**IN THE MATTER OF**
**THE QUEENSLAND FLOODS COMMISSION OF INQUIRY 2011**

**A COMMISSION OF INQUIRY UNDER THE COMMISSIONS OF INQUIRY ACT 1950**

**AND PURSUANT TO THE COMMISSIONS OF INQUIRY ORDER (No. 1) 2011**

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# SECOND SUPPLEMENTARY SUBMISSION ON BEHALF OF QUEENSLAND BULK WATER SUPPLY AUTHORITY

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## PART I
## INTRODUCTION

1. These submissions are made on behalf of Queensland Bulk Water Supply Authority ("**Seqwater**").

2. They address the evidence adduced at the public hearings of the Commission from 11 to 15 April 2011 and from 5 to 27 May 2011, and a number of particular issues which arose during those hearings.

3. They are structured as follows:

   (a) Part II (at pages 3 to 8) sets out the findings sought by Seqwater. The grounds upon which those findings should be made are developed in subsequent Parts.

   (b) Part III (at pages 9 to 11) deals with the cause of the flooding during the January 2011 event.

   (c) Part IV (at pages 12 to 44) deals with issues concerning the interpretation of the Manual.

   (d) Part V (at pages 45 to 52) deals with the use of rainfall forecasts.

   (e) Part VI (at pages 53 to 76) addresses the evidence which leads ultimately to the conclusion that the flood engineers exercised sound judgment during the event.

   (f) Part VII (at pages 77 to 79) addresses Seqwater's compliance with the Manual.

   (g) Part VIII (at pages 80 to 87) deals with issues concerning the full supply level of Wivenhoe Dam at the commencement of the event.

   (h) Part IX (at pages 88 to 90) deals with the review of the Manual.

   (i) Part X (at pages 91 to 96) deals with miscellaneous other issues, including those concerning communications, training and the Flood Operations Centre.

## PART II
## FINDINGS SOUGHT

4. For the reasons developed below, the Commission should make the following findings.

***Cause of the flooding***

5. The cause of the flooding in the Brisbane River basin during the January 2011 event was the extreme rainfall within the catchment both above and below Wivenhoe and Somerset Dams, and not the operation of the dams.

6. If no water had been released from Wivenhoe Dam during the January 2011 event, widespread urban inundation would have occurred in any event.

7. The existence and operation of the dams mitigated the flooding significantly resulting in significantly lower flood levels, and significantly reduced inundation, than would otherwise have been experienced.

8. It is misleading to describe the flooding within the Brisbane River basin during the event as a "dam release flood".

***Interpretation of the Manual***

Primary finding

9. The Manual does not compel decisions to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of the information contained in rainfall forecasts. Rather, it requires the forecast information to be gathered and taken into account, but leaves the weight to be given to forecast information to the professional engineering judgment of the flood engineers.

Subsidiary findings

10. At the time the most recent version of the Manual was approved, it was common knowledge in the art that:

    (a) Rainfall forecasts provided by the Bureau of Meteorology ("**BOM**"), such as 24 hour QPFs, were generally too unreliable to be used as a basis for operational decision making as to dam releases.

(b) It was possible, however, that an exceptional case might arise, perhaps involving a large, stable slow moving rain depression, where BOM could provide a forecast with a high degree of confidence as to the quantitative amount of rainfall that would come from that system over the catchment area.

(c) There was also the prospect of scientific advances in the relatively short term which might enable BOM to provide ordinary forecasts with a higher degree of confidence than it does at present.

(d) It was desirable that the Manual provide the flood engineers with flexibility to accommodate information of the kind referred to in the preceding two subparagraphs during a flood event.

(e) There is a material degree of uncertainty in all model results. By definition, models are only an approximation of reality. Even the results of run-off modelling based on actual rainfall data have a margin for error in the order of 5-10% or more. Thus model results are only tools to be used to assist in the exercise of experienced engineering judgment.

11. The substantial body of uncontradicted expert evidence that the skilled addressee would read the Manual in accordance with Seqwater's interpretation should be accepted.

12. An interpretation of the Manual which rendered it mandatory to make decisions to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of the information contained in rainfall forecasts would:

(a) undermine the objects of the Manual; and

(b) have consequences that are characterised properly as absurd.

***Use of forecasts***

13. Every model run included predictions based on forecasts (or a scaled up quantity based on forecasts). Those "with forecast" predictions were evidenced by the blue line in the model results.

14. The usual practice of flood engineers is not to decide to make additional releases, or to transition from one strategy to the next, on the faith of the blue line in the model results. For this purpose, the blue line was accorded zero weight.

15. However, forecasts were not ignored. In fact, they were considered and used in a number of different ways during the event.

16. ***First***, they were taken into account by the flood engineers in assessing where the event may be heading, and which strategies may have to be engaged, over the coming hours and days. The flood engineers used them to maintain an awareness of what may be possible in the immediate future.

17. ***Secondly***, they were used as a basis for providing advance warning for emergency planning purposes. Armed with an awareness of the possibilities, the flood engineers conveyed that information in their situation reports so that the recipients could respond as appropriate.

18. ***Thirdly***, during the period from about 9pm on Sunday, 9 January 2011, forecasts were showing the weather system moving in a southerly direction, with significant rainfall expected in the downstream catchments. This continued into Monday, 10 January 2011, when the devastating flash flooding occurred in the Lockyer. A material consideration for the flood engineers during this period was the need to avoid additional releases from the dam coinciding with significant flows from downstream catchments. The forecasts were taken into account in deciding to refrain from making additional releases from the dam during this period.

19. ***Fourthly***, on the morning of Tuesday, 11 January 2011, Mr Malone communicated with BOM for the specific purpose of confirming that, according to BOM's best forecast information, the rain falling in the dam catchment was likely to continue. BOM's forecast information was relied on by Mr Malone and Mr Tibaldi in deciding to transition to W4 at 8am (at a time when the water level had not reached 74).

20. The use which the flood engineers made of forecasts was in accordance with:

    (a) sound practice; and

    (b) the Manual.

***Sound judgment***

21. The decisions taken by the flood engineers during the course of the event:

    (a) were the product of careful consideration of the actual circumstances confronting them at the time;

(b) were amply justified in light of the actual circumstances confronting them at the time; and

(c) reflected the exercise of sound professional engineering judgment.

***Compliance with the Manual***

22. In their conduct of flood operations during the event, the flood engineers observed the operational procedures in the Manual.

***Full supply level at the commencement of the event***

23. The Commission should find that:

(a) The full supply level for Wivenhoe Dam is set by the *Moreton Resource Operations Plan* made under the *Water Act* 2000 (Qld), not by the Manual.

(b) The decision whether to change the full supply level is one for the Director-General and the Minister.

(c) In December 2010, the Minister was provided with the following advice by the Water Grid Manager:

(i) Seqwater had advised that:

A. Pre-emptive releases to draw the Wivenhoe and Somerset Dams down to 95 per cent of their combined full supply level may provide some benefits in terms of reduced community and operational impacts during minor inflow events.

B. However, such pre-emptive releases would provide negligible benefits for medium and major flood events.

C. For large events, any impacts would require pre-emptive releases of at least 250,000 ML. This is equivalent to a release of about 16 per cent of the combined storage capacity of Wivenhoe and Somerset Dams.

(ii) From a water security perspective, the Water Grid Manager had no in-principle objection to Wivenhoe and Somerset Dams being drawn down to 95 per cent of their combined full supply level.

(iii) From a water security perspective, the Queensland Water Commission had also confirmed that it did not have any objection to a release on this scale.

(iv) However, the Water Grid Manager would not recommend a pre-emptive release of the scale of 250,000 ML, based on information currently available. The potential water security impacts were considered to be more significant than the negligible benefits. These potential security impacts include costs associated with the earlier or avoidable operation of the desalination facility at capacity, as well as the increased probability of triggering the implementation of a drought response plan.

(v) The Water Grid Manager recommended that the investigations then underway with the Queensland Water Commission to examine the opportunity of raising the full supply level of Wivenhoe Dam for water supply be expanded to include options involving the release of additional water once major inflows are forecast.

(d) The Minister decided prior to Christmas 2010 not to reduce the dam levels to below full supply level.

(e) In view of the above, it was not open to Seqwater to reduce the water level in Wivenhoe Dam below full supply level in advance of the January 2011 flood event.

(f) The advice given by Seqwater in December 2010 in respect of large events was materially the same as the advice which it gave in February 2011.

***Review of the Manual***

24. In accordance with standard practice it is essential that the Manual be reviewed in light of the January 2011 event.

25. However, it is not necessary for the Manual to be amended to properly reflect the strategies as applied by the flood engineers. Upon its proper interpretation, the Manual already properly reflects those strategies.

26. Further, it is important that the issues concerning the Manual be kept in perspective.

27. ***First***, none of the flood engineers were uncertain as to what it meant or required. If the Manual is perceived by others to be ambiguous, that is of little moment. Care must be taken not to do violence to the Manual in the name of making it clearer for those who would not

ordinarily have access to it, and who will never have to use it in flood operations. The risk is that a document which is presently clear to the flood engineers will be replaced with one that does not reflect their understanding of the technical concepts involved, or that denies them the flexibility to exercise the professional engineering judgments which are integral to the proper conduct of flood operations.

28. ***Secondly***, the Manual in its present form provides a reasonable balance between the objectives of preserving dam safety while mitigating the damage and disruption of flooding in downstream areas.

29. ***Thirdly,*** the Manual has served the community well for over 30 years. In this regard, the conduct of operations in accordance with the Manual during flood events in March 1989, April 1989, February 1999, October 2010 and December 2010 ensured that unnecessary damage was not inflicted in areas below Moggill.

30. ***Fourthly***, no mitigation strategy, and therefore no Manual, can produce the optimal outcome for all floods.

31. ***Fifthly***, it is clear that any changes to the operating procedures in the Manual would not have avoided urban inundation given the magnitude of the January 2011 event.

## PART III

## CAUSE OF THE FLOODING

### INTRODUCTION

32. **The Commission should find that**:

(a) **The cause of the flooding in the Brisbane River basin during the January 2011 event was the extreme rainfall within the catchment both above and below Wivenhoe and Somerset Dams, and not the operation of the dams**.

(b) **If no water had been released from Wivenhoe Dam during the January 2011 event, widespread urban inundation would have occurred in any event.**

(c) **The existence and operation of the dams mitigated the flooding significantly resulting in significantly lower flood levels, and significantly reduced inundation, than would otherwise have been experienced**.

(d) **It is misleading to describe the flooding within the Brisbane River basin during the event as a "dam release flood"**.

### ANALYSIS

33. Aspects of these matters are addressed in paragraphs 156 to 179 of Seqwater's Opening Submission dated 11 March 2011. Seqwater relies upon those paragraphs, and adds the following.

34. Paragraphs 156 to 179 of Seqwater's Opening Submission draw upon the analysis contained in Section 8 of Seqwater's Flood Event Report.[1]

35. Dr Nathan was asked to address the question whether the information contained in Section 8 of Seqwater's Flood Event Report accurately describes the January 2011 flood event.

36. In his report, Dr Nathan answered this question as follows:[2]

> 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 historical events, flood volumes indicate the volume of the January 2011 event was almost double that of the January 1974 flood, and rivals the February 1893 flood. Peak water levels at gauging stations 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

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1 Ex. 24.

2 Ex. 409, page ii.

> of the recorded peaks, volumes and peak levels at Somerset and Wivenhoe Dams indicate the January 2011 flood event exceeds 1 in 100 AEP.

37. Mr Babister, the independent expert engaged by the Commission, expressly endorsed Dr Nathan's report.[3]

38. In his oral evidence, Dr Nathan addressed the topic as follows (emphasis added):[4]

> Can you tell us, please, from your professional opinion, what was the extent of the rainfall over the catchment of Wivenhoe during this flood event, and what in your opinion was the ability of the dam to deal with that extent of rainfall?-- Yes, that - look, as a hydrologist I tend to take a catchment wide view, and when I look - when I look at this event, it is **very clear that we've got an extremely large rainfall event. Mother Nature's dumped an inordinate amount of rain in this entire catchment. It is in the order of over eight Sydharbs worth of rainfall volume has landed on the catchment**.
>
> Sorry eight?-- Eight Sydharbs. So people would think of Sydharb as the volume of Sydney Harbour, so if we think over eight Sydney Harbours was dumped on this catchment during that three-day period. So it is a significant amount of water. **If you compare that volume to the available flood storage in the dam, which is probably only around three Sydharbs, you instantly get a feel for what is the ability of that dam to control the flood**. And I understand there has been a lot of analysis around gate operation procedures. Taking a catchment wide view, I think they are probably of second order - second order importance, that really **we have a situation where we have got five Sydharbs worth of rainfall that can't be captured by the dam**. If you look at this figure here on figure 5.1, it shows that, first of all, over - almost half the catchment upstream of Brisbane lies below Wivenhoe Dam, and if you look at the average rainfalls below Wivenhoe Dam and above Wivenhoe Dam, it is probably - a bit less than half of that rainfall fell on the catchment below Wivenhoe Dam. It is particularly interesting, though, to see the yellow and tawny colour dots that sit below Wivenhoe Dam. That's indicating that **at multiple sites immediately below Wivenhoe Dam, they were the areas that received the most extreme rainfall during the event. So the rarities of that - they are the rarest of rainfalls. They are unusual. It is a Noah's Flood kind of rainfall. The likelihood of them being exceeded in any one year is sort of 1 in 500 to 1 in 2000. So very rare rainfalls**. They occurred downstream of the dam. I think when you look at **from a catchment wide perspective, slightly less than half the rainfall fell downstream of Wivenhoe Dam but a very intense part of that storm fell downstream of Wivenhoe Dam**.
>
> You made a comment in that area - I can't recall the exact words but something like when you consider the volume of the rainfall in the catchment, the gate operating procedures we have been talking about at length were of secondary importance. Can you explain what you mean by that?-- **From a perspective of the catchment outlet where you have got eight Sydharbs, or over eight Sydharbs of volume of rainfall, if the available storage in the dam is only three, there is five Sydharbs of water that has got to go somewhere**. So I think if you put it in terms of, say, the '74 event, which is very front of mind for people, **this event was probably twice the volume of the '74 event, yet the flood level at the Port Office gauge was a metre lower than the '74 event**, even though the flood event was nominally twice the size. So **clearly the dam is having an appreciable mitigation effect**. The extent to which you have got more flood mitigation out of it, to me, when you look at the kind of gross catchment conditions we're talking about, you could possibly have got - we could possibly have got more flood mitigation out of it - I truly haven't looked at that and I don't know - but my feeling, when you look at those numbers, is we can only be talking about finessing something; that **the majority of the floods, I think, are due to Mother Nature and we had little control of that**.

39. The Dam Safety Regulator, Mr Allen, was asked about the expression "dam release flood" during his questioning (emphasis added):[5]

> ... there has been talk in the press and elsewhere that what occurred in January was called a dam release flood. That is the implication being the flood occurred because of the releases from the dam and they were unnecessary. That is, the flooding in Brisbane could have been avoided by better management of the dam?-- I am sure in hindsight you could work out ways where the flow in Brisbane could have been reduced marginally but that's not the way you can operate a dam. The - in terms of a dam release flood,

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3 Ex. 407, paragraph 82.
4 T2294/46-T2295/56.
5 T2096/45-T2097/1.

> of course it was a dam release flood, **but the implication of a dam release flood is that it is the fault of the dam not the fault of the rain. I mean, the releases from Wivenhoe were purely the fault of the rain. You have to handle that rain. I mean, if the dam wasn't there and that flow came down to Brisbane it would have been a couple of metres higher than it was**.

40. In his report Mr Babister addressed the misleading nature of the expression "dam release flood" in the present context (emphasis added):[6]

> **The Somerset and Wivenhoe Dams attenuated the peak flood discharge in the lower Brisbane River, resulting in lower flood levels and reduced flood inundation** extent downstream of Wivenhoe Dam than would have been experienced without the existence of the dams. **Damage to urban areas in particular was reduced by the presence and operation of the dams** during the January 2011 flood event.
>
> The terms "dam release flood" implies that the dam is the primary cause of flood discharges, rather than rainfall in catchment areas upstream of the dam. **The application of the term "dam release flood" to the Brisbane River flooding In January 2011 is therefore misleading and has the potential to cause the general public to form an incorrect understanding of the causes and management of the flooding in this instance**. This term should be reserved for situations where discharge from a dam is greater than the discharge would naturally have been without the dam.

41. In his oral evidence, Mr Babister said:[7]

> ... the causative mechanism was rainfall. It wasn't the dam.

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6 Ex. 407, paragraphs 77 and 78.

7 T2172/58-T2173/1.

## PART IV

## INTERPRETATION OF THE MANUAL

### INTRODUCTION

42. The Manual has a specific purpose – to set out operational procedures to be observed by flood engineers during flood events.[8]

43. It is a technical document, written by engineers.[9] Its content is approved by the Dam Safety Regulator, Mr Allen, an engineer with significant technical expertise.

44. It is the product of technical learning and development extending over more than three decades.[10]

45. It is intended to be read and used by flood engineers and a small group of others with technical expertise.[11]

46. Its intended audience does not include the public at large, or lawyers who themselves have no technical expertise.[12] Such people would not ordinarily have access to the document, much less have to use it in high pressure flood operations.

47. The point was made by Mr Allen in the following exchange with Mr Callaghan SC:[13]

> ... you do need to understand how the dam would be operated to understand what is in the manual and to understand what a word or a phrase in the manual means.
>
> MR CALLAGHAN: No argument with that. And is your point I'm guessing - is that there aren't that many people around who would have that understanding?-- Probably not.

48. Lawyers attempting to interpret the Manual must recognise the force of the following evidence given by Mr Allen:[14]

> ... realistically it is an operational manual for the engineers operating the manual. As long as they totally understand what is there. I am quite happy have some legal review of it but the challenge is finding a lawyer who knows something about dams. No realistically, that has been a problem for us. It has been a real problem for us because the two groups talk differently.

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8 The purpose of the Manual is stated expressly in Section 1.3. Statements in extraneous material such as Ex. 391 cannot gainsay this express statement in the Manual itself.

9 T402/27-39.

10 The development of the Manual is addressed in Mr Allen's statement at paragraphs 24, 32-35, 38, and 44-73.

11 T402/27-39. Those holding controlled copies of the Manual are identified in Appendix A.

12 As the definition of "Controlled Document" in Section 1.2 of the Manual indicates, the document is one subject to managerial control over its contents, distribution and storage. Ordinarily, only those identified in Appendix A have access to the document.

13 T2088/53-T2089/2.

14 T2084/8-16.

**PRINCIPLES OF INTERPRETATION**

***The skilled addressee***

49. It is a fundamental principle of interpretation that one is concerned, not with the meaning of the words used by the author in the abstract, but rather with what a reasonable person to whom the words were addressed would have understood the author to mean.

50. This principle is applicable to the interpretation of a broad range of instruments, including contracts.[15] It is especially important where the document to be interpreted deals with a technical subject.

51. The point was explained by Lord Hoffman (with whom the other members of the House of Lords agreed) in ***Kirin-Amgen Inc v Hoechst Marion Roussel Ltd*** [2005] RPC 169. The House of Lords was concerned with the interpretation of a patent. Lord Hoffman referred to the artificial rules of interpretation previously applied under English law, and described the modern approach as follows (at [30]-[33]) (emphasis added):

> It came to be recognised that **the author of a document such as a contract or patent specification is using language to make a communication for a practical purpose** and that a rule of construction which gives his language a meaning different from the way it would have been understood by the people to whom it was actually addressed is liable to defeat his intentions. It is against that background that one must read the well-known passage in the speech of Lord Diplock in *Catnic Components Ltd v Hill & Smith Ltd* [1982] RPC 183 at 243 when he said that the new approach should also be applied to the construction of patent claims:
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> > **A patent specification should be given a purposive construction rather than a purely literal one derived from applying to it the kind of meticulous verbal analysis in which lawyers are too often tempted by their training to indulge**.
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> This was all of a piece with Lord Diplock's approach a few years later in *Antaios Compania Naviera SA v Salen Rederierna AB* [1985] AC 191 at 201 at 233, to the construction of a charterparty:
>
> > … I take this opportunity of restating that, if detailed semantic and syntactical analysis of words in a commercial contract is going to lead to a conclusion that flouts business common sense, it must be made to yield to business common sense.
>
> Construction, whether of a patent or any other document, is of course not directly concerned with what the author meant to say. There is no window into the mind of the patentee or the author of any other document. **Construction is objective in the sense that it is concerned with what a reasonable person to whom the utterance was addressed would have understood the author to be using the words to mean. Notice, however, that it is not, as is sometimes said, "the meaning of the words the author used", but rather what the notional addressee would have understood the author to mean by using those words**. The meaning of words is a matter of convention, governed by rules, which can be found in dictionaries and grammars. **What the author would have been understood to mean by using those words is not simply a matter of rules. It is highly sensitive to the context of and background to the particular utterance. It depends not only upon the words the author has chosen but also upon the identity of the audience he is taken to have been addressing and the knowledge and assumptions which one attributes to that audience**. I have discussed these questions at some length in *Mannai Investment Co Ltd v Eagle Star Life Assurance Co Ltd* [1997] AC 749 and *Investors Compensation Scheme Ltd v West Bromwich Building Society* [1998] 1 WLR 896.

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15 See, e.g., ***Toll (FGCT) Pty Ltd v Alphapharm Pty Ltd*** (2004) 219 CLR 165 at [40] (Gleeson CJ, Gummow, Hayne, Callinan and Heydon JJ).

> **In the case of a patent specification, the notional addressee is the person skilled in the art. He (or, I say once and for all, she) comes to a reading of the specification with common general knowledge of the art**.

52. Thus:

(a) The task of interpretation is informed by the practical purpose of the document.

(b) The search is not "for the meaning of the words the author used".

(c) Rather, the search is for "what the notional addressee would have understood the author to mean by using those words".

(d) What the author would have been understood to mean is not simply a matter of dictionary meanings and grammatical rules.

(e) Rather, it is highly sensitive to the context and background.

(f) The identity of the audience is important, as is the knowledge attributed to that audience.

(g) In the case of a technical document like a patent specification (or, as here, a manual of operating procedures) one should not apply the kind of meticulous verbal analysis in which lawyers are too often tempted by their training to indulge.

(h) Rather, one must look at the document through the eyes of the notional addressee, being a person skilled in the relevant art.

(i) The skilled addressee comes to a reading of the document with common general knowledge of the art.

53. This accords with the decision of the High Court in ***Welch Perrin & Co Pty Ltd v Worrell*** (1961) 106 CLR 588, where Dixon CJ, Kitto and Windeyer JJ held (at 610) that a specification was not to be read:

> ... in the abstract. It must be construed in the light of the common knowledge in the art ...

54. Indeed, there is a large body of Australian authority to the same effect.[16]

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[16] See, e.g., ***Décor Corporation Pty Ltd v Dart Industries Inc*** (1988) 13 IPR 385 at 391 (Lockhart J); ***Flexible Steel Lacing Co v Beltreco Ltd*** (2000) 49 IPR 331 at [81] (Hely J); ***Kinabalu Investments Pty Ltd v Barron & Rawson Pty Ltd*** [2008] FCAFC 178 at [44]-[45] (Sundberg, Emmett and Greenwood JJ); ***H Lundbeck A/S v Alphapharm Pty Ltd*** (2009) 177 FCR 151 at [52]-[54] (Emmett J) and [118] (Bennett J, with whom Middleton J agreed); ***SNF (Australia) Pty Ltd v Ciba Speciality Chemicals Water Treatments Ltd*** [2011] FCA 452 at [21]-[22] (Kenny J).

55. The requirement to interpret the document from the point of view of the skilled addressee, in light of the common knowledge in the art, has important evidentiary implications.

56. In Blanco White, *Patents for Inventions* (5th ed, 1983), sec 2-101, p 9, the learned author said[17] (emphasis added):

> As with any other document questions of construction of a patent specification, arising in legal proceedings, are for the court to decide as a matter of law; **for this purpose the court must first instruct itself as to the technical matters involved, so as to place it in the position of one acquainted with the art concerned – in the position, that is, of a person to whom the specification is addressed**. The document must in particular be read with the skilled addressee's understanding of what the inventor is trying to achieve and his appreciation of what is important, what not.

57. The point was made by the English Court of Appeal in ***General Tire & Rubber Co v Firestone Tyre & Rubber Co Ltd*** [1972] RPC 457 at 485 (emphasis added):

> The earlier publication and the patentees claim must each be construed as they would be at the respective relevant dates by a reader skilled in the art to which they relate having regard to the state of knowledge in such art at the relevant date. The construction of these documents is a function of the court, being a matter of law, but, **since documents of this nature are almost certain to contain technical material, the court must, by evidence, be put in the position of a person of the kind to whom the document is addressed, that is to say, a person skilled in the relevant art at the relevant date** ...

58. In ***Nicaro Holdings Pty Ltd v Martin Engineering Co*** (1990) 91 ALR 513 at 523-524, Gummow J (with whom Jenkinson J agreed) quoted this passage with approval and added:

> It is not for the court by its own efforts to put itself in the position of a person skilled in the relevant art ...

59. Thus, the task of interpretation depends upon ***evidence*** as to the state of knowledge in the relevant art.

60. Moreover, the relevant evidence goes further than this. As Kenny J held in ***SNF (Australia) Pty Ltd v Ciba Speciality Chemicals Water Treatments Ltd*** [2011] FCA 452 at [24]:

> In assisting the task of patent construction, evidence may be given by experts as to the meaning that those skilled in the art would give to technical or scientific terms and as to unusual or special meanings given by such persons to words that might otherwise bear their ordinary meaning: see *Glaverbel SA v British Coal Corp* [1994] RPC 443 at 486. In this case, expert evidence was given to explain how ordinary words were to be understood in a particular industrial context. Admissible evidence may also be given by persons with the knowledge, skill and experience of the notional skilled addressee as to how he or she would have read the specification in the patent at issue or in a prior publication: see *El Dupont de Nemours & Co v Imperial Chemical Industries Plc* (2002) 54 IPR 304 ('*El Dupont*') at 323 [59]. It is for the court to determine the weight to be accorded all such evidence: compare *Allsop Inc v Bintang Ltd* (1989) 15 IPR 686 at 697. Ultimately, it is for the court to construe the complete specification, though with the assistance of all of the relevant evidence adduced in the proceeding: compare *El Dupont* at 323 [60].

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[17] In a passage quoted with approval by the Full Court of the Federal Court in ***Leonardis v Sartas No 1 Pty Ltd*** (1996) 67 FCR 126 at 138 (Burchett, Hill and Tamberlin JJ).

61. Thus, expert evidence is relevant and admissible as to:

(a) ***first***, the meaning that those skilled in the art would give to technical or scientific terms and as to unusual or special meanings given by such persons to words that might otherwise bear their ordinary meaning (including as to how ordinary words were to be understood in a particular technical context); ***and***

(b) ***secondly***, how the expert, with the knowledge, skill and experience of the notional skilled addressee, would read the technical document at issue.[18]

***Purpose and consequences***

62. The principles of interpretation also require:

(a) The meaning of the document to be moulded, if possible, to conform with the purpose of its author – the purpose being judged from the document as a whole and the surrounding circumstances.

(b) Consideration of the consequences of a particular interpretation, recognising that:

(i) the more unreasonable the consequences, the less likely it is that the document was intended to bear that particular interpretation;

(ii) in the face of unreasonable consequences, the particular interpretation should not be adopted unless it is ***abundantly clear*** that that is what the document conveys.

63. As Staughton LJ held in ***Glaverbel SA v British Coal Corporation*** [1995] RPC 255 at 269-270:

> If possible, the meaning of the document must be moulded to conform with the purpose of its author or authors – the purpose being judged from the document as a whole and the surrounding circumstances. To put it another way, there is a conflict with the purpose if a judge is disposed to say to himself – 'he cannot have meant that'. In the *Catnic* case itself, Lord Diplock said (at page 244):
>
> > 'No plausible reason has been advanced why any rational patentee should want to place so narrow a limitation on his invention. On the contrary, to do so would render his monopoly for practical purposes worthless …'

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[18] In this latter respect, the law in Australia may differ from the law in England: compare, e.g., ***Glaverbel SA v British Coal Corporation*** [1995] RPC 255 at 269, where Staughton LJ said:

> The Court should admit evidence of the meaning of technical terms. It may be that expert evidence can go somewhat further than that in aid of interpretation; but I need not decide that in the present case.

> That is in my view an example of the purposive method of construction. It is at least allied to, and perhaps an example of, what Lord Reid said in *L. Schuler A.G. v Wickham Machine Tool Sales Ltd* [1974] A.C. 235 at 251:
>
> > 'The fact that a particular construction leads to a very unreasonable result must be a relevant consideration. The more unreasonable the result the more unlikely it is that the parties can have intended it, and if they do intend it the more necessary it is that they should make their intention abundantly clear.'

64. This is another topic upon which expert evidence is relevant. The expert can address the impact of different assumptions about the correct interpretation of the document.[19]

***Document to be read as a whole***

65. Finally, it is a fundamental principle of interpretation that instruments must be read as a whole. This principle applies to all instruments whether they be statutes,[20] contracts,[21] patents,[22] or otherwise.[23]

**MANDATORY TO MAKE PARTICULAR DECISIONS ON THE BASIS OF FORECASTS?**

***Introduction***

66. The primary issue of interpretation ventilated during the public hearings was whether the Manual rendered it mandatory to make decisions to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of information contained in rainfall forecasts.

67. **The Commission should find that the Manual does not compel decisions to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of the information contained in rainfall forecasts. Rather, the Manual requires the forecast information to be gathered and taken into account, but leaves the weight to be given to that forecast information to the professional engineering judgment of the flood engineers**.

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19 See, e.g., ***Qualcomm Incorporated v Nokia Corporation*** [2008] All ER (D) 09 (Mar) at [10] (Floyd J).

20 ***Project Blue Sky Inc v Australian Broadcasting Authority*** (1998) 194 CLR 355 at [69]-[71] (McHugh, Gummow, Kirby and Hayne JJ).

21 ***Australian Broadcasting Commission v Australasian Performing Right Association Ltd*** (1973) 129 CLR 99 at 109 (Gibbs J).

22 ***Welch Perrin & Co Pty Ltd v Worrell*** (1961) 106 CLR 588 at 610 (Dixon CJ, Kitto and Windeyer JJ).

23 *Halsbury's Laws of England* (4th ed), Vol 12, at [1469].

***Summary of Seqwater's argument***

68. The skilled addressee would:

(a) well know that ordinarily rainfall forecasts provided by BOM, such as 24 hour QPFs, are too unreliable to be used as a basis for operational decision making as to dam releases, and so would rail against the proposition that the Manual made it mandatory to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of them;

(b) well know that there might be exceptional cases, or scientific developments, which might result in the production of forecasts which are sufficiently reliable to be acted upon, and would thus be disposed to read the Manual so as to accord the flood engineers the flexibility to do that in an appropriate case;

(c) well know that the modelling contemplated by the Manual is a mere tool to be used to assist in the exercise of judgment, and would thus be disposed to read:

(i) the Manual so as to give primacy to the judgment of the engineers, and to consign the model results to their proper (subordinate) function of assisting in the exercise of that judgment;

(ii) terms in the Manual such as "likely" or "predicted" as embodying a qualitative professional engineering judgment as to what is truly "likely" or what is "predicted" with an appropriate degree of certainty.

69. This body of knowledge, which is firmly established by the evidence, cannot be ignored. It represents the prism through which the language of the Manual must be examined.

70. The purposes of the Manual are set out clearly in its five objectives. Achieving those objectives would not be advanced by an interpretation which imposed a rigid system rendering it mandatory to make decisions to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of information contained in rainfall forecasts. That interpretation would, for example, result in it being mandatory to move to Strategy W4:

(a) at a time when the safety of the dam was not even close to being in jeopardy;

(b) so as to inundate urban areas, when that was plainly unnecessary.

71. The argument from consequences is allied to this. The consequences of the mandatory interpretation are as unreasonable as one could imagine. That interpretation would require the flood engineers to cause widespread flooding over the floorboards of people's homes when that may turn out to have been unnecessary. This may be characterised properly as absurd.

72. Thus the mandatory interpretation could be adopted only if (in addition to ignoring the viewpoint of the skilled addressee, as well as the substantial body of uncontradicted expert evidence discussed below) it were impossible to mould the meaning of the Manual to accord with the contrary interpretation endorsed by all flood engineers for which Seqwater contends.

73. Upon a proper analysis of the language of the Manual as a whole, there is no difficulty in arriving at the interpretation for which Seqwater contends. That interpretation reflects:

    (a) The express statement of objectives in the Manual.

    (b) The express recognition in the Manual of the limitations of rainfall forecasts.

    (c) The express provisions in the Manual contemplating that it would have a life of up to five years, thus underscoring the need for flexibility.

    (d) The important description of the real time flood model in Section 5.1 of the Manual, which suggests that what is "likely" should (at least ordinarily) be based on actual data, whereas forecasts are (at least ordinarily) relevant only to what may be "possible".

    (e) The fact that pages 22 and 23 of the Manual provide a mere outline of the strategies and cannot displace the definitive statement of them on pages 24 to 30.

    (f) A proper analysis of the definitive statement of the strategies on pages 24 to 30.

    (g) The fact that pages 22 and 23 may readily be reconciled with the proper analysis of the definitive statement of the strategies on pages 24 to 30.

74. Strictly speaking, the fact that the interpretation advanced by Seqwater is ***open*** on the language of the Manual is enough to compel its acceptance, for that is necessary to avoid defeating the purposes of the Manual and the absurd consequences that would flow from the mandatory interpretation. However, on a proper analysis of the language of the Manual as a whole, the interpretation advanced by Seqwater is more than open – it is plainly preferable.

75. Finally, there is the substantial body of uncontradicted expert evidence as to how the skilled addressee would read the Manual. All of the flood engineers spoke with one voice on this

topic. They unanimously read the document in accordance with Seqwater's interpretation. The Dam Safety Regulator, Mr Allen, expressed a view to the same effect. So too did Emeritus Professor Colin Apelt. The other peer reviewers, and Mr Babister, at least implicitly endorsed this view; they certainly did not contradict it. There is thus a substantial body of uncontradicted expert evidence in support of Seqwater's interpretation which cannot be ignored. It would be wrong to reject that evidence, especially when there is no competing body of expert evidence in support of the proposition that the skilled addressee would read the Manual as conveying the mandatory interpretation.

76. These propositions are developed below.

***Evidence as to the state of knowledge in the art***

Introduction

77. **The Commission should find that, at the time the most recent version of the Manual was approved, it was common knowledge in the art that**:

(a) **Ordinary rainfall forecasts provided by BOM, such as 24 hour QPFs, were too unreliable to be used as a basis for operational decision making as to dam releases**.

(b) **It was possible, however, that an exceptional case might arise, perhaps involving a large, stable slow moving rain depression, where BOM could provide a forecast with a high degree of confidence as to the quantitative amount of rainfall that would come from that system over the catchment area**.

(c) **There was also the prospect of scientific advances in the relatively short term which might enable BOM to provide ordinary forecasts with a higher degree of confidence than it does at present**.

(d) **If an engineer did not have flexibility under the Manual to accommodate information of the kind referred to in the preceding two subparagraphs during a flood event, that would leave the engineer in a very difficult situation**.

(e) **There is a material degree of uncertainty in all model results. By definition, models are only an approximation of reality. Even the results of run-off modelling based on actual rainfall data have a margin for error in the order of 5-10% or more. Thus model results are only tools to be used to assist in the exercise of experienced engineering judgment.**

General unreliability of forecasts

78. There was overwhelming evidence that it was well known that ordinary rainfall forecasts provided by BOM, such as 24 hour QPFs, were too unreliable to be used as a basis for operational decision making as to dam releases.

79. In a document headed "Rainfall Forecasting for the Wivenhoe Dam Catchment" dated 24 July 2006,[24] BOM provided advice[25] stating:

> On 6 July, Chris Russell, of Connell Wagner, met with Mike Bergin and Peter Baddiley seeking advice regarding the predictability of significant rain events over the Wivenhoe Dam catchment. Connell Wagner has been engaged by SEQWCo to provide advice on the feasibility of maintaining the water level in the Wivenhoe storage at one metre above Full Supply Level. **As a part of the dam operations under that scenario, it would be required that the additional storage above FSL be released ahead of a major inflow into Wivenhoe Dam. This would require some 24 to 48 hour advance prediction of catchment average rainfalls in the order of 300mm in 24 hours; 375mm in 36 hours and/or 430mm in 48 hours**.
>
> …
>
> … **the experience of Meteorologists and Hydrologists in the Brisbane office of the Bureau is that the short to medium term (0 to 48 hour) prediction of rainfall for the purpose of objective use in flood forecasting models is a difficult task**. Quantitative Precipitation Forecasts (QPF) are available from the Australian and international Numerical Weather Prediction (NWP) models and have been used subjectively in the Brisbane office for many years. Whilst the NWP models have shown improvement in the accuracy of QPF over the past decade or so, **there is still at times considerable error or uncertainty, in the prediction of the location, amount and timing of rainfall events at the catchment scale**.
>
> The improved skill of NWP models in recent years has particularly been in forecasting the development and movement of broad-scale synoptic features that would be likely to produce the threshold rainfall amounts in question. These large-scale features include decaying tropical cyclones, east coast low pressure systems and significant upper level troughs. However **while these systems maybe well forecast on a time scale of 2 to 3 days the very heavy rainfall concentrations are dependent on finer scale (mesoscale) and convective features. Whilst there is often the ability to forecast the potential for a significant rain event to occur in the southeast Qld - northern NSW region, it is difficult (if not impossible) to predict the actual location of the heaviest rain, even with only a few hours notice**.
>
> ...
>
> **Considerable effort is being applied to derive improved deterministic and probabilistic QPFs from NWP models**. In the near future, the Bureau will be providing a publicly available rainfall forecasting service via a website. The rainfall predictions will be generated automatically by combining the outlooks from a suite of Australian and international. Forecast rainfall amounts for 24 hour periods will be given for 4 days ahead, together with the chance of exceeding various amounts from 1mm to 50mm. The latter is a "pseudo" measure of probability based on the consistency in the forecast rain amounts given by up to eight NWP models used in deriving the rainfall forecast. Whilst **it is not considered that this will provide a sufficiently accurate method for objective decision making for pre-releases from Wivenhoe Dam**, the probabilistic rain forecasts may provide a basis for a risk management approach. There may need to be further studies on risk quantification for prediction of high to extreme rainfall events to support this approach. Given that there are **large levels of uncertainty in rainfall forecasts**, the forecasting of hydrological response may require an ensemble of future rain scenarios to be considered for the Wivenhoe Dam application.
>
> …

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24 Ex. 496, attachment "PB7".

25 Which was reaffirmed in December 2010: Ex. 496, attachment "PB6"; and again in Mr Baddiley's evidence to the Commission: Ex. 496, paragraphs 20-25.

> In light of the demand for water in southeast Queensland and the highly variable nature of rainfall in the area the project has many obvious attractions. **However the capability of the science to provide sufficiently reliable 24 to 48 hour advance predictions of high catchment average rainfalls is limited**.

80. This advice was unambiguously to the effect that rainfall forecasts do not provide a sufficiently accurate basis upon which to make releases from the dam ahead of actual inflows. That was because:

(a) "the short to medium term (0 to 48 hour) prediction of rainfall for the purpose of objective use in flood forecasting models is a difficult task";

(b) there is "considerable error or uncertainty, in the prediction of the location, amount and timing of rainfall events at the catchment scale";

(c) "it is difficult (if not impossible) to predict the actual location of the heaviest rain, even with only a few hours notice";

(d) there were "large levels of uncertainty";

(e) the "capability of the science to provide sufficiently reliable 24 to 48 hour advance predictions of high catchment average rainfalls is limited".

81. Indeed, Mr Baddiley's evidence was that:[26]

> The Bureau has over a long period of time advised Seqwater of uncertainty in rainfall forecasts over small space and time scales, such as for catchments.
>
> ...
>
> **The Bureau's view, and the advice which has consistently been provided to Seqwater by the Bureau**, is reflected in Seqwater's "January 2011 Flood Event Report on the Operation of Somerset Dam and Wivenhoe Dam" (Section 6.2, page 55) which states:
>
> > A number of rainfall forecasting tools were provided by the Bureau of Meteorology (BoM) and were used to inform decision-making during the January 2011 Flood Event. Seqwater understands from experience and ongoing discussions with BoM that there are always uncertainties associated with rainfall forecasts. Previous flood event reports have discussed these uncertainties. While rainfall forecasts provide an awareness of potential flood event conditions, as shown below and in previous flood event reports, the forecasts themselves do not provide a definitive basis on which to make operational decisions on releasing flood water from the Dams. Generally, the longer the forecast lead times, the higher the degree of uncertainty in the forecast.

82. The evidence of every relevant witness was consistent with this view.

83. In his statement, Mr Tibaldi referred the "well understood limitations of rainfall forecasts", and to BOM's 2006 advice.[27]

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26 Ex. 496, paragraphs 21 and 24.

27 Ex. 51, paragraph 46.

84. In his oral evidence, Mr Tibaldi said:[28]

> ... the bureau say themselves very clearly that quantitative forecasting, it is just the moment - the way the science is, they cannot give us any sort of forecast with any sort of certainty. If you are talking about quantitative forecasts. That's what they tell us. Again, I refer to Peter Baddiley's statement where he says - I have certainly had the discussion with him on many occasions. He says that that's our shared understanding and he has told us that on many occasions. And I fully agree. I am not an expert in those matters. I take the advice of experts.
>
> No, I was asking about your experience?-- Well, my experience is they're - well, they are up and down. I mean, certainly they are an indication that rain may fall but I have seen quantitative forecasts for, you know, relatively large amounts of rain and none has fallen. I have certainly experienced that, without question.

85. Mr Malone's evidence was:[29]

> I believe QPFs are prepared by BoM based upon the best available scientific knowledge.
>
> However, there are always uncertainties associated with rainfall forecasts. In general the longer the forecast lead time, the higher degree of uncertainty of rainfall, flow and dam level predictions.
>
> In my experience, QPFs are not sufficiently accurate so as to provide a basis for releasing flood waters from the dams. I have attached a paper (**Annexure TM2**) prepared by BoM in 2006 which supports this statement.
>
> In part, this is because the depth predicted is not accurate when compared with the recorded rainfall. The results from previous flood events and the January 2011 Flood Event confirm this. Further comments on this issue are set out in section 6.2 of the Somerset Wivenhoe Flood Report. I agree with those comments.
>
> The other reason why QPFs are also not sufficiently accurate is because they forecast only a depth of rain averaged across the entire catchment. They do not predict the temporal distribution (that is, how the rain is distributed in time) or the spatial distribution (that is, how widespread the rain will be or where it will exactly fall). My understanding is that there is presently no scientific tool or model available to the BoM which would allow it to make such a forecast. The temporal and spatial distribution of rain is critical to the RTFM's prediction of rainfall run-off and routing (see my comments above on these topics). By way of simple example, 50 millimetres of light rain throughout the day over cultivation in the upper reaches of the catchment will run-off and route very differently to 50 millimetres of intense rainfall in 30 minutes in the hills in and about Wivenhoe Dam.

86. Mr Ayre said:[30]

> There is a degree of uncertainty associated with the reliability of rainfall forecasts. Generally speaking, the longer the forecast period, the higher the degree of uncertainty in the accuracy of the forecast. In assessing the strategies used during any flood event, rainfall forecasts provide an awareness of potential flood event conditions but the forecasts by themselves do not provide a sufficiently reliable basis upon which to make operational decisions on releasing floodwaters from the Dams during flood events.

87. Mr Ayre also referred to a body of prior research which concluded that pre-release based upon forecasts was not a viable strategy in managing the dams.[31] That research included a report prepared by Mr Ayre in September 2001 entitled "Feasibility of Making Pre-Releases from SEQWC Reservoirs", and a separate study conducted by Connell Wagner.

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28 T457/45-T458/5.
29 Ex. 45, paragraphs 46-50.
30 Ex. 17, paragraph 203.
31 Ex. 17, paragraphs 214-221.

88. Mr Ruffini said:[32]

> Seqwater receives a 24 hour Quantitative Precipitation Forecast (QPF) from BoM for the dam catchments. This is considered to be the most robust of the current forecast products. ... there are limitations in using this information in an operational sense ... This assessment is consistent with the advice provided ... by BoM in 2006.

89. Mr Allen referred to the limits of BOM's technology and said:[33]

> ... that's one of the things we have to live with in this industry.

90. In his report, Dr Nathan referred a number of times to the known deficiencies in rainfall forecasts.[34]

91. Dr Nathan also gave evidence from which the breadth of knowledge as to the unreliability of forecasts is a clear inference:[35]

> Have you had experience of other flood mitigation dams in Australia to the extent to which they have used weather forecasts in making quantitative decisions about management of a flood event?-- I don't know of any dam owning agency in Australia that is using rainfall forecast quantitatively. We are working with one Asian city at the moment to explore whether or not that's feasible but I don't know of anyone who is actually using it.
>
> Have you had actual experience of some flood mitigation dams in Australia and the manner of which they make decisions about managing flood events?-- My expertise is more in assessing flood risk for dams rather than their operational behaviour so I don't tend to get involved in decisions around gate operations procedures. But, through my experience - as I said, I have worked in every State and Territory on numerous dams and my knowledge of both the agency operating the dam is I haven't ever had - I have never come across anyone actually using this quantitatively.

92. Mr Babister gave evidence that:[36]

> Five years ago, these tools were of limited use and their skill or ability to accurately predict rainfall was quite low.

93. On the question whether things had actually improved in the last five years to the point where forecasts should used quantitatively in making operational decisions about dam releases, Mr Babister ultimately said:[37]

> I'm really just saying they've now got to a point where we should be considering using them and working out whether they are at that point, or whether they need to get a little bit more robust before we start using them.

94. That is, Mr Babister does not assert that forecasts have been shown to be sufficiently reliable for operational decision making. Rather, he thinks that is a matter which should be investigated.

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32 Ex. 42, paragraph 86.
33 T2092/55-56.
34 Ex. 409, pages ii, 9, and 15.
35 T2300/52-T2301/13.
36 T2187/12-15.
37 T2188/35-40.

95. This evidence establishes that at the time the last version of the Manual was approved it would have been well known to the skilled addressee that ordinary rainfall forecasts provided by BOM, such as 24 hour QPFs, are too unreliable to be used as a basis for operational decision making as to dam releases. The Manual itself, at paragraph 1.3, recognises the limitations on being able to obtain accurate forecasts of rainfall during flood events. This is important because the skilled addressee, armed with this knowledge, would rail against the proposition that the Manual made it mandatory to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of rainfall forecasts.

Exceptional cases, future developments, and the need for flexibility

96. Mr Tibaldi addressed this topic in his evidence (emphasis added):[38]

> ... there are three circumstances under which you may ... assign some weight to those forecasts. None were encountered in the January 2011 flood event and the flood operations I have undertaken, I have never encountered one of these circumstances. However, the manual must account for all possibilities. So it was thought prudent to allow provision in the manual that if you encounter these circumstances the provision was there ...
>
> The three circumstances are, and this is my recollection of what was discussed ... – rainfall events that can be predicted with more certainty than others, and the example – I am not a meteorologist, so you would have to get a meteorologist to discuss this ... an **example as I understand it, might be a large, stable slow moving rain depression which a meteorologist might be able to make a judgment that ... he or she could give you a forecast with a deal of certainty as to a quantitative amount of rainfall that would come from that system over the catchment area. So if we get that advice from the bureau that says, well, yes we're giving you a QPF but its not an ordinary QPF because this system is something that's well known and something that can be predicted in advance, we would certainly give more weight to that forecast than we normally would** ... The second circumstance might be ... **we had talked to the bureau at that stage about advances in forecasting and an expectation that at some point in the future, in the short future there could be considerably more certainty attached to the forecasts that they will provide and we felt that the manual needed to account for that** ... And the third circumstance was to do with mobilisation of the flood centre, where it was thought that in terms of preparation sometimes it might be better to mobilise on the basis of a forecast ... so that ... you're in there, in the centre, you're ready, you can take whatever action is necessary and you can track the event.

97. Later, the following exchange occurred between Mr Callaghan and Mr Tibaldi:[39]

> The second of those, I suppose, is something that could happen any time in the five years between revisions of manual? Well that was the thinking. I mean, it's not a quick process because gazettal is involved and there's some legal processes there, so, I mean, its not a quick process to amend the manual, so the thought was to leave that provision in the manual that you would take into account forecast.
>
> What you wanted the manual to do was leave open room for flood engineers' discretion to have regard to advances in meteorological technology or developments? Well the experts in forecasting are the bureau ... certainly not myself. I can't speak for the other flood engineers. I'm very reliant on advice from the bureau in terms of forecasts and I certainly have heed to their advice, particularly if they were to tell me that certain forecasts they were providing, a quantitative forecast, they were providing a great deal of certainty.
>
> But you wanted that reflected in the Manual somehow, the possibility that forecasting technology could improve and that you should be able to take it into account if it did? Correct.

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38 T441/32-T443/8.

39 T444/4-32.

> And you think that's something that should be reflected in a manual of that kind? I believe so.
>
> Yes? If its not reflected and that situation arises, you are in a very difficult position.

98. In his first statement, Mr Ayre referred to his 2001 report, which:

> ... noted that if the accuracy of medium term forecasting improves sufficiently, pre-releases might become viable.

99. In his oral evidence, Mr Ayre referred to the need for flexibility,[40] and to his hope for:[41]

> ... improvements in forecast products which will provide us with the ability to contain greater reliance on them. However, at this point in time, I don't think those products have necessarily demonstrated their worth in that regard. That is just my experience.

100. In his oral evidence, Mr Ruffini said:[42]

> I think as duty engineers we have a clear interpretation about what we think we should do ...
>
> ... it is a question of where forecasts are going, too. The life of this manual is five years and I believe the forecasting, while not there today, I think is improving with time and the reliance on that, you know, in the future may be better.
>
> ... I think it is about sort of where you are today and where you are heading as well.

101. Mr Allen referred to "current technology and forecasting methodologies" and said:[43]

> The accuracy of forecasts is expected to improve over time but it may be a long time before they are of sufficient accuracy to allow great confidence to be placed in them.

102. In his oral evidence, Mr Allen said:[44]

> The Bureau, you know, is good at predicting general weather patterns but they can't model it terribly reliably on the small weather patterns that caused this event. Whereas if it was a big rain depression they would have far more reliability on it and you would be able to trust the judgment or trust the forecast a lot better.

103. This evidence establishes that at the time the last version of the Manual was approved the skilled addressee would have known that there might be exceptional cases, or scientific developments, which might result in the production of forecasts which are sufficiently reliable to be acted upon. Armed with this knowledge, the skilled addressee would be disposed to read the Manual so as to accord the flood engineers the flexibility to do that in an appropriate case.

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40 T104/45-59.
41 T121/30-35.
42 T318/31-44.
43 Ex. 397, paragraph 88.
44 T2111/2-9.

Models are only tools to assist in the exercise of judgment

104. Professor Apelt addressed this topic in his evidence (emphasis added):[45]

> Do you have a view as to what role that modelling should play in the judgment decisions made by the engineers when managing a flood event?-- Yes, yes, I do. And if I could just make - you know, an introductory comment? I have done a lot of work with modelling - not hydrological modelling, but other types, including the hydrodynamic - and I know their limitations. I have great regard for their value, but the thing that I have always tried to instruct my colleagues and students with is that models are not designed to tell you about reality. They give you a good approximation - the very best models give you a good approximation to aspects of reality, and in the use of the RTM it is about aspects of reality that might occur in the future. So they are, in my view, and virtually all modelling is intended to provide - to inform and provide an assistance to the exercise of judgment. It would be inappropriate, in general, to take the absolute numbers from a model and act on them.

105. Professor Apelt was addressing a principle of general application. It is a principle he has always "tried to instruct [his] colleagues and students".

106. The principle has a particular application in the present context.

107. It was reflected in the evidence concerning the uncertainties in the red "without forecast" line model results upon which the flood engineers rely in making their decisions about dam releases.

108. Mr Tibaldi explained them briefly in his first statement:[46]

> A model produces a prediction based on the available data. There are a number of variables or uncertainties in the input data and model parameters which mean that there is a degree of uncertainty as to the accuracy of the predicted result.
>
> One such input is the rain which is recorded as having actually fallen in the catchment. This data is subject to a number of uncertainties.
>
> Across a catchment as large as the Brisbane River basin (approximately 14,000 square kilometres) the rain gauges which record the rainfall cannot be guaranteed to always present a completely accurate picture of the intensity and distribution of rainfall.
>
> Rain is often distributed unevenly across a catchment, which gives rise to uncertainty depending upon the location of particular gauges. It is possible that rain could be falling more intensely between gauges, such that the readings might understate actual rainfall. On the other hand, rain could be falling more intensely over gauges, such that the readings might overstate actual rainfall.
>
> Further, the models have to predict how the rain that has fallen across the catchment is going to flow into the dam. This depends upon the terrain that the water has to flow through and the vegetation and land use arrangements associated with that terrain. The models predict this based on calibration to historical flows. However, vegetation and land use patterns can change over time, which can alter the way in which, and the speed with which, the water flows. Additionally, available stream height and rainfall inputs can vary between present and historical events. These issues provide another source of uncertainty.
>
> The result is that the predictions of flood models based on recorded actual rainfall probably have an average margin for error in the order of plus or minus 5%-10%. In some instances larger errors may be experienced. The results of flood models have to be interpreted with this in mind, especially when making decisions as important as transitioning to Strategy W4. In most cases, a single model run

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45 T2309/11-29.

46 Ex. 51, paragraphs 40-45.

predicting that the dam will just reach 74.00 m AHD at a particular point in the future would not be regarded as providing sufficient certainty to justify the adoption of Strategy W4. Faced with a single model run like this, you still have to ask whether the model is telling you that you really have no other option than to transition to Strategy W4. The very real risk is that you will ramp up releases and cause flooding that you did not need to.

109. Mr Malone elaborated further in his first statement:[47]

> Duty Engineers use a Real Time Flood Model (***RTFM***) to estimate likely dam inflows and predict lake levels based on those inflows less flows out of the dam that are being made or proposed to be made. Models are run regularly during flood events so that the Duty Engineers have up to date predictions of these matters.
>
> The RTFM comprises a suite of hydrologic computer programs that process real time rainfall and water level data. The RTFM is described in more detail in sections 5 and 7 of the Somerset Wivenhoe Flood Report.
>
> A key input into the RTFM (to enable it to predict likely dam inflows) is recorded rainfall data. Recorded rainfall data is the best estimate of rain that has fallen to a time. However, rain may fall intensely on certain gauges but not be widespread. Also, rain may fall in areas between gauges. The Wivenhoe catchment is over 7,000 $km^2$ and there are approximately 20 rain gauges across that area which provide data to the Flood Operations Centre. As a result, although the rain recorded in the gauges is an accurate measurement of the rain that has fallen at that point, there are limitations in using this point information to determine catchment wide rainfall.
>
> Once the rainfall data is inputted to the RTFM, the RTFM does two things.
>
> First, the RTFM runs a rainfall-runoff model to estimate how much of the gross or recorded rain is converted to excess rainfall or run-off. This depends upon a range of parameters such as how wet or dry the catchment is (initial loss) and an estimate of ongoing losses (continuing loss). At the start of the event, the initial loss is selected to match the start of rise of water level at the gauging station. During an event, the ongoing loss is regularly updated to ensure that the model is matching the recorded water level responses.
>
> Secondly, the RTFM routes the excess rainfall generated by the rainfall-runoff model through the catchment to the outlet. By this I mean the RTFM predicts how long it will take for runoff that has generated in a particular area to travel downstream to the dam and in what shape (for example, as a steady flow or as flows with peaks) this response takes. The shape can be demonstrated in graphical form as a hydrograph.
>
> In making these predictions, the RTFM, like all hydrologic models, is not perfect and is not precise. The model is modelling the behaviour of the catchment to rainfall and is attempting to provide an approximate result to the natural processes where rain is falling across a very wide catchment and is running off across a range of different terrains, vegetation and soil types (for example, uncleared land, cultivation and roads).
>
> ... Strategy W4 is only invoked when the RTFM predicts, based on actual rainfall and with some certainty, that the Wivenhoe Dam level will exceed EL74.0 (that is, when the red line on page 73 of **Annexure TM1** reaches EL74.0).
>
> Even then, care needs to be exercised not to prematurely invoke Strategy W4.
>
> Strategy W4 necessarily means moving to a release rate where urban areas below the Dam will be adversely affected.
>
> Given the model is simply a predictive tool, and is not exact, my opinion is that there needs to be a high degree of confidence in the predictions being made by the model before Strategy W4 is invoked.
>
> I would not move to invoke Strategy W4 based on one model run predicting a lake level slightly in excess of EL74.0. I would require a firm indication that the lake level will greatly exceed EL74.0 or additional consecutive runs which confirm the lake level would just exceed EL74.0 and generally

[47] Ex. 45, paragraphs 35-41 and 52-56.

> consider things such as trends in the model results and any rapid deterioration in the weather in the catchment.

110. This evidence establishes that at the time the last version of the Manual was approved the skilled addressee would have known that the modelling contemplated by the Manual is a mere tool to be used to assist in the exercise of judgment. Armed with this knowledge, the skilled addressee would be disposed to read:

(a) the Manual so as to give primacy to the judgment of the engineers, and to consign the model results to their proper (subordinate) function of assisting in the exercise of that judgment;

(b) terms in the Manual such as "likely" or "predicted" as embodying a qualitative professional engineering judgment as to what is truly "likely" or what is "predicted" with an appropriate degree of certainty.

***How those skilled in the art would read the Manual***

111. **The Commission should find that there is a substantial body of uncontradicted expert evidence that the skilled addressee would read the Manual in accordance with Seqwater's interpretation**.

112. Mr Tibaldi expressed the matter clearly in his evidence (emphasis added):[48]

> I think I just need to give a bit of background here because I think just jumping in and focusing in on a few words is really not, you know, giving all that information ...
>
> ... you will notice there is two parts to 8.4. You will notice there is the paragraph you have referred to which talks about getting all your information together before you make a decision, and a key part of that information is forecast rainfall, okay? ... essentially what that paragraph you are referring to is saying in the three dot points below is, right, at the start of the decision making process let's get our information together and let's produce some graphs that would be similar to what is seen in Appendix A to the flood report. Okay? So Appendix A of the flood report has an actual rainfall line, a forecast rainfall line, and a stream flow rainfall line. The stream flow is obviously the historical stuff. So **the first thing you do in your decision making process is get that together** and what we're saying in that paragraph, the intent of it, is that all those things – if you want to make the best decision possible, **you need to use all those things. Then it comes down to the weight ... you will assign to the forecasts, and I think that's really the key question. The manual allows you to assign a zero weight to a forecast if you wish. The weight you assign to a forecast will depend upon the reliability of that forecast as provided by BOM** ... and I refer to Peter Baddiley's statement, senior hydrologist with 30 years' experience at the bureau, who said in his statement that's been supplied to the Commission there is great uncertainties with the quantitative forecasts and they are not suitable for operational decision making ... So what I'm saying is, yes, the intent of that paragraph is to **consider forecasts, but if we read on through here we will see that the manual actually gives you the ability to apply a weight to those forecasts and the general forecasts we get from BOM we're applying zero weight in terms of our operational decision making** ... if you go to **the flowchart, which is where you ... apply the weight** ... The flow chart is on page 23 and the sentence prior to the flowchart says "**A flowchart showing how best to select the appropriate strategy" previously we have got all our information together , now we're coming to the stage where we're going to select the appropriate strategy** ... you will **notice in the flowchart the forecast is not mentioned at all, but the engineer has to choose the strategy to make an engineering judgment or a judgment about what is likely**. He is asked essentially two questions

[48] T439/45-T441/31.

> about what is likely. The first question is about the likely level in Wivenhoe Dam. Again **he has got to make a judgment on what is likely. He can assign whatever weight his judgment feels worthy in terms of the forecasts. Now, as I said, generally the great uncertainties in the QPF as provided by BOM, no weight is provided to those forecasts**.

113. Mr Callaghan then asked Mr Tibaldi about the inclusion of "a form of words ... to clear up doubt about the sorts of things to which you might have regard", prompting the following exchange:[49]

> ... any suggestion of the way in which we could clarify the use of forecasts so that its clear in everyone's mind would be beneficial, no doubt about it, and obviously there is some confusion about it, not amongst the flood engineers I believe, but amongst others.
>
> That's clear enough, I think, so far as you're all concerned, you are all of one mind as to what it meant. It is when the rest of us start looking at it that the problems start; do you agree with that? Yes I do.

114. Mr Callaghan and Mr Tibaldi thus agreed that there is no doubt or disagreement amongst the flood engineers as to how they read the Manual. That is plainly correct.

115. Mr Ayre was challenged by Mr Callaghan about the meaning of pages 22 and 23 of the Manual (emphasis added):[50]

> Yesterday I took you to paragraph 8.4 of the manual .... and I suggested to you that as it reads it requires that one of the things which must inform the choice of strategy is a prediction as to the level of Wivenhoe dam using the best forecast rainfall at the time? Yes, I recall.
>
> All right. And I made the suggestion to you – or I will make it now – that your approach was a departure from that which is required by the Manual? I don't believe necessarily so. **The Wivenhoe flood strategy flowcharts on page 23 actually points to the Wivenhoe level likely to exceed EL 74. It doesn't necessarily specify what basis that's made on**.
>
> Yes, that's true? **And so an interpretation of the Manual, I think, using that flowchart fits with the approach that the flood engineers use**.

116. Thus, Mr Ayre pointed to the term "likely", and noted that it gives the engineers the scope to decide the basis upon which they will determine what is likely.

117. Next, the following exchange occurred with Mr Malone:[51]

> ... can I take you specifically to 8.4 of the manual on page 22? ... Would you agree that that passage seems to suggest at least that the forecast rainfall should be used in predicting the level of the lake for the purposes of choosing the appropriate strategy? My understanding is that we would base the current strategy of recorded rainfall ...
>
> Yes? And the future strategies and where we might get to on the forecast rainfall.

118. Mr Malone plainly considers that the engineers' current approach was within the discretion accorded to the engineers under the Manual.

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49 T444/43/66.
50 T101/55-T102/13.
51 T374/36-55.

119. Mr Callaghan did not challenge Mr Ruffini on his reading of the Manual.

120. The unanimous view of the flood engineers also accords with the view expressed by Professor Apelt:[52]

> It is section 8.4 of the manual. And the first part of that states very clearly the objectives and it also states very clearly that consideration is always to be given to these objectives in descending order, and that, I take, as defining the statement about what's to be done. The strategies then are chosen to achieve those objectives but the appropriate choice of the strategy is going to depend on what is stated there on that middle paragraph, "depend on the actual levels in the dams and the following predictions which are made using the best forecast rainfall and stream flow information available at the time." So **the strategy depends on all of those things, and in my view all that has to be taken into account** before - and the specific matters are itemised there in the three dot points. The general understanding I have from that manual is that **once you have crossed a threshold level, you must implement that strategy, but whether you actually implement the strategy a little bit before on the basis of forecasting is left to the judgment and the interpretation of the people operating the dams**. And the only very specific statement about dam levels is on page - relating to strategy W4 which - okay, the - under the box there, the intent of the strategy - sorry, **"The strategy normally comes into effect when the water level in Wivenhoe Dam reaches 74.0 metres." That's a very clear statement, in my view, and that's the definitive one in terms of making that very serious transition into W4**. There is a provision which requires the implementation of the powers of discretion, through section 2.8, to act before that, but the - the situation then is are you certain that you are going to cross 74.0, then you must invoke W4, and "certain" becomes "sometimes" only when you have actually passed 74 but in the case of this event there was a whole accumulation of information just before that situation, which indicated, "Yes, we're going to cross 74, we should start acting." And **the manual is written by engineers for engineers**, and it draws - tries to draw on the experience of people who have operated the dam and it is the best effort of the people involved to actually set down that experience to guide future operations.

121. The proposition that the particular use to be made of forecasts is left to the judgment of the engineers was also affirmed by Mr Allen:[53]

> Because the forecasts aren't precise you have to use some judgment in what, sort of, recognition you give those forecasts and work out how you are going to pass the event.
> ...

122. A little later, the following exchange occurred:[54]

> Dealing with forecasts, you discuss this in several passages in your witness statement. I have noted down 84, 87 and 140(b). Do I gather the thrust of your opinion is that the extent to which engineers, dam engineers, should rely on forecast rainfall in making operational decisions is best left to the engineers on duty at the time?-- Yes, it is very hard to make a hard and fast rule prior to the event. The flood engineers have access to the Bureau of Meteorology forecasters, they go and talk to those guys and get a feel for what confidence they place in those forecasts. They are the best positioned to be able to do that. You can't do that remotely for, you know, any potential event in the future.

123. The other peer reviewers, and Mr Babister, at least implicitly endorsed this view; they certainly did not contradict it.

124. Indeed, Mr Babister recognised that the particular use to be made of forecasts was “a complex judgment call” for the engineers.[55]

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52 T2308/11-50.
53 T2110/54-56.
54 T2111/14-27.
55 T2176/30-33.

***Purpose and consequences***

125. **The Commission should find that an interpretation of the Manual which rendered it mandatory to make decisions to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of the information contained in rainfall forecasts would**:

(a) **defeat the express purposes of the Manual**; **and**

(b) **have consequences that are characterised properly as absurd**.

126. There was overwhelming evidence of the dangers associated with the mandatory interpretation which would, for example, compel the flood engineers to move to Strategy W4:

(a) at a time when the safety of the dam was not even close to being in jeopardy;

(b) so as to inundate urban areas, when that was plainly unnecessary.

127. The point was addressed in Mr Ayre's oral evidence:[56]

> Let's say that Counsel Assisting the Commission though is there, he's standing in the room with you, and he's pointing to that blue line and saying, "Time to move to W4." Let's just assume that for the moment. You're the senior engineer, it's your call?-- Yes, I would resist the suggestion, because I wouldn't think it was appropriate at that stage, given that the lake level was still at 69.10 metres.
>
> Would you take into account the consequences if you then moved to the W4 strategy?-- The consequences would be very significant, yes.
>
> Let's think about those for a moment. If we look at the manual as to what it tells us is to happen under a W4 strategy - I am looking at page 29 - about halfway down the page, under the paragraph commencing, "Under Strategy W4.", "The release rate is increased as the safety of the dam becomes a priority.", and then the next statement rather suggests the opening of the gates is to occur until the storage level at the Wivenhoe Dam begins to fall?-- Yes.
>
> Now, as you would apply that in practice, does that mean you increase the gates until the outflows exceed inflows?-- Yes.
>
> Now, if we look at the inflows to Wivenhoe Dam on this Sunday evening, if we go back to the Flood Report page 157? Can you tell us what the inflow was at the time?-- The inflow at 9 o'clock? 8 o'clock, I think it was?-- Oh, 8 o'clock when the model run was down was 7,338 cubic meters per second.
>
> So, you would have to increase the releases until you had reached that figure or at least until that figure diminished below the release level?-- Yes, that's correct.
>
> If you had began opening the gates up to release that sort of rate on the Sunday evening, given the flows from Bremer and Lockyer into the Brisbane River, can you give us some idea of what might have been the consequences in Brisbane?-- I believe very significant flooding would have occurred in the lower reaches of the Brisbane River due to the combination of the releases and the downstream tributaries.
>
> So, does that mean water over people's floors?-- I believe it would be certainly a major flood in Brisbane.

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[56] T248/11-T249/32.

> The maximum release date from Wivenhoe in the January '11 period was about seven and a half thousand CUMECS, wasn't it?-- Yes.
>
> So, you would be looking for release rates close to that?-- We're - just looking at the inflows, they don't peak until 8 a.m. on the Monday morning, so I would expect actually the release rates to be somewhere between 7,000 and, indeed, 10,000 cubic meters per second.
>
> What would you say to residents of Brisbane who came to you and said, "Well, you flooded my house, but you didn't need to. Wivenhoe was still five metres below the 74 level. You flooded my house on a forecast that the rain might not fall, it might not fall as much as the Bureau has said, might fall else where."?
>
> COMMISSIONER: That's a rhetorical question, is it, Mr O'Donnell?
>
> MR O'DONNELL: I am inviting a response from Mr Ayre.
>
> COMMISSIONER: Well, what would you say?-- Well, I'd have to agree, there's no guarantee that rainfall in a forecast would necessarily occur in terms of the depth or the location that's been specified.
>
> MR O'DONNELL: Would you say that this highlights the dangers of moving to a strategy like W4 based upon a forecast?-- Yes, I do believe that's the case.

128. Mr Ruffini said:[57]

> ... you just need to understand that sometimes a strategy like that will go horribly wrong. You know, in a case where you will open up and the rain, instead of falling there will go south and fall over Brisbane, and the release that you have just ramped up - the release that you have increased a day before will end up coinciding with rain that falls on Brisbane, and that's just the nature of the quality - the nature of the forecasts at this stage, point in time.
>
> They are the same sort of risks-----?-- That's right.
>
> -----that you juggle at the lower level strategies, aren't they? That's the same sort of risk that you might run when exercising your discretion at W1, just that the stakes are higher if you are exercising-----?-- That's right, the stakes are high and the consequences of forecasts not going your way are higher as well, yeah.

129. Mr Tibaldi referred to a strategy which required forecasts to be followed and said:[58]

> It would be a high risk strategy, in my opinion, and you would certainly run a risk of, you know, causing a lot of urban damage when that was unnecessary. It would be very risky. My knowledge of forecasts, it is not something I would endorse.

130. Mr Allen referred to a formula which required forecasts to be discounted but then acted upon and said:[59]

> Yeah, you can potentially do that but you are going to have to do it with great care because you don't want to lock yourself into an event like the '99 event where we had 7,000 cubic metres a second coming in and the forecasters might have been predicting - I don't remember the actual details of the event but the forecasters might have been predicting more rain to come and you would have had to have then made some more releases which would have gone above the 1800 cubic metres a second we were releasing and then the rain didn't come. So by relying on the forecasts, and if they don't happen, you are then caught by creating damage or inconvenience that you didn't necessarily have to cause.

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57 T317/16-33.
58 T458/15-19.
59 T2111/32-50.

131. As Mr Tibaldi pointed out in his third statement, the application of the mandatory interpretation involving pre-releases based on forecasts would:

(a) likely have resulted in urban areas being inundated unnecessarily in events in March 1989, April 1989, February 1999, October 2010 and December 2010;

(b) inevitably increase the risk of more frequent flood damage to people's homes and commercial buildings in urban areas.[60]

132. An interpretation which requires the relatively frequent inundation of people's homes and commercial buildings in urban areas on the basis of forecasts when that may not be necessary (indeed, when it is in fact not necessary in most cases) would defeat the purposes of the Manual and is characterised properly as absurd.

***A proper analysis of the Manual as a whole***

Objectives

133. The operational procedures defined in the Manual were designed to meet the five identified objectives, which have an express order of importance.[61]

134. The procedures must therefore be interpreted having regard to the objectives they were intended to meet.

135. It would do great violence to the objectives of the Manual to arrive at an interpretation which made it mandatory to release additional volumes of water from the dam, or to transition from one strategy to the next, on the basis of information contained in rainfall forecasts.

136. That interpretation would, for example, result in it being mandatory to move to Strategy W4:

(a) at a time when the safety of the dam was not even close to being in jeopardy;

(b) so as to inundate urban areas, when that was plainly unnecessary.

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60 Ex. 53, paragraphs 10-20.

61 Section 1.1 and Section 3.1.

Express recognition of limitations of forecasts

137. It is made clear early in the Manual that it was drawn recognising "limitations on being able to ... obtain accurate forecasts of rainfall during flood events".[62]

138. This is relevant in at least two respects:

(a) It is unlikely that the intention of the Manual was to make it mandatory for the flood engineers to follow forecasts blindly when the Manual itself recognised expressly that those forecasts were problematic in terms of their accuracy.

(b) Further, its focus is upon limitations recognised to exist ***as at the date the Manual was drawn***. This leads to the next point.

The expected life of the document and the need for flexibility

139. The Manual was expected to be applicable for a period of up to five years.[63]

140. This suggests a need for a degree of flexibility to accommodate developments which may occur during the life of the Manual.

141. That flexibility is provided, relevantly, by entrusting the use (or otherwise) of forecasts to the professional engineering judgment of the flood engineers.

142. On Seqwater's interpretation, should the accuracy and reliability of forecasts suddenly improve, or should BOM advise that a particular forecast is sufficiently reliable to be acted upon, the flood engineers would be at liberty to act. Equally, absent any such development or advice, the flood engineers are at liberty to refrain from acting. The issue is one entrusted to their judgment.

143. Whilst there is provision for amendment of the Manual during its life,[64] that involves a process which may be expected to take time – time which the flood engineers would not have if the development were to occur immediately prior to or during an event.

144. Thus, as Mr Tibaldi said, if you do not have the requisite flexibility "and that situation arises, you are in a very difficult position".[65]

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62 Section 1.3, first dot point.
63 Section 1.6 and Section 7.5.
64 Section 1.8.
65 T444/5-33.

145. Given the Manual's own recognition of the unreliability of forecasts (para. 1.3), an interpretation which would force flood engineers to make decisions based on forecasts seems improbable. A more reasonable interpretation is that the Manual, and in particular part 8.4, was requiring the flood engineers to consider forecast rainfall, but was leaving to the flood engineers an exercise of judgment as to what weight to give to forecasts in the circumstances of a particular flood event.

The Real Time Flood Model and the distinction between "likely" and "possible" scenarios

146. There is an important description of the modelling system used in flood operations, which distinguishes between "likely" and "possible" scenarios (emphasis added):[66]

> A real time flood monitoring and forecasting system has been established in the dam catchments. This system employs radio telemetry to collect, transmit and receive rainfall and stream flow information. The system consists of more than 100 field stations that automatically record rainfall and/or river heights at selected locations in the dam catchments. Some of the field stations are owned by Seqwater with the remainder belonging to other agencies.
>
> The rainfall and river height data is transmitted to Seqwater's Flood Operations Centre in real time. Once received in the Flood Operations Centre, **the data is processed using a Real Time Flood Model (RTFM) to estimate likely dam inflows and evaluate a range of possible inflow scenarios based on forecast and potential rainfall in the dam and catchments**. The RTFM is a suite of hydrologic and hydraulic computer programs that utilise the real time data to assist in the operation of the dams during flood events.

147. The emphasised part of this passage distinguishes between:

(a) "likely dam inflows" – which are estimated from the actual rainfall and stream flow data collected from the field stations and transmitted to the Flood Operations Centre in real time;

(b) "possible inflow scenarios" – which are based on "forecast and potential rainfall in the dam and catchments".

148. This is important because it suggests that the Manual is proceeding on the basis that what is "likely" should (at least ordinarily) be based on actual data, whereas forecasts are (at least ordinarily) relevant only to what may be "possible".

149. Indeed, the name given to the model, the Real Time Flood Model, suggests that its primary purpose is to conduct modelling based on the actual data it receives in real time. This provides further support for the notion that the results that will primarily (or ordinarily) be used are those based on the actual data.

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66 Section 5.1.

Pages 22 and 23 are an outline and cannot displace the definitive statement on pages 24 to 30

150. As is apparent from the first sentence in Section 8.4, pages 22 and 23 merely provide an outline of the four strategies. The strategies themselves are stated more fully, and definitively, from pages 24 to 30.

151. It would be wrong to read the outline of the strategies as though it were a definitive statement of them – the definitive statement plainly appears in the later pages. *A fortiori* it would be wrong to read one part of the outline in isolation (viz. the passage on page 22, divorced from the flowchart on page 23) as though it were a definitive statement of the strategies.

152. Further, it would be wrong to read the definitive statement in the later pages as subordinate to the outline. If there were a real tension between the two (which, for the reasons developed below, there is not), precedence would have to be accorded to the definitive statement.

A proper analysis of the definitive statement of the strategies

153. Strategy W1,[67] Strategy W2,[68] Strategy W3[69] and Strategy W4[70] are all stated expressly to be conditioned on, inter alia, what the "Wivenhoe Storage Level" is "***predicted*** to be".

154. Pages 24 to 30 do not prescribe in mandatory terms the nature or quality of the prediction which will fulfil the condition. They do not render it mandatory to place reliance upon predictions made on a particular basis. However, the Manual does provide guidance in this regard.

155. Predictions, by their nature, may be made with varying degrees of assurance. They may, for example, convey that an outcome is:

(a) possible;

(b) likely;

(c) probable;

(d) highly probable; or

(e) certain.

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67 Page 24, first dot point under heading.
68 Page 27, first dot point under heading.
69 Page 28, first dot point under heading.
70 Page 29, first dot point under heading.

156. There are strong indications in the Manual that the selection of strategies should depend upon a prediction as to what is, at the very least, regarded properly as being "likely".

157. The outline on pages 22 and 23 contains express language to this effect. The final sentence on page 22 introduces the flowchart that follows on page 23 by stating that it shows "how best to select the appropriate strategy at any point in time". The boxes in the flowchart then frame questions expressly in terms of what is "likely".

158. In the context of Strategy W4, page 29 of the Manual relevantly provides (emphasis added):

> **Conditions** • **Wivenhoe Storage Level predicted to exceed 74.00 m AHD**
>
> ...
>
> **The intent of Strategy W4 is to ensure the safety of the dam while limiting downstream impacts as much as possible**
>
> This strategy **normally comes into effect when the water level in Wivenhoe Dam reaches 74.0 m AHD**. However, the Senior Flood Operations Engineers may seek to invoke the discretionary powers of Section 2.8 if earlier commencement is able to prevent the triggering of a fuse plug.
>
> Under Strategy W4 the release rate is increased as the safety of the dam becomes a priority. 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.
>
> **There are no restrictions on gate opening increments or gate opening frequency once the storage level exceeds 74.0 AHD**, as the safety of the dam is of primary concern at these storage levels. However, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered when determining gate opening sequences.

159. At various points during the public hearings, it seemed to be suggested that there was an inconsistency between:

(a) the condition that the storage level be "***predicted to exceed*** 74.00 m AHD" as referred to in the first dot point; and

(b) the explanatory statement that the "strategy normally comes into effect ***when the water level in Wivenhoe Dam reaches*** 74.0m AHD."

160. There is no such inconsistency. As to this:

(a) The condition in the first dot point focuses upon the level ***exceeding*** 74.0 m AHD.

(b) The explanatory statement focuses upon the level ***reaching*** 74.0 m AHD.

(c) Obviously, merely ***reaching*** 74.0 m AHD does not equate to ***exceeding*** 74.0 m AHD.

(d) However, if the level does ***actually reach*** 74.0 m AHD (and it is still raining) one may ***predict*** with a high degree of assurance that the level will ***exceed*** 74.0 m AHD.

(e) In this way, the explanatory statement bears directly upon the degree of assurance which the ***prediction*** referred to in the first dot point should carry before a decision is made to invoke Strategy W4.

(f) The explanatory statement thus gives content to, rather than contradicts, the meaning of the term "***predicted***" as it is used in the first dot point.

(g) It suggests clearly that, on the scale of predictions, we are concerned with those at the end where the degree of assurance is very high.

161. So understood, the explanatory statement does not make it mandatory to wait until the lake level reaches 74.0 m AHD.

162. Rather, it merely states that ***normally*** a prediction that the lake level will ***exceed*** 74.0m AHD should only be regarded as having the requisite degree of assurance when the lake level ***actually reaches*** 74.0 m AHD, thus suggesting a degree of assurance approaching certainty.

163. This interpretation is amply justified by reference to the known consequences of invoking Strategy W4.

164. Under Strategy W4, the primary objective is no longer protection of urban areas from inundation; rather, it is protecting the structural safety of the dam. And as the second paragraph of the passage from page 29 set out above suggests, Strategy W4 requires outflows to be increased until the dam level begins to fall, which necessarily means:

(a) increasing flows beyond those permissible under Strategy W3;

(b) causing urban damage.

165. A decision with such grave consequences should not be made unless absolutely necessary. This obvious proposition in turn suggests that the decision should be based on a predication carrying a very high degree of assurance. Equally, such a decision should not be made on the basis of mere possibilities.

166. In these circumstances, a proper analysis of the definitive statement of the strategies leads to the following conclusions:

(a) They depend upon predictions.

(b) They do not render it mandatory to place reliance upon predictions made on a particular basis.

(c) Rather, they leave this to the professional engineering judgment of the flood engineers.

(d) The Manual does, however, provide important guidance to the flood engineers in this regard.

(e) That guidance relevantly includes:

(i) (from pages 22 and 23) that decisions should be made on the basis of predictions as to what is, at the very least, regarded properly as being "likely".

(ii) (from page 29) that the decision to invoke strategy W4 should be made on the basis of a prediction carrying a very high degree of assurance.

(iii) (from Section 5.1 concerning the RTFM) that what is "likely" (or more than likely) should (at least ordinarily) be based on actual rainfall and stream flow data transmitted to the Flood Operations Centre in real time.

(iv) (from Section 5.1 concerning the RTFM) that forecasts are (at least ordinarily) relevant only to what is "possible", and therefore would not (at least ordinarily) carry the degree of assurance required to justify a decision to release additional volumes of water from the dam, or to transition from one strategy to the next.

Pages 22 and 23 may readily be reconciled with this analysis

167. A proper analysis of the outline on pages 22 and 23 accords with Seqwater's interpretation.

168. The passage on page 22 to which attention has been directed is in the following terms (paragraph numbers have been inserted so as to facilitate analysis):

> [1] The strategy chosen at any point in time will depend on the actual levels in the dams and the following predictions, which are to be made using the best forecast rainfall and stream flow information available at the time:
>
> - 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).
>
> [2] Strategies are likely to change during a flood event as forecasts change and rain is received in the catchments. It is not possible to predict the range of strategies that will be used during the course of a flood event at the commencement of the event. Strategies are changed in response

> to changing rainfall forecasts and stream flow conditions to maximise the flood mitigation benefits of the dams.
>
> [3] When determining dam outflows within all strategies, peak outflow should generally not exceed peak inflow. A flowchart showing how best to select the appropriate strategy to use at any point in time is shown below:

169. Paragraph [1] identifies the information upon which strategy choice is said to "depend".

170. The information comprises "***actual dam levels***" and "***predictions***".

171. The reference to "***actual dam levels***" fits neatly with:

(a) the references on pages 25 and 26 to lake levels under Strategies W1A, W1B, W1C, W1D and W1E;

(b) in respect of Strategies W2 and W3, the statement on page 26 that:

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

(c) in respect of Strategy W4, the explanatory statement on page 29 that:

> This strategy normally comes into effect when the water level in Wivenhoe Dam reaches 74.0 m AHD.

172. These are all references to actual lake levels.

173. The "***predictions***" which "are to be made" are of two different kinds:

(a) ***first***, there is a prediction "using the best forecast rainfall ... information available at the time"; and

(b) ***secondly***, there is a prediction "using the best ... stream flow information available at the time".

174. It will be observed that this corresponds with the information which the flood engineers actually collate in practice.

175. Importantly, paragraph [1] does not:

(a) Identify precisely how strategy choice might "depend" on this information.

(b) Prescribe (in mandatory terms or otherwise) how this information is to be used.

(c) State any preference for one category of information over another.

(d) Prescribe the relative weight to be accorded by the flood engineers to the different categories of information.

176. In these circumstances, the flood engineers cannot be accused of failing to comply with the Manual merely because, in the exercise of their professional engineering judgment, they preferred one category of information over another.

177. Moreover, it is important here to appreciate the logical difficulty with an interpretation that renders it mandatory to make additional releases from the dam, or to transition from one strategy to the next, on the basis of rainfall forecasts. The difficulty arises because, if it is mandatory to act on forecasts, it is also mandatory to act on stream flow information. Yet these two bodies of information will often dictate different actions. For example, a forecast may require transition to Strategy W4 and unconstrained releases producing flows well above 4,000 $m^3$/s at Moggill, whereas the stream flow information may require releases to be constrained within Strategy W3 so that the flows are kept below 4,000 $m^3$/s at Moggill. It would be impossible for the flood engineers simultaneously to obey these inconsistent commands. This conundrum cannot have been intended. And upon a sensible reading, it may readily be avoided.

178. Upon a proper analysis, paragraph [1] serves only to require the collection of the different categories of information so that the flood engineers will then have before them an appropriate suite of information upon which to base the professional engineering judgments they are required to make in the course of flood operations.

179. Paragraph [2] does not alter this conclusion.

180. The paragraph commences with a statement as to when strategies "are ***likely*** to change". It is not concerned to dictate when they ***must*** change.

181. As is apparent from the second sentence, the paragraph is plainly designed to emphasise that flood events are, by their nature, fluid and unpredictable and so require strategies to be revisited and changed throughout the event.

182. Although it refers to strategies being changed "in response to changing rainfall forecasts and stream flow conditions", it does not:

(a) Identify precisely how the change is to be made in response to these two different categories of information.

(b) Prescribe (in mandatory terms or otherwise) how this information is to be used.

(c) State any preference for one category of information over another.

(d) Prescribe the relative weight to be accorded by the flood engineers to the different categories of information.

183. Again:

(a) In these circumstances, the flood engineers cannot be accused of failing to comply with the Manual merely because, in the exercise of their professional engineering judgment, they preferred one category of information over another.

(b) The mandatory interpretation gives rise to the logical difficulty referred to above, viz. requiring the flood engineers simultaneously to obey inconsistent commands.

184. Thus, upon a proper analysis, paragraph [2] serves only to ensure that the flood engineers update their information, and reassess their professional engineering judgments, regularly throughout the event.

185. Then we come to paragraph [3]. Here we see, for the first time in the passage with which we are presently concerned, reference being made to "how best to select the appropriate strategy".

186. We are thus travelling beyond the information which has been collected, and into the realm of how that information is best used in selecting the appropriate strategy.

187. It is relevant to note that, even here, the language is not mandatory. The paragraph refers to how selections are "best" made, rather than how they ***must be*** made. The concept appears to be one of guidance, rather than the imposition of a straitjacket.

188. Next, we come to the flowchart. As has already been observed, the critical questions in the flowchart are couched in terms of what is "***likely***". The significance of this, including its interaction with the description of the RTFM in Section 5.1, has been outlined above. Here again the Manual provides guidance. However, the question of what is "***likely***" is one ultimately left by the Manual to the professional engineering judgment of the flood engineers. In the exercise of that judgment, the flood engineers can decide what (if any) weight they are going to accord to the different categories of information assembled before them.

189. This interpretation of pages 22 and 23:

(a) is plainly open (indeed preferable) having regard to the structure and language of those two pages;

(b) should be preferred because it accords with, rather than contradicts, the interpretation which flows from a proper analysis of the balance of the document;

(c) should also be preferred because it reflects the point of view of the skilled addressee, and the substantial body of uncontradicted expert evidence as to how the skilled addressee would read the document.

## PART V
## USE OF FORECASTS

### INTRODUCTION

190. **The Commission should find that**:

(a) **Every model run included predictions based on forecasts (or a scaled up quantity based on forecasts). Those "with forecast" predictions were evidenced by the blue line in the model results**.

(b) **The flood engineers did not decide to make additional releases, or to transition from one strategy to the next, on the faith of the blue line in the model results. For this purpose, the blue line was accorded zero weight**.

(c) **However, forecasts were not ignored. In fact, they were considered and used in a number of different ways during the event**.

(d) ***First*, they were taken into account by the flood engineers in assessing where the event may be heading, and which strategies may have to be engaged, over the coming hours and days. The flood engineers used them to maintain an awareness of the possibilities for the short term future**.

(e) ***Secondly*, they were used as a basis for providing advance warning for emergency planning purposes. Armed with an awareness of the possibilities, the flood engineers conveyed that information in their situation reports so that the recipients could respond as appropriate**.

(f) ***Thirdly*, during the period from about 9pm on Sunday, 9 January 2011, forecasts were showing the weather system moving in a southerly direction, with significant rainfall expected in the downstream catchments. This continued into Monday, 10 January 2011, when the devastating flash flooding occurred in the Lockyer. A material consideration for the flood engineers during this period was the need to avoid additional releases from the dam coinciding with significant flows from downstream catchments. The forecasts were taken into account in deciding to refrain from making additional releases from the dam at this time**.

(g) ***Fourthly*, on the morning of Tuesday, 11 January 2011, Mr Malone communicated with BOM for the specific purpose of confirming that, according**

**to BOM's best forecast information, the rain was likely to continue such that there was indeed no choice but to invoke Strategy W4. Thus BOM's forecast information contributed to the most serious decision made by the flood engineers during the flood event**.

(h) **The use which the flood engineers made of forecasts was in accordance with:**

(i) **sound practice; and**

(ii) **the Manual**.

**ANALYSIS**

191. The flood engineers uniformly collated information comprising:

(a) actual dam levels;

(b) predictions using the best forecast rainfall information available at the time;

(c) predictions using the best stream flow information available at the time.

192. This is apparent from Ex. 22.

193. The "with forecast" predictions were evidenced by the blue line in the model results.

194. However, it is important to appreciate that during the event there were greater than usual difficulties with the forecasts. Mr Tibaldi's evidence on this topic is set out below. For present purposes the point is that during the event the QPFs proved to be so unreliable that the blue "with forecast" line could not actually be modelled on them. At critical times, forecasts for the next 24 hours were being exceeded by actual rainfall within a matter of a few hours. Thus the models had to be scaled up arbitrarily in an endeavour to keep up with the rain that was actually falling.

195. Each of the flood engineers gave evidence as to their general approach to the use of "with forecast" predictions.

196. In his statement, Mr Tibaldi said:[71]

> The purpose of running models on the "with forecast" basis is to give us an idea of what is possible over coming days so that we can see whether we might have to get into the next strategy at some point in the next few days, and so that we can provide advance warning to Councils and other agencies as to how serious the situation might become in the next few days. That advance warning as to what might happen

[71] Ex. 51, paragraph 47.

> in the next few days assists in emergency planning which might, for example, involve the closure of roads or the mobilisation of emergency resources.

197. In his oral evidence, Mr Tibaldi said:[72]

> ... the general forecasts we get from BOM we're applying zero weight in terms of our operational decision-making.

198. Later, he said:[73]

> ... certainly you are aware of the forecasts, you might be aware of the movement of the systems, but in terms of your strategy selection, you're applying very little weight, often zero weight, in my case always zero weight, to the QPF because of the uncertainties.

199. Finally, having confirmed that he gave forecasts no weight in making decisions about release rates,[74] Mr Tibaldi said:[75]

> ... you always have an awareness of the forecasts. I think you would - I think you would be not making the best decision you could if you had no awareness of the forecasts and what the manual is encouraging you to do is have a look at the forecasts and see where they're taking you. Certainly we had an understanding of where the forecasts were saying the system might head.

200. In his statement, Mr Malone said:[76]

> By including forecast rainfall in the RTFM the Duty Engineers are provided with an idea of where the event might be heading. This information is then used to forewarn agencies about the steps they should be taking in readiness to deal with the event, should the rain which is forecast actually be received.

201. In Mr Malone's oral evidence, the following exchange occurred with Mr Rangiah SC:[77]

> ... generally the Bureau of Meteorology forecasts are not used when making decisions about the appropriate release rates?-- Well, they are considered but not used explicitly. I mean, you don't make releases in the short term based upon forecast rainfall for the next 24 to 48 hours, no.

202. Mr Malone explained:[78]

> That forecast rainfall may be impacting on the areas downstream of the dam, so we would have to take that into consideration. It is not just the dam that we're operating for, it is the mitigating downstream areas, too. So the forecast rainfall may be important to those downstream areas.
>
> So you say you do take into account forecast rainfall in making decisions as to the level of releases?-- Depending on the circumstance. It depends on the circumstances. If the forecast rainfall is for areas downstream, by releasing earlier you might make things worse. So it is a balancing act.

203. Mr Malone was making an important point here. Depending upon the circumstances, forecasts may be used:

(a) not as an ***affirmative criterion*** which leads the engineers to make additional releases; but

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72 T440/56-58.
73 T443/10-15.
74 T449/30-35 and T550/1-9.
75 T449/39-47.
76 Ex. 45, paragraph 51.
77 T385/22-26.
78 T384/34-46.

(b) rather as a ***negative criterion*** which leads the engineers to refrain from making additional releases so as to avoid making things worse downstream.

204. As we shall see, forecasts were in fact used as a negative criterion in this way during the January 2011 event.

205. Mr Ruffini's evidence was:[79]

> ... the forecasts you use - like, if you look at the situation report, we sort of say - sorry, when I make one up, sort of say where we are, then I look at the forecast scenarios to get a sense of where the event is heading -------
>
> ------- Mmm? -------and that's what I sort of put in that situation report about where we're potentially heading, and that starts the wheels in motion about what people should be thinking, about saying, well, this rain hasn't happened yet, but if that sort of thing happens, then this is where we're headed. So that's sort of the way that we use it. In essence, the way that procedures are designed, you just grow from one to the other. Like, you don't - it is - the way they are designed - because they sort of build - they are not - it is not like kind of discrete steps, you actually build to the events. So I would also use - you know, when you are looking at the forecast, you have consideration to the drain times within the dam. So as those - as you - and that's something that, you know, me I look at - when I look at those forecasts and say, well, how are we going, are we still kind of good for that? And that just gives me a feeling for where the event's headed.

206. In his statement, Mr Ayre said:[80]

> In assessing the strategies used during any flood event, rainfall forecasts provide an awareness of potential flood event conditions but the forecasts by themselves do not provide a sufficiently reliable basis upon which to make operational decisions on releasing floodwaters from the Dams during flood events.

207. Later, he said:[81]

> Whilst models on a 'with forecast rainfall' are regularly run to provide awareness on how a flood event might progress (and are particularly useful in preparing the situation reports provided to the relevant agencies that include details of possible bridge closure, river flows and release rates), they are not the best basis upon which to assess 'predicted lake levels'.

208. In his oral evidence, Mr Ayre said:[82]

> ... the modelling we do is consistent for all of the strategies and is based on a consistent approach in terms of adopting the no further rainfall model as the basis of operational decisions, but using the forecast rainfall models as a means of determining where the event is likely to develop to.

209. Later, he said:[83]

> ... the forecast models are really just a sensitivity on what a release strategy will be and its just giving us an idea of an upper bound, if you like, of where the situation could develop to.

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79 T318/54-T319/18.
80 Ex. 17, paragraph 203.
81 Ex. 17, paragraph 305.
82 T85/30-36.
83 T163/49-52.

210. However, this does not mean that forecasts were never used as a basis for decision making. This brings us to the evidence concerning the use of forecasts as a ***negative criterion***.

211. In Situation Report 12, issued at about 9.04 pm on Sunday, 9 January 2011, it was stated:[84]

> Very heavy rainfall has been recorded in the upper reaches of the Brisbane and Stanley in the last 6 hours with totals up to 100 to 140mm. Totals for the last 24 hours range from 100 to 300mm.
>
> Rainfall of similar magnitudes is expected in the 12 to 24 hours, especially around the Bremer/Warrill catchments as the system tracks south.

212. Thus there was an awareness from the forecasts that the system was tracking south, with the prospect of significant rainfall over the downstream catchments in the next 12 to 24 hours.

213. In Situation Report 13, issued at about 1.14 am on Monday, 10 January 2011, it was stated:[85]

> Very heavy rainfall has been recorded in the Upper Brisbane and Stanley Rivers in the last 12 hours with totals up 100 to 240mm. Totals for the last 24 hours range from 100 to 300mm.
>
> Rainfall of similar magnitudes is expected in the 12 to 24 hours around downstream catchments as the system tracks south.
>
> ...
>
> The projected Wivenhoe Dam releases combined with Lockyer flows and local runoff will mean that all crossings downstream of Wivenhoe (Twin Bridges, Fernvale, Savages Crossing, Burtons Bridge, Kholo Bridge, Mt Crosby Weir and Colleges Crossing) will be adversely impacted until at least Saturday 15 January in varying degrees.
>
> Water levels in the lower Brisbane R will be impacted by the combined flows of Lockyer Ck, Bremer River, local runoff and releases from Wivenhoe Dam. If the predicted rainfall eventuates in the downstream tributary catchments the resultant combined flows in the lower Brisbane may exceed the threshold of damaging discharge in the urban areas within the next 24 to 48 hours.

214. In Situation Report 14, issued at about 6.30am on Monday, 10 January 2011, it was stated:[86]

> Moderate to heavy rainfall has been recorded in the Upper Brisbane and Stanley Rivers in the last 12 hours with totals up to 90mm. Totals for the last 24 hours range from 100 to 325mm.
>
> Mt Glorious recorded 100mm in the last 12 hours.
>
> Rainfall of similar magnitudes is expected in the 12 to 24 hours around downstream catchments as the system tracks south.
>
> ...
>
> The projected Wivenhoe Dam releases combined with Lockyer flows and local runoff will mean that all crossings downstream of Wivenhoe (Twin Bridges, Fernvale, Savages Crossing, Burtons Bridge, Kholo Bridge, Mt Crosby Weir and Colleges Crossing) will be adversely impacted until at least Saturday 15 January in varying degrees.
>
> Water levels in the lower Brisbane R will be impacted by the combined flows of Lockyer Ck, Bremer River, local runoff and releases from Wivenhoe Dam. If the predicted rainfall eventuates in the

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84 Ex. 24, Appendix E, page 21.
85 Ex. 24, Appendix E, pages 23-24.
86 Ex. 24, Appendix E, pages 25-27.

> downstream tributary catchments the resultant combined flows in the lower Brisbane may exceed the threshold of damaging discharge in the urban areas within the next 24 to 48 hours ...

215. Mr Ayre said in his second statement:[87]

> The best forecast information (from the BoM's ACCESS models and the WATL website) that was available at that stage indicated that the rainfall producing system was moving south and contracting towards the coast so our expectation at that stage was the metropolitan Brisbane and the Bremer River would bear the brunt of the rainfall on Monday and Tuesday and that was another reason why we did not want to greatly increase the rate of releases considering that downstream Brisbane may well have significant flows from rainfall in the local catchments.
>
> This was a critical issue because if we did release more water on top of the heavy rain in the downstream areas it would have caused more damage than necessary

216. In his oral evidence Mr Ayre said:[88]

> It was a material consideration, that we were aware that the forecast was suggesting the rainfall moving further downstream from Wivenhoe Dam and, indeed, starting to impact on the lower downstream tributaries of the Bremer River and, indeed, Metropolitan Brisbane.

217. This is an important example of forecasts being used as a negative criterion, leading the engineers to refrain from making additional releases so as to avoid making things worse downstream.

218. There is also another example of forecasts playing a material role in decision making. It concerns the decision to transition to Strategy W4.

219. On the morning of Tuesday, 11 January 2011, Mr Malone communicated with BOM for the specific purpose of confirming that, according to BOM's best forecast information, the rain was likely to continue such that there was indeed no choice but to invoke Strategy W4.

220. The Flood Event Log records that:[89]

(a) at 7.22 am on Tuesday, 11 January 2011:

> TM called BoM to appraise of situation. BoM unable to talk and will call back.

(b) at 7.35 am on Tuesday, 11 January 2011:

> Peter Baddiley of BoM called back. Full appraisal of SEQWater strategy. Both SEQWater and BOM results were discussed in detail, and generally agreed with each other.

(c) at 7.56 am on Tuesday, 11 January 2011:

> TM called BOM. Advised Jimmy Stewart and Peter Baddiley that Wivenhoe will ramp up to a minimum release of 3,700 $m^3/s$.

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87 Ex. 18, paragraphs 100-101.
88 T251/30-37.
89 Ex. 23, pages 22-23.

221. In his statement, Mr Malone explained:[90]

> When I arrived for my shift at around 0645, very heavy rainfall was occurring in the catchment. Together with Engineer 4, I generated new model results at 0700. The output of that model run is shown as **Annexure TM3**. It predicted a Wivenhoe Dam level of EL74.35. We then consulted the BoM to see if their model results were predicting the same dam inflows and to discuss short term rainfall predictions for the following hours. As they were, and given the earlier model result plus the very heavy rainfall then falling in the catchment and with the expectation of continuing heavy rainfall, Strategy W4 was invoked at around 0800 on Tuesday 11 January.

222. Thus BOM's forecast information contributed to the most serious decision made by the flood engineers during the flood event.

**CONCLUSION IN RESPECT OF THE USE OF FORECASTS**

223. The use which the flood engineers made of forecasts was in accordance with sound practice at the time. As to this:

(a) It accords with BOM's advice.

(b) It accords with the way other flood mitigation dams in Australia use forecasts. As Dr Nathan said, he has worked in every State and Territory on numerous dams, and he has never come across anyone using forecasts quantitatively.

(c) The independent expert engaged by the Commission, Mr Babister, concluded that the reliance which the flood engineers placed on the forecasts was appropriate:[91]

> As I followed the thrust of your evidence you think the rainfall forecast had useful information in them but they need to be tested as to the extent to which reliance can be placed upon them?-- Yes.
>
> You would envisage extensive modelling testing in the course of the next manual review?-- Yes.
>
> But that, of course, hasn't been today to date?-- No, it hasn't.
>
> It wasn't done during the January event?-- That is right.
>
> Would you accept in those circumstances the extent to which the engineers managing that flood event did place reliance on weather forecasting information was appropriate?-- Yes.
>
> It would have been wrong to have made decisions about releasing water based upon weather forecasting?-- I don't know if it would be wrong. You would have to be very confident in those forecasts so I wouldn't make an absolute ruling of wrong.
>
> So if the flood engineers sitting there during the flood event were not confident in the weather forecast information you would accept the extent to which they placed reliance upon that was appropriate?-- Yes.

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90 Ex. 45, paragraph 57.

91 T2195/25-52.

224. Moreover, the use which the flood engineers made of forecasts was in accordance with the Manual. As to this:

(a) On Seqwater's interpretation, the Manual merely requires the forecast information to be gathered and taken into account, but leaves the particular use to be made of that forecast information to the professional engineering judgment of the flood engineers. There is no doubt that the flood engineers did this. The fact that they did not act on the faith of the blue "with forecast" line in making additional releases does not gainsay this proposition. It was open to them to prefer what, in their professional engineering judgment, was a more reliable category of information.

(b) However, even on the alternative interpretation, the Manual was followed. One cannot focus solely upon the use of the blue "with forecast" line as an ***affirmative criterion*** for the making of additional releases. On any view, the Manual does not dictate precisely ***how*** forecasts are to be used (with, or to the exclusion of, other categories of information). It is sufficient (on the alternative interpretation) for them to be used in any material way. And, as has already been observed, they were used by the flood engineers in four material ways during this event, including:

(i) as a ***negative criterion*** leading to a decision to refrain from making additional releases;

(ii) in making the most serious decision they made during the flood event, viz. the decision to transition to Strategy W4.

## PART VI
## SOUND JUDGMENT

### INTRODUCTION

225. The conduct of flood operations requires the exercise of professional engineering judgment, sometimes in difficult and quickly evolving circumstances.

226. There is no evidence before the Commission capable of supporting a finding that the flood engineers made any error of judgment in their management of this event.

227. In fact, the evidence all points to a finding that they exercised sound judgment in unprecedented circumstances.

228. Indeed, towards the conclusion of the public hearings, Mr Callaghan said:[92]

> ... on the evidence all of [the flood engineers] are dedicated professionals ...
>
> ... the evidence suggests that during the flood events they all worked very hard under difficult conditions ...
>
> And ... no-one has levelled any particular criticism of any individual engineer ...

229. The Commission's findings should reflect these propositions.

230. It is necessary, however, to deal with the two primary themes evident in the questioning of the flood engineers, viz.:

(a) Given a consistent pattern of model results in which the blue "with forecast" line predicted that the lake level would exceed 74 m AHD, the flood engineers could, and perhaps should, have transitioned to Strategy W4 sooner than they did.

(b) From as early as 8am on Saturday, 8 January 2011, it was open to the flood engineers under the Manual to increase releases from Wivenhoe dam so as to produce flows ***at Moggill*** of up to 4,000 $m^3/s$ within Strategy W3,[93] and the flood engineers should have increased releases sooner or more rapidly than they did.

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92 T2249/8-16.

93 In some of the questioning of the flood engineers, it seemed to be suggested that within Strategy W3, discharges of up to 4,000 $m^3/s$ could be made ***from the dam itself*** : see, e.g., T158/45-50. However, it is important to bear firmly in mind that the 4,000 $m^3/s$ threshold is referable to the flow rate ***at Moggill***, which is the product, not only of discharges from the dam, but also of the combined flows downstream of the dam from the Lockyer and Bremer catchments. Thus, the requirement is to balance the ***flows from all of these sources*** so that the ***combined flows*** do not exceed 4000 $m^3/s$ at Moggill. A combined flow of 4,000 $m^3/s$ at Moggill may be reached when the discharges from the dam itself are well below 4,000 $m^3/s$. For example, according to Model Run 31, a combined peak flow of 3,930 $m^3/s$ would be

231. For the reasons developed below, neither of these criticisms is justified.

232. **The Commission should find that the decisions taken by the flood engineers during the course of the event**:

(a) **were the product of careful consideration of the actual circumstances confronting them at the time**;

(b) **were amply justified in light of the actual circumstances confronting them at the time**;

(c) **reflected the exercise of sound professional engineering judgment**.

**CONSISTENT PATTERN OF "WITH FORECAST" RESULTS**

233. One difficulty encountered in assessing the evidence on this question arises from the fact that, whilst Mr Callaghan was prepared to suggest that, for example, the decision to transition to Strategy W4 "could" have been made sooner than it was,[94] he did not suggest that the decision "should" have been made sooner than it was.

234. He did not put to any witness that such a decision "should" have been made at a particular point in time. Nor did he suggest to any of the flood engineers that they had made an error of judgment by failing to act at a particular time.

235. Indeed, Mr Callaghan railed against the suggestion that he had "actually put" that the flood engineers should have acted based on the pattern of results shown in the blue "with forecast" line.[95]

236. All of this is consistent with the observations (set out above) made by Mr Callaghan towards the end of the public hearings.

237. In these circumstances, it is not open to Mr Callaghan to recommend that a finding be made that decisions "should" have been made sooner than they were, or that the flood engineers made an error of judgment by failing to act at a particular time.

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reached at Moggill when the predicted peak outflow from the dam was 2,760 $m^3/s$, the predicted peak flow from the Lockyer was 780$m^3/s$ and the predicted peak flow from the Bremer was 870 $m^3/s$. And, according to Model Run 39, a combined peak flow of 4,410 $m^3/s$ would be reached at Moggill ***even without any discharges from the dam***.

94 See, e.g., T100/46-T101/10.

95 T355/15-27.

238. If Mr Callaghan proposes to change his position, and to embrace a proposition which he had previously disavowed, then that ought to be brought to Seqwater's attention and:

(a) the flood engineers should be given the opportunity to address the issues;

(b) Seqwater should be given the opportunity to address the issues by reference to that evidence.

239. However, on the present state of the evidence, there can be little doubt that the flood engineers exercised sound judgment.

***Matters bearing upon the exercise of the judgment to invoke strategy W4***

240. At the outset, it is necessary to address a number of matters which bear upon the exercise of the judgment to invoke Strategy W4.

241. ***First***, there are the consequences of invoking the strategy.

242. It is uncontroversial that the consequences are extremely serious, necessarily involving putting water over the floorboards of homes in urban areas below Moggill.[96]

243. This underscores the gravity of the decision, and the need for a high degree of assurance that the taking of the decision is actually necessary.

244. It may be observed here that it was apparent from the evidence of the flood engineers that they were acutely aware of the consequences, and hence the gravity, of the decision to invoke Strategy W4.

245. The actual decision was taken by Mr Malone and Mr Tibaldi.

246. The toll which having to make such a grave decision has had on each of these men was apparent when they were giving their evidence.

247. Mr Malone's evidence was:[97]

> You must have appreciated at the time the consequences of moving to W4? I did. I did.
>
> And what were they, as you saw them? I saw that we would be potentially causing people damage to their houses.
>
> Would you have avoided that if you could have? If we could have, yes, certainly.

---

96 The relevant evidence was outlined in Part IV above.

97 T412/9-18.

248. As Mr Malone was giving this evidence, his emotion was palpable.

249. Mr Tibaldi's evidence on the topic was very brief. His distress was obvious. He said what he could, whilst attempting to maintain his composure:[98]

> Did you appreciate the consequences of moving to W4? I did.
>
> Could you see any alternative? I couldn't.

250. The grave consequences were very real. They were well understood. They underscore the proposition that Strategy W4 is a strategy of last resort, to be adopted only when it is adjudged that there is truly no alternative.

251. ***Secondly***, there are the uncertainties in the red "without forecast" line model results upon which the flood engineers rely.

252. These are regarded as the most reliable results available, but they present their own difficulties.

253. Reference has already been made to the evidence of Professor Apelt as to the general principle applicable to modelling, and to the evidence of Messrs Tibaldi and Malone as to the uncertainties attending these particular model results.

254. The point is that even the best available information is subject to a material degree of uncertainty.

255. ***Thirdly***, it is necessary to appreciate just how unreliable the blue "with forecast" line was during this particular event.

256. It is (or ought to be) uncontroversial that the ordinary QPFs issued by BOM are too unreliable to provide a basis for the making of operational decisions about dam releases.

257. However, during this event the QPFs proved to be so unreliable that the blue "with forecast" line could not actually be modelled on them.

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98 T465/17-20.

258. The point was explained by Mr Tibaldi:[99]

> ... in the model runs that are displayed in appendix A, we haven't strictly used the QPFs, we have used something much, much bigger than the QPFs. So that when people say to us, well, this is what the forecast said, why didn't you act on that, they just need to be aware those forecasts aren't the QPFs in those model ones; they are something much, much bigger ...
>
> ... if you get a 24 hour - the QPFs are typically issued at 10 o'clock and 4 p.m. - 10 a.m. and 4 p.m. If you get a QPF issued at 4 p.m., it is saying you are going to get a certain amount of rain, say 50 millimetres of rain, in the 24 hour period. So what it is saying strictly is that once you have got the 50 millimetres, don't expect any more because you are only going to get 50. And that 50 millimetres could occur uniformly through the 24 hours or it could occur very quickly. It depends on the weather systems and such. Now, often in the event we would come to do a model run and it might be, say, six or seven hours, or a period of time after the QPF was issued and we would have already got the amount of rain that the QPF had forecasted. So, strictly speaking, if we were to use those runs we should just use actuals, because the forecaster told us we were going to get 50 millimetres, or whatever, within the 24 hour period and we'd already got it. So if you are going by the forecast you shouldn't be expecting too much more. But, clearly, that wasn't appropriate. Clearly, it wasn't appropriate because it was still raining. So what we actually did - so the QPFs are the best forecast. That's what the best forecaster was telling us. What we did was then add the full volume of the QPF in again, which effectively in some cases doubled or more. I think in one case it may have tripled the QPF and you are taking that into account, essentially, in those forecasts. So then it comes down to how much reliability is in that forecast? I mean, you are just arbitrarily doubling up or maybe tripling the QPF. You know, again, just the uncertainties there. There is not a lot of science in that but that's the best we could do. So I think why that's relevant is it does talk about - in the manual it uses the word "the best forecast" and the best forecast is the QPF. Those forecast runs you have seen in appendix A, they are not the QPF. They are not the QPF. So that needs to be understood. They are something much greater than the QPF. They are scaled up.
>
> From what you say some would be based on the QPF but as the - as the extent of the 12 hour gap between QPFs proceeds, it could be based more and more on something additional to the QPF?-- The ones that would be based on exactly the QPF are the model runs that are done at the time the QPF is issued. All other model runs would generally include - I think every other model run would include more rainfall than what's in the QPF, than what's in the best forecast.
>
> With your real time receipt of information of rain that's falling, when you are doing a model run you have got the real time information as to what rain has been recorded?-- That's correct. What's recorded in the rain gauges, which may not necessarily reflect the full catchment conditions but it is the best we have.
>
> So even if that equalled or exceeded the QPF 12 hour forecast, you might add something additional in?-- Our practice was to - our practice in all of those model runs is to add the full QPF in again. The full QPF. Why was that? Why would you just say, well, we have already received the forecast, so we will just stop there?-- Well, I mean, to do that, I think, was unrealistic. I mean, obviously the forecast was just way wrong so you had to add something in.
>
> Why was the forecast obviously way wrong?-- Well, it was forecasting 50 millimetres in 24 hours, for example, and you might have had - six hours may have passed and you might have had 100 millimetres. So that forecast has to be wrong.

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[99] T455/43-T457/48.

This is also dealt with in the Flood Report (Ex. 24) at page 1 of Appendix A. In describing the model results it was said:

> The forecast rainfall model results apply the full 24-hour catchment average rainfall from the BOM QPFs to the model run. This is regardless of the model run time in relation to the issue time of the forecast, and is regardless of the rainfall since the forecast was issued. In effect, this provides a "worst case" 24-hour scenario.

Thus, if a QPF was received at 4pm, and a model run was conducted at 9pm, the model run would include the rain which had actually fallen between 4pm and 9pm ***and*** the full amount of the forecast rainfall, even if the actual rainfall had already exceeded the full amount of the forecast. In this way, the "with forecast" models could be based on a doubling (or more) of the quantitative amount shown in the QPF.

> Was it affected then by whether it is still raining in the catchment or not?-- Well, we can see rain in real time, so we were aware that rain was still falling, so it would have been - you know, our judgment was it was just wrong to assume no more rain. You can't - again, it is this whole principle of how much emphasis you put on the forecasts. I mean, you can't - particularly with the uncertainty - and we just can't blindly accept them, and here is an example and we didn't blindly accept it because obviously they were wrong.
>
> All right, thanks. Did that affect, then, the weight you give to the with forecast blue line modelling and your decisions about releasing water?-- That's right. As I said, we gave no weight during the event because there was no basis on which we could provide - you know, we could give them weight.

259. This is important in at least two respects:

(a) It demonstrates just how unreliable the forecasts were. Actual rainfall was exceeding the 24 hour forecast within a matter of hours.

(b) It completely undermines the case based on the blue "with forecast" line. That line does not reflect the QPFs. Rather, it reflects an arbitrary scaling up of the forecasts in an endeavour to keep up with what was actually occurring. The notion that this arbitrary blue line should have been preferred to the red line based on actual observations is absurd. And that notion cannot be sustained by reference to page 22 of the Manual on the basis that the arbitrary line reflected the forecasts – as it plainly did not.

260. There was a further dimension to the use that could be made of forecasts during the January flood event. The information being received by the flood engineers from the real time flood monitoring rainfall and stream gauge detectors was repeatedly overtaking the most recent forecast. In other words, forecasts were being superseded by the flood engineers' observations of actual rainfall. The flood engineers' practice in those circumstances was to carry out modelling based on potential (but not forecast) rainfall, until the next forecast issued. The appropriateness of modelling based on potential rainfall, as well as forecast rainfall, is acknowledged in para. 5.1 of the Manual. On any view of the Manual, the engineers were not compelled to make decisions based upon the blue line when it represented potential rainfall, which had not been forecast.

***The circumstances actually confronting the flood engineers***

261. Each of the flood engineers gave evidence as to the actual circumstances confronting them, and the basis upon which they made their decisions, over the period which seemed to be of interest to Mr Callaghan.

262. That period commenced with Model Run 22 at 8pm on Sunday, 9 January 2011. This was the first occasion on which the blue "with forecast" line showed that the lake level would exceed 74.0 m AHD.

263. Mr Ayre's evidence as to this was as follows:[100]

> If you go first to the model runs, Exhibit 22, and turn to model run 22, this is the model run on Sunday, the 9th at 8 p.m.?-- Yes.
>
> And Counsel Assisting the Commission took you to page 120, which is the model Wivenhoe Dam level lakes?-- That's right. That's on the screen, yes.
>
> And he showed you that the blue line exceeded the 74 level?-- Yes.
>
> And one of the questions he put to you was along the lines of, "Well, there you are, the model shows above 74, so that's an appropriate justification for moving to W4 strategy on the night of Sunday, the 9th."?-- In light of the discussion we have just had, I would suggest that we would be relying more heavily on the actual lake levels approaching the EL74 before we would actually invoke Strategy W4.
>
> That's the area I want to explore with you. What I would like to do is imagine we are back in the Flood Operations Centre on Sunday the 9th and can we look at what was actually happening on the dam and what information was available to you as [though we were] flies on the wall. Can we do that?-- Yes.
>
> Now, firstly, can we look at the physical situation at the dam? I think you will find some information about that in the Flood Report. I will go to page 157. Now, at page 157 is part of a section called, "Dam Inflow and Flood Release Details." ?-- Yes.
>
> And if we can look down the left-hand column of page 157, for the 9th of January we see an entry at 8 p.m.?-- Yes, I do.
>
> Which is the same time as the model-----?-- Model run, yes.
>
> -----Counsel Assisting took you to, and if we look across to the right-hand examine columns, we see under the second column, "Lake Level.", the level of the lake at that time?-- 69.1 metres AHD.
>
> Right. So, it's got nearly five metres to rise before the lake level actually crosses the 74 threshold?-- Yes.
>
> Can we look across to the right-hand side of that page? See the columns, "Total Outflow.", and, "Total Inflow."?-- Yes.
>
> Can we see from those what was the outflow of the lake at the time?-- The release was 1,419 cubic meters per second.
>
> And the inflow?-- 7,338 cubic meters per second.
>
> And can we also some of the other considerations applying at the time that are described in your second witness statement, if you wouldn't mind looking at pages 26 and 27? Page 26 at paragraph 76 commences with the situation report at about 9 p.m. on the 9th, so about an hour later than the time we're looking at?-- Yes.
>
> Can you highlight for us what are the key features in that that bear upon this question of should you go to W4 at this time?-- The fact that there was heavy rainfall that had been recorded particularly in the upper reaches of the Brisbane and surrounding catchments which then flowed into Lake Wivenhoe and Lake Somerset.
>
> All right?-- The other important features of it are the actual recorded - the lake levels at that particular time.
>
> The 69.1?-- Yes.
>
> All right. You also discuss at paragraph 78 and 87 a need to close bridges before the releases are dramatically increased?-- Yes.
>
> And that had yet to happen?-- No, Mt Crosby Weir Bridge and Fernvale Bridge, the Brisbane Valley Highway was still open at that stage.

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100 T246/42-T249/32.

So, they would have to be closed before you could ramp up that-----?-- Yes.

Let's say that Counsel Assisting the Commission though is there, he's standing in the room with you, and he's pointing to that blue line and saying, "Time to move to W4." Let's just assume that for the moment. You're the senior engineer, it's your call?-- Yes, I would resist the suggestion, because I wouldn't think it was appropriate at that stage, given that the lake level was still at 69.10 metres.

Would you take into account the consequences if you then moved to the W4 strategy?-- The consequences would be very significant, yes.

Let's think about those for a moment. If we look at the manual as to what it tells us is to happen under a W4 strategy - I am looking at page 29 - about halfway down the page, under the paragraph commencing, "Under Strategy W4.", "The release rate is increased as the safety of the dam becomes a priority.", and then the next statement rather suggests the opening of the gates is to occur until the storage level at the Wivenhoe Dam begins to fall?-- Yes.

Now, as you would apply that in practice, does that mean you increase the gates until the outflows exceed inflows?-- Yes.

Now, if we look at the inflows to Wivenhoe Dam on this Sunday evening, if we go back to the Flood Report page 157? Can you tell us what the inflow was at the time?-- The inflow at 9 o'clock? 8 o'clock, I think it was?-- Oh, 8 o'clock when the model run was down was 7,338 cubic meters per second.

So, you would have to increase the releases until you had reached that figure or at least until that figure diminished below the release level?-- Yes, that's correct.

If you had began opening the gates up to release that sort of rate on the Sunday evening, given the flows from Bremer and Lockyer into the Brisbane River, can you give us some idea of what might have been the consequences in Brisbane?-- I believe very significant flooding would have occurred in the lower reaches of the Brisbane River due to the combination of the releases and the downstream tributaries.

So, does that mean water over people's floors?-- I believe it would be certainly a major flood in Brisbane.

The maximum release date from Wivenhoe in the January '11 period was about seven and a half thousand CUMECS, wasn't it?-- Yes.

So, you would be looking for release rates close to that?-- We're - just looking at the inflows, they don't peak until 8 a.m. on the Monday morning, so I would expect actually the release rates to be somewhere between 7,000 and, indeed, 10,000 cubic meters per second.

What would you say to residents of Brisbane who came to you and said, "Well, you flooded my house, but you didn't need to. Wivenhoe was still five metres below the 74 level. You flooded my house on a forecast that the rain might not fall, it might not fall as much as the Bureau has said, might fall else where."?

COMMISSIONER: That's a rhetorical question, is it, Mr O'Donnell?

MR O'DONNELL: I am inviting a response from Mr Ayre.

COMMISSIONER: Well, what would you say?-- Well, I'd have to agree, there's no guarantee that rainfall in a forecast would necessarily occur in terms of the depth or the location that's been specified.

MR O'DONNELL: Would you say that this highlights the dangers of moving to a strategy like W4 based upon a forecast?-- Yes, I do believe that's the case.

264. Thereafter, Mr Ayre gave evidence addressing a number of different time periods between the Sunday night and the Tuesday morning.[101]

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101 T249/40-T253/25.

265. Take, for example, the position as at about 6.00am on Monday, 10 January 2011 as Mr Ayre was about to come off shift:[102]

> I am looking at the entry for 6 o'clock, towards the end of your shift. We see that the level of the lake is now 70.96?-- ... Yes.
>
> So that's about 71?-- Yeah, very close to 71 metres.
>
> So it still has three metres to rise-----?-- Yes.
>
> -----before you cross the 74 line. The outflows are 1,806 and the inflows are 9,312?-- Yes.
>
> And you describe the situation in your second affidavit at page 35. There is a condition report you quote from just at the end of this shift. Could you tell us what would be the material considerations you think would favour or be opposed to moving to W4 strategy at this time?-- The situation I believe in the Upper Brisbane, the levels had actually peaked and were now starting to fall, so indicating that at least in the Upper Brisbane catchment the inflows were diminishing. It is certainly a large event by any standards, rivalling that of the February 1999 flood, but an event I would expect, given the current lake level, could be contained within the strategy of W3.
>
> Would you see it as a situation where the safety of the dam was under threat?-- Not at that stage.
>
> Or a situation where it was necessary to cause releases which would produce urban flooding at Brisbane?-- No. At that stage I believe we could limit the releases to maximum of 4,000 cubic metres per second as required in strategy W3.
>
> Was there a further consideration described in paragraph 100 and 101 of your statement? Was that a material consideration?-- It was a material consideration, that we were aware that the forecast was suggesting the rainfall moving further downstream from Wivenhoe Dam and, indeed, starting to impact on the lower downstream tributaries of the Bremer River and, indeed, Metropolitan Brisbane.
>
> Can I take you to one other document on this topic? It is in flood report page 19? That's the Flood Event Summary-----?-- Yes.
>
> -----which concludes on Monday the 10th at 9 a.m., so just shortly after your shift comes to an end?-- Yes.
>
> It is on the right-hand column, the last dot point. Could you explain that? That was part of your thinking at the time?-- Yes, it was, although at 9 a.m. I wasn't necessarily on shift but the duty engineers, John Tibaldi and Terry Malone, they would have contributed to this. Effectively, we believed we could actually contain this flood using strategy W3 and limit the releases at that stage to less than 4,000 cubic metres per second.
>
> So your strategy was to avoid urban flooding in Brisbane?-- Yes.
>
> And the statement says "until it was certain it could not be avoided"?-- That's correct.
>
> Had you reached that stage, given the level of the lake?-- No, we did not believe so.

266. Next, take the position as at about 3.00am to 4.00am on Tuesday, 11 January 2011:[103]

> Finally, then, the area Counsel Assisting took you to, the following morning, Tuesday the 11th. He took you to model runs at 3 o'clock and 4 o'clock?-- Yes.
>
> If I take you back to those? Your model run of 34 and 35. 34 shows the red line just touching 74?-- Yes.
>
> 35 shows the red line just nudging over 74?-- Yes.

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102 T250/5-T252/2.

103 T252/25-T253/25.

> In terms of the manual, do we have a situation where the water has yet reached 74?-- No, these were still predicted levels, so they were predicted to occur at 14:00 hours on the 12th, so the following day.
>
> And do we see from the flood report page 158 the level of the lake at that time was about 73.4?-- Yes. So it has still got 600 millimetres to rise?-- Yes.
>
> What were the factors which were in favour or opposed to moving to W4 at this time on the Tuesday morning?-- Well, we certainly were running out of freeboard between the actual lake level and the threshold of invoking W4. At that stage our model predictions were suggesting that if, indeed, we did exceed EL 74 it would not necessarily be by a large margin. So on the basis of trying to maximise protection to downstream areas, we were having to maintain the strategy W3 for as long as possible.
>
> Have you discussed this in your second witness statement at paragraph 139?-- Yes, I do.
>
> And does that reflect you actually gave consideration to moving to W4 at that stage?-- I believe it - we did contemplate whether we needed to but at this point we determined there was no immediate threat to Wivenhoe Dam in terms of security of the dam, so we continued to implement strategy W3.
>
> And did you also speak to the Director of Dam Safety, Mr Allen, about whether it might be permissible to exceed 74 without invoking W4?-- Yes. About 9 p.m., I think it was, the previous evening we did have a discussion with Peter along those lines. Peter agreed in principle that he could consider the senior flood operations engineer using discretion provided the lake level didn't exceed EL 74 by more than a small amount, normally 100 to 200 millimetres, and for a relatively short duration, so less than 12 hours.
>
> All right. That was using your discretion under 2.8 of the manual?-- To be able to do so we would have to apply to Peter to seek use of that discretionary power, yes.
>
> Right. And are those conversations referred to in your witness statement at paragraph 117 and 118?-- Yes, they are.
>
> And also 123?
>
> COMMISSIONER: Mr Ayre, did you find the conversations with Mr Allen in those paragraphs?-- Sorry, yes, I did.

267. Evidence to similar effect was given by Mr Ruffini,[104] Mr Malone,[105] and Mr Tibaldi.[106]

268. This evidence demonstrates:

(a) The extreme dangers associated with the proposition that one might transition to Strategy W4 based on forecasts. Instead of using the flood storage capacity of the dam, it would entail increasing outflows to match inflows so as to stabilise the dam level. This would likely have resulted in:

(i) peak outflow rates materially higher than the peak of 7,464 $m^3/s$ actually experienced during this event;

(ii) an unacceptable risk of the dam outflows combining with flood waters which had fallen, or might still fall, to the south of the dam;

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104 T350/20-T356/22.
105 T404/55-T412/31.
106 T460/5-T465/52.

(iii) devastating flooding in urban areas, when that still appeared to be avoidable.[107]

(b) That, until early in the morning on Tuesday, 11 January 2011, the flood engineers believed that this event could be contained within Strategy W3.

(c) That the actual circumstances confronting the flood engineers at the time amply justified their belief in this regard.

(d) That the decision to transition to Strategy W4 was seen properly as a last resort, given its consequences.

(e) That when the flood engineers attained the requisite degree of assurance that it was necessary to transition to Strategy W4, they did so without delay. They did not do this lightly. They were acutely aware of the consequences. However, they adjudged that there was no other alternative.

(f) That they invoked Strategy W4 before the Manual suggests you "normally" would, viz. before the lake level had actually reached 74.0 m AHD. This was in accordance with the Manual, having regard to the flexibility it accords to the flood engineers in terms of the exercise of their professional engineering judgment. It provides yet another indication of the extraordinary nature of the event with which the flood engineers were dealing.

***Conclusion***

269. Ultimately, the evidence demonstrates that careful consideration was being given to the prevailing circumstances, and that the flood engineers were responding appropriately.

270. They were a team of conscientious, diligent professionals, dealing with a difficult and quickly evolving situation.

271. Mr Callaghan did not suggest that they made any error of judgment in the way in which they responded.

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107 In this regard, see also paragraph 49 of Mr Tibaldi's first statement (Ex. 51):

> At 7.00pm on Sunday, 9 January 2011, the predicted peak of Wivenhoe dam was 72.1 m AHD, and the predicted peak flow at Moggill was 3,300 $m^3/s$. By 3.00pm on Monday, 10 January 2011, the first of the two distinct flood peaks experienced during the January 2011 Flood Event had entered the dam. At that time, the predicted peak of Wivenhoe dam was 73.6 m AHD, and the predicted peak flow at Moggill was 3,910 $m^3/s$. If the second of the two distinct flood peaks (which had not been forecast) had not occurred on Tuesday, 11 January 2011, the flood event would have been contained without exceeding the threshold for urban damage of 4,000 $m^3/s$ at Moggill.

272. This reflects the fact that there is no evidentiary basis for any suggestion that the flood engineers made any error of judgment in their handling of the event.

273. In fact, all of the evidence points to the conclusion that they exercised sound judgment throughout.

**GREATER RELEASES SOONER**

274. This theme was pursued primarily by Mr Rangiah on behalf of a group of residents of Fernvale.

275. The suggestion was that the flood engineers should have increased releases within Strategy W3 sooner or more rapidly than they did in the period from 8am on Saturday, 8 January 2011.

276. The premise of the questioning seemed to be that the flood engineers ought to have appreciated that the magnitude of the coming event was such that they ought to have pre-emptively caused ***some*** flooding in Fernvale, and probably in Brisbane, in an endeavour to avoid ***major*** flooding later in the event.

277. This premise should be rejected. The Commission should find that the flood engineers acted appropriately. That is for the following reasons.

278. ***First***, the information before the flood engineers at the time did not justify making releases at the rates suggested.

279. Even if one were to have relied on the rainfall forecasts, those forecasts would not have justified the making of additional releases.

280. In its early stages, the event was well under control. The flood engineers had no reason to think that the event would be of the magnitude ultimately experienced. For example, they had no reason to think that they were soon to experience not one flood peak, but rather two distinct flood peaks within the space of 36 hours, with each peak on its own being comparable to the 1974 flood.

281. ***Secondly***, the making of releases at the rates suggested would have been contrary to the Manual.

282. The Manual provides that:[108]

> When determining dam outflows within all strategies, peak outflow should generally not exceed peak inflow.

283. And Strategy W3:[109]

(a) provides for a ***maximum*** flow rate of 4,000$m^3$/s at Moggill;

(b) expressly requires consideration of lower level objectives when making decisions on water releases;

(c) thus contemplates that one would ordinarily keep the flow rates at the lower end of the range, increasing them only as is adjudged to be necessary to protect urban areas from inundation; when it is adjudged that releases towards the top end of the range are necessary to protect urban areas from inundation, the lower level objectives will be accorded less relative weight (and perhaps no weight) in accordance with the instruction that the primary consideration is protecting urban areas from inundation.

284. Releases at the rates suggested would have entailed:

(a) peak outflows exceeding peak inflows;

(b) a failure to give appropriate consideration to lower level objectives; and

(c) a jump to the maximum release rate before that was justified on the information then available.

285. ***Thirdly***, from Sunday night there was a need to moderate releases having regard to conditions in the downstream catchments. That is, there was a need to avoid making additional releases from the dam which would coincide with the significant flows from downstream catchments which:

(a) had been predicted from Sunday night;

(b) were in fact experienced as a result of the devastating flash flooding that occurred in the Lockyer on Monday.

286. ***Fourthly***, the evidence does not support the proposition that the making of releases at the rates suggested would have avoided major flooding later in the event. In fact, the evidence

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108 Page 22.
109 Page 28.

supports the conclusion that, given the magnitude of the event, major flooding was inevitable. Evidence to that effect was particularly given by Mr Ayre and Dr Nathan.

***Saturday, 8 January 2011 – 8am to midnight***

287. During this period:

(a) The lake level rose no higher than 68.65 m AHD[110] – there was thus almost 5 ½ m of storage remaining before the lake would reach 74.0 m AHD.

(b) Peak inflows rose no higher than 1799 $m^3/s$.[111]

(c) By midnight inflows had tailed off to 899$m^3/s$, and the lake level was about to start falling.[112]

288. In these circumstances, there was no justification for increasing release rates to the levels suggested.

289. Mr Ayre dealt with this in his second statement:[113]

> I am aware that some commentators have suggested that after the January 2011 Flood Event more water should have been released from Wivenhoe Dam over the course of Saturday 8 January 2011. I reject this suggestion. Over the course of the Saturday, the lake level at Wivenhoe Dam rose from 68.32m AHD to 68.65m AHD. There was a still a significant amount of flood storage would have been available in the Dam if rainfall increased significantly. The lake level was predicted to peak at 68.7m AHD at about 1am on Tuesday 11 January 2011 (more than 48 hours away), by which time the releases from the Dam would need to have been increased gradually to 1,480m³/s. By the end of Saturday, releases from Wivenhoe Dam had already been increased to 1,242m³/s, which meant that the estimated maximum required release rate of 1,480m³/s, which was required to be reached at 1am on Tuesday, was easily obtainable. By 5am Sunday morning, the release rate had already been increased to 1,336m³/s.
>
> I also note that rainfall was not significant over the course of the Saturday and that inflow rates into Wivenhoe Dam on the Saturday decreased from the peak rate of 2,144m³/s at 7am down to 899m³/s by 11pm. Further rainfall had been forecast but as set out in my first statement, and as I had identified in the 5:53pm situation report, it was only if and when further rainfall eventuated that increased releases from Wivenhoe Dam would be necessary and justified.
>
> For these reasons, it was appropriate that releases from Wivenhoe Dam maximised protection to urban areas while still minimising the impact to rural life downstream.

290. The topic also arose during Mr Ayre's questioning:[114]

> Now, under strategy W3, it was open to you to release up to 4,000 CUMECS?-- It is. However, that would have made releases in excess of inflows, and therefore not in keeping with an overall flood mitigation strategy.

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110 Ex. 24, pages 155-156.
111 Ibid.
112 Ibid.
113 Ex. 18, paragraphs 55-57.
114 T158/46-T159/4.

> Well, on that basis, it was certainly open to release more than 1,250 CUMECS at that stage?-- On the basis the modelling that was undertaken, and keeping with our operational strategies that we implement, the unnecessary or needless inundation of bridges or property is to be avoided, and that's in keeping with the way we operated on that Saturday afternoon.
>
> But, nevertheless, it was open to you to increase the rate of release at that stage because you were engaging strategy W3?-- I don't believe there is any justification for doing so.

291. Later the following exchange occurred:[115]

> Can you ... make any comment on his suggestion that circumstances on Saturday the 8th warranted higher outflows? -- Certainly the releases being made at that time were at or near the actual inflows, so if we were making greater releases then we wouldn't be acting as a flood mitigation storage.

292. In responding to a question about one of Mr O'Brien's unfounded assertions, Mr Ayre had explained:[116]

> ... the very nature of flood mitigation dams means you do store water at the earlier parts of the event to meet predefined release targets. The assertion here that we were storing water so that we can release later in the event, I think, is somewhat misleading. If we have a look at the numbers in terms of flood volumes that occurred over the period from Thursday through to midnight on Sunday, the 9th, there was something like – I will just find it – 560,000 megalitres of inflow and we had released approximately 230,000 megalitres of water in that timeframe. So, effectively we had actually around about 340,000 megalitres of water in storage during that period and that equates to a lake level of around EL 68.6, which is just above the W1, W2 threshold level. So, effectively we'd only utilised some 22 per cent of the total flood storage capacity available to us.

***The period to 7.00 pm on Sunday, 9 January 2011***

293. During this period the lake level rose no higher than 68.97 m AHD,[117] thus leaving more than 5 m of storage before the lake would reach 74.0 m AHD.

294. However, inflows had started to increase materially in the afternoon.

295. Mr Malone was on shift at the time.

296. In his first statement, Mr Malone said:[118]

> I was the Duty Engineer on shift during 0700 to 1900 on Sunday 9 January 2011. During that shift, I undertook an assessment of the potential for runoff volumes into the dams during the next three days. I did this by comparing rainfall and runoff since the commencement of the event up to that time and determining the fraction of rainfall which had been converted to runoff or "conversion rate". I applied this fraction to the lower and upper limits of the forecast rainfall for the following 3 days to determine the potential runoff volumes. After I completed my assessment I sent it to all of the Flood Operations Engineers. A copy of the assessment is shown in the Somerset Wivenhoe Flood Report at page 207 of Appendix K. Following this, Engineer 1 arranged a roundtable meeting of all Duty Engineers in the Flood Operations Centre at 1530. Engineer 4 attended by telephone, but Engineers 1 and 3 joined me in the Flood Operations Centre. We discussed the developing event, the current model predictions, the forecast rainfall and where we thought things might get to if significant rain continued to fall. My best recollection is that it was decided in that meeting that from the next shift (that is, the shift starting 1900 that day) the Flood Operations Centre would be staffed by two Duty Engineers until the situation stabilised.

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115 T255/42-49.
116 T137/57-T138/12.
117 Ex. 24, pages 156-157.
118 Ex. 45, paragraph 21.

297. The developments in the release strategy during the afternoon and evening are evident from Situation Reports 11 and 12.

298. According to Situation Report 11, prepared at about 5pm:[119]

> The dam level is currently rising again, with the current level being 68.70m AHD. Estimated peak inflow to the dam just from the Upper Brisbane R is about 5,000m3/s and, at this stage, the dam will reach at least 72.5 m AHD during Wednesday morning. River levels upstream of the dam are rising quickly with significant inflow being generated from the intense heavy rainfall. The current gate operation strategy will maintain flows of around 1,600m³/s in the mid-Brisbane River for the next 24 hours. This may mean temporarily reducing releases from Wivenhoe Dam as Lockyer flows increase. However, releases may have to be increased significantly during Monday depending on the rain in the next 12 to 24 hours. The current release rate from Wivenhoe Dam is 1,400m3/s (120,000ML/day).
>
> Since the commencement of the event on 02/01/2011 approximately 210,000ML has been released from the dam, with an event total approaching 1,000,000ML (including Somerset outflow) based on the recorded rainfall to date. The total release for the event is likely to increase over the next few days based on the current rainfall forecasts. At this stage, releases will continue until at least Saturday 15th January 2011.

299. According to Situation Report 12, prepared at about 9pm:[120]

> River levels upstream of the dam are rising quickly with significant inflow being generated from the intense heavy rainfall. Flows in the Brisbane River at Gregor's Ck have already reached 6,700m3/s and the river is still rising.
>
> The dam level is rising again, with the current level being 69.10m AHD (1,410,000ML with about 300,00 of flood storage). Estimated peak inflow to the dam just from the Upper Brisbane R alone may reach as high as 7,500m3/s and, at this stage, the dam will reach at least 73.0 m AHD during Tuesday morning. Given the rapid increase in inflow volumes, it will be necessary to increase the release from Wivenhoe Monday morning.
>
> The objective for dam operations will be to minimise the impact of urban flooding in areas downstream of the dam and, at this stage, releases will be kept below 3,500m3/s and the combined flows is the lower Brisbane will be limited to 4,000m3/s. This is below the limit of urban damages in the City reaches.
>
> The current release rate from Wivenhoe Dam is 1,400m3/s (120,000ML/day). Gate opening will start to be increased from noon Monday and the release is expected increase to at least 2,600m3/s during Tuesday morning.
>
> Since the commencement of the event on 02/01/2011 approximately 220,000ML has been released from the dam, with an event total approaching 1,000,000ML without further rain and as much as 1,500,000ML with forecast rainfall of (both including Somerset outflow). At this stage, releases will continue until at least Sunday 16th January 2011.

300. Mr Malone was questioned about this:[121]

> And at that stage the current release rate was 1,400? That's what-----
>
> You agree with that?-- Yes, that's what the situation report says.
>
> And it was intended to increase the rate of release to at least 2,600 CUMECS on the Tuesday morning. Now, was the delay in attempting to increase the rates of release until Tuesday morning related to a desire to keep the downstream crossings open for as long as possible?

---

119 Ex. 24, Appendix E, page 20.
120 Ex. 24, Appendix E, pages 21-22.
121 T380/30-T381/1.

> COMMISSIONER: I am not quite sure that's right, Mr Rangiah, because the increases start from noon Monday. It is not as if they have been deferred till Tuesday morning, it is just that's where it will get to by Tuesday morning.
>
> MR RANGIAH: Yes. Well, perhaps I can put it slightly differently. The increase to 2,600 was to take place progressively until it reached 2,600 on the Tuesday morning?-- That was the expectation at the time.
>
> And - but that figure of 2,600 or that release rate could have been reached earlier than Tuesday morning, couldn't it?--Yes, but we would have increased downstream flooding.
>
> And it was that desire to delay downstream flooding that resulted in you not increasing the rate more rapidly to 2,600 at that stage, is that correct?-- No, I don't see that – how you can draw that conclusion.

301. Also by the time of Situation Report 12, another consideration had emerged. Under the heading "Rainfall", the Situation Report stated:[122]

> Very heavy rainfall has been recorded in the upper reaches of the Brisbane and Stanley in the last 6 hours with totals up to 100 to 140mm. Totals for the last 24 hours range from 100 to 300mm.
>
> Rainfall of similar magnitudes is expected in the 12 to 24 hours, especially around the Bremer/Warrill catchments as the system tracks south.

302. Thus there was an awareness from the forecasts that the system was tracking south, with the prospect of significant rainfall over the downstream catchments in the next 12 to 24 hours. As has already been observed, this became a material consideration in determining release strategies from about this time.

303. All of this reveals a proactive and responsible approach to the evolving situation. It does not entail unjustified delay. Rather, it reflects a responsible progression through Strategy W3, bearing in mind lower level objectives, and increasing release rates as was adjudged to be necessary to protect urban areas from inundation.

***The period from 7.00pm on Sunday, 9 January 2011 to 3pm on Monday, 10 January 2011***

304. There was a practical reason why releases could not be ramped up suddenly on the Sunday night. The additional releases would have inundated the Fernvale Bridge and Mount Crosby Weir Bridge. For safety reasons, it was essential that these bridges be closed before releases were increased. By about 11.30pm, police were on site at the Fernvale Bridge.[123] And by about 1.00am on Monday, 10 January 2011, the bridge was closed.[124]

305. However, the concerns about downstream catchments were becoming very real by about this time.

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122 Ex. 24, Appendix E, page 21.
123 Ex. 18, paragraphs 78-86.
124 Ex. 24, page 18, second column, third bullet point.

306. Situation Report 13, issued at about 1.14 am on Monday, 10 January 2011, recorded:[125]

> Very heavy rainfall has been recorded in the Upper Brisbane and Stanley Rivers in the last 12 hours with totals up 100 to 240mm. Totals for the last 24 hours range from 100 to 300mm.
>
> Rainfall of similar magnitudes is expected in the 12 to 24 hours around downstream catchments as the system tracks south.
>
> ...
>
> The projected Wivenhoe Dam releases combined with Lockyer flows and local runoff will mean that all crossings downstream of Wivenhoe (Twin Bridges, Fernvale, Savages Crossing, Burtons Bridge, Kholo Bridge, Mt Crosby Weir and Colleges Crossing) will be adversely impacted until at least Saturday 15 January in varying degrees.
>
> Water levels in the lower Brisbane R will be impacted by the combined flows of Lockyer Ck, Bremer River, local runoff and releases from Wivenhoe Dam. If the predicted rainfall eventuates in the downstream tributary catchments the resultant combined flows in the lower Brisbane may exceed the threshold of damaging discharge in the urban areas within the next 24 to 48 hours.

307. Situation Report 14, issued at about 6.30am on Monday, 10 January 2011, recorded:[126]

> Moderate to heavy rainfall has been recorded in the Upper Brisbane and Stanley Rivers in the last 12 hours with totals up to 90mm. Totals for the last 24 hours range from 100 to 325mm.
>
> Mt Glorious recorded 100mm in the last 12 hours.
>
> Rainfall of similar magnitudes is expected in the 12 to 24 hours around downstream catchments as the system tracks south.
>
> ...
>
> The projected Wivenhoe Dam releases combined with Lockyer flows and local runoff will mean that all crossings downstream of Wivenhoe (Twin Bridges, Fernvale, Savages Crossing, Burtons Bridge, Kholo Bridge, Mt Crosby Weir and Colleges Crossing) will be adversely impacted until at least Saturday 15 January in varying degrees.
>
> Water levels in the lower Brisbane R will be impacted by the combined flows of Lockyer Ck, Bremer River, local runoff and releases from Wivenhoe Dam. If the predicted rainfall eventuates in the downstream tributary catchments the resultant combined flows in the lower Brisbane may exceed the threshold of damaging discharge in the urban areas within the next 24 to 48 hours ...

308. Mr Ayre said in his second statement:[127]

> The best forecast information (from the BoM's ACCESS models and the WATL website) that was available at that stage indicated that the rainfall producing system was moving south and contracting towards the coast so our expectation at that stage was the metropolitan Brisbane and the Bremer River would bear the brunt of the rainfall on Monday and Tuesday and that was another reason why we did not want to greatly increase the rate of releases considering that downstream Brisbane may well have significant flows from rainfall in the local catchments.
>
> This was a critical issue because if we did release more water on top of the heavy rain in the downstream areas it would have caused more damage than necessary

---

125 Ex. 24, Appendix E, pages 23-24.

126 Ex. 24, Appendix E, pages 25-27.

127 Ex. 18, paragraphs 100-101. See also T251/30-37.

309. Another issue which arose in this period concerned information received from the Brisbane City Council (the "**BCC**") to the effect that there would be urban damage at flows of 3,500m$^3$/s at Moggill.

310. For a brief period, the flood engineers attempted to accommodate this information.

311. This was entirely appropriate, and in accordance with the Manual, because it directly promoted the primary objective of Strategy W3, which is to protect urban areas from inundation.[128]

312. In his third statement, Mr Tibaldi said:[129]

> This action was taken with the aim of protecting urban areas below Moggill from inundation and followed a conversation with the BCC.
>
> This pause in increasing the flow at Moggill from 3,500m³/s to 4,000m³/s did not, in my opinion, have any impact on the outflows from the dam the following day or on the peak flow at Moggill during the flood event.
>
> The reason for this is that the six hour pause in increasing releases resulted in a maximum of 10,800ML being held in the dam above what would have been released had the pause not occurred. This is a relatively insignificant volume when compared to the total flood event volume of 2,650,000ML and equates to an increase in storage level of less than seven centimetres when the event peaked at a lake level of EL 74.97m. A seven centimetre increase or decrease in lake level at this time or in the period leading up to this time would have had no impact on the decisions to release flood water that were made on 11 January 2011 and therefore would not have increased the flood peak in the Brisbane River below Moggill.

313. Thus, in addition to being appropriate and in accordance with the Manual, the brief pause in increasing flows was of no moment in the scheme of this event.

314. It is possible to draw back and take an overview of the period from 7.00pm on Sunday, 9 January 2011 to 3.00pm on Monday, 10 January 2011. Mr Tibaldi has done this in his first statement:[130]

> At 7.00pm on Sunday, 9 January 2011, the predicted peak of Wivenhoe dam was 72.1 m AHD, and the predicted peak flow at Moggill was 3,300 m$^3$/s. By 3.00pm on Monday, 10 January 2011, the first of the two distinct flood peaks experienced during the January 2011 Flood Event had entered the dam. At that time, the predicted peak of Wivenhoe dam was 73.6 m AHD, and the predicted peak flow at Moggill was 3,910 m$^3$/s. If the second of the two distinct flood peaks (which had not been forecast) had not occurred on Tuesday, 11 January 2011, the flood event would have been contained without exceeding the threshold for urban damage of 4,000 m$^3$/s at Moggill. If releases had been ramped up during this period, that would have involved making releases which would have exceeded the threshold for urban damage of 4,000 m$^3$/s at Moggill. It would have involved making releases of the kind contemplated by Strategy

---

128 Ex. 24, page 19, final column, last dot point; T251/39-T252/2. It is also relevant here that the threshold of 4,000m$^3$/s at Moggill is, in terms of Strategy W3, a maximum or upper bound. The flood engineers did not exceed this upper bound. And they were at liberty to make judgments as to how flows might best be adjusted below the upper bound in pursuit of the primary objective of protecting urban areas from inundation.

129 Ex. 53, paragraphs 7-9. The text set out above incorporates the correction referred to in Mr Tibaldi's fourth statement (Ex. 54).

130 Ex. 51, paragraph 49.

> W4 before the conditions for adopting Strategy W4 were met. If the second of the two distinct flood peaks had not occurred, the ramping up of releases during this period would have inundated urban areas when that was unnecessary.

315. Thus, by 3pm on Monday, 10 January 2011, the flood engineers had little remaining ability to increase releases within Strategy W3.

316. And, for the reasons developed above, the suggestion that releases should have been increased before this time is without foundation.

317. Indeed, the judgment to refrain from making additional releases during this period, particularly having regard to conditions in the downstream catchments, was sound.

318. The independent expert engaged by the Commission, Mr Babister, observed that:[131]

> ... the flows from the Brisbane River coincided with the falling limb of the flow in the Bremer River. Earlier releases of dam flow may have increased the peak flood level and inundation extent at Ipswich.

319. Later, Mr Babister opined:[132]

> When the Wivenhoe Dam Operational strategy is primarily concerned with flood mitigation (Strategy W1 to W3), there is an objective to prevent the combined flow of dam releases with flows from the Bremer River and Lockyer Creek exceeding damaging levels. This objective was fulfilled in while operating under Strategies W1 to W3.

320. Thus, on Sunday and Monday, the flood engineers successfully avoided the peak flows coinciding, which event would likely have increased peak flood levels and inundation.

***Increasing releases as suggested would not have avoided major flooding later in the event***

321. In his second statement, Mr Malone detailed modelling which he had undertaken to assess the impact of releases being increased from 1,450$m^3$/s at 0900 Sunday, 9 January 2011 to 3,000 $m^3$/s at 0000 Monday, 10 January 2011, and continuing to be increased until 1500 Tuesday, 11 January 2011.[133]

322. Mr Malone examined the peak flow and the peak height at the Brisbane Port Office Gauge.

323. In terms of peak flow, Mr Malone said:[134]

> The modelled release of water from Wivenhoe dam is shown in Figure 1. The reduction in peak discharge from Wivenhoe dam is apparent by comparing the peak of the solid blue line (which is the actual release during the 2011 flood event) with the peak of the dotted blue line (which is the modelled scenario I have outlined above). The volume under the solid blue and dotted blue lines is the same (that is, 2,650,000ML).

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131 Report of Mr Babister, paragraph 106.
132 Report of Mr Babister, paragraph 165.
133 Ex. 33, paragraphs 2 and 3.
134 Ex. 33, paragraphs 3(f)-(g).

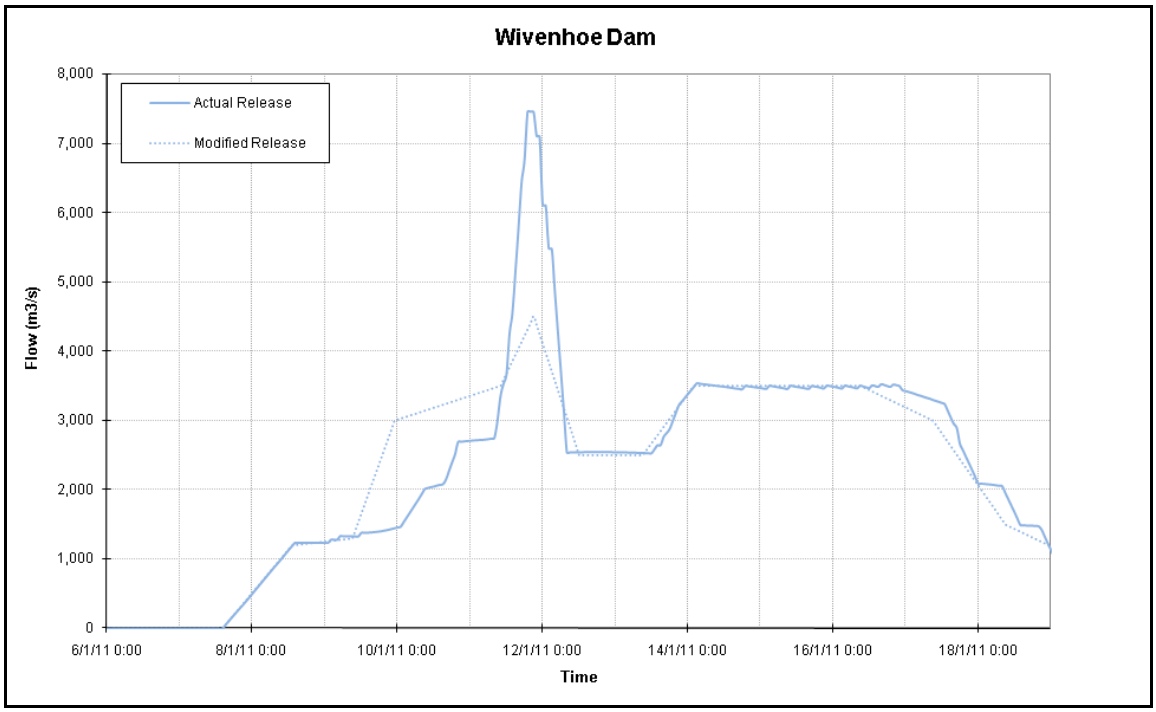


***Figure 1***

The modelled impact of this modified release strategy upon the flow at Moggill is shown in Figure 2. I note that the reduction in peak flow is only small, but the onset of damaging flows of 4,000m³/s as set out in the manual is earlier and lasts for about 12 hours longer.

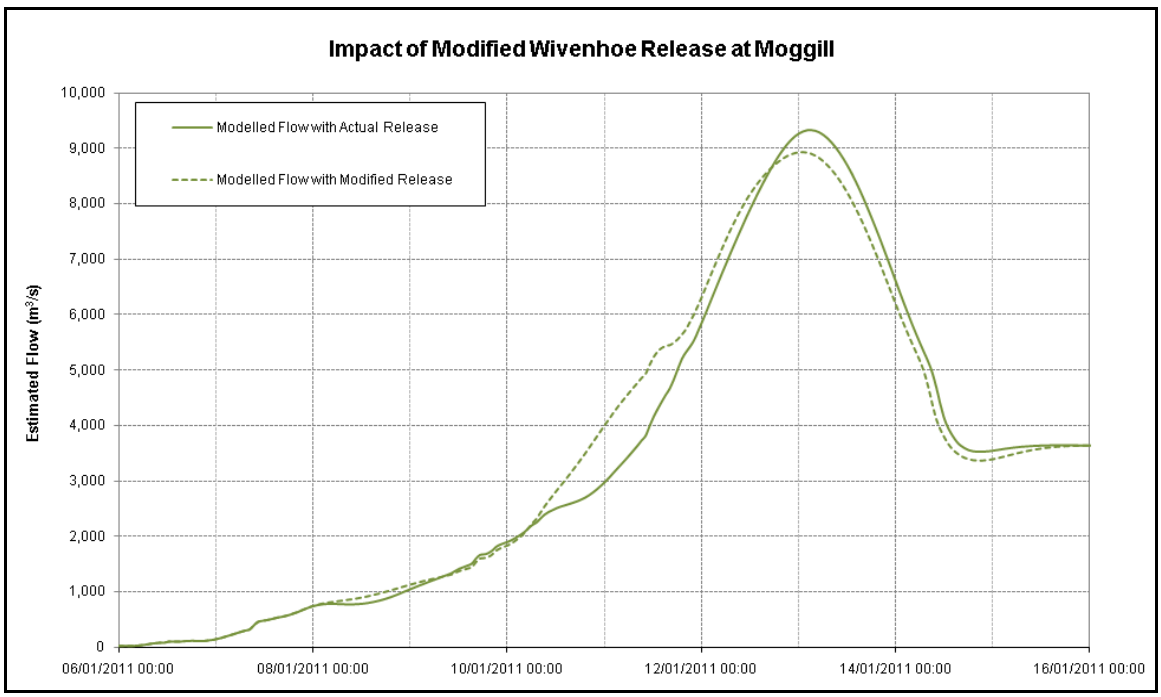


***Figure 2***

324. Thus, whilst the peak discharge from the dam would have reduced to less than 5,000 $m^3/s$, the reduction in the peak flow at Moggill would only have been small, and damaging flows would have started sooner and lasted longer.

325. In terms of peak height, Mr Malone said:[135]

> Figure 3 below shows that the modelled impact of releasing earlier from Wivenhoe dam as has been suggested would have had minimal impact on the peak height at the Brisbane Port Office gauge.

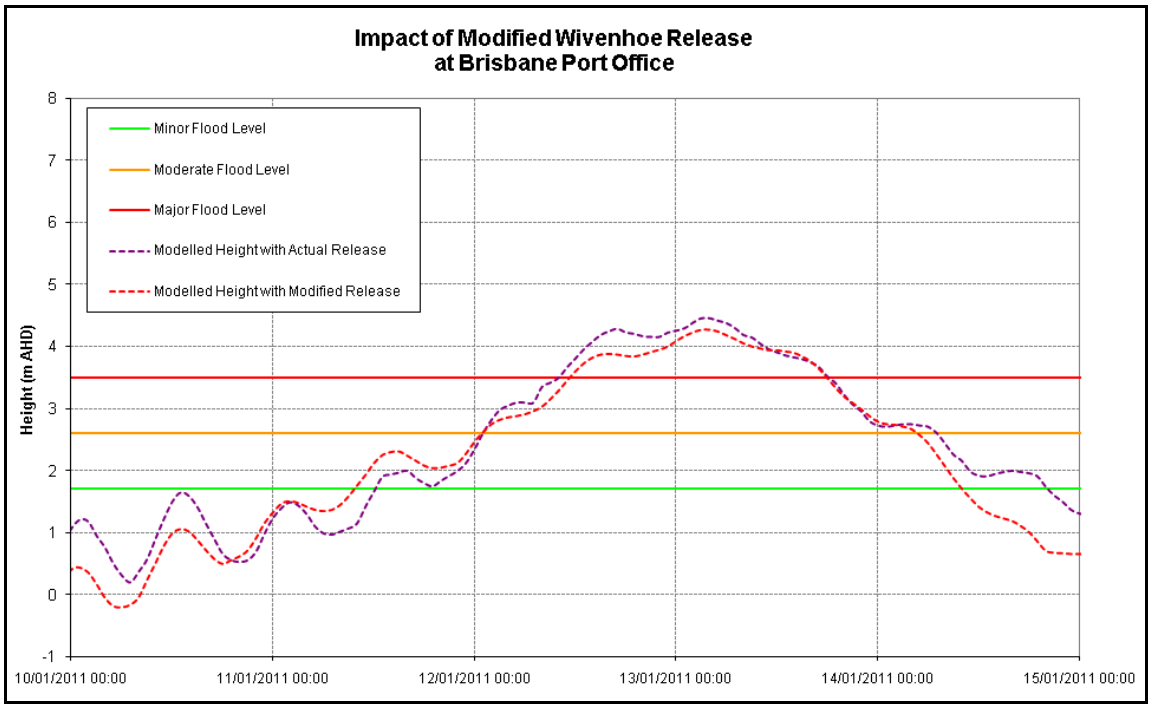


***Figure 3***

326. Thus there would have been minimal impact on the peak height at the Brisbane Port Office gauge. Mr Malone explained the reason for this as follows:[136]

> This is largely due to the interaction between the main river channel and its adjacent floodplain at several locations along the river between Wivenhoe Dam and Brisbane. This behaviour is driven as much by flood volumes as flood peaks. In the case of the early release strategy, flood volumes do not change. The flood peaks of the Lockyer River, Bremer River and local area runoff remains unchanged under the early release suggestion, hence the minimal impact in the lower reaches.

327. Mr Malone expressly acknowledged that his results were based on a hydrologic model, when a hydrodynamic model would be more appropriate and expected to give more accurate results. However, he also expresses the opinion that the results are indicative of the relative impact of the suggested change in the release strategy.[137]

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135 Ex. 33, paragraph 3(h).
136 Ex. 33, paragraph 3(j).
137 Ex. 33, paragraph 3(i).

328. There is no evidence before the Commission to contrary effect.

329. Moreover, the evidence supports the conclusion that it was inevitable that Strategy W4 would have to be invoked causing significant flooding in urban areas, given:

(a) the vast inflows to Wivenhoe Dam during the 72 hour period from Sunday, 9 January 2011 to Tuesday, 11 January 2011; and

(b) the physical storage capacity of the dam.[138]

330. Mr Tibaldi calculated the inflows in this period to be approximately 1.5 million megalitres.[139]

331. The significance of this was addressed in Mr Ayre's evidence:[140]

> MR O'DONNELL: I am interested in the figure 9.1.2 in the flood report. The dark blue line which starts in the bottom left-hand corner indicating the inflows to the dam. You see the distinguishing feature of the two large spikes in the middle of the page in the dark blue line?-- Yes.
>
> Being the two major inflows to the dam?-- They were, yes.
>
> All of which takes place between about Sunday the 9th and the end of Tuesday the 11th?-- Yes.
>
> So roughly three days?-- Yes, a very short duration event in the context of the flood volume.
>
> And could I ask you to assume the calculation, if you take from the 2.65 million megalitres, the inflows before and after the 9th to the 12th - in other words, you are just looking at what was the inflow on the three days, the 9th, the 10th and the 11th?-- Yes.
>
> We get a calculation of about 1.55 million megalitres?-- I believe that would be close to the mark, yes.
>
> So you have got about 1.55 million megalitres flowing into Wivenhoe over three days?-- Yes.
>
> Your flood capacity between level 68 and 74, if we look at what that capacity is compared to an inflow of 1.55?-- Notionally we have 1.42 million megalitres of flood storage available.
>
> I am interested in the levels between 68 and 74. If you look in the manual, please, if you go to page 52. That's appendix C to the manual?-- Yes.
>
> Now, down the left-hand column we have the levels and in the next adjoining columns we have the storage capacity and the flood capacity?-- Yes.
>
> I am interested in the flood capacity which you see starts at zero at level 67?-- Yes.
>
> If we look up to level 74, the flood capacity is 910,000 megalitres?-- Yes.
>
> So if my figures are right, the inflow on the three days is about 1.55 million megalitres, it is well in excess of the storage capacity between level 67 and 74?-- Yes.
>
> Did that have some - looking at it with hindsight - some inevitable consequences for the management-----?-- Certainly the characteristics of the event being a double peaked and effectively a back-ended loaded storm, meant that the size of the event during those periods was in excess of what is physically available in the flood mitigation compartments of Wivenhoe Dam.

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138 Detailed in Appendix C to the Manual.
139 T466/50-53.
140 T254/18-T255/29.

Does it have any consequence in terms of the inevitability of going to a W4 strategy and therefore releasing high rates of water?-- Well, the effect of it means you have got no other option, yes.

So whether you enter a W4 strategy on the Sunday night, or the Monday morning, or the Tuesday morning, with hindsight was it inevitable, given the rate of inflow that you would have to go to a W4?-- I believe it would have been, yes.

And therefore it would have been in combination with flows from the Bremer and Lockyer flooding into Brisbane?-- Yes.

## PART VII
## COMPLIANCE WITH THE MANUAL

332. **The Commission should find that, in their conduct of flood operations during the event, the flood engineers observed the operational procedures in the Manual**.

333. The consensus of expert opinion is that the flood engineers complied with the Manual.

334. The evidence of the peer reviewers on this topic, and the reasons why they support a finding of compliance with the Manual, were addressed in Seqwater's supplementary submission dated 4 April 2011.[141]

335. Mr Babister, the independent expert engaged by the Commission, was asked:

> Were the releases from the Somerset and Wivenhoe Dams in accordance with the flood manual?

336. Mr Babister's response was:[142]

> Three independent reviews found that the dam releases were in accordance with The Manual. Minor deviations were observed that were attributed to ambiguity with The Manual. Further discussion is provided in Section 5.6.

337. In effect, he restated the opinions expressed in the independent reviews, without casting any doubt upon them.

338. As is apparent from Section 5.6 of Mr Babister's report, whether the identified "deviations" amounted to non-compliance with the Manual depends primarily upon the interpretation of the Manual.

339. And, when the Manual is properly interpreted, it is plain that the identified "deviations" did not amount to non-compliance.

340. As to the implementation of Strategy W2:[143]

(a) In the definitive statement of the strategies, at the conclusion of the discussion of Strategy W1, it is stated:[144]

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

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141 Paragraphs 175-193.
142 Paragraph 167.
143 Referred to in paragraph 85 of Mr Babister's report.
144 Page 26, last paragraph.

(b) Thus the detailed statement of the strategies makes it clear that it is permissible to transition from Strategy W1 to Strategy W3 if that is adjudged to be appropriate.

(c) In the present case, such a transition was appropriate and in accordance with the Manual.

(d) The point was developed in Seqwater's Supplementary Submission dated 4 April 2011 as follows:

> [182] As explained in the Wivenhoe Flood Report, Strategy W2 was bypassed early in the event because it was not possible to limit the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill. This was not possible because the releases from Wivenhoe Dam at that time already exceeded the naturally occurring peaks at Lowood and Moggill.
>
> [183] The conditions for the adoption of Strategy W2 are set out on page 27 of the Wivenhoe Flood Manual and the conditions for the adoption of Strategy W3 are set out on page 28 of the Wivenhoe Flood Manual. The flow chart on page 23 of the Wivenhoe Flood Manual is a shorthand guide to the strategies which are explained in more detail later in the Manual; it does not supersede or override that more detailed explanation. Seqwater accepts that the flow chart on page 23 of the Wivenhoe Flood Manual does not accurately record the requirements of Strategy W2 as detailed on page 27 of the Wivenhoe Flood Manual. The flow chart will be corrected in the next version of the Wivenhoe Flood Manual.
>
> [184] There was no failure to comply with the Wivenhoe Flood Manual because the requirements of Strategy W2 could not be fulfilled at the relevant time, so the appropriate course was to invoke Strategy W3, which is what Seqwater did.
>
> [185] Put another way, there was no failure to comply with the Wivenhoe Flood Manual because:
>
> (a) The Wivenhoe Flood Manual does not require Strategy W2 to be adopted unless the conditions for its adoption are met.
>
> (b) In this case, those conditions were never met, and there was no point in attempting to invoke Strategy W2.
>
> (c) The Wivenhoe Flood Manual does not prevent the adoption of Strategy W3 as soon as its conditions are met.

341. As to the use of forecasts:[145]

(a) On Seqwater's interpretation, the Manual merely requires the forecast information to be gathered and taken into account, but leaves the particular use to be made of that forecast information to the professional engineering judgment of the flood engineers. There is no doubt that the flood engineers did this. The fact that they did not act on the faith of the blue "with forecast" line in making additional does gainsay this proposition. It was open to them to prefer what, in their professional engineering judgment, was a more reliable category of information.

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[145] Referred to in paragraph 86 of Mr Babister's report.

(b) However, even on the alternative interpretation, the Manual was followed. One cannot focus solely upon the use of the blue "with forecast" line as an ***affirmative criterion*** for the making of additional releases. On any view, the Manual does not dictate precisely ***how*** forecasts are to be used (with, or to the exclusion of, other categories of information). It is sufficient (on the alternative interpretation) for them to be used in any material way. And, as has already been observed, they were used by the flood engineers in four material ways during this event, including:

(i) as a ***negative criterion*** leading to a decision to refrain from making additional releases;

(ii) in making the most serious decision they made during the flood event, viz. the decision to transition to Strategy W4.

342. As to gate closure sequences after the flood peak had passed:[146]

(a) The Manual provides expressly that:[147]

> Rapid closure of radial gates is permissible however when there is a requirement to preserve storage or reduce downstream flooding.

(b) Plainly there was an imperative to reduce downstream flooding in the present case.

(c) Accordingly, the rapid gate closure sequence was amply justified, and in accordance with the Manual.

343. Mr Allen also addressed the matter in a preliminary way in his evidence:[148]

> From your review of the flood report, have you identified any respect in which the management of the dam during the flood event was not in accordance with the manual?-- I haven't found anything to date but I haven't completed my review of it at this stage.

344. This evidence tends to support the views of the other experts; it certainly does not contradict those views.

345. In these circumstances, the Commission should find that the flood engineers observed the operational procedures in the Manual.

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146 Ibid.
147 Page 32, last paragraph, first sentence.
148 T2097/3-9.

## PART VIII

## FULL SUPPLY LEVEL AT THE COMMENCEMENT OF THE EVENT

### INTRODUCTION

346. **The Commission should find that**:

(a) **The full supply level ("FSL") for Wivenhoe Dam is set by the *Moreton Resource Operations Plan* (the "ROP") made under the *Water Act* 2000 (Qld), not by the Manual**.

(b) **The decision whether to change the full supply level is one for the Director-General and the Minister**.

(c) **In December 2010, the Minister was provided with the following advice from the Water Grid Manager**:

(i) **Seqwater had advised that**:

A. **Pre-emptive releases to draw the Wivenhoe and Somerset Dams down to 95 per cent of their combined full supply level may provide some benefits in terms of reduced community and operational impacts during minor inflow events**.

B. **However, such pre-emptive releases would provide negligible benefits for medium and major flood events**.

C. **For large events, any impacts would require pre-emptive releases of at least 250,000 ML. This is equivalent to a release of about 16 per cent of the combined storage capacity of Wivenhoe and Somerset Dams**.

(ii) **From a water security perspective, the Water Grid Manager had no in principle objection to Wivenhoe and Somerset Dams being drawn down to 95 per cent of their combined full supply level**.

(iii) **From a water security perspective, the Queensland Water Commission had also confirmed that it did not have any objection to a release on this scale**.

(iv) **However, the Water Grid Manager would not recommend a pre-emptive release of the scale of 250,000 ML, based on information currently available. The potential water security impacts were considered to be more significant than the negligible benefits. These potential security impacts include costs associated with the earlier or avoidable operation of the desalination facility at capacity, as well as the increased probability of triggering the implementation of a drought response plan**.

(v) **The Water Grid Manager recommended that the investigations then underway with the Queensland Water Commission to examine the opportunity of raising the full supply level of Wivenhoe Dam for water supply be expanded to include options involving the release of additional water once major inflows are forecast**.

(d) **The Minister decided prior to Christmas 2010 not to reduce the dam levels to below full supply level**.

(e) **In view of the above, it was not open to Seqwater to reduce the water level in Wivenhoe Dam below full supply level in advance of the January 2011 flood event.**

(f) **The advice given by Seqwater in December 2010 in respect of large events was materially the same as the advice which it gave in February 2011**.

**FSL IS SET BY THE ROP**

347. By s95(1) of the *Water Act* 2000 (Qld):

> The chief executive may prepare a resource operations plan to implement a water resource plan for any water in the plan area ...

348. By s105(1) of the *Water Act* 2000 (Qld):

> The chief executive may amend a resource operations plan.

349. At all material times, the chief executive (within the meaning of these provisions) was Mr John Bradley, the Director-General of the Department of Environment and Resource Management.[149]

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149 T2024/11-15.

350. Mr Bradley delegated the task of preparing the ROP to his Deputy Director-General, Ms Debbie Best.[150]

351. The ROP was approved by the Governor-in-Council on 4 December 2009 and gazetted on 7 December 2009.[151]

352. Section 72 of the ROP provides:

> (1) The operating levels for the infrastructure in the Central Brisbane River and Stanley River water supply schemes are specified in Attachment 5, Table 1, Table 2 and Table 3.
>
> (2) The resource operations licence holder must not release or supply water from any infrastructure when the water level in that infrastructure is at or below its minimum operating level.
>
> (3) The resource operations licence holder must not release water from any infrastructure unless the release is necessary to:
>
> (a) meet minimum flow rates in section 75; or
>
> (b) supply downstream demand.

353. Attachment 5, Table 1, then provides (inter alia):

**Table 1 Wivenhoe Dam, Brisbane River**

| | |
|---|---|
| **Description of water infrastructure** | |
| Description | Zone earth fill and rock fill saddle dam |
| Full supply level | EL 67.0 m AHD |
| ... | ... |
| **Storage capacity** | |
| Full supply volume | 1 165 200 ML |
| ... | ... |

354. Thus the ROP is the legal instrument which sets the FSL.

355. It is unclear why Mr Bradley cavils with this obvious proposition.[152]

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150 Ex. 390, paragraph 33, attachment "JNB-8". T2024/25-31.

151 Ex. 390, paragraph 33.

152 Most recently in his fourth statement, which was made Ex. 527 during the bulk tender of documents at the conclusion of the final day of the public hearings.

356. The FSL is not simultaneously "set" by the Manual as Mr Bradley has suggested.

357. The Manual is not apt to set a legal standard of general application.

358. It applies only in flood events and even then Seqwater is under no legal obligation to comply with it.

359. Further, the Manual does not provide any legal authority for Seqwater to release water from the dams.

360. The release of water from the dams is governed by a suite of statutory instruments made under the *Water Act* 2000 (Qld). As to this:

(a) By condition 1 of Seqwater's Resource Operations Licence ("**ROL**"),[153] Seqwater must comply with the operational arrangements and supply requirements detailed in Chapter 5 of the ROP.

(b) By s72(3) of the ROP,[154] there is a prima facie prohibition on releasing water save (relevantly) to meet downstream demand.

(c) This prima facie prohibition is, however, modified by an interim program,[155] which permits releases to be made for flood mitigation purposes.

(d) These instruments carry important legal consequences, for it is an offence under s813(1) of the *Water Act* 2000 (Qld) for Seqwater to contravene a condition of its ROL.

361. The proposition that this is the operative legal framework is reinforced by the way in which the temporary reduction in the Wivenhoe lake level was effected in February 2011. That reduction entailed an amendment to the ROP, and the approval by Mr Bradley of a revised interim program submitted under the (amended) ROP.[156]

362. The latest revision of the Manual was obviously drawn against the background of this legal framework. As Mr Borrows said during the telephone discussion with Mr Bradley and others on 8 February 2011, the Manual is a "taker" rather than a "decider" of FSL.[157]

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153 Made under Chapter 2, Part 4, Division 3 of the *Water Act* 2000 (Qld).
154 Made under Chapter 2, Part 4, Division 2 of the *Water Act* 2000 (Qld).
155 Made under s13 of the ROP.
156 Ex. 390, paragraphs 62, 63, 65, 66, and 68.
157 Ex. 393, attachment "PB-21", second page, at about point 6 on the page.

**MECHANISM FOR CHANGING FSL**

363. The FSL could only be changed by a variation to the Moreton ROP. The Minister gave an accurate account in his evidence:[158]

> Can I ask you the question what is the actual mechanism by which the full supply level of Wivenhoe might be changed, either temporarily or permanently?-- If we decided to go down that path, the first thing that would have to have occurred was the Resource Operations Plan for the Moreton Basin would have to have been changed, because that's the overarching regulation that determines how much water can be stored. Once that would have been amended by regulation, it would have then been open to Seqwater to then seek to change the dam operation manual to reflect the new determined full supply level.
>
> All right. So the Resource Operation Plan has to be changed. You say it is the overarching regulation?-- As I understand it, yes.
>
> All right. How is that changed? How do you change that?-- That is changed by the Director-General and goes to - then goes to myself, and then goes to Governor in Council, because it is a regulation under the Water Act.
>
> All right. So, ultimately, whilst it might be initiated by the Director-General and signed off by the Governor, that's your decision?-- I'm part of the approval - I'm part of the approval process, yes.
>
> Well, as responsible Minister, it is your decision, isn't it?-- It's in the first instance the Director-General's decision, yes.
>
> He works for you?-- Sure, and it's put to me for approval, I then take it to Cabinet, and then to Governor in Council.
>
> Yes. Okay. So, it's you and Cabinet agrees with it before it actually happens; is that right?-- Correct.

364. Later, the following exchange occurred:[159]

> Well, you, on advice from your Director-General who works for you and after consultation with Cabinet, can amend the Resource Operation Plan?-- That's right. Yes. And that's the topic that we're on at the moment?-- Yes.
>
> Is the reduction of the full supply level?-- Correct.
>
> You're the only one who can effect that?-- Yes.

**ADVICE GIVEN TO MINISTER IN DECEMBER 2010**

365. The advice given to the Minister in December 2010 was reduced to writing in a letter from the Water Grid Manager to the Minister dated 24 December 2010, together with an attachment prepared by the Water Grid Manager.[160]

366. The advice conveyed by the Water Grid Manager's letter was relevantly:

(a) Seqwater had advised that:

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158 T30/29-T31/19.
159 T36/22-31.
160 Ex. 10, attachment "SR-11".

(i) Pre-emptive releases to draw the Wivenhoe and Somerset Dams down to 95% of their combined full supply level may provide some benefits in terms of reduced community and operational impacts during minor inflow events.[161]

(ii) However, such pre-emptive releases would provide negligible benefits for medium and major flood events.[162]

(iii) For large events, any impacts would require pre-emptive releases of at least 250,000 ML. This is equivalent to a release of about 16 per cent of the combined storage capacity of Wivenhoe and Somerset Dams.[163]

(b) From a water security perspective, the Water Grid Manager had no in principle objection to Wivenhoe and Somerset Dams being drawn down to 95 per cent of their combined full supply level.[164]

(c) From a water security perspective, the Queensland Water Commission had also confirmed that it did not have any objections to a release on this scale.[165]

(d) However, the Water Grid Manager would not recommend a pre-emptive release of the scale of 250,000 ML, based on information currently available. The potential water security impacts were considered to be more significant than the negligible benefits. These potential security impacts include costs associated with the earlier or avoidable operation of the desalination facility at capacity, as well as the increased probability of triggering the implementation of a drought response plan.[166]

(e) The Water Grid Manager recommended that the investigations then underway with the Queensland Water Commission to examine the opportunity of raising the full supply level of Wivenhoe Dam for water supply be expanded to include options involving the release of additional water once major inflows are forecast.[167]

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161 This appears on the page 1 of the letter and on page 5 of the attachment.

162 This appears on page 1 of the letter and on page 4 of the attachment in the first dot point in the paragraph commencing "Seqwater has advised that ...".

163 This appears on page 4 of the attachment in the second dot point in the paragraph commencing Seqwater has advised that ...". See also the evidence given by the Minister at T54/4-T55/25 and T58/8-T59/15.

164 This appears on page 1 of the letter and page 5 of the attachment.

165 This appears on page 2 of the letter.

166 This appears on page 4 of the attachment in the paragraph commencing "A pre-emptive release of this scale is not recommended ...". See also the evidence given by the Minister at T54/4-T55/25 and T58/8-T59/15.

167 This appears on page 2 of the letter and page 4 of the attachment.

367. It seems the Minister had decided not to reduce the dam levels to below full supply level earlier in December 2010 after the substance of the advice had been conveyed to him by the Water Grid Manager.[168]

368. Accordingly, it was not open to Seqwater to reduce the water level in Wivenhoe Dam below full supply level in advance of the January 2011 flood event.

369. The advice given by Seqwater in December 2010 in respect of large events was materially the same as the advice which it gave in February 2011. As to this:

(a) As we have seen, Seqwater's advice in December 2010 was that:

(i) for large events, any impacts would require pre-emptive releases of at least 250,000 ML;

(ii) this is equivalent to a release of about 16 per cent of the combined storage capacity of Wivenhoe and Somerset Dams.

(b) As the Minister accepted in his evidence, 16 per cent of the combined storage capacity of Wivenhoe and Somerset Dams equates to approximately 25 per cent of the storage capacity of Wivenhoe Dam alone.[169]

(c) Seqwater's advice of 10 February 2011 was that a reduction in Wivenhoe Dam's storage level to 75% of its FSL will provide appreciable flood mitigation benefits.[170]

370. There was, however, a difference in the advice given by the Water Grid Manager at these two times. As to this:

(a) As we have seen, the Water Grid Manager's advice in December 2010 was that it would not recommend a pre-emptive release of the scale of 250,000 ML, based on information currently available. The potential water security impacts were considered to be more significant than the negligible benefits. These potential security impacts include costs associated with the earlier or avoidable operation of the desalination facility at capacity, as well as the increased probability of triggering the implementation of a drought response plan.

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168 T35/5-30; T409/9-20; T41/18-T42/19; T44/2-35

169 T58/12-40.

170 Ex. 10, attachment "SR-18".

(b) In February 2011, the Water Grid Manager advised that it had no objection, from a water security perspective, to Wivenhoe Dam being drawn down to 75% of its full supply level.[171]

371. This new advice from the Water Grid Manager, which was to the effect that water security would not be prejudiced, was one of the essential pre-requisites to Seqwater making its recommendation on 10 February 2011.[172]

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171 This advice was conveyed by letter from the Water Grid Manager to Seqwater dated 9 February 2011: see Ex. 393, attachment "PB-22". It was also referred to in Seqwater's letter to the Minister dated 10 February 2011: see Ex. 10, attachment "SR-18".

172 T2240/10-T2241/9.

## PART IX
## REVIEW OF THE MANUAL

372. As at the date of these submissions, Seqwater has not received the Commission's response to Seqwater's Draft Study Proposal for Wivenhoe Dam and Somerset Dam Optimisation Study.

373. Seqwater will await receipt of that response, and receipt of any preliminary findings or recommendations, before making detailed submissions on this topic.

374. However, it is appropriate to step back so as not to lose sight of some fundamental propositions.

375. In accordance with standard practice, it is essential that the Manual be reviewed in light of the January 2011 event.

376. However, it is not necessary for the Manual to be amended to properly reflect the strategies as applied by the flood engineers. Upon its proper interpretation, the Manual already properly reflects those strategies.[173]

377. Further, it is important that the issues concerning the Manual be kept in perspective.

378. ***First***, none of the flood engineers were uncertain as to what it meant or required.[174] If the Manual is perceived by others to be ambiguous, that is of little moment.[175] Care must be taken not to do violence to the Manual in the name of making it clearer for those who would not ordinarily have access to it, and who will never have to use it in flood operations. The risk is that a document which is presently clear to the flood engineers will be replaced with one that does not reflect their understanding of the technical concepts involved, or that denies them the flexibility to exercise the professional engineering judgments which are integral to the proper conduct of flood operations.

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173 These matters are addressed in detail in Part IV above.

174 Again, the evidence as to the flood engineers' common understanding is addressed in detail in Part IV above.

175 It is important here to not to confuse ***deliberate flexibility*** with ***lax ambiguity***. The Commissioner expressed a concern the substance of which was that "there are about three different ways in which it is expressed in the manual which could mean you take into account forecast rainfall ... which could mean that you just take into account the run-off, which could mean you just look at the water in the dam": T382/42-52. However, for the reasons developed in Part IV above, language such as "likely" and "predicted" was chosen carefully because it is elastic enough to accommodate the making of decisions on the basis of any of these categories of information, depending upon the professional engineering judgment of the flood engineers. This preservation of flexibility is desirable. It is a virtue, not a vice.

379. ***Secondly***, the Manual in its present form provides a reasonable balance between the objectives of preserving dam safety while mitigating the damage and disruption of flooding in downstream areas.[176]

380. ***Thirdly,*** the Manual has served the community well for over 30 years.[177] In this regard, the conduct of operations in accordance with the Manual during flood events in March 1989, April 1989, February 1999, October 2010 and December 2010 ensured that unnecessary damage was not inflicted in areas below Moggill.[178]

381. ***Fourthly***, no mitigation strategy, and therefore no Manual, can produce the optimal outcome for all floods.[179]

382. ***Fifthly***, it is clear that any changes to the operating procedures in the Manual would not have avoided urban inundation given the magnitude of the January 2011 event.[180]

383. There is one final observation which should be made before leaving this topic. The scope of any concerns the Commission may have about particular language in the Manual is not presently clear to Seqwater. However, it is apprehended that a number of concerns may exist, given this statement which Mr Callaghan made to Mr Ruffini:[181]

> ... I can understand the whole manual has to be reviewed – and I would suggest to you that it flawed in many respects, some perhaps unimportant in the scheme of things, some quite serious – and that a comprehensive review of the whole manual may well take a long time, or at least many months. But ...

384. Mr Callaghan did not identify for Mr Ruffini (or any other witness) the "many respects" in which he apparently perceives the Manual to be flawed. They have not been disclosed to Seqwater. Accordingly, Seqwater is not presently in a position to address them.

385. Plainly the Commission should not make any findings reflecting Mr Callaghan's undisclosed perceptions prior to:

(a) the witnesses with the appropriate engineering skill and experience, including the flood engineers, being given the opportunity to address the issues – as we have been

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176 Report of Mr Babister, paragraph 137.
177 T2084/52-57.
178 Ex. 53, paragraphs 15-16.
179 Report of Mr Babister, paragraph 168.
180 This is evident from a number of sources including: (a) the evidence referred to in Part III above; (b) the modelling attached to Mr Malone's second statement: Ex. 33; (c) the evidence as to the sheer volume of inflows on 9, 10 and 11 January, 2011 compared with the finite flood storage capacity of the dam referred to in Part VI above; (d) Mr Babister's opinion that under the current operational procedure it is unlikely that reducing the dam to 75% of FSL would have had a significant impact on flood levels downstream of the dam: Report of Mr Babister, paragraph 172.
181 T316/20-25.

at pains to point out, their perceptions are the ones which are legally and practically significant;

(b) Seqwater being given the opportunity to address the issues by reference to that evidence.

## PART X
## MISCELLANEOUS

386. A number of other issues arose during the public hearings. These are dealt with in turn below.

### FLOOD OPERATIONS CENTRE

387. In his opening statement, Mr Callaghan SC suggested that the conditions in the Flood Operations Centre[182] "*seemed to us to have fallen short from this which should have in such a vital workplace*".[183] Mr Callaghan SC then referred to a number of examples of matters to be considered (including loss of power, difficulty contacting relatives and difficult sleeping arrangements).

388. The evidence does not support any finding that the conditions at the Flood Operations Centre were lacking in any material respect.

389. Although it is clear that the magnitude of the event severely tested the Flood Operations Centre, the engineers, the technical assistants and the dam operators, all performed very well under the challenging circumstances of the event.

390. It is true that some flood engineers identified some areas where minor improvements could be made.[184] Seqwater's Flood Event Report identifies similar matters.[185]

391. But at no time:

(a) did the Flood Operations Centre lose power;

(b) did the Real Time Flood Model suffer system failure; or

(c) was the decision making of the engineers adversely impacted,

because of the minor issues identified above.

392. It was also suggested that the flood engineers in the Flood Operations Centre were distracted by, for example, communications with BCC regarding the threshold of damaging flows.[186]

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182 The Flood Operations Centre is located in SunWater's premises and is made available to Seqwater under the Service Level Agreement – Ex. 416-service schedule.

183 T20/41-57.

184 See Mr Ayre's statement (Ex. 17) at paragraphs 140, 395, 396, 397 and 399. See also T115/41-55.

185 Ex. 24 – sections 13 and 14.

But this suggestion is without foundation. Communications between agencies, in particular between the Flood Operations Centre, BOM and councils is critical to the management of flood events. Indeed, as has already been observed,[187] far from being a distraction, this particular communication with BCC was proper to achieve the best overall outcome.[188]

393. The Commission should also note that, consistent with plans in place prior to the January 2011 event, a new Seqwater Flood Operations Centre will be in place from 1 July 2011. In making these new arrangements, Seqwater is giving appropriate consideration to the minor issues referred to in paragraph 390 above.

**REAL TIME FLOOD MODEL**

394. There is no issue that the Real Time Flood Model (as a rainfall runoff-routing model) is an appropriate tool to assess flood mitigation strategies and be used in real-time flood estimation.[189]

395. However, an issue arose during the public hearings relating to whether the Real Time Flood Model used by Seqwater was aged and whether this had any impact on operations.[190]

396. Although it is true that the software was developed 15 years ago, the Real Time Flood Model has been the subject of ongoing updates, calibration and successful use in actual events.[191]

397. The evidence demonstrates that the Real Time Flood Model performed well during the January 2011 event.[192]

398. In particular, the Real Time Flood Model:

(a) operated in a stable manner;[193]

(b) provided sufficient information to make operational decisions;[194] and

(c) produced results which correlated with the output of other modelling platforms.[195]

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186 T117/15-28.
187 See paragraph 311 of these submissions.
188 T213/26-30.
189 Ex. 407, paragraph 126
190 T80/39-T81/3.
191 Ex. 24 – section 7.
192 Ex. 24, page 215.
193 Ex. 17, paragraph 198; Ex. 44, p 5.
194 Ex. 17, paragraphs 198; Ex. 24, section 7.3 (p 110); T110/5-9; T2127/30-39.
195 Ex. 17, paragraphs 198; Ex. 24, section 7.3 (pp 110-112).

399. Dr Nathan concluded in his report:[196]

> The configuration and calibration of the flood simulation model, which is the core of the system, is consistent with established practice. The manner in which historic and forecast rainfalls are input to the model is adequate, and the method used to adjust rainfall losses during the event is soundly based on observed data. The model allows for flows associated with earlier rainfalls to be adequately considered, and appropriate steps are taken to help ensure that all inputs are reconciled prior to determining the required gate operations.

400. In his oral evidence, Mr Babister said:[197]

> most of the components of the real time model are actually quite good. They seem to perform well.

401. Accordingly, there is no foundation in any suggestion that the apparent age of the Real Time Flood Model adversely impacted on flood operations.

402. A further issue which arose was whether Seqwater should have used a calibrated hydrodynamic model during flood operations in January 2011. Mr Babister recommends that such a model be used during real time operations. However, Mr Babister's opinion is:

(a) against the weight of expert evidence;[198] and

(b) is expressed by an expert who frankly conceded he did not have any experience in using hydrodynamic models in real time flood operations.[199]

403. Further, Mr Babister said it was unlikely the way the dam was operated in the January 2011 flood event would have changed significantly had a hydrodynamic model been used (in addition to the Real Time Flood Model).[200]

404. The Commission should also note that Seqwater is currently in the process of implementing a new software system[201] to replace the RTFM. The new system will incorporate the existing hydrologic models and a new suite of hydrologic and hydrodynamic models, will be state of

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196 Ex. 409, p i.

197 T2220/2-3.

198 Dr Nathan was firmly of the opinion that a hydrodynamic model should not be used in real time operations as anything other than a back up. He said the flood engineers should direct their time to the areas of most uncertainty, which was in the rainfall and run-off estimates which are not areas for the hydrodynamic model – see T2292/38 – 2293/2 and T2304/18-43. Also, in a response to the Commission's list of issues, Colin Apelt has expressed a firm view that a hydrodynamic model should not be used in real time flood operations. Terry Malone and Barton Maher have expressed reservations about the use of the model in real time flood operations in their responses to the Commission's list of issues.

199 T2199/29-35.

200 Ex. 407, paragraph 171.

201 The Deltares FEWS system – see Ex. 17 paragraph 162 and Ex. 24 p 215.

the art, and will be operational before the next wet season. Seqwater presently expects to operate the new system in parallel with the RTFM next wet season.

**COMMUNICATION DURING FLOOD EVENTS**

405. Seqwater has previously made detailed submissions to the Commission in relation to Seqwater's role in communications during the January 2011 flood event.[202] A detailed account of those communications is contained in Mr Drury's witness statement.[203]

406. In short:

(a) Seqwater is not compelled to perform any specific functions under the *Disaster Management Act* 2003 (Qld);

(b) once an emergency was declared under the Grid Emergency Response Plan on 10 January 2011, Seqwater was not to present a public face independent of the Grid Manager;[204]

(c) Seqwater is not responsible for communications with residents in respect of dam releases or flooding. This is the responsibility of Councils. Seqwater is responsible for the provision of timely information relating to dam releases to BOM and Councils for use by those agencies in developing warnings.[205]

407. It is beyond doubt that Seqwater issued timely information relating to dam releases to BOM and Councils.[206] Seqwater is not aware of any suggestion by the Commission to the contrary.

408. The evidence also establishes that Seqwater complied with the draft protocol governing communications of flooding information for the Brisbane River catchment.[207]

409. Seqwater notes that a number of submissions from the public, particularly residents downstream of Wivenhoe Dam and North Pine Dam, have suggested that Seqwater has responsibility for warning residents of impending releases from the dams. For the above reasons, Seqwater has no such responsibility.

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202 Section D of Seqwater's Supplementary Submission dated 4 April 2011.
203 Ex. 430.
204 Ex. 430, paragraph 22 and Seqwater's Supplementary Submission dated 4 April 2011 paragraph 117.
205 Ex. 430, RD2.
206 Ex. 430, particularly RD5; Ex 24, Appendix E; Emails containing actual and projected releases issued by Duty Engineer to BOM and BCC in Ex. 433 Annexures 43-55.
207 Ex. 430.

410. Plainly, this is appropriate. Seqwater is not responsible for predicting river levels or issuing flood warnings. There are a range of emergencies in respect of which councils must communicate with residents (including bushfires, storm surges, tsunamis, earthquakes and flooding). It does not make sense, and will be apt to cause confusion for residents, if Seqwater is charged with responsibility to warn residents of dam releases, particularly given:

(a) flooding may not arise following dam releases;

(b) flooding may arise even if there are no dam releases.

411. **The Commission should find that Seqwater has no responsibility for issuing warnings to residents downstream of Wivenhoe Dam and North Pine Dam or residents generally**.

412. The Commission should also note Seqwater's proposal (set out in Seqwater's Flood Event Report of 2 March 2011[208]) that there be a review of the draft protocol governing communications of flooding information for the Brisbane River catchment and the protocol should be finalised.

**NORTH PINE DAM**

413. Mr Callaghan raised with Mr Allen the potential inadequacy of the North Pine Dam spillway.[209] This issue was first raised by Seqwater in the North Pine Flood Event Report dated 11 March 2011.[210]

414. As Mr Allen noted, Seqwater is investigating the issue and most of the work will be completed by the end of June 2011.[211] The work is proceeding in accordance with the requirements of the Dam Safety Regulator.[212]

415. Critically, Mr Allen noted that "*there's no risk to the every day safety of North Pine*".[213]

416. Given the above, the Commission should not make any recommendations in respect of this matter.

417. A separate issue was raised as to whether local residents should be permitted vehicular access across the dam wall when downstream crossings are flooded.[214] But there are very good reasons why this has not been permitted by Seqwater (including workplace safety issues).[215]

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208 Ex. 24, pp 221, 222 and 225.
209 T2075/33-54.
210 Ex. 30, piii (last bullet point).
211 T2075/56-58.
212 Ex. 30, piii (last bullet point).
213 T2076/17-19.

418. The Commission should not recommend the granting of vehicular access across the dam wall during flood events.

**SEQWATER'S FLOOD PREPAREDNESS**

419. Late in the public hearings, it was faintly suggested for the first time that Seqwater was not properly prepared for the flood season.[216] The suggestion was made in view of the lapsing of Mr Ruffini's registration and later questions focussed on an apparent gap between the extension of the Service Level Agreement under which SunWater Limited provides flood services to Seqwater.[217]

420. Seqwater's flood preparedness is clearly set out in Exhibit 26. It is also explained in the Flood Event Report.[218] None of this was challenged.

421. The Service Level Agreement pursuant to which SunWater Limited provides certain flood services to Seqwater was in place (practically and legally) at all times during the flood season.

422. The lapsing of Mr Ruffini's registration does not alter the position. It is the personal responsibility of each engineer to retain their registration and there were exceptional circumstances surrounding the lapse in registration in any event.

B O'Donnell QC

A Pomerenke

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214 T1516/14-44.

215 T2261/9-28.

216 T2250/2-8. It is hardly surprising that Seqwater's Chief Executive Officer was not able to list (in the witness box) specifically what is done by Seqwater by way of preparation for each wet season. These are clearly operational matters.

217 T2250-2252

218 Section 4.