# QUEENSLAND FLOODS COMMISSION OF INQUIRY

# JOINT EXPERT STATEMENT

# BRISBANE RIVER FLOOD FREQUENCY

# 25 OCTOBER 2011

400 George Street Brisbane
GPO Box 1738 Brisbane
Queensland 4001 Australia
Telephone **1300 309 634**
Facsimile **+61 7 3405 9750**
www.floodcommission.qld.gov.au
ABN 82 696 762 534

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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 the Q100 flood level on the Brisbane River from Moggill to the ocean and as to the probability of the 2011 flood event. Mr Babister's final report was received in September 2011. That report was the subject of review by Dr Michael Leonard and Dr Rory Nathan. Reports of Drs Leonard and Nathan were received by the Commission in September 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, several 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 23 October 2011, between 11am and 6pm at a conference room in The Marque Hotel, 103 George Street, Brisbane. Participants in the conference were Peter Davis SC (Chair), Professor Colin Apelt, Mark Babister, Neil Collins, Erwin Weinmann, Dr Sharmil Markar, Dr Michael Leonard, Drew Bewsher and Dr Rory Nathan.
6. Prior to the conference, a list of seven questions was distributed to the experts and to Mr Davis. These questions served as a focus of the discussions. The questions appear as annexure "A" to this report.

7. In initial discussions at the conference, two matters emerged. The first was that the experts considered it important to make a statement as to the context against which the experts were considering the various issues raised. The statement appears below under the heading "*Context of the Issues for Determination*".
8. The second matter was that the experts considered that Question 6 raised fundamental issues which impacted upon matters raised in the other questions. It was therefore decided by the experts to deal with the questions in order of 6, 1, 2, 3, 4, 5 and 7.
9. What appears below under headings identifying the various questions is the agreed position of all experts at the conference. 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 peaks 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 and 11, which all agree represent best national practice.

# Answers to questions

## Question 6

13. What is needed in the context of issues of such potentially wide-ranging impact is to complete a comprehensive flood study is an analysis of flood behaviour throughout the entire Brisbane River catchment in order to determine the flood risk along the lower reaches of the Brisbane River.

14. 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.

15. 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.

16. 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*

17. 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.

18. 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.

19. 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. Concerns have also been

[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.

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 River that has been used as a basis for other studies, without some underlying assumptions in the collection and analysis of that data being documented or made publicly available. All experts agree that there are many examples.

20. 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*

21. 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.

22. 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.

23. 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.

24. Flood frequency analysis of peak flows and volumes is required as validation at all key downstream locations 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.

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

### *Hydraulic model*

26. 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 over the full floodplain of the Brisbane River and its major tributaries downstream of the dams, and the downstream areas of all major tributaries influenced by backwater flooding from the Brisbane River. Hydraulic modelling will identify the limits of the backwater influence and standard techniques of flood estimation can be used upstream of any backwater limits.
27. 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.
28. 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 Brisbane River 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.
29. 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.

30. 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).
31. 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*

32. 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.
33. 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 Dams Optimisation Study.
34. 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 1

35. 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 a best estimate for decision making, but any decision-making should consider the implications of the uncertainty about the best estimate.
36. 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.

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

## Question 2

38. The experts consider that this question is answered by the answer to Question 6 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.

## Questions 3, 4 and 5

39. Mark Babister has made the calculations. All experts say that without the comprehensive flood study described in the answer to question 6 (including all the particular data and modelling mentioned in that answer) it is not possible to conclude:

    a. That the level of 3.3m AHD is an appropriate flood level figure at the Port Office corresponding to Q100;

    b. That 4.32m AHD is an appropriate flood level figure at the Port Office corresponding to Q100;

    c. Whether the January 2011 Brisbane flood was a 1 in 120 flood along the lower reaches of the Brisbane River;

40. Further, on the basis of the material available, no opinion is expressed as to whether 3.3m stated as Q100 in the Independent Expert Review Panel of 2003 is appropriate on the data then available.

41. Further:

a. The detailed studies mentioned in answer 6 are necessary to determine full answers to questions 3, 4 and 5.

b. It is noted that the Independent Expert Review Panel *Report to Brisbane City Council*(2003), and the Sinclair Knight Merz *Brisbane River Flood Study* (18 December 2003) report, Mark Babister's *Final Report to the Queensland Flood Commission of Inquiry* (May 2011), and the Joint Flood Taskforce Report (March 2011), all stated that detailed Monte Carlo modelling would be required to provide a robust estimate of the Q100.

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

d. Any town planning decisions based on the analyses contemplated by the answer to question 6 would be less subject to change as new information becomes available.

42. Mark Babister, as is evident, joins in the conclusions in paragraph 39, 40 and 41 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 6.

43. 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 6.

44. 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 6.

45. 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.

## Question 7

46. 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.

DATED at BRISBANE this 25th day of October 2011.

[redacted] .....

Emeritus Professor Colin Apelt

[redacted]

Mark Babister

[redacted]

Neil Collins [redacted]

[redacted]

Erwin Weinmann

[redacted] .....

Dr Sharmil Markar

Dr Michael Leonard

[redacted]

Drew Bewsher

[redacted]

Dr Rory Nathan

# Annexure A

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

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

2. For the purpose of setting the range, 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?

3. Mr Babister's calculation of the Q100 using data preceding the January 2011 flood is 4.07 metres AHD at the City Gauge (Appendix C, Table C 1). The Independent Expert Review Panel (2003) best estimate of the Q100 was 3.3 metres AHD (p21). 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?

4. With the benefit of the January 2011 flood data, Mr Babister's calculations suggest that the Q100 is 4.32 metres AHD at the City Gauge (p38, Table 13). Is this figure defensible as being a figure falling within a range which would be considered reasonable?

5. Mr Babister has calculated the AEP of the January 2011 flood in Brisbane as being 1 in 120. 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?

6. What should be done now in a comprehensive flood study in order to provide a best estimate of Q100?

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

Q100 means the 1% AEP flood in current conditions.