Brisbane Flooding January 2011

An Avoidable Disaster – Submission in response to Hydraulic Modelling Reports

31 August 2011

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[redacted]

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A	Draft	MOB	23-Jul-11
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Contents

1. INTRODUCTION

This submission is in response to the Queensland Floods Commission of Inquiry invitation for submissions in response to the following hydraulic modelling reports: -

- Joint Calibration of a Hydrologic and Hydrodynamic Model of the Lower Brisbane River – Technical Report, prepared by Sinclair Knight Merz (SKM) (1).
- Review of Hydraulic Modelling – Final Report, prepared by Mark Babister and others at WMAwater (2).

The Commission has noted that the SKM Report describes modelling work carried out for SEQWater and that the Commission engaged Mr Babister to review the SKM modelling. The Commission also noted that it received and published the final version of the WMAwater report on 28 July 2011.

This submission also takes the opportunity in Section 5 to update key information on the flood at the Brisbane City Gauge detailed in the original submission (3) utilising revised data for tidal heights at the Brisbane Bar and Brisbane City Gauge provided by Tidal Unit - Maritime Safety Queensland, Department of Transport and Main Roads (DTMR) (4). Please refer to Attachment 2 for terms of the license under which the data has been used.

As required by the license a copy of this submission has also been provided to DTMR.

2. SUMMARY

In the following sections of this submission the: -

- Joint Calibration of a Hydrologic and Hydrodynamic Model of the Lower Brisbane River – Technical Report, prepared by Sinclair Knight Merz (SKM)

is referred to as the SKM Report, and

- Review of Hydraulic Modelling – Final Report, prepared by Mark Babister and others at WMAwater

is referred to as the WMA Report.

2.1 Key Unanswered Questions

Despite both reports being issued more than five months after the end of the January 2011 Flood Event the following key questions remain unanswered: -

1. Why do none of the operating procedures permit the Somerset radial gates to be closed to retain flood waters? Is there an issue with the integrity of Somerset, the operation of the radial gates or the capability of the dam itself?
2. What percentage of the water that actually flooded Brisbane came from the very high releases from Wivenhoe on Tuesday 11th January?
3. What was the impact of these very high releases on the flood height in the Bremer River?
4. What was the impact of these very high releases on the flood height in Lockyer Creek?

2.2 Submissions

Below is a summary of submissions in relation to the above reports. Additional detail is provided in subsequent sections.

1. In the light of the Commission's finding that the Operations Manual(5) required that the Operator's prediction of lake level should be made using the best available forecast rainfall information and that the subsequent choice of strategy should depend upon that prediction, it is considered a major failing of both the SKM Report and the WMA Report that neither appear to have considered any release strategies that take account of this finding.
2. It appears that the Commissions finding above may not have been available to the Independent Engineer when the WMA Report was due to be submitted to the Commission by 13th July 2011. This may explain the lack of consideration of alternative release strategies. It is submitted that further consideration of alternative release strategies is required, taking into account the Commission's finding above. Refer to Section 8.
3. Data released by the Commission on Friday 29th July shows that Strategy W3 was not implemented at the time claimed by SEQWater. This and the potential that Strategy W3 was required to be implemented earlier than claimed by SEQWater requires further examination by the Independent Engineer. Refer to Section 8
4. It appears to be widely agreed that flows in the Brisbane River due to releases from Wivenhoe interact substantially with all inflows downstream of the dam, especially at the junctions with Lockyer Creek and the Bremer River. It also appears to be widely recognised that a hydrodynamic model is necessary to properly analyse these impacts. To date both

reports fail to adequately address the interaction at Lockyer Creek or the Bremer River. Refer to Section 3.3.

5. When the SKM report was presented to the Commission's Independent Engineer on 24th June the Model was judged as unsuitable for modelling flood flows in the Lower Brisbane River. Further review of Version 1 of the Model in this submission is therefore considered inappropriate. However comments in relation to two of the Conclusions in the SKM Report are included in Section 3. No submissions have therefore been made in relation to Version 1 of the Model.

6. A Version 2 of the Model presented in the SKM report was apparently prepared subsequent to the release of the SKM Report, however it does not appear the Commission has released any report prepared by SKM in relation to Version 2 of the Model. It is submitted that release of such a report is critical to independent analysis of the January Flood Event.

7. It is of serious concern that more than five months after the end of the January Flood Event, the MIKE 11 flood model relied on by SEQWater for rigorous analysis of flood impacts in the Brisbane River, including the design and operation of the Fuse Plugs, was found to be unsuitable by the Commission's Independent Engineer. It is submitted that the Commission should consider whether the lack of a valid hydrodynamic model representing the lower reaches of the Brisbane River seriously impaired the validity of the design basis for the Fuse Plugs or the preparation of Revision 6 and Revision 7 of the Operational Manual (5).

8. Version 2 of the Model was not provided to the Commission's Independent Engineer by SEQWater and their consultants until after the close of business on Wednesday 6th July, providing only five working days for review, analysis and finalisation of the Independent Engineer's report. It is submitted that this period of time is totally inadequate for any proper analysis of the Model and may be the reason for the rather limited analysis that appears to have been undertaken. It is further submitted that the Commission's Independent Engineer should be involved in further development of the Model to allow the deficiencies indentified to be rectified.

9. The predictions of Version 2 of the Model appear to have been verified, inter alia, against data sourced from Brisbane River at City Gauge Station Number 540198 owned by SEQWater (6) which appear to be in error. The tidal data for Brisbane Bar and Brisbane Port Office, owned by Maritime Safety Queensland (MSQ) and DTMR, indicates lower river heights at the Brisbane City Gauge for the majority of the January Flood Event than data apparently used to verify the Model. MSQ advised that the tidal data for both the Brisbane Bar and the Brisbane Port Office are checked regularly and validated weekly. They also advised that other data sets are not checked and due to the way that they log data will give a different answer

10. There are a number of obvious deficiencies in Version 2 of the Model: -

    - It fails to predict the minor peak at the Brisbane City Gauge that occurred around 17:20 Tuesday 12th January,
    - The predicted peak height at the Brisbane City Gauge is 470 mm higher than the actual measured peak,
    - The predicted time of the peak at the Brisbane City Gauge is approximately ten (10) hours earlier than the actual peak.

11. It appears therefore that the Model overestimates the peak flows past the Brisbane City Gauge and therefore underestimates the contribution of releases from Wivenhoe.

12. Version 2 of the Model is not adequate to make an assessment of the contribution of Wivenhoe releases to the peak of the flood in Brisbane.

13. As a result of these deficiencies in the current "best" hydrodynamic model, it is submitted that significant further development work is required prior to the Commission finalising its conclusions.

14. The WMA Report makes no examination of the influence of the operation of Somerset even though this was requested as part question 1 posed to the Independent Engineer by the Commission.

15. There remains no agreed assessment of the magnitude of the January rainfall event. Most significantly for the Commission this assessment is necessary to give guidance as to the appropriateness of the outcomes achieved by the dam Operators. If the January rainfall event was at the rare end of expectations, e.g. towards an AEP of 1 in 5,000, a higher degree of flooding would represent a better achievement than would the same level of flooding for an event with an AEP of 1 in 50 to 1 in 100. There appears to be a considerable range of views on the AEP of the January rainfall event and it is therefore considered essential that this analysis be available to the Commission. Neither the SKM Report nor the WMA Report addresses this issue.

16. The SKM Report indicates that the modelling of flows against stream heights at Moggill is considered to be less reliable. As the estimated flow past Moggill is a critical value in determining releases from Wivenhoe under the Operational Manual (5), it is submitted that this may reduce the Operator's ability to comply with the requirements of the Operational Manual.

17. Neither SEQWater nor the Commission has made available sufficient data to enable independent analysis of the operation of Wivenhoe and Somerset and their contribution to the flooding in Brisbane or the upper river valley. It is submitted that all data should be made available for independent review.

3. SKM SEQWATER JOINT CALIBRATION

3.1 General

No submissions are made in relation to Version 1 of the Model in the SKM Report (1). As noted in the WMA Report (2), this model was presented for review after the close of business on Friday 24th June and WMA identified a number deficiencies.

3.2 Comment on Conclusions

Two conclusions, repeated below, presented in Section 8.2 of the SKM Report (1) warrant comment.

> *The results of the hydrodynamic modelling confirm the following conclusions in the Seqwater report:*
>
> - *Even if the flood flows in the Stanley River and upper Brisbane River had been contained, and there were no releases from Wivenhoe Dam (Case 2), the flows from Lockyer Creek, Bremer River and other uncontrolled catchment flows would still have exceeded the threshold of urban damage; and,*
> - *If there had not been any flows from Lockyer Creek, Bremer River and the other uncontrolled catchments, the actual releases from Wivenhoe Dam (Case 3) would have caused only minor flooding in Brisbane City.*
>
> *The hydrodynamic modelling provides updated results for the last two conclusions in the Seqwater report, namely:*
>
> - *Without Wivenhoe Dam (Case 4), the peak flow would have been in the order of 11,700 m³/s and the peak height would have been in the order of 1.2 metre higher at Brisbane City; and,*
> - *Without Somerset and Wivenhoe Dams (Case 5), the peak flow would have been of the order of 13,000 m³/s and the peak height would have been approximately 1.9 metres higher at the Port Office gauge.*

The last two considerations (Case 4 and Case 5) appear irrelevant. I am not aware of any serious commentator who has suggested that the flooding in Brisbane would not have been worse without either Somerset or Wivenhoe. However the questions that are being rightly asked and must be addressed by the hydrodynamic model are: -

- Did the operation of either or both dams during the January Flood Event achieve the reasonably expected level of flood mitigation in Brisbane?
- Could alternative operating strategies have eliminated or substantially reduced the flooding in Brisbane?
- Did the operation of the dams cause unnecessary flooding and or damage in the upper Brisbane River valley, along Lockyer Creek or the Bremer River?

In relation to the first two conclusions above it is noted that consideration of potential flooding due to releases solely from Wivenhoe alone (Case 3) or rainfall downstream from Wivenhoe alone (Case 2) are similarly irrelevant.

It appears to be widely agreed that flows in the Brisbane River due to releases from Wivenhoe interact substantially with all other inflows downstream of the dam, especially at the junction with Lockyer Creek and the Bremer River. It also appears to be widely recognised that a hydrodynamic

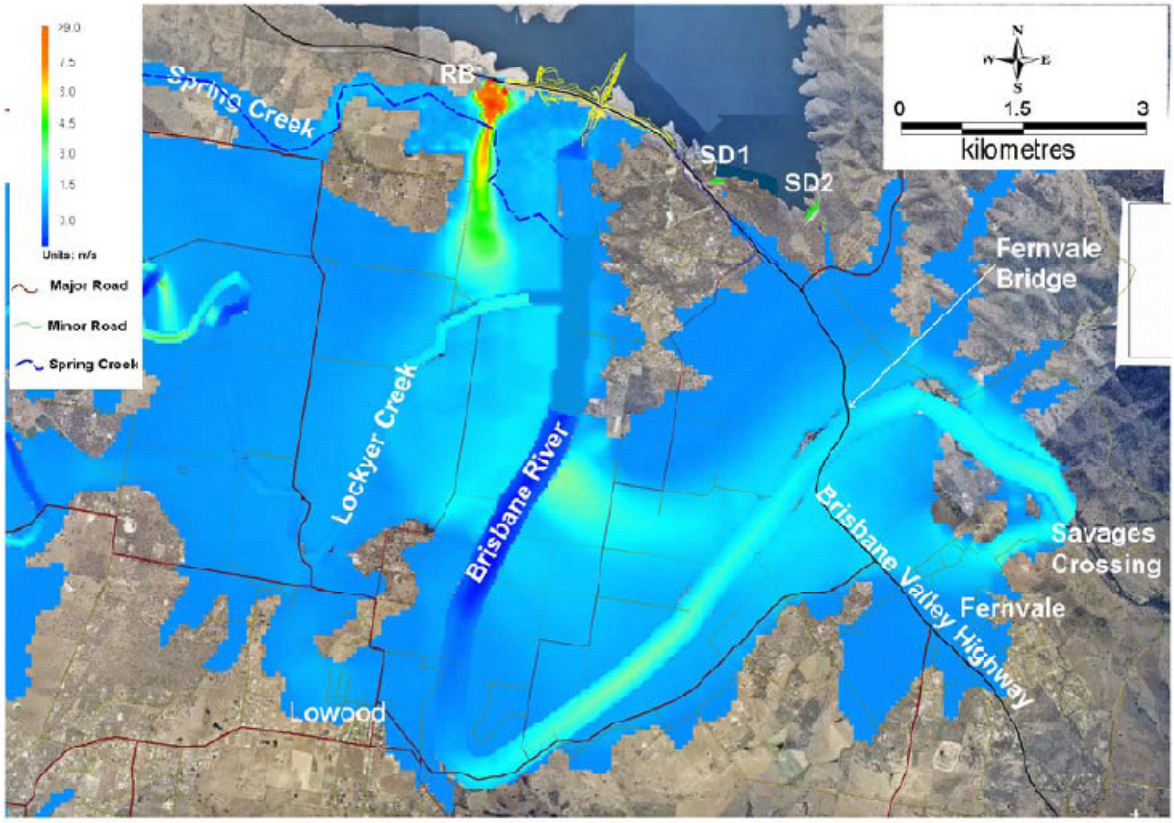
model is necessary to properly analyse these impacts. Both the SKM Report and WMA Report appear to have so far failed in adequately modelling this interaction.

3.3 Upper Brisbane River Valley

There is a flood basin below Wivenhoe which consists of two separate low lying areas, Lowood and Fernvale, with Savages Crossing providing a natural restriction causing water to back up into these low lying areas. This basin is capable of holding a large quantity of water and may explain the tail in river flows experienced at Mt Crosby after the high flows. To what extent has this flood basin been taken into account and what was the impact of the high releases from Wivenhoe on the height of this basin?

A plot of the inundation and velocities from the TUFLOW model as outlined in "Coping with Probably Maximum Flood – An Alliance Delivery for Wivenhoe Dam" by Chandler, Maher, Macnish and Roads is copied below.

Figure 7 –Inundation Extent and Velocity Plot for the Single Spillway on the Right Embankment.



Another paper suggested that *"the rate of water rise downstream of Savages Crossing is not significantly affected by fuse plug breaches. It appears that the rapid increase in flows from all fuse plug breaches is mitigated by the large floodplain storage upstream from Savages Crossing*". See page 6 of Wivenhoe Dam Flood Security Upgrade by Gill, Cooper, Maher, Macnish and Roads. This may also be true for high releases from Wivenhoe. The Lowood pumping station gauge did not rise significantly post the high releases from Wivenhoe. The basin is large and may have already been filled with water from both Wivenhoe and Lockyer and flows out of Wivenhoe acted to block/backup water in Lockyer Creek.

3.4 Flow at Moggill

The SKM Report indicates that in Version 1, the modelling of flows against stream heights at Moggill is considered to be less reliable. Refer to the following extracts: -

> *6.3. Comparison of modelled and recorded levels at key sites*
>
> *The resulting calibration of the hydrodynamic model to the January 2011 event is shown in Figure 6-4 to Figure 6-8. The MIKE 11 model produced excellent calibrations to all gauges on the Brisbane River with the exception of Moggill. As mentioned in Section 5.4, the hydrodynamic processes at Moggill are likely to be affected by the Bremer River reach which has not been reviewed as part of this project. For this reason, the local water level results near Moggill are considered to be less reliable.*

And then again at page 59

> *This analysis shows that the initial rating curves developed using the URBS hydrological model were generally appropriate at the majority of locations along the Lower Brisbane River. However, at some locations (particularly Mt Crosby and Moggill) the initial URBS rating significantly underestimated the peak flow for the January 2011 event. It is estimated that the peak flow at Brisbane Port Office during the January 2011 event was approximately 9,600 m^3/s.*
>
> *.....*
>
> *The MIKE 11 model produced excellent calibrations to all gauges on the Brisbane River with the exception of Moggill (where the calibration is only fair). The calibrations provide only a slight improvement on the initial calibrations using the URBS hydrologic model, though the physical basis of the MIKE 11 hydrodynamic model gives greater confidence in extrapolating the model outside the range of calibration and hence for assessing the implications of different operating strategies.*

The estimated flow past Moggill is a critical value in determining releases from Wivenhoe in accordance with the Operational Manual (5). Neither the SKM Report (1) nor the WMA Report (2) address whether this impacted on the Operator's ability to satisfactorily determine the appropriate releases from Wivenhoe dam in order to comply with the requirements of the Strategies specified in the Operational Manual.

4. VERSION 2 MODEL PREDICTIONS

Scaling of the curves provided in the WMA Report (2) at Figure 10 indicates that Version 2 of the Model appears to predict the following in relation to the flood peak at the Brisbane City Gauge: -

Version 2 Model Prediction	
Peak Height	4.73 mAHD
Time of peak	17:00 Wednesday 12th January

However the tidal data for the Brisbane Port Office provided by Tidal Unit - Maritime Safety Queensland, Department of Transport and Main Roads indicates the following: -

Actual	
Peak Height	4.26 mAHD
Time of peak	03:20 Thursday 13th January

Maritime Safety Queensland advised that the tidal data for both the Brisbane Bar and the Brisbane Port Office are checked regularly and validated weekly. They also advised that other data sets are not checked and due to the way that they log data will give a different answer.

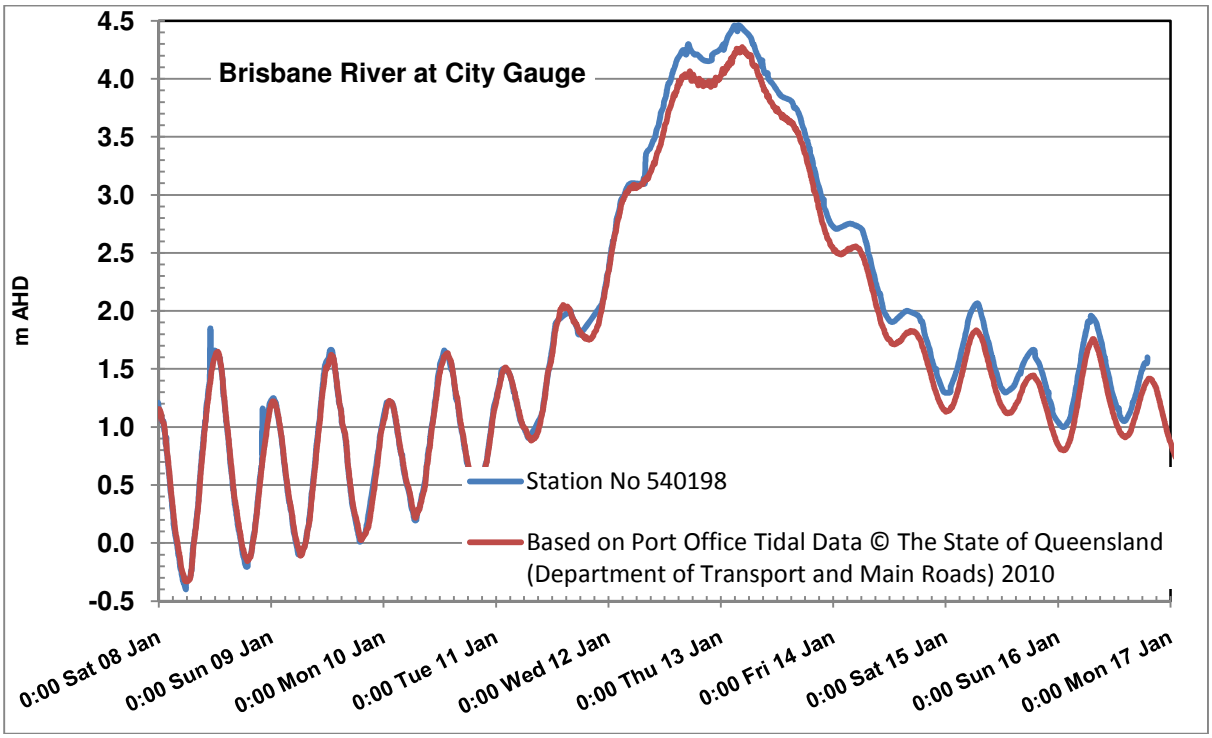
This indicates that Version 2 of the Model is likely to be in error at the Brisbane City Gauge by the following: -

Likely Error in Version 2 Model	
Peak Height	470 mm
Time of peak	approximately 10 hrs early

This is unsatisfactory given that the Model has been matched with the actual event at Mt Crosby, only approximately 67 kilometres upstream

5. THE FLOOD – REVISED DATA

Below is a revised plot of the height of the Brisbane River at the City Gauge between Saturday 8th January and Sunday 16th January showing data from both data sources (6) and (4).



It would appear that the gauge, Station Number 540198 (6), experienced a displacement of approximately 250 mm between 07:48 and 08:09 Wednesday 12th January. Subsequently this gauge reported a river level approximately 200 mm higher than data provided by MSQ (4).

This results in the following changes to the major characteristics of the flood at the Brisbane City Gauge as reported in the Original Submission (3).

Original Submission		
Characteristic	**Time**	**Height (mAHD)**
Peak	02:57 Thursday 13th Jan	4.46
Minor Peak	17:03 Wednesday 12th Jan	4.3

Revised Data		
Characteristic	**Time**	**Height (mAHD)**
Peak	03:20 Thursday 13th Jan	4.26
Minor Peak	17:20 Wednesday 12th Jan	4.07

Original Submission			
Characteristic	**Time into**	**Time out of**	**Duration (hrs)**

Major Flood	10:00 Wednesday 12th Jan	18:09 Thursday 13th Jan	32.15
Moderate Flood	00:57 Wednesday 12th Jan	06:57 Friday 14th Jan	54
Minor Flood	12:09 Tuesday 11th Jan	20:18 Friday 14th Jan	80.15

Revised Data			
Characteristic	**Time into**	**Time out of**	**Duration (hrs)**
Major Flood	11:30 Wednesday 12th Jan	16:50 Thursday 13th Jan	29.33
Moderate Flood	01:00 Wednesday 12th Jan	23:20 Thursday 13th Jan	46.33
Minor Flood	12:10 Tuesday 11th Jan	19:00 Friday 14th Jan	78.83

The period comprising the designated Major Flood at the City Gauge appears to encompass three high tides which are expected to have influenced the river height at the City Gauge. The estimated times for the major influence of the high tides at the Brisbane City Gauge during this period are: -

Original Submission	**Revised Data**
14:15 Wednesday 12th Jan	14:30 Wednesday 12th Jan
02:34 Thursday 13th Jan	03:50 Thursday 13th Jan
14:54 Thursday 13th Jan	15:50 Thursday 13th Jan

It would appear that initiation of the Major Flood at the City Gauge commenced on the rising tide for the high at 14:30 (was 14:15). The major peak of 4.26 (was 4.46) mAHD at the City Gauge corresponded almost exactly with the expected influence at 03:50 (was 02:34) of the next high tide. The minor peak of 4.07 (was 4.3) mAHD at 17:20 (was 17:03) Wednesday 12th January therefore probably represents the highest river flows past the Brisbane City Gauge.

6. SIGNIFICANT POINTS FROM WMA REPORT

WMA rejected Version 1 of the SKM model prepared by and used by SEQWater in their submission to the Commission in support of the operation of the dams, noting: -

> *It is noteworthy however that previous results obtained using the Version 1 model, presented in SKM's report (Reference 2) will require revision in light of the serious issues identified with Version 1 of the model.*

The WMA Report is subsequently based on an amended Version 2 model also prepared jointly by SKM and SEQWater. WMA does not conclude that this revised Version 2 model is satisfactory and there remain a number of deficiencies which are summarised in paragraph 56 of the WMA Report and discussed in detail elsewhere. WMA concludes that the Version 2 model *"whilst not ideal, the model presented the best available opportunity to answer questions from the Commission",* bearing in mind that the review had to be completed in five working days.

And in case you miss it, WMA repeats no less than three times that the Version 2 revised model (my emphasis): -

> *is considered **fit for purpose** to address **most** of the questions put forward to WMAwater by the Commission*

The WMA Report makes no examination of the influence of the operation of Somerset even though this was requested as part question 1 posed by the Commission to the Independent Engineer.

From the perspective of this submission the most severe of the limitations noted by WMA of the Version 2 model are:-

- Prediction of the flood peak at the Brisbane City Gauge
- Analysis of the impact of Lockyer Creek inflows
- Analysis of the contribution of Wivenhoe releases to the peak of the flood in Brisbane

The Model only analyses the Brisbane River downstream of Mt Crosby and does not examine the impact of releases from Wivenhoe on flows from Lockyer Creek and backflow flooding in Lockyer Creek. There is no modelling of any flooding impacts in the Brisbane Valley upstream of Mt Crosby.

One of the most significant outstanding questions is exactly what contribution the releases from Wivenhoe made to the flooding in Brisbane. This apparently cannot be reliably determined from the Version 2 Model leaving WMA to conclude: -

> *With regards to contribution to the flood peak, from Moggil to the Port Office the proportion of peak flow contributed by Wivenhoe Dam and non-Wivenhoe Dam sources was roughly equivalent.*

This does not seem to be much of an advance on the conclusions drawn from very basic data and included in the Original Submission (3) to the Commission dated 11th March 2011, repeated below.

The following table summarises the estimated contribution of releases from Wivenhoe to the flood event at the Brisbane City Gauge.

Starting Time	***Finishing Time***	***Releases from Wivenhoe (ML)***	***Contribution to Flow at City Gauge (%)***
11:00 Tuesday 11th Jan	*19:09 Wednesday 12th Jan*	*518,000*	*55% to 60%*
01:57 Tuesday 10th Jan	*07:57 Thursday 13th Jan*	*729,000*	*50% to 56%*
13:09 Monday 10th Jan	*21:18 Thursday 13th Jan*	*975,000*	*[3] to 58%*

Note 3: The lower bound has not been estimated as an upper range of flows has not been estimated for the Minor Flood due to the absence of the required data for levels in Moreton Bay.

MWA reviewed a limited number of alternative release strategies, of which the most interesting is Option C. In Option C, under Strategy W3 the releases from Wivenhoe would be increased to the upper allowable limit as soon as possible. So this is a strategy that is fully compliant with the current Operating Manual and does not incorporate any use of rainfall forecasts. Version 2 of the model forecasts that under this scenario, the peaks at Moggill and the Brisbane City Gauge would have been respectively 0.7 m and 0.3 m lower.

The WMA Report concludes at paragraph 15 and 16: -

15. *Whilst the flood level reductions indicated in Table 6 would have been a benefit and reduced flood damages if they had been achieved, generally such scenarios could not have been reasonably achieved with the information available at the time and under the current operating strategies stipulated by the Manual. Nonetheless, these scenarios highlight that for this event, earlier increases in releases from Wivenhoe Dam during 9 and 10 January could have reduced the eventual peak outflow and the resulting severity of flooding experienced downstream.*

16. *With the information available during their operations, and using the strategies defined by The Manual, WMAwater believe the Flood Engineers achieved close to the best possible mitigation result for the January 2011 flood event.*

WMA seem to imply that as SEQWater did not have knowledge of future events that it is not reasonable to consider operation of the dams at the upper limits of releases permitted by a given Strategy. In a submission to the Commission, Greg McMahon examines this question of decision making in the light of unknown future events.

In any rational decision making process, known circumstances and restrictions must be analysed and a decision made which minimises the future risk. By selecting release strategies that did not incorporate the possibility of future heavy rainfall, SEQWater were gambling that such a future event would not occur. Sometimes this approach will succeed but it does not minimise the future risk and it always remains a gamble.

Based on the WMA Report, it is simply a matter of record that solely using the information available at the time, complying with Strategy W3 and without including any rainfall forecast, but operating at the upper limits permitted by the Strategy, the Operator would have achieved reductions at Moggill and the Brisbane City Gauge of 0.7 m and 0.3 m respectively.

When reviewing the WMA report it is important to bear in mind the rather limited nature of the questions that were actually asked by the Commission, repeated below.

I write to confirm the Commission requests that you review the hydrodynamic model being developed by SKM for Seqwater. Further the Commission requests that if possible, you use the model to answer the following questions:

1. *To what extent was flooding (other than flash flooding) in the mid-Brisbane River, the Lockyer Valley, Ipswich and Brisbane during January 2011 caused by releases from the Somerset and Wivenhoe Dams?*
2. *To what extent did the manner in which flood waters were released from the Somerset and Wivenhoe Dams avoid or coincide with peak flows from the Bremer River and Lockyer Creek?*
3. *Had the levels in Somerset and Wivenhoe Dams been reduced to 75 per cent of full supply level by the end of November 2010 (both with and without amendments to the trigger levels for strategy changes in the Wivenhoe Manual) what impact would this have had on flooding?*
4. *What effect would the implementation of different release strategies (to be identified by you) have had on flooding?*

Please include in your report a detailed assessment as to any difficulties with the model, together with suggestions as to how (if at all), those difficulties may be remedied.

Please also provide a detailed explanation as to the limitations upon any results which you may obtain using the model.

For instance there is no question relating to the use of rainfall forecasts although WMA did look at the possibility of an earlier implementation of Strategy W4 justified on the basis of forecast rainfall. This should be regarded as a serious omission given the Commission's own findings that the Operational Manual required that the Operator's prediction of lake level should be made using the best available forecast rainfall information. It is essential that the Independent Engineer review alternative strategies taking into account the Commission's finding.

7. MAGNITUDE OF FLOOD EVENT

7.1 General

A key missing piece of data is the magnitude of the rainfall event in January 2011 that led to the flooding. There remains considerable uncertainty as to the Return Frequency of this event and the relative size of the event compared to previous rainfall events such as in 1974 and 1893 events. Neither the SKM Report nor the WMA Report addresses this issue at all.

This comparison is considered essential for a number of reasons, however the most significant for the purposes of the Inquiry is to give guidance as to the appropriateness of the outcomes achieved by the dam Operators. If the January rainfall event was at the rare end of expectations, e.g. towards an event with an AEP of 1 in 5,000, a higher degree of flooding would represent a better achievement than would the same level of flooding for an event with an AEP of 1 in 50 to 1 in 100.

In addition if the rainfall event was of the same magnitude as the 1974 event it may be necessary to revise the 1 in 100 design basis that has been used for development of flood management policies within Brisbane and the rest of the Brisbane River Valley.

It is therefore considered essential that this analysis be available to the Commission as there appears to be a considerable range of views of the return frequency of the January event.

7.2 Basis for Concern

In a previous Supplementary Submission (7) it was noted that during the January 2011 Flood Event operation of the dams almost resulted in initiation of the Fuse Plugs. This was only expected to occur in an event with an AEP in the range of 1 in 4,500 to 1 in 6,000.

> *Studies, carried out prior to the January Flood Event and subsequent to the installation of the Fuse Plugs, forecast that the trigger level for Strategy W4 (i.e. 74 mAHD) would have an AEP in the range of 1 in 430 to 1 in 500 and that Fuse Plug initiation would have an AEP in the range of 1 in 4,500 to 1 in 6,000. Refer GHD study for SEQWater in December 2009* (8).
>
> *It remains an unresolved concern that the January event exceeded the trigger level for Strategy W4 and almost resulted in initiation of a Fuse Plug when the estimated AEP of the Flood Event is substantially less than 1 in 4,500 and likely to be less than 1 in 500. Mark Babister in paragraph 81 of his report to the Commission*(9) *noted "The assessment in the SKM report that the January 2011 flood event "exceeds 1 in 100 AEP" is considered the most reasonable estimate based on available information until more detailed analysis can be undertaken."*

7.3 Estimates by Others

7.3.1 SEQWater

Page ii Executive Summary of the Flood Event Report (10) SEQWater states *"The volume of total inflow into Wivenhoe Dam during the Event was 2,650,000ML. This volume is almost double (190%) the comparable volume of inflow from the January 1974 flood event, and comparable with the flood of 1893."*

The above SEQWater estimate of inflows to Wivenhoe appears to only be obtained if the total inflow to the dam is calculated for the whole of the period between Thursday 6th January 2011 and Wednesday 19th January 2011.

If the calculation is instead limited to the period from 09:00 Sunday 9th January to 24:00 Wednesday 12th January which corresponded to the major rainfall events, the total inflow to Wivenhoe was around 2,033,943 ML and this includes 400,532 ML of releases from Somerset.

7.3.2 Bureau of Meteorology

In the Special Climate Statement 24, first issued 7th January 2011 and subsequently updated 25th January 2011 (11), the Bureau of Meteorology indicated that the rainfall event was closer to the 1974 event. Refer to extract below: -

A comparison of the 2011 southeast Queensland rainfall with previous events

While all of the data is yet to be compiled, a preliminary comparison can be made between the three-day rainfall totals from the 10-12 January 2011 event with those of 25-27 January 1974 is shown in Figure 5.

Peak rainfalls from the 1974 event were substantially heavier than those in 2011. A number of stations had three-day totals from 25-27 January 1974 in excess of 1000 mm, the highest being 1215.0 mm at Mount Tamborine, compared with the 2011 event peak of 648.4 mm. Many stations in the 1974 event experienced daily totals which exceeded 400 mm; the highest were 563.2 mm at Mount Tamborine and 561.5 mm at Wundurra, in the Gold Coast hinterland, while in the Brisbane area 475.8 mm fell on 26 January at Enoggera Reservoir. 1974 also saw much heavier rainfall in metropolitan Brisbane than 2011, with Brisbane's three-day and peak one-day totals of 600.4 mm and 314.0 mm in 1974 comparing with 166.2 mm and 110.8 mm in 2011. However, in 1974 the heaviest rains were close to the coast, whereas in 2011 heavy falls spread further inland, and on the western fringe of the Brisbane River catchment and on the Great Dividing Range 2011 was the wetter of the two events (Figure 5, right). The weeks prior to the 1974 event, whilst wetter than normal, were also less wet than the equivalent weeks prior to the 2011 event. Over the Brisbane River catchment as a whole, average three-day rainfall in the 1974 event was 348.5 mm, compared with 286.4 mm in 2011, and all four major sub-catchments were also wetter in 1974 than in 2011, although by small margins in the cases of the Bremer (1974 442.1 mm; 2011 417.1 mm) and Lockyer (1974 331.3 mm; 2011 292.0 mm) sub-catchments.

Insufficient rainfall data exist for a comprehensive assessment of the 1893 event. However, the available station data indicate that peak rainfalls in the region during the 1893 event were much heavier than those during either the 1974 or 2011 events. Crohamhurst, in the Glasshouse Mountains inland from the Sunshine Coast, received 907.0 mm on 3 February 1893, which remains an Australian daily record, whilst three-day totals included 1715.0 mm at Mooloolah and 1680.3 mm at Crohamhurst.

The Bureau noted *"This statement is based on preliminary data available as of 23 January 2011, which may be subject to change as a result of standard quality control procedures"*, however no updated statement appears to have been issued.

7.3.3 SKM and SEQWater

In their joint report on the Operation of Somerset and Wivenhoe Dams (12) SKM and SEQWater noted only that the peak levels "*indicate the January 2011 flood event exceeds 1 in 100 AEP".*

> *"The conclusions drawn by Seqwater are considered to be broadly defensible. It is considered that the annual exceedance probability of the rainfalls for the whole dam catchment is around 1 in 100 to 1 in 200, though the annual exceedance probability of the most extreme point rainfalls that occurred in the centre of the Brisbane River catchment is likely to be between 1 in 500 and 1 in 2000. When compared with historic events, flood*

volumes indicate the volume of the January 2011 event was almost double the 1974 flood, and rivals the February 1983 flood.

Peak water levels at gauges in the Brisbane River above Wivenhoe Dam were the highest on record. In the Lockyer Valley, peak water levels exceeded the 1974 levels and may well have been larger than those of 1893. A comparison of the recorded peaks, volumes and peak levels at Somerset and Wivenhoe Dams indicate the January 2011 flood event exceeds 1 in 100 AEP."

7.3.4 WMAwater

In paragraph 81 of the first WMA Report (9) it was noted that: -

> *The SKM report raises similar reservations as those outlined above about the validity of comparisons against design flood characteristics to estimate flood severity. The assessment in the SKM report that the January 2011 flood event "exceeds 1 in 100 AEP" is considered the most reasonable estimate based on available information until more detailed analysis can be undertaken.*

This detailed analysis does not appear to have been completed, or if it has been completed has not been reported.

8. IMPLEMENTATION OF STRATEGIES

The primary consideration for each of the Strategies is repeated below.

> *Strategy W1 - The Primary Consideration is Minimising Disruption to Downstream Rural Life*
>
> *Strategy W2 - is a Transition Strategy where the primary consideration changes from Minimising Impact to Downstream Rural Life to Protecting Urban Areas from Inundation.*
>
> *Strategy W3 – The primary consideration is Protecting Urban Areas from Inundation.*

The tigger point for Strategies W2 and W3 is a Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD.

8.1 Earlier Implementation of Strategy W3

Appendix A of the Flood Event Report (10) shows the results of several Model runs completed by SEQWater.

Model Run 7, shown as being carried out at 09:00 7th January, forecast a Wivenhoe level of 68.2 m without including the rainfall forecast and 68.5 m including the rainfall forecast.

The subsequent Model Run 8, shown as being carried out at 15:00 7th January, forecast a Wivenhoe level of 68.4 m without including the rainfall forecast and 68.9 m if the rainfall forecast was included.

Given the Commission's finding that the Operations Manual(5) required that the Operator's prediction of lake level should be made using the best available forecast rainfall information and that the subsequent choice of strategy should depend upon that prediction, it is apparent that Strategy W1 should have been abandoned and Strategy W2 or W3 adopted as early as 09:00 Friday 7th January but certainly no later than 15:00 Friday 7th January.

8.2 Benefits of Earlier Implementation of Strategy W3

The WMA Report (2) noted, at paragraph 15, the potential benefits of increased releases earlier in the Flood Event.

> *Nonetheless, these scenarios highlight that for this event, earlier increases in releases from Wivenhoe Dam during 9 and 10 January could have reduced the eventual peak outflow and the resulting severity of flooding experienced downstream.*

This modelling needs to be carried out in the light of uncertainties surrounding the change in Strategies from W1 to W2 or W3.

8.3 Actual Implementation of Strategy W3

The Wivenhoe lake level actually exceed 68.5 m AHD at 07:11 8th January

QFCI Exhibit 20 Statement of Robert Ayre 11-4-11.pdf includes the statement that Strategy W2 was not implemented and Strategy W3 was implemented at 08:00 8th January. Also in cross examination before the Commission, copied below, Mr Ayre stated that Strategy W3 was implemented at 08:00 Saturday 8th January even though there was apparently no written record of that decision.

However QFCI Exhibit 433, Statement of James Charalambous, released to me by the Commission on Friday 29th July includes copies of Actual and Projected Wivenhoe Releases issued by the Duty Engineer in the Flood Operations Centre. These documents indicate that there was no change in the release strategy at 08:00 Saturday 8th January.

The two relevant sets of data, shown on page 739 and page 767 of James Charalambous statement, were issued at: -

- 10:23 7th January 2011, and
- 14:57 8th January 2011

The data shown in the Actual and Projected Wivenhoe Releases needs to be considered in conjunction with Model Run 7 and Model Run 8.

Model Run 7, shown as being carried out at 09:00 7th January 2011 forecast a Wivenhoe level of 68.2 m without including the rainfall forecast and 68.5 m including the rainfall forecast.

The subsequent Model run 8, shown as being carried out at 15:00 7th January, forecast a Wivenhoe level of 68.4 m without including the rainfall forecast and 68.9 m if the rainfall forecast was included.

The data for Actual and Projected Wivenhoe Releases issued at 10:23 on 7th January was just after Model Run 7 so in neither case, with or without rainfall forecast, was it anticipated that Strategy W2 or W3 would be implemented. In addition, based on statements by SEQWater that they did not use the "with rainfall forecast" the Operator still would not have anticipated implementing Strategy W2 or W3 based on the results of Model run 8 carried out at 15:00 7th January.

A comparison between the two sets of Actual and Projected Wivenhoe Releases is tabulated below. The full data sets have not been included but only sufficient data for this comparison.

The first data set issued at 10:23 on 7th January obviously shows the Projected releases through to, and beyond 08:00 8th January 2011, based on the projected strategies. The second data set shows the actual release rates through to 14:00 8th January. The Projected release rates in the first data set were developed on the basis of not expecting an implementation of Strategy W2 or W3. Whereas the second data set should show the change in release rates due to the adoption of Strategy W3 at 08:00 on the 8th January.

However the actual release rates in the second data set up until 13:00 on 8th January are essentially identical to the projected release rates of the first data set which were developed on the basis of not implementing Strategy W2 or W3. The projected release rates between the two sets of data do not become substantially different till 23:00 on the 8th January. This means that there was no change in Strategy at 08:00 on the 8th.

This comparison does not enable determination of which Strategy was implemented at any particular time. However it does show that there is no evidence of a change in Strategy at 08:00 on the 8th January which required an increase in release rates; e.g. from one which sought to minimise disruption to downstream rural life to one which sought to protect urban areas from inundation.

XN: MR RANGIAH 156 WIT: AYRE R A

I see, thank you. Now, in paragraph 34, you say that by about 8 a.m. Wivenhoe Dam had reached 68.52 metres AHD. Then you say, "Because this level was above the predicted lake level of 68.5 metres AHD and relevant to strategy W1, I was conscious of the fact that we were transitioning the strategies from W1 to W2 or W3."?-- Yes.

When was W3 engaged?-- It was engaged with the directive that John Ruffini had issued, essentially, which required the releases to be taken to 1,250 CUMECS by 2 p.m. on that Saturday afternoon.

Well, when was that directive given?-- I will just have to refer to my schedule 1 in my first statement.

Could I perhaps trigger your memory by suggesting that it was at 8 a.m.?-- Yes, it would have been just - during the handover that was occurring between John and I.

And is that recorded anywhere?-- The directives?

The transition from W2 to W3?-- The change in strategies are outlined in our situation reports which were issued approximately every 12 hours.

And it is not recorded in the flood log event, is that right?-- That's correct, yeah.

So is it the case that you weren't transitioning from W1 to W2 or W3; you were in fact at W3 at 8 a.m.?-- As I explained this morning, it is not a step jump process. We do - we do transition gradually from each of the strategies, and as we had just entered the lower level of the range between 68.5 and 74, we were, indeed, in that transition process.

Well, at what point in time can you say that you had transitioned to W3?-- When the lake level exceeds EL 68.5.

And, in fact, you say in paragraph 34 that the level was above 68.5 by 8 a.m.?-- Yes.

So by 8 a.m. you had transitioned into W3?-- That's correct.

So it is not correct to say that "we were transitioning the strategies from W1 to W2 or W3"?-- As I said, it is not a step jump type arrangement; it is really a gradual transition from each of the strategies.

Now, you say then, "I knew that Burtons Bridge had been inundated on Friday evening, as had Kholo Bridge, so I was now concentrating on ensuring that Mt Crosby Weir Bridge was not inundated by making sure the releases plus the combined flows from Lockyer Creek were less than 1,900 cubic metres per second."?-- That's correct.

You accept that at that stage you were in W3?-- Yes.

And the primary consideration under W3 is protecting urban areas from inundation, is that correct?-- That's the primary objective, yes.

And there are other objectives, such as minimising disruption to the rural life, or retaining full supply level, which remain relevant?-- Yes, correct, yes.

But they have a lower priority?-- They do, yes.

8.4 Alternative Strategies

Ian Chalmers the Supervising Engineer for Wivenhoe Dam has his own suggestions on how Wivenhoe could have been used to manage the recent flood. His analysis shows that the following could have been achieved: -

- A Maximum Discharge Rate of 3350 cubic metres per sec – less than half the actual peak release, and
- A Maximum Dam Water Level of EL. 72.90 – well below any trigger level for the Fuse Plugs

Both would have occurred at 06:00 to 07:00 Wednesday 12th January if this flood had been managed in the following manner: -

- At 09:00 am on Thursday 6th January commence opening the gates in a logical, rational sequence.
- By early evening all five gates are set at 6.00 metres vertical opening.

8.5 Comparison of Data Sets for Actual and Predicted Releases

Date and Time	Actual and Projected Releases				Strategy Adopted as advised by SEQWater
	10:23 07 January 2011		14:57 08 January 2011		
	Exhibit p739		Exhibit p767		
00:00 05 January	50	Actual	50	Actual	
01:00 05 January	50	Actual	50	Actual	
02:00 05 January	50	Actual	50	Actual	
03:00 05 January	50	Actual	50	Actual	
04:00 05 January	50	Actual	50	Actual	
05:00 05 January	50	Actual	50	Actual	
06:00 05 January	50	Actual	50	Actual	
07:00 05 January	50	Actual	50	Actual	
08:00 05 January	50	Actual	50	Actual	
09:00 05 January	50	Actual	50	Actual	
10:00 05 January	50	Actual	50	Actual	
11:00 05 January	50	Actual	50	Actual	
12:00 05 January	50	Actual	50	Actual	
13:00 05 January	50	Actual	50	Actual	
14:00 05 January	50	Actual	50	Actual	
15:00 05 January	50	Actual	50	Actual	
16:00 05 January	50	Actual	50	Actual	
17:00 05 January	50	Actual	50	Actual	
18:00 05 January	50	Actual	50	Actual	
19:00 05 January	50	Actual	50	Actual	
20:00 05 January	50	Actual	50	Actual	
21:00 05 January	50	Actual	50	Actual	
22:00 05 January	50	Actual	50	Actual	
23:00 05 January	50	Actual	50	Actual	
00:00 06 January	50	Actual	50	Actual	
01:00 06 January	50	Actual	50	Actual	
02:00 06 January	50	Actual	50	Actual	
03:00 06 January	50	Actual	50	Actual	
04:00 06 January	50	Actual	50	Actual	
05:00 06 January	50	Actual	50	Actual	
06:00 06 January	50	Actual	50	Actual	
07:00 06 January	50	Actual	50	Actual	W1A Implemented
08:00 06 January	50	Actual	50	Actual	
09:00 06 January	50	Actual	50	Actual	
10:00 06 January	50	Actual	50	Actual	
11:00 06 January	50	Actual	50	Actual	
12:00 06 January	50	Actual	50	Actual	
13:00 06 January	50	Actual	50	Actual	
14:00 06 January	50	Actual	50	Actual	
15:00 06 January	50	Actual	50	Actual	
16:00 06 January	50	Actual	50	Actual	
17:00 06 January	50	Actual	50	Actual	
18:00 06 January	50	Actual	50	Actual	
19:00 06 January	50	Actual	50	Actual	
20:00 06 January	50	Actual	50	Actual	

Date and Time	Actual and Projected Releases				Strategy Adopted as advised by SEQWater
	10:23 07 January 2011		14:57 08 January 2011		
	Exhibit p739		Exhibit p767		
21:00 06 January	50	Actual	50	Actual	
22:00 06 January	50	Actual	50	Actual	
23:00 06 January	50	Actual	50	Actual	
00:00 07 January	50	Actual	50	Actual	
01:00 07 January	50	Actual	50	Actual	
02:00 07 January	50	Actual	50	Actual	W1B implemented
03:00 07 January	50	Actual	50	Actual	
04:00 07 January	50	Actual	50	Actual	
05:00 07 January	50	Actual	50	Actual	
06:00 07 January	50	Actual	50	Actual	
07:00 07 January	50	Actual	50	Actual	
08:00 07 January	50	Actual	50	Actual	
09:00 07 January	50	Actual	50	Actual	W1C Implemented
10:00 07 January	50	Actual	50	Actual	
11:00 07 January	50	Projected	50	Actual	
12:00 07 January	50	Projected	50	Actual	
13:00 07 January	50	Projected	50	Actual	
14:00 07 January	50	Projected	50	Actual	
15:00 07 January	101	Projected	64	Actual	W1D Implemented
16:00 07 January	152	Projected	116	Actual	
17:00 07 January	204	Projected	167	Actual	
18:00 07 January	254	Projected	217	Actual	
19:00 07 January	303	Projected	266	Actual	
20:00 07 January	352	Projected	315	Actual	
21:00 07 January	398	Projected	362	Actual	
22:00 07 January	450	Projected	415	Actual	W1E Implemented
23:00 07 January	465	Projected	467	Actual	
00:00 08 January	510	Projected	520	Actual	
01:00 08 January	562	Projected	573	Actual	
02:00 08 January	614	Projected	626	Actual	
03:00 08 January	665	Projected	679	Actual	
04:00 08 January	717	Projected	732	Actual	
05:00 08 January	767	Projected	785	Actual	
06:00 08 January	818	Projected	838	Actual	
07:00 08 January	869	Projected	892	Actual	
08:00 08 January	921	Projected	940	Actual	W3 Implemented
09:00 08 January	970	Projected	992	Actual	
10:00 08 January	1020	Projected	1044	Actual	
11:00 08 January	1070	Projected	1097	Actual	
12:00 08 January	1121	Projected	1150	Actual	
13:00 08 January	1169	Projected	1201	Actual	
14:00 08 January	1217	Projected	1252	Actual	
15:00 08 January	1216	Projected	1253	Projected	
16:00 08 January	1215	Projected	1253	Projected	
17:00 08 January	1214	Projected	1254	Projected	
18:00 08 January	1212	Projected	1254	Projected	
19:00 08 January	1211	Projected	1254	Projected	
20:00 08 January	1210	Projected	1254	Projected	
21:00 08 January	1209	Projected	1254	Projected	

Date and Time	Actual and Projected Releases				Strategy Adopted as advised by SEQWater
	10:23 07 January 2011		14:57 08 January 2011		
	Exhibit p739		Exhibit p767		
22:00 08 January	1208	Projected	1254	Projected	
23:00 08 January	1207	Projected	1300	Projected	
00:00 09 January	1205	Projected	1299	Projected	
01:00 09 January	1204	Projected	1299	Projected	
02:00 09 January	1203	Projected	1298	Projected	
03:00 09 January	1202	Projected	1298	Projected	
04:00 09 January	1200	Projected	1349	Projected	
05:00 09 January	1199	Projected	1348	Projected	
06:00 09 January	1198	Projected	1347	Projected	
07:00 09 January	1196	Projected	1346	Projected	
08:00 09 January	1194	Projected	1345	Projected	
09:00 09 January	1192	Projected	1344	Projected	
10:00 09 January	1190	Projected	1343	Projected	
11:00 09 January	1188	Projected	1393	Projected	
12:00 09 January	1186	Projected	1392	Projected	
13:00 09 January	1137	Projected	1391	Projected	
14:00 09 January	1087	Projected	1390	Projected	
15:00 09 January	1036	Projected	1388	Projected	
16:00 09 January	985	Projected	1387	Projected	
17:00 09 January	936	Projected	1386	Projected	
18:00 09 January	886	Projected	1434	Projected	
19:00 09 January	835	Projected	1432	Projected	
20:00 09 January	785	Projected	1431	Projected	
21:00 09 January	735	Projected	1429	Projected	
22:00 09 January	685	Projected	1427	Projected	
23:00 09 January	635	Projected	1426	Projected	
00:00 10 January	585	Projected	1424	Projected	
01:00 10 January		Projected	1472	Projected	
02:00 10 January		Projected	1470	Projected	
03:00 10 January		Projected	1468	Projected	
04:00 10 January		Projected	1466	Projected	
05:00 10 January		Projected	1464	Projected	
06:00 10 January		Projected	1462	Projected	
07:00 10 January		Projected	1460	Projected	
08:00 10 January		Projected	1458	Projected	
09:00 10 January		Projected	1456	Projected	
10:00 10 January		Projected	1454	Projected	
11:00 10 January		Projected	1452	Projected	
12:00 10 January		Projected	1450	Projected	
13:00 10 January		Projected	1448	Projected	
14:00 10 January		Projected	1445	Projected	
15:00 10 January		Projected	1442	Projected	

9. NOTES

1. As per the Original Submission (3), the words Operator and SEQWater are used interchangeably in this submission. There has been no attempt to understand the actual legal structure defining the relationship between the beneficial owners of the assets and any relationships they may have with other parties who may provide services to the owners such as design, construction, maintenance or operating services. The terms Operator and SEQWater are therefore shorthand for the legally responsible entity for the provision of the required services at the particular time.

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11. ABBREVIATIONS

AEP	Annual Exceedance Probability
BoM	Bureau of Meteorology
DERM	Department of Environment and Resource Management (Qld)
DTMR	Department of Transport and Main Roads
EL	Elevation
mAHD	metres Australian Height Datum
m^3/sec	cubic metres per sec, 1000 litres per sec
mm	millimetres
MSQ	Maritime Safety Queensland
Operator	Refer to Section 9
SEQWater	Refer to Section 9

ATTACHMENT 1

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ATTACHMENT 2

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2. Upon completion of your study, a copy of the data sets and the final report be forwarded to MSQ and,
3. This tidal data is licensed under a Creative Commons Attribute, Share alike license http://creativecommons.org/licenses/by-sa/2.5/au/

MSQ advised that the datum for each of these gauges is as below: -

- Datum for the heights is Lowest Astronomical Tide (LAT) datum for Brisbane Bar. At Brisbane Bar the LAT datum is 1.24m below the Australian Height Datum (AHD).
- Datum for the heights is Low Water Datum (LWD) datum for Brisbane Port Office. At Brisbane Port Office the LWD datum is 1.15m below the Australian Height Datum (AHD).

The times are referred to Australian Eastern Standard Time.