Brisbane Flooding January 2011

An Avoidable Disaster – Supplementary Submission 1

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M. J. O'Brien
[redacted]

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Contents

1. INTRODUCTION

This supplementary submission is considered relevant to the Queensland Floods Commission of Inquiry under Section 2(f) of the Terms of Reference (1).

> *Implementation of the systems operation plans for dams across the state and in particular the Wivenhoe and Somerset release strategy and an assessment of compliance with, and the suitability of the operational procedures relating to flood mitigation and dam safety.*

This supplementary submission includes additional detailed consideration of the Operational Manual (2) extending the consideration in Section 10.1 of the Original Submission (3). In particular it further supports the conclusions in Section 2.2 of the Original Submission reproduced below, specifically conclusions 1 and 3

2.2 Operational Manual

1. *While compliance with the Operational Manual is not a focus of this submission, it would appear that at times SEQWater did not comply with the requirements of the Manual, while at other times, appear not to have used the flexibility that the Manual provided and consequently would fail to meet the objectives of the Manual.*
2. *There appears to be no provision in the Operational Manual (2) which prevented the Operator from reducing the level in the dam below FSL.*
3. *The Operational Manual does not appear to substantially constrain the Operator's ability to undertake the appropriate course of action.*
4. *It is of concern that based on the Flood Event Log entry for 00:45 Monday 10th January, the non-damaging flow within Brisbane is not well understood by all parties, especially as achieving the maximum rate of release from Wivenhoe up to this flow is essential for maintaining the maximum capability for flood mitigation.*

This supplementary submission does not seek to address whether the procedures specified in the Manual are adequate for the management of flood events. Nothing contained in this supplementary submission should be read as support for the current Manual. The submission merely examines whether a consistent interpretation of the wording used in the Manual can be achieved.

While I am also aware that SEQWater has provided statements by several expert engineers who have examined compliance with the Manual, this supplementary submission does not extend the conclusions above.

SEQWater has stated that the Revision 7 of the Operational Manual was gazetted on 22nd January 2010 as an approved flood mitigation manual under the Water Supply (Safety and Reliability) Act 2008. Compliance or non compliance with the requirements of the Manual therefore relies on a legal assessment which is outside of my area of expertise.

2. CONCLUSIONS

1. The Manual clearly defines that the *"prediction"* of the maximum storage level in Wivenhoe is to be determined using "*the best forecast rainfall and stream flow information available at the time"*.
2. The Manual is not specific as to what might constitute "*the best forecast rainfall'*, but a forecast of no further rainfall would not be prudent if it was actually raining over any of the catchment at the time of the prediction.
3. It can be argued, possibly quite validly, that the use of different terminology (including predicted, expected and likely) implying different criteria may lead to a conflict, however, that should not detract from following the specified strategy unless that conflict cannot be resolved.
4. There are no inherent conflicts in the Manual which should lead an engineer to conclude that Strategies W1, W2, W3 and W4 may be selected other than on the basis of the *"predicted"* Wivenhoe storage level.

3. STATUS OF MANUAL

3.1 General

SEQWater has provided the following history leading to the development, approval and gazettal of the current Revision 7 of the Manual.

Issue No	Date	Gazette Date
0	27 October 1968	
1	6 October 1992	
2	13 November 1997	
3	24 August 1998	
4	6 September 2002	16 October 2002
5	4 October 2004	27 October 2004
6	20 December 2004	2 February 2005
7	November 2006	22 December 2009

SEQWater has stated that six revisions of the Manual have been undertaken since 1992 and that leading experts have been involved in the development of the Manual. It is therefore reasonable to expect that the current Manual is the result of substantial development and refinement. A considerable number of people with a wide range of expertise would have contributed to the progressive development of the Manual, its review and approval and in the preparation of expert technical studies and reports which underpin the Manual.

The Manual is clearly written to be used by a group of personnel with a particular skill set. References in the Manual to terms which are not further defined, such as fuse plugs and ogee spillway, clearly indicate that the Manual is directed to skilled personnel.

From submissions to the Commission and as a result of questioning at the Commission some details have emerged in relation to some of the personnel involved in the drafting of the current Revision 7 of the Manual. It is also clear that changes introduced in Revision 7 required the preparation of external studies such as the Somerset-Wivenhoe Interaction Study. However a number of key details regarding the preparation of Revision 7 are still unclear. These include: -

- Was a formal committee established for the preparation of this revision?
- If so what were its operating parameters?
- When did preparation of the revision commence?
- What level of justification and review supported changes in this revision?
- Were formal drafts prepared?
- Are any of these still available?
- What review process was adopted prior to approval and gazettal?
- Who was involved in the review process prior to approval and gazettal?
- What external studies were relied on in the preparation of revision 7?

Because the Manual has had such an extended period of review and refinement by multiple individuals it would be unwise to assume that apparent conflicts in the Manual were the result of an unintended error or as the result of confusion by one or more individuals. It is possible, but a rational explanation for any apparent conflict should first be sought. Only if there were no reasonable interpretation could it then be concluded that a conflict actually existed.

3.2 Flexibility

Revision 7 of the Manual provides enormous flexibility to the Operator. Generally there are no prescriptive methods of calculation specified and, except for Strategy W4A, there are no minimum release rates specified.

Therefore where the manual is specific as to methods that should be adopted it clearly represents an area were compliance was deemed to be essential.

4. MANUAL OF OPERATIONAL PROCEDURES REVISION 7

4.1 General

Revision 7 of the Manual includes a number of changes from Revision 6. Two of the most obvious changes were the introduction of Section 9.4 Flood Operations Strategies for Somerset, including Strategies S1, S2 and S3, which did not form part of Revision 6 and the almost complete restructuring of Section 8.4 Flood Operations Strategies for Wivenhoe. The fundamental concepts remained similar except for the obvious change in the Flood Operations Strategies for Wivenhoe being the move from using the actual lake level to using the predicted lake level as the basis for selection of Strategies.

It was noted in Section 10.1 of the Original Submission that: -

Rev 6 and Rev 7 of the Manual of Operational Procedures have been reviewed and the essential difference is that in Rev 7, selection of the release criteria is to be based on the predicted levels in the dams whereas Rev 6 is around the actual levels. This would mean that during an event where the dam levels are rising a particular operating strategy would normally be selected earlier under Rev 7 than it would have been under Rev 6.

- *Section 8.3 Initial Flood Control Actions Rev 7 specifies that the FOC must make a number of predictions. The equivalent Section in Rev 6 is different.*
- *Rev 7 includes a flowchart at page 23 and all the decisions on selection of the operating strategy are based on the likely outcome while there is no equivalent in Rev 6.*
- *Each of the operating strategies in Rev 7 is based on "Wivenhoe Storage Level predicted to be....." whereas in Rev 6 the strategy is based on the actual level.*

Rev 6 still required some predictions of river and stream flows but the selection of the operating strategies was not based on the predicted levels in Wivenhoe or Somerset.

In Revision 7 the wording within all Conditions for Strategies W1, W2, W3 and W4 for Wivenhoe utilises the wording *"Wivenhoe Storage Level predicted to ....."*. The Conditions for all operating strategies for Somerset, S1, S2 and S3, use a slightly different terminology "*Somerset Dam Level expected to exceed "* and *"Wivenhoe Dam not expected....."* or *"Wivenhoe Dam expected....."*.

The change to use of predicted levels for Wivenhoe in Revision 7 does not appear to be accidental as it has been changed consistently throughout Section 8 of the Manual. Section 8.4 also specifies certain data that must be included as part of the preparation of the prediction.

No access has been provided to the various drafts leading to the issue of Revision 7 which might show how and when this concept was introduced and the reasons for introducing this change.

4.2 Predicted, Actual, Likely and Expected

In various sections of revision 7 of the Manual the words Predicted, Expected and Likely are used to qualify lake levels. The following sections examine whether this potentially introduces inconsistencies and hence confusion as to which of the strategies should be implemented at a particular time.

In addition to their generally accepted meanings, the words Predicted, Expected and Likely could have the following additional implications for an engineer when used in a technical document.

- **Predicted**. This would generally imply the output of a calculation method or a model as opposed to a prediction by a clairvoyant.

- **Likely**. Over a range of circumstances which have been analysed is more likely to occur than not occur and so refers to an event that has a probability of occurring which exceeds 50%.
- **Expected**. Would be very similar to Likely, but could also be expected to have a higher level of probability.

The Manual gives no guidance for the appropriate method of determining Expected or Likely lake levels; however Section 8.4 is prescriptive to the extent that the predictions of the Maximum Levels in Wivenhoe and Somerset *"are to be made using the best forecast rainfall and stream flow information available at the time"*.

While it is possible that use of different terminology in different sections of the Manual could lead to confusion of personnel required to interpret the Manual and such confusion is undesirable, it is not a justification for departing from the specified requirements of the Manual.

4.3 Why is this Important?

In the original submission it was concluded, in part, in Section 2.1 that: -

5. *SEQWater were slow to react through the whole period examined.*
6. *The delay in responding, especially in the days leading up to Monday 10th January, eventually left SEQWater with few alternatives.*
7. *Even after SEQWater were aware at 0:55 on Monday 10th that increases in release rates were required to avoid triggering the fuse plug, the required release rates were not implemented until after 09:00 Tuesday 11th.*
8. *Given the delay in responding leading up to Monday 10th, if SEQWater had increased the release rates at 0:55 on Monday 10th the duration and extent of the Major Flooding in Brisbane would have been substantially reduced and potentially eliminated.*

Based on submissions and in responses to questions before the Commission it would appear that SEQWater did not use predications of the lake level in Wivenhoe based on the best forecast rainfall to determine the Wivenhoe operating strategies. In most cases the Wivenhoe operating strategy was selected later than it would have been if predications of the lake level in Wivenhoe were based on the *"best forecast rainfall"*. This is one possible explanation as to why SEQWater appeared to be slow to react.

4.4 Interpretation of Section 8.4

An understanding of Section 8.4 of the Manual is essential to a proper review of the selection of Strategies for Wivenhoe.

1. Section 8.4 does not specify whether actual levels in the dams or predictions of the maximum storage levels in Wivenhoe and Somerset are to be used for the selection of Strategies. It merely says that the strategy will depend on both; e.g. *"The strategy chosen at any point in time will depend on the actual levels in the dams and the following predictions".*
2. However it does specify that the predictions for: -
   - *Maximum storage levels in Wivenhoe and Somerset Dams.*
   - *Peak flow rate at the Lowood Gauge (excluding Wivenhoe Dam releases).*
   - *Peak flow rate at the Moggill Gauge (excluding Wivenhoe Dam releases).*

   "are to be made using the best forecast rainfall and stream flow information available at the time".

3. It does not specify, and there is no guidance provided, as to how the *"best forecast rainfall"* is to be selected; e.g. whether this is a "no rainfall forecast", the QPF or a 3 or 5 day forecast issued by the BoM. Presumably the selection of the *"best forecast rainfall"* is determined by the Operator. However it is not likely that selection of a "no rainfall forecast" while it was currently raining over the catchment would be considered prudent.

Section 8.4 includes a flowchart *"showing how best to select the appropriate strategy to use at any point in time"*. The criteria then used in the flow chart are based on *"Is Wivenhoe level likely to exceed..."*. The Manual does not specify how to determine the *"likely"* level in Wivenhoe and it may be argued that this could be different from the *"predicted"* level in Wivenhoe. However the use of *"best"* in the introduction to the flow chart would not imply a mandatory condition and therefore would not be in conflict with the mandatory provision of *"predicted"* used in the Conditions to the Strategies.

4.5 Strategy W1

It has been suggested that the use of the words *"Lake Level greater than ....."* in Strategies *W1A, W1B*, W1C, W1D and W1E are in conflict with the Condition specified in Strategy W1 of *"Wivenhoe Storage Level predicted to be less that 68.50 m AHD"* and therefore confuses selection of the appropriate Strategy. However that suggestion is not valid for the following reasons.

For all circumstances during the rising flood where the level in Wivenhoe is predicted to be below 68.5 mAHD, the actual level will meet one of the Lake Level requirements specified in Strategies W1A, W1B, W1C, W1D and W1E. Therefore on a strict reading Strategy W1 requires: -

- That Strategy W1 may only be selected while the Wivenhoe Storage Level is **predicted** to be less than 68.5 m AHD, and
- That selection of the sub strategy W1A, W1B, W1C, W1D or W1E is to be based on the **actual** lake level.

This is fully in accordance with the expectations of Section 8.4 which states that

> *"The strategy chosen at any point in time will depend on the **actual** levels in the dams and the following **predications**....."*

It has been further suggested that the text in bold at the end of Strategy W1, and reproduced below, is further indication that use of the words *"Wivenhoe Storage Level predicted to be less that 68.5 m AHD"* are in conflict with the requirements of the remainder of Strategy W1.

> ***If the level reaches EL 68.5 m AHD in Wivenhoe Dam, switch to Strategy W2 or W3 as appropriate.***

A strict reading of these two requirements would indicate that irrespective of whether the Wivenhoe Storage Level was **predicted** to be less than 68.5 m AHD and Strategy W1 might normally be selected, the section in bold clearly emphasises that Strategy W2 or W3 must be selected if the **actual** Wivenhoe Storage Level reaches EL 68.5 m AHD.

There do not appear to be any grounds for confusion in the selection of the appropriate Strategy introduced by the wording in Strategy W1.

4.6 Strategy W4

It is also instructive to look at the actual requirements specified for Strategy W4 in the Manual compared with some of the discussion.

- One of the specified Conditions for Strategy W4 is *"Wivenhoe Storage Level predicted to exceed 74 mAHD"*.

- Reference to the earlier portions of Section 8.6 requires that predictions of the maximum storage level in Wivenhoe are "*to be made using the best forecast rainfall and stream flow information available at the time"*.
- Strategy W4A requires a *"Lake Level between 74.0 and 75.5 m AHD".*
- Strategy W4B requires a *"Lake Level greater than 75.5 m AHD".*

In almost every conceivable circumstance, the level in Wivenhoe will be *"predicted to exceed 74.0 m AHD"* before it is actually "*between 74.0 and 75.5 m AHD"* or is "*greater than 75.5 m AHD"*. A strict interpretation therefore requires that Strategy W4 is implemented before either Strategy W4A or W4B is implemented. Further, Strategy W4 is implemented based on the **predicted** lake level while sub Strategies W4A and W4B are implemented only on the **actual** lake level.

Again this would be fully consistent with the expectations of Section 8.4.

It has been suggested that moving to Strategy W4 potentially too early was undesirable as under this Strategy it is necessary to immediately increase the release rate to at least match the inflow rate. This is presumably based on the wording used in the introduction to Strategy W4: -

> *Opening of the gates is to occur generally in accordance with the requirements of Section 8.6, until the storage level of Wivenhoe Dam begins to fall.*

And in Strategy W4A: -

> *Gate openings are generally to occur at the minimum intervals and sequences as specified in Section 8.6 until the storage level of Wivenhoe Dam begins to fall.*

And the knowledge that the Wivenhoe Dam level will only begin to fall if the rate of release exceeds the inflow rate.

As noted above, it is clear that the Manual requires Strategy W4 to be implemented without necessarily triggering Strategy W4A or W4B, and it is therefore important to recognise the following: --

- Both sections use the word *"generally"* which implies that strict compliance with Section 8.6 is not mandatory.
- The wording used in Strategy 4A refers to *"at the minimum intervals and sequences"* which indeed implies that the level should be reduced as soon as possible limited only by the *"minimum intervals and sequences"* specified in Section 8.6 which are 500 mm every 10 minutes; or less *"if the gates are at risk of being overtopped or the safety of the dam is at risk"*.
- The wording used in the introduction to Strategy W4 does not generally require the *"minimum intervals and sequences"* specified in Section 8.6 to be followed. Instead it "*generally"* requires compliance with all of Section 8.6. Section 8.6 specifies different requirements for circumstances when the releases from the dam are below 4000 cubic metres per second or in excess of 4000 cubic metres per second. In addition it includes a section entitled Normal Gate Operation Sequences which simply specifies gate openings.
- The wording in the introduction to Strategy W4 does not require that the level in Wivenhoe should be reduced as soon as possible limited only by the "*minimum intervals and sequences"* specified in Section 8.6.

Therefore a strict interpretation makes it clear that Strategy W4 can be implemented without implementing Strategy W4A and more importantly does not immediately trigger the requirement that releases immediately equal inflows. This requirement is only triggered when Strategy W4A is implemented as required by the wording "*Lake Level between 74.0 and 75.5 m AHD"*.

In addition one of the other Conditions of Strategy W4, that there is *"No limit on Maximum Release rate"* means that Strategy W4 already acts to meet the circumstances envisaged by the proposed new Strategy W3A.

It has also been suggested that the use of the words *"the dam water level reaches"* in Strategy W4B further confuses whether the predicted level should be used. As already stated above Strategy W4B is not selected until the condition of *"Lake Level greater than 75.5 m AHD"* and so no conflict can arise.

Strategy W4 already provides the additional required flexibility and much of the discussion would appear to be based on a poor understanding of the actual requirements specified in Strategy W4. Without knowledge of the full team involved in the preparation of Revision 7, the discussions and intermediate drafts, it is not immediately clear how this situation could arise.

This interpretation is given further support by the use of *"effect"* in the first paragraph after the Conditions which states: -

> *This strategy normally comes into effect when the water level in Wivenhoe Dam reaches 74.0 m AHD. However the Senior Flood Operations Engineer may seek to invoke the discretionary powers of Section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.*

This indicates that even though Strategy W4 has been selected, there is no requirement to *"effect"* the requirements of Strategy W4 until the dam level reaches 74.0 m AHD. In the meantime it gives the Operator all the flexibility accorded by Strategy W4.

4.7 Somerset Strategies

As pointed out in Section 4.1 the wording in the Conditions for the Somerset Strategies, S1, S2 and S3, does not use *"predicted"* and instead uses "*Somerset Dam Level expected to exceed ...*" and *"Wivenhoe Dam not expected....."* or *"Wivenhoe Dam expected....."*.

It may therefore be validly argued that when determining the strategy for use in Somerset that an alternative method of forecasting the levels in Somerset and Wivenhoe may be used. In addition, it can be argued that in this alternative method of forecasting there is no requirement to use *"the best forecast rainfall and stream flow information available at the time"* as is required by Section 8.4 of the Manual for a prediction of the levels in Somerset and Wivenhoe.

This argument may be valid, but it requires the Operator to run two different models, one utilised for the selection of Strategies for Wivenhoe, which requires the use of "*the best forecast rainfall*", and a different one for the selection of Strategies for Somerset which did not require the use of "*the best forecast rainfall*".

However it cannot be argued that this different model utilised for the selection of Strategies for Somerset was also suitable for the selection of Strategies for Wivenhoe as it would then be in conflict with the requirements of the Manual.

4.8 Analysis

Revision 7 of the Manual does refer to Actual, Predicted, Expected and Likely lake levels and specifies which data is to be used only in the calculation of Predicted lake levels, leaving it to the Operator's discretion on what data to include for calculation of Expected and Likely lake levels.

The Predicted, Expected and Likely lake levels at any time could be different depending on the discretion used by the Operator in the calculation of Expected and Likely lake levels. However there does not appear to be any section of the manual where any conflict would arise by selecting the Actual, Predicted, Expected or Likely lake levels strictly as specified in the Manual, even where the Predicted, Expected and Likely lake levels are different.

Additional work would be required by the Operator in determining Predicted lake levels in accordance with the Manual and also calculating Expected or Likely lake levels using the Operator's discretion. However there appears to be no reason why the Operator could not determine Expected and Likely lake levels in accordance with the procedure specified for Predicted lake levels and use that single calculation for all purposes of the Manual.

It may be that much of the operation of the dam is carried out in accordance with past practice and custom rather than strictly by reference to the Manual. While it may be relatively minor in the circumstances, it is worthwhile considering the straightforward issue of declaration of the Flood Event.

Section 2.2 of the Manual (2), reproduced below, is very clear and requires the Flood Event to be declared based solely on when the expected level in either Wivenhoe or Somerset exceeds FSL. The requirement is also prefaced with the normally mandatory requirement of *"must"*.

> *A Duty Flood Operations Engineer is on call at all times. The Duty Flood Operations Engineer must constantly review weather forecasts and catchment rainfall and must declare a Flood Event if the water level of either Wivenhoe or Somerset Dam is expected to exceed Full Supply Level as a result of prevailing or predicted weather conditions.*

The Flood Event Report (4) states that the Flood Event was not declared until 07:42 on Thursday 6 January 2011, even though for the current event the level in Wivenhoe was actually above FSL prior to 06:30 Tuesday 4th January. Section 4.3 of the Flood Event Report (4) appears to imply that the Operator required the additional precondition of *"flood releases are likely"* before actually declaring a Flood Event.

> *The Seqwater Flood Procedure Manual requires the Duty Flood Operations Engineer to declare a flood event and mobilise the Flood Operations Centre, if the Duty Flood Operations Engineer considers it likely the FSL of Somerset Dam or Wivenhoe Dam will be exceeded as a result of rainfall occurring in the Dam catchments and flood releases are likely. The Flood Operations Centre is mobilised as soon as a flood event is declared. Flood Operations Engineer 2 was the Duty Flood Operations Engineer who declared the January 2011 Flood Event by email at 07:42 on Thursday 6 January 2011 (see Appendix H).*

This approach seems to be further emphasised in Mr Ayre's response to my Original Submission at Item 114 and 115 where he states that even though the lake levels of both Wivenhoe and Somerset were above FSL on 06:30 Tuesday 4th January there was no requirement for a Flood Event to be declared because the releases were operational releases rather than flood releases. Section 2.2 of the Manual makes no reference to releases and does not distinguish between operational and flood releases. The Manual makes no link between the declaration of a Flood Event and the mobilisation of the Flood Operations Centre.

4.9 Transition between Strategies

There has been some discussion about "transitioning between Strategies", however this is not a concept that is supported by the Manual. Each Strategy has a defined set of criteria and none of the defined set of criteria would place you between Strategies.

The concept of "transition" is used in the Manual, but is quite different from any concept of transitioning between strategies; e.g.

- In Strategy W2 which is described as "a transition strategy", and
- In Section 9.5 Gate Opening Sequences in relation to "transition on opening and closing sequences."

The flexibility in the Manual described in Section 3.2 already enables the Operator to select gate opening strategies and release rates that ensure there is no requirement for any dramatic changes in release rates when moving between Strategies.

4.10 Non Damaging Flows

Some confusion has been expressed at the use of the terminology "*that 4000 m^3/s at Moggill is the upper limit of non-damaging floods downstream"* such as in the following extract from Strategy W3.

> *The intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4000 m^3/s, noting that 4000 m^3/s at Moggill is the upper limit of non-damaging floods downstream.*

Based on the submissions and statements made to the Commission it is apparent that there is a range of flows at Moggill which can cause damage downstream, including flows from as low as 3500 m^3/s. Obviously therefore, there is a range of flows that are considered by different parties as non-damaging downstream. The wording above simply would imply that 4000 m^3/s is the upper limit of this range of non-damaging flows.

5. NOTES

1. As per the original submission (3), the words Operator and SEQWater are used interchangeably in this supplementary 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.

6. BIBLIOGRAPHY

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2. **SEQWater.** *Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam.* November 2009 Revision 7.

3. **O'Brien, M J.** *Brisbane Flooding January 2011 - An Avoidable Disaster.* Brisbane : s.n., 2011.

7. ABBREVIATIONS

BoM	Bureau of Meteorology
DERM	Department of Environment and Resource Management (Qld)
EL	Elevation
mAHD	metres Australian Height Datum
m^3/sec	cubic metres per sec, 1000 litres per sec
Operator	Refer to Section 5
SEQWater	Refer to Section 5