Appendix 14

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Acceptable Flood Capacity Assessment
(GHD Pty Ltd)

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Gladstone Area Water Board

Report for Awoonga Saddle Dam No. 3

Acceptable Flood Capacity Assessment

May 2009

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1. Executive Summary

Following a review of the Awoonga Dam AFC Assessment Report by the Department of Natural Resources and Water, GAWB were requested to provide further information for incorporation into the New Dam Safety Condition DS16. This request was related to the incremental flood discharge and extended population at risk resulting from a flood induced failure of Saddle Dam No. 3. Saddle Dam No. 3 had previously been considered an auxiliary spillway, operating without failure.

The additional information required was:

- The extended failure impact zone and the incremental population at risk (Inc PAR) due [to] extreme flood induced failure of Saddle Dam No. 3.
- The revised Acceptable Flood Capacity (AFC) of Saddle Dam No. 3 based on the maximum Incremental Population At Risk (PAR) from flood induced failure of this saddle dam.
- Concept design options and cost estimate to upgrade Saddle Dam No. 3 into a controlled flood discharge structure.
- The total cost estimate to upgrade the current stage of Awoonga Dam to meet the minimum AFC requirements. This would include the potential cost for upgrading of Saddle Dam No. 3 into a controlled flood discharge outlet if required. Depending on the outcome of the analysis, staged upgrading approach could be considered by the Board.

Study Outcome

At the current level of the Saddle Dam 3, the estimated population at risk in the event of a breach is in the order of 600, for which the Acceptable Flood capacity for design of the Saddle Dam 3 is the PMP-Design Flood.

Saddle Dam 3 has a 37% compliance of the AFC, which places it in the Tranche 2 programming for which upgrade works are required by 2015 to provide a a minimum flood discharge capacity of 50% of the AFC.

The AFC upgrade for the Awoonga Saddle Dam 3 has been evaluated using a number of options including:

- RCC capping protection of the existing embankment at RL 47.9m or a raised protection level to 48.5m with likely overtopping AEPs of 1 in 1200 and 1 in 2000 respectively (Option 1);
- Removal of the existing embankment and replacement with a new RCC gravity section with height varying from RL 47.9m to RL 55m (Option 2);
- Removal of the existing embankment and protection of the Saddle surface (Option 2E);
- Provision of a fuse plug section with overtopping sections adjacent to the fuse plug (Option 3);
- A new embankment constructed to RL 55 m (Option 4).

Conclusions

The following conclusions can be made regarding each of the options:

- The options involving RCC capping of the embankment (Option 1), while technically feasible and recent common practice for providing the increased protection of auxiliary embankments such as Saddle Dam 3, are of a similar cost to the replacement RCC gravity structure.
- The Options involving the replacement of the existing embankment with a RCC gravity section (Option 2) will provide a robust solution for the Saddle Dam AFC upgrade with an estimated cost of between $24M to $26M for a height of RL 47.9m and RL 48.5m respectively.
- The lowest cost option for meeting the AFC compliance is the removal of the existing Saddle Dam down to a non erodible surface along the alignment of the existing embankment and protection of the saddle using a concrete/RCC slab (Option 2E - $7.5M). This option will result in a significantly reduced PAR because there is no sudden increase in breach flow resulting from failure of an embankment or concrete gravity section. However, this option will result in more frequent flooding through the saddle dam for which the AEP at which flow commences is about 1 in 100 compared with the other options where the crest level is greater than or equal to the present Saddle Dam level of RL 47.9 m AHD. The impact of this increased frequency of operation on the downstream is under consideration by GAWB and may not be acceptable to the Board.
- The use of fuse plugs (Option 3) for improving the overall performance of the Saddle dam discharge rating does not show any marked improvement over the construction of a RCC gravity structure and the cost estimates are higher than the gravity structure. It is, therefore recommended that this option not be pursued further in the detailed design phase.
- The construction of a new embankment to RL 55 m (Option 4) will result in a significant increase in the PAR in the event of a breach which means that the AFC will be the PMF event for this option. This is acceptable, provided the embankment height is raised to at least the main CFRD level of RL 55.4 m. The increase in cost for an embankment constructed to this height may be in the order of 10% for which the total cost will be about $22M. The flood routing analyses have shown that the PMF will overtop the main CFRD embankment unless provision is made for additional discharge through the Saddle Dam 6 using a 220 m channel excavated to RL 50 m through this saddle. The AEP at which this saddle commences operation is likely to be in the order of 1 in 5000 AEP.
- All of the options provide flexibility for the possible future raising to the ultimate Stage 2B crest level of RL 65.3 m, however, the future raises have not been evaluated as part of the present AFC assessment.
- The use of Saddle Dam 3 or 6 as Auxiliary spillways will result in discharge down the Tucker Creek tributary where the Callide Pipeline crosses at about 1km from the junction with the Boyne river. Analyses completed for the Awoonga Alliance design of the upgrade to FSL 40m and design checks for the present study have shown that the velocities of flow are relatively low in the region of the pipeline varying from about 0.5 m/s for low flows up to between 1.4 m/s to 2.4 m/s for the highest flows (PMP-DF). The variation in flow velocity is due to the uncertainty of the pipeline location along the creek in relation to the sections where the Mike 11 model was used to determine the discharge and velocity data. Similarly, the depths of flow over the pipeline may be between 6.5 and 24m

depending on the flood magnitude, however, the analyses show that the pipeline will not be directly impacted by the tributary flow due to the backwater effect of the flows in the Boyne River. This should be reviewed and additional analyses competed for the final design of the AFC upgrade option to ensure the pipeline is protected.

- We have assumed that as GAWB own the land that would be affected by construction activities no Council approvals will be required. Regulator approval would need to be obtained prior to construction.
- In order to provide complete protection for the full Upgrade to PMF capacity of the Main Dam spillway left abutment non overflow section, which is also deficient, an additional cost of $0.63M will be required for each of the above options.

Recommendations

The following are recommended for the AFC Upgrade:

- Either the replacement RCC gravity structure constructed to RL 48.5 m (Option 2B) at a cost of $25.6M or the complete removal and protection of the saddle against further erosion Option 2E at a cost of $7.5M be used for the AFC upgrade. The raise to RL 48.5 m will provide immunity to about the 1 in 2000 AEP event for flow through the saddle while the removal of the saddle embankment will lower the immunity against flow through the saddle dam to about the 1 in 100 AEP event. The GAWB council will need to be made aware of the impact of this lowered immunity, which would include more frequent erosion in the gully downstream from the saddle dam and resulting deposition of material into the Boyne river. It must be stressed that any of the other options involving the use of the Saddle Dam 3 for an auxiliary spillway will result in similar downstream consequences but with reduced frequency of occurrence.
- An alternative recommendation is the construction of the Embankment Dam (Option 4) at a cost of $22M to provide immunity of flow though the Saddle dam up to the PMF. This option must include the provision of an auxiliary spillway channel through Saddle Dam 6 at EL 50.0 m and should take account of the future raising of the Awoonga Dam, which will be evaluated during the detailed design phase of the AFC Upgrade.
- The location of the Callide pipeline in the Tucker Creek tributary should be identified in the existing Mike 11 model used for evaluating the downstream flows and discharges from the main dam spillway and the Saddle dam auxiliary spillway. Additional cross sections at the pipeline location should then be used to evaluate the depths and discharges with varying flows for the final design of the AFC upgrade option to ensure the pipeline is protected.
- In order to proceed with the design for the proposed AFC upgrades, the geotechnical investigations presented on Table 29 of the present report are considered necessary for each of the options.
- The protection bund at Frost Quarry should be completed as soon as possible by the Quarry owners in order to comply with the AFC requirement for the Quarry (***Frost Quarry responsibility***).

Table 1.1 Assessment Summary

Item	Description
Name of dam	Awoonga Dam
Location of dam	Lot 90, Plan CTN 168
Region	Queensland
Shire	Parish of Riverston in the County of Clinton
Nearest Town	Benarby
Nearest City	Calliope
Stream and AMTD	Boyne River 22.9 km
Name of owner	Gladstone Area Water Board
Owner contact details	Postal address: PO Box 466, Gladstone, 4680 QLD Telephone: 07 4976 300 Facsimile: 07 4972 5632 Email: rwest@gawb.qld.gov.au
Status of dam	Existing
Year construction completed	2001 to raise FSL 40.0 m (Initial construction in 1950's)
Date last Failure Impact Assessment	2009
Maximum population at risk	601
Failure impact rating	Category 2
Hazard Rating	High A
MAIN DAM	
Type of dam	Concrete Faced Rockfill dam with an-gated concrete gravity spillway section.
Height of dam (above lowest D/S toe)	EL 55.4 m
Storage Volume	777,000 ML at FSL
Catchment area	2,230 km^2
Spillway description	◗ Un-gated concrete gravity spillway ◗ Crest at EL 40.0m ◗ Crest length 110.95m

Item	Description
Discharge capacity at the dam crest	20,900 m^3/s
Spillway operating rules	None
SADDLE DAM No. 3	
Type of dam	Miscellaneous Fill Embankment
Height of dam (above lowest D/S toe)	3m (maximum)
Spillway description	Broad-crest weir formed by road
Discharge capacity at the dam crest	N/A
Spillway operating rules	Free overflow
AEP of dam crest flood	1 in 1200
Acceptable Flood Capacity (AFC)	PMP-DF
AEP of the AFC	1 in 450,000
Spillway design flood	PMP-DF
Current spillway capacity	1 in 2000 before potential breach failure by overtopping

2. Background

Following a review of the Awoonga Dam AFC Assessment Report by the Department of Natural Resources and Water, GAWB were requested to provide further information for incorporation into the New Dam Safety Condition DS16. This request was related to the incremental flood discharge and extended population at risk resulting from a flood induced failure of Saddle Dam No. 3. Saddle Dam No. 3 had previously been considered an auxiliary spillway, operating without failure.

The additional information required was:

- The extended failure impact zone and the incremental population at risk (Inc PAR) due [to] extreme flood induced failure of Saddle Dam No. 3.
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3. Available Information and Level Datum

A number of existing reports were available for this study, those of particular relevance included:

- Awoonga Dam Raising Spillway Crest EL 40.0m Design Report (Awoonga Alliance, 2002);
- Awoonga Dam Boyne River Dam Break and Flood Modelling Study (Sunwater, 2003);
- Awoonga Dam Design Flood Hydrology Report (Sunwater, 2008);
- Awoonga Dam Spillway Crest FSL 40.0m AHD, Dam Crest EL 55.40m AHD, Data Book (GHD, 2008); Design drawings accompany the Data Book including a plan of the dam and cross sections of the main dam embankment and spillway, and the Saddle Dam No. 3 embankment;
- Acceptable Flood capacity Study Awoonga Dam Gladstone Area Water Board, Connell Wagner, 20 October 2008. This report includes plans from the State Water Projects Awoonga Dam Raising Engineering Feasibility Studies showing the location of the various Saddle dams along the northern side of the Awoonga reservoir, including Saddle Dam No 3 and 6.

Copies of selected drawings are reproduced in Appendix A.

GAWB provided a range of GIS data to facilitate the assessment. This data included:

- Digital Cadastre Database (DCDB);
- Aerial imagery; and,
- One metre contour coverage.

Sunwater prepared an URBS hydrology model as part of their Awoonga Dam Design Flood Hydrology Study (Sunwater, 2008). This model was calibrated to a number of historical flood events and was used by Sunwater to simulate design flood event hydrographs from the Boyne River catchment and flood routing through Awoonga Dam based on the most recent design rainfall totals for large to extreme flood events.

Sunwater also prepared an unsteady flow hydraulic model of the Boyne River downstream of Awoonga Dam that included its major tributaries. This model was established with the intent of determining the 1 in 100 AEP flood line for the Boyne River and to determine the dam break flood line for potential failures of the main embankment of the dam.

Copies of the reports, models, and model outputs relating to the hydrology model and the hydraulic models model were made available for this study.

The level datum used throughout the project is Australian Height Datum (AHD).

4. Description of Dam and General Information

This section provides details and characteristics about Awoonga Dam, Awoonga Saddle Dam No. 3 and Awoonga Saddle Dam No 6, including ownership and geometry. Design drawings for Awoonga Dam and Saddle Dam No. 3 are provided in Appendix A. The information for Awoonga Saddle Dam No. 3 is drawn from the Dam Data Book (GHD, 2008), while the Awoonga Saddle Dam details were abstracted from the AFC report (Connell Wagner 2008) and the available one metre contour survey.

4.1 Dam Details

Name of dam:	Awoonga Dam
Owner of dam:	Gladstone Area Water Board
Status of dam:	Existing
Property description:	Lot 90, Plan CTN 168, Parish of Riverston in the County of Clinton and city of Calliope
Construction Completed:	2001 to raise to FSL 40.0m (initial construction in 1950s)

4.2 Dam Characteristics

Description	Value
GENERAL	
Dam Type	Concrete faced rockfill dam with an un-gated concrete gravity spillway section.
Purpose	Water supply
Catchment Area	2,230 km^2
Catchment description	Forest reserves and natural vegetation
Full Supply Level (FSL)	RL 40.0m
Storage at Spillway Crest Level	777,000 ML
Inundation Area at FSL	6,780 ha
Total Dam Length	828m
Dam Embankment Length	658m
Crest Level – non-spillway, left abutment	RL 52.0m

Crest Level – embankment	RL 55.4m
Crest Level – R/H Spillway Retaining Wall	RL 55.4m
Crest Width – Embankment	6m
Embankment Slopes	1.3H : 1V
Spillway Height above Lowest Foundation	17.5 m
Embankment Height Above River Bed	53.0m
SPILLWAY	
Spillway Type	Un-gated concrete gravity ogee spillway
Spillway Crest Level	RL 40.0m
Spillway Crest Length	110.95m
Approach Channel	120m – width of spillway EL 25m – floor level
Energy Dissipation Method	Modified Hydraulic Jump Type
Design Head	Unknown
Control Description	None
SADDLE DAM No. 3	
Crest Level	RL 47.9m
Natural Ground level	RL 45.0m Lowest level
Crest Length	380m
Embankment Slopes	1V:4H Upstream, and 1V:2H Downstream
Embankment Slope Protection	Grass on upstream and downstream slopes
Embankment Height above Natural Surface	2.9m (maximum)
Embankment Height Above Bed Rock	5m along the general foundation area to 15m at a known sheared zoned investigated during the Awoonga Alliance design for the FSL raise to RL 40m using Borehole DD3

OUTLET WORKS	
Intake Tower	Dry tower reinforced concrete with bridge access from the main wall
Auxiliary Intake Tower	Wet Intake tower in the left abutment of the main dam with access from the embankment dam crest
Provision for Selective Withdrawal	Baulk stack with open baulks at optimum level
Outlet Conduit	2200 mm diameter cement lined steel pipe
Length of Outlet Conduit	191m
Outlet Guard Valve	2200 mm diameter butterfly valve
Bulkhead Gate	3776 mm wide by 3728 mm high mild steel baulk (5 tonnes mass)

5. Flood Hydrology

5.1 Height-Volume-Discharge Relationship

The height-discharge relationship for Awoonga Dam was reviewed for this study as there was some uncertainty about the flow through the proposed Saddle Dam No. 6 location.

A height-discharge relationship was established as part of the dam design for the raising of the full supply level to RL 40.0 m AHD which was subsequently used in the most recent Awoonga Dam Design Flood Hydrology Report (Sunwater, 2008). The Sunwater report makes reference to a drawing that was produced as part of the Awoonga Alliance Dam Design Report of 2002 as the source of the rating curve, however that drawing could not be located.

An independent assessment of the rating for this study concluded that the coefficient of discharge for the ogee spillway was 1.84, which seems to be quite low compared to a typical value of 2.1. A lower coefficient is not unusual where the depth of approach is quite shallow, which was the case when the full supply level of the dam was RL 30.0m. It is understood that the original rating for a FSL RL of 30.0m was based on a physical model, it is not know whether the coefficient of discharge derived from the model results were applied to the design for the raising of Awoonga Dam to RL 40.0m.

The estimated coefficient of discharge for the auxiliary spillway (Saddle Dam No. 3) was also estimated to be 1.84. There are a number of proposed saddle dams identified for future raises of the Awoonga Dam (see Appendix A, Drawing A3-213923) and Saddle Dam No. 6 is of significance as the natural surface level in this saddle is around 51m. The lowest natural surface level for all the other future saddle dam locations is at least RL 56m. It appears from the rating review for this study that the flow through the natural saddle at the future Saddle Dam No. 6 site has not been included.

For the purposes of this study, the spillway rating curve has been updated to incorporate the estimated flow through the proposed Saddle Dam No. 6 location while retaining the existing rating for the main spillway and Saddle Dam No. 3. The adopted height-discharge-volume relationship for Awoonga Dam is listed in Table 2. This table shows the relative contributions of the Main Spillway, Saddle Dam No. 3, and the existing natural saddle at the location of the proposed future Saddle Dam No. 6 that is based on the coefficients of discharge of 1.84 for the Main Spillway and Saddle Dam No. 3 with their respective crest lengths of 110.95 m and 380 m.

The adopted height-discharge relationship is plotted on Figure 5-1 and the height-volume relationship is plotted on Figure 5-2.

Table 2 Awoonga Dam Height-Discharge-Volume Relation for Existing Arrangement

Level (m AHD)	Main Spillway		Saddle Dam No. 3		Natural Saddle at Saddle Dam No. 6		Total Flow (m^3/s)	Volume (ML) Above FSL
	Head (m)	Flow (m^3/s)	Head (m)	Flow (m^3/s)	Head (m)	Flow (m^3/s)		
40	0	0	-	-	-	-	0	0
41	1	188	-	-	-	-	188	69,792
42	2	546	-	-	-	-	546	143,610
43	3	1,014	-	-	-	-	1,014	221,815
44	4	1,599	-	-	-	-	1,599	304,898
45	5	2,262	-	-	-	-	2,262	393,251
46	6	3,008	-	-	-	-	3,008	486,754
47	7	3,833	-	-	-	-	3,833	585,581
47.9	7.9	4,596	0	0	-	-	4,596	679,124
48	8	4,619	0.1	22	-	-	4,641	689,518
49	9	5,512	1.1	807	-	-	6,319	798,855
50	10	6,456	2.1	2,128	-	-	8,584	914,002
51	11	7,448	3.1	3,816	0	0	11,264	1,034,612
52	12	8,486	4.1	5,805	1	90	14,381	1,161,243
53	13	9,569	5.1	8,053	2	285	17,907	1,294,346
54	14	10,694	6.1	10,534	3	694	21,922	1,433,441
55	15	11,860	7.1	13,228	4	1,295	26,383	1,578,488
56	16	13,065	8.1	16,119	5	1,649	30,833	1,729,459

Note: Main spillway flows up to and including 47.9 metres are based on the rating curve used in the Awoonga Dam Design Flood Hydrology Report (Sunwater, 2008).

Figure 5-1 Adopted Height-Discharge Relationship for Awoonga Dam

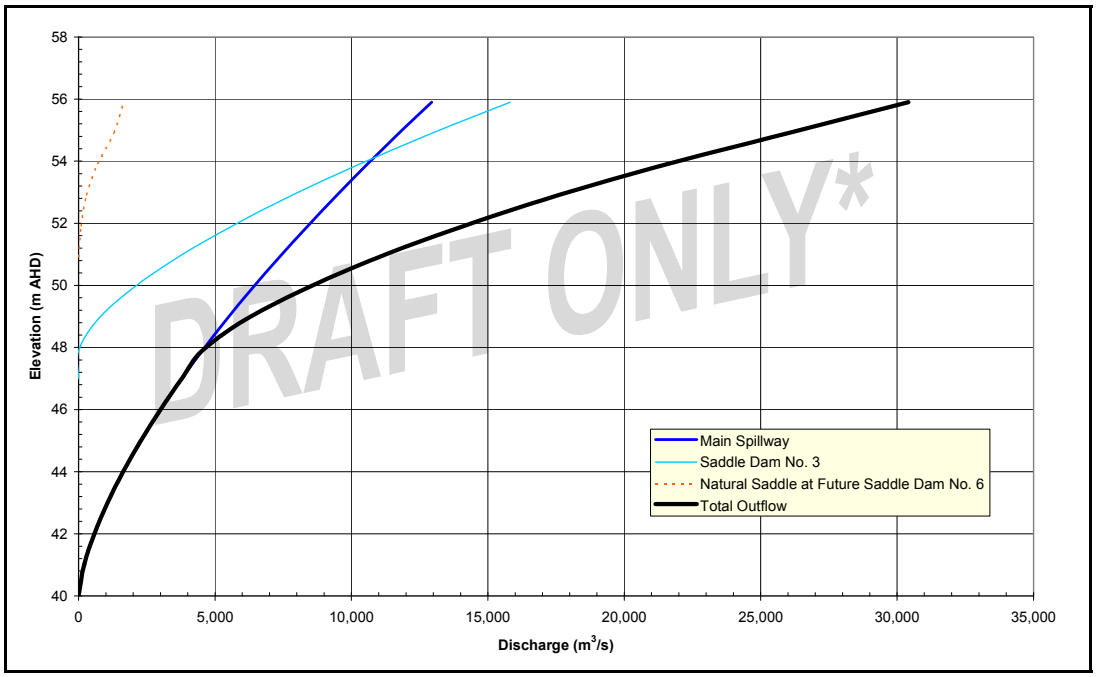
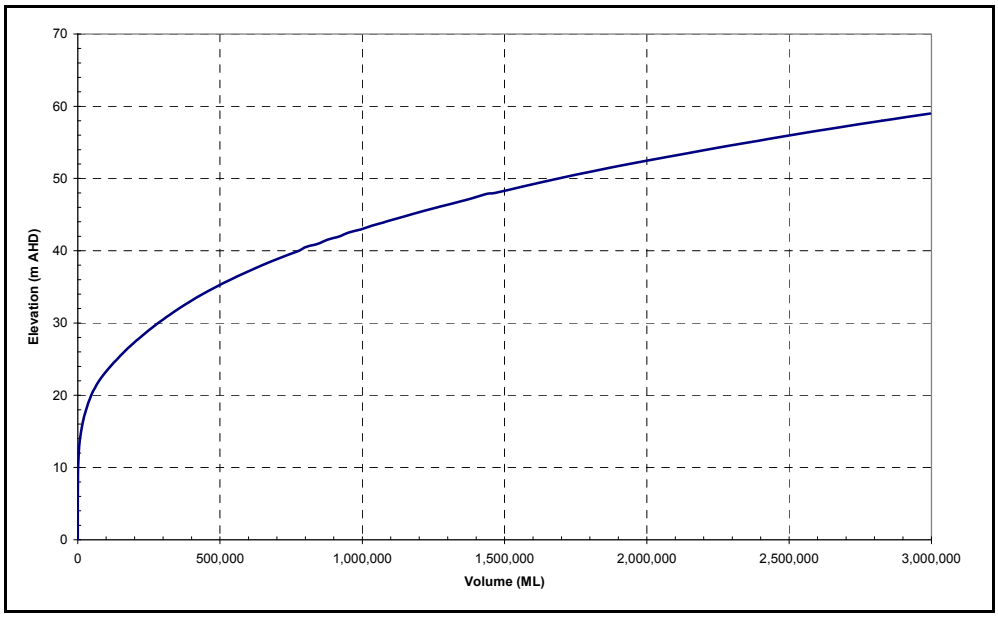


Figure 5-2 Adopted Height-Volume Relationship for Awoonga Dam



5.2 Previous Hydrological Assessment

A flood hydrology model of the Awoonga Dam catchment was previously created by Sunwater (2008) and catchment subdivision adopted is reproduced in Appendix B. This model was calibrated to eight

historical floods, and the calibrated model was then used to estimate design inflows to, and outflows from, the Awoonga Dam. The design event Annual Exceedance Probability (AEP) range was from 1 in 2 to the 1 in 200,000 event. The Probable Maximum Precipitation Design Flood (PMP-DF) was also assessed, and the AEP of this event was estimated to be 1 in 450,000. Storm durations from 12 hours to 120 hours were simulated to estimate the critical storm durations and peak water levels in the dam for each AEP. In conducting these simulations the dam was assumed to be initially full at the commencement of each flood event simulation.

5.2.1 Flood Definitions

PMP-DF

In recent years the term Probable Maximum Precipitation-Design Flood (PMP-DF) has been introduced as being the flood derived from the Probable Maximum Precipitation (PMP) event under Annual Exceedance Probability (AEP) neutral conditions. That is, under the assumptions where the AEP of the flood is the same as that of the rainfall that caused it (Nathan et al, 2002).

Nathan et al (2002) nominates the inputs most commonly requiring special consideration with respect to AEP neutrality as rainfall losses and initial storage level. The design objective is to select values that are most likely to occur. Temporal patterns are another important factor that impacts on AEP neutrality and Australian Rainfall and Runoff Guideline (IEAust, 1999) advises the use of design patterns provided by the Commonwealth Bureau of Meteorology which are the Average Variability Method (AVM) temporal patterns from the GTSMR are applied to determine the PMP-DF.

Therefore, combining PMP rainfalls with the AVM temporal pattern and typical loss parameters through a hydrological model should yield the PMP-DF.

PMF

The Probable Maximum Flood (PMF) is defined as the limiting value of flood that could reasonably be expected to occur. While it is possible to estimate an upper limiting value of flood magnitude, it is not possible at present to assign an AEP to this event. In practice, the magnitude of the PMF will be greater than the magnitude of the PMP-DF, but its AEP will be smaller (IEAust, 1999).

With regard to losses, losses should be equal to, or possibly a little less than the minimum value in large floods observed on a catchment. In all cases, losses are likely to be low, in many regions of Australia an initial loss of zero and a continuing loss rate of 1 mm/hr (IEAust, 1999).

Temporal patterns provided with generalised PMP methods could be used, however, more severe patterns may be adopted. In doing so, re-arrangement of patterns to give the highest possible flood peak is at variance with the objective of deriving a limiting value of flood that could reasonably occur (IEAust, 1999).

The GTSMR supplies the top 10 historic temporal patterns for the relevant standard area and duration. Notionally, five of the top ten historical temporal patterns should produce floods that are smaller than the PMP-DF (Green et al, 2005).

Common practice is to adopt the historic temporal pattern that yields the largest peak outflow from the

Dam represents the PMF event.

5.2.2 Design Flood Event Results

A summary of the peak inflow rates into Awoonga Dam is given in Table 3, while the peak outflow rates are summarised in Table 4 for large to extreme floods. The flood frequency plot of peak water levels in Awoonga Dam is shown in Figure 5-3 and for peak inflows and outflows in Figure 5-4.

These results indicate that the Dam Crest Flood (DCF) AEP is approximately 1 in 1,200. This is the flood where the peak water level reaches the Saddle Dam No. 3 embankment crest.

Table 3 Awoonga Dam Peak Inflow Results (Sunwater, 2008)

AEP (1 in Y)	Critical Storm Duration (Hours)	Time to Peak Inflow (Hour)	Peak Inflow Rate (m^3/s)	Runoff Volume (ML)
50	18	19	4,570	428,000
100	18	18	5,610	521,000
500	18	19	8,240	741,000
1,000	18	19	9,600	852,000
2,000	18	19	11,100	974,000
5,000	18	20	13,400	1,153,000
10,000	18	20	15,400	1,300,000
20,000	18	20	17,500	1,454,000
50,000	18	20	20,500	1,669,000
100,000	24	20	22,900	1,837,000
200,000	24	23	25,800	2,295,000
450,000	24	23	29,100	2,534,000

Table 4 Awoonga Dam Peak Outflow Results (Sunwater, 2008)

AEP (1 in Y)	Peak Inflow (m^3/s)	Time of Peak Inflow (Hours)	Peak Outflow (m^3/s)	Time of Peak Outflow (Hours)	Peak Water Level (m)	Critical Duration (Hours)
50	4,000	40	1,960	69	44.54	72
100	4,840	40	2,460	69	45.26	72
500	6,840	41	3,770	54	46.93	48
1,000	7,850	41	4,520	54	47.81	48
2,000	8,900	41	5,440	54	48.41	48
5,000	10,600	41	7,130	53	49.32	48
10,000	11,900	42	8,540	52	49.96	48
20,000	13,400	42	10,110	52	50.58	48
50,000	17,800	32	12,400	42	51.42	36
100,000	20,000	32	14,300	42	52.06	36
200,000	22,300	31	16,400	42	52.69	36
450,000	25,200	31	18,900	41	53.43	36

Figure 5-3 Awoonga Dam Peak Water Level Flood Frequency Plot (Sunwater, 2008)

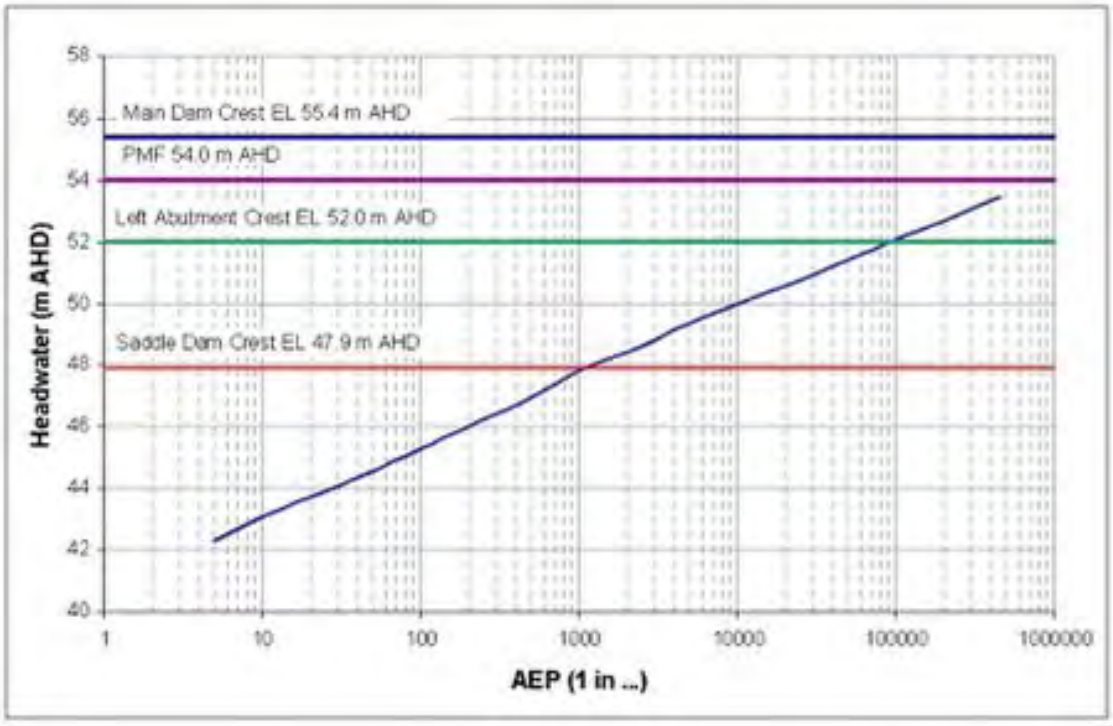
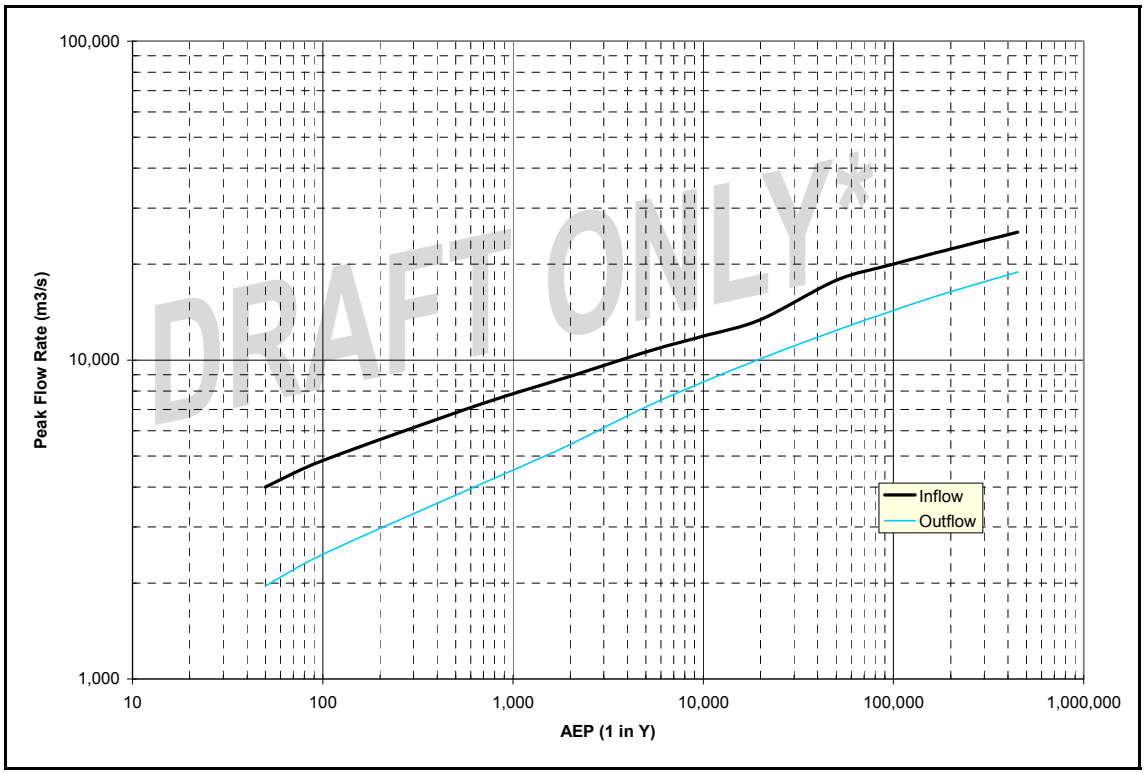


Figure 5-4 Awoonga Dam Discharge Frequency Plot



5.2.3 Probable Maximum Flood Estimate

As part of the Awoonga Dam Design Flood Hydrology study, Sunwater investigated the Probable Maximum Flood (PMF). Details on the investigation are summarised below.

The AVM temporal pattern for the coastal region, as determined by the Bureau of Meteorology (BoM), was used as the definitive storm pattern to produce the extreme flood events. This AVM pattern is selected to maintain the AEP neutrality in the resultant flood estimates.

However, this pattern is the result of averaging the 10 largest storms for each standard duration and for each zone. As there are uncertainties involved in the use of a single design temporal pattern, the 10 individual storm patterns have also been analysed for the critical duration storm event for the 36 hour PMP. This allows the suitability of the AVM temporal pattern to be assessed.

The highest peak inflow occurs in Storm No 3, the February 1954 flood, and was estimated to be 32,200 m^3/s.

Table 5 compares the peak outflows and levels of the 10 different storms with the results obtained from the AVM design temporal pattern. Storm No 3, based on the February 1954 temporal pattern, produced the highest peak outflow of 20,800 m^3/s during the 36 hour duration event and this is considered to be the PMF.

Table 5 Awoonga Dam, Probable Maximum Flow Outflow Results (Sunwater, 2008)

Storm Pattern Number	Storm Pattern Name	Peak Outflow (m^3/s)	Variation from AVM Outflow (%)	Peak Water Level (m AHD)
AVM	AVM	18,900	0	53.43
1	1893FEB03-1	17,900	-5	53.16
2	1898APR03-2	20,400	8	53.87
3	**1954FEB21-1**	**20,800**	**10**	**53.99**
4	1955FEB25-2	17,700	-6	53.09
5	1956JAN22-2	19,600	4	53.63
6	1963APR16-4	19,500	3	53.61
7	1974JAN09-3	18,700	-1	53.38
8	1974JAN27-2	17,700	-6	53.1
9	1974MAR13-4	17,800	-6	53.13
10	1989MAR14-1	19,500	3	53.61

5.3 Updated Flood Routing for AFC Options

During a workshop held in Gladstone on 2nd April 2006, the following options were considered for passing the AFC for the Saddle dam:

- RCC capping protection of the existing embankment at RL 47.9m or a raised protection level to 48.5m with likely overtopping AEPs of 1 in 1200 and 1 in 2000 respectively (Option 1);
- Removal of the existing embankment and replacement with a new RCC gravity section with height varying from RL 47.9m to RL 55m (Option 2);
- Removal of the existing embankment and protection of the Saddle surface – This option was not included in the workshop but was evaluated as part of the present study (Option 2E);
- Provision of a fuse plug section with overtopping sections adjacent to the fuse plug (Option 3);
- A new embankment constructed to RL 55 m (Option 4).

The floodrouting for each of these options is discussed below.

5.3.1 Existing Saddle Dam Embankment (EL 47.9m)

The previous flood routing used the rating curve that probably excluded the flow through the existing natural saddle at the location of the future Saddle Dam No. 6, which has a level of about RL 51m at the lowest point. Therefore, the design flood routing results where the peak water level exceeds the natural saddle invert of 51m AHD are likely to be slightly different for floods with an AEP smaller than 1 in

20,000.

Flood routing was conducted for the PMP-DF and PMF event, and for a number of scaled PMP-DF inflow hydrographs. The purpose of this analysis was to identify possible upgrade options that may exist for Awoonga Dam to meet with the objects of the AFC guidelines. The results of this analysis are shown in Table 6 and are all based on the 36 hour inflow hydrograph for both the PMP-DF and the PMF.

The result for the PMF indicates that the peak water level decreases by about 0.1 metres when flow across the existing natural saddle at the site of the future Saddle Dam No. 6 is taken into account. The difference is smaller for the PMP-DF.

Table 6 Flood Routing Results for AFC of the Existing Dam Crest EL 47.9m (36 hr Storm Duration)

Design Flood Event	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Peak Water Level
PMF	32,200	21,900	53.9
PMP-DF	25,200	19,600	53.3
67% of PMP-DF	16,900	11,500	51.1
60% of PMP-DF	15,100	9,800	50.4
37% of PMP-DF	9,300	4,600	47.9
20% of PMP-DF	5,200	2,300	45.0

5.3.2 Raising Saddle Dam No. 3

Flood routing was performed for the PMP-DF assuming a raising of Saddle Dam No. 3 to a crest level of between 51.1 m and 55.0 m and the results are shown in Table 7. Raising the embankment crest to a level of 51.1 m resulted in a peak water level that is approximately 0.8 metres below the main dam embankment. A raise to an elevation of 53.0 m is likely to result in a peak water level that is about 0.3 metres below the main dam embankment. These results allow for flow through the natural saddle at the future Saddle Dam No. 6 location.

Table 7 PMP-DF Flood Routing Results for Options to Raise Saddle Dam No. 3

Saddle Dam No. 3 Crest Level (m)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Peak Water Level (m)	Assumed Crest Length for Saddle dam overflow (m)
51.1	25,200	17,300	54.6	380
52.0	25,200	16,800	54.8	430
53.0	25,200	16,000	55.1	475

Saddle Dam No. 3 Crest Level (m)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Peak Water Level (m)	Assumed Crest Length for Saddle dam overflow (m)
54.0	25,200	15,100	55.3	520
55.0	25,200	14,200	55.5	570
>=55.0	25,200	13,900	55.5	0*

* not allowing any flow over Saddle Dam No. 3 embankment

Raising the Saddle Dam No. 3 embankment crest to an elevation of 55.0 m is likely to result in a peak water level that overtops the main dam embankment. Additional simulations were, therefore, conducted where a channel was constructed through the natural saddle at the site of the future Saddle Dam No. 6. In order to yield a peak water level of 55.0 m, so that there is no flow over the main dam embankment or the Saddle Dam No. 6 embankment, a channel section with the following dimensions was needed:

- Invert level of 50 m (an excavation of about 1 metre below the saddle invert)
- base width of approximately 220 m,
- side slopes of 10H:1V.

The estimated peak water level for this arrangement is 55.0m for a peak inflow rate of 25,200 m^3/s to yield a peak outflow rate of 15,800 m^3/s.

An alternative arrangement to raising Saddle Dam No. 3 embankment crest to 55 m was to increase it to RL 53.0 m, and include a channel section through the natural saddle that has the following dimensions:

- an invert of RL 50.0 m
- a base width of 150 m,
- side slopes of 10H:1V.

5.3.3 Fuse Plug Spillway

A fuse plug option has been analysed assuming the following:

- Fuse plug width 25 m
- Non of Bays 4
- Rate of erosion 70 m/hr
- Base Elevation 43 m
- Crest Elevation for breach commencement 47.0m with 0.5m incremental level for each bay

The following crest levels were used for the section adjacent to the fuse plugs.

Dam Crest Elevation	Type of Section adjacent to Fuse Plug
◗ 47.9m	RCC overtopping protection of existing embankment or New RCC Gravity Section
◗ 51.1m	New RCC Gravity Section
◗ 55.0m	Non overtopping Embankment or New RCC Gravity Section

The fuse plug model was run using the PMP-DF 36hr and 48hr storm duration events resulting in the output data shown on Table 8.

Table 8 Fuse Plug Floodrouting Results

Dam Crest level Adjacent to Fuse Section (m AHD)	Peak Reservoir Level (m AHD)	Peak Inflow (m^3/s)	Outflows (m^3/s)			
			Total	Main Spillway	Fuseplug	Saddle Dam
36 hr PMP-DF Storm Duration						
47.9	52.54	25241	20380	9266	4125	6988
51.1	53.64	25241	18511	10830	4856	2824
55.0	54.08	25241	16701	11535	5166	0
48 hr PMP-DF Storm Duration						
47.9	52.29	21345	19322	8940	3961	6420
51.1	53.55	21345	18166	10694	4796	2677
55.0	54.07	21345	16671	11514	5157	0

6. Dam Break Analysis

This section describes the breach model and breach modelling scenarios used in this study to determine the AFC requirements and to evaluate the various upgrade options.

6.1 Breach Model

The estimation of the breach hydrographs was performed using GHD's in-house breach development spreadsheet routine, which is generally based on the methodology outlined in Section 4.7.4 of DNRM (2002) and Fread (1988). This method uses the following data to produce the outflow hydrograph taking into account the development of the breach with time:

Sunny Day Failure

- Dam geometry;
- Storage capacity curve; and
- Assumed level for initiation of piping.

Flood Failure

- Dam geometry;
- Storage capacity curve;
- Inflow hydrograph;
- Spillway rating curve; and,
- Level for initiation of failure.

For each of the breach scenarios, the corresponding "No Breach" flood was calculated to evaluate the incremental flood impacts. In the case of the existing embankment, it was assumed that the breach would initiate when the embankment was overtopped by 100 mm while for the RCC upgrade options, it was assumed that the section would fail at the peak water level for the flood being routed through the dam.

6.2 Breach Scenarios

Breach scenarios were investigated taking into account the likely downstream concurrent flows in accordance with the FIA Guidelines (DNRM, 2002). For floods over a dam that have an AEP between 1 in 1,000 and 1 in 10,000, the downstream flood AEP to consider is 1,000 times greater. That is, for a 1 in 2,000 AEP event over the dam, the downstream flood AEP to adopt is 1 in 2. For those flood events with an AEP of smaller than 1 in 10,000 over a dam, the downstream flood AEP is limited to 1 in 100.

With respect to estimating the Population at Risk (PAR), the greatest PAR coincides with the greatest incremental impact of flooding. This is likely to happen when there is a significant flood event in the catchment to the dam and negligible or minor flow in the watercourse and tributaries downstream of the dam.

The following overtopping failure events were, therefore, investigated for this study to determine the AFC of the existing Saddle Dam 3 embankment:

- 1 in 2,000 AEP Overtopping Failure

- 1 in 5,000 AEP Overtopping Failure
- 1 in 10,000 AEP Overtopping Failure
- 1 in 20,000 AEP Overtopping Failure

Breach estimates were made for the following Awoonga Dam AFC options:

- RCC Embankment with a Crest Level of 47.9m
- RCC Embankment with a Crest Level of 51.1m
- RCC Embankment with a Crest Level of 55.0m

6.3 Breach Modelling Assumptions

6.3.1 Breach Foundation Level

One of the key parameters for Awoonga Saddle Dam No. 3 is the likely final breach base level. During the design for raising the dam to its current FSL of 40.0 m AHD (Stage II), a preliminary geotechnical investigation was made. The investigation consisted of seismic sections, dozer trenches and one diamond drill hole (DD3) in an area where weathering was deepest. It was found that in general the foundations would resist deep scour on overflow, and the dozer trenching reached non-erodible, slightly weathered rock of high strength over a large part of the saddle length (Awoonga Alliance, 2002). The Awoonga Alliance reached the conclusion that scour occurring as a consequence of large overflows is expected to be limited to 2 metres or less.

The lowest natural surface level at the toe of the Saddle Dam No. 3 embankment is around 45 m AHD. Therefore, the adopted breach base level for this study was 43 m AHD.

6.3.2 Breach Extent

Given the Saddle Dam No. 3 embankment is not a structure that holds back water during non-flood events, the breach size is not likely to conform to typical breach sizes associated with failures of main dam embankments. For this study, it was assumed that most of the embankment, if not all of the embankment would potentially erode away during an overtopping flood event.

Existing Embankment

A range in potential embankment failure extents was considered. In the case of the existing Saddle Dam No. 3, there is a natural divide between the western and eastern halves of the embankment and a partial and entire embankment failure was, therefore, assessed with the breach geometry determined as a function of the volume of material lost. For a partial embankment failure the volume of material lost was assumed to be 16,800 m^3 (one side of the saddle eroded) and for the full embankment failure, the volume of material lost was assumed to be 31,000 m^3.

RCC Upgrade Options for AFC

With the RCC option of an embankment crest level of 47.9m, two breach lengths of 54 m and 90 m were considered to reflect the plausible length of the concrete section that could fail during a flood event.

Breach estimates were made for a range of AEP events from the 1 in 2,000 event to the 1 in 100,000 AEP event and the PMP-DF.

For the RCC Option of an embankment crest level of 51.1m, the two breach lengths of 100m and 150m were considered to reflect the plausible length of the concrete section that could fail during a flood event. Breach estimates were made for the 1 in 20,000 and 1 in 100,000 AEP events and the PMP-DF.

As the existing hydraulic model does not contain any 36 hour storm duration hydrographs, the analyses were based on the 48 hour storm duration.

6.4 Breach Results

6.4.1 Existing Embankment

The breach results for the partial embankment failure and the full embankment failure scenarios of the existing embankment are provided below.

Partial Embankment Failure Existing Saddle Dam

The breach results are presented in Table 9 for the partial embankment failure (volume of material lost approximately 16,800 m^3). This table lists the flow through the main spillway, through the breach, the total outflow through the saddle dam embankment area, and the entire outflow from the dam (combining main spillway flow and saddle dam embankment area flow).

Table 9 Estimated Awoonga Saddle Dam No. 3 Breach Results for Partial Embankment Failure with Crest Level RL 47.9m

AEP Event	Peak Inflow (m^3/s)	Peak WL (m)	Spillway Flow (m^3/s)	Saddle Dam Breach Flow (m^3/s)	Overtopping Flow (m^3/s)	Total Saddle Dam Outflow (m^3/s)	Total Outflow (m^3/s)
1 in 2,000	8,920	48.11	4,720	3,250	70	3,320	8,040
1 in 5,000	10,520	48.52	5,090	3,650	340	3,990	9,080
1 in 10,000	11,850	48.95	5,470	4,090	750	4,840	10,310
1 in 20,000	13,330	49.40	5,890	4,570	1,290	5,860	11,750

Table 10 Estimated Awoonga Saddle Dam No. 3 Flood Routing Results for No Embankment Failure with Crest Level RL 47.9m

AEP Event	Spillway Flow (m^3/s)	Saddle Dam No Breach Flow (m^3/s)	Total Flow (m^3/s)	Peak Water Level (m)
1 in 2,000	4,990	270	5,260	48.41
1 in 5,000	5,820	1,200	7,020	49.32
1 in 10,000	6,440	2,100	8,540	49.96
1 in 20,000	7,050	3,110	10,160	50.58

For all the AEP events considered, the estimated breach base width and breach top width was 174 m and 179 m respectively with a breach depth of 4.9 m. This yields a breach side slope of 0.5H:1V. The breach development time was 1.2 hours.

The increase in peak outflow was found to be the greatest for the 1 in 2,000 AEP event with an increase of approximately 2,800 m^3/s. The relative increase in peak outflow decreases with increasing flood magnitude. For the 1 in 20,000 AEP event, the incremental increase in peak outflow is around 1,600 m^3/s.

The hydrograph plots for the 1 in 2,000, 1 in 5,000, 1 in 10, 000, and 1 in 20,000 AEP scenarios are shown in Figure 6-1, Figure 6-2, Figure 6-3, and Figure 6-4 respectively. These plots show the estimated flow hydrograph for the main spillway, across the saddle dam embankment, and the breach hydrograph component as well as the simulated water level trace.

Figure 6-1 Partial Failure Breach Hydrograph, 1 in 2,000 AEP Flood Event

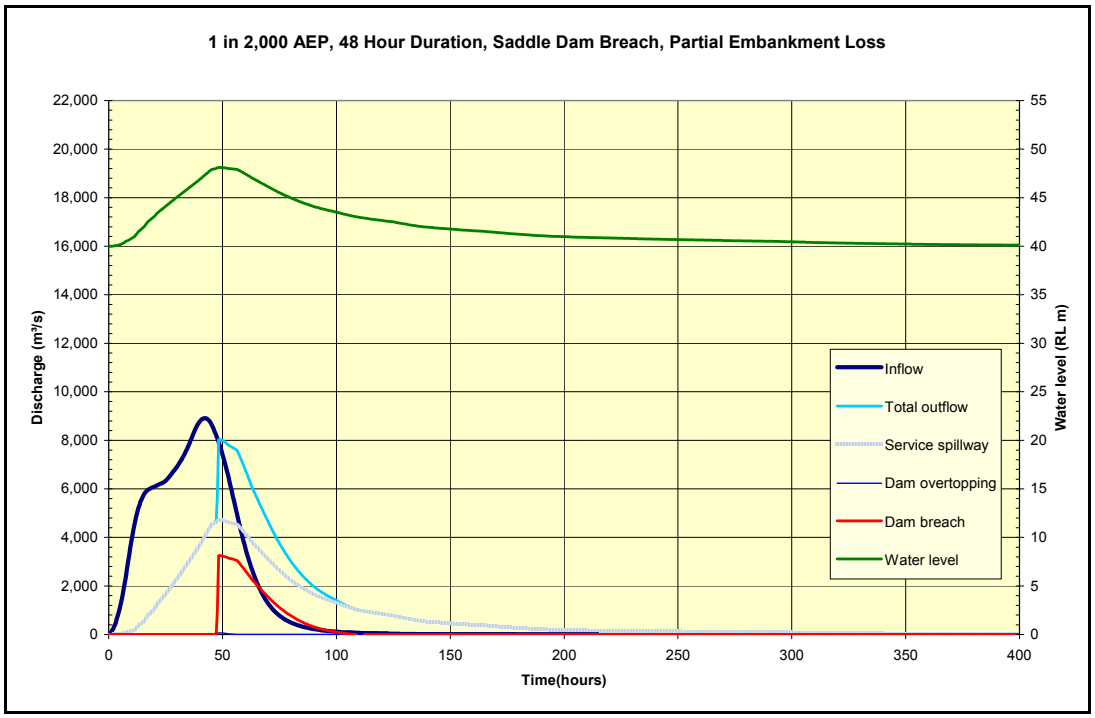


Figure 6-2 Partial Failure Estimated Breach Hydrograph, 1 in 5,000 AEP Flood Event

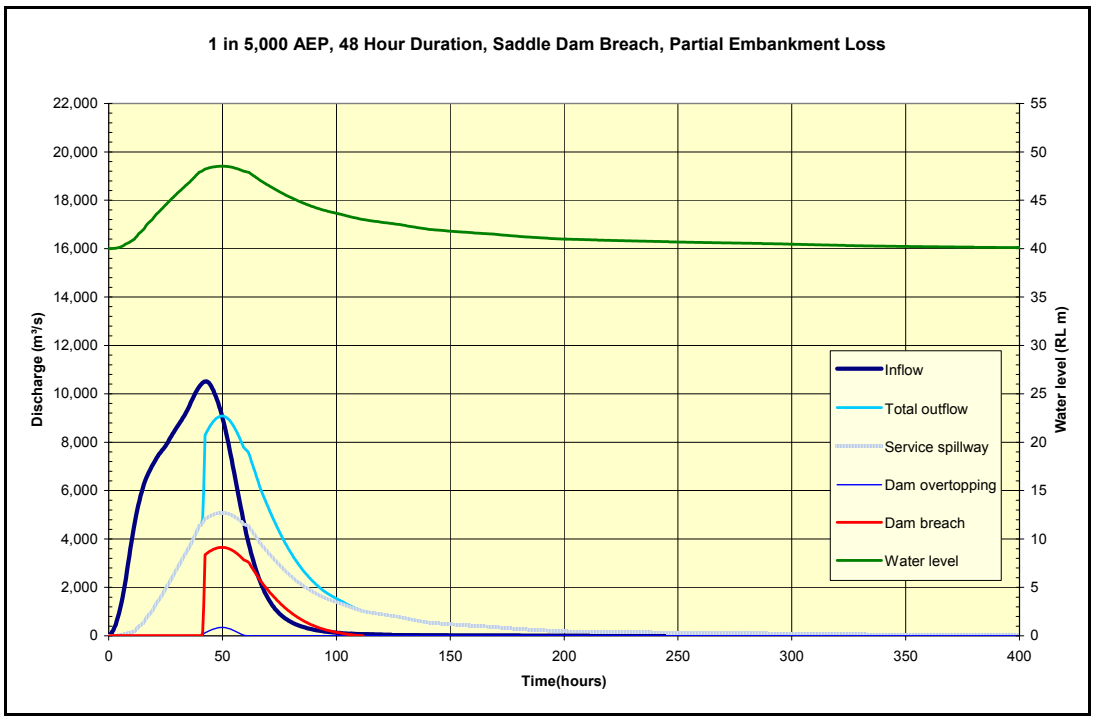


Figure 6-3 Partial Failure Estimated Breach Hydrograph, 1 in 10,000 AEP Flood Event

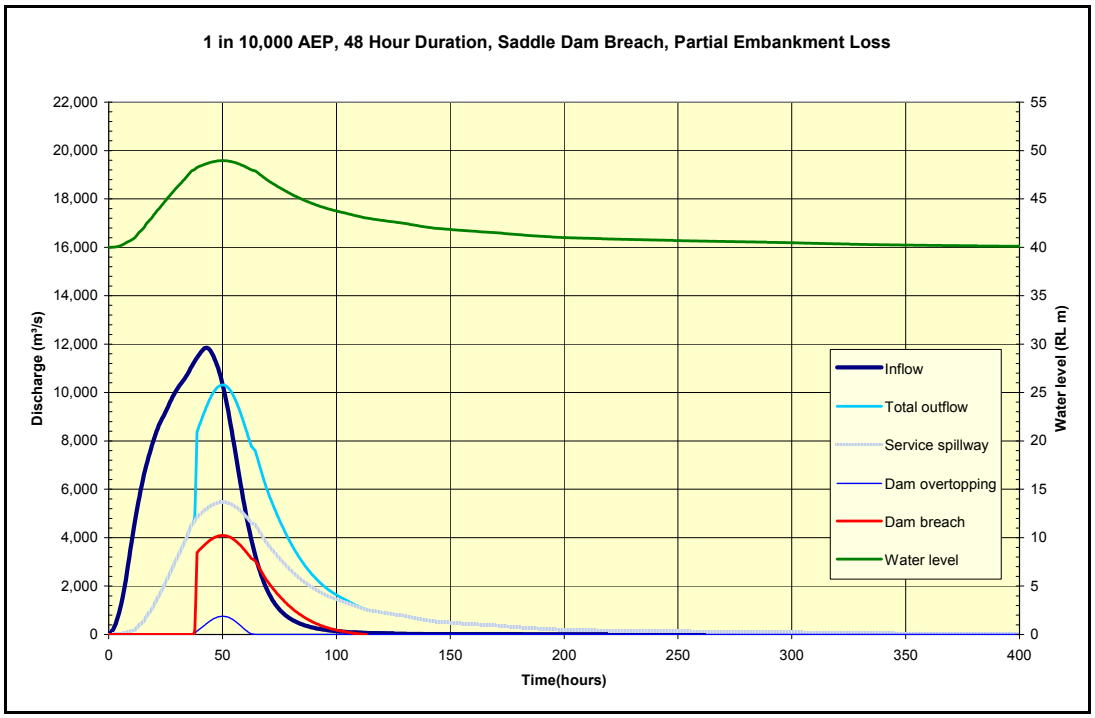
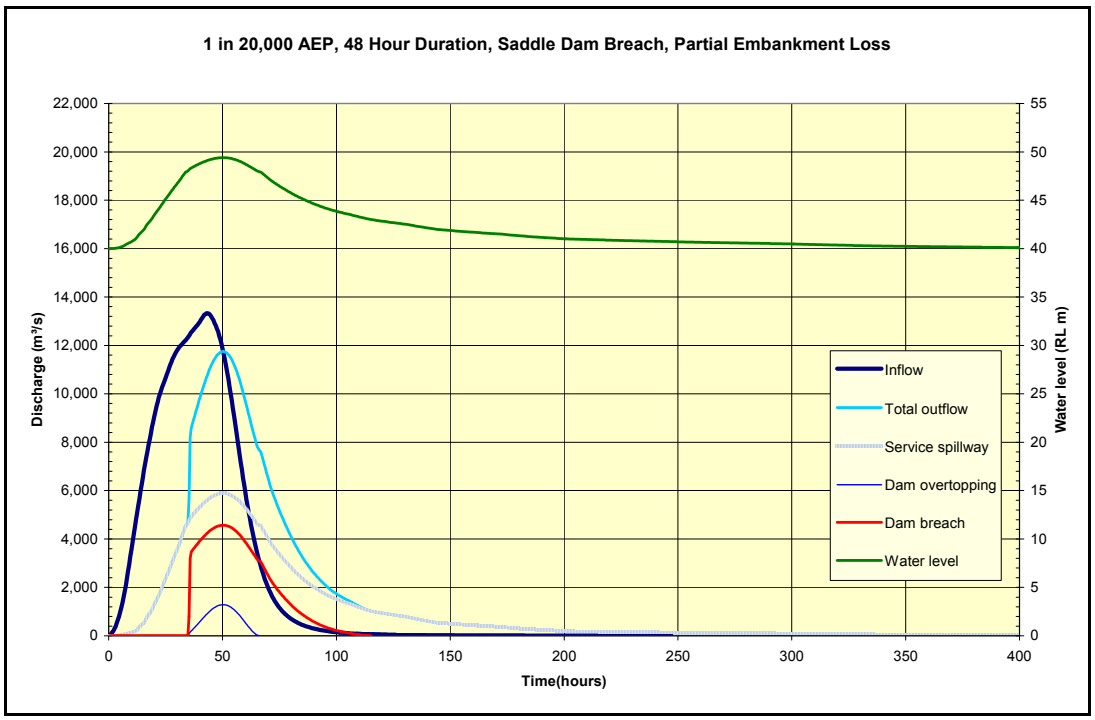


Figure 6-4 Partial Failure Estimated Breach Hydrograph, 1 in 20,000 AEP Flood Event



Full Embankment Failure Existing Saddle Dam

The breach results are presented in Table 11 for the full embankment failure (volume of material lost approximately 31,000 m^3). This table lists the flow through the main spillway, through the breach, the total outflow through the saddle dam embankment area, and the entire outflow from the dam (combining main spillway flow and saddle dam embankment area flow).

Table 11 Estimated Awoonga Saddle Dam No. 3 Breach Results for Full Embankment Failure with Crest Level RL 47.9m

AEP Event	Peak Inflow (m^3/s)	Peak WL (m)	Spillway Flow (m^3/s)	Saddle Dam Breach Flow (m^3/s)	Overtopping Flow (m^3/s)	Total Saddle Dam Outflow (m^3/s)	Total Outflow (m^3/s)
1 in 2,000	8,920	48.11	4,720	5,960	70	6,030	10,720
1 in 5,000	10,520	48.22	4,820	6,190	130	6,320	11,140
1 in 10,000	11,850	48.34	4,920	6,400	200	6,600	11,520
1 in 20,000	13,330	48.66	5,200	6,980	460	7,440	12,640

For all the AEP events considered, the estimated breach base width and breach top width were 322 m and 327 m respectively with a breach depth of 4.9 m. This yields a breach side slope of 0.5H:1V. The breach development time was 1.5 hours.

The increase in peak outflow for the 1 in 2,000 AEP event with failure compared to non-failure is approximately 5,300 m^3/s. The relative increase in peak outflow decreases with increasing flood magnitude. For the 1 in 20,000 AEP event, the incremental increase in peak outflow is around 1,500 m^3/s.

The hydrograph plots for the 1 in 2,000, 1 in 5,000, 1 in 10, 000, and 1 in 20,000 AEP scenarios are shown in Figure 6-5, Figure 6-6, Figure 6-7, and Figure 6-8 respectively. These plots show the estimated flow hydrograph for the main spillway, across the saddle dam embankment, and the breach hydrograph component as well as the simulated water level trace.

Figure 6-5 Full Failure Breach Hydrograph, 1 in 2,000 AEP Flood Event

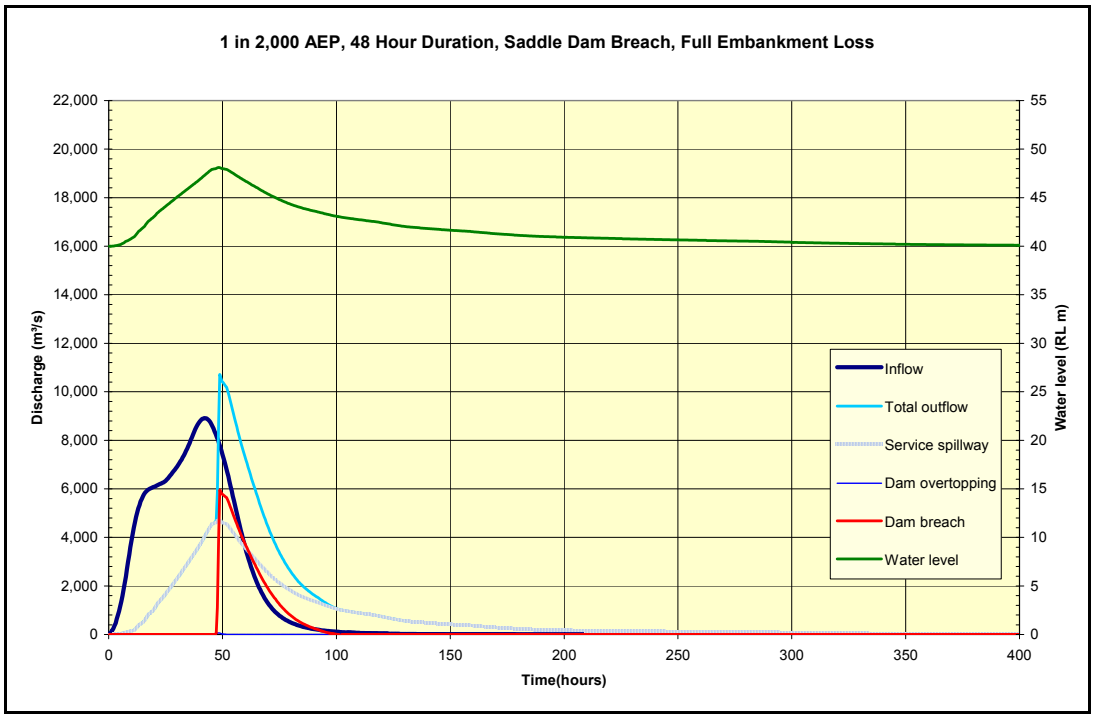


Figure 6-6 Full Failure Estimated Breach Hydrograph, 1 in 5,000 AEP Flood Event

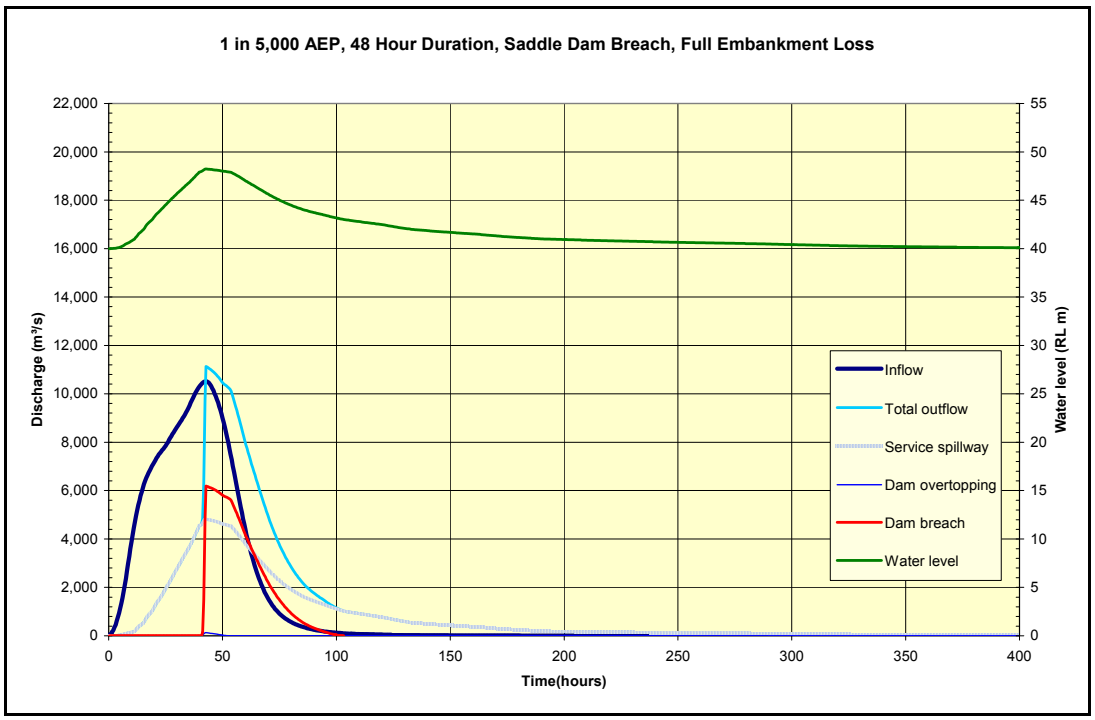


Figure 6-7 Full Failure Estimated Breach Hydrograph, 1 in 10,000 AEP Flood Event

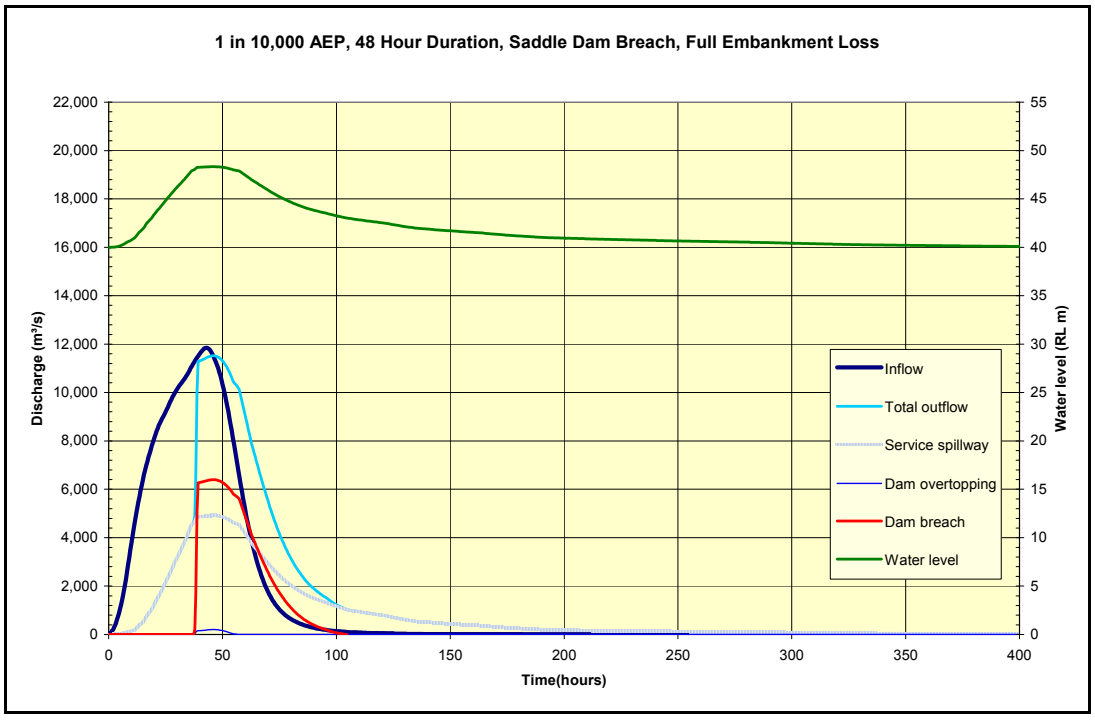
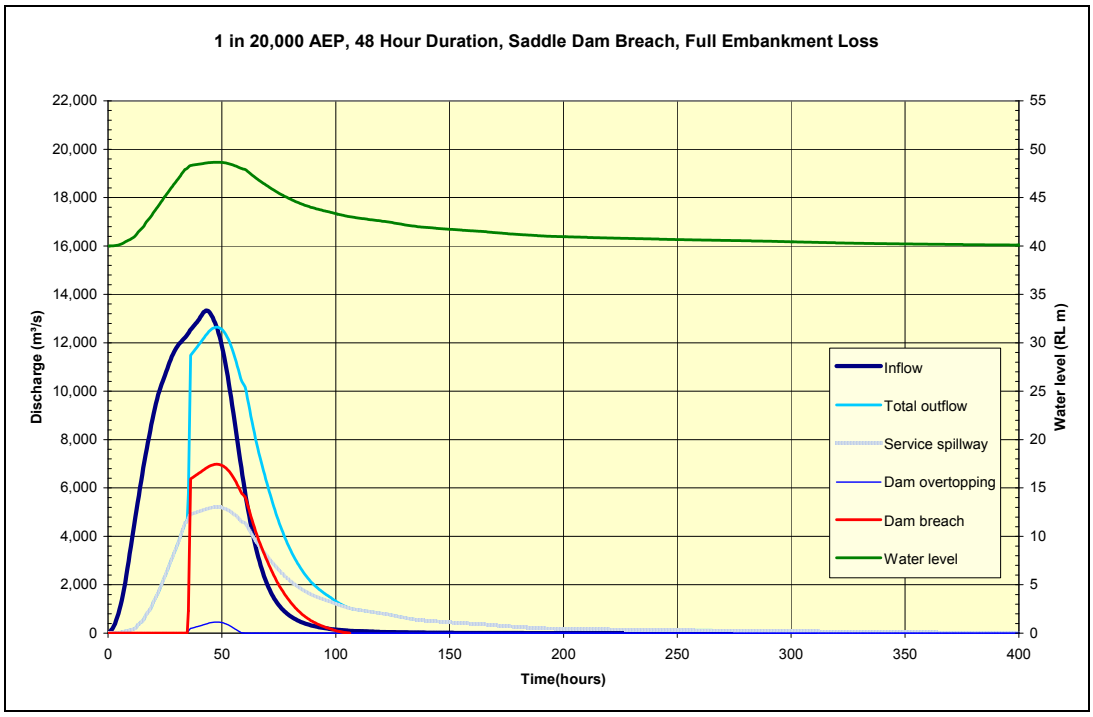


Figure 6-8 Full Failure Estimated Breach Hydrograph, 1 in 20,000 AEP Flood Event



6.4.2 AFC Upgrade Options

Failure of Saddle Dam No. 3 RCC Section Crest Level of 47.9m

The estimated outflows from Awoonga Dam for the failure of the RCC Saddle Dam with a crest level of 47.9 m are shown in Table 12 and Table 13 for the failure lengths of 54 m and 90 m respectively. The results in these tables indicate the increase in peak outflow over the non-failure cases is generally about 20% for the shorter failure length, and around 30% for the longer failure length.

Table 12 Breach Result, RCC Section Crest Level 47.9m, Failure Length of 54m

AEP Event	Peak Flow Rates (m^3/s)				Peak Water Level (m)	No Failure Peak Outflow (m^3/s)	Increase in Peak Outflow (%)
	Main Spillway	Saddle Dam Breach	Saddle Dam Overtopping	Total			
1 in 2,000	5,000	1,140	270	6,410	48.4	5,440	18
1 in 5,000	5,820	1,440	1,190	8,450	49.3	7,130	19
1 in 10,000	6,470	1,690	2,150	10,300	50.0	8,540	21
1 in 20,000	7,070	1,1920	3,140	12,130	50.6	10,110	20
1 in 100,000	8,600	2,540	6,040	17,200	52.1	14,300	20
PMP-DF	10,060	3,140	9,110	23,320	53.4	18,900	23

Table 13 Breach Result, RCC Section Crest Level 47.9m, Failure Length of 90m

AEP Event	Peak Flow Rates (m^3/s)				Peak Water Level (m)	No Failure Peak Outflow (m^3/s)	Increase in Peak Outflow (%)
	Main Spillway	Saddle Dam Breach	Saddle Dam Overtopping	Total			
1 in 2,000	5,000	1,860	270	7,130	48.4	5,440	31
1 in 5,000	5,820	2,360	1,190	9,370	49.3	7,130	31
1 in 10,000	6,470	2,700	2,150	11,370	50.0	8,540	33
1 in 20,000	7,070	3,130	3,140	13,340	50.6	10,110	32
1 in 100,000	8,600	4,120	6,040	18,760	52.1	14,300	31
PMP-DF	10,060	5,080	9,110	24,260	53.4	18,900	28

Failure of Saddle Dam No. 3 RCC Section with Crest Level of 51.1m

The estimated outflows from Awoonga Dam for the failure of the RCC Saddle Dam with a crest level of 51.1 m are shown in Table 14 and Table 15 for the failure lengths of 100 m and 150 m respectively. The results in these tables indicate the increase in peak outflow over the non-failure cases is between 30% and 50% for the shorter failure length, and between about 50% and 70% for the longer failure length. In both cases the higher incremental increase in discharge coincides with the larger AEP event considered (i.e. 1 in 20,000 AEP).

Table 14 Breach Result, RCC Section Crest Level 51.1m, Failure Length of 100m

AEP Event	Peak Flow Rates (m^3/s)				Peak Water Level (m)	No Failure Peak Outflow (m^3/s)	Increase in Peak Outflow (%)
	Main Spillway	Saddle Dam Breach	Saddle Dam Overtopping	Total			
1 in 20,000	8,020	4,100	320	12,350	51.6	Main 8020 Saddle 320	48
1 in 100,000	9,760	5,340	3,120	18,000	53.2	Main 9760 Saddle 3120	40
PMP-DF	11,260	6,310	6,580	23,170	54.5	Main 11260 Saddle 580	30

Table 15 Breach Result, RCC Section Crest Level 51.1m, Failure Length of 150m

AEP Event	Peak Flow Rates (m^3/s)				Peak Water Level (m)	No Failure Peak Outflow (m^3/s)	Increase in Peak Outflow (%)
	Main Spillway	Saddle Dam Breach	Saddle Dam Overtopping	Total			
1 in 20,000	8,020	6,060	320	14,260	51.6	Main 8020 Saddle 320	71
1 in 100,000	9,760	7,910	3,120	20,550	53.2	Main 9760 Saddle 3120	60
PMP-DF	11,260	9,330	6,580	26,150	54.5	Main 11260 Saddle 580	46

Failure of Saddle Dam No. 3 RCC Embankment Crest Level of 55m

The estimated outflows from Awoonga Dam for the failure of the RCC Saddle Dam with a crest level of 55.0 m are shown in Table 16 for the failure lengths of 100 m and 150 m respectively. The results in these tables indicate the increase in peak outflow over the non-failure cases is about 40% for the shorter failure length, and about 60% for the longer embankment failure length. Almost all of the incremental

discharge increase is associated with the failure of the Saddle Dam No. 3 embankment.

Table 16 PMP-DF Breach Result, RCC Crest Level 55m

RCC Section Failure Length (m)	Peak Flow Rates (m^3/s)				Peak Water Level (m)	No Failure Peak Outflow[1] (m^3/s)	Increase in Peak Outflow (%)
	Main Spillway	Saddle Dam Breach	Saddle Dam Overtopping	Total			
100	11,900	7,000	3,900	22,800	55.0	Main 12,000 Saddle 4,000	43
150	11,900	10,300	3,900	26,200	55.0	Main 12,000 Saddle 4,000	64

The no failure outflow from the Saddle Dam shown in the above table includes the flow through excavated saddle at future Saddle Dam No. 6.

Failure of Saddle Dam No. 3 Earthfill Embankment Crest Level of 55m

The estimated outflows from Awoonga Dam for the failure of an embankment section with a crest level of 55.0 m are shown in Table 17 for various failure lengths as appropriate to the volume of material removed during the breach event.

Table 17 PMP-DF Breach Result, Embankment Section Crest Level 55m

Emb. Section Failure Length (m)	Emb. Volume Removed (m^3)	Percent of Emb. Length (%)	Peak Water Level (m)	Peak Inflow[1] (m^3/s)	Total Outflow (Breach + Main Spillway Flow) (m^3/s)	Peak Outflow[1] (m^3/s)		Percent Increase (%)
						Main Spillway	Saddle Dam Breach	
252	120,000	44%	54.84	25,241	29,654	12,866	16910	131%
150	72800	26%	54.85	25,241	23,287	12,884	10,403	81%

As shown above, a breach of the Saddle dam 3 with the embankment height at RL 55 m will result in a significant increase in outflow when compared with the analysis completed for the embankment failure at RL 47.9 (Table 11) for which the breach flow was in the order of 6000m^3/s. This will result in a significant increase in the PAR which means that the AFC will likely be increased from the PMP-DF to the PMF event for this option. This is acceptable, provided the embankment height is raised to at least the main CFRD level of RL 55.4 m. The increase in cost for an embankment constructed to this height may be in the order of 10%.

7. Consequence Assessment

This section of the report describes the routing of breach and flood flows downstream of Awoonga Saddle Dam No. 3. Sunwater (2003) had previously developed a Mike 11 model of the Boyne River and its major tributaries and a copy of this model was made available for use in this study. The hydraulic modelling results are presented together with the estimates of the Population At Risk (PAR) due to the incremental impact of failure for the scenarios investigated to determine the Saddle Dam AFC requirement and to evaluate the upgrade options required to meet the AFC for the Saddle Dam.

7.1 Hydraulic Model Description

MIKE11 is a hydrodynamic model which uses an implicit, finite-difference computation scheme for unsteady flows in rivers and estuaries. The results of a hydrodynamic simulation consist of a time series of water levels and discharges. Version 2008 of the software was used in this assessment.

Data requirements for such a model include:

- definition of the watercourse network schematic;
- cross-sectional information at various locations along the reach of the watercourse;
- surface roughness values;
- definition of upstream and downstream boundary conditions; and,
- inflow hydrographs at various locations along the reach of the watercourse.

Each of these requirements is discussed below.

7.1.1 Network Schematic and Cross-Sectional Information

The location and chainage of cross sections used in the model are shown in Appendix C (Sunwater Drawing 220483). The entire original model developed by Sunwater was used and details of the hydraulic model can be found in the Awoonga Dam Boyne River Dam Break and Flood Modelling Study (Sunwater 2003).

7.1.2 Upstream and Downstream Boundary Conditions

The upstream boundary condition for all models were the relevant outflow hydrograph from Awoonga Dam main spillway and outflow from Saddle Dam No. 3. The main spillway flow was assumed to enter directly into the upper reach of the Boyne River (immediately downstream of the dam). The flow through Saddle Dam No. 3 area was assumed to enter the tributary of Tucker Gully.

As the lower reaches of the Boyne River are tidal, the downstream boundary condition for the model was a constant water level (2.42m) representing the Highest Astronomical Tide (HAT). This condition was set at the downstream end of both the South Trees Inlet and the Boyne River (Sunwater, 2003).

7.1.3 Inflow Hydrographs at Various Reach Locations

Runoff hydrographs from the catchment downstream of the Awoonga Dam for the 1 in 100 AEP event were estimated by Sunwater (2003) based on RORB hydrological modelling using regional relationship estimates for the key model parameter k_c. For the scenarios investigated in this study, estimates were required for the 1 in 2, 1 in 5, 1 in 10, and 1 in 20 AEP events, however, the original RORB model was not available for this study to generate the relevant runoff hydrographs.

To estimate the 1 in 2 to 1 in 20 AEP tributary flows, the 1 in 100 AEP hydrographs were scaled according to the AEP rainfall intensities.

The tributary sub-catchments are illustrated in Appendix C Drawing Number 220734 (Sunwater, 2003).

7.2 Estimated Peak Water Levels

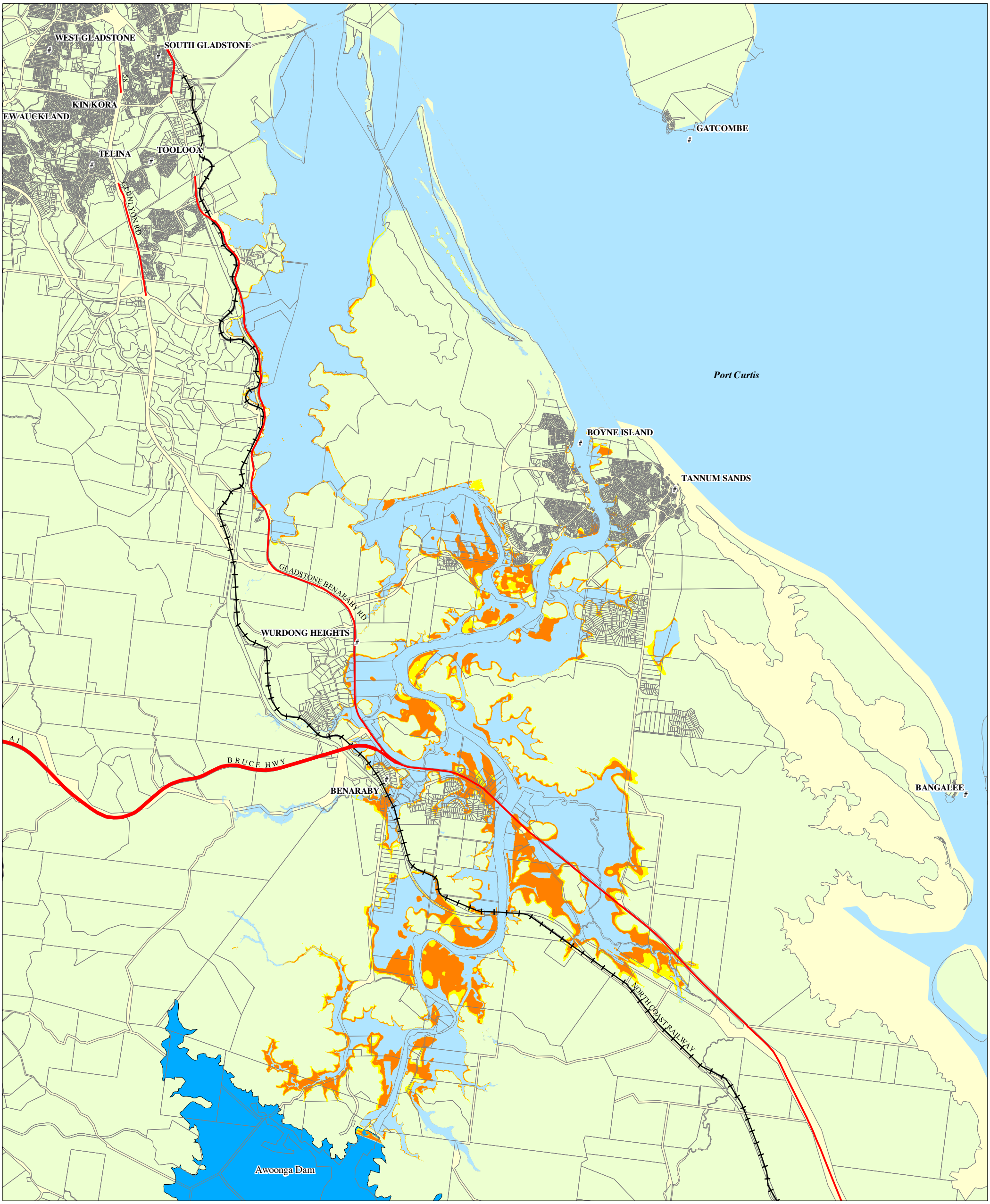
7.2.1 Existing Saddle Dam No 3

The following hydraulic modelling scenarios were investigated for the Saddle dam 3:

- 1 in 2,000 AEP with and without Saddle Dam Embankment Failure;
- 1 in 5,000 AEP with and without Saddle Dam Embankment Failure;
- 1 in 10,000 AEP with and without Saddle Dam Embankment Failure; and,
- 1 in 20,000 AEP with and without Saddle Dam Embankment Failure.

A summary of the estimated peak water levels is provided in Table C1 in Appendix C for the various modelling scenarios. This table shows the estimated peak water levels with, and without failure. Long section plots for the four AEP scenarios are provided in Appendix C.

The extents of flooding for the 1 in 2,000, 1 in 5,000, and 1 in 10,000 AEP scenarios are plotted in Figure 7-1, Figure 7-2, and Figure 7-3 respectively. These figures indicate that the greatest incremental impact occurs with the 1 in 2,000 AEP event and that the incremental impact decreases with decreasing AEP. For this reason, the 1 in 20,000 AEP flood extent is not mapped. A detailed map sequence for the 1 in 2,000 AEP event is provided in Appendix C and it shows the buildings at risk of incremental flooding against an aerial imagery background.



LEGEND

- No Failure Flood Extent
- Incremental Impact for Partial Embankment Breach to RL 43m AHD
- Incremental Impact for Full Embankment Breach to RL 43m AHD

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1000 times larger.

1:75,000

0 1 2

kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

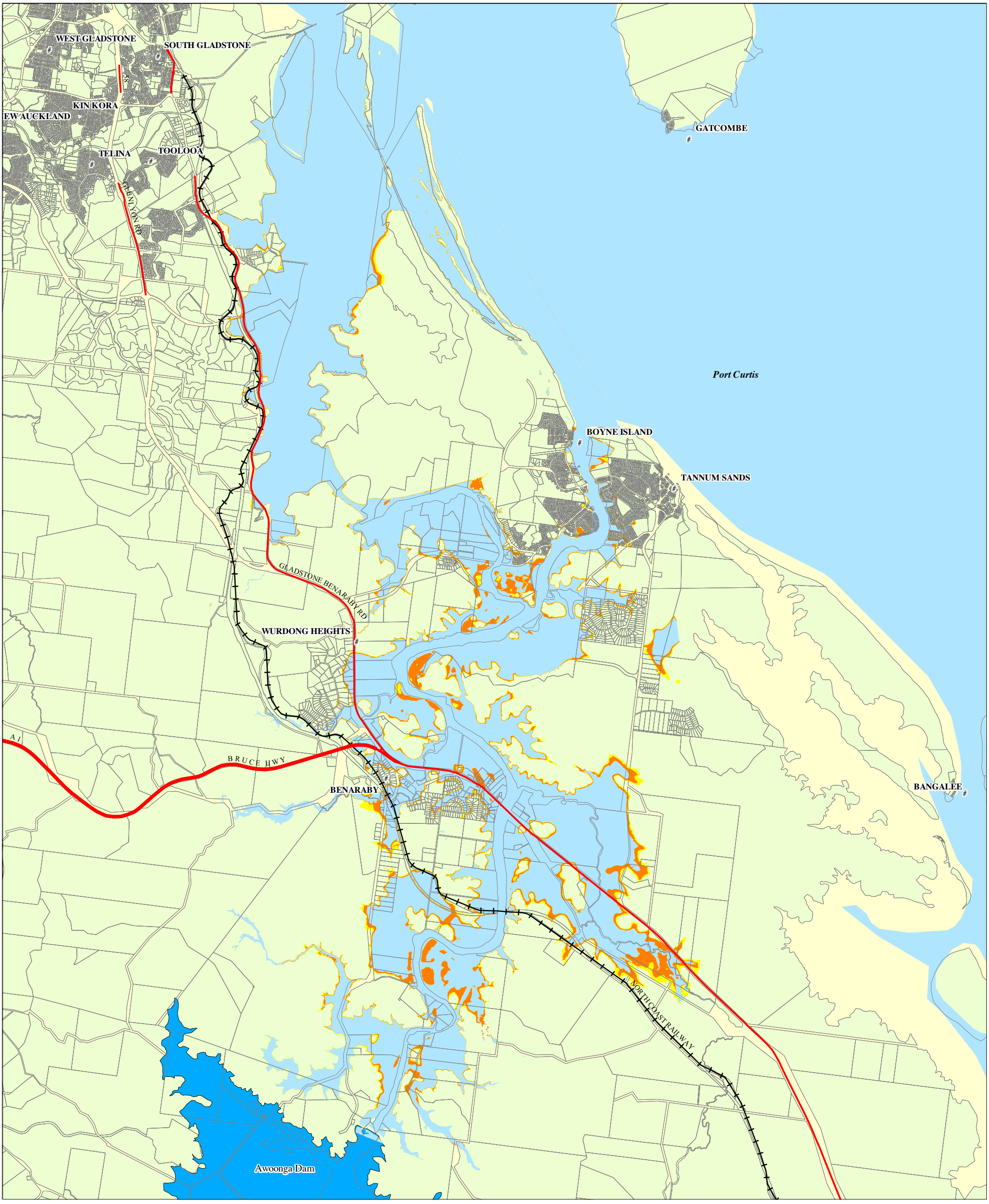
Job Number 41-21180-00
Revision 0
Date 19 Apr 2009

Incremental Flood Impact
1 in 2,000 AEP Flood Event

Figure 7.1

G:\41\21180\CADD\GIS\zMapInfo\41-21180-25.wor
Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au

Data source: NRW, Digital Cadastre Database, 2009, Geosciences Australia, Auslig 1:1 Million Vector and Raster Topographic Data, 2001. Created by: T Loxton



LEGEND

- No Failure Flood Extent
- Incremental Impact for Partial Embankment Breach to RL 43m AHD
- Incremental Impact for Full Embankment Breach to RL 43m AHD

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1000 times larger.

1:75,000

0 1 2

kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

Job Number 41-21180-00
Revision 0
Date 19 Apr 2009

Incremental Flood Impact
1 in 5,000 AEP Flood Event

Figure 7.2

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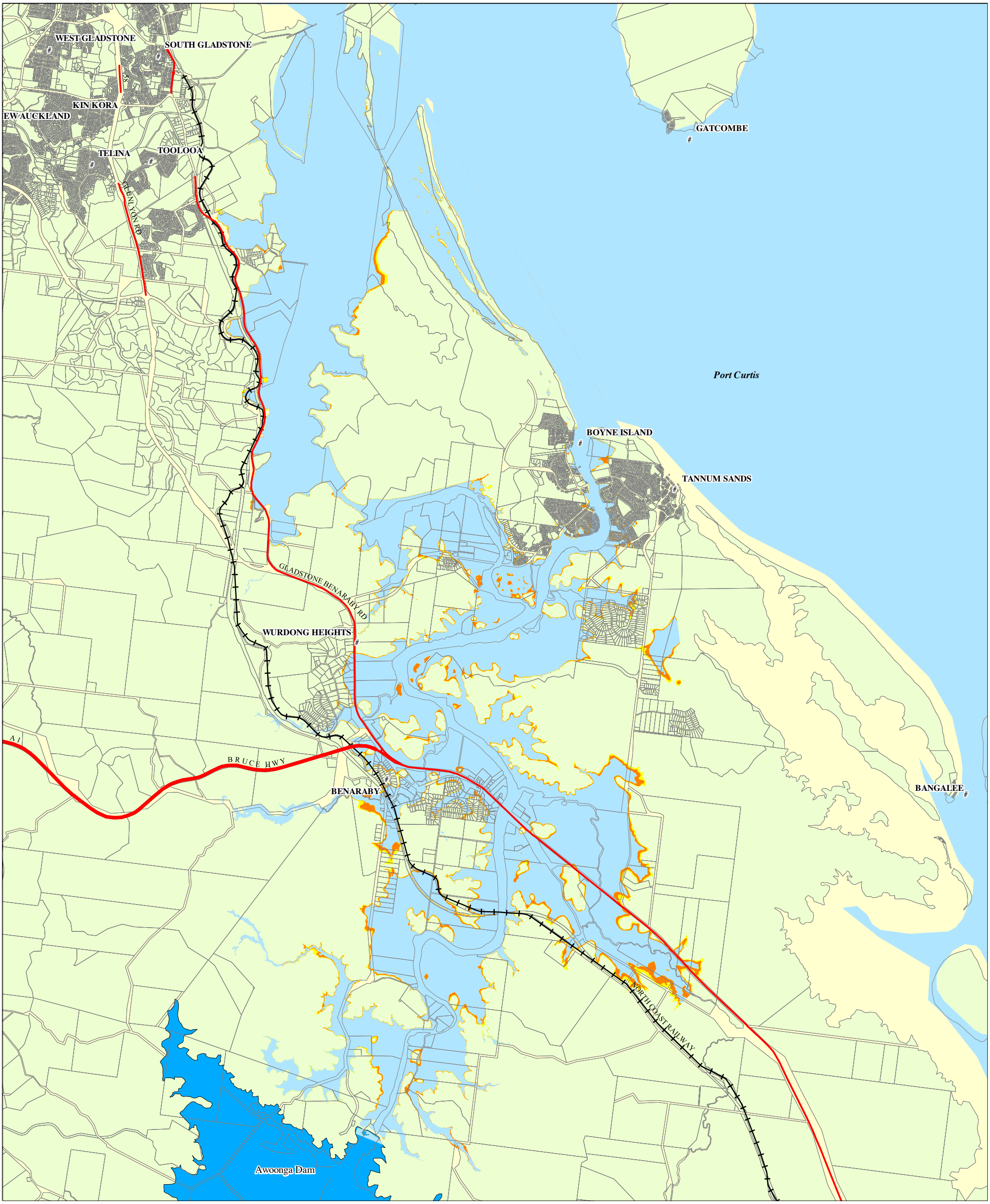
Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au



LEGEND

- No Failure Flood Extent
- Incremental Impact for Partial Embankment Breach to RL 43m AHD
- Incremental Impact for Full Embankment Breach to RL 43m AHD

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1000 times larger.

1:75,000

0 1 2 kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

Incremental Flood Impact 1 in 10,000 AEP Flood Event

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Date	19 Apr 2009

Figure 7.3

G:\41\21180\CADD\GIS\zMapInfo\41-21180-27.wor
Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au

7.2.2 RCC Saddle Dam No. 3 Embankment with a Crest Level of 47.9m

The peak water level results are summarised in Table C2 in Appendix C. These results indicate that the greatest incremental increase is associated with the 1 in 2,000 AEP event. The extent of flooding for this event is shown in Figure 7.4, which includes the incremental increase.

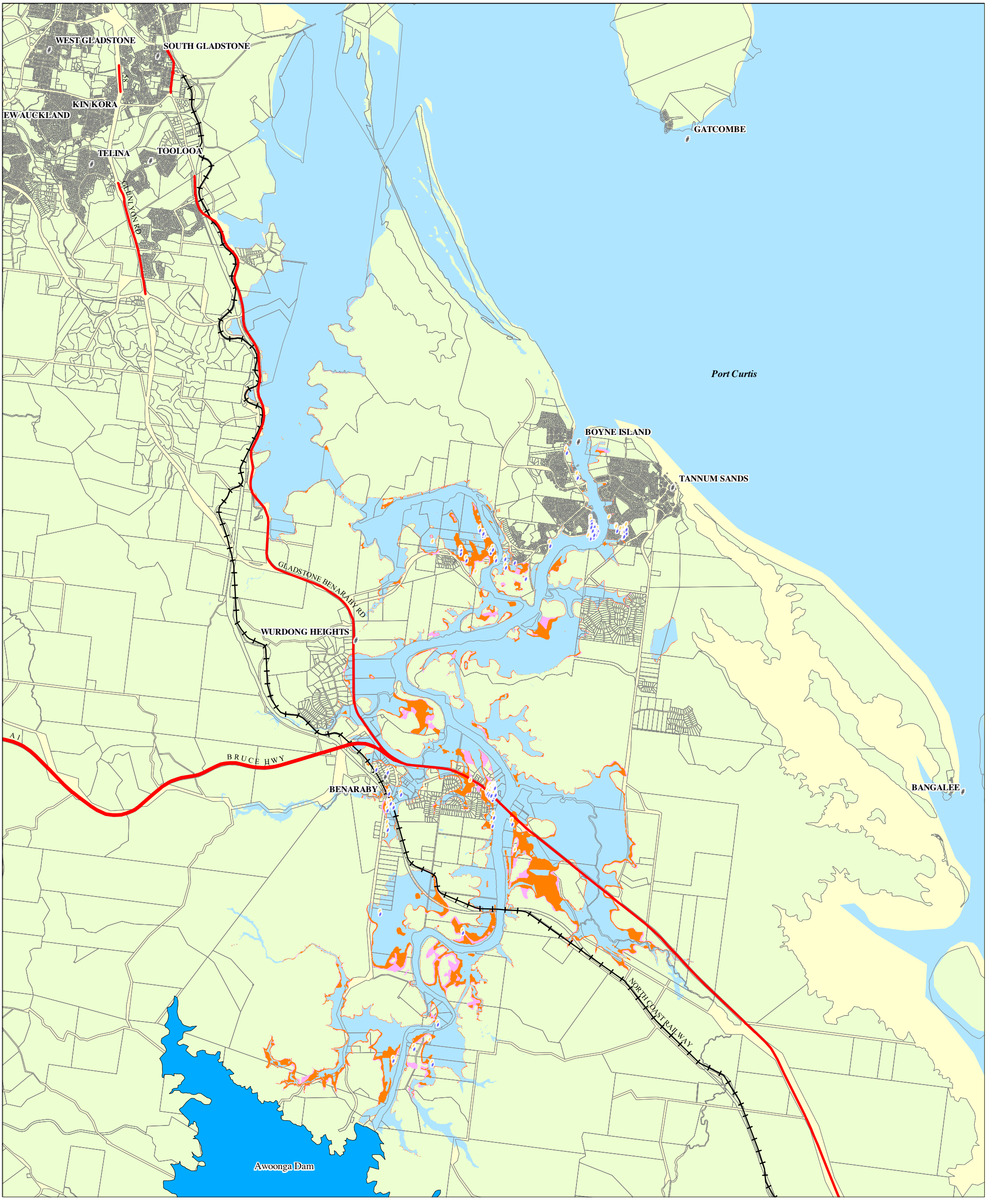
7.2.3 RCC Saddle Dam No. 3 Embankment with a Crest Level of 51.1m

The peak water level results are summarised in Table C3 in Appendix C. These results indicate that the greatest incremental increase is associated with the PMP-DF event. The extent of flooding for this event is shown in Figure 7.5, which includes the incremental increase.

7.2.4 RCC Saddle Dam No. 3 Embankment with a Crest Level of 55m

The peak water level results are summarised in Table C4 in Appendix C. These results indicate that the greatest incremental increase is associated with the PMP-DF event. The extent of flooding for this event is shown in Figure 7.6, which includes the incremental increase.

The flood extent for the PMP-DF with the current embankment level at EL 47.9 m and no breach of the Saddle Dam 3 is shown on Figure 7.7.



LEGEND

- No Failure Flood Extent
- Incremental Impact for 54m Breach Width
- Incremental Impact for 94m Breach Width
- # Buildings Affected by Incremental Impact, 54m Breach Width
- # Buildings Affected by Incremental Impact, 90m Breach Width

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1000 times larger.

1:75,000

0 1 2 kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

RCC Embankment Crest 47.9m 1 in 2,000 AEP Flood Event

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Revision 0
Date 19 Apr 2009

Figure 7.4

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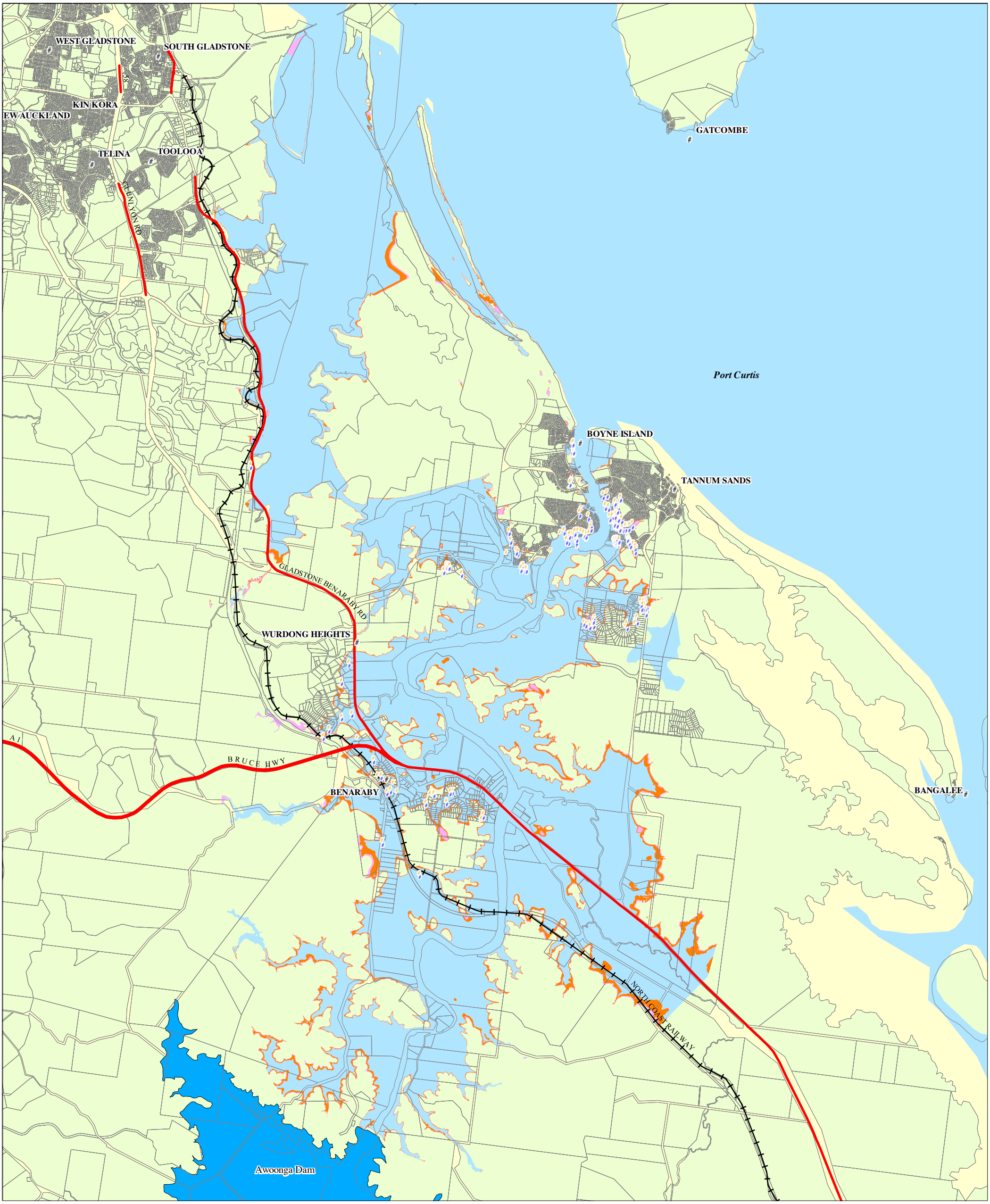
Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au



LEGEND

- No Failure Flood Extent
- Incremental Impact for 100m Breach Width
- Incremental Impact for 150m Breach Width
- # Buildings Affected by Incremental Impact, 54m Breach Width
- # Buildings Affected by Incremental Impact, 90m Breach Width

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1000 times larger.

1:75,000

0 1 2 kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

Job Number 41-21180-00
Revision 0
Date 19 Apr 2009

RCC Embankment Crest Level 51.1m PMP-Design Flood Event

Figure 7.5

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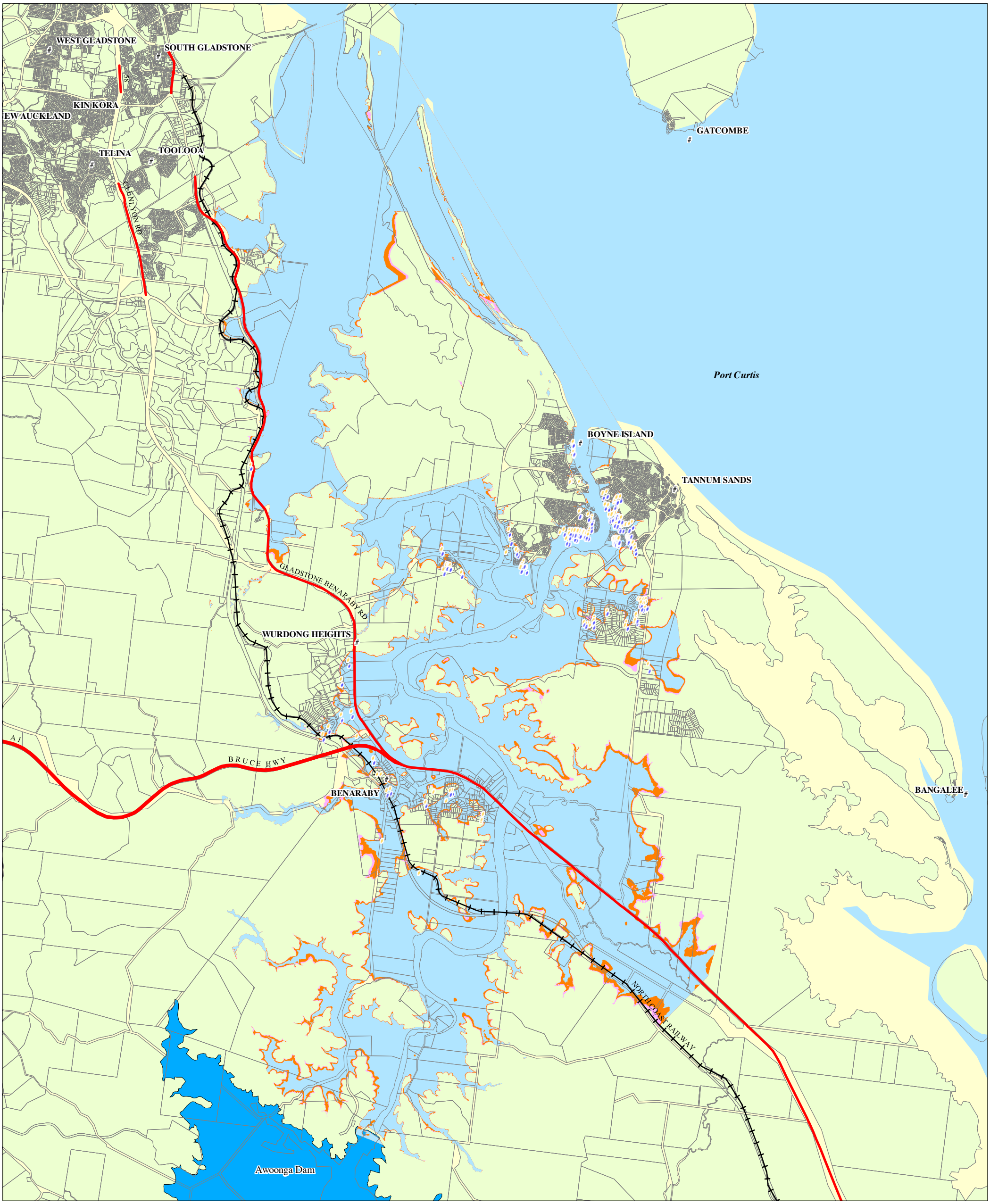
Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au



LEGEND

- No Failure Flood Extent
- Incremental Impact for 100m Breach Width
- Incremental Impact for 150m Breach Width
- # Buildings Affected by Incremental Impact, 100m Breach Width
- # Buildings Affected by Incremental Impact, 150m Breach Width

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1 in 100 AEP.

1:75,000

0 1 2 kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

Job Number 41-21180-00
Revision 0
Date 29 May 2009

RCC Embankment Crest Level 55m PMP-Design Flood Event

Figure 7.6

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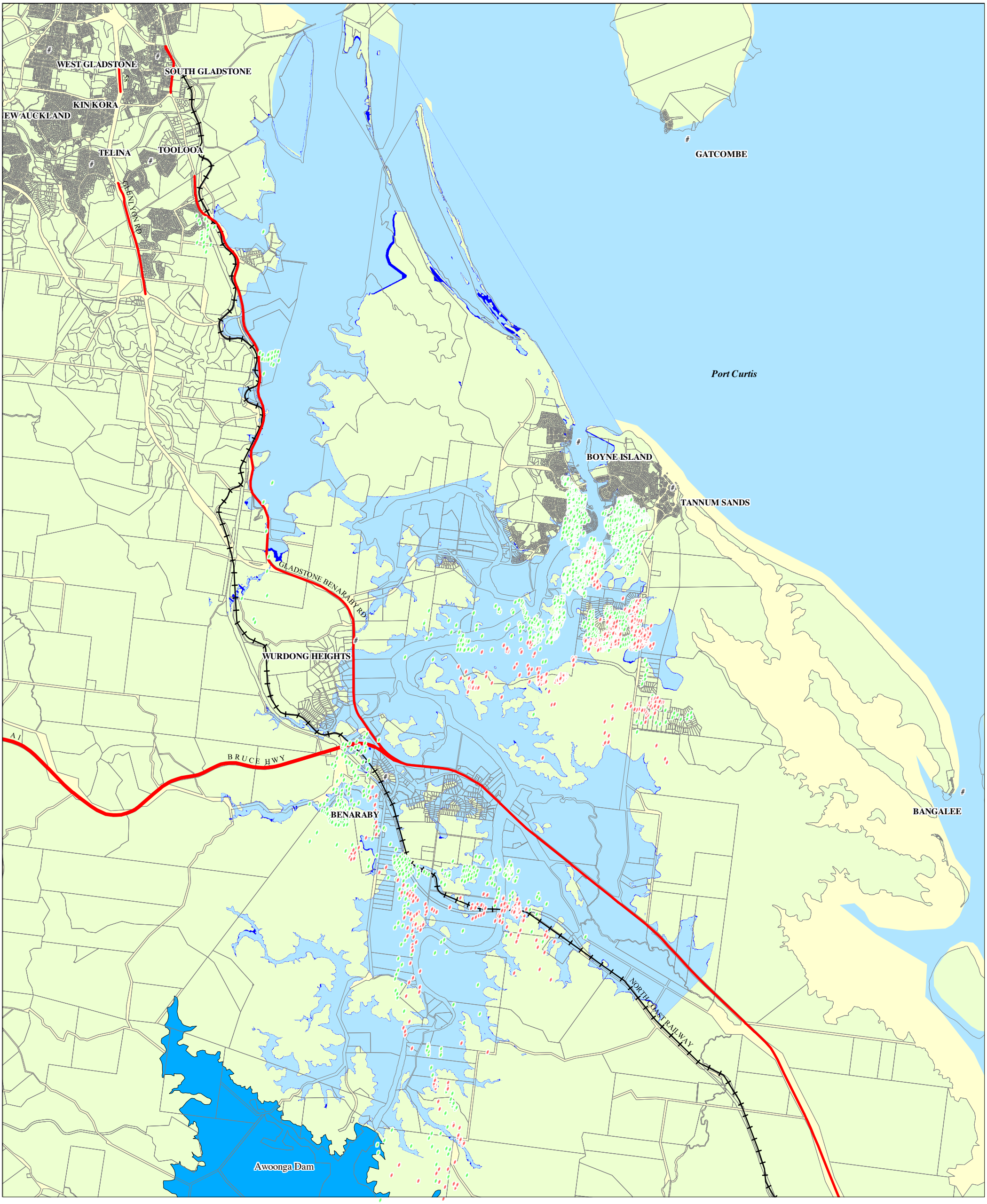
Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au



LEGEND

Flood Depth >= 300mm

No Failure Flood Extent

\# Buildings Affected by more than 300mm of Flooding

\# Buildings Not Affected by more than 300mm of Flooding

Note: The AEP of the flood event in the figure title is for the flood event over the dam's catchment while the flood downstream of the dam has an AEP that is 1 in 100 AEP.

1:75,000

0 1 2

kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

0

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 AFC Assessment

Existing Saddle Dam No. 3 PMP-Design Flood Event

Job Number	41-21180-00
Revision	0
Date	29 May 2009

Figure 7.7

G:\41\21180\CADD\GIS\zMapInfo\41-21180-29.wor

Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia

T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au

7.3 Population At Risk

The identification of buildings that are at risk of flooding was made from interpretation of the aerial imagery provided for this study. No other information was available to discriminate between the different types of dwellings (for example, houses or flats). The no failure number of buildings represent the number of buildings where the depth of inundation is at least 300 mm. The estimated number of buildings for the breach scenarios represent the additional number of buildings affected by the breach where the depth of flooding is at least 300 mm.

The FIA Guidelines (DNRM, 2002) provide default populations for a variety of buildings. The default rate for units is 1.7, for caravan sites it is 1.8, and for houses it is 2.9. The vast majority of buildings considered at risk are residential sites (either caravan sites, units, or houses). For the purposes of comparing options, a minimum population rate of 1.7 was adopted.

7.3.1 Existing Saddle Dam Embankment with Crest Level of 47.9m

The incremental impact for Saddle Dam 3 breach during the 1 in 2,000 AEP to the 1 in 10,000 AEP flood events are mapped in Figure 7-1, Figure 7-2 and Figure 7-3 respectively.

These figures show the approximate locations of residential dwellings, sporting facilities, and commercial premises that are affected by the incremental impact of breach failure (i.e. more than 300 mm increase in peak water levels). The locations of these buildings were determined from an inspection of the aerial imagery and the DCDB provided by GAWB.

The estimated number of buildings are summarised in Table 18 for the incremental impact breaching failure during the 1 in 2,000 AEP, 1 in 5,000 AEP, and 1 in 10,000 AEP events. The number of buildings shown in this table are in addition to those flooded by a flood without failure, and the estimated number of the latter are also provided in the table. The results demonstrate the greatest incremental increase occurs during the 1 in 2,000 AEP event scenario.

The FIA Guidelines (DNRM, 2002) provide default populations for a variety of buildings. The default rate for units is 1.7, for caravan sites it is 1.8, and for houses it is 2.9. The vast majority of buildings considered at risk are residential sites (either caravan sites, units, or houses). During a site visit to the affected areas, a significant number of the inundated properties were observed to be in caravan parks for which a minimum population rate is 1.8. Using this value, the estimated PAR is considered to be at least 610.

Table 18 Estimated Number of Affected Buildings for flood and breach failure of the Existing Saddle Dam Embankment No. 3 with Crest Level of 47.9m

AEP Event	No Failure	Partial Embankment Failure	Full Embankment Failure
1 in 2,000	84	202	339
1 in 5,000	270	171	240
1 in 10,000	425	80	127

7.3.2 RCC Saddle Dam No. 3 with Crest Level of 47.9m

The estimated number of buildings affected by the flood and saddle dam breach scenarios for the RCC Saddle Dam failure with the crest level of 47.9 m are summarised in Table 19 for the 1 in 2,000 AEP, 1 in 20,000 AEP, and the PMP-DF events. The results demonstrate the greatest incremental increase occurs during the 1 in 2,000 AEP event scenario, however, in no case does the number of buildings exceed the condition for the existing earthfill embankment failure at RL 47.9m.

Table 19 Estimated Number of Affected Buildings for flood and breach failure of the RCC Saddle Dam No. 3 with Crest Level of 47.9m

AEP Event	No Failure	Incremental Number of Buildings for Breach Length	
		54m Breach Length	90m Breach Length
1 in 2,000	165	81	135
1 in 20,000	549	50	-
PMP-DF	824	41	-

Note "-" indicates the incremental increase in building numbers was not computed for this AEP event as it does not yield the greatest incremental increase based on the shorter breach length result.

7.3.3 RCC Saddle Dam No. 3 with Crest Level of 51.1m

The estimated number of buildings affected by the flood and saddle dam breach scenarios for the RCC Saddle Dam failure with the crest level of 51.1 m are summarised in Table 20 for the 1 in 20,000 AEP, 1 in 100,000 AEP, and the PMP-DF events. The results demonstrate the greatest incremental increase occurs during the PMP-DF event scenario, however, in no case does the number of buildings exceed the condition for the existing earthfill embankment failure at RL 47.9m.

Table 20 Estimated Number of Affected Buildings for flood and breach failure of the RCC Saddle Dam No. 3 with Crest Level of 51.1m

AEP Event	No Failure	Incremental Number of Buildings for Breach Length	
		100m Breach Length	150m Breach Length
1 in 20,000	413	80	-
1 in 100,000	567	82	-
PMP-DF	729	118	163

Note "-" indicates the incremental increase in building numbers was not computed for this AEP event as it does not yield the greatest incremental increase based on the shorter breach length result.

7.3.4 RCC Saddle Dam No. 3 with Crest Level of 55m

Given that the largest incremental number of buildings affected by the breach for the RCC saddle dam with the level at 51.1m occurred for the PMP-DF event, the estimated number of buildings affected by the flood and saddle dam breach scenarios for the RCC Saddle Dam failure with the crest level of 55 m was estimated, as shown on Table 21 for the PMP-DF event. As shown on this table, the number of buildings exceed the condition for the existing earthfill embankment failure at RL 47.9m

Table 21 Estimated Number of Affected Buildings for PMP- DF flood and breach failure of the RCC Gravity Saddle Dam No. 3 with Crest Level of 55 m

No Failure	100m Breach Length	150m Breach Length
614	98	148

7.3.5 Embankment Saddle Dam No. 3 with Crest Level of 55m

As discussed in Section 6.4.2, a breach of the Saddle Dam 3 with the embankment height at RL 55 m will result in a significant increase in outflow when compared with the analysis completed for the embankment failure at RL 47.9. Inundation mapping for this analysis has not been developed as it is expected that the increase in the PAR above that presented in Table 18 will result in the AFC being increased from the PMP-DF to the PMF.

8. Acceptable Flood Capacity Assessment for Saddle Dam No. 3

8.1 Acceptable Flood Capacity (AFC)

The Fallback methodology recommended for determining the AFC for the dam as outlined in the Queensland *Guidelines on Acceptable Flood Capacity for Dams* (DNRW, 2007) has been used for the present study. The fall-back option is a standards based approach, and may result in a higher design requirement and potentially higher upgrading cost than the alternative risk assessment procedure provided in the Guideline.

The steps involved in the fall-back option are as follows:

1. Conduct a consequence assessment for potential dam failure;

   The Consequence assessment completed for the Saddle Dam 3 has shown that the highest incremental PAR was determined to be 610 for the Full Embankment Failure of Saddle Dam 3 during the 1 in 2000 AEP flood event. Given that there are about 339 houses, the Severity of Damage and Loss is expected to be Major in accordance with the ANCOLD Guidelines on Assessment of Consequences of Dam Failure (ANCOLD 2000). The analyses for the flood and breach scenarios were carried out for a range of events from the 1 in 2000 event to the 1 in 20,000 AEP event, assuming the dam to be at the FSL at the start of the flood.

2. Determine the Hazard Category.

   Based on the Severity of Damage and Loss as being major and the Incremental Population at Risk as between 100 and 1000, the Hazard Category for failure of Saddle Dam 3 was assessed to be High A, in accordance with table 1 of the Guidelines reproduced below.

<table>
<tr><th rowspan="2">Incremental Population at Risk (PAR)</th><th colspan="4">Severity of Damage and Loss</th></tr>
<tr><th>Negligible</th><th>Minor</th><th>Medium</th><th>Major</th></tr>
<tr><td>$2 \leq PAR \leq 10$</td><td>Low
Notes 1</td><td>Significant
Note 5</td><td>Significant
Note 5</td><td>High C
Note 6</td></tr>
<tr><td>$10 < PAR \leq 100$</td><td rowspan="3">Note 1</td><td>Significant
Notes 2 and 5</td><td>High C
Note 6</td><td>High B
Note 6</td></tr>
<tr><td>$100 < PAR \leq 1000$</td><td rowspan="2">Note 2</td><td>High A
Note 6</td><td>High A
Note 6</td></tr>
<tr><td>$PAR > 1000$</td><td>Note 3</td><td>Extreme
Note 6</td></tr>
</table>

3. Identify the required range of the Annual Exceedence Probability (AEP) flood for the dam.

   As shown on Table 2 of the guidelines, reproduced below, the Acceptable Flood Capacity for Saddle Dam 3 with a High A hazard category is the PMP-Design Flood.

   The AFC requirement for the Main Dam is the PMF for which the Saddle Dam AFC upgrade should

be capable of accommodating without compromising the safety of the main dam.

Incremental Population at Risk (PAR)	Severity of Damage and Loss			
	Negligible	Minor	Medium	Major
2 ≤ PAR ≤ 10	Low	Significant	Significant	High C
10 < PAR ≤ 100		Significant	High C	High B
100 < PAR ≤ 1000			High A	High A
PAR > 1000				Extreme

Severity of Damage and Loss	Incremental Population at Risk (PAR)	AEP
Negligible	2 ≤ PAR ≤ 10	5.0×10^{-4}
Minor	2 ≤ PAR ≤ 10	5.0×10^{-4}
Medium	2 ≤ PAR ≤ 10	5.0×10^{-4}
Major	2 ≤ PAR ≤ 10	1.0×10^{-4}
Negligible	2 ≤ PAR ≤ 10	5.0×10^{-4}
Minor	2 ≤ PAR ≤ 10	1.0×10^{-4}
Medium	2 ≤ PAR ≤ 10	1.0×10^{-4}
Major	2 ≤ PAR ≤ 10	C
Minor	10 < PAR ≤ 100	5.0×10^{-4}
Medium	10 < PAR ≤ 100	1.0×10^{-4}
Major	10 < PAR ≤ 100	1.0×10^{-4}
Major	10 < PAR ≤ 100	1.0×10^{-5}
Minor	10 < PAR ≤ 100	1.0×10^{-4}
Medium	10 < PAR ≤ 100	1.0×10^{-4}
Major	10 < PAR ≤ 100	C
Major	10 < PAR ≤ 100	B
Medium	100 < PAR ≤ 1000	A
Major	100 < PAR ≤ 1000	A
Major	100 < PAR ≤ 1000	A
Major	100 < PAR ≤ 1000	A
Major	PAR > 1000	PMF
Major	PAR > 1000	PMF
Major	PAR > 1000	PMF

If in this region, go to the next highest severity of Damage and Loss category for the same PAR

Where

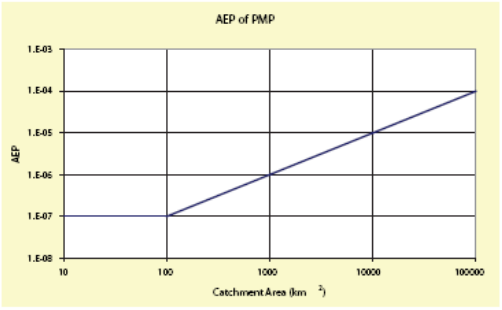
A = PMP Design Flood

B = PMP Design Flood or 10^{-6}, whichever is the smaller flood event

C = PMP Design Flood or 10^{-5} whichever is the smaller flood event

Note that the probability of the PMP Design Flood is a function of the catchment area.

Table 2: Required range of A cceptable Flood Capacities for different hazard categories



4. For each failure case, interpolate the required AEP for the flood within the identified range using the procedure defined in Appendix C of the Guidelines;

   As discussed above, the AEP for the AFC flood requirement for the Saddle Dam 3 is the PMP-DF.

5. Determine the required AEP of the critical duration rainfall event by selecting the flood with the lowest AEP from step 4;

   The PMP-DF rainfall events have been analysed for the AFC requirements, as discussed above in Section 5.

6. Determine the storage inflow hydrograph for the critical storm commensurate with the AEP of the design flood event rainfall.

   The Critical duration PMP-DF hydrograph was assessed in the Sunwater Hydrology report (Table 4) to be 36 hrs while for the purpose of the present evaluation, the 48 hour storm event was found to be more critical with respect to the Saddle Dam and has, therefore been used for the AFC assessment.

8.2 Assessment of Saddle Dam AFC Compliance

8.2.1 Analysis Methodology

The procedure adopted for determining the proportion of the Acceptable Flood Capacity able to be safely passed by the Saddle Dam was in accordance with the NRW Guidelines on Acceptable Flood Capacity for Dams, as follows:

- The discharge values of the critical duration Spillway Capacity Flood inflow hydrograph (PMP-DF) were scaled by a factor 'k' to produce a 'trial' flood event such that:

  $Q_{trial} = k\ Q_{cdsdf}$

  where Q_{trial} = The discharge ordinate of the trial flood event

  Q_{cdsdf} = Discharge ordinate of the critical duration Spillway Capacity Flood

  k = the proportion of the Acceptable Flood Capacity

  The 'time base' for the trial inflow hydrograph remained unaltered from the AFC hydrograph

- The resultant flood was then routed through the storage to determine the headwater level in the reservoir until the storage just reached the Saddle Dam crest level for the embankment or RCC options. This proportion of the Acceptable Flood Capacity was taken to be the percentage compliance of the Saddle Dam.
- In the case of the RCC remedial options, the likelihood of failure occurring when the water level reaches the dam crest level is very low. When designed to pass flow over the crest, the RCC options, and in particular the RCC Gravity option could be considered to be fully compliant with the guidelines ie k = 100%. This compliance does not, however, take into account the downstream considerations of damage to the environment due to flow in the Creek from the Saddle dam back to the Boyne River.

8.2.2 AFC Compliance Assessment for Existing Structures

The results of the assessment given in the AFC report (Connell Wagner 2008) are listed below, together with the current evaluation carried out for the Spillway and Saddle dam using the above methodology.

- Main Dam Embankment 100%
  - PMF Level 1.4m below dam Crest Level
- Spillway Left Abutment Wall 62%
  - Based on current level RL 52 m and Sunwater hydrology 1:100,000 AEP flood event flood peak inflow of approximately 20,000 m^3/sec and outflow 14,300 m^3/s with reservoir level 52.06m. This is 62% of the AFC inflow for PMF of 32,200m^3/s.

– Current assessment based on percentage of the PMF 36hr inflow using the above procedure both with and without overtopping flow over the Saddle Dam 3 Crest at RL 47.9 m as follows.

Saddle dam Overflow	Inflow (m^3/s)	Outflow (m^3/s)	Depth of Flow over Saddle Dam 3 Crest (m)	% AFC
Yes	23,372	13,624	4.1	72.5%
No	20,588	8,576	0	63.9%

- Saddle Dam No. 3 90%
  - Based on Population at Risk of 11 people and Minor severity of loss and damage resulted in an AFC of 1 in 3000 AEP with a peak inflow of about 8,900m^3/s. Current inflow of 8050m^3/s (AEP of 1 in 1200) with the reservoir level at the Saddle Dam crest level RL 47.9m giving 90% compliance.
  - The current AFC for the Saddle dam is the PMP-DF for which the compliance is reduced from the 90% computed in the 2008 AFC report to **37%** based on the above methodology for which the inflow is 9300 m^3/s and the outflow is 4600 m^3/s with the reservoir level at RL 47.9 m.

- Spillway 100%
- Outlet Works 100%
- Northern Abutment Ridge 100%
- Frost Quarry Protection Works 100%
  - At the time of the latest site inspection 1st April 2009, one of the protection bunds was not completed, as shown on the photo below and this would result in inundation of the quarry at lower AEP of about 1:500 and not 1:100,000 design value.

8.2.3 AFC Compliance for Raised Embankment Options

The ability of the raised Saddle Dam No. 3 embankment to pass the PMP-DF was assessed for the 36 hour and 48 hour storms. With regard to the PMF, only the 36 hour storm was considered as no inflow hydrograph was available for the 48 hour PMF event. The results are summarised in Table 22.

Table 22 AFC Compliance for Raised Saddle Dam No. 3 Embankment Options

Option	Result Parameter	PMP-DF 36 Hour	PMP-DF 48 Hour	PMF 36 Hour
Saddle Dam No. 3 Raised to RL 51.1m	Pecentage of Inflow	59%	58%	57%
	Peak Water Level (m)	51.1	51.1	51.1
	Peak Inflow (m^3/s)	15,100	12,300	18,400
	Peak Outflow (m^3/s)	7,600	7,600	7,500
Saddle Dam No. 3 Raised to RL 55m*, excavated Saddle 6	Pecentage of Inflow	100%	100%	99%
	Peak Water Level (m)	55.0	55.0	55.4
	Peak Inflow (m^3/s)	25,200	21,300	31,900
	Peak Outflow (m^3/s)	15,800	16,000	16,700

* Saddle Dam No. 3 Embankment raised to at least RL 55.0m, the simulations assumed no flow across Saddle Dam No. 3 crest.

8.2.4 Upgrade Schedule

Based on Table 23 below, which is taken from the Guidelines on Acceptable Flood Capacity for Dams, the current Saddle dam at 37% compliance with the AFC will be required to be upgraded by 2015 to the 50% AFC flood capacity.

As shown on this table, options to increase the compliance to 60%, proposed for the present study will then allow deferment of further upgrade work to 2025 at the earliest. Ultimately, the dam must be upgraded to pass 100% of the AFC by 2035.

Table 23 Upgrade Schedule for AFC Compliance

Tranche	Required Minimum Flood Capacity	Date by which the Required Minimum Flood Capacity is to be in place for existing dams
1	25% of AFC or 1:500 AEP flood event (whichever is the bigger flood)	These dams must be upgraded as soon as possible[1]
2	50% of AFC or 1:2000 AEP flood event (whichever is the bigger flood)	1 October 2015 [2,3]
3	75% of AFC	1 October 2025 [2,3]
4	100% of AFC	1 October 2035 [2,3]

Notes to Table

1 As a guide, it is expected that up to about 5 years may be required to complete a spillway upgrade for dams greater than 10 meters in height, and 2 years will be required to complete a spillway upgrade for smaller dams. However, each case will be considered on its own merits

2 In each case the required spillway capacity will need to be reassessed just prior to the undertaking of final spillway upgrade works to ensure that the required Acceptable Flood Capacity has not changed and that the planned spillway capacity is still consistent with the specified upgrade program

3 The timing of the second and third tranche will be determined once the Acceptable Spillway Capacity, and related, assessments have been completed for all or most of the known referable dams. This is anticipated to occur by 1 July 2008

9. Upgrade Options – Concept Design

9.1 Options

This section of the report briefly describes the engineering features of the proposed upgrade options presented on Table 24.

Table 24 Awoonga Saddle Dam 3 AFC Upgrade Options

Option	Description	Crest Level (m)
1A	RCC Protection of Existing Embankment	47.9
1B		48.5
2A	New RCC Dam	47.9
2B		48.5
2C		51.1
2D		55.0
2E	Removal of Existing Embankment and Erosion Protection	45.0
3A	New Fuseplugs with RCC Protection of Existing Embankment	47.9
3B		48.5
3C	New Fuseplugs with New RCC dam	47.9
3D		48.5
3E		51.1
3F		55.0
4	New Embankment Dam	55.0
5	Using Saddle No. 6 as auxiliary spillway	Included in Options with Crest Level 55m

9.2 Foundation

The geotechnical conditions at Saddle Dam No. 6 are described in the Stage 1 Design Report (June 2002) and Geotechnical Investigations Report (September 2000). In general, non-erodible slightly weathered rock of high strength was found over a large part of the saddle length. There are several slightly to distinctly weathered dykes along the alignment, and an area near the western end of the saddle from approximately CH450 to CH500 which is extremely weathered. The extremely weathered area between CH450 and CH500 was protected during the Stage 1 Raising with a PVC coated rock

mattress. The Geotechnical Investigation report indicated material in this area could be erodible to EL 33m.

For the upgrade options requiring a non-erodible foundation we have assumed excavation of at least 2 m over the majority of the length, and locally deep excavation (to EL 33m) and treatment being required in the extremely weathered zone between CH 450m and CH 500m.

9.3 Option 1 –RCC Dam Protection of Existing Embankment

9.3.1 General

This option also involves RCC as the non erodible "surface" material placed on the existing embankment to prevent erosion during overtopping. As upstream approach velocities are low, the RCC would be placed as protection to the crest, downstream face and toe of the existing structure.

After trimming and levelling of the existing embankment (300 mm stripping assumed) the RCC would be placed on the crest and 5 m wide on the downstream face.

For the PMF, flow depth over the EL 47.9 m crest of the dam is about 6m. Flow velocities at the toe of the embankment under PMF conditions would be around 14 m/s with a flow depth of about 1.7 m, necessitating significant works to protect the toe from eroding. These works would involve excavating the toe down to non-erodible material (approximately 2 m for most of the dam, but deeper in the extremely weathered zone from CH 450 to CH 500) and construction of a horizontal stilling basin to promote the formation of a hydraulic jump for energy dissipation. The length of the slab needs to be about 10 m to contain the PMF hydraulic jump.

The slab of the stilling basin would need to be designed to resist uplift from the differential water loadings resulting from the hydraulic jump, requiring conventional reinforced concrete and rock anchors. Flow depth downstream of the hydraulic jump will be about 5m. This water level has been adopted in determining the buoyant loads on the underside of the stilling basin slab, ie ignoring water depth upstream of the hydraulic jump. Assuming 60 kPa uplift and submerged unit weight for the concrete slab, N28 rock dowels at 2 m centres extending 6 m into the rock are required.

Grout enriched RCC (GERCC) is proposed for all exposed surfaces. GERCC improves impermeability and abrasion resistance of the regions to which it is introduced by enriching the RCC with additional cementitious material.

Suitable aggregates for the RCC mix are assumed to be available at the right bank quarry where material for the main embankment raising was sourced. The dominant rock type is argillite with minor siltstone bands. No investigations on the suitability of this material or mix designs have been carried out.

9.4 Option 2 – New RCC Dam

9.4.1 General

This option involves the construction of a roller compacted concrete gravity dam along an alignment similar to the current Saddle Dam No. 3. The main benefit of an RCC dam is its resistance to erosion in the event of overtopping due to the nature of the material and the need to found it on high strength rock.

Typically we anticipate at least 2m stripping will be required over the entire footprint of the dam with substantially more excavation and treatment in the vicinity of CH450 to CH500. This is based on geotechnical information in the detailed design and investigation reports of the Stage 1 raising.

Several crest levels have been looked at for various AFC scenarios. Most will involve overtopping of the structure, except for the option with a crest level of EL 55.

The dam cross section would typically have a vertical upstream face, a 5 m wide crest, and downstream face slope of 0.9H:1V. The geometry would need to be confirmed during detailed design. RCC is typically placed in 300 mm thick layers. The downstream face will be stepped, with the vertical height of each step being 300 mm.

A 5m long slab immediately downstream of the toe will be provided for additional protection against erosion from water overflowing the structure. This slab would be backfilled with excavated material following construction to natural ground levels. If flow occurred over the dam the backfill would gradually be eroded down to the slab level. This slab will not be required for the option with a crest level of EL 55.

Grout enriched RCC (GERCC) is proposed for the upstream face, crest and faces of the downstream steps. GERCC improves impermeability and abrasion resistance of the regions to which it is introduced by enriching the RCC with additional cementitious material.

Suitable aggregates for the RCC mix are assumed to be available from Frost quarry where material for the main embankment raising was sourced. No investigations on the suitability of this material or mix designs have been carried out.

9.5 Option 3 –Fuseplugs

This option involves the construction of a fuseplug spillway within the saddle dam in addition to either RCC protection of the remainder of the existing dam or a new RCC dam or an embankment to a height necessary to prevent overtopping of the raised embankment. The proposed fuseplug arrangement would incorporate 4 bays, each 25 m wide, separated by reinforced concrete freestanding cantilever walls, each capable of accommodating the differential load resulting from removal of a fuse section with the adjacent fuse section remaining in place.. The fuse plugs in between the walls would be constructed on non-erodible rock and the rock between the walls protected against significant erosion using dental concrete and shotcrete. The selection of the location of the fuseplugs would be based on the geology to ensure that they are founded on non-erodible rock. Additional geotechnical investigations will be necessary in order to confirm this location. Limited downstream erosion protection would therefore be expected. The fuse plug section has presently been positioned at the ridge along the saddle dam in order to ensure that the base of the fuse plugs at RL 43m are founded on sound rock.

The fuseplug geometry of the embankments would be based on the ASCE and USBR guidelines as follows:

- 2.5H:1V upstream slope;
- 2H:1V downstream slope;
- crest width of approximately 5.5 m (based on adopted dimensions of core and filter zones);
- channel invert at EL 43;
- fuseplug crest levels vary;
- pilot channel invert levels vary; and
- pilot channel crest length of 5 m (greater than one-half the height of the fuseplug).

The adopted internal zoning and material gradings would be based on the ASCE and USBR guidelines. The embankment will consist of:

- a clay core;
- upstream and downstream sand filters;
- upstream and downstream shells;
- gravel surfacing on the crest; and
- slope protection.

9.6 Option 4 – New Embankment Dam

This option involves the construction of a new embankment dam up to EL 55 which would prevent any overflow through the saddle. The embankment design is shown on the attached Sketched and incorporates a zoned embankment with internal filter and cut-off trench down to sound rock which will require surface preparation suitable for placement of core to prevent piping across the foundation core interface.

However, if this option is considered for the final raise of the Awoonga FSL to the Stage 2B level, it will be necessary to include foundation grouting to limit seepage.

The flood routing analyses (Section 5.3.2) have shown that the PMF will overtop the main CFRD embankment unless provision is made for additional discharge through the Saddle Dam 6 using a 220 m channel excavated to RL 50 m at this saddle.

9.7 Saddle No. 6 Auxiliary Spillway

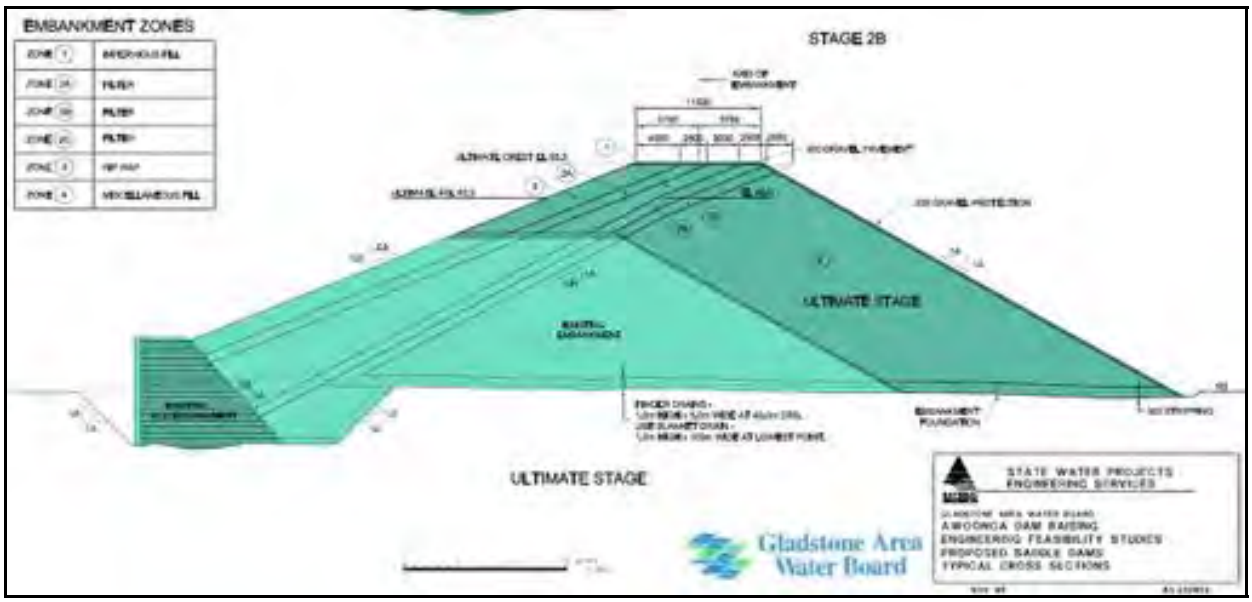
As discussed in Section 5.3.2, the operation of Saddle Dam 6 as an Auxiliary spillway is required if the Saddle Dam is raised to elevations above about EL 53m. The Saddle dam would be lowered from the present level of about EL 51m to EL 50m and widened to provide a channel varying from 150m to 220m, depending on the Saddle Dam raising option.

9.8 Future FSL raising

The Proposed RCC slope protection and the RCC gravity section are both in keeping with the proposal

put forward for the engineering feasibility study of Awoonga dam for which provision was made for raising the dam to a final level of RL 65.3 m, as shown on Figure 9-1

Figure 9-1 Awoonga Dam Feasibility Study Proposed Saddle dam Typical Sections



9.9 Downstream Effects of Saddle Dam Flow in the Tucker Creek leading back to the Awoonga River

The flow from the Saddle Dam passes into the Tucker Creek tributary where the Callide Pipeline crosses (1 km before it joins the creek). The Awoonga Dam Alliance design report provides the following data on discharges and mean velocities for various events routed through the Saddle Dam into the Tucker tributary.

Table 25 Flood Routing Stage 2A Auxiliary Spillway at Saddle Dam No 3 with crest at EL 49.4m (Awoonga Dam Raising Stage 1 – FSL 40.0m, Design Report)

Design Report AEP Event	Depth through Saddle dam (m)	Discharge (m^3/s)		Tailwater Level at Little Oakey Creek (m)	Mean Velocity at Callide Pipeline (m/s)
		Saddle Dam	Main Dam		
500	0	0	5327	18.6	0
1000	0.53	268	5839	19.7	0.5
10,000	2.18	2266	7515	24.3	1.1

During the Awoonga Alliance design stage, these velocities were not considered high enough to damage any of the structures or pipelines in the path of the flowing water.

In order to verify this assessment, the present Mike 11 model for the embankment at 47.9 m was used to obtain the flow data for various flood events leading discharging into the Tucker tributary at Chainage 2914 m (Section T16), and Tucker Gully at Chg 6350 m (Section TU8) as shown on Figure 9-2. Both of these sections are close to the Callide pipeline crossing.

Figure 9-2 Mike 11 Cross Section Locations in close proximity to Saddle Dam 3

Table 26 Flood Routing Data for Saddle Dam Discharge into Tucker Gully Tributary at Chg 2914m, Cross Section T1-6 (NGL 11.5m)

AEP Event	Discharge through Saddle Dam 3 (m^3/s)	Tucker Creek Flood Data		
		Water Level (m)	Flood Depth (m)	Mean Flow Velocity (m/s)
2000	264	18.0	6.5	0.7
20,000	3104	22.8	11.3	2.4
PMP-DF	5200	26.6	15.1	2.4

Table 27 Flood Routing Data for Saddle Dam Discharge into Tucker Gully at Chg 6350, Cross Section TU-8, (NGL 1.9m)

AEP Event	Discharge through Saddle Dam 3 (m^3/s)	Tucker Creek Flood Data		
		Water Level (m)	Flood Depth (m)	Mean Flow Velocity (m/s)
2000	282	18.0	16.1	0.7
20,000	3140	22.4	20.5	1.2
PMP-DF	5200	26.4	24.5	1.4

As shown above, the results from these analyses are in good agreement with the Awoonga Alliance Design data and indicate that the flow velocities vary from about 0.5m/s up to 2m/s for the range of events up to the 1 in 20,000 AEP event.

9.10 Cost Estimates

The details of the cost estimates are contained in Appendix E and summarised below.

The cost estimates presented in this section have been developed for the purposes of comparing options and may be used for preliminary budgeting. The scope and quality of these works has not been fully defined and therefore the estimates are not warranted by GHD.

9.10.1 Assumptions

The direct construction cost of the major items were developed from rates available from similar projects, published data, and advice from suppliers or contractors. The costs were then escalated as follows:

- Minor items and establishment costs – 20%
- Design, tender and supervision activities – 10%
- Indirect costs – client overheads, management – 20%
- Contingencies – 30%

Minor items and establishment costs were added as 20% of the direct construction costs, to obtain the estimated contract cost.

The direct project cost was estimated by allowing 10% for design, tender and supervision.

A total project cost was then obtained by including an extra 20% for client indirect costs including environmental assessments and project management.

Lastly a contingency of 30% was added to the estimated total project cost, in view of the uncertainty regarding quantities, rates and unforseen circumstances.

The detailed schedules in Appendix E include a brief description of the scope of the activity and type of work for each work item.

Table 28 Awoonga Saddle Dam 3 AFC Upgrade Options Cost Estimates

Option	Description	Crest level (m AHD)	Project Cost Estimate ($)
1A	RCC Overtopping Protection Existing Embankment	47.90	$ 24,980,670
1B	RCC Overtopping Protection Existing Embankment	48.50	$ 26,102,934
2A	New RCC Gravity Dam	47.90	$ 23,774,494
2B	New RCC Gravity Dam	48.50	$ 25,578,353
2C	New RCC Gravity Dam	51.10	$ 37,412,060
2D	New RCC Gravity Dam	55.00	$ 56,246,018
2E	Removal of Saddle and RCC protection of Saddle	45.00	$ 7,537,187
3A	RCC Overtopping Existing embankment plus fuseplugs	47.90	$ 25,836,988
3B	RCC Overtopping Existing embankment plus fuseplugs	48.50	$ 26,965,945
3C	New RCC Gravity Dam plus fuseplugs	47.90	$ 25,746,898
3D	New RCC Gravity Dam plus fuseplugs	48.50	$ 27,067,360
3E	New RCC Gravity Dam plus fuseplugs	51.10	$ 36,601,456
3F	New RCC Gravity Dam plus fuseplugs	55.00	$ 50,188,573
4	New Embankment (Note 1)	55.00	$ 19,822,374 $ 21,804,611

Note 1 As discussed in Section 6.4.2, the breach of the embankment for Option 4 will likely result in an increase in the PAR with the AFC being increased from the PMP-DF to the PMF for which the embankment height would be increased to ensure no overtopping occurs and the cost for this option could be increased by about 10%, as shown.

10. Conclusions and Recommendations

10.1 Conclusions

The following conclusions are based on the analysis presented above.

- At the current level of the Saddle Dam 3, the estimated population at risk in the event of a breach is in the order of 600, for which the Acceptable Flood capacity for design of the Saddle Dam 3 is the PMP-Design Flood.
- Saddle Dam 3 has a 37% compliance of the AFC, which places it in the Tranche 2 programming for which upgrade works are required by 2015 to provide a minimum flood discharge capacity of 50% of the AFC.
- The options involving RCC capping of the embankment (Option 1), while technically feasible and common practice for providing the increased protection of auxiliary embankments such as Saddle Dam 3, are of a similar cost to the replacement RCC gravity structure.
- The Options involving the replacement of the existing embankment with a RCC gravity section (Option 2) will provide a robust solution for the Saddle dam AFC upgrade with an estimated cost of between $24M to $26M for a height of RL 47.9m and RL 48.5m respectively.
- The lowest cost option for meeting the AFC compliance is the removal of the existing Saddle Dam down to a non erodible surface along the alignment of the existing embankment and protection of the saddle using a concrete/RCC slab (Option 2E - $7.5M). This option will result in a significantly reduced PAR because there is no sudden increase in breach flow resulting from failure of an embankment or concrete gravity section. However, this option will result in more frequent flooding through the saddle dam for which the AEP at which flow commences is about 1 in 100 compared with the other options where the crest level is greater than or equal to the present Saddle Dam level of RL 47.9 m AHD.
- The use of fuse plugs (Option 3) for improving the overall performance of the Saddle dam discharge rating does not show any marked improvement over the construction of a RCC gravity structure and the cost estimates are higher than the gravity structure. It is, therefore recommended that this option not be pursued further in the detailed design phase.
- The construction of a new embankment to RL 55 m (Option 4) will result in a significant increase in the PAR in the event of a breach which means that the AFC will be the PMF event for this option. This is acceptable, provided the embankment height is raised to at least the main CFRD level of RL 55.4 m. The increase in cost for an embankment constructed to this height may be in the order of 10% for which the total cost will be about $22M. The flood routing analyses have shown that the PMF will overtop the main CFRD embankment unless provision is made for additional discharge through the Saddle Dam 6 using a 220 m channel excavated to RL 50 m at this saddle. The AEP at which this saddle commences operation is likely to be between 1 in 5000 to 1 in 10,000 AEP.
- The construction of a non overflow section in Saddle Dam 3 to RL 55 m will result in overtopping of the Main Dam embankment at the PMP-DF or PMF events with resulting extreme consequences. In

order to prevent overtopping the Main Dam, it has been assumed that the Saddle Dam 6 would be used as an auxiliary spillway with a channel section of between 150m to 200m wide excavated down to RL 50m through this saddle.

- The use of Saddle Dam 3 or 6 as Auxiliary spillways will result in discharge down the Tucker Creek tributary where the Callide Pipeline crosses at about 1km from the junction with the Boyne river. Analyses completed for the Awoonga Alliance design of the upgrade to FSL 40m and design checks for the present study have shown that the velocities of flow are relatively low in the region of the pipeline varying from about 0.5m/s for low flows up to between 1.4m/s to 2.4m/s for the highest flows (PMP-DF). The variation in flow velocity is due to the uncertainty of the pipeline location along the creek in relation to the sections where the Mike 11 model was used to determine the discharge and velocity data. Similarly, the depths of flow over the pipeline may be between 6.5 and 24m depending on the flood magnitude, however, the analyses show that the pipeline will not be directly impacted by the tributary flow due to the backwater effect of the flows in the Boyne River. This should be reviewed and additional analyses competed for the final design of the AFC upgrade option to ensure the pipeline is protected.
- In order to provide complete protection for the full Upgrade to PMF capacity of the Main Dam spillway left abutment non overflow section, which is also deficient, an additional cost of $0.63M will be required for each of the above options (Connell Wagner AFC Report 2008)
- All of the options provide flexibility for the possible future raising to the ultimate Stage 2B crest level of RL 65.3 m, however, the future raises have not been evaluated as part of the present AFC assessment.
- We have assumed that as GAWB own the land that would be affected by construction activities no Council approvals will be required. Regulator approval would need to be obtained prior to construction.
- At the time of the Annual site inspection on the 1st April 2009, one of the protection bunds at Frost Quarry was not completed and this would result in inundation of the quarry at lower AEP of about 1:500 and not 1:100,000 design value.

10.2 Recommendations

- It is recommended that either the replacement RCC gravity structure constructed to RL 48.5m or the complete removal and protection of the saddle against further erosion be used for the AFC upgrade. The raise to RL 48.5m will provide immunity to about the 1 in 2000 AEP event for flow through the saddle while the removal of the saddle embankment will lower the immunity against flow through the saddle dam to about the 1 in 100 AEP event. The GAWB council will need to be made aware of the impact of this lowered immunity, which would include erosion in the gully downstream from the saddle dam and resulting deposition of material into the Boyne river. It must be stressed that any option involving the use of the Saddle Dam for an Auxiliary spillway will result in similar downstream consequences but with reduced frequency of occurrence.
- An alternative recommendation is the construction of the Embankment dam (Option 4) to provide immunity of flow though the Saddle dam up to the PMF, however, this option will require construction

of the auxiliary spillway through Saddle dam 6 and must take account of the future raising of the Awoonga Dam, which should be evaluated during the detailed design phase of the AFC Upgrade.

- The location of the Callide pipeline in the Tucker Creek tributary should be identified in the existing Mike 11 model used for evaluating the downstream flows and discharges from the main dam spillway and the Saddle dam auxiliary spillway. Additional cross sections at the pipeline location should then be used to evaluate the depths and discharges with varying flows for the final design of the AFC upgrade option to ensure the pipeline is protected.
- In order to proceed with the design for the proposed AFC upgrades, the investigations presented on Table 29 are considered necessary for each of the options.

Table 29 Additional Investigations

Option	Investigations required
All	◗ Environmental approvals
1 and 2	◗ Additional geotechnical investigations – Drilling to confirm rock levels – Test pitting – Investigation of quarry and suitability of aggregates for RCC – Trial crushing of aggregates ◗ Trial RCC mix design and testing of mixes
4	◗ Additional geotechnical investigations – Drilling to confirm rock levels – Test pitting – Sourcing core and filter material – Investigation of quarry and suitability of rock for rip rap

- The protection bund at Frost Quarry should be completed as soon as possible by the Quarry owners in order to comply with the AFC requirement for the Quarry.

11. Certifying Registered Professional Engineer

GHD Pty Ltd Certification

Name:	Malcolm Barker
Registration Number:	RPEQ No. 7468
Contact Details:	GHD Pty Ltd
	201 Charlotte St
	Brisbane Qld 4000
Telephone	07 3316 3636
Email	malcolm.barker@ghd.com.au

Certification:

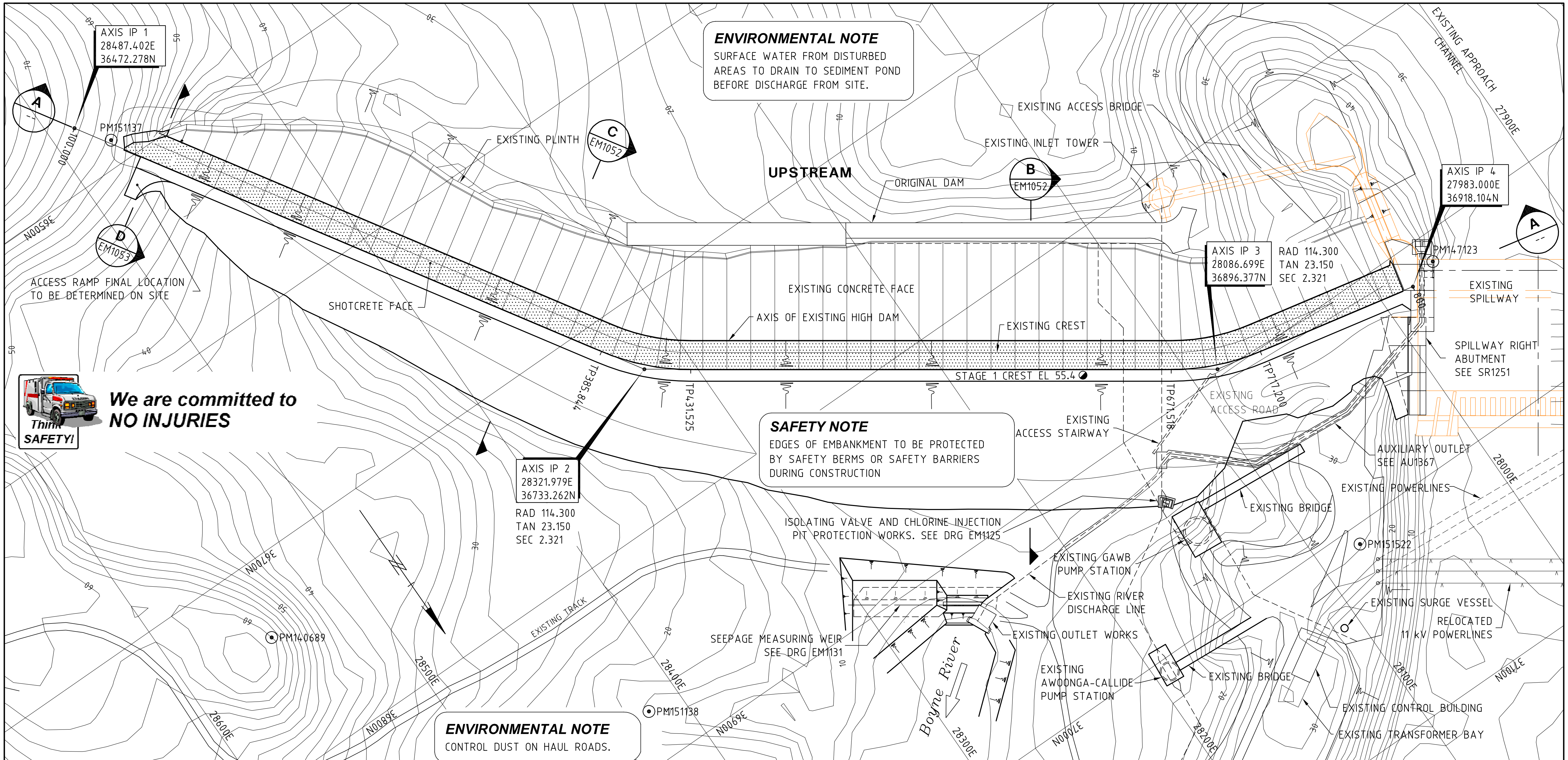
In accordance with the requirements of the NRW Guidelines on Acceptable Flood Capacity for Dams, we hereby certify that:

- The AFC assessment is reasonable and accurate and has been undertaken in accordance with the NRW Guidelines on Acceptable Flood Capacity for Dams.

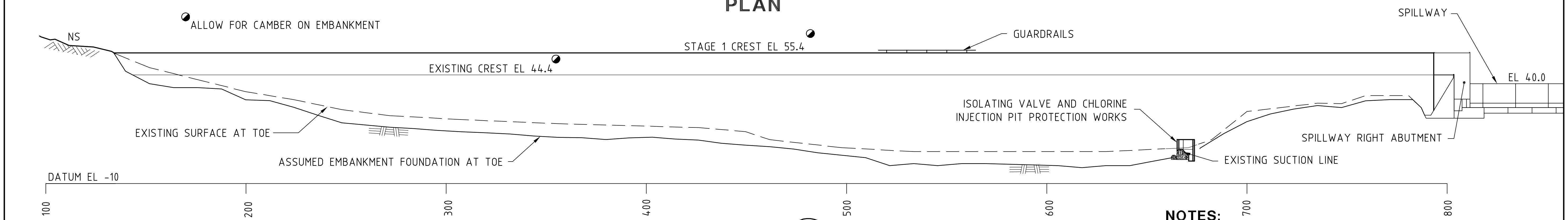
Signature……. Date:……/……/……..

Appendix A

Relevant Drawings


AXIS IP 1
28487.402E
36472.278N
ENVIRONMENTAL NOTE
SURFACE WATER FROM DISTURBED AREAS TO DRAIN TO SEDIMENT POND BEFORE DISCHARGE FROM SITE.
EXISTING APPROACH CHANNEL
27900E
EXISTING ACCESS BRIDGE
EXISTING INLET TOWER
PM151137
100.000
EXISTING PLINTH
UPSTREAM
ORIGINAL DAM
AXIS IP 4
27983.000E
36918.104N
N00596
ACCESS RAMP FINAL LOCATION TO BE DETERMINED ON SITE
PM147123
AXIS IP 3
28086.699E
36896.377N
RAD 114.300
TAN 23.150
SEC 2.321
EXISTING CONCRETE FACE
EXISTING SPILLWAY
SHOTCRETE FACE
AXIS OF EXISTING HIGH DAM
EXISTING CREST
SPILLWAY RIGHT ABUTMENT SEE SR1251
STAGE 1 CREST EL 55.4
We are committed to
NO INJURIES
Think SAFETY!
TP385.844
TP431.525
TP671.518
TP717.200
EXISTING ACCESS ROAD
EXISTING ACCESS STAIRWAY
SAFETY NOTE
EDGES OF EMBANKMENT TO BE PROTECTED BY SAFETY BERMS OR SAFETY BARRIERS DURING CONSTRUCTION
AUXILIARY OUTLET SEE AU1367
28000E
AXIS IP 2
28321.979E
36733.262N
RAD 114.300
TAN 23.150
SEC 2.321
EXISTING POWERLINES
EXISTING BRIDGE
ISOLATING VALVE AND CHLORINE INJECTION PIT PROTECTION WORKS. SEE DRG EM1125
PM151522
N00763
EXISTING GAWB PUMP STATION
EXISTING RIVER DISCHARGE LINE
EXISTING SURGE VESSEL
RELOCATED 11 kV POWERLINES
EXISTING OUTLET WORKS
PM140689
EXISTING TRACK
SEEPAGE MEASURING WEIR SEE DRG EM1131
28500E
28400E
EXISTING AWOONGA-CALLIDE PUMP STATION
EXISTING BRIDGE
28100E
N00763
EXISTING CONTROL BUILDING
28600E
N00896
PM151138
N00696
Boyne River
28300E
N00703
28200E
EXISTING TRANSFORMER BAY
ENVIRONMENTAL NOTE
CONTROL DUST ON HAUL ROADS.

PLAN


ALLOW FOR CAMBER ON EMBANKMENT
SPILLWAY
NS
STAGE 1 CREST EL 55.4
GUARDRAILS
EXISTING CREST EL 44.4
EL 40.0
ISOLATING VALVE AND CHLORINE INJECTION PIT PROTECTION WORKS
EXISTING SURFACE AT TOE
SPILLWAY RIGHT ABUTMENT
EXISTING SUCTION LINE
ASSUMED EMBANKMENT FOUNDATION AT TOE
DATUM EL -10
100
200
300
400
500
600
700
800

SECTION A/--

NOTES:

1. EXISTING ACCESS STAIRWAY TO BE REMOVED PRIOR TO PLACEMENT OF EMBANKMENT MATERIAL.
2. FOR GENERAL NOTES, SEE DRG GN1002.

FOR AS BUILT SURVEY, REFER DRGS EM1057 - EM1061

Q:\AwoongaDamRaisingE-01791\AsBuilt\EM1051z.dwg
22 Jul 2002 2:20 PM

REVISION				
DATE		REMARKS	CKD	PSD
28.6.02	Z	AS BUILT	RP	PAJ
29.5.01	D	SEEP WEIR, AUX OUTLET, PROTECTN WORKS	PGR	HH 14/6
17.11.00	C	FOR CONSTRUCTION		
15.9.00	A	PTC VERSION		

REFERENCE DRAWINGS	
EM1056	GRADING CURVE
EM1121	INSTRUMENTATION - LAYOUT
EM1125	ISOLATING VALVE AND CHLORINE INJECTION PIT - PROTECTION WORKS
EM1077	RIGHT ABUTMENT CONCRETE
EM1052-3	ARRANGEMENT - SHEET 2 & 3

SCALES: 0 50 100 METRES 1:2000

Safe Production

DRAFTING RET	DESIGN APPROVED P.G.RICHARDSON
DRAFTING CHK KFP	DAM DESIGN LEADER
DESIGN DR	APPROVED FOR ISSUE H.HOLLAND 23/11/00
DESIGN CHK RR	DAM DESIGN MANAGER

AWOONGA ALLIANCE
Gladstone Area Water Board

AWOONGA DAM RAISING STAGE 1
EMBANKMENT
ARRANGEMENT

SW REFERENCE

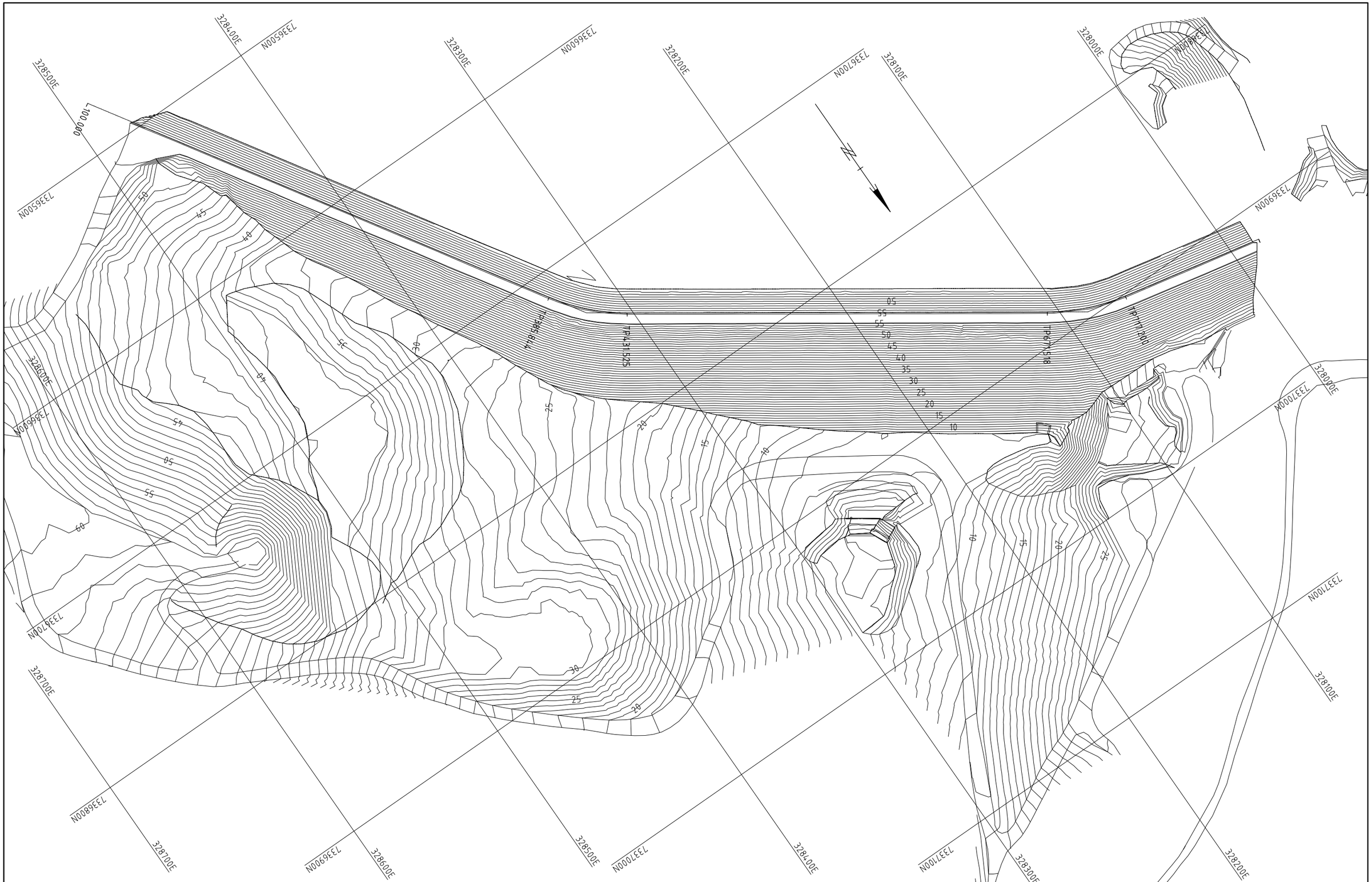
DRAWING NUMBER **EM1051**

DATE NOV 2000

SH 1 OF 3

A | C | D | Z

AS BUILT



FOR AS BUILT SURVEY REFER DRG EM1060

REVISION						REFERENCE DRAWINGS		
28.6.02	Z	AS BUILT	RP	PAJ				
DATE		REMARKS	CKD	PSD		EM1060	AS BUILT SURVEY	

SCALES

0 50 100 METRES
1:2000

Safe Production

DRAFTING KFP	DESIGN APPROVED
DRAFTING CHK	DAM DESIGN LEADER
DESIGN	APPROVED FOR ISSUE
DESIGN CHK	DAM DESIGN MANAGER

AWOONGA ALLIANCE

Gladstone Area Water Board

AWOONGA DAM RAISING STAGE 1

EMBANKMENT

FINISHED SURFACE CONTOURS

SW REFERENCE	
DRAWING NUMBER	EM1061
DATE	JUN 2002
	Z

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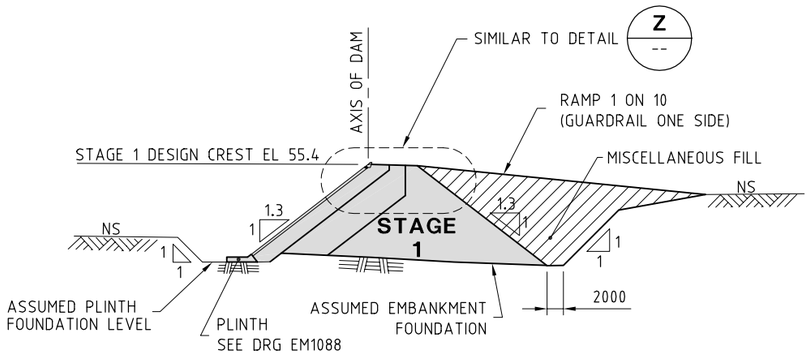
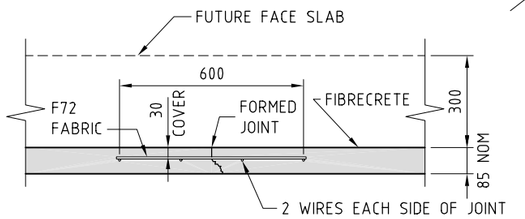
22 May 2002 3:10 PM



SECTION D / EM1051

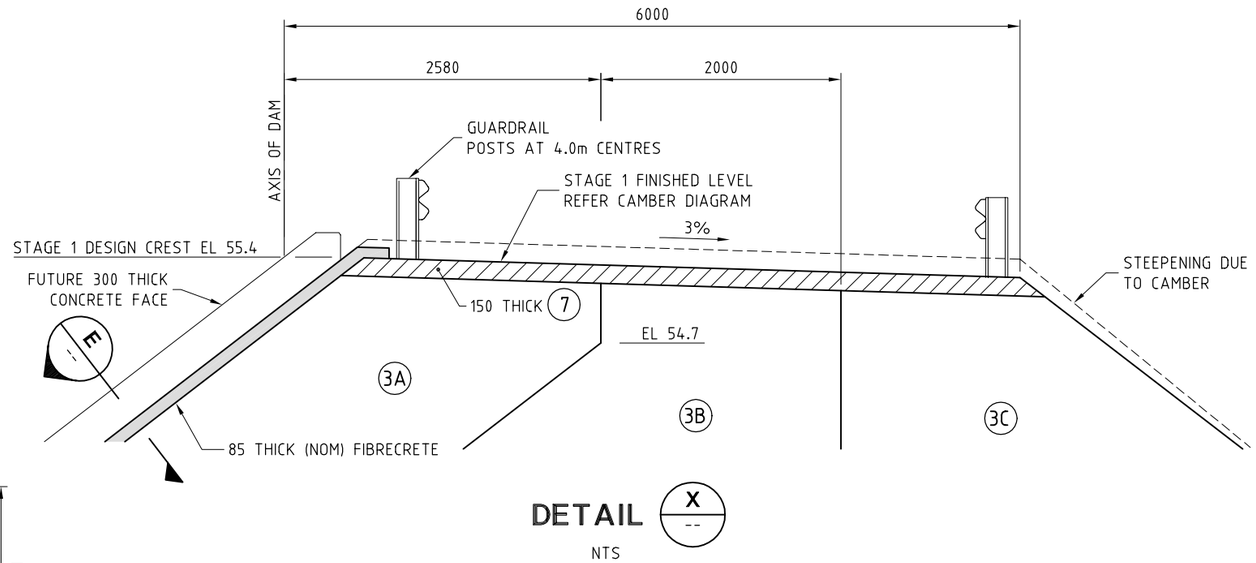
SCALE A



TYPICAL CONSTRUCTION JOINT

SECTION E / --

NOT TO SCALE



DETAIL X / --

NTS

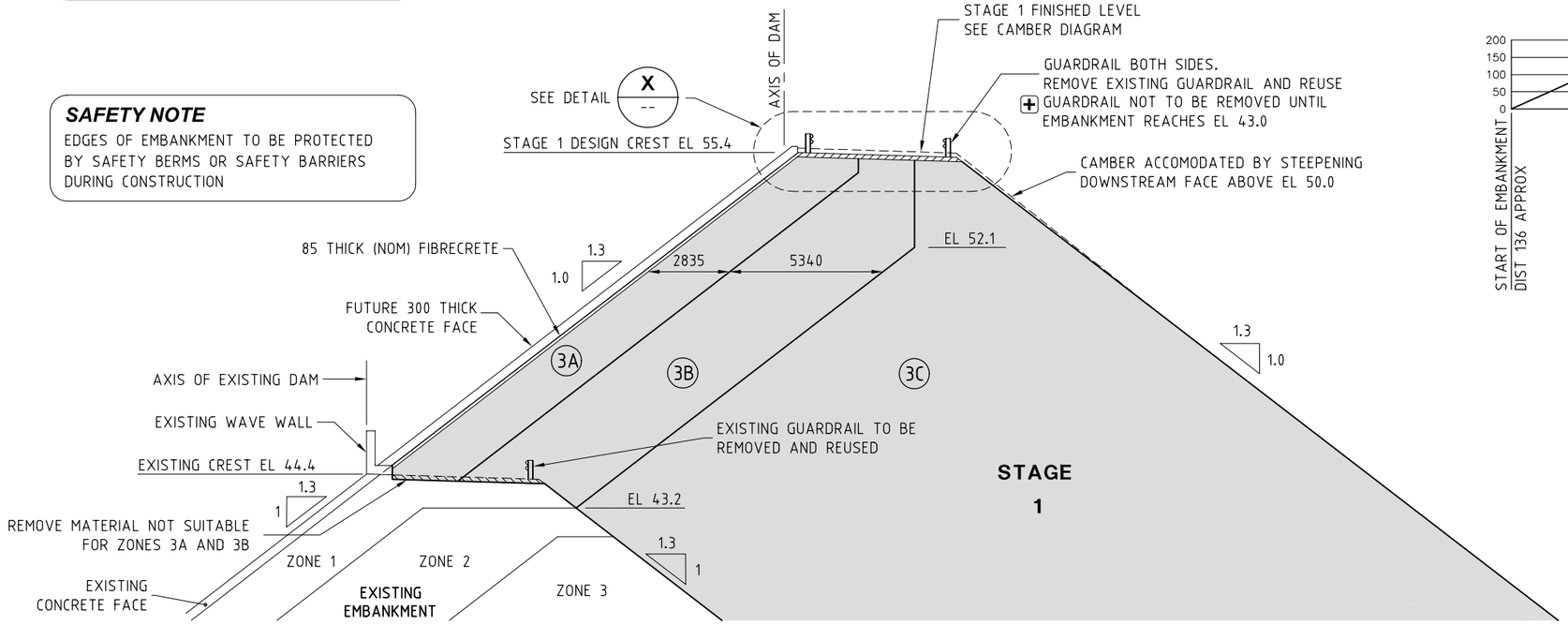
SAFETY NOTE

WHERE A PERSON CAN FALL UP TO 1.5m BARRICADES AND SIGNAGE TO BE CONSIDERED.

WHERE A PERSON CAN FALL 1.5m OR GREATER EDGE PROTECTION TO BE INSTALLED.

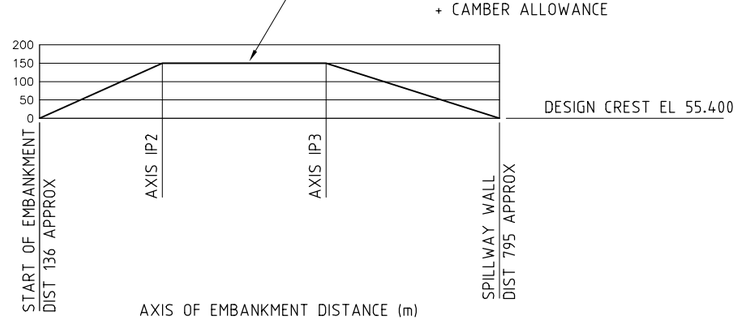
SAFETY NOTE

EDGES OF EMBANKMENT TO BE PROTECTED BY SAFETY BERMS OR SAFETY BARRIERS DURING CONSTRUCTION



DETAIL Z / EM1052

SCALE B



AXIS OF EMBANKMENT DISTANCE (m)

CAMBER DIAGRAM

There is no "I" in TEAMWORK

AS BUILT

Q:\AwoongaDamRaisingE-01791\AsBuilt\EM1052z.dwg
10 Jul 2002 9.49 AM

REVISION					REFERENCE DRAWINGS		
28.6.02	Z	AS BUILT	RP	PAJ			
20.12.01	E	FIBRECRETE SUBSTITUTED FOR SHOTCRETE	PGR	HH 21/1			
6.7.01	D	F72 FABRIC IN SHOTCRETE	PGR	HH 6/7			
17.11.00	C	FOR CONSTRUCTION					
3.11.00	B	PRELIMINARY ISSUE					
15.9.00	A	PTC VERSION					
DATE		REMARKS	CKD	PSD	EM1051	ARRANGEMENT – SHEET 1 OF 3	

SCALES

A 0 10 20 30 37.5 METRES 1:750

B 0 5000 10000 MILLIMETRES 1:200

Safe Production

DRAFTING	RET
DRAFTING CHK	KFP
DESIGN	DR
DESIGN CHK	RR
DESIGN APPROVED	P.G.RICHARDSON
DAM DESIGN LEADER	
APPROVED FOR ISSUE	H.HOLLAND 29/11/00
DAM DESIGN MANAGER	

AWOONGA ALLIANCE

Gladstone Area Water Board

AWOONGA DAM RAISING STAGE 1

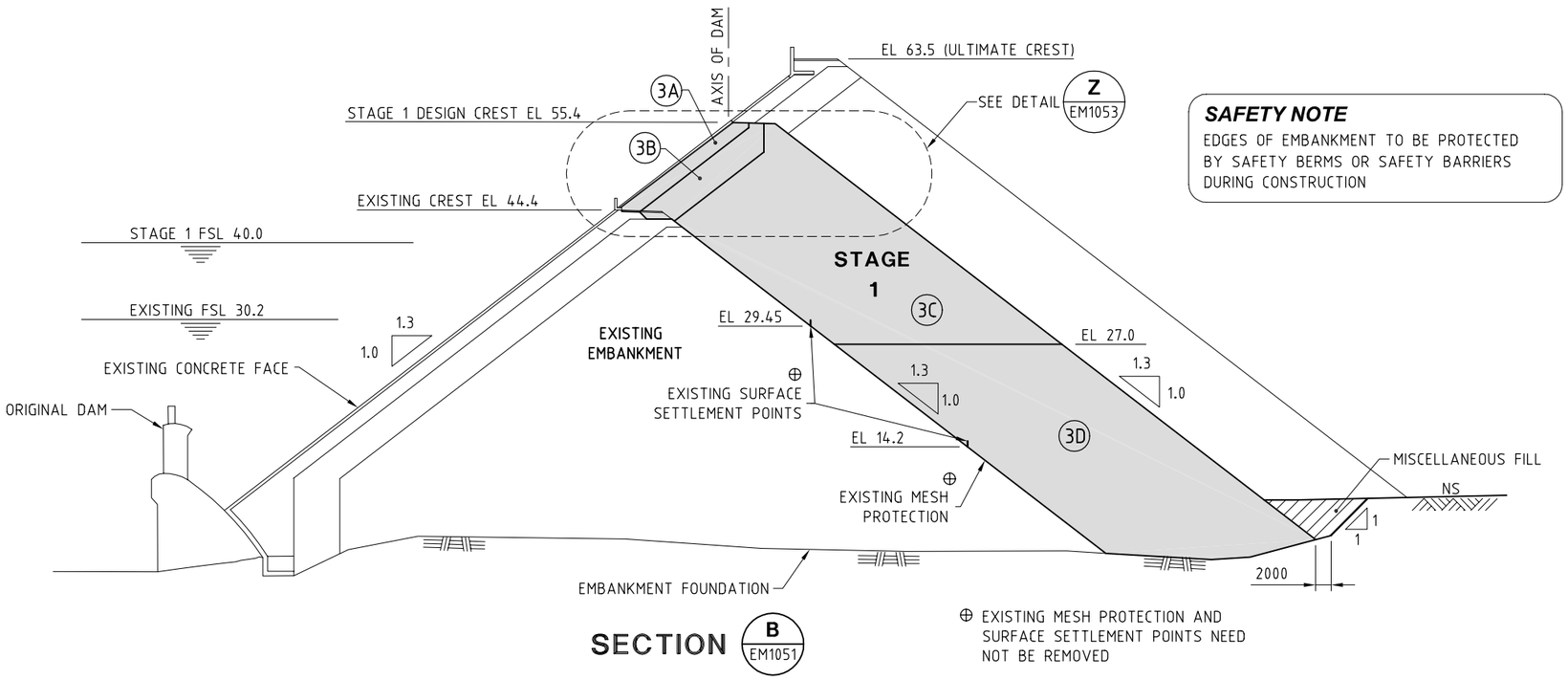
EMBANKMENT

ARRANGEMENT

SH 3 OF 3

SW REFERENCE	
DRAWING NUMBER	EM1053
DATE	NOV 2000
	A B C D Z

AS BUILT



SECTION B EM1051

⊕ EXISTING MESH PROTECTION AND SURFACE SETTLEMENT POINTS NEED NOT BE REMOVED

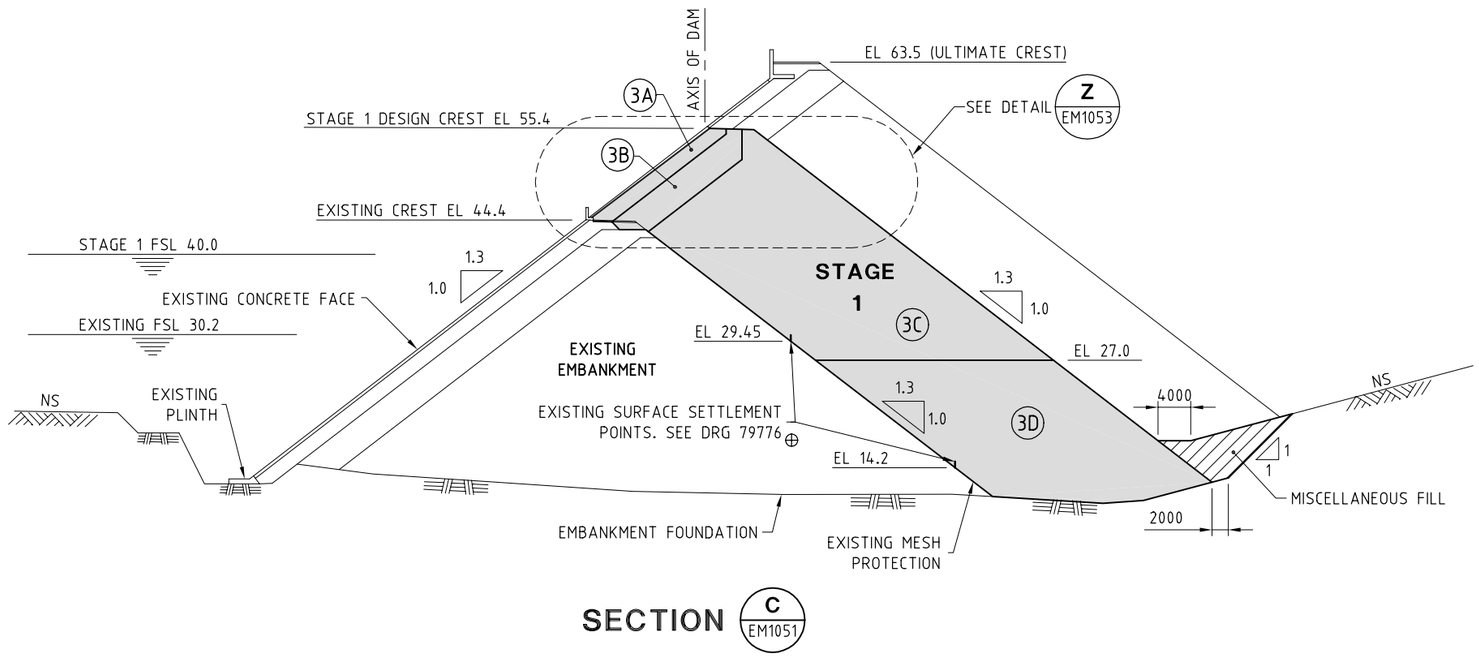
SAFETY NOTE

EDGES OF EMBANKMENT TO BE PROTECTED BY SAFETY BERMS OR SAFETY BARRIERS DURING CONSTRUCTION

EMBANKMENT ZONES

ZONE	MATERIAL	MAXIMUM SIZE	MAXIMUM COMPACTED LAYER THICKNESS
3A	FINE ROCKFILL	100	500
3B	ROCKFILL	250	500
3C	ROCKFILL	1000	1500
3D	ROCKFILL	1500	2000
7	GRAVEL PAVEMENT	100	——

FOR GRADING CURVES, SEE DRG EM1056



SECTION C EM1051

Prior Planning Prevents Poor Performance

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10 Jul 2002 9.49 AM

REVISION	DATE		REMARKS	CKD	PSD
	28.6.02	Z	AS BUILT	RP	PAJ
	17.11.00	C	FOR CONSTRUCTION		
	3.11.00	B	PRELIMINARY ISSUE		
	15.9.00	A	PTC VERSION		

REFERENCE DRAWINGS: EM1051 ARRANGEMENT – SHEET 1 OF 3

SCALES: 0 10 20 30 37.5 METRES, 1:750

Safe Production

DRAFTING RET | DRAFTING CHK KFP | DESIGN DR | DESIGN CHK RR

DESIGN APPROVED P.G.RICHARDSON, DAM DESIGN LEADER

APPROVED FOR ISSUE H.HOLLAND 29/11/00, DAM DESIGN MANAGER

AWOONGA ALLIANCE
Gladstone Area Water Board

AWOONGA DAM RAISING STAGE 1
EMBANKMENT
ARRANGEMENT

SH 2 OF 3

SW REFERENCE

DRAWING NUMBER EM1052

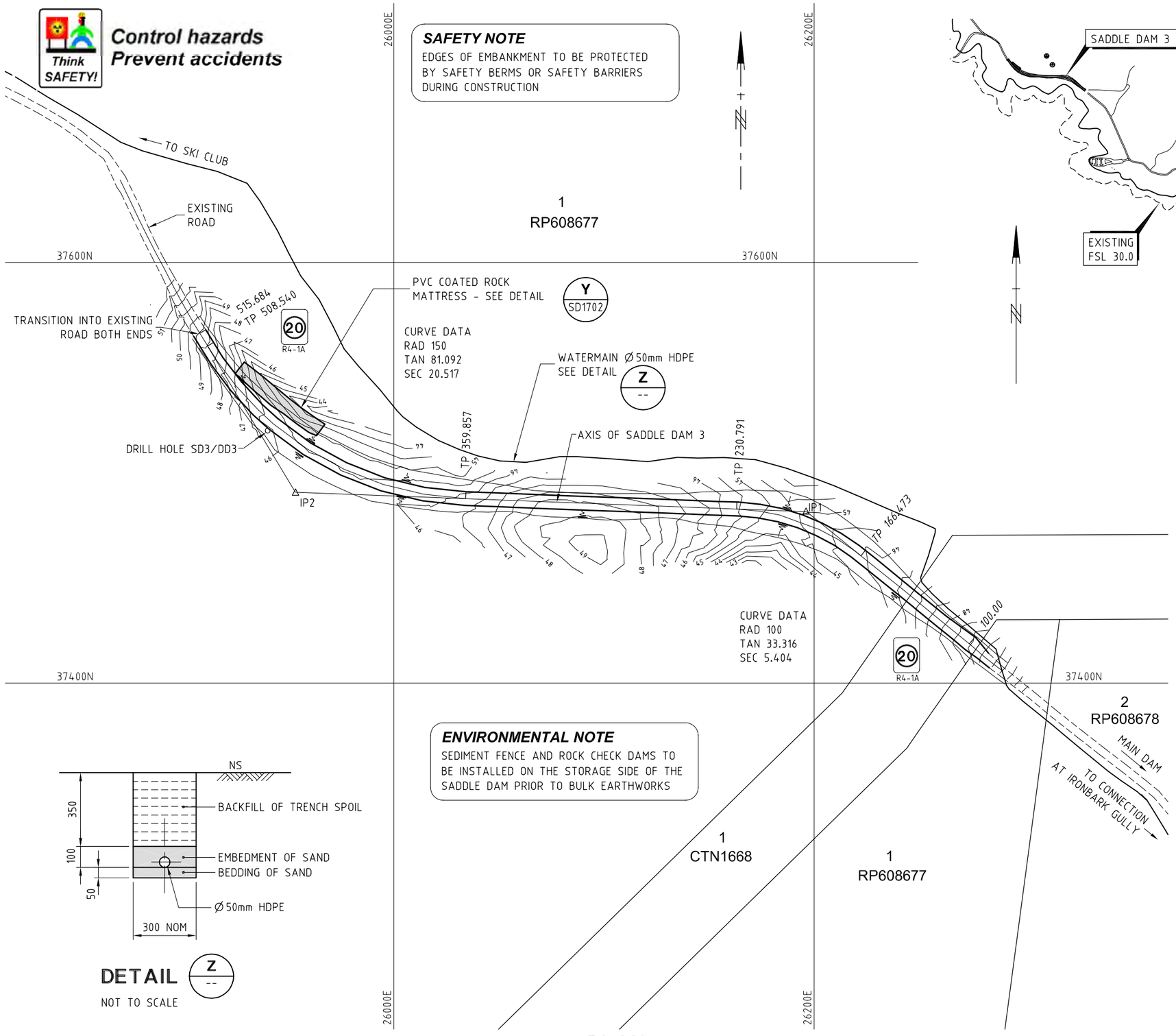
DATE NOV 2000

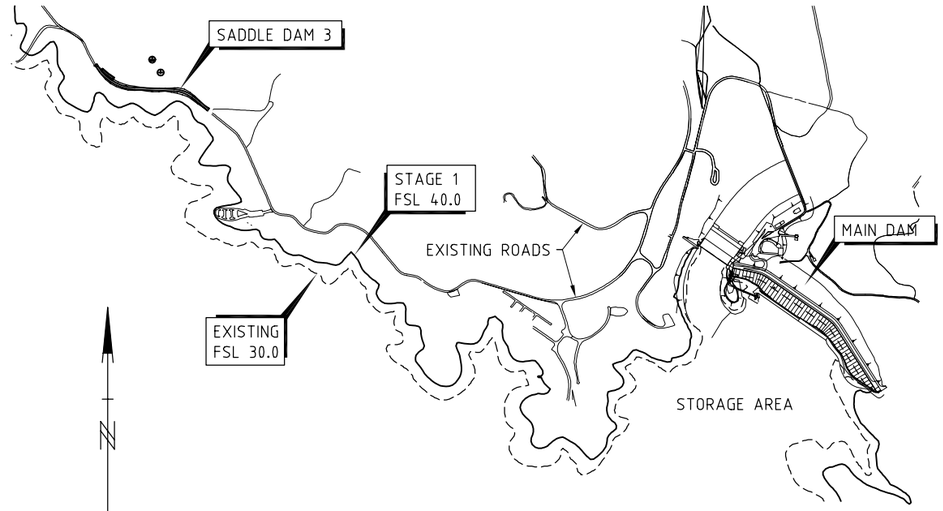
A B C Z

Control hazards
Prevent accidents

Think SAFETY!

SAFETY NOTE
EDGES OF EMBANKMENT TO BE PROTECTED BY SAFETY BERMS OR SAFETY BARRIERS DURING CONSTRUCTION





LOCATION PLAN
SCALE B

STATION CO-ORDINATES

STATION	EASTING	NORTHING
DIST 100	26274.031	37418.677
IP1	26196.500	37481.500
IP2	25953.200	37490.700
DIST 515.684	25907.700	37566.300

ENVIRONMENTAL NOTE
SEDIMENT FENCE AND ROCK CHECK DAMS TO BE INSTALLED ON THE STORAGE SIDE OF THE SADDLE DAM PRIOR TO BULK EARTHWORKS

DETAIL Z
NOT TO SCALE

PLAN
SCALE A

FOR AS BUILT SURVEY REFER DRG SD1703

NOTES:

1. LEVELS DATUM : AHD DERIVED
   PM 87470 = EL 61.125
2. AZIMUTH DATUM : AMG84
   PM 87470 - PM 87473 108° 51' 31.3"
3. COORDINATES ORIGIN: PLANE COORDINATES
   PM 87470 E 27 817.024 N 36 710.192
   COORDINATES ORIGIN: AMG COORDINATES
   PM 87470 E 327 817.024 N 7336 710.192
4. CONTOURS DERIVED FROM GROUND SURVEY (CIVILCAD FILE 'ADSD')
5. PROPERTY BOUNDARIES DERIVED FROM DCDB
6. WORKS TO BE CONSTRUCTED IN ACCORDANCE WITH QLD STANDARD SPECIFICATIONS FOR ROADWORKS, 2000 EDITION.
7. ALL SIGNS AND LINE MARKINGS ARE TO BE CARRIED OUT IN ACCORDANCE WITH THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES. SIGNS TO BE LOCATED 600mm BEHIND GUIDE POSTS. SIGN SUPPORTS ARE 50NB POSTS H = 2.1m SEE QDMR DRG 1368.
8. TRAFFIC SIGNS TO HAVE CLASS 1 REFLECTORIZATION TO AS 1906.

AS BUILT

Q:\AwoongaDamRaisingE-01791\AsBuilt\SD1701Z.dwg
19 Jul 2002 3.08 PM

REVISION					REFERENCE DRAWINGS		
28.6.02	Z	AS BUILT	RP	PAJ			
23.4.01	C	FOR CONSTRUCTION					
5.1.01	B2	PRELIMINARY ISSUE 2					
8.12.00	B	PRELIMINARY ISSUE					
15.9.00	A	PTC VERSION			GT1670	SADDLE DAMS – LOCATION OF EXPLORATION SITES	
DATE		REMARKS	CKD	PSD	SD1702	ARRANGEMENT – SH 2	

SCALES
A 0 50 100 METRES 1:2000
B 0 500 1000 METRES 1:20000

Safe Production

DRAFTING	DESIGN APPROVED
RET/IMP	P.G.RICHARDSON
DRAFTING CHK	DAM DESIGN LEADER
KFP	
DESIGN	APPROVED FOR ISSUE
RR	H.HOLLAND 4.5.01
DESIGN CHK	DAM DESIGN MANAGER
PGR	

AWOONGA ALLIANCE
Gladstone Area Water Board

AWOONGA DAM RAISING STAGE 1
SADDLE DAMS
SADDLE DAM 3 ARRANGEMENT

SH 1 OF 2

SW REFERENCE
DRAWING NUMBER
SD1701
DATE FEB 2001
A | B | B2 | C | Z

AS BUILT

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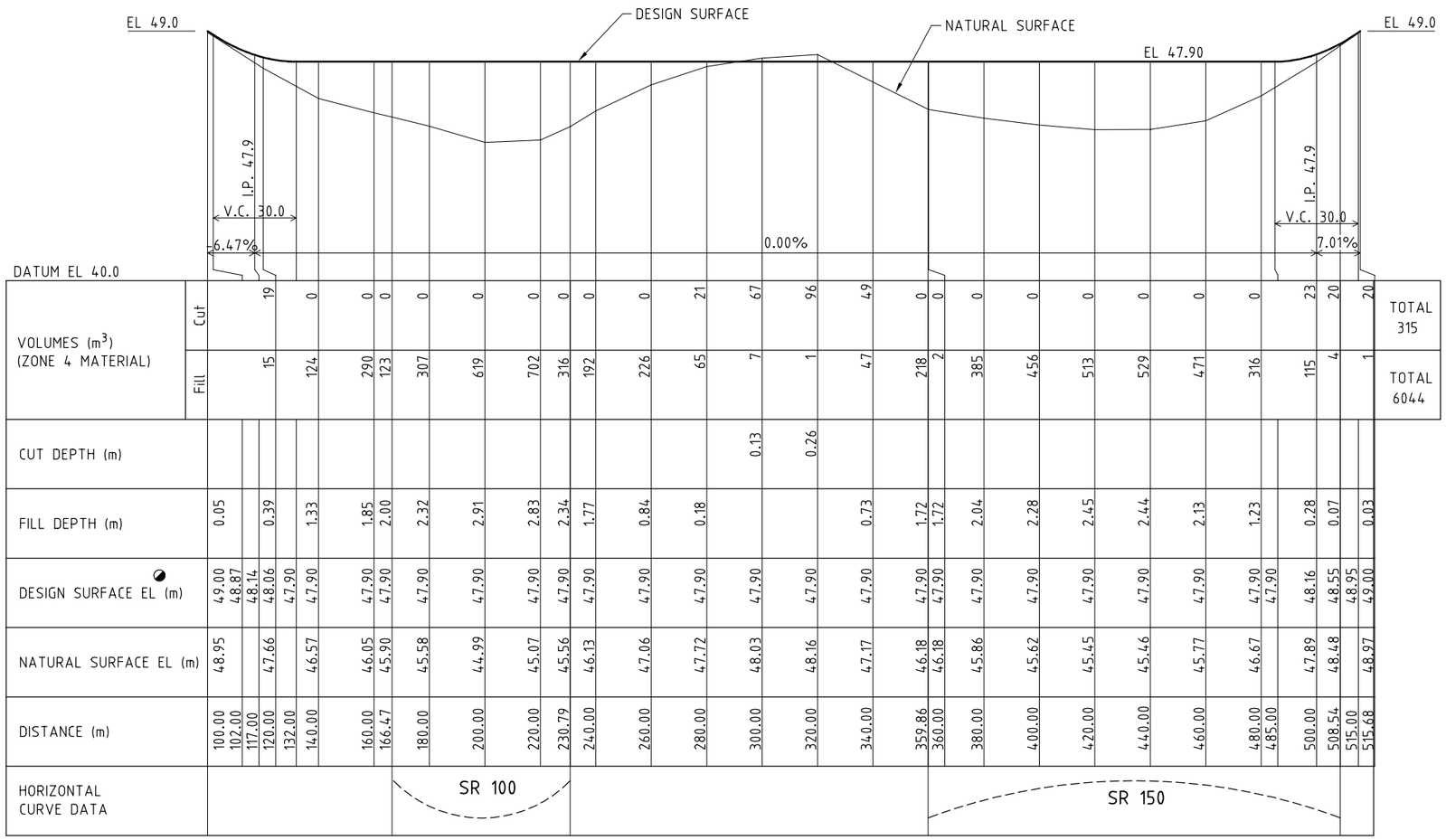


DATUM EL 40.0

VOLUMES (m^3) (ZONE 4 MATERIAL)	Cut			19	0	0	0	0	0	0	0	0	21	67	96	49	0	0	0	0	0	0	0	23	20	20	TOTAL 315			
	Fill			15	124	290	123	307	619	702	316	192	226	65	7	1	47	218	2	385	456	513	529	471	316	115	4	1	TOTAL 6044		
CUT DEPTH (m)															0.13	0.26														
FILL DEPTH (m)	0.05			0.39	1.33	1.85	2.00	2.32	2.91	2.83	2.34	1.77	0.84	0.18			0.73	1.72	1.72	2.04	2.28	2.45	2.44	2.13	1.23	0.28	0.07	0.03			
DESIGN SURFACE EL (m) ◕	49.00	48.87	48.14	48.06	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	48.16	48.55	48.95	49.00		
NATURAL SURFACE EL (m)	48.95			47.66	46.57	46.05	45.90	45.58	44.99	45.07	45.56	46.13	47.06	47.72	48.03	48.16	47.17	46.18	46.18	45.86	45.62	45.45	45.46	45.77	46.67	47.89	48.48	48.97			
DISTANCE (m)	100.00	102.00	117.00	120.00	132.00	140.00	160.00	166.47	180.00	200.00	220.00	230.79	240.00	260.00	280.00	300.00	320.00	340.00	359.86	360.00	380.00	400.00	420.00	440.00	460.00	480.00	485.00	500.00	508.54	515.00	515.68
HORIZONTAL CURVE DATA									SR 100																						
																														SR 150	

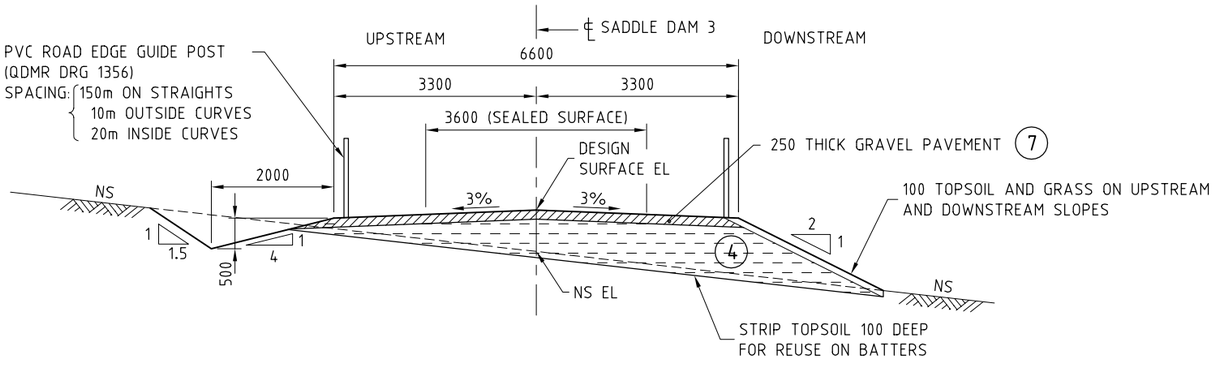
◕ FOR "AS BUILT' LEVELS REFER DRG SD1703

LONGITUDINAL SECTION

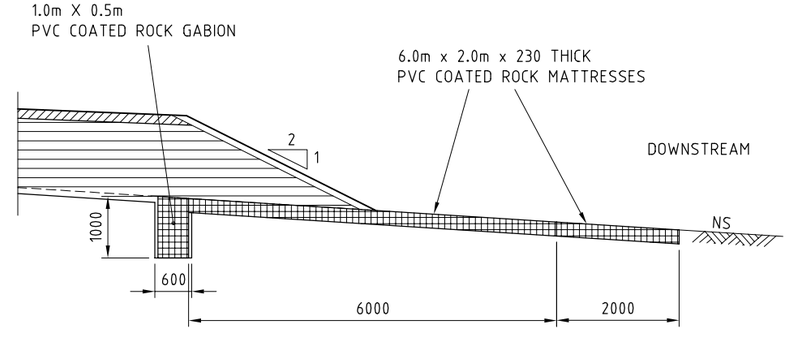
Scale Horizontal 1 : 2000 Vertical 1 : 200

EMBANKMENT ZONES

ZONE	(4)	MISCELLANEOUS FILL (SEE SPECIFICATION)
ZONE	(7)	GRAVEL PAVEMENT



TYPE CROSS SECTION



SECTION Y / SD1701

(SEE DWG GT1670 FOR GEOTECHNICAL INFORMATION)

GENERAL

ASSUMED SUBGRADE % CBR	15
TRAFFIC LOAD (ESA'S) / ROAD CLASS	1×10^4

PAVEMENT PROFILE

PRIMER SEAL TYPE - APPLICATION RATE (l/m2) NOMINAL STONE (mm) - APPLICATION RATE (m2/m3)	AMC4 - 1.0 ◕ 10 - 135
BASE (TOP) COURSE (mm) LOCALLY OCCURRING GRAVEL, CBR 15	125

Safety is EVERYBODY'S Responsibility

REVISION						REFERENCE DRAWINGS		
28.6.02	Z	AS BUILT	RP	PAJ				
23.4.01	C	FOR CONSTRUCTION						
5.1.01	B2	PRELIMINARY ISSUE 2						
8.12.00	B	PRELIMINARY ISSUE						
15.9.00	A	PTC VERSION						
DATE		REMARKS	CKD	PSD		SD1701	ARRANGEMENT – SH 1	

SCALES

0 1000 2000 3000 4000 5000 MILLIMETRES
1 : 100

Safe Production

DRAFTING RET/IMP	DESIGN APPROVED P.G.RICHARDSON	AWOONGA ALLIANCE
DRAFTING CHK KFP	DAM DESIGN LEADER	Gladstone Area Water Board
DESIGN RR	APPROVED FOR ISSUE H.HOLLAND 4.5.01	
DESIGN CHK PGR	DAM DESIGN MANAGER	

AWOONGA DAM RAISING STAGE 1

SADDLE DAM

SADDLE DAM 3 ARRANGEMENT

SH 2 OF 2

SW REFERENCE	
DRAWING NUMBER	SD1702
DATE	FEB 2001
A B B2 C Z	

AS BUILT

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09 Jul 2002 3:24 PM

25850E 25900E 25950E 26000E 26050E 26100E 26150E 26200E 26250E 26300E

37650N 37600N 37550N 37500N 37450N 37400N

INSET

JOINS INSET

SURVEY FILES 300041 & 900037

REVISION						REFERENCE DRAWINGS		
28.6.02	Z	AS BUILT	RP	PAJ				
DATE		REMARKS	CKD	PSD		SD1701	SADDLE DAM 3 – ARRANGEMENT	

SCALES

0 10 20 30 40 50 METRES
1 : 1000

Safe Production

DRAFTING KFP	DESIGN APPROVED
DRAFTING CHK	DAM DESIGN LEADER
DESIGN	APPROVED FOR ISSUE
DESIGN CHK	DAM DESIGN MANAGER

AWOONGA ALLIANCE
Gladstone Area Water Board

AWOONGA DAM RAISING STAGE 1
SADDLE DAMS
SADDLE DAM 3
AS BUILT SURVEY

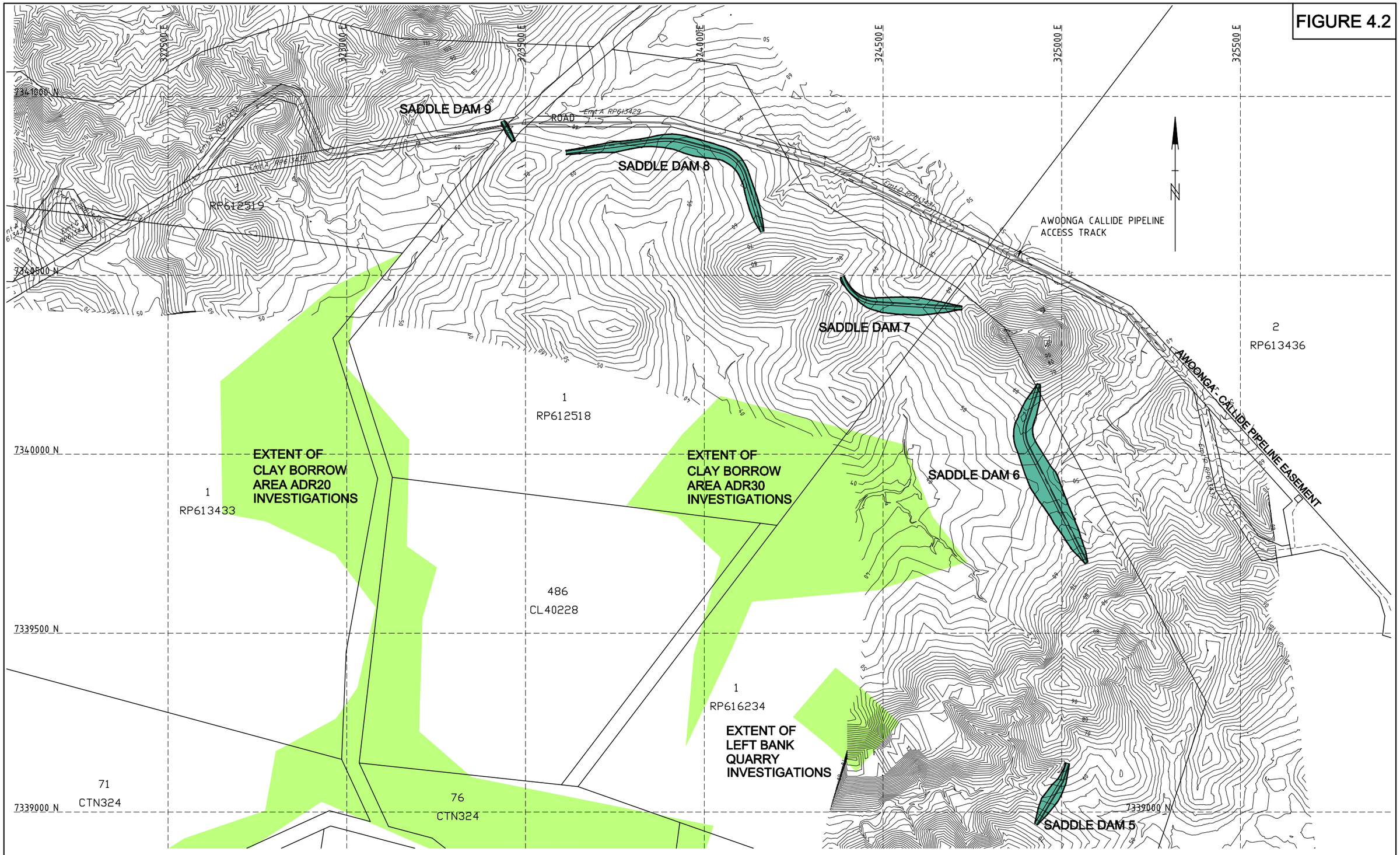
SW REFERENCE

DRAWING NUMBER
SD1703

DATE JUN 2002

Z

FIGURE 4.2



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NATURAL RESOURCES

STATE WATER PROJECTS
ENGINEERING SERVICES

GLADSTONE AREA WATER BOARD

AWOONGA DAM RAISING
ENGINEERING FEASIBILITY STUDIES
LOCATION AND FOOTPRINT OF SADDLE DAMS
FOR ULTIMATE DEVELOPMENT TO FSL 62.0m

SH 2 OF 2

Gladstone Area Water Board

NOV 99

A3-213923

Appendix B

Hydrological Information

BOYNE RIVER - AMTD 22.7km
AWOONGA DAM
DESIGN FLOOD HYDROLOGY
CATCHMENT MAP AND URBS MODEL LAYOUT

231408

Appendix C

Hydraulic Modelling Information

LOCALITY PLAN

LEGEND:

S6 — MODEL CROSS SECTION AND LABEL

MODELLED STREAM ALIGNMENT

AWOONGA DAM

REVISION	DATE		REMARKS	CKD	PSD

REFERENCE DRAWINGS		
	220481–82	PHOTO MOSAIC – SDF FSL 55 MAXIMUM FLOOD LEVELS SHS 1 & 2
	220479–80	PHOTO MOSAIC – PMF FSL 55 MAXIMUM FLOOD LEVELS SHS 1 & 2
	220477–78	PHOTO MOSAIC – SDF FSL 45 MAXIMUM FLOOD LEVELS SHS 1 & 2
	220475–76	PHOTO MOSAIC – PMF FSL 45 MAXIMUM FLOOD LEVELS SHS 1 & 2
	220473–74	PHOTO MOSAIC – SDF FSL 40 MAXIMUM FLOOD LEVELS SHS 1 & 2
	220471–72	PHOTO MOSAIC – PMF FSL 40 MAXIMUM FLOOD LEVELS SHS 1 & 2

SCALES

0 1000 2000 3000 3750 METRES

1:75000

DRAFTING	DESIGN
RET	
DRAFTING CHK	DESIGN CHK
APPROVED	
PROJECT MANAGER WATER STUDIES	

SunWater

AWOONGA DAM

BOYNE RIVER DAM BREAK AND FLOOD MODELLING STUDY

FSL 40.0, 45.0 AND 55.0 HYDRAULIC MODEL LAYOUT

CONTRACT NUMBER

DRAWING NUMBER **220483**

DATE OCT 2003

P:\G Projects 2003-2004\G-80600_Gladstone Area Water Board (GAWB)\03_Boyne River\01_BoyneRiverFloodStudy\drafting\220483.dwg

14 Oct 2003 2:59 PM

LEGEND:

- STREAM
- CATCHMENT BOUNDARY
- Yunka Creek — CATCHMENT NAME
- SUB CATCHMENT BOUNDARY
- 13 — NODE

PORT CURTIS

TANNUM SANDS

Cattle Creek

Boyne River

South Tree Inlet

Wappentake Creek

Creek No 2

Wurdongi Creek

Creek No 3

Machine Creek

Creek No 1

Tucker Gully

Yunka Creek

COOMAL CREEK

Station Creek

AWOONGA DAM

P:\G Projects 2003-2004\G-80600_Gladstone Area Water Board (GAWB)\03_Boyne River\01_BoyneRiverFloodStudy\drafting\220734.dwg
14 Oct 2003 11:12 AM

REVISION					DRAWINGS
DATE		REMARKS	CKD	PSD	REFERENCE

SCALES

0 1000 2000 3000 3750 METRES

1:75000

DRAFTING	DESIGN
RET	
DRAFTING CHK	DESIGN CHK
APPROVED	
PROJECT MANAGER WATER STUDIES	

SunWater

AWOONGA DAM

BOYNE RIVER DAM BREAK AND FLOOD MODELLING STUDY

CATCHMENT BELOW DAM

CONTRACT NUMBER

DRAWING NUMBER 220734

DATE OCT 2003

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event

Table C1 - Peak Water Levels, Saddle Dam No. 3

Branch	Chainage (m)	Cross Section ID	Location	1 in 2,000 AEP Peak Water Levels (m)			1 in 5,000 AEP			1 in 10,000 AEP			1 in 20,000 AEP		
				No Failure	Partial Breach	Full Breach	No Failure	Partial Breach	Full Breach	No Failure	Partial Breach	Full Breach	No Failure	Partial Breach	Full Breach
BOYNERIVER 0.00	0			39.96	39.96	39.96	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
BOYNERIVER 100.00	100			39.96	39.96	39.96	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
BOYNERIVER 100.00	100			39.96	39.96	39.96	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
BOYNERIVER 150.00	150			39.98	39.98	39.98	39.97	39.97	39.97	39.97	39.97	39.97	39.97	39.97	39.97
BOYNERIVER 350.00	350			19.67	21.41	22.73	20.03	22.49	23.25	21.50	23.40	23.84	22.83	24.32	26.09
BOYNERIVER 420.00	420			19.67	21.41	22.73	20.03	22.49	23.25	21.50	23.40	23.84	22.83	24.31	26.09
BOYNERIVER 420.00	420			19.67	21.41	22.73	20.03	22.49	23.25	21.50	23.40	23.84	22.83	24.31	26.09
BOYNERIVER 817.70	817.7	B21.7	D/S Awoonga Dam	19.13	21.12	22.53	20.00	22.22	23.06	21.44	23.15	23.65	22.73	24.07	25.82
BOYNERIVER 1383.80	1383.8	B21.15		18.71	20.89	22.36	19.98	21.99	22.89	21.38	22.92	23.49	22.64	23.84	25.58
BOYNERIVER 1985.90	1985.9	B20.6		18.09	20.58	22.16	19.96	21.71	22.70	21.32	22.66	23.30	22.54	23.60	25.30
BOYNERIVER 2182.33	2182.33		Tucker Gully	17.98	20.54	22.13	19.96	21.66	22.67	21.31	22.61	23.27	22.53	23.56	25.25
BOYNERIVER 2182.33	2182.33			17.98	20.54	22.13	19.96	21.66	22.67	21.31	22.61	23.27	22.53	23.56	25.25
BOYNERIVER 2462.80	2462.8	B20.1		17.63	20.15	21.68	19.59	21.29	22.26	20.95	22.25	22.87	22.15	23.18	24.77
BOYNERIVER 3120.26	3120.26		Coomal Ck	17.35	19.81	21.28	19.27	20.97	21.92	20.64	21.94	22.53	21.82	22.86	24.35
BOYNERIVER 3120.26	3120.26			17.35	19.81	21.28	19.27	20.97	21.92	20.64	21.94	22.53	21.82	22.86	24.35
BOYNERIVER 3313.40	3313.4	B18.95	Pikes Crossing	17.26	19.72	21.18	19.19	20.87	21.82	20.55	21.84	22.43	21.72	22.76	24.25
BOYNERIVER 3976.40	3976.4	B18.3		16.79	19.24	20.59	18.73	20.35	21.26	20.03	21.28	21.87	21.16	22.18	23.61
BOYNERIVER 4740.10	4740.1	B17.6		15.65	18.02	19.24	17.54	19.07	19.97	18.73	19.95	20.56	19.81	20.81	22.29
BOYNERIVER 5457.30	5457.3	B17.0	Manns Weir 50m U/S	15.29	17.59	18.77	17.14	18.61	19.53	18.28	19.47	20.11	19.36	20.35	21.87
BOYNERIVER 5457.30	5457.3	B17.0	Little Oaky Ck	15.29	17.59	18.77	17.14	18.61	19.53	18.28	19.47	20.11	19.36	20.35	21.87
BOYNERIVER 5934.10	5934.1	B16.7		14.93	17.25	18.41	16.80	18.28	19.21	17.94	19.14	19.80	19.03	20.04	21.60
BOYNERIVER 6676.80	6676.8	B16.0	Yunka Ck	14.49	16.67	17.82	16.22	17.72	18.67	17.38	18.60	19.29	18.49	19.52	21.17
BOYNERIVER 6676.80	6676.8	B16.0		14.49	16.67	17.82	16.22	17.72	18.67	17.38	18.60	19.29	18.49	19.52	21.17
BOYNERIVER 7293.40	7293.4	B15.5		14.14	16.17	17.28	15.72	17.21	18.16	16.88	18.09	18.78	17.97	19.00	20.67
BOYNERIVER 8050.70	8050.7	B14.8	O'L Station Offtake	13.71	15.67	16.78	15.23	16.73	17.68	16.39	17.61	18.30	17.49	18.53	20.22
BOYNERIVER 8050.70	8050.7	B14.8	QR Railway Bridge	13.71	15.67	16.78	15.23	16.73	17.68	16.39	17.61	18.30	17.49	18.53	20.22
BOYNERIVER 8522.40	8522.4	B14.35		13.50	15.48	16.61	15.04	16.56	17.53	16.22	17.46	18.16	17.34	18.39	20.10
BOYNERIVER 8856.20	8856.2	B14.0		13.44	15.43	16.57	14.99	16.52	17.50	16.17	17.42	18.13	17.30	18.36	20.08
BOYNERIVER 9247.40	9247.4	B13.6		13.29	15.28	16.42	14.84	16.37	17.36	16.02	17.28	17.99	17.16	18.22	19.95
BOYNERIVER 9679.30	9679.3	B13.2		13.12	15.11	16.23	14.67	16.19	17.17	15.84	17.10	17.81	16.98	18.04	19.77
BOYNERIVER 10080.40	10080.4	B12.8		12.97	14.98	16.11	14.53	16.07	17.07	15.72	17.00	17.72	16.87	17.95	19.70
BOYNERIVER 10401.00	10401			12.83	14.85	15.98	14.40	15.94	16.95	15.59	16.87	17.59	16.75	17.83	19.58
BOYNERIVER 10402.80	10402.8			12.86	14.87	16.01	14.44	15.98	16.99	15.62	16.91	17.63	16.78	17.86	19.61
BOYNERIVER 10412.80	10412.8	B12.5		***12.84***	***14.86***	***16.00***	***14.42***	***15.96***	***16.97***	***15.61***	***16.89***	***17.61***	***16.77***	***17.84***	***19.59***
BOYNERIVER 10414.00	10414			12.83	14.85	15.98	14.40	15.95	16.95	15.59	16.88	17.60	16.75	17.83	19.58
BOYNERIVER 10646.10	10646.1	B12.2	Bruce H'way Bridge	12.74	14.77	15.92	14.32	15.88	16.89	15.52	16.81	17.54	16.69	17.77	19.53
BOYNERIVER 10832.90	10832.9		Station Ck	12.63	14.67	15.82	14.21	15.77	16.79	15.42	16.71	17.44	16.59	17.67	19.44
BOYNERIVER 10832.90	10832.9			12.63	14.67	15.82	14.21	15.77	16.79	15.42	16.71	17.44	16.59	17.67	19.44
BOYNERIVER 11254.50	11254.5	B11.6		12.21	14.14	15.21	13.71	15.18	16.12	14.84	16.05	16.73	15.94	16.95	18.61
BOYNERIVER 11848.60	11848.6	B11.05	Boyne Trib2 &	11.54	13.30	14.28	12.91	14.25	15.10	13.95	15.03	15.66	14.94	15.85	17.36
BOYNERIVER 11848.60	11848.6	B11.05	O'L Boyne Offtake	11.54	13.30	14.28	12.91	14.25	15.10	13.95	15.03	15.66	14.94	15.85	17.36
BOYNERIVER 12303.00	12303			11.19	12.91	13.84	12.53	13.82	14.63	13.53	14.58	15.17	14.48	15.36	16.78
BOYNERIVER 12303.00	12303		Boyne Trib1	11.19	12.91	13.84	12.53	13.82	14.63	13.53	14.58	15.17	14.48	15.36	16.78
BOYNERIVER 12455.40	12455.4	B10.5		11.06	12.76	13.68	12.38	13.66	14.46	13.37	14.40	14.98	14.31	15.17	16.55
BOYNERIVER 12785.40	12785.4		Machine Ck	10.72	12.36	13.25	12.01	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
BOYNERIVER 12785.40	12785.4			10.72	12.36	13.25	12.01	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
BOYNERIVER 12874.90	12874.9	B10.2		10.62	12.24	13.11	11.89	13.10	13.85	12.82	13.79	14.34	13.71	14.52	15.77
BOYNERIVER 13251.30	13251.3	B9.8		10.42	12.04	12.91	11.69	12.89	13.65	12.62	13.59	14.14	13.51	14.32	15.58
BOYNERIVER 13865.90	13865.9	B9.1		9.85	11.35	12.17	11.03	12.16	12.87	11.90	12.82	13.33	12.74	13.49	14.67
BOYNERIVER 14304.56	14304.56		Wurdong Ck	9.61	11.07	11.86	10.76	11.85	12.54	11.60	12.49	12.99	12.42	13.15	14.29
BOYNERIVER 14304.56	14304.56			9.61	11.07	11.86	10.76	11.85	12.54	11.60	12.49	12.99	12.42	13.15	14.29
BOYNERIVER 14472.20	14472.2	B8.5		9.54	11.00	11.78	10.69	11.77	12.46	11.53	12.41	12.90	12.33	13.06	14.18
BOYNERIVER 14964.20	14964.2	B8.0		9.28	10.69	11.46	10.39	11.45	12.12	11.21	12.07	12.55	12.00	12.70	13.81
BOYNERIVER 15341.20	15341.2	B7.55		8.89	10.22	10.93	9.94	10.93	11.56	10.71	11.51	11.96	11.45	12.10	13.13
BOYNERIVER 15741.50	15741.5	B7.2		8.58	9.86	10.55	9.59	10.55	11.15	10.33	11.11	11.53	11.05	11.67	12.66
BOYNERIVER 16062.90	16062.9		O'L Boyne D/S	8.45	9.72	10.40	9.46	10.40	11.00	10.19	10.96	11.38	10.89	11.51	12.49
BOYNERIVER 16062.90	16062.9			8.45	9.72	10.40	9.46	10.40	11.00	10.19	10.96	11.38	10.89	11.51	12.49
BOYNERIVER 16145.40	16145.4	B6.8		8.41	9.68	10.36	9.42	10.37	10.96	10.15	10.92	11.34	10.86	11.47	12.46
BOYNERIVER 16727.90	16727.9	B6.2		7.99	9.21	9.87	8.96	9.88	10.46	9.67	10.42	10.82	10.36	10.94	11.88
BOYNERIVER 17358.60	17358.6	B5.55		7.51	8.71	9.36	8.47	9.37	9.94	9.17	9.90	10.28	9.85	10.41	11.31
BOYNERIVER 17722.19	17722.19		South Trees	6.91	7.98	8.57	7.77	8.60	9.12	8.41	9.09	9.43	9.04	9.54	10.35
BOYNERIVER 17722.19	17722.19			6.91	7.98	8.57	7.77	8.60	9.12	8.41	9.09	9.43	9.04	9.54	10.35
BOYNERIVER 17874.50	17874.5			6.75	7.83	8.43	7.62	8.45	8.98	8.26	8.95	9.30	8.90	9.41	10.24
BOYNERIVER 18184.66	18184.66		Cattle Ck	6.58	7.68	8.30	7.46	8.33	8.87	8.13	8.84	9.20	8.79	9.32	10.17
BOYNERIVER 18184.66	18184.66			6.58	7.68	8.30	7.46	8.33	8.87	8.13	8.84	9.20	8.79	9.32	10.17
BOYNERIVER 18476.20	18476.2	B4.5		6.38	7.47	8.07	7.26	8.10	8.63	7.91	8.60	8.95	8.55	9.07	9.90
BOYNERIVER 18884.20	18884.2	B4.05		5.99	7.01	7.56	6.82	7.60	8.09	7.42	8.06	8.38	8.01	8.48	9.24
BOYNERIVER 19282.40	19282.4	B3.65		5.85	6.86	7.41	6.68	7.45	7.94	7.28	7.91	8.24	7.87	8.34	9.11
BOYNERIVER 19869.50	19869.5	B3.15		5.49	6.47	7.01	6.31	7.07	7.55	6.90	7.52	7.84	7.48	7.94	8.68
BOYNERIVER 20263.70	20263.7	B2.75		5.12	6.03	6.55	5.90	6.62	7.07	6.46	7.05	7.34	7.00	7.44	8.13
BOYNERIVER 20684.60	20684.6	B2.45		4.74	5.62	6.11	5.52	6.21	6.63	6.06	6.61	6.89	6.57	6.98	7.65
BOYNERIVER 20866.30	20866.3	B2.25		4.62	5.48	5.95	5.39	6.06	6.49	5.91	6.47	6.76	6.43	6.85	7.51
BOYNERIVER 21269.40	21269.4	B1.85	John Oxley Bridge	4.19	4.95	5.36	4.92	5.51	5.89	5.37	5.87	6.12	5.83	6.21	6.81
BOYNERIVER 21471.70	21471.7	B1.65		3.80	4.43	4.75	4.46	4.93	5.24	4.82	5.22	5.42	5.19	5.48	5.93
BOYNERIVER 21861.20	21861.2	B1.2		3.52	4.05	4.28	4.15	4.52	4.75	4.44	4.74	4.88	4.72	4.93	5.25
BOYNERIVER 22251.30	22251.3	B0.9		3.00	3.32	3.39	3.65	3.89	4.01	3.84	4.00	4.06	3.99	4.08	4.15
BOYNERIVER 22636.00	22636	B0.5		2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42
COOMALCK 0.00	0	C1		37.08	37.08	37.08	37.31	37.31	37.31	37.43	37.43	37.43	37.57	37.57	37.57
COOMALCK 398.20	398.2	C2		33.38	33.38	33.38	33.88	32.83	32.67	33.01	33.29	32.89	33.66	33.42	32.88
COOMALCK 794.20	794.2	C3		39.32	39.32	39.32	31.78	33.69	31.27	31.82	36.13	31.99	38.66	38.47	31.15
COOMALCK 1209.50	1209.5	C4		31.25	31.25	31.25	31.17	29.16	29.72	30.95	30.63	30.45	31.04	31.03	27.32
COOMALCK 1813.30	1813.3	C5		24.82	24.82	24.82	24.08	23.43	23.46	24.07	24.85	24.11	24.78	25.01	24.35
COOMALCK 2352.80	2352.8	C6		18.29	19.81	21.32	19.58	21.10	22.00	20.85	22.19	22.67	22.03	23.07	24.35
COOMALCK 3112.20	3112.2	C7		17.36	19.81	21.28	19.28	20.98	21.93	20.66	21.98	22.55	21.85	22.91	24.35
COOMALCK 3751.30	3751.3	C8		17.35	19.81	21.28	19.27	20.97	21.92	20.64	21.96	22.54	21.83	22.89	24.35
COOMALCK 4222.50	4222.5	C9		17.34	19.81	21.28	19.27	20.96	21.91	20.63	21.93	22.52	21.81	22.85	24.35
COOMALCK 4305.00	4305			17.35	19.81	21.28	19.27	20.97	21.92	20.64	21.94	22.53	21.82	22.86	24.35
YUNKACK 0.00	0	Y1		33.45	33.45	33.45	33.70	33.70	33.70	33.86	33.86	33.86	34.04	34.04	34.04
YUNKACK 574.20	574.2	Y2		25.89	25.89	25.89	26.12	26.12	26.12	26.27	26.27	26.27	26.44	26.44	26.44
YUNKACK 948.90	948.9	Y3		21.62	21.62	21.62	21.77	21.77	21.77	21.87	21.87	21.87	21.98	21.98	21.98
YUNKACK 1253.10	1253.1	Y4		18.53	18.57	18.57	18.63	19.35	18.76	18.70	18.70	19.30	18.79	19.53	21.17
YUNKACK 1835.50	1835.5	Y5		14.49	16.67	17.82	16.22	17.73	18.67	17.38	18.61	19.30	18.49	19.52	21.17
YUNKACK 2434.60	2434.6	Y6		14.49	16.67	17.82	16.22	17.72	18.67	17.38	18.60	19.29	18.49	19.52	21.17
YUNKACK 2763.00	2763	Y7		14.49	16.67	17.82	16.22	17.72	18.67	17.38	18.60	19.29	18.49	19.52	21.17
TUCKERGULLY 0.00	0			34.87	34.87	34.87	35.44	35.44	35.44	35.71	35.71	35.71	35.97	35.97	35.97
TUCKERGULLY 1066.80	1066.8	TU-1		33.15	33.15	33.15	33.54	33.54	33.54	33.79	33.79	33.79	34.08	34.08	34.08
TUCKERGULLY 1965.80	1965.8	TU-2		28.33	28.33	28.33	28.61	28.61	28.61	28.78	28.78	28.78	28.99	28.99	28.99
TUCKERGULLY 2491.10	2491.1	TU-3		25.04	25.04	25.04	25.37	25.37	25.37	25.55	25.55	25.55	25.77	25.77	25.77
TUCKERGULLY 3217.50	3217.5	TU-4		20.84	20.84	22.36	21.08	21.87	22.87	21.74	22.88	23.48	22.87	23.81	25.33
TUCKERGULLY 3966.50	3966.5	TU-5		18.01	20.66	22.32	20.49	21.82	22.83	21.70	22.79	23.42	22.80	23.72	25.33
TUCKERGULLY 4522.10	4522.1	TU-6		17.99	20.66	22.30	20.49	21.80	22.83	21.67	22.74	23.42	22.77	23.69	25.33
TUCKERGULLY 5384.20	5384.2	TU-7	Awoonga Dam Rd Xing	17.99	20.66	22.30	20.49	21.78	22.83	21.65	22.73	23.42	22.76	23.67	25.33
TUCKERGULLY 5765.40	5765.4		Tucker Trib	17.98	20.66	22.30	20.49	21.77	22.83	21.65	22.72	23.42	22.76	23.67	25.33
TUCKERGULLY 5765.40	5765.4			17.98	20.66	22.30	20.49	21.77	22.83	21.65	22.72	23.42	22.76	23.67	25.33
TUCKERGULLY 6350.10	6350.1	TU-8		17.98	20.58	22.19	20.17	21.70	22.72	21.43	22.65	23.32	22.61	23.60	25.28
TUCKERGULLY 6669.00	6669	TU-9		17.98	20.54	22.13	19.96	21.66	22.67	21.31	22.61	23.27	22.53	23.56	25.25
TUCKERTRIB 0.00	0			35.10	40.22	42.07	41.96	40.75	42.26	42.32	41.33	42.41	42.64	41.98	42.84
TUCKERTRIB 206.20	206.2	T1-1		34.01	38.42	40.10	40.00	38.90	40.27	40.33	39.43	40.40	40.62	40.02	40.80
TUCKERTRIB 730.40	730.4	T1-2		30.03	34.09	35.71	35.62	34.57	35.88	35.95	35.08	36.04	36.26	35.64	36.47
TUCKERTRIB 1416.70	1416.7	T1-3		23.39	27.82	29.54	29.45	28.32	29.74	29.82	28.89	29.95	30.18	29.54	30.50
TUCKERTRIB 1944.80	1944.8	T1-4		19.05	24.32	26.60	26.50	25.16	26.95	27.00	25.99	27.33	27.52	26.90	28.30
TUCKERTRIB 2331.50	2331.5	T1-5		18.34	23.28	25.51	25.39	24.18	25.92	25.91	25.04	26.35	26.47	25.98	27.43

Table C1 - Peak Water Levels, Saddle Dam No. 3

Branch	Chainage (m)	Cross Section ID	Location	1 in 2,000 AEP Peak Water Levels (m)			1 in 5,000 AEP			1 in 10,000 AEP			1 in 20,000 AEP		
				No Failure	Partial Breach	Full Breach	No Failure	Partial Breach	Full Breach	No Failure	Partial Breach	Full Breach	No Failure	Partial Breach	Full Breach
TUCKERTRIB 2914.70	2914.7	T1-6	Awoonga Dam Rd Xing	18.03	21.51	23.53	22.93	22.54	23.97	23.58	23.48	24.49	24.30	24.43	26.05
TUCKERTRIB 3377.00	3377			17.98	20.66	22.30	20.49	21.77	22.83	21.65	22.72	23.42	22.76	23.67	25.33
STATIONCK 0.00	0	S1		15.55	15.55	15.83	15.87	15.87	16.80	15.98	16.73	17.46	16.60	17.69	19.46
STATIONCK 684.50	684.5	S2		13.84	14.67	15.83	14.22	15.79	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 1599.70	1599.7	S3		12.63	14.67	15.83	14.22	15.79	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 2431.30	2431.3	S4		12.63	14.67	15.83	14.22	15.79	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 3013.70	3013.7	S5		12.63	14.67	15.83	14.22	15.79	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 3734.90	3734.9	S6	Bruce H'way	12.63	14.67	15.83	14.22	15.79	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 4481.70	4481.7	S7		12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 5140.80	5140.8	S8		12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 5918.90	5918.9	S9		12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 6575.50	6575.5	S10		12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 6954.40	6954.4		O'L Station D/S	12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 6954.40	6954.4			12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
STATIONCK 7691.00	7691	S11		12.63	14.67	15.82	14.21	15.77	16.79	15.42	16.71	17.44	16.59	17.67	19.44
MACHINECK 0.00	0	M1		33.39	33.39	33.39	33.55	33.55	33.55	33.65	33.65	33.65	33.78	33.78	33.78
MACHINECK 726.30	726.3	M2		28.45	28.45	28.45	28.64	28.64	28.64	28.77	28.77	28.77	28.92	28.92	28.92
MACHINECK 1186.80	1186.8	M3		26.34	26.34	26.34	26.54	26.54	26.54	26.67	26.67	26.67	26.82	26.82	26.82
MACHINECK 1699.10	1699.1	M4		22.60	22.60	22.60	22.85	22.85	22.85	22.99	22.99	22.99	23.15	23.15	23.15
MACHINECK 2214.80	2214.8	M5		20.52	20.52	20.52	20.78	20.78	20.78	20.84	20.84	20.84	20.91	20.91	20.91
MACHINECK 2730.60	2730.6	M6		16.75	16.75	16.75	17.08	17.08	17.08	17.16	17.16	17.16	17.26	17.26	17.26
MACHINECK 3140.90	3140.9	M7		14.44	14.44	14.44	14.73	14.73	14.73	14.93	14.93	14.93	15.16	15.16	15.96
MACHINECK 3611.90	3611.9	M8		12.40	12.40	13.25	12.61	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
MACHINECK 4246.80	4246.8	M9	Road/Rail X-ing	10.72	12.36	13.25	12.01	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
MACHINECK 5099.90	5099.9	M10		10.72	12.36	13.25	12.01	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
MACHINECK 5868.40	5868.4	M11	Bruce H'way 100m U/S	10.72	12.36	13.25	12.01	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
MACHINECK 6711.00	6711	M12		10.72	12.36	13.25	12.01	13.23	14.00	12.96	13.94	14.50	13.86	14.68	15.96
O'LSTATION 0.00	0			13.71	15.67	16.78	15.23	16.73	17.68	16.39	17.61	18.30	17.49	18.53	20.22
O'LSTATION 304.10	304.1	O2-1		13.70	15.62	16.72	15.18	16.67	17.62	16.33	17.55	18.24	17.43	18.47	20.16
O'LSTATION 1252.20	1252.2	O2-2		13.59	15.38	16.49	14.95	16.44	17.41	16.10	17.34	18.04	17.22	18.27	19.99
O'LSTATION 1924.60	1924.6	O2-3		12.84	14.99	16.16	14.52	16.12	17.13	15.76	17.06	17.79	16.93	18.02	19.77
O'LSTATION 2385.50	2385.5			12.66	14.76	15.93	14.29	15.88	16.91	15.52	16.83	17.56	16.70	17.79	19.56
O'LSTATION 2588.00	2588	O2-4	Bruce H'way	12.63	14.67	15.83	14.22	15.78	16.80	15.43	16.73	17.46	16.60	17.69	19.46
WURDONGCK 0.00	0	W1		26.00	26.00	26.00	26.14	26.14	26.14	26.23	26.23	26.23	26.34	26.34	26.34
WURDONGCK 616.40	616.4	W2		20.67	20.67	20.67	20.84	20.84	20.84	20.95	20.95	20.95	21.08	21.08	21.08
WURDONGCK 1311.60	1311.6	W3		15.28	15.28	15.28	15.50	15.50	15.50	15.65	15.65	15.65	15.83	15.83	15.83
WURDONGCK 1752.90	1752.9	W4		12.62	12.62	12.62	12.89	12.89	12.89	13.06	13.06	13.06	13.26	13.26	14.29
WURDONGCK 2482.50	2482.5	W5	GLD/Benaraby Rd 100m D/S	9.61	11.07	11.86	10.76	11.85	12.54	11.60	12.49	12.99	12.42	13.15	14.29
WURDONGCK 3446.50	3446.5	W6		9.61	11.07	11.86	10.76	11.85	12.54	11.60	12.49	12.99	12.42	13.15	14.29
WURDONGCK 4664.00	4664	W7		9.61	11.07	11.86	10.76	11.85	12.54	11.60	12.49	12.99	12.42	13.15	14.29
BOYNETRIB1 0.00	0	T2-1		24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04
BOYNETRIB1 573.10	573.1	T2-2		16.24	16.24	16.24	16.24	16.24	16.24	16.24	16.24	16.24	16.24	16.24	16.79
BOYNETRIB1 1368.30	1368.3	T2-3		11.19	12.91	13.85	12.53	13.82	14.63	13.53	14.58	15.17	14.48	15.36	16.78
BOYNETRIB1 1848.20	1848.2	T2-4	Bruce H'way 75m D/S	11.19	12.91	13.85	12.53	13.82	14.63	13.53	14.58	15.17	14.48	15.36	16.78
BOYNETRIB1 2194.80	2194.8	T2-5		11.19	12.91	13.84	12.53	13.82	14.63	13.53	14.58	15.17	14.48	15.36	16.78
BOYNETRIB1 2663.00	2663	T2-6		11.19	12.91	13.84	12.53	13.82	14.63	13.53	14.58	15.17	14.48	15.36	16.78
BOYNETRIB2 0.00	0	T3-1		18.37	18.37	18.37	18.33	18.33	18.33	18.33	18.33	18.33	18.33	18.33	18.33
BOYNETRIB2 381.20	381.2	T3-2		14.60	14.60	14.60	14.53	14.53	15.10	14.53	15.04	15.66	14.95	15.87	17.36
BOYNETRIB2 713.60	713.6	T3-3		11.54	13.30	14.28	12.91	14.25	15.10	13.95	15.04	15.66	14.94	15.85	17.36
BOYNETRIB2 1247.10	1247.1	T3-4		11.54	13.30	14.28	12.91	14.25	15.10	13.95	15.03	15.66	14.94	15.85	17.36
BOYNETRIB2 1804.00	1804	T3-5		11.54	13.30	14.28	12.91	14.25	15.10	13.95	15.03	15.66	14.94	15.85	17.36
O'LANDBOYNE 0.00	0			11.54	13.30	14.28	12.91	14.25	15.10	13.95	15.03	15.66	14.94	15.85	17.36
O'LANDBOYNE 462.10	462.1	O3-1		9.85	11.46	12.22	11.13	12.20	12.84	11.97	12.79	13.26	12.72	13.41	14.41
O'LANDBOYNE 843.90	843.9	O3-2		9.15	10.68	11.38	10.36	11.38	12.00	11.15	11.96	12.43	11.89	12.58	13.55
O'LANDBOYNE 1492.50	1492.5	O3-3		8.51	9.79	10.49	9.52	10.49	11.11	10.27	11.07	11.51	11.00	11.65	12.64
O'LANDBOYNE 1924.31	1924.31		O'Land01 U/S	8.46	9.72	10.40	9.46	10.40	11.00	10.19	10.96	11.38	10.90	11.51	12.49
O'LANDBOYNE 1924.31	1924.31			8.46	9.72	10.40	9.46	10.40	11.00	10.19	10.96	11.38	10.90	11.51	12.49
O'LANDBOYNE 2032.00	2032	O3-4		8.45	9.72	10.40	9.46	10.40	11.00	10.19	10.96	11.38	10.89	11.51	12.49
O'LAND01 0.00	0			8.46	9.72	10.40	9.46	10.40	11.00	10.19	10.96	11.38	10.90	11.51	12.49
O'LAND01 415.30	415.3	O4-01		8.38	9.54	10.15	9.30	10.16	10.70	9.96	10.67	11.05	10.61	11.18	12.10
O'LAND01 1018.80	1018.8	O4-02		8.16	9.14	9.67	8.94	9.68	10.19	9.50	10.16	10.52	10.10	10.64	11.56
O'LAND01 1360.20	1360.2	O4-03		7.48	8.59	9.21	8.36	9.22	9.80	9.02	9.76	10.17	9.70	10.30	11.27
O'LAND01 1988.30	1988.3	O4-04		6.81	8.08	8.78	7.81	8.81	9.44	8.58	9.40	9.83	9.34	9.96	10.98
O'LAND01 2586.50	2586.5	O4-05		6.65	7.91	8.62	7.64	8.65	9.28	8.42	9.24	9.67	9.18	9.81	10.82
O'LAND01 3091.00	3091	O4-06		6.59	7.75	8.41	7.51	8.44	9.03	8.22	8.99	9.39	8.93	9.51	10.47
CATTLECK 0.00	0	CC1	Tannum Sands Rd 50m D/S	7.58	7.75	8.41	7.67	8.44	9.03	8.22	8.99	9.39	8.93	9.51	10.47
CATTLECK 743.60	743.6	CC2		6.59	7.75	8.41	7.51	8.44	9.03	8.22	8.99	9.39	8.93	9.51	10.47
CATTLECK 1293.10	1293.1	CC3		6.59	7.75	8.41	7.51	8.44	9.03	8.22	8.99	9.39	8.93	9.51	10.47
CATTLECK 1994.43	1994.43		O'Land 01 D/S	6.59	7.75	8.41	7.51	8.44	9.03	8.22	8.99	9.39	8.93	9.51	10.47
CATTLECK 1994.43	1994.43			6.59	7.75	8.41	7.51	8.44	9.03	8.22	8.99	9.39	8.93	9.51	10.47
CATTLECK 2124.80	2124.8	CC4		6.59	7.72	8.36	7.49	8.39	8.96	8.18	8.92	9.30	8.87	9.42	10.33
CATTLECK 2335.00	2335			6.58	7.68	8.30	7.46	8.33	8.87	8.13	8.84	9.20	8.79	9.32	10.17
STHTREES 0.00	0	ST1	Sth Trees/BoyneR Bifurcate	6.91	7.98	8.57	7.77	8.60	9.12	8.41	9.09	9.43	9.04	9.54	10.35
STHTREES 851.80	851.8	ST2		5.59	6.69	7.26	6.51	7.31	7.82	7.13	7.79	8.20	7.72	8.33	9.26
STHTREES 1579.60	1579.6	ST3	Boyne Is Rd Bridge	5.19	6.31	6.90	6.13	6.97	7.49	6.79	7.46	7.89	7.39	8.03	8.98
STHTREES 2361.30	2361.3	ST4		4.88	6.04	6.63	5.87	6.70	7.23	6.52	7.19	7.64	7.12	7.78	8.75
STHTREES 2829.50	2829.5	ST5		4.77	5.95	6.54	5.78	6.61	7.14	6.43	7.11	7.56	7.04	7.70	8.67
STHTREES 3773.50	3773.5	ST6		4.57	5.79	6.38	5.62	6.47	6.99	6.28	6.96	7.42	6.89	7.56	8.53
STHTREES 4171.60	4171.6	ST7		4.49	5.72	6.31	5.55	6.39	6.92	6.21	6.89	7.35	6.82	7.49	8.45
STHTREES 4595.40	4595.4	ST8		4.36	5.59	6.18	5.43	6.27	6.79	6.09	6.75	7.21	6.69	7.35	8.30
STHTREES 5122.39	5122.39		Ten Mile Ck	4.20	5.42	6.00	5.27	6.09	6.60	5.91	6.57	7.01	6.50	7.15	8.07
STHTREES 5122.39	5122.39			4.20	5.42	6.00	5.27	6.09	6.60	5.91	6.57	7.01	6.50	7.15	8.07
STHTREES 5493.40	5493.4	ST9		4.10	5.30	5.87	5.16	5.96	6.47	5.79	6.43	6.87	6.37	7.01	7.91
STHTREES 6390.90	6390.9	ST10		3.46	4.46	4.97	4.39	5.09	5.54	4.93	5.51	5.91	5.45	6.03	6.81
STHTREES 7658.80	7658.8	ST11		2.75	3.56	3.99	3.64	4.17	4.50	4.06	4.48	4.78	4.44	4.87	5.56
STHTREES 8251.05	8251.05		Eleven Mile Ck	2.68	3.47	3.90	3.57	4.09	4.41	3.98	4.39	4.68	4.35	4.77	5.44
STHTREES 8251.05	8251.05			2.68	3.47	3.90	3.57	4.09	4.41	3.98	4.39	4.68	4.35	4.77	5.44
STHTREES 9287.10	9287.1	ST12		2.54	3.27	3.67	3.41	3.88	4.18	3.78	4.16	4.42	4.12	4.51	5.13
STHTREES 11258.10	11258.1	ST13		2.42	2.79	3.11	3.06	3.41	3.65	3.33	3.63	3.85	3.60	3.92	4.46
STHTREES 12688.10	12688.1	ST14		2.42	2.42	2.64	2.81	3.06	3.24	3.00	3.23	3.41	3.21	3.47	3.91
STHTREES 14444.90	14444.9	ST15		2.42	2.42	2.42	2.65	2.81	2.93	2.77	2.93	3.05	2.91	3.09	3.43
STHTREES 17478.00	17478	ST16		2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42
TENMILECK 0.00	0	T4-1	GLD/Benaraby Boyne X-ing	9.88	9.88	9.88	10.02	10.02	10.02	10.11	10.11	10.11	10.21	10.21	10.21
TENMILECK 510.20	510.2	T4-2		4.26	5.42	6.00	5.27	6.09	6.60	5.91	6.57	7.01	6.50	7.15	8.08
TENMILECK 1040.50	1040.5	T4-3		4.20	5.42	6.00	5.27	6.09	6.60	5.91	6.57	7.01	6.50	7.15	8.08
TENMILECK 1753.90	1753.9	T4-4		4.20	5.42	6.00	5.27	6.09	6.60	5.91	6.57	7.01	6.50	7.15	8.08
TENMILECK 2298.00	2298	T4-5		4.20	5.42	6.00	5.27	6.09	6.60	5.91	6.57	7.01	6.50	7.15	8.07
ELEVENMILECK 0.00	0	T5-1		12.06	12.06	12.06	12.30	12.30	12.30	12.46	12.46	12.46	12.65	12.65	12.65
ELEVENMILECK 883.90	883.9	T5-2	GLD/Benaraby Rd	4.54	4.54	4.54	4.77	4.77	4.77	4.94	4.94	4.94	5.14	5.14	5.44
ELEVENMILECK 1811.40	1811.4	T5-3		2.68	3.47	3.90	3.57	4.09	4.41	3.98	4.39	4.68	4.35	4.77	5.44
ELEVENMILECK 3118.20	3118.2	T5-4		2.68	3.47	3.90	3.57	4.09	4.41	3.98	4.39	4.68	4.35	4.77	5.44
ELEVENMILECK 3887.00	3887			2.68	3.47	3.90	3.57	4.09	4.41	3.98	4.39	4.68	4.35	4.77	5.44
LITTLEOAKYCK 0.00	0	O1-1A		17.29	17.59	18.77	17.37	18.62	19.54	18.28	19.49	20.13	19.36	20.36	21.87
LITTLEOAKYCK 670.00	670	O1-2A		15.29	17.59	18.77	17.14	18.62	19.54	18.28	19.49	20.13	19.36	20.36	21.87
LITTLEOAKYCK 1834.00	1834	O1-3A		15.29	17.59	18.77	17.14	18.61	19.53	18.28	19.47	20.11	19.36	20.35	21.87
LITTLEOAKYCK 1958.00	1958			15.29	17.59	18.77	17.14	18.61	19.53	18.28	19.47	20.11	19.36	20.35	21.87
SPILLWAY 0.00	0			39.96	39.96	39.96	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
SPILLWAY 300.00	300			19.67	21.41	22.73	20.03	22.49	23.25	21.50	23.40	23.84	22.83	24.31	26.09

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event
RCC Embankment Level 47.9m

Table C2 - Peak Discharges (m^3/s), Saddle Dam No. 3

Branch	1 in 2,000 AEP Event			1 in 20,000 AEP			PMPDF		
	No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m
BOYNERIVER 50.00	62	62	62	62	62	62	62	62	62
BOYNERIVER 125.00	335	335	335	335	335	335	335	335	335
BOYNERIVER 250.00	0	0	0	0	0	0	0	0	0
BOYNERIVER 385.00	5	5	6	5	6	6	5	6	6
BOYNERIVER 618.85	4991	4984	4964	7053	7049	7049	9897	9645	9609
BOYNERIVER 1100.75	4990	4979	4956	7059	7043	7042	9896	9634	9584
BOYNERIVER 1684.85	4990	4977	4945	7063	7036	7036	9893	9627	9569
BOYNERIVER 2084.11	4989	4974	4940	7064	7031	7030	9888	9622	9560
BOYNERIVER 2322.56	5266	6330	6965	10181	11892	12885	18634	20737	22265
BOYNERIVER 2791.53	5265	6325	6959	10182	11882	12871	18628	20731	22254
BOYNERIVER 3216.83	5326	6351	7050	10278	11882	12897	18672	20670	22155
BOYNERIVER 3644.90	5309	6313	7000	10237	11854	12860	18651	20659	22136
BOYNERIVER 4358.25	5278	6254	6927	10207	11825	12822	18628	20644	22115
BOYNERIVER 5098.70	5280	6248	6927	10209	11820	12810	18629	20627	22088
BOYNERIVER 5695.70	5219	6164	6733	10099	11654	12556	18553	20436	21775
BOYNERIVER 6305.45	5213	6154	6702	10084	11615	12515	18535	20399	21713
BOYNERIVER 6985.10	5201	6128	6636	10046	11528	12386	18487	20292	21531
BOYNERIVER 7672.05	5198	6119	6625	10038	11507	12353	18474	20253	21466
BOYNERIVER 8286.55	5047	5727	6096	7692	8515	8986	11236	12098	12719
BOYNERIVER 8689.30	5044	5717	6078	7685	8494	8957	11226	12067	12671
BOYNERIVER 9051.80	5039	5705	6056	7675	8467	8918	11216	12035	12622
BOYNERIVER 9463.35	5036	5698	6044	7671	8454	8900	11212	12020	12598
BOYNERIVER 9879.85	5036	5695	6037	7669	8445	8888	11210	12011	12581
BOYNERIVER 10240.70	5046	5702	6039	7679	8450	8886	11216	12007	12569
BOYNERIVER 10401.90	5179	5839	6166	7838	8606	9064	11351	12131	12721
BOYNERIVER 10407.80	5187	5834	6157	7872	8631	9065	11385	12164	12722
BOYNERIVER 10413.40	6445	7070	7456	9678	10565	11047	12992	13900	14525
BOYNERIVER 10530.05	5054	5708	6040	7690	8456	8893	11225	12012	12568
BOYNERIVER 10739.50	5032	5681	6010	7659	8415	8846	11201	11979	12525
BOYNERIVER 11043.70	5121	5938	6386	9854	11062	11721	18217	19784	20742
BOYNERIVER 11551.55	5120	5937	6384	9853	11060	11719	18215	19782	20740
BOYNERIVER 12075.80	4076	4647	4957	7331	8159	8606	12804	13810	14421
BOYNERIVER 12379.20	4077	4647	4957	7325	8146	8589	12782	13785	14404
BOYNERIVER 12620.40	***4075***	***4643***	***4950***	***7319***	***8136***	***8573***	***12767***	***13774***	***14392***
BOYNERIVER 12830.15	4073	4638	4943	7313	8126	8557	12752	13763	14381
BOYNERIVER 13063.10	4073	4638	4943	7313	8126	8557	12752	13762	14380
BOYNERIVER 13558.60	4073	4637	4941	7312	8124	8554	12751	13761	14379
BOYNERIVER 14085.23	4073	4636	4941	7312	8123	8553	12751	13760	14378
BOYNERIVER 14388.38	4069	4626	4929	7301	8103	8527	12739	13741	14354
BOYNERIVER 14718.20	4069	4626	4928	7300	8103	8527	12739	13741	14354
BOYNERIVER 15152.70	4068	4626	4928	7300	8102	8527	12738	13741	14353
BOYNERIVER 15541.35	4068	4626	4927	7300	8102	8526	12738	13740	14353
BOYNERIVER 15902.20	4068	4625	4927	7300	8102	8526	12738	13740	14352
BOYNERIVER 16104.15	4729	5317	5618	7703	8394	8758	12333	13144	13639
BOYNERIVER 16436.65	4729	5317	5617	7702	8393	8756	12332	13143	13637
BOYNERIVER 17043.25	4728	5316	5617	7702	8392	8755	12332	13143	13636
BOYNERIVER 17540.39	4728	5316	5616	7702	8391	8754	12331	13142	13635
BOYNERIVER 17798.34	3012	3196	3287	3763	3843	3879	3952	3984	4008
BOYNERIVER 18029.58	3012	3196	3287	3762	3841	3876	3952	3981	4004
BOYNERIVER 18330.43	3394	3787	4017	5862	6386	6670	9772	10504	10948
BOYNERIVER 18680.20	3394	3787	4017	5862	6386	6670	9772	10504	10948
BOYNERIVER 19083.30	3394	3787	4017	5862	6386	6670	9772	10504	10948
BOYNERIVER 19575.95	3394	3787	4017	5862	6386	6670	9772	10503	10948
BOYNERIVER 20066.60	3394	3787	4017	5861	6386	6670	9772	10503	10948
BOYNERIVER 20474.15	3394	3786	4017	5861	6386	6669	9772	10503	10947
BOYNERIVER 20775.45	3394	3786	4017	5861	6386	6669	9772	10503	10947
BOYNERIVER 21067.85	3394	3786	4017	5861	6386	6669	9772	10503	10947
BOYNERIVER 21370.55	3394	3786	4017	5861	6385	6669	9772	10503	10947
BOYNERIVER 21666.45	3394	3786	4017	5861	6385	6669	9772	10503	10947
BOYNERIVER 22056.25	3394	3786	4017	5861	6385	6669	9771	10503	10947
BOYNERIVER 22443.65	3394	3786	4017	5861	6385	6669	9771	10503	10947
COOMALCK 199.10	49	49	49	111	111	111	168	168	168
COOMALCK 596.20	220	49	49	125	125	125	168	168	168
COOMALCK 1001.85	734	104	84	742	742	1303	357	309	255
COOMALCK 1511.40	2697	50	54	314	276	578	195	198	169
COOMALCK 2083.05	1628	263	435	204	230	374	266	353	285
COOMALCK 2732.50	450	154	273	246	259	362	262	301	264
COOMALCK 3431.75	434	183	308	274	294	329	282	375	302
COOMALCK 3986.90	343	195	317	309	335	333	332	399	344
COOMALCK 4263.75	337	195	301	305	331	336	334	396	346
YUNKACK 287.10	18	18	18	40	40	40	60	60	60
YUNKACK 761.55	17	17	17	39	39	39	60	60	60
YUNKACK 1101.00	17	17	17	39	39	39	59	59	59
YUNKACK 1544.30	354	346	346	39	39	39	59	59	59
YUNKACK 2135.05	130	124	124	39	39	39	59	76	72
YUNKACK 2598.80	162	164	164	43	54	57	97	108	114
TUCKERGULLY 533.40	64	64	64	145	145	145	221	221	221
TUCKERGULLY 1516.30	64	64	64	145	145	145	221	221	221
TUCKERGULLY 2228.45	64	64	64	145	145	145	220	220	220
TUCKERGULLY 2854.30	64	64	64	145	145	145	220	220	220
TUCKERGULLY 3592.00	64	64	64	145	145	145	220	220	220
TUCKERGULLY 4244.30	64	64	64	145	145	145	220	220	220
TUCKERGULLY 4953.15	64	64	64	145	145	145	220	220	220
TUCKERGULLY 5574.80	64	64	64	145	145	145	220	220	220
TUCKERGULLY 6057.75	284	1383	2036	3150	4924	6038	8766	11142	12752
TUCKERGULLY 6509.55	284	1368	2026	3134	4900	5991	8754	11125	12721
TUCKERTRIB 103.10	265	1404	2128	3106	5051	6257	8762	11241	13079
TUCKERTRIB 468.30	265	1406	2130	3106	5050	6254	8762	11241	13071
TUCKERTRIB 1073.55	265	1404	2126	3106	5047	6246	8762	11240	13063
TUCKERTRIB 1680.75	265	1404	2124	3106	5041	6235	8761	11235	13047
TUCKERTRIB 2138.15	265	1402	2117	3105	5025	6207	8760	11219	12999
TUCKERTRIB 2623.10	265	1401	2115	3104	5016	6193	8759	11211	12968
TUCKERTRIB 3145.85	264	1396	2107	3104	5000	6169	8757	11201	12929
STATIONCK 342.25	137	137	137	310	310	310	471	471	471
STATIONCK 1142.10	136	136	136	309	309	309	461	461	461
STATIONCK 2015.50	135	135	135	302	302	302	444	444	444
STATIONCK 2722.50	135	135	135	302	302	302	443	443	443
STATIONCK 3374.30	135	135	135	301	301	301	441	457	492
STATIONCK 4108.30	134	134	134	301	301	301	498	572	612
STATIONCK 4811.25	132	132	136	298	320	360	600	686	729
STATIONCK 5529.85	127	164	189	329	410	457	749	853	906
STATIONCK 6247.20	143	198	227	389	488	547	882	1002	1064
STATIONCK 6764.95	156	216	248	415	518	580	934	1061	1127
STATIONCK 7322.70	246	456	637	2374	3045	3420	7191	8129	8702
MACHINECK 363.15	59	59	59	134	134	134	204	204	204
MACHINECK 956.55	59	59	59	134	134	134	203	203	203
MACHINECK 1442.95	59	59	59	134	134	134	203	203	203
MACHINECK 1956.95	59	59	59	134	134	134	203	203	203
MACHINECK 2472.70	59	59	59	134	134	134	203	203	203
MACHINECK 2935.75	59	59	59	134	134	134	203	203	203
MACHINECK 3376.40	59	59	59	134	134	134	203	203	203
MACHINECK 3929.35	59	59	59	134	134	134	203	203	203
MACHINECK 4673.35	59	59	59	134	134	134	203	203	203
MACHINECK 5484.15	59	59	59	134	134	134	203	203	203
MACHINECK 6289.70	58	58	58	132	132	132	202	238	260
O'LSTATION 152.05	150	419	598	2359	3054	3449	7235	8226	8852
O'LSTATION 778.15	150	417	595	2353	3041	3429	7224	8203	8818
O'LSTATION 1588.40	149	416	593	2346	3026	3407	7211	8180	8785
O'LSTATION 2155.05	149	414	591	2343	3020	3398	7205	8170	8772
O'LSTATION 2486.75	149	414	590	2342	3017	3393	7203	8165	8765

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event
RCC Embankment Level 47.9m

Table C2 - Peak Discharges (m^3/s), Saddle Dam No. 3

Branch	1 in 2,000 AEP Event			1 in 20,000 AEP			PMPDF		
	No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m
WURDONGCK 308.20	26	26	26	58	58	58	88	88	88
WURDONGCK 964.00	25	25	25	57	57	57	87	87	87
WURDONGCK 1532.25	25	25	25	57	57	57	87	87	87
WURDONGCK 2117.70	25	25	25	56	56	56	85	85	85
WURDONGCK 2964.50	25	25	25	56	56	56	85	86	93
WURDONGCK 4055.25	33	42	52	93	113	122	179	199	211
BOYNETRIB1 286.55	4	4	4	4	4	4	29	31	32
BOYNETRIB1 970.70	4	55	73	21	25	27	25	25	29
BOYNETRIB1 1608.25	4	10	14	6	12	14	32	37	40
BOYNETRIB1 2021.50	5	15	15	17	25	27	59	67	70
BOYNETRIB1 2428.90	6	18	20	32	41	44	87	96	100
BOYNETRIB2 190.60	2	2	2	11	31	36	33	38	36
BOYNETRIB2 547.40	2	2	2	4	22	39	60	48	53
BOYNETRIB2 980.35	3	5	7	11	19	25	45	54	55
BOYNETRIB2 1525.55	8	12	15	25	33	36	71	81	82
O'LANDBOYNE 231.05	1046	1292	1431	2522	2904	3115	5433	5976	6314
O'LANDBOYNE 653.00	1046	1292	1431	2522	2904	3115	5432	5976	6314
O'LANDBOYNE 1168.20	1046	1291	1431	2521	2903	3114	5432	5975	6313
O'LANDBOYNE 1708.41	1046	1291	1430	2520	2901	3112	5431	5973	6310
O'LANDBOYNE 1978.16	664	706	727	744	745	745	794	796	799
O'LAND01 207.65	385	597	737	2115	2605	2876	5832	6563	7017
O'LAND01 717.05	384	597	737	2115	2605	2875	5832	6562	7016
O'LAND01 1189.50	384	597	737	2114	2604	2874	5831	6561	7015
O'LAND01 1674.25	384	597	736	2114	2603	2873	5830	6559	7013
O'LAND01 2287.40	384	596	736	2113	2601	2870	5829	6558	7011
O'LAND01 2838.75	384	596	736	2112	2600	2869	5828	6556	7009
CATTLECK 371.80	16	16	16	36	36	36	56	56	56
CATTLECK 1018.35	16	16	16	35	35	35	54	54	54
CATTLECK 1643.77	31	36	39	33	37	40	59	66	70
CATTLECK 2059.62	385	597	736	2112	2599	2868	5827	6554	7006
CATTLECK 2229.90	385	597	736	2112	2599	2868	5827	6554	7006
STHTREES 425.90	1716	2119	2328	3946	4594	4940	8382	9187	9687
STHTREES 1215.70	1714	2115	2323	3942	4584	4927	8378	9179	9677
STHTREES 1970.45	1713	2110	2318	3937	4575	4916	8374	9173	9669
STHTREES 2595.40	1710	2106	2314	3933	4567	4906	8371	9167	9662
STHTREES 3301.50	1707	2100	2308	3928	4557	4895	8367	9160	9654
STHTREES 3972.55	1705	2095	2304	3925	4551	4888	8364	9156	9649
STHTREES 4383.50	1704	2093	2302	3923	4548	4886	8364	9155	9648
STHTREES 4858.90	1703	2091	2301	3922	4547	4884	8363	9154	9646
STHTREES 5307.90	1701	2088	2298	3920	4542	4879	8361	9151	9643
STHTREES 5942.15	1700	2087	2297	3919	4541	4878	8361	9150	9642
STHTREES 7024.85	1700	2087	2297	3919	4540	4877	8360	9149	9641
STHTREES 7954.93	1697	2081	2291	3915	4532	4867	8357	9144	9634
STHTREES 8769.08	1692	2073	2282	3908	4520	4851	8351	9136	9623
STHTREES 10272.60	1691	2071	2279	3906	4516	4845	8349	9132	9619
STHTREES 11973.10	1690	2069	2277	3903	4510	4838	8347	9128	9614
STHTREES 13566.50	1690	2068	2276	3902	4507	4833	8345	9125	9609
STHTREES 15961.45	3340	3340	3340	3900	4502	4826	8341	9119	9602
TENMILECK 255.10	29	29	29	66	66	66	100	100	100
TENMILECK 775.35	82	87	87	66	66	66	100	100	100
TENMILECK 1397.20	30	30	30	66	66	66	100	100	100
TENMILECK 2025.95	71	59	59	66	66	66	98	98	98
ELEVENMILECK 441.95	40	40	40	90	90	90	137	137	137
ELEVENMILECK 1347.65	40	40	40	90	90	90	137	137	137
ELEVENMILECK 2464.80	82	83	83	90	90	90	136	136	136
ELEVENMILECK 3502.60	211	209	209	90	90	90	134	134	134
LITTLEOAKYCK 335.00	21	21	21	48	48	48	73	73	73
LITTLEOAKYCK 1252.00	217	108	122	129	145	151	167	227	217
LITTLEOAKYCK 1896.00	60	153	169	195	198	205	276	300	315
SPILLWAY 150.00	0	0	0	0	0	0	0	0	0

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event
Embankment at RL 51.1m (Approximately 60% AFC)

Table C3 - Peak Water Levels (m), Saddle Dam No. 3

Branch	Chainage (m)	Cross Section ID	Location	1 in 20,000 AEP			1 in 100,000 AEP			PMP-DF		
				No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m
BOYNERIVER 0.00	0			39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
BOYNERIVER 100.00	100			39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
BOYNERIVER 100.00	100			39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
BOYNERIVER 150.00	150			39.97	39.97	39.97	39.97	39.97	39.97	39.97	39.97	39.97
BOYNERIVER 350.00	350			23.14	24.53	25.16	25.59	27.06	27.72	27.95	29.42	30.05
BOYNERIVER 420.00	420			23.14	24.53	25.16	25.59	27.05	27.72	27.95	29.42	30.05
BOYNERIVER 420.00	420			23.14	24.53	25.16	25.59	27.05	27.72	27.95	29.42	30.05
BOYNERIVER 817.70	817.7	B21.7	D/S Awoonga Dam	22.53	24.12	24.81	25.03	26.70	27.41	27.46	29.11	29.78
BOYNERIVER 1383.80	1383.8	B21.15		21.96	23.74	24.50	24.50	26.36	27.12	26.98	28.81	29.52
BOYNERIVER 1985.90	1985.9	B20.6		21.18	23.28	24.13	23.84	25.97	26.79	26.43	28.49	29.25
BOYNERIVER 2182.33	2182.33		Tucker Gully	21.05	23.21	24.06	23.72	25.90	26.74	26.33	28.44	29.20
BOYNERIVER 2182.33	2182.33			21.05	23.21	24.06	23.72	25.90	26.74	26.33	28.44	29.20
BOYNERIVER 2462.80	2462.8	B20.1		20.65	22.73	23.56	23.27	25.36	26.15	25.82	27.86	28.58
BOYNERIVER 3120.26	3120.26		Coomal Ck	20.30	22.33	23.14	22.86	24.90	25.67	25.40	27.43	28.13
BOYNERIVER 3120.26	3120.26			20.30	22.33	23.14	22.86	24.90	25.67	25.40	27.43	28.13
BOYNERIVER 3313.40	3313.4	B18.95	Pikes Crossing	20.21	22.22	23.03	22.76	24.78	25.55	25.29	27.31	28.00
BOYNERIVER 3976.40	3976.4	B18.3		19.73	21.63	22.39	22.17	24.06	24.77	24.63	26.56	27.21
BOYNERIVER 4740.10	4740.1	B17.6		18.52	20.28	20.96	20.89	22.57	23.19	23.28	25.09	25.69
BOYNERIVER 5457.30	5457.3	B17.0	Manns Weir 50m U/S	18.10	19.83	20.52	20.47	22.12	22.73	22.86	24.69	25.29
BOYNERIVER 5457.30	5457.3	B17.0	Little Oaky Ck	18.10	19.83	20.52	20.47	22.12	22.73	22.86	24.69	25.29
BOYNERIVER 5934.10	5934.1	B16.7		17.77	19.51	20.19	20.16	21.82	22.44	22.61	24.46	25.07
BOYNERIVER 6676.80	6676.8	B16.0	Yunka Ck	17.21	18.97	19.67	19.66	21.37	22.01	22.21	24.11	24.73
BOYNERIVER 6676.80	6676.8	B16.0		17.21	18.97	19.67	19.66	21.37	22.01	22.21	24.11	24.73
BOYNERIVER 7293.40	7293.4	B15.5		16.71	18.44	19.14	19.15	20.86	21.50	21.73	23.66	24.29
BOYNERIVER 8050.70	8050.7	B14.8	O'L Station Offtake	16.23	17.97	18.66	18.69	20.39	21.04	21.29	23.22	23.86
BOYNERIVER 8050.70	8050.7	B14.8	QR Railway Bridge	16.23	17.97	18.66	18.69	20.39	21.04	21.29	23.22	23.86
BOYNERIVER 8522.40	8522.4	B14.35		16.05	17.82	18.53	18.56	20.28	20.93	21.18	23.14	23.77
BOYNERIVER 8856.20	8856.2	B14.0		16.00	17.78	18.49	18.53	20.25	20.91	21.16	23.12	23.76
BOYNERIVER 9247.40	9247.4	B13.6		15.86	17.64	18.36	18.39	20.12	20.77	21.03	22.99	23.63
BOYNERIVER 9679.30	9679.3	B13.2		15.68	17.46	18.17	18.21	19.94	20.59	20.86	22.81	23.45
BOYNERIVER 10080.40	10080.4	B12.8		15.56	17.36	18.09	18.12	19.87	20.53	20.80	22.78	23.42
BOYNERIVER 10401.00	10401			15.43	17.24	17.96	18.00	19.75	20.41	20.68	22.65	23.29
BOYNERIVER 10402.80	10402.8			15.46	17.27	17.99	18.03	19.78	20.44	20.70	22.67	23.31
BOYNERIVER 10412.80	10412.8	B12.5		***15.45***	***17.25***	***17.98***	***18.01***	***19.76***	***20.43***	***20.69***	***22.66***	***23.30***
BOYNERIVER 10414.00	10414			15.43	17.24	17.96	18.00	19.75	20.41	20.68	22.65	23.29
BOYNERIVER 10646.10	10646.1	B12.2	Bruce H'way Bridge	15.36	17.18	17.90	17.95	19.70	20.36	20.63	22.61	23.25
BOYNERIVER 10832.90	10832.9		Station Ck	15.26	17.08	17.81	17.85	19.61	20.27	20.54	22.52	23.16
BOYNERIVER 10832.90	10832.9			15.26	17.08	17.81	17.85	19.61	20.27	20.54	22.52	23.16
BOYNERIVER 11254.50	11254.5	B11.6		14.69	16.39	17.08	17.12	18.76	19.39	19.65	21.49	22.09
BOYNERIVER 11848.60	11848.6	B11.05	Boyne Trib2 &	13.81	15.34	15.95	15.99	17.49	18.08	18.32	20.04	20.60
BOYNERIVER 11848.60	11848.6	B11.05	O'L Boyne Offtake	13.81	15.34	15.95	15.99	17.49	18.08	18.32	20.04	20.60
BOYNERIVER 12303.00	12303			13.40	14.87	15.45	15.48	16.91	17.48	17.72	19.38	19.92
BOYNERIVER 12303.00	12303		Boyne Trib1	13.40	14.87	15.45	15.48	16.91	17.48	17.72	19.38	19.92
BOYNERIVER 12455.40	12455.4	B10.5		13.24	14.69	15.25	15.28	16.67	17.24	17.47	19.10	19.63
BOYNERIVER 12785.40	12785.4		Machine Ck	12.83	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
BOYNERIVER 12785.40	12785.4			12.83	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
BOYNERIVER 12874.90	12874.9	B10.2		12.70	14.06	14.59	14.63	15.87	16.41	16.64	18.19	18.70
BOYNERIVER 13251.30	13251.3	B9.8		12.50	13.86	14.39	14.43	15.68	16.17	16.40	17.97	18.48
BOYNERIVER 13865.90	13865.9	B9.1		11.79	13.07	13.56	13.59	14.75	15.16	15.37	16.82	17.31
BOYNERIVER 14304.56	14304.56		Wurdong Ck	11.49	12.74	13.22	13.25	14.37	14.77	14.97	16.27	16.76
BOYNERIVER 14304.56	14304.56			11.49	12.74	13.22	13.25	14.37	14.77	14.97	16.27	16.76
BOYNERIVER 14472.20	14472.2	B8.5		11.42	12.65	13.12	13.16	14.27	14.66	14.86	16.11	16.59
BOYNERIVER 14964.20	14964.2	B8.0		11.11	12.30	12.77	12.80	13.89	14.27	14.47	15.65	16.08
BOYNERIVER 15341.20	15341.2	B7.55		10.61	11.73	12.16	12.19	13.20	13.56	13.75	14.85	15.19
BOYNERIVER 15741.50	15741.5	B7.2		10.24	11.31	11.72	11.75	12.73	13.09	13.28	14.37	14.72
BOYNERIVER 16062.90	16062.9		O'L Boyne D/S	10.09	11.15	11.56	11.59	12.56	12.91	13.10	14.18	14.52
BOYNERIVER 16062.90	16062.9			10.09	11.15	11.56	11.59	12.56	12.91	13.10	14.18	14.52
BOYNERIVER 16145.40	16145.4	B6.8		10.06	11.12	11.53	11.56	12.53	12.88	13.07	14.15	14.48
BOYNERIVER 16727.90	16727.9	B6.2		9.58	10.61	10.99	11.03	11.94	12.28	12.46	13.48	13.80
BOYNERIVER 17358.60	17358.6	B5.55		9.07	10.08	10.45	10.49	11.36	11.68	11.86	12.84	13.15
BOYNERIVER 17722.19	17722.19		South Trees	8.33	9.25	9.58	9.61	10.40	10.68	10.85	11.75	12.03
BOYNERIVER 17722.19	17722.19			8.33	9.25	9.58	9.61	10.40	10.68	10.85	11.75	12.03
BOYNERIVER 17874.50	17874.5			8.18	9.11	9.45	9.48	10.29	10.58	10.75	11.67	11.95
BOYNERIVER 18184.66	18184.66		Cattle Ck	8.05	9.01	9.36	9.39	10.22	10.52	10.69	11.62	11.91
BOYNERIVER 18184.66	18184.66			8.05	9.01	9.36	9.39	10.22	10.52	10.69	11.62	11.91
BOYNERIVER 18476.20	18476.2	B4.5		7.82	8.76	9.11	9.14	9.95	10.24	10.40	11.30	11.59
BOYNERIVER 18884.20	18884.2	B4.05		7.35	8.21	8.52	8.55	9.28	9.54	9.69	10.49	10.74
BOYNERIVER 19282.40	19282.4	B3.65		7.20	8.06	8.38	8.41	9.15	9.41	9.56	10.37	10.62
BOYNERIVER 19869.50	19869.5	B3.15		6.83	7.67	7.97	8.00	8.72	8.98	9.13	9.94	10.20
BOYNERIVER 20263.70	20263.7	B2.75		6.39	7.18	7.47	7.50	8.17	8.41	8.55	9.32	9.55
BOYNERIVER 20684.60	20684.6	B2.45		5.99	6.74	7.01	7.04	7.68	7.92	8.06	8.82	9.06
BOYNERIVER 20866.30	20866.3	B2.25		5.84	6.60	6.88	6.91	7.55	7.79	7.93	8.68	8.91
BOYNERIVER 21269.40	21269.4	B1.85	John Oxley Bridge	5.31	5.99	6.23	6.26	6.84	7.06	7.19	7.90	8.13
BOYNERIVER 21471.70	21471.7	B1.65		4.77	5.31	5.50	5.52	5.95	6.12	6.22	6.77	6.95
BOYNERIVER 21861.20	21861.2	B1.2		4.40	4.81	4.94	4.96	5.26	5.40	5.48	5.93	6.08
BOYNERIVER 22251.30	22251.3	B0.9		3.81	4.03	4.08	4.08	4.15	4.19	4.25	4.55	4.65
BOYNERIVER 22636.00	22636	B0.5		2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42
COOMALCK 0.00	0	C1		37.92	37.92	37.92	37.57	37.57	37.57	37.92	37.92	37.92
COOMALCK 398.20	398.2	C2		33.24	33.24	33.24	33.36	32.88	32.92	33.24	33.24	33.24
COOMALCK 794.20	794.2	C3		29.79	33.00	33.00	39.56	31.16	31.06	30.15	30.40	30.38
COOMALCK 1209.50	1209.5	C4		26.47	28.65	28.65	31.43	29.85	27.42	26.47	27.46	28.13
COOMALCK 1813.30	1813.3	C5		21.80	22.94	23.34	25.20	24.93	25.67	25.45	27.43	28.13
COOMALCK 2352.80	2352.8	C6		20.31	22.36	23.17	22.98	24.90	25.67	25.42	27.43	28.13
COOMALCK 3112.20	3112.2	C7		20.30	22.33	23.15	22.87	24.90	25.67	25.41	27.43	28.13
COOMALCK 3751.30	3751.3	C8		20.30	22.33	23.14	22.86	24.90	25.67	25.41	27.43	28.13
COOMALCK 4222.50	4222.5	C9		20.30	22.33	23.14	22.86	24.90	25.67	25.40	27.43	28.13
COOMALCK 4305.00	4305			20.30	22.33	23.14	22.86	24.90	25.67	25.40	27.43	28.13
YUNKACK 0.00	0	Y1		34.48	34.48	34.48	34.04	34.04	34.04	34.48	34.48	34.48
YUNKACK 574.20	574.2	Y2		26.84	26.84	26.84	26.44	26.44	26.44	26.84	26.84	26.84
YUNKACK 948.90	948.9	Y3		22.25	22.25	22.25	21.98	21.98	22.01	22.25	24.11	24.73
YUNKACK 1253.10	1253.1	Y4		18.99	18.99	19.67	19.66	21.37	22.01	22.21	24.11	24.73
YUNKACK 1835.50	1835.5	Y5		17.21	18.97	19.67	19.66	21.37	22.01	22.21	24.11	24.73
YUNKACK 2434.60	2434.6	Y6		17.21	18.97	19.67	19.66	21.37	22.01	22.21	24.11	24.73
YUNKACK 2763.00	2763	Y7		17.21	18.97	19.67	19.66	21.37	22.01	22.21	24.11	24.73
TUCKERGULLY 0.00	0			36.53	36.53	36.53	35.97	35.97	35.97	36.53	36.53	36.53
TUCKERGULLY 1066.80	1066.8	TU-1		34.48	34.48	34.48	34.08	34.08	34.08	34.48	34.48	34.48
TUCKERGULLY 1965.80	1965.8	TU-2		29.50	29.50	29.50	28.99	28.99	28.99	29.50	29.50	29.50
TUCKERGULLY 2491.10	2491.1	TU-3		26.28	26.28	26.28	25.77	25.97	26.81	26.37	28.50	29.26
TUCKERGULLY 3217.50	3217.5	TU-4		21.95	23.27	24.14	23.74	25.97	26.81	26.36	28.50	29.26
TUCKERGULLY 3966.50	3966.5	TU-5		21.05	23.27	24.14	23.74	25.97	26.81	26.36	28.50	29.26
TUCKERGULLY 4522.10	4522.1	TU-6		21.05	23.26	24.14	23.74	25.97	26.81	26.36	28.50	29.26
TUCKERGULLY 5384.20	5384.2	TU-7	Awoonga Dam Rd Xing	21.05	23.26	24.14	23.74	25.97	26.81	26.35	28.50	29.26
TUCKERGULLY 5765.40	5765.4		Tucker Trib	21.05	23.26	24.14	23.74	25.97	26.81	26.35	28.50	29.26
TUCKERGULLY 5765.40	5765.4			21.05	23.26	24.14	23.74	25.97	26.81	26.35	28.50	29.26
TUCKERGULLY 6350.10	6350.1	TU-8		21.05	23.22	24.09	23.73	25.92	26.76	26.34	28.46	29.22
TUCKERGULLY 6669.00	6669	TU-9		21.05	23.21	24.06	23.72	25.90	26.74	26.33	28.44	29.20
TUCKERTRIB 0.00	0			34.87	41.01	42.25	39.21	43.24	44.36	41.57	44.82	45.85
TUCKERTRIB 206.20	206.2	T1-1		33.82	39.13	40.26	37.54	41.17	42.21	39.64	42.64	43.63
TUCKERTRIB 730.40	730.4	T1-2		29.89	34.79	35.87	33.25	36.84	37.89	35.28	38.38	39.42
TUCKERTRIB 1416.70	1416.7	T1-3		23.17	28.57	29.76	26.98	30.84	31.99	29.42	32.71	33.82
TUCKERTRIB 1944.80	1944.8	T1-4		21.10	25.64	27.11	24.58	28.67	30.00	27.70	31.24	32.45
TUCKERTRIB 2331.50	2331.5	T1-5		21.06	24.80	26.20	24.20	27.82	29.08	27.20	30.44	31.59
TUCKERTRIB 2914.70	2914.7	T1-6	Awoonga Dam Rd Xing	21.05	23.69	24.78	23.85	26.57	27.61	26.60	29.22	30.19
TUCKERTRIB 3377.00	3377			21.05	23.26	24.14	23.74	25.97	26.81	26.35	28.50	29.26
STATIONCK 0.00	0	S1		16.52	17.10	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 684.50	684.5	S2		15.26	17.10	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 1599.70	1599.7	S3		15.26	17.10	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 2431.30	2431.3	S4		15.26	17.10	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 3013.70	3013.7	S5		15.26	17.10	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 3734.90	3734.9	S6	Bruce H'way	15.26	17.10	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 4481.70	4481.7	S7		15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 5140.80	5140.8	S8		15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 5918.90	5918.9	S9		15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 6575.50	6575.5	S10		15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 6954.40	6954.4		O'L Station D/S	15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 6954.40	6954.4			15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
STATIONCK 7691.00	7691	S11		15.26	17.08	17.81	17.85	19.61	20.27	20.54	22.52	23.16
MACHINECK 0.00	0	M1		34.12	34.12	34.12	33.78	33.78	33.78	34.12	34.12	34.12
MACHINECK 726.30	726.3	M2		29.24	29.24	29.24	28.92	28.92	28.92	29.24	29.24	29.24
MACHINECK 1186.80	1186.8	M3		27.05	27.05	27.05	26.82	26.82	26.82	27.05	27.05	27.05
MACHINECK 1699.10	1699.1	M4		23.52	23.52	23.52	23.15	23.15	23.15	23.52	23.52	23.52
MACHINECK 2214.80	2214.8	M5		21.11	21.11	21.11	20.91	20.91	20.91	21.11	21.11	21.11
MACHINECK 2730.60	2730.6	M6		17.50	17.50	17.50	17.26	17.26	17.26	17.50	18.43	18.95
MACHINECK 3140.90	3140.9	M7		15.49	15.49	15.49	15.16	16.07	16.62	16.85	18.43	18.95
MACHINECK 3611.90	3611.9	M8		13.20	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
MACHINECK 4246.80	4246.8	M9	Road/Rail X-ing	12.83	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
MACHINECK 5099.90	5099.9	M10		12.83	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
MACHINECK 5868.40	5868.4	M11	Bruce H'way 100m U/S	12.83	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
MACHINECK 6711.00	6711	M12		12.83	14.21	14.76	14.79	16.07	16.62	16.85	18.43	18.95
O'LSTATION 0.00	0			16.23	17.97	18.66	18.69	20.39	21.04	21.29	23.22	23.86
O'LSTATION 304.10	304.1	O2-1		16.17	17.91	18.60	18.63	20.34	20.98	21.24	23.18	23.81
O'LSTATION 1252.20	1252.2	O2-2		15.94	17.69	18.41	18.44	20.16	20.82	21.08	23.03	23.67
O'LSTATION 1924.60	1924.6	O2-3		15.59	17.43	18.16	18.20	19.94	20.60	20.87	22.84	23.48
O'LSTATION 2385.50	2385.5			15.36	17.20	17.93	17.97	19.73	20.40	20.66	22.65	23.29
O'LSTATION 2588.00	2588	O2-4	Bruce H'way	15.26	17.09	17.83	17.87	19.63	20.30	20.56	22.55	23.19
WURDONGCK 0.00	0	W1		26.60	26.60	26.60	26.34	26.34	26.34	26.60	26.60	26.60
WURDONGCK 616.40	616.4	W2		21.38	21.38	21.38	21.08	21.08	21.08	21.38	21.38	21.38
WURDONGCK 1311.60	1311.6	W3		16.25	16.25	16.25	15.83	15.83	15.83	16.25	16.27	16.76
WURDONGCK 1752.90	1752.9	W4		13.72	13.72	13.72	13.26	14.37	14.77	14.97	16.27	16.76
WURDONGCK 2482.50	2482.5	W5	GLD/Benaraby Rd 100m D/S	11.49	12.74	13.22	13.25	14.37	14.77	14.97	16.27	16.76
WURDONGCK 3446.50	3446.5	W6		11.49	12.74	13.22	13.25	14.37	14.77	14.97	16.27	16.76
WURDONGCK 4664.00	4664	W7		11.49	12.74	13.22	13.25	14.37	14.77	14.97	16.27	16.76

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event
Embankment at RL 51.1m (Approximately 60% AFC)

Table C3 - Peak Water Levels (m), Saddle Dam No. 3

Branch	Chainage (m)	Cross Section ID	Location	1 in 20,000 AEP			1 in 100,000 AEP			PMP-DF		
				No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m	No Failure	Breach of 54m	Breach of 90m
BOYNETRIB1 0.00	0	T2-1		24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04	24.04
BOYNETRIB1 573.10	573.1	T2-2		16.24	16.24	16.24	16.24	16.91	17.49	17.72	19.38	19.91
BOYNETRIB1 1368.30	1368.3	T2-3		13.40	14.87	15.45	15.48	16.91	17.48	17.72	19.38	19.92
BOYNETRIB1 1848.20	1848.2	T2-4	Bruce H'way 75m D/S	13.40	14.87	15.45	15.48	16.91	17.48	17.72	19.38	19.92
BOYNETRIB1 2194.80	2194.8	T2-5		13.40	14.87	15.45	15.48	16.91	17.48	17.72	19.38	19.92
BOYNETRIB1 2663.00	2663	T2-6		13.40	14.87	15.45	15.48	16.91	17.48	17.72	19.38	19.92
BOYNETRIB2 0.00	0	T3-1		18.33	18.33	18.33	18.33	18.33	18.33	18.34	20.04	20.60
BOYNETRIB2 381.20	381.2	T3-2		14.53	15.35	15.97	16.01	17.50	18.08	18.32	20.04	20.60
BOYNETRIB2 713.60	713.6	T3-3		13.81	15.34	15.95	15.99	17.50	18.08	18.32	20.04	20.60
BOYNETRIB2 1247.10	1247.1	T3-4		13.81	15.34	15.95	15.99	17.49	18.08	18.32	20.04	20.60
BOYNETRIB2 1804.00	1804	T3-5		13.81	15.34	15.95	15.99	17.49	18.08	18.32	20.04	20.60
O'LANDBOYNE 0.00	0			13.81	15.34	15.95	15.99	17.49	18.08	18.32	20.04	20.60
O'LANDBOYNE 462.10	462.1	O3-1		11.86	13.02	13.47	13.50	14.49	14.86	15.03	16.08	16.41
O'LANDBOYNE 843.90	843.9	O3-2		11.06	12.18	12.65	12.68	13.62	13.97	14.15	15.16	15.48
O'LANDBOYNE 1492.50	1492.5	O3-3		10.17	11.28	11.70	11.74	12.70	13.05	13.24	14.30	14.63
O'LANDBOYNE 1924.31	1924.31		O'Land01 U/S	10.09	11.15	11.56	11.59	12.56	12.91	13.10	14.18	14.51
O'LANDBOYNE 1924.31	1924.31			10.09	11.15	11.56	11.59	12.56	12.91	13.10	14.18	14.51
O'LANDBOYNE 2032.00	2032	O3-4		10.09	11.15	11.56	11.59	12.56	12.91	13.10	14.18	14.52
O'LAND01 0.00	0			10.09	11.15	11.56	11.59	12.56	12.91	13.10	14.18	14.51
O'LAND01 415.30	415.3	O4-01		9.88	10.85	11.23	11.26	12.16	12.49	12.67	13.70	14.02
O'LAND01 1018.80	1018.8	O4-02		9.43	10.33	10.69	10.72	11.62	11.95	12.14	13.17	13.49
O'LAND01 1360.20	1360.2	O4-03		8.93	9.95	10.35	10.38	11.34	11.68	11.87	12.93	13.26
O'LAND01 1988.30	1988.3	O4-04		8.48	9.60	10.01	10.05	11.04	11.39	11.59	12.66	12.99
O'LAND01 2586.50	2586.5	O4-05		8.32	9.44	9.86	9.90	10.88	11.23	11.43	12.50	12.83
O'LAND01 3091.00	3091	O4-06		8.13	9.17	9.56	9.60	10.53	10.86	11.05	12.09	12.41
CATTLECK 0.00	0	CC1	Tannum Sands Rd 50m D/S	8.13	9.17	9.56	9.60	10.53	10.86	11.05	12.09	12.41
CATTLECK 743.60	743.6	CC2		8.13	9.17	9.56	9.60	10.53	10.86	11.05	12.09	12.41
CATTLECK 1293.10	1293.1	CC3		8.13	9.17	9.56	9.60	10.53	10.86	11.05	12.09	12.41
CATTLECK 1994.43	1994.43		O'Land 01 D/S	8.13	9.17	9.56	9.60	10.53	10.86	11.05	12.09	12.41
CATTLECK 1994.43	1994.43			8.13	9.17	9.56	9.60	10.53	10.86	11.05	12.09	12.41
CATTLECK 2124.80	2124.8	CC4		8.09	9.10	9.47	9.50	10.38	10.70	10.88	11.87	12.18
CATTLECK 2335.00	2335			8.05	9.01	9.36	9.39	10.22	10.52	10.69	11.62	11.91
STHTREES 0.00	0	ST1	Sth Trees/BoyneR Bifurcate	8.33	9.25	9.58	9.61	10.40	10.68	10.85	11.75	12.03
STHTREES 851.80	851.8	ST2		7.06	7.97	8.37	8.41	9.30	9.62	9.82	10.80	11.10
STHTREES 1579.60	1579.6	ST3	Boyne Is Rd Bridge	6.71	7.65	8.06	8.11	9.02	9.34	9.55	10.54	10.85
STHTREES 2361.30	2361.3	ST4		6.44	7.39	7.82	7.87	8.79	9.12	9.33	10.33	10.63
STHTREES 2829.50	2829.5	ST5		6.36	7.31	7.74	7.79	8.71	9.05	9.26	10.26	10.57
STHTREES 3773.50	3773.5	ST6		6.21	7.16	7.59	7.65	8.57	8.90	9.12	10.11	10.42
STHTREES 4171.60	4171.6	ST7		6.14	7.09	7.52	7.57	8.49	8.82	9.03	10.02	10.32
STHTREES 4595.40	4595.4	ST8		6.01	6.95	7.38	7.43	8.34	8.66	8.87	9.84	10.14
STHTREES 5122.39	5122.39		Ten Mile Ck	5.84	6.76	7.18	7.23	8.11	8.43	8.63	9.58	9.87
STHTREES 5122.39	5122.39			5.84	6.76	7.18	7.23	8.11	8.43	8.63	9.58	9.87
STHTREES 5493.40	5493.4	ST9		5.72	6.62	7.03	7.09	7.94	8.25	8.45	9.38	9.66
STHTREES 6390.90	6390.9	ST10		4.87	5.68	6.05	6.10	6.84	7.11	7.29	8.11	8.35
STHTREES 7658.80	7658.8	ST11		4.01	4.61	4.89	4.93	5.57	5.81	5.97	6.66	6.88
STHTREES 8251.05	8251.05		Eleven Mile Ck	3.93	4.51	4.78	4.83	5.45	5.68	5.84	6.51	6.72
STHTREES 8251.05	8251.05			3.93	4.51	4.78	4.83	5.45	5.68	5.84	6.51	6.72
STHTREES 9287.10	9287.1	ST12		3.73	4.27	4.52	4.56	5.15	5.36	5.51	6.14	6.33
STHTREES 11258.10	11258.1	ST13		3.29	3.72	3.93	3.97	4.46	4.65	4.77	5.30	5.47
STHTREES 12688.10	12688.1	ST14		2.98	3.30	3.47	3.50	3.92	4.07	4.18	4.61	4.75
STHTREES 14444.90	14444.9	ST15		2.75	2.98	3.10	3.12	3.44	3.56	3.64	4.00	4.11
STHTREES 17478.00	17478	ST16		2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42
TENMILECK 0.00	0	T4-1	GLD/Benaraby Boyne X-ing	10.46	10.46	10.46	10.21	10.21	10.21	10.46	10.46	10.46
TENMILECK 510.20	510.2	T4-2		5.84	6.76	7.18	7.24	8.11	8.43	8.63	9.58	9.87
TENMILECK 1040.50	1040.5	T4-3		5.84	6.76	7.18	7.23	8.11	8.43	8.63	9.58	9.87
TENMILECK 1753.90	1753.9	T4-4		5.84	6.76	7.18	7.23	8.11	8.43	8.63	9.58	9.87
TENMILECK 2298.00	2298	T4-5		5.84	6.76	7.18	7.23	8.11	8.43	8.63	9.58	9.87
ELEVENMILECK 0.00	0	T5-1		13.03	13.03	13.03	12.65	12.65	12.65	13.03	13.03	13.03
ELEVENMILECK 883.90	883.9	T5-2	GLD/Benaraby Rd	5.64	5.64	5.64	5.14	5.46	5.68	5.84	6.52	6.73
ELEVENMILECK 1811.40	1811.4	T5-3		3.93	4.51	4.78	4.83	5.45	5.68	5.84	6.51	6.73
ELEVENMILECK 3118.20	3118.2	T5-4		3.93	4.51	4.78	4.83	5.45	5.68	5.84	6.51	6.72
ELEVENMILECK 3887.00	3887			3.93	4.51	4.78	4.83	5.45	5.68	5.84	6.51	6.72
LITTLEOAKYCK 0.00	0	O1-1A		18.10	19.84	20.52	20.47	22.12	22.73	22.86	24.69	25.29
LITTLEOAKYCK 670.00	670	O1-2A		18.10	19.84	20.52	20.47	22.12	22.73	22.86	24.69	25.29
LITTLEOAKYCK 1834.00	1834	O1-3A		18.10	19.83	20.52	20.47	22.12	22.73	22.86	24.69	25.29
LITTLEOAKYCK 1958.00	1958			18.10	19.83	20.52	20.47	22.12	22.73	22.86	24.69	25.29
SPILLWAY 0.00	0			39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95	39.95
SPILLWAY 300.00	300			23.14	24.53	25.16	25.59	27.05	27.72	27.95	29.42	30.05

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event
Embankment Crest Level of 55m

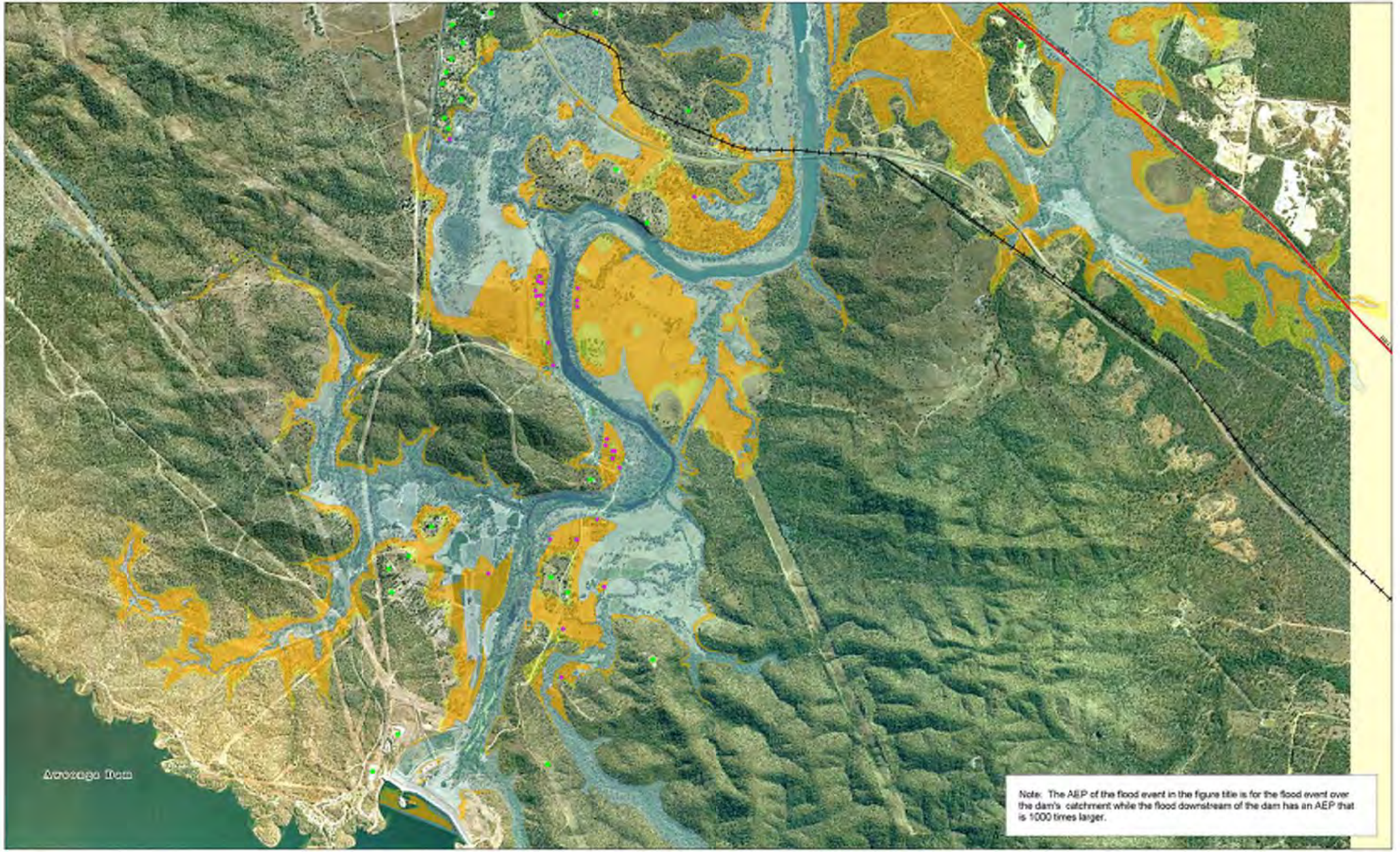
Table C4 - Peak Water Levels (m), Saddle Dam No. 3

Branch	Chainage (m)	Cross Section ID	Location	PMP-DF		
				No Failure	Breach of 100m	Breach of 150m
BOYNERIVER 0.00	0			39.95	39.95	39.95
BOYNERIVER 100.00	100			39.95	39.95	39.95
BOYNERIVER 100.00	100			39.95	39.95	39.95
BOYNERIVER 150.00	150			39.97	39.97	39.97
BOYNERIVER 350.00	350			27.65	29.41	30.17
BOYNERIVER 420.00	420			27.65	29.40	30.17
BOYNERIVER 420.00	420			27.65	29.40	30.17
BOYNERIVER 817.70	817.7	B21.7	D/S Awoonga Dam	27.10	29.05	29.87
BOYNERIVER 1383.80	1383.8	B21.15		26.56	28.70	29.57
BOYNERIVER 1985.90	1985.9	B20.6		25.93	28.31	29.25
BOYNERIVER 2182.33	2182.33		Tucker Gully	25.81	28.25	29.20
BOYNERIVER 2182.33	2182.33			25.81	28.25	29.20
BOYNERIVER 2462.80	2462.8	B20.1		25.32	27.67	28.57
BOYNERIVER 3120.26	3120.26		Coomal Ck	24.92	27.22	28.10
BOYNERIVER 3120.26	3120.26			24.92	27.22	28.10
BOYNERIVER 3313.40	3313.4	B18.95	Pikes Crossing	24.81	27.10	27.98
BOYNERIVER 3976.40	3976.4	B18.3		24.16	26.33	27.16
BOYNERIVER 4740.10	4740.1	B17.6		22.81	24.86	25.61
BOYNERIVER 5457.30	5457.3	B17.0	Manns Weir 50m U/S	22.38	24.44	25.21
BOYNERIVER 5457.30	5457.3	B17.0	Little Oaky Ck	22.38	24.44	25.21
BOYNERIVER 5934.10	5934.1	B16.7		22.11	24.20	24.98
BOYNERIVER 6676.80	6676.8	B16.0	Yunka Ck	21.70	23.84	24.63
BOYNERIVER 6676.80	6676.8	B16.0		21.70	23.84	24.63
BOYNERIVER 7293.40	7293.4	B15.5		21.21	23.38	24.19
BOYNERIVER 8050.70	8050.7	B14.8	O'L Station Offtake	20.77	22.94	23.75
BOYNERIVER 8050.70	8050.7	B14.8	QR Railway Bridge	20.77	22.94	23.75
BOYNERIVER 8522.40	8522.4	B14.35		20.66	22.85	23.67
BOYNERIVER 8856.20	8856.2	B14.0		20.64	22.83	23.65
BOYNERIVER 9247.40	9247.4	B13.6		20.50	22.70	23.52
BOYNERIVER 9679.30	9679.3	B13.2		20.33	22.52	23.34
BOYNERIVER 10080.40	10080.4	B12.8		20.27	22.48	23.31
BOYNERIVER 10401.00	10401			20.14	22.36	23.18
BOYNERIVER 10402.80	10402.8			20.17	22.37	23.20
BOYNERIVER 10412.80	10412.8	B12.5		***20.16***	***22.37***	***23.19***
BOYNERIVER 10414.00	10414			20.14	22.36	23.19
BOYNERIVER 10646.10	10646.1	B12.2	Bruce H'way Bridge	20.09	22.32	23.14
BOYNERIVER 10832.90	10832.9		Station Ck	20.00	22.23	23.05
BOYNERIVER 10832.90	10832.9			20.00	22.23	23.05
BOYNERIVER 11254.50	11254.5	B11.6		19.15	21.22	21.99
BOYNERIVER 11848.60	11848.6	B11.05	Boyne Trib2 &	17.87	19.78	20.49
BOYNERIVER 11848.60	11848.6	B11.05	O'L Boyne Offtake	17.87	19.78	20.49
BOYNERIVER 12303.00	12303			17.28	19.12	19.81
BOYNERIVER 12303.00	12303		Boyne Trib1	17.28	19.12	19.81
BOYNERIVER 12455.40	12455.4	B10.5		17.05	18.85	19.53
BOYNERIVER 12785.40	12785.4		Machine Ck	16.45	18.18	18.84
BOYNERIVER 12785.40	12785.4			16.45	18.18	18.84
BOYNERIVER 12874.90	12874.9	B10.2		16.24	17.95	18.60
BOYNERIVER 13251.30	13251.3	B9.8		16.00	17.72	18.38
BOYNERIVER 13865.90	13865.9	B9.1		15.01	16.58	17.22
BOYNERIVER 14304.56	14304.56		Wurdong Ck	14.62	16.03	16.67
BOYNERIVER 14304.56	14304.56			14.62	16.03	16.67
BOYNERIVER 14472.20	14472.2	B8.5		14.51	15.89	16.51
BOYNERIVER 14964.20	14964.2	B8.0		14.13	15.48	16.00
BOYNERIVER 15341.20	15341.2	B7.55		13.44	14.69	15.12
BOYNERIVER 15741.50	15741.5	B7.2		12.97	14.21	14.64
BOYNERIVER 16062.90	16062.9		O'L Boyne D/S	12.80	14.02	14.44
BOYNERIVER 16062.90	16062.9			12.80	14.02	14.44
BOYNERIVER 16145.40	16145.4	B6.8		12.76	13.99	14.41
BOYNERIVER 16727.90	16727.9	B6.2		12.17	13.33	13.73
BOYNERIVER 17358.60	17358.6	B5.55		11.59	12.70	13.08
BOYNERIVER 17722.19	17722.19		South Trees	10.60	11.61	11.97
BOYNERIVER 17722.19	17722.19			10.60	11.61	11.97
BOYNERIVER 17874.50	17874.5			10.50	11.53	11.89
BOYNERIVER 18184.66	18184.66		Cattle Ck	10.43	11.48	11.85
BOYNERIVER 18184.66	18184.66			10.43	11.48	11.85
BOYNERIVER 18476.20	18476.2	B4.5		10.15	11.17	11.52
BOYNERIVER 18884.20	18884.2	B4.05		9.46	10.37	10.68
BOYNERIVER 19282.40	19282.4	B3.65		9.33	10.24	10.57
BOYNERIVER 19869.50	19869.5	B3.15		8.91	9.82	10.14
BOYNERIVER 20263.70	20263.7	B2.75		8.34	9.20	9.50
BOYNERIVER 20684.60	20684.6	B2.45		7.85	8.71	9.00
BOYNERIVER 20866.30	20866.3	B2.25		7.72	8.56	8.86
BOYNERIVER 21269.40	21269.4	B1.85	John Oxley Bridge	7.00	7.79	8.08
BOYNERIVER 21471.70	21471.7	B1.65		6.07	6.68	6.91
BOYNERIVER 21861.20	21861.2	B1.2		5.36	5.87	6.05
BOYNERIVER 22251.30	22251.3	B0.9		4.16	4.50	4.62
BOYNERIVER 22636.00	22636	B0.5		2.42	2.42	2.42
COOMALCK 0.00	0	C1		37.92	37.92	37.92
COOMALCK 398.20	398.2	C2		33.24	33.24	33.24
COOMALCK 794.20	794.2	C3		30.61	30.67	29.73
COOMALCK 1209.50	1209.5	C4		26.77	27.55	28.11
COOMALCK 1813.30	1813.3	C5		25.01	27.24	28.12
COOMALCK 2352.80	2352.8	C6		24.95	27.22	28.11
COOMALCK 3112.20	3112.2	C7		24.92	27.22	28.11
COOMALCK 3751.30	3751.3	C8		24.92	27.22	28.10
COOMALCK 4222.50	4222.5	C9		24.91	27.22	28.10
COOMALCK 4305.00	4305			24.92	27.22	28.10
YUNKACK 0.00	0	Y1		34.48	34.48	34.48
YUNKACK 574.20	574.2	Y2		26.84	26.84	26.84
YUNKACK 948.90	948.9	Y3		22.25	23.85	24.63
YUNKACK 1253.10	1253.1	Y4		21.70	23.85	24.63
YUNKACK 1835.50	1835.5	Y5		21.70	23.84	24.63
YUNKACK 2434.60	2434.6	Y6		21.70	23.84	24.63
YUNKACK 2763.00	2763	Y7		21.70	23.84	24.63
TUCKERGULLY 0.00	0			36.53	36.53	36.53
TUCKERGULLY 1066.80	1066.8	TU-1		34.48	34.48	34.48
TUCKERGULLY 1965.80	1965.8	TU-2		29.50	29.50	29.50
TUCKERGULLY 2491.10	2491.1	TU-3		26.28	28.31	29.26
TUCKERGULLY 3217.50	3217.5	TU-4		25.84	28.30	29.26
TUCKERGULLY 3966.50	3966.5	TU-5		25.84	28.30	29.26
TUCKERGULLY 4522.10	4522.1	TU-6		25.84	28.30	29.26
TUCKERGULLY 5384.20	5384.2	TU-7	Awoonga Dam Rd Xing	25.83	28.30	29.26
TUCKERGULLY 5765.40	5765.4		Tucker Trib	25.83	28.30	29.26
TUCKERGULLY 5765.40	5765.4			25.83	28.30	29.26
TUCKERGULLY 6350.10	6350.1	TU-8		25.82	28.27	29.22
TUCKERGULLY 6669.00	6669	TU-9		25.81	28.25	29.20
TUCKERTRIB 0.00	0			40.70	44.40	45.59
TUCKERTRIB 206.20	206.2	T1-1		38.86	42.25	43.38
TUCKERTRIB 730.40	730.4	T1-2		34.52	37.96	39.17
TUCKERTRIB 1416.70	1416.7	T1-3		28.57	32.25	33.56
TUCKERTRIB 1944.80	1944.8	T1-4		26.81	30.77	32.22
TUCKERTRIB 2331.50	2331.5	T1-5		26.41	30.01	31.39
TUCKERTRIB 2914.70	2914.7	T1-6	Awoonga Dam Rd Xing	25.99	28.92	30.10
TUCKERTRIB 3377.00	3377			25.83	28.30	29.26
STATIONCK 0.00	0	S1		20.03	22.25	23.08
STATIONCK 684.50	684.5	S2		20.03	22.25	23.08
STATIONCK 1599.70	1599.7	S3		20.03	22.25	23.08

Saddle Dam No. 3 Failure Impact Assessment
48 Hour Duration Flood Event
Embankment Crest Level of 55m

Table C4 - Peak Water Levels (m), Saddle Dam No. 3

Branch	Chainage (m)	Cross Section ID	Location	PMP-DF		
				No Failure	Breach of 100m	Breach of 150m
STATIONCK 2431.30	2431.3	S4		20.03	22.25	23.08
STATIONCK 3013.70	3013.7	S5		20.03	22.25	23.08
STATIONCK 3734.90	3734.9	S6	Bruce H'way	20.03	22.25	23.08
STATIONCK 4481.70	4481.7	S7		20.03	22.25	23.08
STATIONCK 5140.80	5140.8	S8		20.03	22.25	23.08
STATIONCK 5918.90	5918.9	S9		20.03	22.25	23.08
STATIONCK 6575.50	6575.5	S10		20.03	22.25	23.08
STATIONCK 6954.40	6954.4		O'L Station D/S	20.03	22.25	23.08
STATIONCK 6954.40	6954.4			20.03	22.25	23.08
STATIONCK 7691.00	7691	S11		20.00	22.23	23.05
MACHINECK 0.00	0	M1		34.12	34.12	34.12
MACHINECK 726.30	726.3	M2		29.24	29.24	29.24
MACHINECK 1186.80	1186.8	M3		27.05	27.05	27.05
MACHINECK 1699.10	1699.1	M4		23.52	23.52	23.52
MACHINECK 2214.80	2214.8	M5		21.11	21.11	21.11
MACHINECK 2730.60	2730.6	M6		17.50	18.19	18.85
MACHINECK 3140.90	3140.9	M7		16.45	18.19	18.85
MACHINECK 3611.90	3611.9	M8		16.45	18.19	18.85
MACHINECK 4246.80	4246.8	M9	Road/Rail X-ing	16.45	18.19	18.84
MACHINECK 5099.90	5099.9	M10		16.45	18.19	18.84
MACHINECK 5868.40	5868.4	M11	Bruce H'way 100m U/S	16.45	18.19	18.84
MACHINECK 6711.00	6711	M12		16.45	18.18	18.84
O'LSTATION 0.00	0			20.77	22.94	23.75
O'LSTATION 304.10	304.1	O2-1		20.71	22.89	23.71
O'LSTATION 1252.20	1252.2	O2-2		20.55	22.75	23.57
O'LSTATION 1924.60	1924.6	O2-3		20.33	22.55	23.37
O'LSTATION 2385.50	2385.5			20.13	22.35	23.18
O'LSTATION 2588.00	2588	O2-4	Bruce H'way	20.03	22.25	23.08
WURDONGCK 0.00	0	W1		26.60	26.60	26.60
WURDONGCK 616.40	616.4	W2		21.38	21.38	21.38
WURDONGCK 1311.60	1311.6	W3		16.25	16.25	16.67
WURDONGCK 1752.90	1752.9	W4		14.62	16.03	16.67
WURDONGCK 2482.50	2482.5	W5	GLD/Benaraby Rd 100m D/S	14.62	16.03	16.67
WURDONGCK 3446.50	3446.5	W6		14.62	16.03	16.67
WURDONGCK 4664.00	4664	W7		14.62	16.03	16.67
BOYNETRIB1 0.00	0	T2-1		24.04	24.04	24.04
BOYNETRIB1 573.10	573.1	T2-2		17.29	19.12	19.81
BOYNETRIB1 1368.30	1368.3	T2-3		17.28	19.12	19.81
BOYNETRIB1 1848.20	1848.2	T2-4	Bruce H'way 75m D/S	17.28	19.12	19.81
BOYNETRIB1 2194.80	2194.8	T2-5		17.28	19.12	19.81
BOYNETRIB1 2663.00	2663	T2-6		17.28	19.12	19.81
BOYNETRIB2 0.00	0	T3-1		18.33	19.78	20.49
BOYNETRIB2 381.20	381.2	T3-2		17.87	19.78	20.49
BOYNETRIB2 713.60	713.6	T3-3		17.87	19.78	20.49
BOYNETRIB2 1247.10	1247.1	T3-4		17.87	19.78	20.49
BOYNETRIB2 1804.00	1804	T3-5		17.87	19.78	20.49
O'LANDBOYNE 0.00	0			17.87	19.78	20.49
O'LANDBOYNE 462.10	462.1	O3-1		14.73	15.93	16.35
O'LANDBOYNE 843.90	843.9	O3-2		13.86	15.01	15.41
O'LANDBOYNE 1492.50	1492.5	O3-3		12.94	14.15	14.56
O'LANDBOYNE 1924.31	1924.31		O'Land01 U/S	12.80	14.02	14.44
O'LANDBOYNE 1924.31	1924.31			12.80	14.02	14.44
O'LANDBOYNE 2032.00	2032	O3-4		12.80	14.02	14.44
O'LAND01 0.00	0			12.80	14.02	14.44
O'LAND01 415.30	415.3	O4-01		12.39	13.54	13.95
O'LAND01 1018.80	1018.8	O4-02		11.85	13.02	13.42
O'LAND01 1360.20	1360.2	O4-03		11.57	12.78	13.19
O'LAND01 1988.30	1988.3	O4-04		11.28	12.51	12.92
O'LAND01 2586.50	2586.5	O4-05		11.13	12.34	12.76
O'LAND01 3091.00	3091	O4-06		10.76	11.94	12.34
CATTLECK 0.00	0	CC1	Tannum Sands Rd 50m D/S	10.76	11.94	12.34
CATTLECK 743.60	743.6	CC2		10.76	11.94	12.34
CATTLECK 1293.10	1293.1	CC3		10.76	11.94	12.34
CATTLECK 1994.43	1994.43		O'Land 01 D/S	10.76	11.94	12.34
CATTLECK 1994.43	1994.43			10.76	11.94	12.34
CATTLECK 2124.80	2124.8	CC4		10.60	11.73	12.11
CATTLECK 2335.00	2335			10.43	11.48	11.85
STHTREES 0.00	0	ST1	Sth Trees/BoyneR Bifurcate	10.60	11.61	11.97
STHTREES 851.80	851.8	ST2		9.54	10.66	11.04
STHTREES 1579.60	1579.6	ST3	Boyne Is Rd Bridge	9.26	10.39	10.78
STHTREES 2361.30	2361.3	ST4		9.04	10.18	10.57
STHTREES 2829.50	2829.5	ST5		8.97	10.11	10.50
STHTREES 3773.50	3773.5	ST6		8.82	9.96	10.35
STHTREES 4171.60	4171.6	ST7		8.74	9.87	10.26
STHTREES 4595.40	4595.4	ST8		8.59	9.70	10.07
STHTREES 5122.39	5122.39		Ten Mile Ck	8.36	9.44	9.81
STHTREES 5122.39	5122.39			8.36	9.44	9.81
STHTREES 5493.40	5493.4	ST9		8.18	9.24	9.60
STHTREES 6390.90	6390.9	ST10		7.05	7.99	8.30
STHTREES 7658.80	7658.8	ST11		5.77	6.56	6.83
STHTREES 8251.05	8251.05		Eleven Mile Ck	5.64	6.41	6.68
STHTREES 8251.05	8251.05			5.64	6.41	6.68
STHTREES 9287.10	9287.1	ST12		5.33	6.04	6.29
STHTREES 11258.10	11258.1	ST13		4.62	5.22	5.43
STHTREES 12688.10	12688.1	ST14		4.05	4.54	4.72
STHTREES 14444.90	14444.9	ST15		3.55	3.94	4.08
STHTREES 17478.00	17478	ST16		2.42	2.42	2.42
TENMILECK 0.00	0	T4-1	GLD/Benaraby Boyne X-ing	10.46	10.46	10.46
TENMILECK 510.20	510.2	T4-2		8.36	9.44	9.81
TENMILECK 1040.50	1040.5	T4-3		8.36	9.44	9.81
TENMILECK 1753.90	1753.9	T4-4		8.36	9.44	9.81
TENMILECK 2298.00	2298	T4-5		8.36	9.44	9.81
ELEVENMILECK 0.00	0	T5-1		13.03	13.03	13.03
ELEVENMILECK 883.90	883.9	T5-2	GLD/Benaraby Rd	5.64	6.41	6.68
ELEVENMILECK 1811.40	1811.4	T5-3		5.64	6.41	6.68
ELEVENMILECK 3118.20	3118.2	T5-4		5.64	6.41	6.68
ELEVENMILECK 3887.00	3887			5.64	6.41	6.68
LITTLEOAKYCK 0.00	0	O1-1A		22.38	24.44	25.21
LITTLEOAKYCK 670.00	670	O1-2A		22.38	24.44	25.21
LITTLEOAKYCK 1834.00	1834	O1-3A		22.38	24.44	25.21
LITTLEOAKYCK 1958.00	1958			22.38	24.44	25.21
SPILLWAY 0.00	0			39.95	39.95	39.95
SPILLWAY 300.00	300			27.65	29.40	30.17



1:25,000
0 0.5 1
kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 56

N

LEGEND
- Building Affected by No Failure Flood
- Building Affected by Partial Breach
- Building Affected by Full Breach
- Building Not Affected by Flooding

- No Failure Flood Extent
- Incremental Impact for Partial Embankment Failure, Breach Invert Level of 43m AHD
- Incremental Impact for Full Embankment Failure, Breach Invert Level of 43m AHD

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 FIA

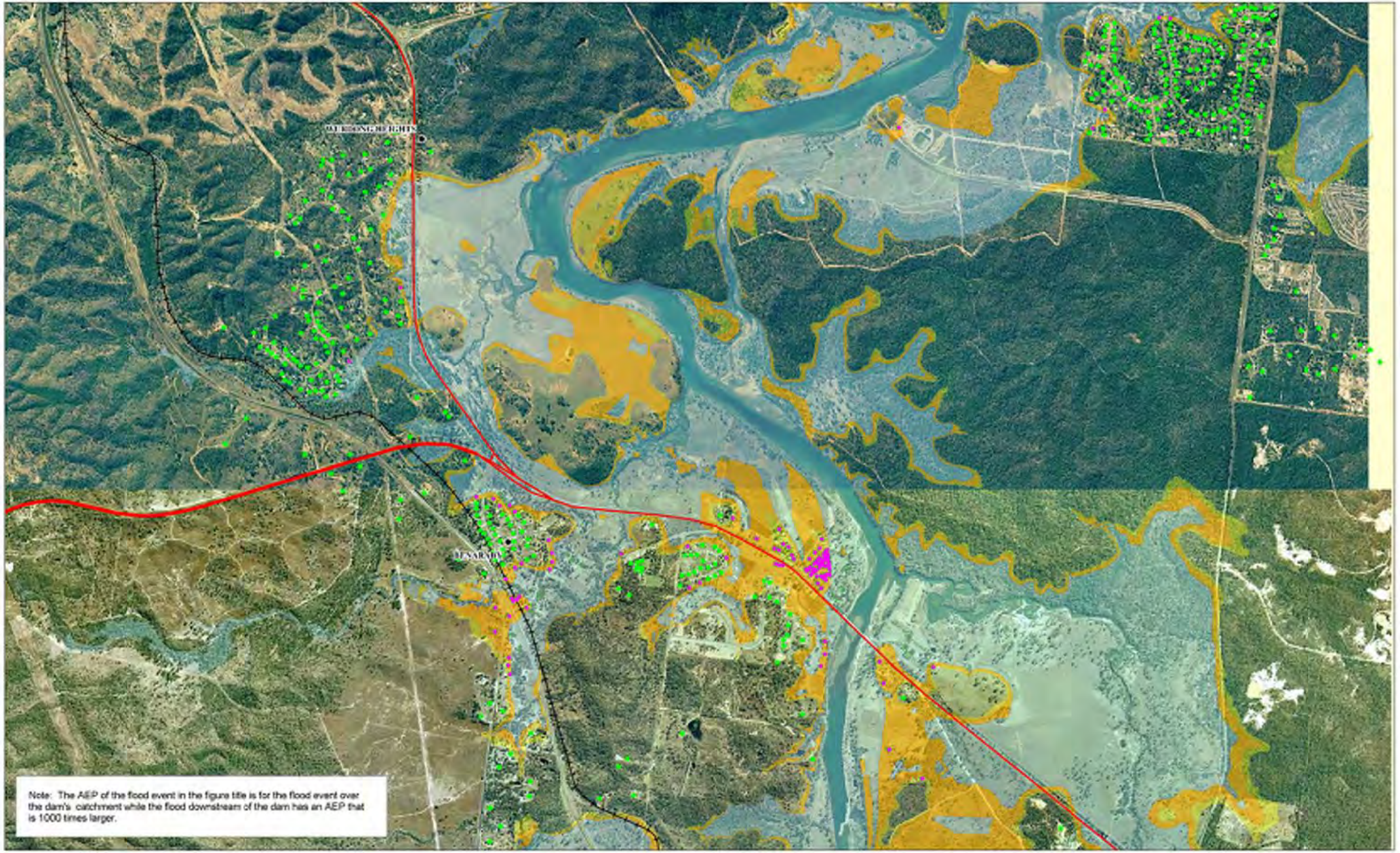
Estimated Buildings at Risk
1 in 2, 000 AEP Flood Event

Job Number	41-21150-00
Revision	0
Date	19 Apr 2009

Figure C5

G:\41\21150\CAD\GIS\MapInfo\21150-01.wor

Suite 4, 1-3 Annand Street Toowoomba QLD 4350 Australia
T 61 7 4633 8000 F 61 7 4613 1687 E tbamail@ghd.com.au W www.ghd.com.au



1:25,000

0 0.5 1

kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 56

N

LEGEND

- Building Affected by No Failure Flood
- Building Affected by Partial Breach
- Building Affected by Full Breach
- Building Not Affected by Flooding

No Failure Flood Extent

Incremental Impact for Partial Embankment Failure, Breach Invert Level of 43m AHD

Incremental Impact for Full Embankment Failure, Breach Invert Level of 43m AHD

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 FIA

Job Number 41-21180-00
Revision 0
Date 19 Apr 2009

Estimated Buildings at Risk 1 in 2, 000 AEP Flood Event

Figure C6

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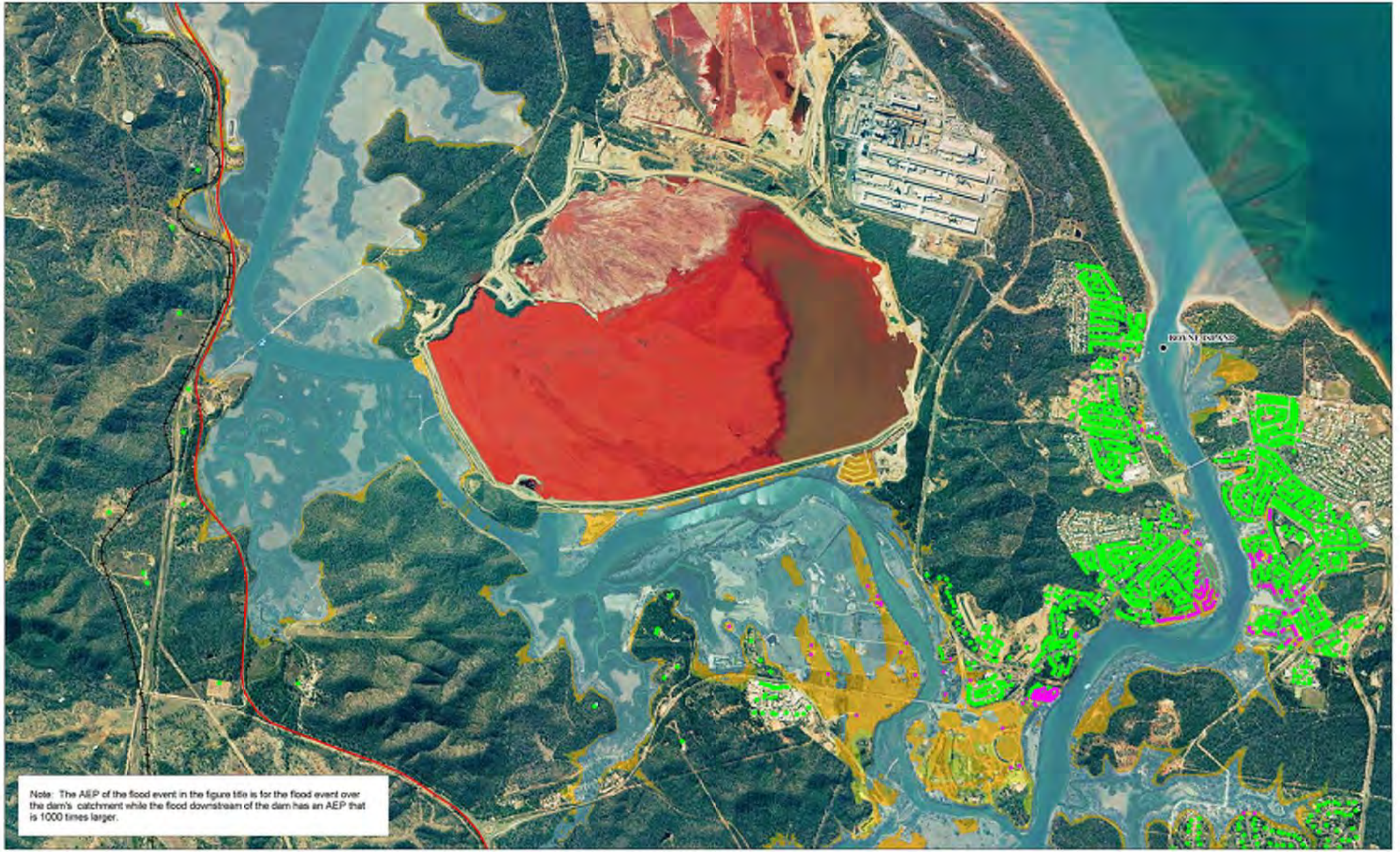

1:25,000
0 0.5 1
kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 56

N

LEGEND
- Building Affected by No Failure Flood
- Building Affected by Partial Breach
- Building Affected by Full Breach
- Building Not Affected by Flooding

No Failure Flood Extent

Incremental Impact for Partial Embankment Failure, Breach Invert Level of 43m AHD

Incremental Impact for Full Embankment Failure, Breach Invert Level of 43m AHD

Gladstone Area Water Board
Awoonga Saddle Dam No. 3 FIA

Estimated Buildings at Risk 1 in 2, 000 AEP Flood Event

Job Number	41-21150-00
Revision	0
Date	19 Apr 2009

Figure C7

G:\41\21150\CAD\GIS\Mxd\Mxd\21150_19.mxd

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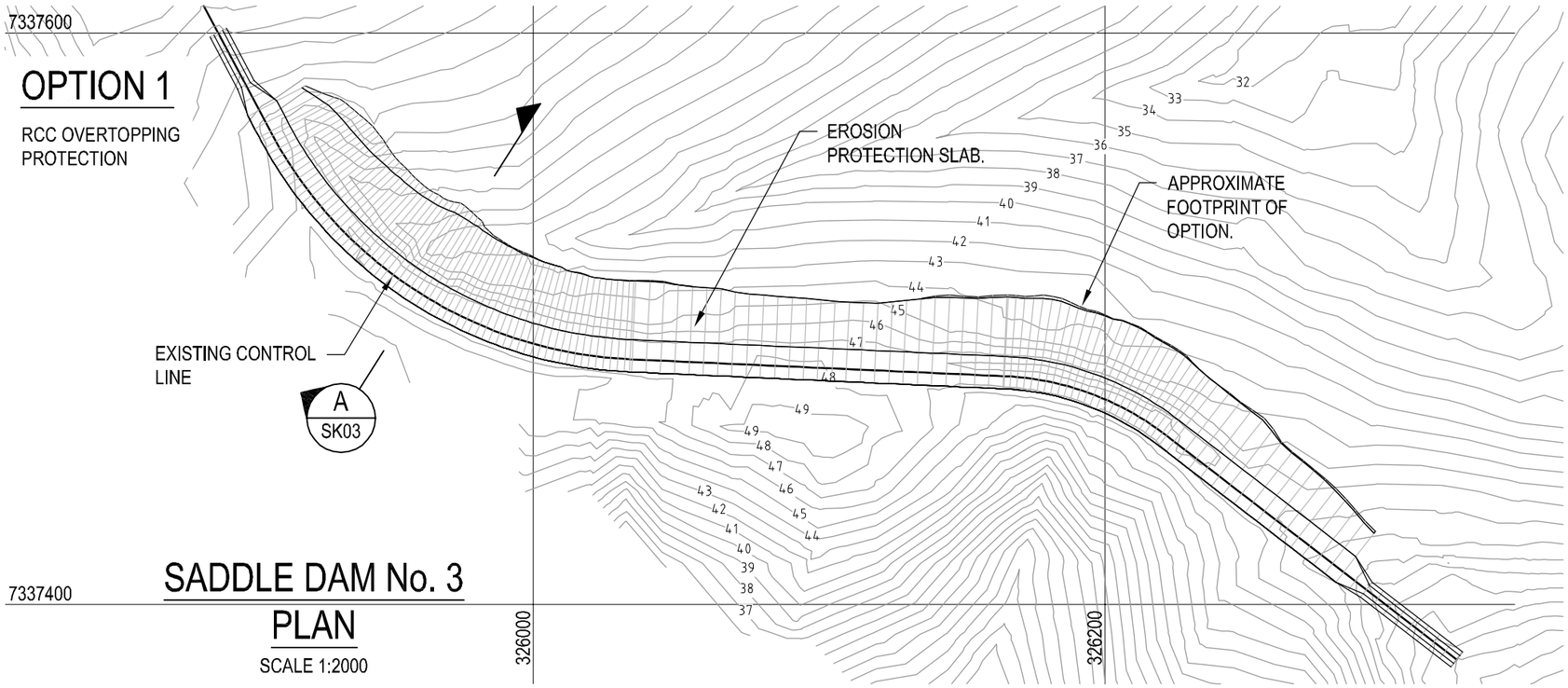
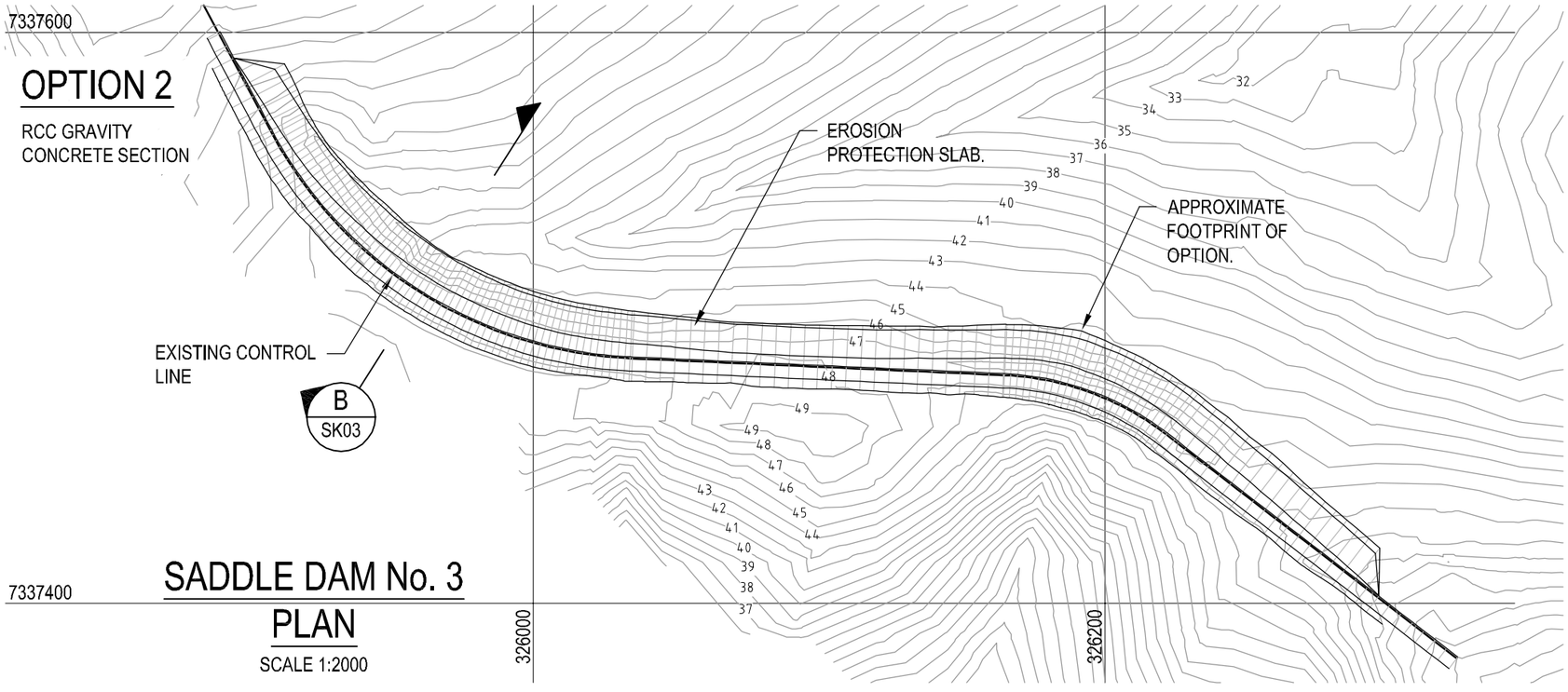
Appendix D

AFC Options Design Sketches





NOTES:

1. HORIZONTAL DATUM: AMG 84
2. CONTOURS DERIVED FROM SURVEY PROVIDED BY GAWB.
3. CONTROL LINE GIVEN ON DRAWING N°. SD1702 HAS BEEN ADJUSTED TO SUIT THE "AS BUILT" SURVEY.

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

PRELIMINARY

A	INITIAL ISSUE	MBB	29.05.09
rev	description	app'd	date

GLADSTONE AREA WATER BOARD
ACCEPTABLE FLOOD CAPACITY ASSESSMENT

AWOONGA SADDLE DAM NO. 3 PLAN - OPTIONS 1 AND 2

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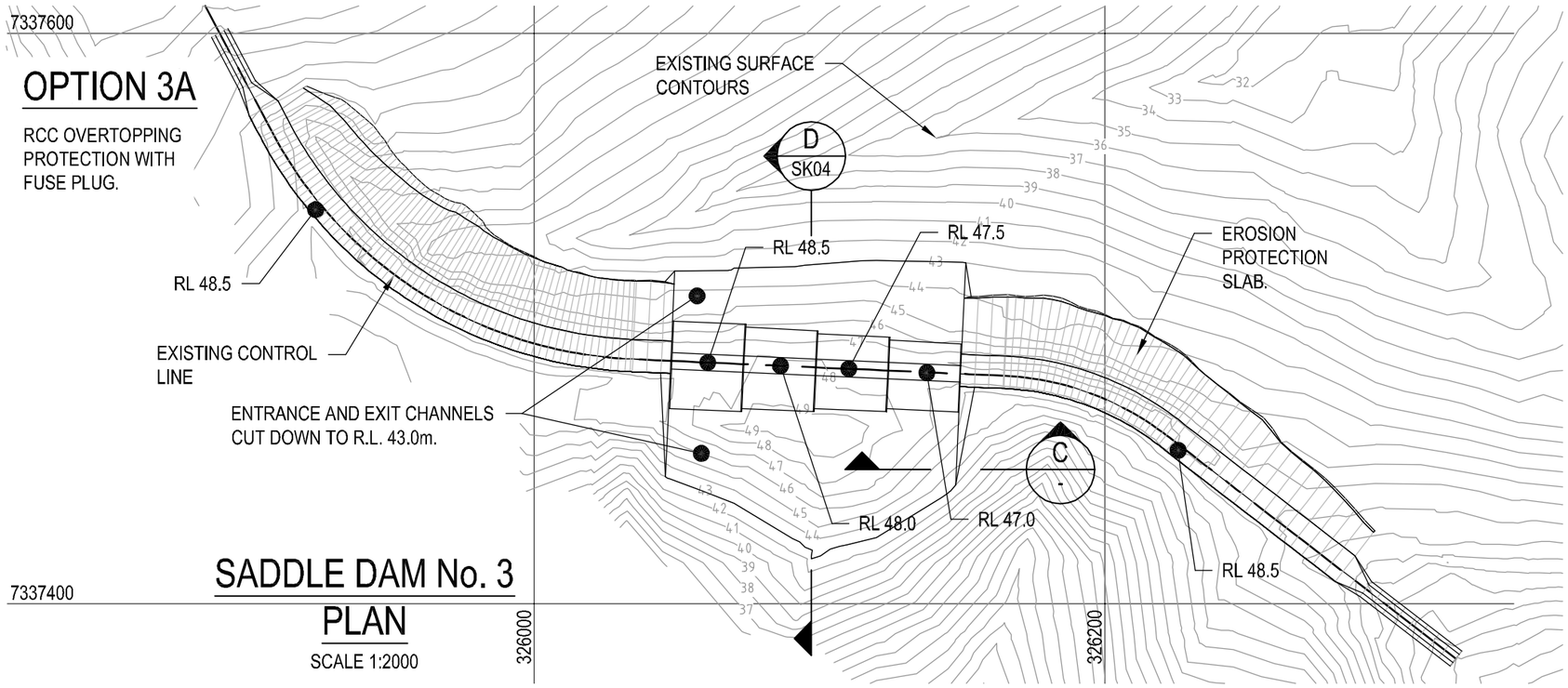
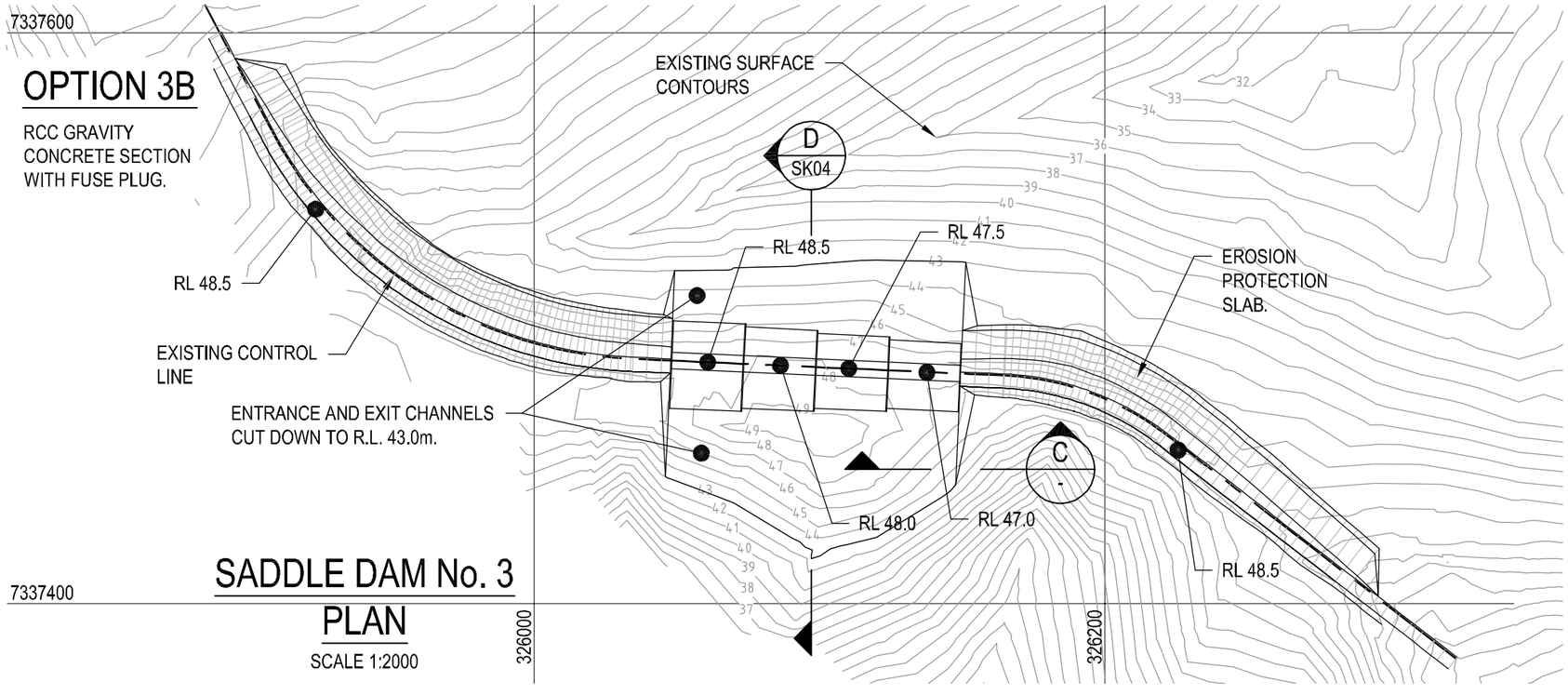
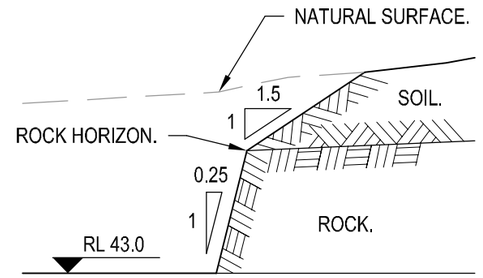
scale	1:2000 for A3	job no.	41-20176
date	MAY 2009	rev no.	A

approved SK01

Plot Date: 29 May 2009 - 9:26 AM Plotted by: Monique Hammond , #### Cad File No: G:\41\20176\CADD\Drawings\41-20176-SK01.dwg







C
-
SECTION
SCALE 1 :100

EXCAVATED PROFILE FOR ENTRANCE AND EXIT CHANNEL FOR FUSEPLUG SECTION.

0 1 2 3m
SCALE 1:100 AT ORIGINAL SIZE

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	MBB	29.05.09

GLADSTONE AREA WATER BOARD
ACCEPTABLE FLOOD CAPACITY ASSESSMENT

AWOONGA SADDLE DAM NO. 3 PLAN - OPTIONS 3A AND 3B

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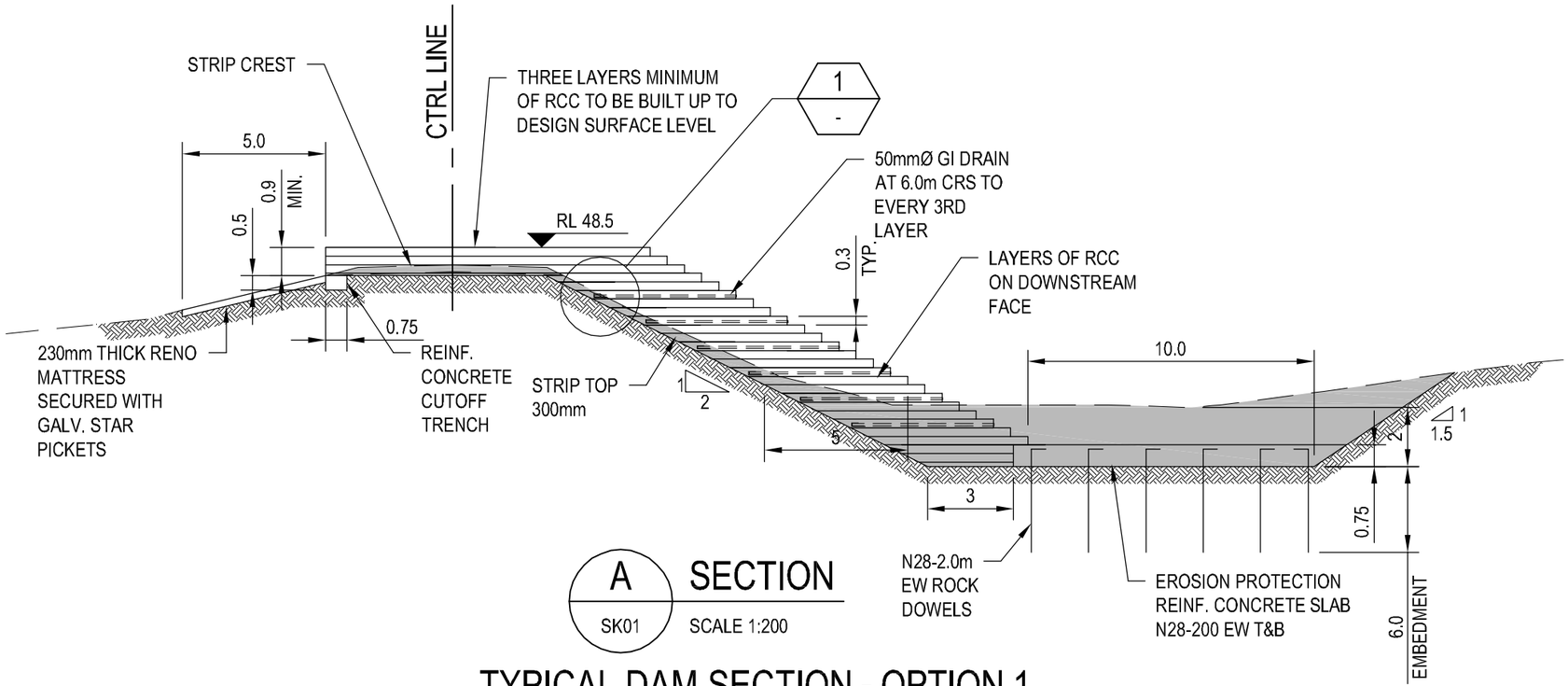
scale	AS SHOWN for A3	job no.	41-20176
date	MAY 2009	rev no.	A

approved SK02

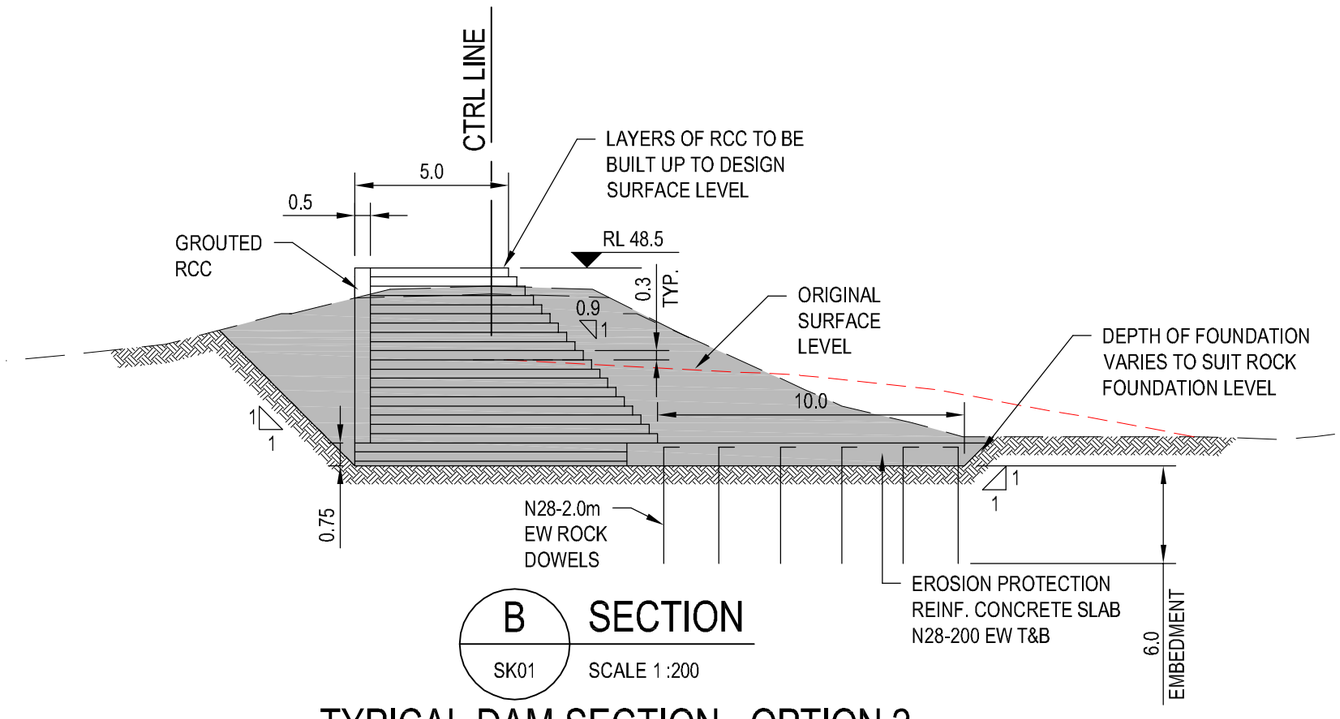
Plot Date: 29 May 2009 - 8:49 AM Plotted by: Robert Wardale , #### Cad File No: G:\41\20176\CADD\Drawings\41-20176-SK02.dwg



A SECTION

SK01 SCALE 1:200

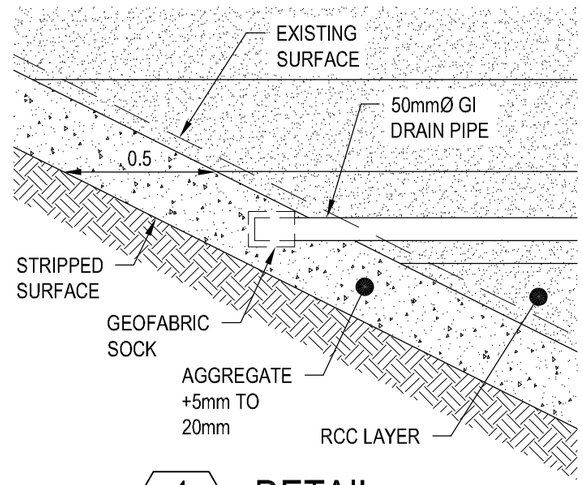
TYPICAL DAM SECTION - OPTION 1



B SECTION

SK01 SCALE 1 :200

TYPICAL DAM SECTION - OPTION 2



1 DETAIL

- SCALE 1 : 20

0 0.2 0.4 0.6m

SCALE 1:20 AT ORIGINAL SIZE

0 2 4 6m

SCALE 1:200 AT ORIGINAL SIZE

PRELIMINARY

A	INITIAL ISSUE	MBB	29.05.09
rev	description	app'd	date

GLADSTONE AREA WATER BOARD

ACCEPTABLE FLOOD CAPACITY ASSESSMENT

AWOONGA SADDLE DAM NO. 3 SECTIONS

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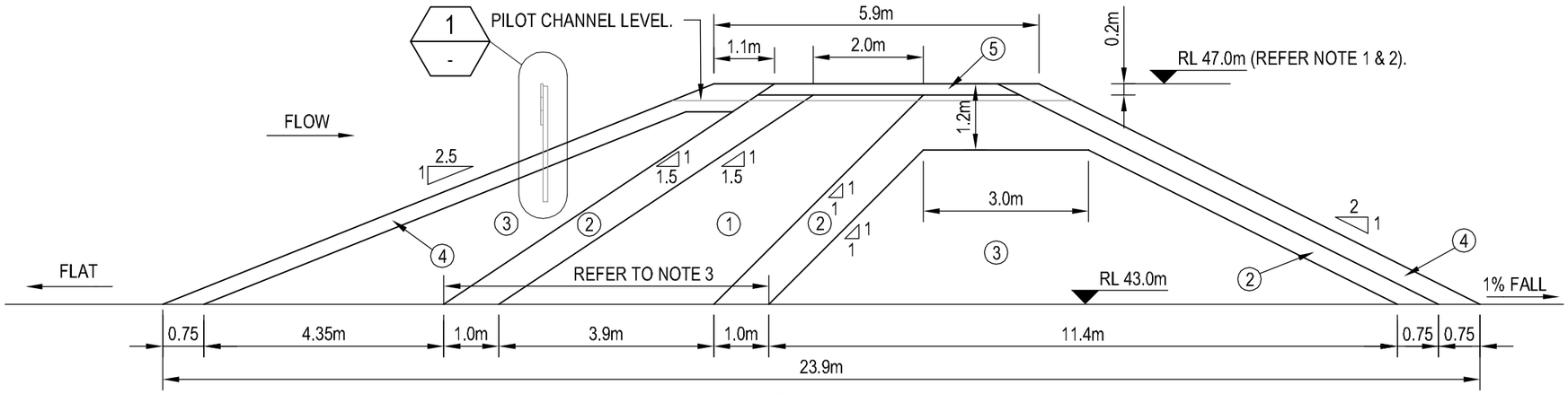
scale	AS SHOWN for A3	job no.	41-20176
date	MAY 2009	rev no.	A

approved SK03

Plot Date: 29 May 2009 - 8:50 AM Plotted by: Monique Hammond , #### Cad File No: G:\41\20176\CADD\Drawings\41-20176-SK03.dwg



A SECTION
SK02 SCALE 1 :100

FUSEPLUG EMBANKMENT (OPTIONS 3A AND 3B) - TYPICAL SECTION

ZONES

1. CORE
2. FILTER
3. UPSTREAM AND DOWNSTREAM SHELL
4. SLOPE PROTECTION
5. ROAD BASE

ZONE 2 GRADING LIMITS

D (mm)	% PASSING
0.075	0 - 5
0.14	0 - 15
0.7	15 - 60
3.5	60 - 100
20	90 - 100
75	100

ZONE 3 GRADING LIMITS

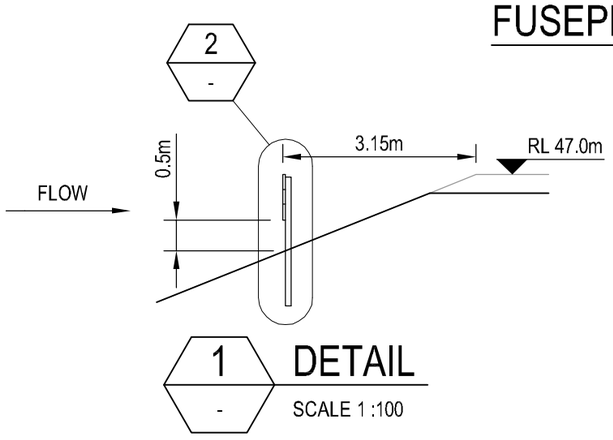
D (mm)	% PASSING
0.075	0
1.2	0 - 15
4.75	15 - 60
9.5	38 - 90
19	60 - 100
75	100

ZONE 4 TYPICAL GRADING

D (mm)	% PASSING
60	0
75	0-10
100	0-80
150	20-100
200	80-100
250	100

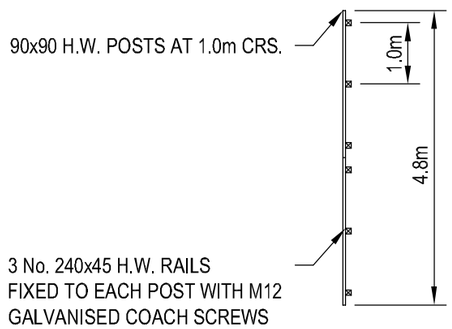
NOTES:

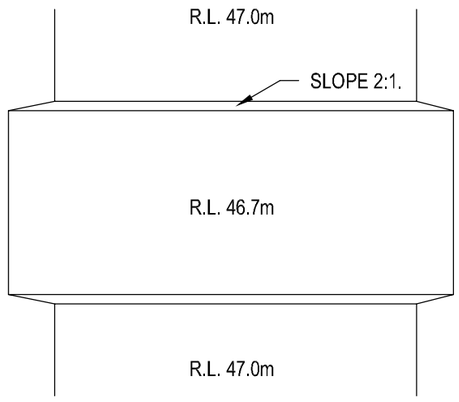
1. THE FUSEPLUG EMBANKMENT SHALL BE CONSTRUCTED TO 50mm HIGHER THAN THOSE LEVELS INDICATED TO ALLOW FOR SETTLEMENT.
2. THE OWNER SHALL SURVEY THE CREST AND PILOT CHANNEL LEVELS ONCE EVERY 5 YEARS TO CONFIRM THE SPECIFIED LEVELS ARE MAINTAINED.
3. WEAKER UNSUITABLE MATERIAL SHALL BE EXCAVATED AND BACKFILLED WITH DENTAL CONCRETE OF GRADE N20. ALL EDGES OF DENTAL CONCRETE AND SLURRY SHALL BE PREPARED TO MINIMISE POTENTIAL FEATHER EDGES. FRIABLE OR FRACTURED ROCK IN THIS AREA SHALL BE COVERED WITH A SAND/CEMENT SLURRY. THE SLURRY SHALL COMPRISE THE CEMENT, WATER AND FINE AGGREGATE OF GRADE 20Mpa CONCRETE, WHICH SHALL BE THOROUGHLY MIXED AND SPREAD TO A THICKNESS OF 15mm OVER THE FRACTURED ROCK USING BROOMS OR OTHER SUITABLE MEANS. THE SLURRY SHALL BE FULLY CURED IN ACCORDANCE WITH MRD 11.20 OR AS3600 AS APPROPRIATE. PRIOR TO PLACEMENT OF CORE MATERIAL OVER THE SLURRY, THE SURFACE SHALL BE MOISTENED IN ACCORDANCE WITH THE SPECIFICATION. NO VEHICULAR EQUIPMENT IS TO PASS OVER THE SLURRY AREA UNTIL COMPLETION OF THE SPECIAL COMPACTION LAYER OVER THE FOUNDATION.



1 DETAIL
- SCALE 1 :100

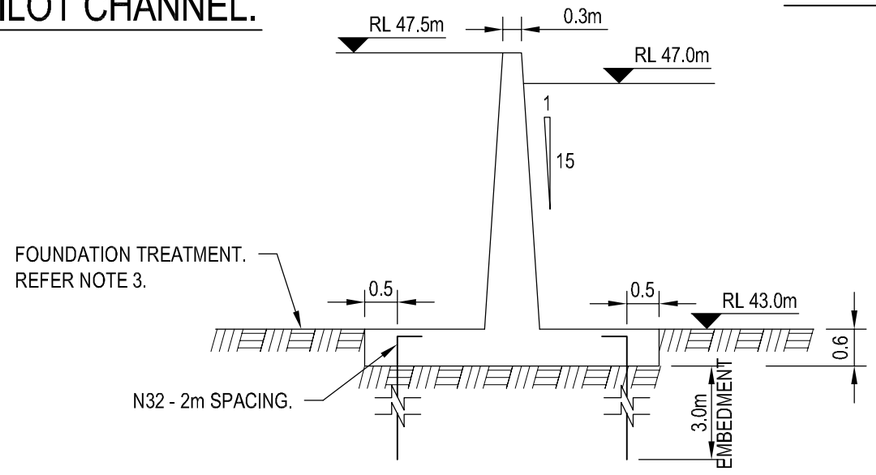
TIMBER WAVE BAFFLE IN FRONT OF 3m WIDE FUSEPLUG PILOT CHANNEL.





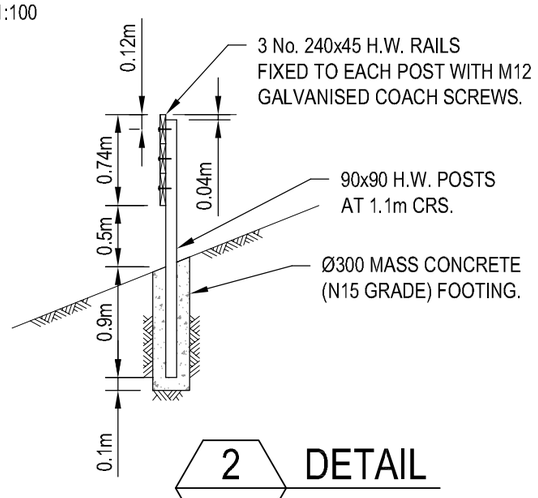
PLAN OF PILOT CHANNEL.

SCALE 1:100



TYPICAL DIVIDE WALL BETWEEN FUSEPLUGS.

SCALE 1:100



2 DETAIL
- SCALE 1 :50

0 0.5 1.0 1.5m
SCALE 1:50 AT ORIGINAL SIZE

0 1 2 3m
SCALE 1:100 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	MBB	29.05.09

GLADSTONE AREA WATER BOARD
ACCEPTABLE FLOOD CAPACITY ASSESSMENT

AWOONGA SADDLE DAM NO. 3 FUSEPLUG DETAILS

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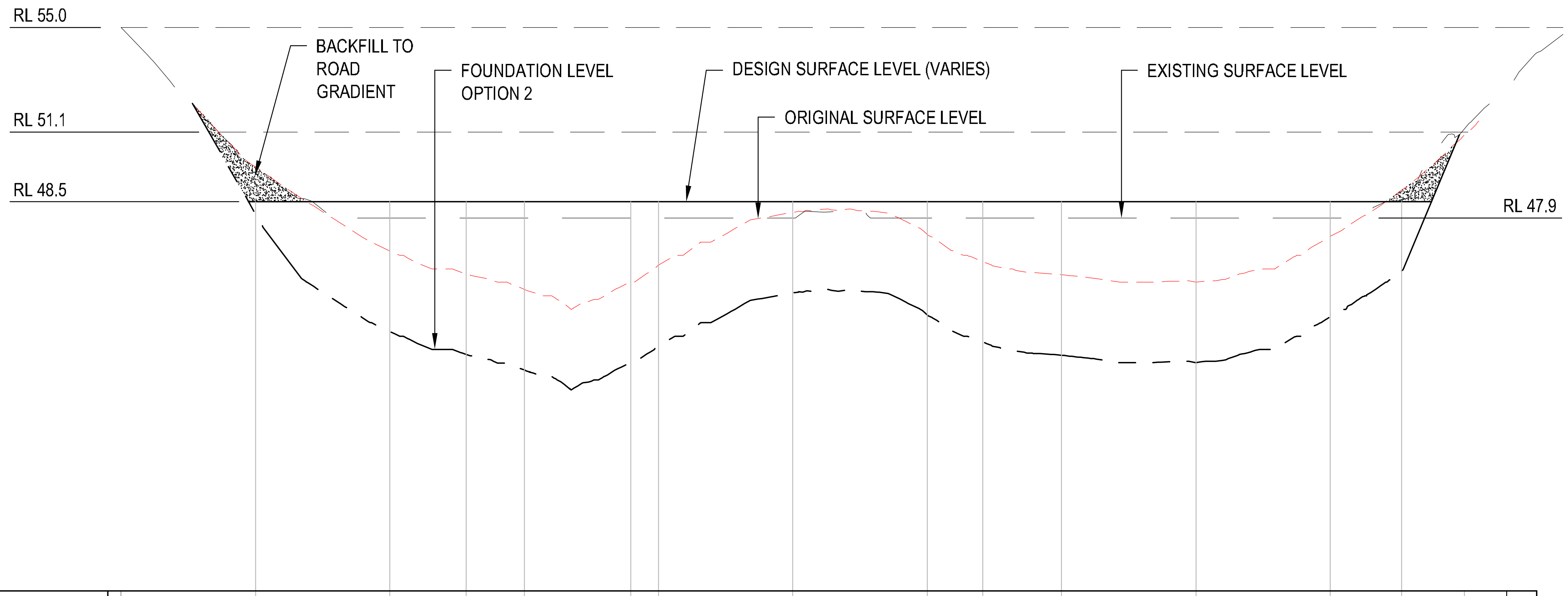
scale	AS SHOWN for A3	job no.	41-20176
date	MAY 2009	rev no.	A

approved SK04

Plot Date: 29 May 2009 - 8:46 AM Plotted by: Robert Wardale , #### Cad File No: G:\41\20176\CADD\Drawings\41-20176-SK04.dwg



DATUM RL. 34.00

VERTICAL ALIGNMENT: L=515.68m, G=0%

HORIZONTAL ALIGNMENT: L=128.38m | L=61.22m R=-100.00m | L=131.13m | L=155.90m R=150.00m | L=63.68m

DAM FOUNDATION OPTN2			43.66	42.81	42.24	42.50	43.14	45.11	44.29	43.28	42.78	42.51	44.21	45.93	
ORIGINAL SURFACE LEVEL		49.80	46.66	45.81	45.24	45.50	46.14	48.11	47.29	46.28	45.78	45.51	47.22	48.93	51.00
DESIGN SURFACE LEVEL			48.500	48.500	48.500	48.500	48.500	48.500	48.500	48.500	48.500	48.500	48.500		
EXISTING SURFACE LEVEL	55.00	49.74	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	47.90	48.57	51.23
CHAINAGE	50.00	100.00	150.00	178.38	200.00	239.60	250.00	300.00	350.00	370.73	400.00	450.00	500.00	526.63	550.00

LONGITUDINAL SECTION - CTRL DAM03

HORZ 1:2000 VERT 1:200

NOTE:
CHAINAGES ARE SELECTED TO CONFORM AS CLOSELY AS POSSIBLE WITH DRAWING N°. SD1702

VERTICAL SCALE 1:200 AT ORIGINAL SIZE 0 2 4 6m
HORIZONTAL SCALE 1:2000 AT ORIGINAL SIZE 0 20 40 60m

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	MBB	29.05.09

GLADSTONE AREA WATER BOARD
ACCEPTABLE FLOOD CAPACITY ASSESSMENT

AWOONGA SADDLE DAM NO. 3 LONGITUDINAL SECTION

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scale AS SHOWN for A3 | job no. 41-20176
date MAY 2009 | rev no. A
approved SK05

NOTES:

1. INVERT OF CUT OFF TRENCH TO BE CLEANED OFF USING AIR AND WATER PRIOR TO PLACEMENT OF EMBANKMENT FILL. DENTAL CONCRETE TO BE USED TO FILL AREAS OF UNSUITABLE ROCK AND CEMENT AND SLURRY TO BE PLACED OVER FRIABLE OR JOINTED ROCK TO PREVENT PIPING ALONG THE ROCK/EMBANKMENT INTERFACE.
2. ALL EMBANKMENT MATERIAL ZONE 1 AND 1A TO BE PLACED AT ±2% OF OMC TO MINIMUM 98% STANDARD DENSITY.

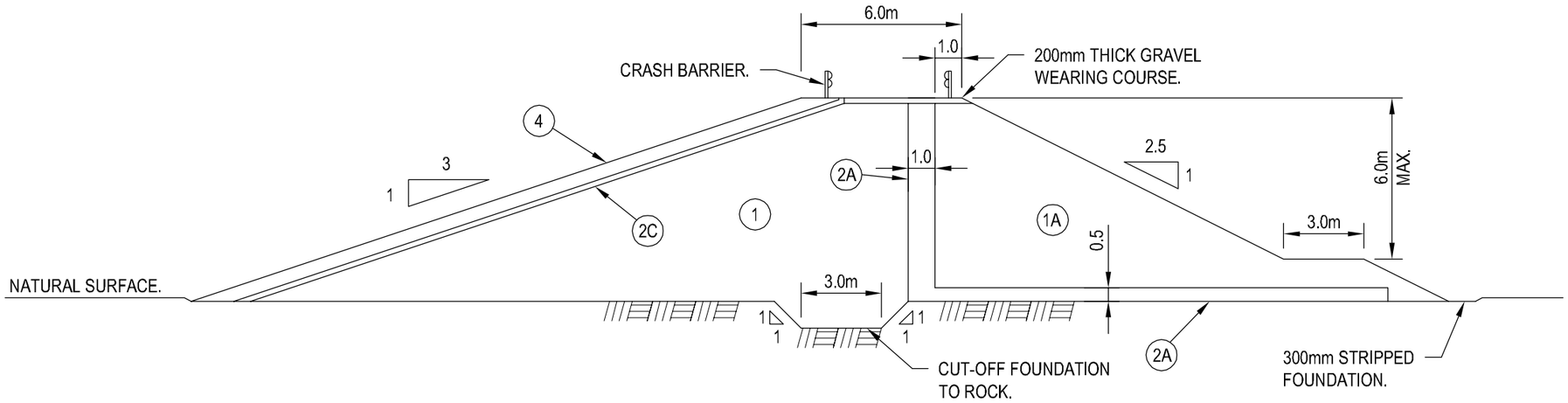
(1) IMPERVIOUS FILL.

(1A) FILL

(2A) SAND FILTER

(2C) 200mm THICK FILTER ZONE

(4) 500mm THICK RIP RAP



NEW EMBANKMENT - OPTION 4
TYPICAL SECTION

SCALE 1:200

0 2 4 6m
SCALE 1:200 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	MBB	29.05.09

GLADSTONE AREA WATER BOARD
ACCEPTABLE FLOOD CAPACITY ASSESSMENT
AWOONGA SADDLE DAM NO. 3
OPTION 4 DETAILS

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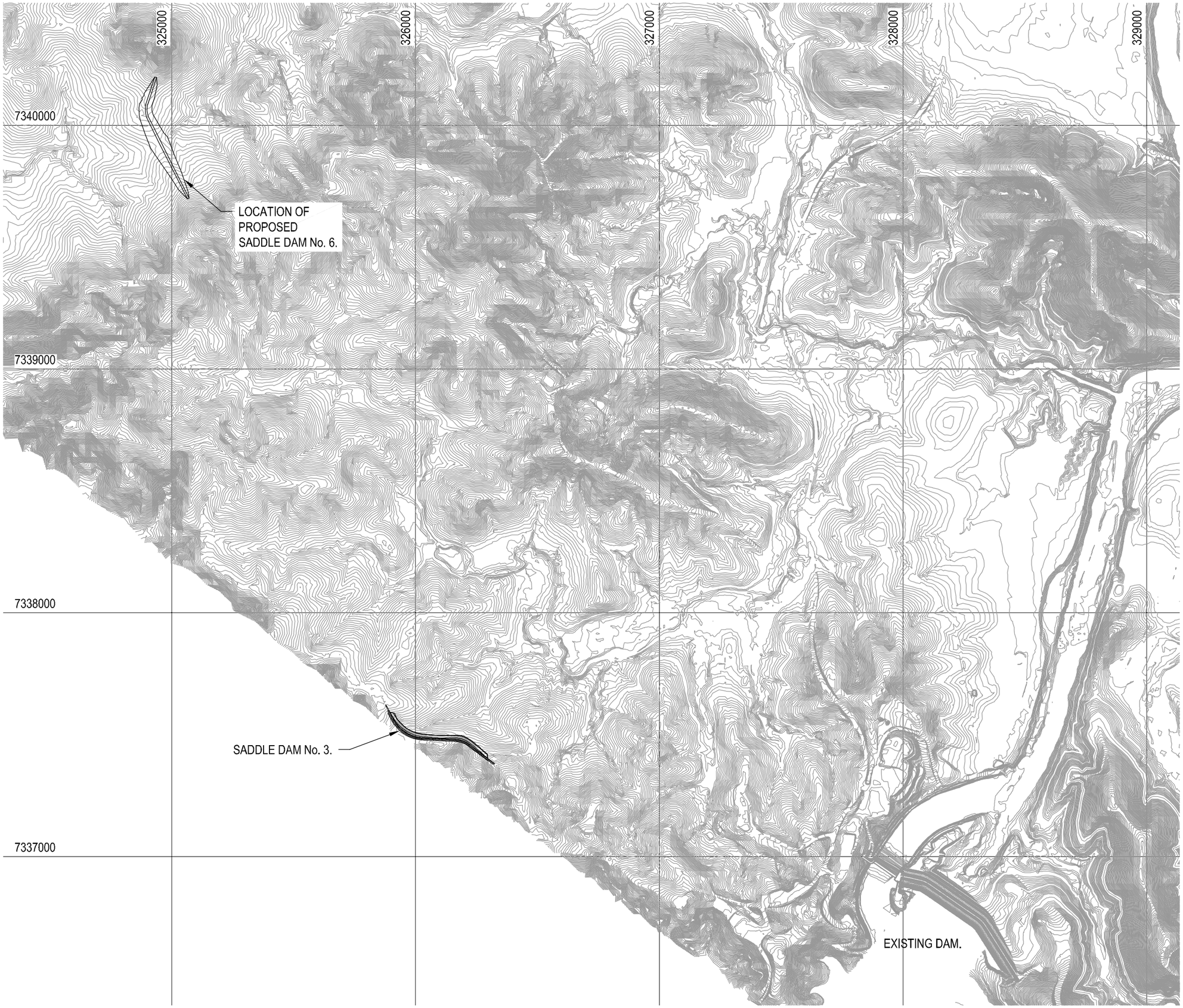
scale	1:200 for A3	job no.	41-20176
date	MAY 2009	rev no.	A

approved SK06

Plot Date: 29 May 2009 - 8:47 AM Plotted by: Robert Wardale , #### Cad File No: G:\41\20176\CADD\Drawings\41-20176-SK06.dwg



0 200 300 450m
SCALE 1:15,000 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	MBB	29.05.09

GLADSTONE AREA WATER BOARD
ACCEPTABLE FLOOD CAPACITY ASSESSMENT

AWOONGA SADDLE DAM NO. 3
LOCALITY PLAN

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scale | 1:15000 for A3 | job no. | 41-20176
date | MAY 2009 | rev no. | A

approved SK07

Plot Date: 29 May 2009 - 8:47 AM Plotted by: Monique Hammond , #### Cad File No: G:\41\20176\CADD\Drawings\41-20176-SK07.dwg

Appendix E

AFC Options Cost Estimates

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 1A - RCC Protection of Existing Dam
Crest Level EL47.9 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Strip dam crest and downstream face	m^3	4,150	$	5.00	$	20,750		
	Excavate toe area, stockpile, re-place and compact following construction of stilling basin and embankment protection	m^3	19,200	$	15.00	$	288,000		
								$	*308,750*
2	**Overtopping Protection**								
	Construct reinforced concrete erosion protection slab	m^3	4,900	$	1,000.00	$	4,900,000		
	Drill, install, grout stilling basin slab rock dowels	m	6,000	$	120.00	$	720,000		
	Supply and place RCC to downstream face and crest	m^3	11,000	$	350.00	$	3,850,000		
	Supply, install PVC coated mattress and rockfill	m^2	2,000	$	250.00	$	500,000		
	Foundation preparation for concrete	m^2	7,800	$	50.00	$	390,000		
	Gravel filter zone	m^3	2,000	$	100.00	$	200,000		
								$	*10,560,000*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	200,000.00	$	200,000		
								$	*200,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place RCC in extremely weathered zone	m^3	2,500	$	350.00	$	875,000		
								$	*1,062,500*
5									
						$	-		
						$	-		
						$	-		
								$	-
6									
						$	-		
						$	-		
						$	-		
								$	-
						Total		**$**	**12,131,250**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 308,750	
2	Overtopping Protection	$ 10,560,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5		$ -	
6		$ -	
	Sub-total		$ 12,131,250
7	20% for minor items and establishment costs	$ 2,426,250	
	Sub-total Direct Costs		**$ 14,557,500**
8	Allow 10% for Design, Tender and Supervision	$ 1,455,750	
	Sub-total		$ 16,013,250
9	20% Indirect costs	$ 3,202,650	
	Sub-total		$ 19,215,900
10	Add 30% contingencies	$ 5,764,770	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 24,980,670**
11	Add GST 10%	$ 2,498,067	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 27,478,737

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 1B - RCC Protection of Existing Dam
Crest Level EL48.5 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Strip dam crest and downstream face	m^3	4,150	$	5.00	$	20,750		
	Excavate toe area, stockpile, re-place and compact following construction of stilling basin and embankment protection	m^3	19,200	$	15.00	$	288,000		
								$	*308,750*
2	**Overtopping Protection**								
	Construct reinforced concrete erosion protection slab	m^3	4,900	$	1,000.00	$	4,900,000		
	Drill, install, grout stilling basin slab rock dowels	m	6,000	$	120.00	$	720,000		
	Supply and place RCC to downstream face and crest	m^3	12,500	$	350.00	$	4,375,000		
	Supply, install PVC coated mattress and rockfill	m^2	2,000	$	250.00	$	500,000		
	Foundation preparation for concrete	m^2	7,800	$	50.00	$	390,000		
	Gravel filter zone	m^3	2,200	$	100.00	$	220,000		
								$	*11,105,000*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	200,000.00	$	200,000		
								$	*200,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place RCC in extremely weathered zone	m^3	2,500	$	350.00	$	875,000		
								$	*1,062,500*
5									
						$	-		
						$	-		
						$	-		
								$	-
6									
						$	-		
						$	-		
						$	-		
								$	-
						Total		**$**	**12,676,250**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 308,750	
2	Overtopping Protection	$ 11,105,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5		$ -	
6		$ -	
	Sub-total		$ 12,676,250
7	20% for minor items and establishment costs	$ 2,535,250	
	Sub-total Direct Costs		**$ 15,211,500**
8	Allow 10% for Design, Tender and Supervision	$ 1,521,150	
	Sub-total		$ 16,732,650
9	20% Indirect costs	$ 3,346,530	
	Sub-total		$ 20,079,180
10	Add 30% contingencies	$ 6,023,754	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 26,102,934**
11	Add GST 10%	$ 2,610,293	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 28,713,227

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 2A - New RCC Dam
Crest Level EL47.9 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	17,200	$ 15.00	$ 258,000	
	Foundation preparation	m^2	9,900	$ 50.00	$ 495,000	
						$ 933,000
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	4,500	$ 1,000.00	$ 4,500,000	
	Drill, install, grout stilling basin slab rock dowels	m	6,000	$ 120.00	$ 720,000	
	Supply and place RCC for dam	m^3	11,800	$ 350.00	$ 4,130,000	
					$ -	
					$ -	
					$ -	
						$ 9,350,000
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 350.00	$ 875,000	
						$ 1,062,500
5						
					$ -	
					$ -	
					$ -	
						*$ - *
6						
					$ -	
					$ -	
					$ -	
						*$ - *
					Total	**$ 11,545,500**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 933,000	
2	New RCC Dam	$ 9,350,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5		$ -	
6		$ -	
	Sub-total		$ 11,545,500
7	20% for minor items and establishment costs	$ 2,309,100	
	Sub-total Direct Costs		**$ 13,854,600**
8	Allow 10% for Design, Tender and Supervision	$ 1,385,460	
	Sub-total		$ 15,240,060
9	20% Indirect costs	$ 3,048,012	
	Sub-total		$ 18,288,072
10	Add 30% contingencies	$ 5,486,422	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 23,774,494**
11	Add GST 10%	$ 2,377,449	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 26,151,943

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 2B - New RCC Dam
Crest Level EL48.5 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	17,600	$ 15.00	$ 264,000	
	Foundation preparation	m^2	10,150	$ 50.00	$ 507,500	
						$ 951,500
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	4,500	$ 1,000.00	$ 4,500,000	
	Drill, install, grout stilling basin slab rock dowels	m	6,000	$ 120.00	$ 720,000	
	Supply and place RCC for dam	m^3	14,250	$ 350.00	$ 4,987,500	
					$ -	
					$ -	
					$ -	
						$ 10,207,500
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 350.00	$ 875,000	
						$ 1,062,500
5						
					$ -	
					$ -	
					$ -	
						*$ - *
6						
					$ -	
					$ -	
					$ -	
						*$ - *
					Total	**$ 12,421,500**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 951,500	
2	New RCC Dam	$ 10,207,500	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5		$ -	
6		$ -	
	Sub-total		$ 12,421,500
7	20% for minor items and establishment costs	$ 2,484,300	
	Sub-total Direct Costs		**$ 14,905,800**
8	Allow 10% for Design, Tender and Supervision	$ 1,490,580	
	Sub-total		$ 16,396,380
9	20% Indirect costs	$ 3,279,276	
	Sub-total		$ 19,675,656
10	Add 30% contingencies	$ 5,902,697	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 25,578,353**
11	Add GST 10%	$ 2,557,835	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 28,136,188

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 2C - New RCC Dam
Crest Level EL51 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	20,050	$ 15.00	$ 300,750	
	Foundation preparation	m^2	12,650	$ 50.00	$ 632,500	
						$ 1,113,250
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	5,150	$ 1,000.00	$ 5,150,000	
	Drill, install, grout stilling basin slab rock dowels	m	6,000	$ 120.00	$ 720,000	
	Supply and place RCC for dam	m^3	28,350	$ 350.00	$ 9,922,500	
					$ -	
					$ -	
					$ -	
						$ 15,792,500
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 350.00	$ 875,000	
						$ 1,062,500
5						
					$ -	
					$ -	
					$ -	
						*$ - *
6						
					$ -	
					$ -	
					$ -	
						*$ - *
					Total	**$ 18,168,250**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 1,113,250	
2	New RCC Dam	$ 15,792,500	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5		$ -	
6		$ -	
	Sub-total		$ 18,168,250
7	20% for minor items and establishment costs	$ 3,633,650	
	Sub-total Direct Costs		**$ 21,801,900**
8	Allow 10% for Design, Tender and Supervision	$ 2,180,190	
	Sub-total		$ 23,982,090
9	20% Indirect costs	$ 4,796,418	
	Sub-total		$ 28,778,508
10	Add 30% contingencies	$ 8,633,552	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 37,412,060**
11	Add GST 10%	$ 3,741,206	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 41,153,266

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 2D - New RCC Dam
Crest Level EL55 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$	15.00	$	180,000		
	Excavate foundation, assume 2m stripping	m^3	25,300	$	15.00	$	379,500		
	Foundation preparation	m^2	16,150	$	50.00	$	807,500		
								$	*1,367,000*
2	**New RCC Dam**								
	Construct reinforced concrete erosion protection slab	m^3	6,000	$	1,000.00	$	6,000,000		
	Drill, install, grout stilling basin slab rock dowels	m	6,000	$	120.00	$	720,000		
	Supply and place RCC for dam	m^3	60,300	$	300.00	$	18,090,000		
						$	-		
						$	-		
						$	-		
								$	*24,810,000*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	200,000.00	$	200,000		
								$	*200,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place RCC in extremely weathered zone	m^3	2,500	$	300.00	$	750,000		
								$	*937,500*
5									
						$	-		
						$	-		
						$	-		
								$	-
6									
						$	-		
						$	-		
						$	-		
								$	-
						Total		**$**	**27,314,500**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 1,367,000	
2	New RCC Dam	$ 24,810,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 937,500	
5		$ -	
6		$ -	
	Sub-total		$ 27,314,500
7	20% for minor items and establishment costs	$ 5,462,900	
	Sub-total Direct Costs		**$ 32,777,400**
8	Allow 10% for Design, Tender and Supervision	$ 3,277,740	
	Sub-total		$ 36,055,140
9	20% Indirect costs	$ 7,211,028	
	Sub-total		$ 43,266,168
10	Add 30% contingencies	$ 12,979,850	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 56,246,018**
11	Add GST 10%	$ 5,624,602	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 61,870,620

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 2E - Remove Existing Embankment, New Concrete Road
Crest Level Min EL45 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$	15.00	$	180,000		
	Excavate foundation, assume 2m stripping	m^3	6,350	$	15.00	$	95,250		
	Foundation preparation	m^2	3,150	$	50.00	$	157,500		
								$	*432,750*
2	**New Concrete Dam/Road**								
	Construct Road (6m wide x 0.30 m thick)	m^3	900	$	600.00	$	540,000		
	Supply and place concrete where foundation level is below EL45	m^3	1,500	$	600.00	$	900,000		
						$	-		
						$	-		
						$	-		
						$	-		
								$	*1,440,000*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	100,000.00	$	100,000		
								$	*100,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place Concrete in extremely weathered zone	m^3	2,500	$	600.00	$	1,500,000		
								$	*1,687,500*
5									
						$	-		
						$	-		
						$	-		
								$	-
6									
						$	-		
						$	-		
						$	-		
								$	-
						Total		**$**	**3,660,250**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 432,750	
2	New Concrete Dam/Road	$ 1,440,000	
3	Geotech Investigations	$ 100,000	
4	Extremely Weathered Foundation Zone	$ 1,687,500	
5		$ -	
6		$ -	
	Sub-total		$ 3,660,250
7	20% for minor items and establishment costs	$ 732,050	
	Sub-total Direct Costs		**$ 4,392,300**
8	Allow 10% for Design, Tender and Supervision	$ 439,230	
	Sub-total		$ 4,831,530
9	20% Indirect costs	$ 966,306	
	Sub-total		$ 5,797,836
10	Add 30% contingencies	$ 1,739,351	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 7,537,187**
11	Add GST 10%	$ 753,719	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 8,290,905

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 3A - RCC Protection of Existing Dam + Fuseplugs
Crest Level EL47.9 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Strip dam crest and downstream face	m^3	3,050	$	5.00	$	15,250		
	Excavate toe area, stockpile, re-place and compact following construction of stilling basin and embankment protection	m^3	14,150	$	15.00	$	212,250		
								$	*227,500*
2	**Overtopping Protection**								
	Construct reinforced concrete erosion protection slab	m^3	3,700	$	1,000.00	$	3,700,000		
	Drill, install, grout stilling basin slab rock dowels	m	4,500	$	120.00	$	540,000		
	Supply and place RCC to downstream face and crest	m^3	8,150	$	350.00	$	2,852,500		
	Supply, install PVC coated mattress and rockfill	m^2	1,500	$	250.00	$	375,000		
	Foundation preparation for concrete	m^2	6,000	$	50.00	$	300,000		
	Gravel filter zone	m^3	1,700	$	100.00	$	170,000		
								$	*7,937,500*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	200,000.00	$	200,000		
								$	*200,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place RCC in extremely weathered zone	m^3	2,500	$	350.00	$	875,000		
								$	*1,062,500*
5	**Fuseplug Construction (4 bays 25 m wide each)**								
	Excavate to EL43	m^3	7,000	$	50.00	$	350,000		
	Foundation preparation	m^2	3,150	$	50.00	$	157,500		
	Supply, place, compact Zone 1 material	m^3	1,800	$	300.00	$	540,000		
	Supply, place, compact Zone 2 material	m^3	1,750	$	220.00	$	385,000		
	Supply, place, compact Zone 3 material	m^3	5,350	$	90.00	$	481,500		
	Supply, place, compact Zone 4 material	m^3	930	$	40.00	$	37,200		
	Road base	m^3	120	$	150.00	$	18,000		
						$	-		
								$	*1,969,200*
6	**Fuseplug Concrete**								
	Divider walls	m^3	170	$	2,500.00	$	425,000		
	Divider slabs	m^3	450	$	1,500.00	$	675,000		
	Rock dowels	m	420	$	120.00	$	50,400		
								$	*1,150,400*
						Total		**$**	**12,547,100**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 227,500	
2	Overtopping Protection	$ 7,937,500	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5	Fuseplug Construction (4 bays 25 m wide each)	$ 1,969,200	
6	Fuseplug Concrete	$ 1,150,400	
	Sub-total		$ 12,547,100
7	20% for minor items and establishment costs	$ 2,509,420	
	Sub-total Direct Costs		**$ 15,056,520**
8	Allow 10% for Design, Tender and Supervision	$ 1,505,652	
	Sub-total		$ 16,562,172
9	20% Indirect costs	$ 3,312,434	
	Sub-total		$ 19,874,606
10	Add 30% contingencies	$ 5,962,382	
TOTAL ESTIMATED PROJECT COST (excl. GST)			**$ 25,836,988**
11	Add GST 10%	$ 2,583,699	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 28,420,687

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 3B - RCC Protection of Existing Dam + Fuseplugs
Crest Level EL48.5 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Strip dam crest and downstream face	m^3	1,700	$	5.00	$	8,500		
	Excavate toe area, stockpile, re-place and compact following construction of stilling basin and embankment protection	m^3	14,150	$	15.00	$	212,250		
								$	*220,750*
2	**Overtopping Protection**								
	Construct reinforced concrete erosion protection slab	m^3	3,700	$	1,000.00	$	3,700,000		
	Drill, install, grout stilling basin slab rock dowels	m	4,500	$	120.00	$	540,000		
	Supply and place RCC to downstream face and crest	m^3	9,150	$	350.00	$	3,202,500		
	Supply, install PVC coated mattress and rockfill	m^2	1,500	$	250.00	$	375,000		
	Foundation preparation for concrete	m^2	6,000	$	50.00	$	300,000		
	Gravel filter zone	m^3	2,000	$	100.00	$	200,000		
								$	*8,317,500*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	200,000.00	$	200,000		
								$	*200,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place RCC in extremely weathered zone	m^3	2,500	$	350.00	$	875,000		
								$	*1,062,500*
5	**Fuseplug Construction (4 bays 25 m wide each)**								
	Excavate to EL43	m^3	7,000	$	50.00	$	350,000		
	Foundation preparation	m^2	3,150	$	50.00	$	157,500		
	Supply, place, compact Zone 1 material	m^3	1,800	$	300.00	$	540,000		
	Supply, place, compact Zone 2 material	m^3	1,750	$	220.00	$	385,000		
	Supply, place, compact Zone 3 material	m^3	5,350	$	90.00	$	481,500		
	Supply, place, compact Zone 4 material	m^3	930	$	40.00	$	37,200		
	Road base	m^3	120	$	150.00	$	18,000		
						$	-		
								$	*1,969,200*
6	**Fuseplug Concrete**								
	Divider walls	m^3	210	$	2,500.00	$	525,000		
	Divider slabs	m^3	500	$	1,500.00	$	750,000		
	Rock dowels	m	420	$	120.00	$	50,400		
								$	*1,325,400*
						Total		**$**	**13,095,350**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 220,750	
2	Overtopping Protection	$ 8,317,500	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5	Fuseplug Construction (4 bays 25 m wide each)	$ 1,969,200	
6	Fuseplug Concrete	$ 1,325,400	
	Sub-total		$ 13,095,350
7	20% for minor items and establishment costs	$ 2,619,070	
	Sub-total Direct Costs		**$ 15,714,420**
8	Allow 10% for Design, Tender and Supervision	$ 1,571,442	
	Sub-total		$ 17,285,862
9	20% Indirect costs	$ 3,457,172	
	Sub-total		$ 20,743,034
10	Add 30% contingencies	$ 6,222,910	
TOTAL ESTIMATED PROJECT COST (excl. GST)			**$ 26,965,945**
11	Add GST 10%	$ 2,696,594	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 29,662,539

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 3C - New RCC Dam PLUS Fuseplugs
Crest Level EL47.9 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	13,250	$ 15.00	$ 198,750	
	Foundation preparation	m^2	7,450	$ 50.00	$ 372,500	
						$ 751,250
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	3,400	$ 1,000.00	$ 3,400,000	
	Drill, install, grout stilling basin slab rock dowels	m	4,500	$ 120.00	$ 540,000	
	Supply and place RCC for dam	m^3	9,800	$ 350.00	$ 3,430,000	
					$ -	
					$ -	
					$ -	
						$ 7,370,000
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 350.00	$ 875,000	
						$ 1,062,500
5	**Fuseplug Construction (4 bays 25 m wide each)**					
	Excavate to EL43	m^3	7,000	$ 50.00	$ 350,000	
	Foundation preparation	m^2	3,150	$ 50.00	$ 157,500	
	Supply, place, compact Zone 1 material	m^3	1,800	$ 300.00	$ 540,000	
	Supply, place, compact Zone 2 material	m^3	1,750	$ 220.00	$ 385,000	
	Supply, place, compact Zone 3 material	m^3	5,350	$ 90.00	$ 481,500	
	Supply, place, compact Zone 4 material	m^3	930	$ 40.00	$ 37,200	
	Road base	m^3	120	$ 150.00	$ 18,000	
					$ -	
					$ -	
						$ 1,969,200
6	**Fuseplug Concrete**					
	Divider walls	m^3	170	$ 2,500.00	$ 425,000	
	Divider slabs	m^3	450	$ 1,500.00	$ 675,000	
	Rock dowels	m	420	$ 120.00	$ 50,400	
						$ 1,150,400
					Total	**$ 12,503,350**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 751,250	
2	New RCC Dam	$ 7,370,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5	Fuseplug Construction (4 bays 25 m wide each)	$ 1,969,200	
6	Fuseplug Concrete	$ 1,150,400	
	Sub-total		$ 12,503,350
7	20% for minor items and establishment costs	$ 2,500,670	
	Sub-total Direct Costs		**$ 15,004,020**
8	Allow 10% for Design, Tender and Supervision	$ 1,500,402	
	Sub-total		$ 16,504,422
9	20% Indirect costs	$ 3,300,884	
	Sub-total		$ 19,805,306
10	Add 30% contingencies	$ 5,941,592	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 25,746,898**
11	Add GST 10%	$ 2,574,690	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 28,321,588

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 3D - New RCC Dam PLUS Fuseplugs
Crest Level EL48.5 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	13,500	$ 15.00	$ 202,500	
	Foundation preparation	m^2	7,600	$ 50.00	$ 380,000	
						$ 762,500
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	3,400	$ 1,000.00	$ 3,400,000	
	Drill, install, grout stilling basin slab rock dowels	m	4,500	$ 120.00	$ 540,000	
	Supply and place RCC for dam	m^3	11,600	$ 350.00	$ 4,060,000	
					$ -	
					$ -	
					$ -	
						$ 8,000,000
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 350.00	$ 875,000	
						$ 1,062,500
5	**Fuseplug Construction (4 bays 25 m wide each)**					
	Excavate to EL43	m^3	7,000	$ 50.00	$ 350,000	
	Foundation preparation	m^2	3,150	$ 50.00	$ 157,500	
	Supply, place, compact Zone 1 material	m^3	1,800	$ 300.00	$ 540,000	
	Supply, place, compact Zone 2 material	m^3	1,750	$ 220.00	$ 385,000	
	Supply, place, compact Zone 3 material	m^3	5,350	$ 90.00	$ 481,500	
	Supply, place, compact Zone 4 material	m^3	930	$ 40.00	$ 37,200	
	Road base	m^3	120	$ 150.00	$ 18,000	
					$ -	
						$ 1,969,200
6	**Fuseplug Concrete**					
	Divider walls	m^3	170	$ 2,500.00	$ 425,000	
	Divider slabs	m^3	450	$ 1,500.00	$ 675,000	
	Rock dowels	m	420	$ 120.00	$ 50,400	
						$ 1,150,400
					Total	**$ 13,144,600**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 762,500	
2	New RCC Dam	$ 8,000,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5	Fuseplug Construction (4 bays 25 m wide each)	$ 1,969,200	
6	Fuseplug Concrete	$ 1,150,400	
	Sub-total		$ 13,144,600
7	20% for minor items and establishment costs	$ 2,628,920	
	Sub-total Direct Costs		**$ 15,773,520**
8	Allow 10% for Design, Tender and Supervision	$ 1,577,352	
	Sub-total		$ 17,350,872
9	20% Indirect costs	$ 3,470,174	
	Sub-total		$ 20,821,046
10	Add 30% contingencies	$ 6,246,314	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 27,067,360**
11	Add GST 10%	$ 2,706,736	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 29,774,096

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 3E - New RCC Dam PLUS Fusegates
Crest Level EL51 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	16,000	$ 15.00	$ 240,000	
	Foundation preparation	m^2	9,800	$ 50.00	$ 490,000	
						$ 910,000
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	4,050	$ 1,000.00	$ 4,050,000	
	Drill, install, grout stilling basin slab rock dowels	m	4,500	$ 120.00	$ 540,000	
	Supply and place RCC for dam	m^3	22,550	$ 350.00	$ 7,892,500	
					$ -	
					$ -	
					$ -	
						$ 12,482,500
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 350.00	$ 875,000	
						$ 1,062,500
5	**Fuseplug Construction (4 bays 25 m wide each)**					
	Excavate to EL43	m^3	7,000	$ 50.00	$ 350,000	
	Foundation preparation	m^2	3,150	$ 50.00	$ 157,500	
	Supply, place, compact Zone 1 material	m^3	1,800	$ 300.00	$ 540,000	
	Supply, place, compact Zone 2 material	m^3	1,750	$ 220.00	$ 385,000	
	Supply, place, compact Zone 3 material	m^3	5,350	$ 90.00	$ 481,500	
	Supply, place, compact Zone 4 material	m^3	930	$ 40.00	$ 37,200	
	Road base	m^3	120	$ 150.00	$ 18,000	
					$ -	
					$ -	
						$ 1,969,200
6	**Fuseplug Concrete**					
	Divider walls	m^3	170	$ 2,500.00	$ 425,000	
	Divider slabs	m^3	450	$ 1,500.00	$ 675,000	
	Rock dowels	m	420	$ 120.00	$ 50,400	
						$ 1,150,400
					Total	**$ 17,774,600**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 910,000	
2	New RCC Dam	$ 12,482,500	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,062,500	
5	Fuseplug Construction (4 bays 25 m wide each)	$ 1,969,200	
6	Fuseplug Concrete	$ 1,150,400	
	Sub-total		$ 17,774,600
7	20% for minor items and establishment costs	$ 3,554,920	
	Sub-total Direct Costs		**$ 21,329,520**
8	Allow 10% for Design, Tender and Supervision	$ 2,132,952	
	Sub-total		$ 23,462,472
9	20% Indirect costs	$ 4,692,494	
	Sub-total		$ 28,154,966
10	Add 30% contingencies	$ 8,446,490	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 36,601,456**
11	Add GST 10%	$ 3,660,146	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 40,261,602

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 3F - New RCC Dam PLUS Fuseplugs
Crest Level EL55 m

Item No.	Description	Unit	Quantity	Rate	Amount	Subtotal
1	**Excavation**					
	Excavate and dispose of existing saddle dam embankment	m^3	12,000	$ 15.00	$ 180,000	
	Excavate foundation, assume 2m stripping	m^3	20,550	$ 15.00	$ 308,250	
	Foundation preparation	m^2	12,750	$ 50.00	$ 637,500	
						$ 1,125,750
2	**New RCC Dam**					
	Construct reinforced concrete erosion protection slab	m^3	4,050	$ 1,000.00	$ 4,050,000	
	Drill, install, grout stilling basin slab rock dowels	m	4,500	$ 120.00	$ 540,000	
	Supply and place RCC for dam	m^3	48,000	$ 300.00	$ 14,400,000	
					$ -	
					$ -	
					$ -	
						$ 18,990,000
3	**Geotech Investigations**					
	Drilling, test pitting, quarry investigation	LS	1	$ 200,000.00	$ 200,000	
						$ 200,000
4	**Extremely Weathered Foundation Zone**					
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$ 75.00	$ 187,500	
	Supply and place RCC in extremely weathered zone	m^3	2,500	$ 300.00	$ 750,000	
						$ 937,500
5	**Fuseplug Construction (4 bays 25 m wide each)**					
	Excavate to EL43	m^3	7,000	$ 50.00	$ 350,000	
	Foundation preparation	m^2	3,150	$ 50.00	$ 157,500	
	Supply, place, compact Zone 1 material	m^3	1,800	$ 300.00	$ 540,000	
	Supply, place, compact Zone 2 material	m^3	1,750	$ 220.00	$ 385,000	
	Supply, place, compact Zone 3 material	m^3	5,350	$ 90.00	$ 481,500	
	Supply, place, compact Zone 4 material	m^3	930	$ 40.00	$ 37,200	
	Road base	m^3	120	$ 150.00	$ 18,000	
					$ -	
						$ 1,969,200
6	**Fuseplug Concrete**					
	Divider walls	m^3	170	$ 2,500.00	$ 425,000	
	Divider slabs	m^3	450	$ 1,500.00	$ 675,000	
	Rock dowels	m	420	$ 120.00	$ 50,400	
						$ 1,150,400
					Total	**$ 24,372,850**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 1,125,750	
2	New RCC Dam	$ 18,990,000	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 937,500	
5	Fuseplug Construction (4 bays 25 m wide each)	$ 1,969,200	
6	Fuseplug Concrete	$ 1,150,400	
	Sub-total		$ 24,372,850
7	20% for minor items and establishment costs	$ 4,874,570	
	Sub-total Direct Costs		**$ 29,247,420**
8	Allow 10% for Design, Tender and Supervision	$ 2,924,742	
	Sub-total		$ 32,172,162
9	20% Indirect costs	$ 6,434,432	
	Sub-total		$ 38,606,594
10	Add 30% contingencies	$ 11,581,978	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 50,188,573**
11	Add GST 10%	$ 5,018,857	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 55,207,430

Awoonga Saddle Dam No. 3 - AFC Assessment - Upgrade Options
Option 4 - New Embankment
Crest Level EL55 m

Item No.	Description	Unit	Quantity		Rate		Amount		Subtotal
1	**Excavation**								
	Clearing, grubbing, 0.3m stripping	m^3	12,000	$	10.00	$	120,000		
	Foundation preparation	m^2	36,000	$	10.00	$	360,000		
	Cutoff excavation	m^3	6,750	$	75.00	$	506,250		
								$	*986,250*
2	**New Embankment**								
	Supply, place, compact Zone 1 material	m^3	143,500	$	35.00	$	5,022,500		
	Supply, place, compact Zone 2 material	m^3	11,500	$	85.00	$	977,500		
	Supply, place, compact Zone 4 material	m^3	7,850	$	50.00	$	392,500		
	Road construction	m^2	3,600	$	50.00	$	180,000		
	Guardrail	m	1,200	$	150.00	$	180,000		
						$	-		
								$	*6,752,500*
3	**Geotech Investigations**								
	Drilling, test pitting, quarry investigation	LS	1	$	200,000.00	$	200,000		
								$	*200,000*
4	**Extremely Weathered Foundation Zone**								
	Excavate extremely weathered material and disposal, foundation preparation	m^3	2,500	$	75.00	$	187,500		
	Supply and place Concrete in extremely weathered zone	m^3	2,500	$	600.00	$	1,500,000		
								$	*1,687,500*
5									
						$	-		
						$	-		
						$	-		
								$	-
6									
						$	-		
						$	-		
						$	-		
								$	-
						Total		**$**	**9,626,250**

ITEM	DESCRIPTION	Amount	Sub-total
1	Excavation	$ 986,250	
2	New Embankment	$ 6,752,500	
3	Geotech Investigations	$ 200,000	
4	Extremely Weathered Foundation Zone	$ 1,687,500	
5		$ -	
6		$ -	
	Sub-total		$ 9,626,250
7	20% for minor items and establishment costs	$ 1,925,250	
	Sub-total Direct Costs		**$ 11,551,500**
8	Allow 10% for Design, Tender and Supervision	$ 1,155,150	
	Sub-total		$ 12,706,650
9	20% Indirect costs	$ 2,541,330	
	Sub-total		$ 15,247,980
10	Add 30% contingencies	$ 4,574,394	
	TOTAL ESTIMATED PROJECT COST (excl. GST)		**$ 19,822,374**
11	Add GST 10%	$ 1,982,237	
	TOTAL ESTIMATED PROJECT COST (incl. GST)		$ 21,804,611

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Document Status

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