QUEENSLAND FLOODS COMMISSION OF INQUIRY

JOINT EXPERT STATEMENT

BREMER RIVER FLOOD FREQUENCY

25 OCTOBER 2011

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Report of the Chair

1. The Queensland Floods Commission of Inquiry ("the Commission") commissioned a report from Mark Babister as to flood frequency at Ipswich, resulting from Brisbane and Bremer River flows. Mr Babister's final report was received in October 2011. That report was the subject of a review by Dr Michael Leonard. Dr Leonard's report was also received by the Commission in October 2011.
2. The Commission then wrote to interested parties, inviting the submission to the Commission of any further expert evidence. As a result of that communication, further reports were submitted.
3. The result of that process was the accumulation of a solid body of expert opinion.
4. It was then determined by the Commission that a conference of the experts would be held, chaired by an independent party, with a view to establishing common ground between the experts.
5. The conference occurred on 24 October 2011 between 10am and 1pm at a conference room in The Marque Hotel, 103 George Street, Brisbane. Participants in the conference were Peter Davis SC (Chair), Mark Babister, Neil Collins, Dr Sharmil Markar, Dr Michael Leonard and Dr Rory Nathan.
6. At the start of the conference, a list of nine questions was distributed to the experts. These questions served as a focus of the discussions. The questions appear as annexure "A" to this report.
7. The participants in the conference had all participated in the conference of expert hydrologists (Brisbane River Flood Frequency) which had been held on

23 October 2011. Much of what was agreed in the conference of 23 October 2011 was considered by the experts in the conference of 24 October 2011 to apply to the issue of Ipswich flood frequency. Therefore, it will be noted that in many respects, this report repeats matters that were agreed in the conference of 23 October 2011.

8. The experts who conferred on 24 October 2011 formed the view that it was necessary, in stating their position concerning Ipswich flood frequency, to make the statement which appears below under the heading *"Context of the Issues for Determination"*.

9. Following the statement under the heading *"Context of the Issues for Determination"* is the agreed position of all experts at the conference in relation to each of the questions posed. Each of the experts has signed this report in acknowledgement of their agreement with its contents.

Dated at Brisbane this 25th day of October 2011.

Peter J Davis SC

Context of the issues for Determination

10. Characterising flood behaviour over the full probability domain is an essential requirement for sound risk-based planning and management. See, for example, National Flood Risk Advisory Group Guidelines; Floodplain management in Australia: best practice principles and guidelines (SCARM Report 73).

a. The costs of flooding are balanced against the costs of protection. (Costs is defined in a broad sense, so as to include social, economic, environmental costs.)

    i. There are a number of different issues including but not exhaustively: population density; ease of evacuation; damage to property; potential for loss of life; critical infrastructure; impacts on development costs and property values.

    ii. Note: different flood events are weighted with their different probabilities.

b. The probability domain required to address sound risk-based management spans from a 1 in 2 flood event to the probability approaching that of the probable maximum flood ('PMF').

11. Flood behaviour looks to the peak flows and volumes of the flood and probable inundation levels, not just a Q100 figure, which is a single exceedance probability ('AEP') which may or may not be the appropriate figure in all management circumstances.

12. All experts agree with the propositions in paras 10 and11, which all agree represent best national practice.

13. Additional complexities are added to the study of the Ipswich area by the interaction between the Brisbane and Bremer rivers leading to influence of Brisbane River backwater on flood levels in Ipswich. These additional complexities require special consideration over and above estimation of flooding in the lower Brisbane River. Flooding can be experienced in Ipswich by force of the effects of the Brisbane River and/or the Bremer River, and in

some circumstances flooding will occur without influences from the operation of the Wivenhoe and Somerset Dams.

Answers to questions

Question 1

14. What is needed in the context of issues of such potentially wide-ranging impact is to complete a comprehensive flood study that includes an analysis of flood behaviour throughout the entire Brisbane River catchment including the Bremer River in order to determine the flood risk along the lower reaches of the Brisbane and Bremer rivers.
15. All experts agree that any comprehensive study would include a full range of floods including an estimate of Q100, e.g. a 1 in 2 flood to the PMF.
16. The reports that have been received deal only with flooding from the Lower Bremer and Brisbane Rivers. Any comprehensive approach may involve detailed analysis of other local tributary catchments. Hydraulic modelling will identify the limits of the backwater influence and standard techniques of flood estimation can be used upstream of the backwater limits.
17. The intention of the study should be to be comprehensive in terms of the data sources used and the range of the best practice methodologies applied, and the intention here is not to prescribe the particular methodology or to restrict the flood study to one particular methodology. The experts all agree that reconciling the outcomes of different methodologies ought to allow the corroboration of results.
18. Below is a list of factors to be taken into account in preparing any comprehensive flood study:
    a. Data;

b. Hydrological model;[1]

c. Hydraulic model.[2]

Data

19. All experts experienced some frustration by the fact that there is not a central repository of all the available data and all experts agree that it is essential that such a repository be created, maintained and updated constantly and be available for access by all relevant stakeholders.

20. This would include accumulation of all data that is presently available from different sources, together with the results of any review and analysis of all that data.

21. The collection of further data on significant events is warranted. All experts suspect that there is such data even for events that are now very old, for instance there could be a reconstruction of astronomical tides during 1841 and other periods before the installation of tide gauges. Events such as the 1841 flood for instance, while primarily impacting Brisbane still have relevance to flood behaviour in the Ipswich area. Concerns have also been expressed that the data has in the past been analysed by a range of different methodologies, which therefore affects the consistency of interpretation. Care needs to be taken before accepting data that has been relied upon in the past, e.g. data prepared by agencies to construct flow sequences, ratings and topography for Brisbane and Bremer Rivers that has been used as a basis for other studies, without some underlying assumptions in the collection and analysis of the data

[1] By this term, the experts mean the model for the transformation of rainfall to streamflow.
[2] By this term, the experts mean the model for the transformation of streamflow to inundation levels and extents.

being documented or made publicly available. All experts agree that there are many examples.

22. Sources of data and methods of derivation where relevant:

    a. Channel and floodplain characteristics for hydraulic modelling (current and historic conditions)

        i. Topographic data (LIDAR, bathymetry);

        ii. Structures;

        iii. Vegetation state of the flood plain;

        iv. Survey datum;

        v. Development in the flood plain;

        vi. Sediment transport characteristics of the Brisbane and Bremer Rivers and major tributaries;

    b. Rainfall:

        i. Historic rainfall data – Sub-daily, daily-point rainfall – the experts understand that this has been compiled by Seqwater with data going back to the 1800s although even this is incomplete and is still being compiled;

        ii. Radar datasets relevant to historic storm events since inception, plus documentation;

        iii. Probabilistic rainfall data – need an agreed comprehensive dataset (including average depth over catchment , temporal and spatial patterns);

    c. Stream flow – observed levels (peak, continuous and anecdotal), flow gaugings and rating curves over different time periods;

d. Tide levels (historic and probabilistic) – including astronomical tides, tidal anomalies, including storm tides, synoptic systems, and wind information;

e. Historic inundation extents and levels;

f. Dam operations, discharges and level data;

g. Historic land use conditions;

h. Synthetic time series of Somerset and Wivenhoe dam behaviour (water level inflow and outflow) over extended periods corresponding to current dam operating conditions.

Hydrological modelling

23. The experts agree that while that it may not be practicable that there be one model for use by all the various agencies, such as Brisbane City Council, Seqwater, Ipswich City Council, Bureau of Meteorology, Department of Environment and Resource Management etc., it is imperative that the different models reflect a common understanding of data and flood behaviour. Models required for flood forecasting and dam operational purposes will have some different requirements to that specified below.

24. In order to characterise flood behaviour over the full probability domain the flood models would need to be run in a Monte Carlo framework where the following factors need to be treated in a probabilistic manner. The factors are:

    a. Temporal and spatial patterns of rainfall to help address the question of different timing and hydrograph shape of tributary inflows and dam outflows;

    b. Initial catchment conditions (catchment moisture conditions);

    c. Initial water level in dams;

d. Potential variability of operating procedure and physical operating conditions;

e. Tidal conditions, including tidal anomalies;

f. Long-term inflow volumes and rainfall;

g. The correlation between the above factors, which should be conditioned by physical reasoning including advice from hydrometeorological experts.

25. For design purposes, the model needs to demonstrate its ability to reproduce flood behaviour in a consistent manner at key locations in the catchment, including Brisbane City and Ipswich City, with regard to factors including:

a. Hydrograph attenuation;

b. Flood volume frequency distribution;

c. Peak flow frequency and distribution;

d. The observed variability in the timing of major tributary flows;

e. Flood behaviour under no dam conditions and flood behaviour under current conditions;

f. The probabilistic flood level frequency behaviour in the Ipswich area.

26. Flood frequency analysis of peak flows and volumes is required as validation at all key downstream locations, including unregulated tributaries and the Bremer River under no dam and current conditions. This information will need to be used to reconcile any differences between the different methods at sites unaffected by backwater influence.

27. Consideration should be given to pooling regional information where considered relevant and appropriate.

Hydraulic model

28. Models required for flood forecasting and operational purposes will have different requirements to that specified below. The modelling below is aimed specifically at determining flood levels, flows and extents for the Bremer River from just upstream of Ipswich City and the lower Brisbane River, including any backwater influences due to the Brisbane River.
29. Models for site-specific investigations may be required and these would need to be developed in a manner consistent with the hydraulic model of the whole lower Brisbane River.
30. Attention should be given to the trade-off between model complexity and practicality of use. Development of a suitable industry standard 1D/2D hydrodynamic model of the lower reaches of the Bremer and Brisbane rivers is required. This model needs to be suitable for assessing historical changes to the river bathymetry and needs to have a run time that is practical for detailed calibration and assessment of changes, it is expected that some hundreds of simulations would be required for both calibration and assessment purposes.
31. The non-unique relationship between flow and level as derived from the hydraulic models would need to be considered in the hydrological modelling at locations heavily influenced by downstream conditions.
32. Consideration should be given to the ability of the model to handle moveable bed conditions during a flood to evaluate sensitivity of flood levels to changing river conditions (scour and deposition).
33. The joint-probability of flooding and elevated ocean levels needs to be considered in a manner that takes advantage of both hydrologic and hydraulic modelling frameworks.

Other comments

34. In order to achieve the consistency and shared understanding of the data and modelling outputs, the relevant stakeholders should be involved in the assessment of model calibration and performance.
35. The experts agree that all of the above modelling would be most appropriately carried out in conjunction with the Commission's recommendations 2.12 and 2.13, and with the Wivenhoe and Somerset Dam Optimisation Study.
36. The experts agree that the interaction between flood levels in the Brisbane and Bremer Rivers need to be carefully and precisely modelled. This might require development of a separate, more detailed model to investigate these influences, or at least be given special consideration in the design of the overall model.
37. The experts also agree that a factor relevant to the study will be climate change. There is considerably more uncertainty about how rainfall will change than ocean levels. The influence of these factors on flood estimates and planning should be assessed.

Question 2

38. Both analyses suffer the same broad limitations of being prepared without the benefit of the comprehensive flood study as described in answer to Question 1.
39. While Babister explicitly considered the issue of joint probability, and the experts consider that to be a critical consideration, all experts agree that his report suffered from limitations of input data and modelling. The central issue of joint probability is not properly addressed in the Sargent Report or in any earlier reports. The experts all regard that this is a central weakness of the

Sargent Report and the earlier reports and such results need to be approached with caution on this issue.

40. The reports of Babister and Sargent do highlight the need for the comprehensive flood study as described in answer to Question 1.

Question 3

41. It is important to understand that any flood estimate for planning purposes (e.g. the Q100 or Defined Flood Event) will have a range of uncertainty about it. It is necessary to select the best estimate for decision making, but any decision-making should consider the implications of the uncertainty about the best estimate.

42. A comprehensive approach will add robustness to the best estimate and a better understanding of uncertainty. It should improve our ability to give a quantitative rather than qualitative assessment of the range of uncertainty. Some uncertainty can be reduced by further effort, but residual uncertainty will always remain.

43. On any assessment it's imperative that salient assumptions upon which the assessment is based are clearly stated and their significance explained.

Question 4

44. The experts consider that this question is answered by the answer to Question 1 because all the elements of analysis that have been identified need to be considered and, as is plain from the text of this report, the list of requirements is not exhaustive.

Question 5

45. It is impossible to identify the limitations on an estimate of Q100, or upon a range in which Q100 falls, until a comprehensive flood study is completed. At that time, the nature of the factors that most contribute to uncertainty will be identified. If the comprehensive flood study is completed, then the estimate is less likely to change as new information becomes available. This is especially so, given that what is contemplated is a number of methodologies, which ought to corroborate results.

Question 6

46. The experts agree that Ipswich has exceptional but not unique flooding characteristics. In particular the incremental consequences of exceeding the flood planning level are more severe than commonly encountered in other flood plains. For example, major flooding in Ipswich is a level above 11.7m AHD at Ipswich City Gauge, whereas the 1893 flood event reached a peak of 24.5m AHD, while the recent January 2011 event reached 19.25m AHD (Babister, *Supplementary Report – Ipswich Flood Frequency Analysis*, October 2011, [20]). These characteristics exacerbate the already considerable uncertainties surrounding the flood estimates (including Q100) at Ipswich. Acute management issues are associated with floods that exceed the planning level.

47. The experts agree that these factors, including the sensitivity to uncertainty, have particular significance for flood plain management and emergency management in Ipswich. The experts repeat and emphasise the matters raised under the heading '*Context of the issues for determination*'.

Question 7

48. There are complexities which exist in determining Q100. These include:

    a. Interaction between the two rivers;

    b. Significant variation of flood levels;

    c. Impact of the dams;

    d. Wide uncertainty bounds;

    e. Need for explicit consideration of joint hydrologic inputs.

Questions 8 and 9

49. Mark Babister and Sargent have made calculations. All experts say that without the comprehensive flood study described in answer to question 1 (including all the particular data and modelling mentioned in that answer) it is not possible to conclude:

    a. That the level of 15.28m AHD is an appropriate flood level figure corresponding to Q100 at David Trumpy Bridge (Ipswich City Gauge);

    b. That 20.6m AHD is an appropriate flood level figure corresponding to Q100 at David Trumpy Bridge (Ipswich City Gauge);

    c. Whether the 2011 Ipswich flood was a 1 in 75 flood;

50. Further, the detailed studies mentioned in answer to question 1 are necessary to determine full answers to questions 8 and 9. In particular;

    a. It would be expected as further information becomes available in future, the estimate would be less vulnerable to change.

    b. Any town planning decisions based on the analyses contemplated by the answer to question 1 would be less subject to change as new information becomes available.

51. Mark Babister, as is evident, joins in the conclusions in paragraphs 49 and 50 and notes that his report contains qualifications and represents his best efforts within the time available to calculate Q100 at the time without the benefit of the data and modelling mentioned in the answer to question 1.
52. The experts agree that it is inappropriate to set a figure corresponding to Q100 for any purpose at the present time, without doing the work mentioned in the answer to question 1.
53. The experts also agree that it would be inappropriate to use the flood level estimates in Mark Babister's report for planning purposes without doing the work in answer to question 1.
54. Mark Babister points out that his understanding of the purposes of his report were to investigate whether a different estimate of the Q100 would be made on the basis of new information now available and his report was not intended by him for use for planning purposes.

DATED at Brisbane this 25th day of October 2011

[redacted]

Dr Sharmil Markar

[redacted]

Mark Babister

[redacted]

Neil Collins

[redacted]

Dr Rory Nathan

[redacted]

Dr Michael Leonard

Annexure A

Questions to be considered through concurrent expert evidence exercise
Bremer River flood frequency

1. What should be done now in a comprehensive flood study in order to provide a best estimate of the Q100 (among a range of floods between Q2 and the probable maximum flood) at Ipswich?

2. What, if any, are the limitations to the analysis of the Q100 performed by Sargent (2006) and Babister (2011)?

3. Is it appropriate to derive a single "best estimate" of the Q100 at Ipswich or is it more appropriate to derive a value that lies within a "reasonable range"?

4. For the purpose of setting the range of the Q100 at Ipswich, what agreement is there about the factors which are:

    a. essential to take into account and
    b. desirable to take into account

    and if not, what are the areas of disagreement and consensus?

5. What are the limitations on an estimate of Q100 or a range within which Q100 falls at Ipswich, even if a comprehensive flood study is completed? (for example, uncertainty that will remain, climate change, historical record bias)

6. Does Ipswich have an exceptional "hydrological situation" such that a different approach to floodplain management is warranted than that which is suitable for most areas of Queensland? Refer to Mark Babister's comments regarding the town of Windsor, New South Wales at [20] – [23].

7. Are there any other complexities which exist in determining the Q100 at Ipswich?

8. The Sargent 2006 estimate of Q100 is 15.28 metres AHD (Table 1, page 14 of Mark Babister's Bremer River Report). Mark Babister's estimate of the Q100 is 20.6 metres AHD (Table 4, page 27). Is each of these figures defensible as being a figure falling within a range which would be considered reasonable? Can it be determined whether one of these figures it more likely to be nearer the true estimate than another? If so, which one?

9. Mr Babister has calculated the AEP of the January 2011 flood in Ipswich as being 1 in 75 ([80]). Is this figure defensible as being a figure falling within a range which would be considered reasonable? What is the reasonable range for this estimate?

Q100 means the 1% AEP flood in current conditions.