QFCI

Date: 16/05/11 JM

Exhibit Number: 397

Statement of PETER HUGH ALLEN

Volume 1 of 2

Exhibit Copy

STATEMENT OF PETER HUGH ALLEN

I, Peter Hugh Allen, of c/- 41 George Street, Brisbane, Queensland, Public Servant in the State of Queensland state as follows:-

1. I have been provided with a copy of a letter from the Commissioner, Queensland Floods Commission of Inquiry dated 25 March 2011 detailing the topics my statement should cover. I have also been sent an e-mail dated 31 March 2011 requiring me to provide comment on an additional topic. Both documents are attached and marked **'PHA–01'**.

Role and Qualifications

2. My substantive position is that of Director, Dam Safety (Water Supply) in the Office of the Water Supply Regulator, Environment and Natural Resource Regulation division, Operations and Environmental Regulator business group, Department of Environment and Resource Management (DERM).

3. I am 57 years old. I was awarded a civil engineering degree with 1st class honours and a University Medal from the University of Queensland in 1975. I was also awarded a Master of Engineering Science from the University of Queensland in 1986. I have over 36 years of professional engineering experience associated with the design, construction and operations of dams. I am a Registered Professional Engineer in Queensland (Reg No. 2979), a Corporate Member of the Institution of Engineers Australia (Membership No. 13696) and I am registered on the National Professional Engineering Register as a Civil Engineer. A copy of my *curriculum vitae* is attached and marked **'PHA–02'**.

4. I started worked in the Queensland public service in 1975 as an Engineer Division II in the Irrigation and Water Supply Commission and I have remained in the iterations of that Commission ever since up to the present Department of Environment and Resource Management. I worked for the majority of my time in the Design Division where I was primarily involved in the design of major water supply dams such as Wivenhoe Dam, Burdekin Falls Dam, Peter Faust Dam and Kroombit Dam. I was also

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Peter Hugh Allen

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team leader of the project that extensively reviewed the design flood hydrology of Wivenhoe Dam, Somerset Dam and North Pine Dam and the development of the Real Time Flood Modelling System for these dams in the early 1990s. I was one of the original Senior Flood Operations Engineers for these dams when State Water Projects won the contract to operate the dams in 1996 and I was responsible for flood operations in the Flood Operations Centre during the February and March 1999 flood events. I commenced work in the dam safety area of the then Department of Natural Resources in 1998 as a Principal Engineer in the Dam Safety unit. I was appointed Director, Dam Safety (Water Supply) in the Dam Safety unit in February 2002. I withdrew from flood operations after the 1999 flood events because of the potential conflict of interest between being the senior flood operations engineer responsible for the conduct of flood operations during a flood event on the one hand and the person who was responsible for the safety of the dams during any flood event and who after a flood event was responsible for determining if the actions taken during a flood event were reasonable and ordering a dam owner to take whatever actions were deemed appropriate after conducting a review of the flood event. I have had no operational role in the Flood Operations Centre since that time.

5. I have been actively involved in the dam industry through my involvement in the Australian National Committee on Large Dams (ANCOLD). I have contributed to the development of several ANCOLD guidelines and I am currently involved in the review of the ANCOLD *Guideline for the Design of Dams for Earthquakes* and am a 'peer reviewer' of the current review of the ANCOLD *Assessment of the Consequences of Dam Failure*. I was Secretary of ANCOLD from 2002 to 2005 and I am currently DERM's voting representative on ANCOLD.

6. In my substantive position, I report directly to Mr Robert Reilly, General Manager, Office of the Water Supply Regulator. My duties as Director, Dam Safety (Water Supply) are to manage the regulation of, and foster best practice strategies, dam safety management policies and procedures for the planning, construction and ongoing operation and management of large water supply and flood mitigation dams in Queensland. Towards the end of 2010 I also became responsible for the provision of technical advice to the regulators of containment dams under the provisions of the

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Environmental Protection Act 1994. These dams contain waste and hazardous substances and typically are from mining and other extractive industries.

7. The powers for the safety of dams in Queensland are currently contained in the *Water Supply (Safety and Reliability) Act 2008* (the Water Supply Act). Specifically, Chapter 4 of the Water Supply Act contains the provisions regarding referable dams and flood mitigation. There are also transitional provisions in relation to the *Water Act 2000* contained in Chapter 9 of that Act. Specifically, Subdivision 3 of Division 1 of Part 2 deals with referable dams and flood mitigation.

8. The chief executive of DERM has delegated to my substantive position the powers shown under the *Water Supply (Chief Executive Delegation (No.1) 2009*, a copy of which is attached and marked **'PHA–03'**.

1. A Brief History of Wivenhoe and Somerset Dams ("the Dams") – their original construction, dimensions and features and upgrades since construction

Wivenhoe Dam

9. Wivenhoe Dam is a referable dam with a Category 2 failure impact rating. The estimated population at risk in the event of dam failure is 244 000. It is located at AMTD 150.2 on the Brisbane River.

10. In June 1971 the Co-ordinator General (CoG) reported on investigations on 'Future Brisbane Water Supply and Flood Mitigation' and recommended construction of a dam at Wivenhoe. A copy of this document can be provided upon request.

11. Shortly after the 1974 flood, the project was approved when the CoG declared the construction authority for the project which involved a dam at Wivenhoe for flood mitigation and water supply. Design commenced in 1974 by the then Irrigation and Water Supply Commission. Construction commenced in 1977 under the control of the Irrigation and Water Supply Commission and the embankment and spillway were completed by contracts and day labour by 1984. The spillway gates were completed and commissioned by 1986. A General Arrangement drawing of the original spillway showing the original Full Supply Level (FSL) is attached as **'PHA-04'**.

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Peter Hugh Allen **Witness**

12. Following improvements in flood estimation techniques, in 2002/03, a review of the flood adequacy of the dam identified a deficiency in spillway adequacy and an alliance involving designers, constructors and SEQWater was formed to investigate, design and construct works to remediate the deficiency. The ensuing upgrade, which raised the capacity to about 80% of the required Probable Maximum Flood capacity, was completed in 2005. It entailed:

- Construction of a 3 bay fuse plug near the right abutment;
- Raised concrete parapet wall along the length of the dam; and
- Strengthening of the spillway structure with post tensioned anchors.

13. It is important to note that the spillway upgrade of Wivenhoe Dam completed in 2005 did not in any way reduce the available flood mitigation storage in Wivenhoe Dam. The flood mitigation storage could be defined in two ways:

(a) If the flood mitigation storage is defined as the storage range to which the flood mitigation procedures 2 and 3 apply (see topic 2(g)), then the upper limit of these procedures did not change at all as a result of the upgrade. It remained as EL 74.0 mAHD; and

(b) If the flood mitigation storage is defined as the storage capacity available for the temporary storage of flood waters during the course of a flood event, then it actually increased because the maximum storage level in the dam went from EL 77 mAHD (as originally designed) to EL 80 mAHD as a result of the upgrade.

14. The upgrade was all about improving the safety of the dam and reducing the risk of failure. A second stage upgrade is currently required by 2035 to increase the spillway capacity to 100% of the Probable Maximum Flood capacity.

15. A hydro-electric power station with an output capacity of 4.5 MW was installed on a river outlet in 2003.

16. The maximum water level experienced at the dam is EL74.97 mAHD during the January 2011 flood event.

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Somerset Dam

17. Somerset Dam is also a referable dam with a Category 2 failure impact rating. The estimated population at risk in the event of dam failure is 72 though this ignores the potential for failure of the dam to also cause failure of Wivenhoe Dam.

18. The following is a very brief description of the design and construction of Somerset Dam. It is based on the records available in DERM's dam safety records. I suspect more detail is available from Seqwater who maintain a Data Book on the dam (in accordance with Dam Safety Condition DS 5) which contains all the details on the dam and the available documentation on its design and construction.

19. Somerset Dam is constructed across the Stanley River at AMTD 4.2 km between Little Mount Brisbane and Mount Somerset. It was constructed by Stanley River Works Board in the period 1935 to 1953 with a delay in construction as a result of the war during the period from 1942 to 1948. The site had been identified as a potential dam site following the 1893 flood.

20. The maximum water level experienced in the reservoir was EL 106.55 mAHD during the 1974 flood.

21. Apart from refurbishment of operating equipment there have been no significant modifications to the dam since its completion. I understand that the original Full Supply Level for Somerset Dam was EL 99 mAHD. I have attached a copy of one of the original general arrangement drawings for Somerset Dam as **'PHA–05'** and have reviewed the available drawings that are stored in DERM. None of these drawings appears to nominate a Full Supply Level for Somerset Dam. However, I have seen correspondence from the early 1980s which refers to a Full Supply Level of EL 99.0 mAHD. Attempts are currently being made to locate this correspondence. If it is located, it will be provided to the Commission.

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22. A series of investigations by two (2) consultants[1] [2] have been undertaken principally during the 2000's to establish the maximum level to which water can safely be stored in the dam. The level adopted based on these investigations was EL 109.7.

2. Information regarding the Manual of Operational Procedures at Wivenhoe and Somerset Dams ("the Manual"), including:

(a) Its original creation, the process for creation and the impetus to have a manual

Original creation

23. I am not absolutely sure why the original Flood Mitigation Manuals (Manuals) were created. However, I have heard that the decision to develop the Manuals was to remove any political influence from decisions to retain or release flood waters from flood mitigation dams and to place the responsibility for such decisions in the hands of highly qualified and experienced technical experts charged with the responsibility of making rational decisions on the basis of the available evidence.

24. The original Manual was created in 1980 following the 1974 flood and before the construction of Wivenhoe Dam.

Process for creation

25. Manuals are typically approved for flood operations at dams where there is an ability to vary the discharge for a given headwater and there are likely to be significant consequences as a result of those operations. The consequences might range from minor flood damages through to significant loss of life. To minimise the risk of these consequences occurring and to ensure that the dam is operated safely and within design parameters, there is a need to set out the operating procedures to be followed during flood events.

26. Currently only three dams, being Wivenhoe, Somerset and North Pine dams, all of them owned by Seqwater, are required to prepare and submit a Manual to the chief executive, DERM for approval. The primary reason for these dams to have Manuals is

[1] "Somerset Dam, Stability of Abutment Monoliths", NSW Department of Commerce, Report No. DC 05099, May 1995.
[2] "Somerset Dam Crack Investigation", SMEC, July 2008

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that they are used for flood mitigation purposes and have gates where flow can be controlled.

27. The existing statutory provisions in relation to Manuals, which are the same as those in the previous Act (i.e. *Water Act 2000*), are contained in the Water Supply Act. The provisions are covered in sections 370 to 374 of the Water Supply Act, and commenced on 1 July 2008.

28. Section 370 of the Water Supply Act provides that dam owners may be required to prepare a Manual. Section 371 of the Water Supply Act provides the chief executive with the power to approve, by gazette notice, a Manual for a dam. The chief executive may also get advice from an advisory council before approving the Manual (section 371 (4)). However, an advisory council has not been formally formed to provide advice to the chief executive since the commencement of the *Water Act 2000*.

29. Advisory councils can provide two broad types of advice. Firstly, expert advice relevant to the topic and secondly, advice from stakeholders that will be affected by the proposed decision. Previous Advisory Councils have typically been made up of technical experts who have had significant experience in the design of the Dams or have been involved in flood operations for the Dams. Because the Brisbane City Council was the original operator of the three dams, it was represented in the Technical Advisory Committee before Seqwater took over the Dams.

30. Section 372 of the Water Supply Act provides that a Manual may be subject to amendment by DERM and section 373 provides for its review by the owner of a dam. Section 374 provides that the owner of a dam "does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures" in the manual.

31. The most recent approval dates for the Manuals for each of these dams are:

- North Pine Dam, gazetted on 17 December 2010; and
- Wivenhoe and Somerset Dams (approval for one manual for both dams), gazetted on 22 January 2010.

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32. For the current Manuals, the dam owner has arranged (and paid for) appropriate expert analysis/advice by consultants; while a range of stakeholders, e.g. all of the local councils for the locations that would be impacted by floodwater releases, and relevant Queensland Government agencies, are extensively consulted by the dam owner, during the Manual process. [DERM has attended as an observer during various meetings organised by the dam owner during a review process]. DERM has not received any written adverse comment, from local councils, on any Manual in the last 10 years.

Impetus to have a Manual

33. The impetus for a Manual for Wivenhoe in particular is demonstrated by the requirement to produce quite a range of discharges and it is designed to be able to vary its discharge from the dam to match variations, for instance, in the discharge from Lockyer Creek and the Bremer River which enters the Brisbane River just downstream of Wivenhoe dam in order that downstream bridges can be kept trafficable for as long as possible. Similarly discharges can be limited to keep floods at Brisbane and Ipswich below major damage levels to the extent that these discharges arise from above the dam and the safety of the dam is not at risk. This is what occurred in the 1999 flood event where the rain mainly fell in the catchment behind Wivenhoe Dam and the dam was able to wholly mitigate the flood by storing the flood waters within the dam.

(b) The Process for amendment of the Manual

34. The Manuals are considered living documents that need regular review and updating as circumstances change and experience with new flood events is considered and reviewed. Indeed, review mechanisms are built into the Manuals to facilitate this outcome. In this respect, because of the magnitude of the January 2011 flood event, the experiences in this event offer an ideal learning and development opportunity to review the Manuals for Wivenhoe, Somerset and North Pine Dams.

35. Importantly, there are no decision making criteria in the Water Supply Act in regard to Manuals. I do not know why this is the case. However, to date, Seqwater have undertaken a relatively comprehensive consultation process when reviewing the Manuals prior to submission to the chief executive of DERM for approval. This has

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involved consultation with Brisbane City Council officers, Ipswich City Council officers, the flood engineers, the dam safety regulator and the Bureau of Meteorology (BoM).

36. The following points are also worth noting in relation to approving Manuals:

- There are no requirements for consultation with stakeholders, or seeking expert advice, prior to approving a Manual;
- There is no period of time within which the decision maker is required to make a decision;
- Previously, there was no guidance as to a Manual's contents Nonetheless; the matters covered in the two Manuals have been similar for over 20 years. This has now been remedied by DERM work procedure DS5.1 Flood Mitigation Manual for a Dam. A copy of this manual has already been provided to the Commission;
- There is no defined process (including consultation arrangements) by which a dam owner develops a Manual;
- Manuals can be approved for periods up to five years. This reflects the significant development effort/elapsed time that is involved in a comprehensive review of a Manual. Further, in the absence of major flood events that may highlight areas that could require a review of the Manual (or significant policy changes on matters such as Full Supply Level), there has been no particular reason to incur the cost associated with such a review; and
- There is no statutory requirement for a dam owner to comply with the Manual. The only incentive is the provision of protection from liability afforded by section 374 if they comply with the operational procedures in the Manual.

37. I do not know why the above has occurred; it is most likely just the way that, historically, the process has evolved.

38. The philosophy followed by the dam owners and DERM in developing, reviewing and approving Manuals has been one of continuous improvement, i.e. a flood event occurs, and the learnings from it are incorporated into the next version of the Manual.

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39. The approval of the current Manual for Wivenhoe and Somerset Dams was made before the finalisation of DERM's work practice *DS 5.1 Flood Mitigation for a Dam* covering such approvals. My decision in approving that Manual is attached and marked as **'PHA–06'.** The decision took into account the notes Seqwater submitted with their submission of the Manual for approval. These notes detailed the changes made to the Manual - a copy of which are attached and marked as **'PHA–07'**.

40. More generally, in approving the Wivenhoe/Somerset Manual, I took into account the following factors:

(a) The changes proposed from the previous version of the manual were relatively minor and well justified from a technical perspective. (The previous Manual had a 24 year history of technical development, combined with ongoing consultation with a number of QLD Government agencies, the BoM and the local councils whose areas at that time were impacted by flood water releases.);

(b) The general consultation processes indicated that the proposed Manual had the support of QLD Government agencies and the current local councils - Brisbane City Council, the Ipswich and Somerset Councils. Further no adverse comments were received from these councils after the Manual was distributed to them following the approval; and

(c) Seqwater have not advised of any inconsistencies with relevant government policies or strategies. On the FSL issue specifically, I was aware that Seqwater had been involved in discussions on the contribution that Wivenhoe/Somerset dams would need to make to SEQ water supplies. I assumed that the nominated FSLs for Wivenhoe and Somerset took these discussions into account.

41. The current version of the Manual for North Pine Dam was approved in accordance with the procedure detailed in *DS5.1 Flood Mitigation for a Dam*, a copy of which has already been provided to the Commission.

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42. Comments made in this statement on the review of both Manuals as a result of the recent flood events are by no means exhaustive as my review of the Seqwater flood event reports is not yet complete. The Terms of Reference of the Commission of Inquiry explicitly refer to a review of the operation of the dams and the Commission may identify issues and gather additional evidence that needs to be considered. However, if any urgent issues are identified, DERM will need to implement interim solutions to minimise the risks of dam safety incidents or failures.

(c) The substantive Amendments made over the seven revisions

(d) Involvement in those revisions

(e) The reasons for those amendments

(f) Any change in operating strategy that required amendments and reasons for that change in operating strategy

43. Questions (c) to (f) are inter-related and I have chosen to put the responses together.

44. The Manuals of Operational Procedures for Flood Mitigation at Wivenhoe, Somerset and North Pine Dams have always been intended to be 'living' documents. This is the reason why flood event reports and five yearly reviews are required. These document the performance of the system during flood events and enable the lessoned learnt to be built into the system. This occurred following the 1999 flood events (which was the first major event following development of the current system) and, the January 2011 event, because of its magnitude, will be an ideal opportunity to learn from the experience.

45. The following sections of this Statement summarise the changes/developments for each version of the Manual since the initial Manual in 1980. I am aware of the following versions of the Manual:

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Peter Hugh Allen **Witness**

Revision No.	Date	Amendment Details	Approved by
-	19 February 1980		N.T.E. Hewitt, Minister for Water Resources
-	24 May 1984		J.P. Goleby, Minister for Water Resources
0	27 October 1986	Original Issue	Yet to be located. However two early drafts are available.
1	6 October 1992	Complete revision and re-issue	E. Casey, Minister for Primary Industry
2	13 November 1997	Complete revision and re-issue	H. Hobbs, Minister for Natural Resources
3	24 August 1998	Change to page 23	
4	6 September 2002	Complete revision and re-issue	R. Reilly, General Manager, Water Industry Compliance, Department of Natural Resources and Mines
5	4 October 2004	Complete revision	P. Allen, Director Dam Safety (Water Supply), Department of Natural Resources and Mines
6	20 December 2004	Miscellaneous amendments and re-issue	P. Allen, Director Dam Safety (Water Supply), Department of Natural Resources and Mines
7	November 2009	Complete Revision	P. Allen, Director Dam Safety (Water Supply), Department of Environment and Resource Management

* I am not sure why the 1980 and 1984 editions of the Manual were not listed as 'Revisions' although it may be due to Wivenhoe Dam becoming fully operational in 1986.

** In this and subsequent Revisions this year is shown as "1968" which was incorrect. This error was rectified in the current Revision 7.

46. As seen in the following parts of this section, the Manual has evolved over time as new systems were developed and new flood events were experienced.

47. I was never involved in Revisions of the Manuals prior to Revision 4. For these manuals, I have just listed the key components of the Manuals.

February 1980

48. The earliest Manual that I have been able to locate is the *Manual for Operational Procedures for Flood Mitigation for Somerset Dam and Wivenhoe Dam and Splityard Creek Dam during period of Construction of Wivenhoe Dam, 19th February 1980.*

49. This Manual had many of the components of latest Manual (Revision 7). At the time, Somerset Dam was owned by the Brisbane City Council and it listed the Chief Engineer and Manager of the Water Supply and Sewerage Department of the Brisbane

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City Council as the 'Operator'. Because Wivenhoe Dam had not been built at the time, it concentrated on Somerset Dam operations. Amongst other issues, it provided for:

- Discretionary powers;
- A flood event report after each flood;
- Five categories of flood from 'small fresh' through to 'major flood';
- 'Reference Gauges';
- Dealing with closely spaced floods by draining storm waters 'as quickly as would be consistent with the other major operating principals'. Procedure 'D' required the draining of the flood storage in 5 days 'without increasing the flood levels in the Brisbane River below the Stanley junction;
- It contained the same opening and closing intervals for the Somerset regulators and sluices as in the current Manual;
- Five operating procedures for Somerset which were graded in a similar manner to those in place for Wivenhoe. They were mainly based on keeping downstream bridges open as long as possible etc. with the ultimate procedure allowing discharge onto the rising limb of the Upper Brisbane discharge hydrograph; and
- A 'loss of communication' provision for Somerset Dam.

50. It also listed essentially the same set of objective as applied through to Revision 6. These were:

(a) Structural safety of the dams;

(b) Optimum protection of urban development in the Lower Brisbane River;

(c) Capacity of the dams to deal with closely spaced floods;

(d) Minimum disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries; and

(e) Minimum disruption to navigation in the Brisbane River.

51. I am not aware of from where the 'Summary of Operating Procedures A, B, C, C1 and D' was derived.

May 1984

52. The 1980 version of the Manual was superseded in May 1984 with the *Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam*

during period of Construction of Wivenhoe Dam. This version of the Manual had a very similar format to the current Manual.

53. The Manual covered dam operations during the installation of the Wivenhoe Dam radial gates with 'Minimal damage is caused to spillway structures and gates' being included as the third most important objective. In addition to the construction provisions, the Manual provided for:

- The same Wivenhoe radial gate opening and closing intervals as currently adopted; and
- A gradation from Procedure 1 to 4 for Wivenhoe as the magnitude of the flood increased. The procedures did not provide elevation limits in Wivenhoe. Instead they were set by what could be achieved downstream.

54. Section 6.3.1 (b) seems to be the first mention of a limitation of the discharge below 4,000 m^3/sec ... '*The discharge where possible does not exceed the damaging flood flow of 4,000 m^3/sec in the Brisbane River taking into account flows from Lockyer Creek and Bremer River*'.

1986 Version of Manual

55. At the current time, a copy of the 1986 Manual is yet to be located. However, I have located two draft versions of this Manual dated '29 Jan 85' and '18 Jul 85'. The July draft refers to the discharge from Wivenhoe Dam under Procedure 2 not to '*exceed the lesser of:*

(i) 3,500 m3/sec:

(ii) the peak flood flow of Lockyer Creek, or the predicted peak flood flow of the Bremer River, whichever is greater.'

56. This is the first mention of the 3500 m3/sec criterion for Procedure 2.

1992 Version of Manual

57. Came into operation from 6th October 1992 when it was approved by the then Minister for Primary Industry.

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58. Excerpt from Page 1 of 1992 Manual:

"The first manual so approved specified that its application be for five years and that it then be reviewed. This Manual, which is the result of an extensive review of the first Manual by a Working Group established by the Technical Advisory Committee, will in turn require a major reformulation when a computer based time system currently under development is implemented.

Although a large number of detailed changes have been made to the original Manual, the basic procedures for operation of both dams have not been varied. Neither have the primary objectives varied from those defined in the original manual of ensuring safety of the dams, their ability to deal with extreme and closely spaced floods and the protection of downstream areas.

The procedures for gate openings at Wivenhoe Dam which are based on river heights at key inflow gauges and on expected downstream inflows also essentially remain the same.

The changes of detail have mostly arisen from a need to recognise the legislative changes regarding the Board and Technical Advisory Committee, changes intended to remove some ambiguities and to update details of, for example, locations of gauging stations.

A significant addition has been the provision for designation by the Headworks operator of the "Engineer" and of "Operations Engineers" in a Schedule of Authorities, to better reflect the requirements of the referable dam provisions of the Water Resources Act, and the requirements for the registration of professional engineers in Queensland. The Engineer and the Operations Engineers are employed by the Headworks Operator which is responsible for flood operations of the storages."

59. The 'Board' at the time was the South East Queensland Water Board which was created under the provisions of the *South East Queensland Water Board Act 1979-1991*.

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60. In effect the 'Engineer' was the equivalent to today's 'Senior Flood Operations Engineer' and the 'Operations Engineers' were today's 'Flood Operations Engineers'. Section 2.2 of the 1992 Manual also specified the qualifications and experience of the Engineers which are identical to those of Section 2.5 of the November 2009 Manual.

61. Amongst other things, this version of the Manual provided for:

(a) The extension of the seven day drainage period by 'several days' in major floods because it may not be achievable because of downstream flood conditions;

(b) 5 yearly review of the Manual and an 'operational audit' after each major flood event;

(c) A formal report to the South East Queensland Water Board by 30th September each year on:

   i. the 'training and state of preparedness of operations personnel';

   ii. the 'status of the communication networks'; and

   iii. the' status of data acquisition systems';

(d) Guidelines on the selection of operating procedures for Wivenhoe Dam based on predicted heights at key gauges;

(e) Procedures 2 and 3 had the same discharge criteria as in the current version of the Manual;

(f) Reference to EL 74.0 mAHD as being the level for the triggering of unrestricted releases from Wivenhoe; and

(g) Simplification of the Somerset Dam procedures without a great deal of detail as to how the interaction between Somerset and Wivenhoe should be managed.

1997 Version of the Manual

62. This version of the Manual recognised the existence of an expanded flood monitoring and warning radio telemetry network (ALERT) had been installed in the Brisbane River Catchment and that a computerised flood operational model which allows for rainfall and river modelling in real time based on data from the ALERT system had been developed and implemented. It was also recognised that the accuracy and reliability of the system during a flood event had not yet been proven.

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63. Amongst other things, this version of the Manual provided for:

(a) Procedure 1 being split into five partitions with maximum discharge criteria and headwater criteria applied to each partition;

(b) The first use of the 'Interaction Line' for the operation of Somerset Dam relative to Wivenhoe Dam; and

(c) The nomination of the Senior Flood Operations Engineers and the Flood operations Engineers in the 'Schedule of Authorities'.

August 1998 Version of the Manual

64. This was an editorial change due to the increase in the height of Burton's Bridge with an increase in discharge capacity under the Bridge from 250 m^3/sec to 430 m^3/sec. An approved Manual for this version has not been located but there is only the one change on page 23 which is referred to above.

October 2002 Version of the Manual

65. This was the first version of the Manual approved under the provisions of the *Water Act 2000.*

66. Changes from the previous version of the Manual mostly arose from refinements to the gate opening and closing sequences based on the experiences during the February and March 1999 flood events. There were also some changes that were necessary because of the change of the legislative requirements covering the approval of the Manuals i.e. the responsible Minister was no longer required to approve the Manual.

67. Following the relative success of the closure sequence for the February 1999 flood event, minimum closure intervals for the Wivenhoe spillway gates were specified based on the recession curves of the 1974 flood in order to minimise bank slumping following the peak of the flood event.

October 2004 Version of the Manual

68. The changes to the 2002 version of the manual arose out of the need to cover the construction period for the spillway upgrade for Wivenhoe Dam (May 2004 to December 2005) with the addition of the three bay right abutment fuse plug spillway

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and following the fuse plugs becoming operational. The changes were designed to enable Wivenhoe Dam to pass a 1 in 100,000 AEP flood event. The Manual nominated the trigger elevations for each fuse plug and the discharge capacities of the fuse plugs.

69. It was noted in the approval recommendation that South East Queensland Water Corporation's *"intention to seek review of the flood mitigation manual was flagged during the design process for the dam upgrading and an initial document containing revised operating procedures was circulated to the reference group of Natural Resources and Mines (DERM Dam Safety), SunWater (Operator of the dams), Brisbane City Council, Ipswich City Council, Esk Shire Council, and Bureau of Meteorology representatives in May 2004. David Gill of SEQWC also contacted Kilcoy Shire Council regarding the manual revisions. Subsequently where possible the SEQWC has attempted to incorporate the wishes of all parties regarding the operating procedures into the document."*

'The procedures for Somerset Dam remain unchanged from the currently approved manual.

The procedures for Wivenhoe Dam remain generally unchanged for lake levels up to EL 74.0 providing the same downstream flood mitigation effects up to this level. Above this level, the gates may be opened at a quicker rate than previously to minimise the likelihood of the coffer dam being overtopped (i.e. during the construction period). *Additional provisions are also included for the conduct of the works in the main spillway area to ensure full use can be made of the radial gates.'*

December 2004 Version of the Manual

70. There were several editorial errors in the October 2004 version of the Manual. The South East Queensland Water Corporation (the dam owners at the time) wished these to be corrected and this was done in the December 2004 version of the Manual.

71. The key revision was to ensure SEQWater could contract another organisation to discharge the responsibilities of the Headworks Operator as it had done with

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SunWater. The actual operational procedures for the gates at the dams remained unchanged from the previous version of the manual.

November 2009 Version of the Manual

72. This is the current version of the Manual. A copy of my notes on the decision for approval of the Manual (see 'PHA–06').

73. Copies of the approved Manuals dated 19 February 1980, 24 May 1984, 6 October 1992, 13 November 1997, 6 September 2002, 4 October 2004 and 20 December 2004 as well the 18 July 1985 draft copy of the1986 Manual are attached and marked **'PHA-08'**. As mentioned, I have not located a copy of the 24 August 1998 Manual but it contained only one minor amendment at page 23. The current Manual of November 2009 has previously been provided to the Commission.

(g) The way the current Manual work in practice

Wivenhoe Dam

Strategy W1 -	***The Primary Consideration is Minimising Disruption to Downstream Rural Life***
Conditions	• **Wivenhoe Storage Level predicted to be less than 68.50 m AHD** • **Maximum release predicted to be less than 1,900 m^3/s** • **The primary consideration is minimising disruption to downstream rural life**

74. The first procedure 'W1' is all about minimising disruption to rural life in the valleys of the Brisbane and Stanley Rivers. Depending on the headwater level in Wivenhoe, the discharge from the dam is limited with the aim of keeping the downstream bridges and crossings open. As the headwater increases, more crossings are progressively inundated. Because Lockyer Creek enters the Brisbane River downstream of Wivenhoe, there is provision to limit the discharge from Wivenhoe to mirror the discharge from Lockyer Creek. For example, if operating under Procedure 1B with 200 m^3/sec discharging from Lockyer Creek, the aim would be to keep the discharge to less than 230 m^3/sec to keep Burton's Bridge open for traffic. If the discharge from Lockyer Creek was sufficient to close Burton's Bridge without any discharge from Wivenhoe, then the aim would transfer to keeping the next bridge open. The upper

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Peter Hugh Allen **Witness**

Wivenhoe elevation limit for Procedure W1 (EL 68.5 mAHD) is largely based on experience over a large number of smaller historical events. It provides a gradation into the more major floods for which Procedures 2, 3 and 4 are applicable.

Strategy W2 -	***Strategy W2 is a Transition Strategy where the primary consideration changes from Minimising Impact to Downstream Rural Life to Protecting Urban Areas from Inundation***
Conditions	• **Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD** • **Maximum Release predicted to be less than 3,500 m^3/s** • **This is a transition strategy in which the primary consideration changes from minimising disruption to downstream rural life to protecting urban areas from inundation** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

Strategy W3 –	***The primary consideration is Protecting Urban Areas from Inundation***
Conditions	• **Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD** • **Maximum Release should not exceed 4,000 m^3/s** • **The primary consideration is protecting urban areas from inundation** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

75. Procedures 2 and 3 effectively run in parallel and are aimed at providing flood mitigation benefits to the urbanised areas downstream of the dam. Procedure 2 tries to limit the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill, while remaining within the upper limit of non-damaging floods at Lowood (3,500 m^3/s). The Table at the bottom of page 27 of the Wivenhoe/Somerset Manual obviously needs amending to accommodate the situation where very little flow is coming from Lockyer Creek and the Bremer River but major flooding is occurring in the Brisbane River. The limits of 3,500 m^3/sec at Lowood and 4,000 m^3/sec at Moggill are based largely on experience based limits supported by flood modelling in the 1980s. However, these were essentially confirmed by studies undertaken as part of the Brisbane Valley Flood Minimisation Study project for Brisbane, Ipswich and Esk Shire Council in 2006, 2007. As shown below, Figure 4.1 of the Brisbane City Flood Damage Assessment report[3] showed that of the potential direct flood damage at 4,000

[3] Brisbane Valley Flood Damage Minimisation Study, Brisbane City Flood Damage Assessment, Brisbane City Council, City Design, October 2006, WRM Water and Environmental.

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Peter Hugh Allen **Witness**

m^3/sec in the Brisbane River was about 1% of the expected damage at flows of 8,000 m^3/sec.

Table 4.1 Residential and Non-Residential Flood Damage Summary Results, Brisbane City

Flood Discharge (m^3/s)	Residential			Non-Residential			Total Damage ($million)
	Total Damage ($million)	No. of Flood Damaged Properties	Average Damage Per Property ($1000)	Total Damage ($million)	No. of Flood Damaged Buildings	Average Damage Per Building ($1000)	
1000	0	0	0	0.002	1	2.06	0.002
2000	0	0	0	0.24	1	241.48	0.24
3000	0.40	29	13.78	0.71	4	177.81	1.11
4000	4.22	138	30.56	1.75	26	67.12	5.97
5000	29.10	831	35.02	13.30	125	106.41	42.40
6000	98.27	2052	47.89	59.07	383	154.23	157.34
7000	225.76	4073	55.43	169.27	803	210.80	395.03
8000	382.63	6280	60.93	288.54	1356	212.78	671.17
10000	718.21	10296	69.76	589.12	2259	260.79	1307.33

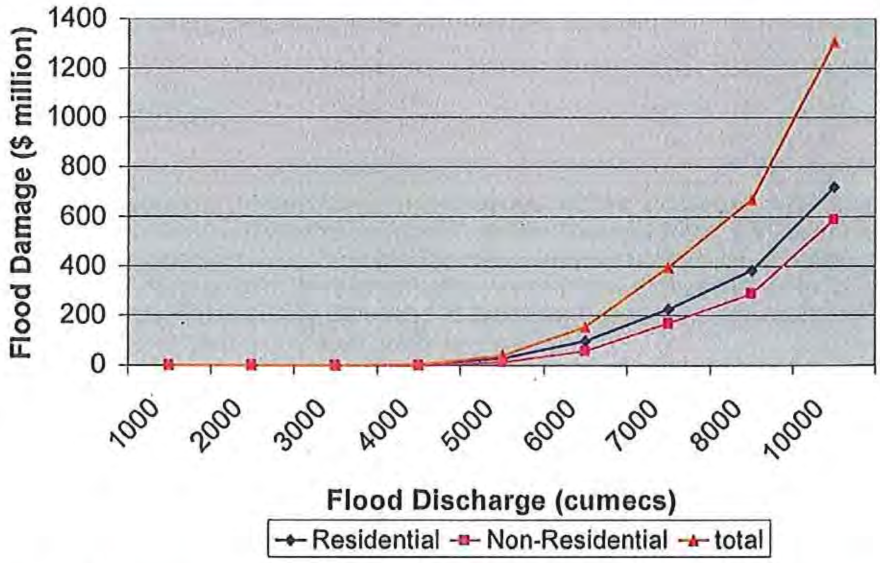

Figure 1 Total Damage Estimates for Brisbane City from Brisbane City Flood Damage Assessment (Figure 4.1 of Report) (1)

76. Similarly the Ipswich City Flood Damage Assessment Report [4] confirmed that the flood damage for Ipswich City was about 1% of the 8,000 m^3/sec discharge damage at around 3,500 m^3/sec.

[4] Brisbane Valley Flood Damage Minimisation Study, Ipswich City Flood Damage Assessment, Ipswich City Council, November 2006, WRM Water and Environmental.

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Peter Hugh Allen Witness

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Table 4.1 Residential and Non-Residential Flood Damage Summary Results, Ipswich City

Flood Discharge (m³/s)	Residential Total Damage ($million)	Residential No. of Flood Damaged Properties	Residential Average Damage Per Property ($1000)	Non-Residential Total Damage ($million)	Non-Residential No. of Flood Damaged Buildings	Non-Residential Average Damage Per Building ($1000)	Total Damage ($million)
1000	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0
3000	0.23	6	38.09	0.03	2	15.06	0.26
4000	3.97	98	40.50	1.14	102	11.22	5.11
5000	19.09	393	48.58	3.99	152	26.23	23.08
6000	54.20	899	60.29	10.59	212	49.96	64.79
7000	110.59	1558	70.98	24.50	315	77.77	135.09
8000	181.95	2425	75.03	47.50	449	105.78	229.45
10000	327.42	4161	78.69	102.33	845	121.11	429.75

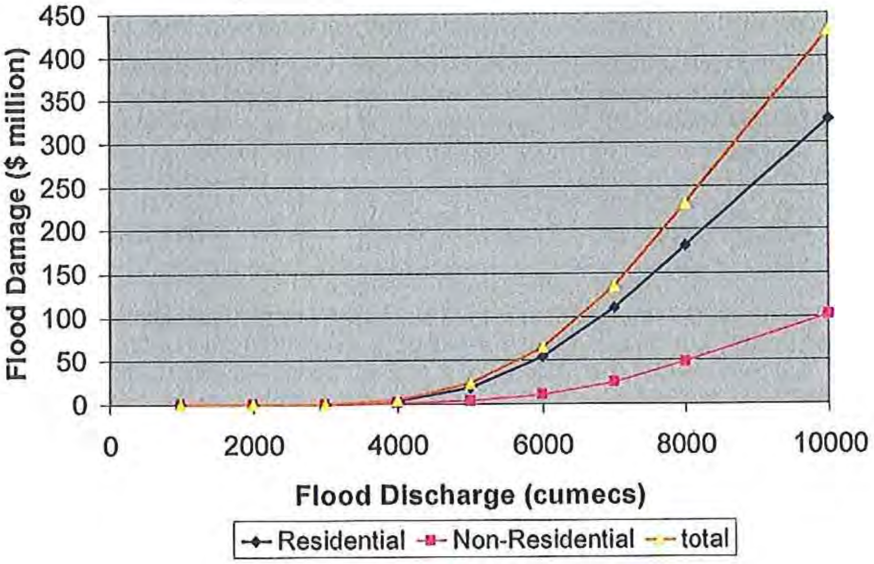

Figure 2 Total Damage Estimates for Ipswich City from Ipswich City Flood Damage Assessment (Figure 4.1 of Report) (2)

Strategy W4 –	***The primary consideration is Protecting the Structural Safety of the Dam***
Conditions	• **Wivenhoe Storage Level predicted to exceed 74.00m AHD** • **No limit on Maximum Release rate** • **The primary consideration is protecting the structural safety of the dam** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

77. Procedure 4 is focussed on ensuring the safety of the dam while limiting downstream impacts as much as possible. It requires increasing dam discharges until the headwater level in the dam has peaked. Importantly, such discharges are made without consideration of the discharges from Lockyer Creek and the Bremer River. This procedure has to be implemented so that the dam can withstand the maximum flood

considered possible by the BoM. Such a failure would put many more metres of water through Brisbane, Ipswich and other downstream communities and would put around 244,000 people at risk. This is what puts Wivenhoe in the 'Extreme' hazard category and requires it to be designed, constructed and operated to the highest possible standards. When Wivenhoe Dam was originally designed in the mid to late 1970s, it was designed in accordance with the highest standards of the day using the then estimates of the Probable Maximum Flood which was just becoming available. The Acceptable Flood Capacity of Wivenhoe Dam remains the Probable Maximum Flood. However since then, the estimates of the Probable Maximum Precipitation (which runs off the catchment to produce the Probable Maximum Flood) have significantly increased due largely to much better processes in analysing and understanding storms and a much greater quantity and quality of rainfall data. This meant that the original dam only had a capacity to pass about a 1:30,000 Annual Exceedance Probability (AEP) flood event prior to 2005. As a consequence, SEQWater (now Seqwater) upgraded the spillway capacity to about 80% of the required Acceptable Flood Capacity with the construction of the auxiliary spillway (which contains the fuse plugs) which was completed in 2005. According to Schedule in Section 4 of DERM's Guidelines on Acceptable Flood Capacity of Referable Dams, a further upgrade to 100% of the Acceptable Flood Capacity will be required by 2035. This upgrade did not alter the flood mitigation capacity of Wivenhoe Dam. However, provision was included in the 2010 version of the Manual to enable earlier releases to avoid triggering a fuse plug if the predicted peak headwater level in Wivenhoe was just going to exceed the trigger level.

Somerset Dam

78. Somerset Dam is operated in tandem with Wivenhoe Dam with the basic principle being to trend towards the interaction line which effectively keeps the risks of failure of both dams to similar levels. However, this may need to be reconsidered to reflect the fact that cascade failure of both dams is likely if Somerset Dam fails with greater than about a 1:500 AEP flood event passing through it. In terms of a worst case scenario, reducing the risk of failure of Somerset Dam is preferable to both dams failing at the same time.

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Peter Hugh Allen **Witness**

Strategy S1 – Minimising Impact on Rural Life Upstream	
Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam not expected to reach EL 67.0 (FSL) during the course of the Flood Event**

79. Procedure S1 is all about draining the flood storage of Somerset Dam into a drawn down Wivenhoe Dam storage while minimising the impact on rural life upstream of the dam. Procedure S1 is really only applicable in relatively small flood events which are concentrated in the Stanley River catchment. Consideration is also given to minimising the downstream environmental impacts from the release.

Strategy S2 – Minimise Impacts below Wivenhoe Dam	
Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam level expected to exceed EL 67.0 (FSL) but not exceed EL 75.5 (fuse plug initiation) during the course of the Flood Event**

80. The intent of this strategy is to maximise the benefits of the flood storage capabilities of the dam while protecting the structural safety of both dams.

81. Operations are to target a correlation of water levels in Somerset Dam and Wivenhoe Dam as set out in the graph below. The operations target line shown on this graph is to generally be followed as the flood event progresses with gate operations being undertaken with the aim of movement of the operating point towards the target line in a progressive manner. It will not necessarily be possible to adjust the duty point directly towards the target line in a single gate operation.

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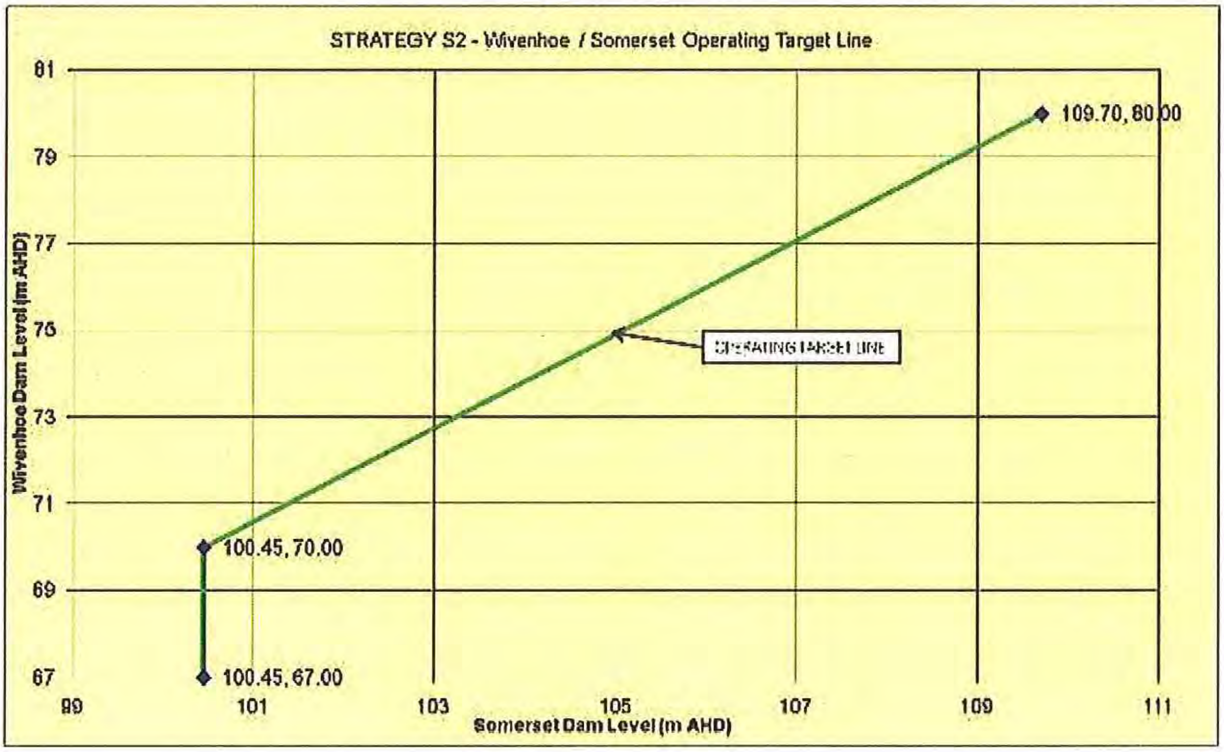

Strategy S3 - Protect the Structural Safety of the Dam	
Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam level expected to exceed EL 75.5 (fuse plug initiation) during the course of the Flood Event**

82. In addition to the operating protocols used in Strategy S2, to prevent fuse plug initiation, consideration can be given to temporary departure from the operating protocols contained in this strategy under the following conditions:

- The safety of Somerset Dam is the primary consideration and cannot be compromised; and
- The peak level in Somerset dam cannot exceed EL 109.7.

83. Procedure S3 gives the Flood Engineer some scope to retain some flood storage in Somerset Dam rather than discharging it into Wivenhoe Dam and increasing the likelihood of fuse plug initiation. Consideration will need to be given in future revisions of the Manual as to just how much flood water can be stored in Somerset Dam under these circumstances without increasing the risk of failure of Somerset Dam too much.

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(h) How the weather forecasts provided by the Bureau of Meteorology should be taken into account

84. The BoM provides a range of forecasts to the Flood Operations Centre ("the FOC"). These forecasts are discussed in more detail in the Seqwater flood event report for the January 2011 event. They are used to determine what is likely to occur in terms of dam inflows and downstream tributary flows over the next forecast period. A discussion paper on the accuracy of the forecasts provided to the Flood Engineers clearly indicates that there is a significant degree of uncertainty in rainfall forecasts which gets worse the further into the future the forecast applies.

85. Because arrangements are in place for the Flood Engineers to discuss the weather situation with BoM forecasters, the Flood Engineers also have an avenue, if considered necessary, to discuss upcoming weather predictions with those who make them.

86. There has been a lot of press reports and anecdotal comment that the Flood Engineers should have placed much greater reliance on the long range forecasts and pre-released significant quantities of water from Wivenhoe Dam prior to the event. It needs to be recognised that such a practice would have involved some potential risks. These include:

- What would happen if the pre-release discharge coincided with significant inflows coming out of the Bremer or Lockyer Creek? This is especially the case for the Bremer because it is 15 to 20 hours downstream of Wivenhoe and the Flood Engineer would have to estimate what is likely to be discharged from the Bremer when the Wivenhoe flows reached the junction of the Bremer and the Brisbane Rivers. If a pre-release close to the 3,500 m^3/sec limit for minimal damage for Ipswich, was made and significant flows came down the Bremer, avoidable damages could result. If the target was to (say) keep one of the bridges open the consequences might be less but the situation might have to be monitored carefully to ensure the crossing could be closed in time to prevent traffic being caught on the bridge as it was inundated; and
- What if a pre-release is made and the rain event does not eventuate? Much of the pre-released water would no longer be available for consumptive use.

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87. In terms of gate operations once the event has begun forecasts are a very important part of determining gate operations. The following issues are relevant:

- The hydrologic models of the catchment allow estimates to be made of the inflow hydrographs coming into the dams. They model the effects on inflows of the rain that has already fallen on the catchment and the rain that is forecast. This normally provides significant warning of incoming flows. The models estimate the magnitudes of the inflows and the time that it will arrive at the reservoir. If the rain falls directly on the reservoir however (as occurred during the second inflow peak event on 11 January 2011) the rainfall instantaneously reports to the reservoir as inflow with little or no warning time;
- The Seqwater Report for the January 2011 flood event demonstrated that the forecasts for the next 24 hours significantly **under-estimated** (by up to 200%) actual rainfall for the early/middle part of the event, and significantly **over-estimated** (by up to 200%) rainfall for the latter part of the event;
- If forecast, instead of actual rainfall (and thus actual river flows), had been used as a major decision making criterion, the releases could have been lower than they actually were in the early/middle part of the event, and greater in the latter part of the event. The net effect would then have been to worsen the flood peak in urban areas; and
- The three and five day forecasts have greater uncertainty than the 24 hour forecasts.

88. Note that the above comments are <u>not</u> a criticism of the BoM – rather, it reflects current technology and forecasting methodologies. 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.

89. The Flood Engineers therefore have to apply a great deal of judgement in deciding how to respond to rainfall forecasts. It becomes a case of 'what if' and ensuring that the dams are able to respond to the potential variations from the available forecasts.

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(i) The different weight given to the priorities in the Manual in practice, and how the implementation of those priorities has changed over the seven revisions of the Manual

90. The priorities of the dam operation objectives have changed very little over all the variations to the Manuals. The variations that have occurred have been at the lower end of the priorities with the higher level objectives of:

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation; and
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers; being virtually unchanged since the very early version of the Manual.

91. The lower end of the objectives has had some movement and this is best explained in Seqwater's submission for the approval of the November 2009 Manual.

92. The structural safety of the dam is the obvious highest priority. The consequences of the loss of the dam in terms of the loss of life and the damages are so catastrophic that they are to be avoided at all costs. There would be about 244,000 people at risk if Wivenhoe Dam was to fail in an extreme flood event. This is the case even before the loss of the water supply is considered.

93. The provision of optimum protection of the urbanised areas from inundation ranks next because of the number of houses potentially inundated by flooding and the damage caused. Although serious, it is nowhere near the damage caused by the loss of the dam.

94. However, some of the downstream bridges are inundated for weeks during major events and for Burton's Bridge there is no alternative access to the people who live on the northern side of the river.

95. The 4th and 5th objects were originally:

- Minimise disruption and impact upon Wivenhoe Power Station, and
- Minimise disruption to navigation in the Brisbane River.

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These have been replaced by:

- Retain the storage at Full Supply Level at the conclusion of the Flood Event; and
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

96. The provision to return the storages to Full Supply Level was always there (e.g. in Revision 6 of the Wivenhoe/ Somerset Manual it was in Section 8.6 (d)) but it was stated more explicitly in Revision 7.

97. The disruption caused by Wivenhoe releases has never been a significant factor in determining releases as navigation has been interrupted by other factors such as debris coming down the river during the May 2009 flood event when no discharges were made form Wivenhoe.

98. The flora and fauna priority was put in to allow Seqwater to organise teams to gather stranded fish and relocate them at the end of the event at a time of their choosing when it was safe to do so.

(j) The ability to draw dams down below Full Supply Level in the Manual and in what circumstances that would be appropriate

99. Wivenhoe, Somerset and North Pine are, unlike most Queensland dams, able to use their gates and sluices to significantly draw down their storage levels below FSL at a relatively rapid rate. This was demonstrated by the release of about 300,000 ML from Wivenhoe following the January 2011 flood event.

100. However, there are several issues to be considered. These include:

(a) Any release needs to be done safely so that it does not endanger people wanting to use downstream crossings;

(b) Releases will inconvenience those who wish to use the inundated crossings;

(c) Those making the release may have to throttle back releases if downstream inflows are forecast or occur so as to not exceed the maximum discharge limit adopted;

(d) There may not be sufficient time between inflows to make much of a difference; E.g. the post Christmas flood event before the January 2011 event only ceased with the

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closure of the last gate on New Years eve. High discharges may be required to make a significant difference and these may have significant consequences if unforecast rain subsequently occurs before the release clears the river system;

(e) Just because a seasonal outlook of say an 80% chance of above average rainfall is made, it does not automatically mean there will be a major flood; and

(f) Because rainfall forecasts get more uncertain the further out the forecast rainfall is, greater care needs to be taken with longer term releases.

3. Current Dimensions and Features of the Dams

Wivenhoe Dam

Dam		
	Type of Dam	Zoned earth and rockfill with mass concrete and gated spillway
	Reservoir level at FSL	EL67.0
	Storage capacity at FSL	1 150 000 ML
	Surface area at FSL	10 820 ha
	Minimum operating level for water supply	EL 34.0
Main embankment (right of spillway)		
	Crest length	1 210 m
	Embankment crest level	EL 79.0 (original) EL 80.1 (including 2005 parapet wall)
	Maximum height above foundation level	59 m
	Volume of earth and rockfill	3 014 348 m^3
Main embankment (left of spillway)		
	Crest length	1 050 m
	Volume of earth and rockfill	984 003 m^3
	Embankment crest level	EL 79.0
Saddle Dams		
	No of saddle dams	2
	Combined crest length	430 m
	Crest level	EL 80.0
	Combined volume of fill	61 368 m^3
Spillway		
	No of radial spillway gates	5
	Size of each gate	12 m wide by 16.6 m high
	Width of gate piers	3.5 m
	Level of fixed concrete crest	EL 57.0

	Bed level of approach channel	EL 48.0
	Level of flip bucket tip	EL 45.0
	Concrete quantity	130 160 m^3
Auxiliary Spillway (constructed 2005)		
	Type	Fuse plug (3 bays)
	Base level	EL 57.0
	Bay minimum crest levels	EL 75.7, EL 76.2, EL 76.7
	Bay widths	34 m, 64.5 m, 65.5 m (total of 164 m)
Outlet works		
	Outlet penstocks	One 3.6 m diameter and one 1.9 m diameter
	River outlets	2 of 1 500 mm fixed cone dispersion valves

Somerset Dam

Dam		
	Type of dam	Mass Concrete Gravity
	Length of dam at deck level	305 m
	Maximum height above foundation level	58 m
	Lowest foundation level	EL 54.77
	Total volume of mass concrete	205 700 m^3
	Dam Crest Level	
	Bridge deck level	EL 112.34
	Non overflow crest level	EL 107.46
	Concrete spillway crest	EL 100.45
	Full Supply Level	EL 99.0
	Minimum Water Level	EL 69.97
	Galleries	
	Upper level	EL 88.9
	Lower level	EL 66.0
Spillway		
	Location	Monoliths I to P
	Number of radial spillway gates	8
	Size of each crest gate	7.9 m wide by 7.0 m high
	Top of gates when closed	EL 107.48
	Radius of spillway gates	7.0 m
	Centreline of trunnion bearings	EL 103.73
	Clear length of spillway	63.4 m
Sluice Gates		
	Number of Sluice Gates	8
	Size of each sluice gate	3.66 m high by 2.44 m wide

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	Invert level of sluice entrance	EL 71.2
Regulators		
	Number of regulators	4
	Level of centreline of regulators	EL 69.97
	Type and size of regulators	2.3 m fixed cone dispersion valves
Storage		
	Reservoir level at FSL	4 210 ha
	Storage Capacity at FSL	379 849 ML
Power Station		
	Location	Right side of spillway
	Approx capacity	4 MW

4. The adequacy of the capacity of the Dams for the purposes of water security

101. I have no involvement in water supply security issues and have no comment to make on this issue.

5. The adequacy of the capacity of the Dams for the purpose of flood mitigation

102. There is no accepted standard on the adequacy of the capacity of dams for the purpose of flood mitigation. The question that has to be asked is more 'What degree of flood mitigation is required?' and 'How is that to be provided?'

103. Certainly, Wivenhoe and Somerset dams do provide a significant degree of flood mitigation but its usefulness is largely dependent on the magnitude of the incoming flood and whether there are heavy or light rainfalls downstream of the dam. As indicated below, the degree of flood mitigation required or able to be provided by any dam depends on a range of factors.

104. These factors include a range of structural and non-structural strategies that can be implemented to mitigate the consequences of floods. The preferred solution will depend on the individual circumstances of each situation. In summary, these include:

- The construction of dams or other structures to temporarily store floodwaters to reduce the magnitude of flood discharges flowing past the population at risk;

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Peter Hugh Allen **Witness**

- The construction of levees or diversion structures to isolate the population at risk from the flood waters;
- The development and implementation of floodplain management plans so that population at risk within the flood plain is minimised or at least the risk of their inundation is reduced to tolerable levels; and
- The development and implementation of Emergency Action Plans so that the population at risk can react in an appropriate, coordinated manner in the event of a flood emergency for a wide range of potential floods from relatively frequent events up to the Probable Maximum Flood type events. The degree of planning should be more detailed for the more frequent events but should be able to be escalated to the much rarer events if they occur. Such flood plans should include:
    - Consultation with emergency planners and other stakeholders and a detailed assessment of the risks of flooding and the consequences of such floods if they were to occur;
    - The provision of accurate real time flood forecasting and flood monitoring systems;
    - The provision of appropriate, timely warnings to the population at risk so that they can adequately prepare for incoming floods or evacuate out of the areas at risk;
    - Gathering of adequate survey data to enable all potential populations at risk to accurately interpret flood warnings;
    - The establishment of emergency excavation centres above flood levels;
    - Education of the population at risk so they know what to expect and what to do in emergency situations; and
    - The regular exercising and updating of these plans so that they remain relevant and all parties know what to do in the event of a flood emergency.

105. The ability of a particular option to provide flood mitigation depends on a large number of parameters. Determining the most appropriate approach can involve detailed hydrologic and hydraulic model studies and assessment of the costs and effectiveness. If a dam is to provide a significant degree of flood mitigation it needs to be specifically addressed during the initial design or during major upgrades.

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Peter Hugh Allen **Witness**

106. When designing flood mitigation projects, a combination of strategies is often employed to maximise the degree of flood mitigation provided by the project. The strategies might include:

(a) Determining what degree of flood mitigation is actually required.
This tends to be a political decision although in some circumstances it might be justified on a cost benefit basis. For example, Peter Faust Dam at Proserpine was designed to limit the discharge of the flood of record (Cyclone Ada of 1970) to a maximum value. Similarly, the upgraded Hinze Dam has been designed to limit the 1 in 100 AEP flood discharge to a nominated discharge and this provides a specific level of flood mitigation downstream;

(b) Maximising the proportion of the catchment at the location of interest that is controlled by the dam.
If a dam only controls a small proportion of the catchment above a town, then it cannot have any control over floods originating from the remainder of the catchment e.g. Wivenhoe only controls about 50% of the catchment of the Brisbane River above Brisbane – it cannot control floods originating in Lockyer Creek or the Bremer River;

(c) Maximising the ability of the dam to temporarily store water during a flood event.
If a dam can temporarily store a relatively large proportion of an incoming flood event, it may be able to discharge the incoming flow at a much slower rate to mitigate the downstream impacts. This is the case with Wivenhoe Dam which has 1.45 million megalitres of flood storage above full supply level. Any reduction in this flood storage capacity will reduce its ability to mitigate floods;

(d) Some dams are designed with restrictive spillways so that only relatively small discharges can occur. This means inflows must be stored until sufficient head can be built up to drive the discharge through the spillway. This is how Peter Faust Dam and Maroon Dam operate. It also applies for Hinze Dam but only up to the 1 in 100 AEP flood event. For flood magnitudes larger than this the headwater rises above the constricted part of the spillway and a much wider part of the spillway comes into action with a significant increase of flood discharge;

(e) Providing the required degree of flood mitigation for the nominated magnitude of the flood event;

(f) The larger the event, the quicker the available flood storage behind the dam is filled and the degree of flood mitigation provided by the dam is reduced. Thus a dam is

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likely to provide greater degree of flood mitigation for a 1 in 5 AEP flood event than a 1 in 100 AEP event and a 1 in 10,000 AEP flood event of similar duration;

(g) Ensuring the storage is drawn down at the start of the event.

If a dam storage is half empty at the start of an event, this storage will have to be filled first before any discharge occurs. This is often extremely difficult to organise in Australia's uncertain weather. Some dams such as the Burdekin Falls Dam can discharge for such long periods that this cannot be assured while others which are reliably drawn down during the period prior to the wet season that this might be more reliably achieved. However, if you deliberately draw it down at the start of a 'wet season' and the wet season does not eventuate, you run the risk of not having sufficient water available for future seasons.

(h) Ensuring the dam is close to the location it is designed to protect for greater flood mitigation benefit.

Locations a long way downstream of a dam will probably receive a much lower degree of flood mitigation from a dam than locations in closer proximity to the dam. This is because flood peaks typically mitigate naturally (attenuate) as they proceed downstream;

(i) Installing gated spillways to provide some flexibility to control discharges;

This was the strategy applied to Wivenhoe Dam in combination with the provision of a significant flood storage capacity. The provision of gates, however, does not always provide flood mitigation.

At North Pine Dam, there is very little flood storage provided above Full Supply Level so that inflows have to be released as soon as they can. Similarly, because of the relatively flat terrain around Beardmore Dam near St George, the dam is operated to minimise headwater rises and discharges are matched to inflows as closely as possible;

(j) Flood detention basins are special types of dams designed specifically to provide flood mitigation. They are normally kept empty to maximise flood storage. When a flood event occurs, initial discharges are through relatively small outlets until a headwater level is reached so that the safety of the dam needs to be ensured and a larger spillway comes into play. There are now a number of these basins across Queensland in areas such as Ipswich, the Gold Coast and Cairns. They are usually designed to protect downstream urban developments;

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(k) Maximising the ability of flood channels to pass flood discharges. This can be done by removing debris from flow paths, enlarging them or removing channel constrictions such as levees or embankments which restrict flow paths. This typically requires a balance between retarding the flood waters in the up-stream parts of the catchment and discharging them more quickly at the down stream end of the catchment;

(l) Purchasing and relocation of flood affected dwellings (such as has occurred for example in Northey Street in Brisbane); and

(m) Levees are a relatively common means of protecting population at risk. However, the population needs to be aware that relying on levees is associated with a high level of risk. If levees are overtopped or fail prematurely, the population at risk can be suddenly exposed to very high flood levels with little warning and insufficient time to evacuate. They need to be well maintained and regularly monitored during flood events. There also needs to be recognition that floods greater than the design flood event for the levees can occur and contingency plans need to be prepared for this eventuality.

6. Any planned future upgrades of the dams

107. The only upgrades that I am aware of for North Pine Dam, Wivenhoe Dam and Somerset Dam are those associated with future Acceptable Flood Capacity upgrades. Under current arrangements, these upgrades will need to be completed in accordance with the Schedule in Section 4 of DERM's *Guidelines on Acceptable Flood Capacity for Referable Dams, February 2007*. It is reproduced in the following Table.

Tranche	Required minimum flood discharge capacity	Date by which the required minimum flood capacity is to be in place for existing dams
1	**25 per cent** of AFC or **1:500 AEP** flood event (whichever is the bigger flood)	These dams must be upgraded as soon as possible
2	**50 per cent** of AFC or **1:2000 AEP** flood event (whichever is the bigger flood)	1 October 2015
3	**75 per cent** of AFC	1 October 2025
4	**100 per cent** of AFC	1 October 2035

Table 3: Schedule for Dam Safety Upgrades

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108. According to our information prior to the January flood event, the dams have the following approximate spillway capacities:

Dam	Required Spillway Capacity	Proportion of AFC able to be discharged	Reqd. Date to complete upgrade
Wivenhoe Dam	Probable Maximum Flood (PMF)	≈ 80%	2035
Somerset Dam	PMF	≈ 60%	2025
North Pine Dam	PMF	≈ 60%	2025

109. Following the January 2011 event, these spillway adequacies will have to be revisited taking into account what actually happened for these events. Potentially the greatest impact will be on the spillway adequacy of North Pine Dam. This is discussed further in Section 20.

110. Certainly there has been a lot of consideration of options for raising the Full Supply Level of Wivenhoe Dam. This seems to have begun as Wivenhoe Dam was filling following the prolonged drought before the current wet period when the storage level of Wivenhoe dropped to about 17% of the FSL capacity. As I understand it, Seqwater were initially examining proposals to increase the FSL storage capacity but that the project was then handed over to the Queensland Water Commission. My principal concern with this proposal was how Wivenhoe Dam would be operated during floods if the storage level was increased. The issues that I raised included:

- If the FSL was raised to EL 68.5 mAHD, would Procedure W1 have run for the same 1.5 metre range currently applied or would it have to be compressed?
- What would the impact be on the EL 74.0 mAHD trigger for Procedure W4; and
- What would the impact have been on the spillway adequacy of Wivenhoe Dam?

111. I still have not received any proposals as to how these flood operations issues might be resolved and I would not be prepared to endorse any raising of the FSL until these issues were resolved. My most recent meeting with the Queensland Water Commission was in September 2010. However, I understand the issue was also raised in Parliament following the October 2010 floods.

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112. Similar questions would arise for any lowering of the Full Supply Level. However, they are not as serious as for the raising of the Full Supply Level because at the very worst, any incoming flood would have to fill the deficit up to the old Full Supply Level before the existing arrangements would begin to apply.

113. I recognise that there are often several feasible options in any project to upgrade dams. However, as Director Dam Safety (Water Supply) I have no power to direct that a particular type of upgrade option be undertaken. My interest is that the option adopted by the dam owner is appropriate and will bring the dam up to a suitable standard within the nominated timeline and to ensure that it does not impose any increase in risk though the course of construction.

7. The water security needs of South East Queensland to 2050

114. I have no involvement in water supply issues and have no comment to make on this issue. I understand that is the role of the Queensland Water Commission.

8. Role in relation to the Full Supply Levels of the Dams

115. The only way that I would get involved in the setting of the Full Supply Level of any referable dams would be in relation to dam safety issues. As stated above, I have no involvement in water supply issues and I only get involved if dam safety is at risk.

9. Role in relation to dam operations at Wivenhoe, Somerset and North Pine Dams

116. I did not have any operational role in the flood events throughout the State in the wet season from 1 September 2010 to 31 March 2011. That was entirely the responsibility of the dam owners and their nominated Flood Operations Engineers. However, as part of my role, I did maintain some awareness of water levels for the 3 dams (Wivenhoe, Somerset and North Pine) through the BoM website.

117. As indicated in the Seqwater flood event logs for Wivenhoe, Somerset and North Pine dams, I did have several discussions with the flood operations engineers over events

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that were occurring with these dams. My comments on these discussions are contained in the attachment marked as **'PHA–09'**.

118. DERM also received the Technical Situation Reports (TSRs) from the SEQ Water Grid Manager (presumably these reports will be/have been provided by the SEQ Water Grid Manager to the Commission) and most of the base reports from Seqwater on which they were based which are attached and marked as **'PHA–10'**.

119. However, all three dams are Category 2 referable dams under the provisions of the Water Supply Act and are the subject of Manuals also approved under that Act. Seqwater also own and operate 21 other referable dams in the South East Queensland region.

120. Therefore, the role that I undertake in relation to all referable dams is:

- Applying dam safety conditions to ensure that an adequate dam safety management program is applied to the dams;
- Auditing the dam safety management programs;
- Developing and reviewing the Manuals as required;
- Reviewing Flood Event Reports and Flood Preparedness Reports required under the Manuals;
- Maintaining contact with the dam owner's representatives to ensure the effectiveness of the owner's dam safety management program; and
- Taking a proactive involvement in any proposed dam upgrades.

Note: In responding to Questions 10 to 15, I have assumed that a reference to the 'Dams' is a reference to Wivenhoe Dam, Somerset Dam and North Pine Dam. Additionally, when discussing reductions in the Full Supply Level of a dam, I have assumed that these questions relate to Wivenhoe Dam.

10. When, how and why the Full Supply Level at the Dams which existed at the time of the January 2011 Floods Event was determined

121. As I understand it, the Full Supply Levels for all dams were determined at the time of original construction. The general arrangement drawings of Wivenhoe Dam, Somerset Dam and North Pine Dam when they were originally constructed shows the Full

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Supply Levels for Wivenhoe and North Pine dams. The Full Supply Levels are EL 67.0 mAHD and EL 39.6 mAHD respectively. There is no mention of Full Supply Level on the early Somerset Dam drawings. I have found a reference to Full Supply Level of EL 99.0 mAHD in documentation from the 1980's. The drawings for all 3 dams are at 'PHA–4', 'PHA–05' and 'PHA–15' respectively.

11. An account of all discussions, correspondence, meetings or briefings or briefings he participated in from 1 September 2010 to 31 March 2011 regarding possible changes to the Full Supply Level of the Dams (and provision of all notes made of all discussions or meetings regarding decreasing the Full Supply Level between 1 September 2010 and 31 March 2011)

122. For the last year or so there has been considerable discussion about raising of the FSL of Wivenhoe Dam and it was raised in Parliament following the October 2010 flood event. The Queensland Water Commission was assigned the task of investigating the proposal and the most recent discussions that I had on the subject was at a meeting with QWC on 17 September 2010 at QWC offices. As discussed in topic 6 of this Statement, I had reservations about raising the FSL on a permanent basis.

Discussions were held in January 2011 following the January 2011 flood event as to what could be done to improve the flood mitigation capability of Wivenhoe Dam. I have listed the meeting for which I have meeting notes. These include:

Date	Topic & Reference	General Comment
17th January – 9:00am	General briefing of Minister Robertson by Seqwater	There was some discussion of the ways flood storage might be provided and the magnitude of the flood events since October
25th January – 1:30pm	Seqwater, Water Grid, QWC, DERM	Discussed the effect of FSL on flood impacts. Progress on Flood Event report, what would be the triggers for pre-release? ROPs, the extent of discretion in section 2.8 of the Manual. Balancing impacts on water security and flood in reducing FSL.
31st January –	Meeting with Minster	If a flood is greater than 1:200

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8:30am	Robertson	AEP flood event it will create benefits.
	Greg Claydon, Rob Drury, Tad Bagdon	How do you get around the water entitlements issues? 25% is equivalent to 100% of Seqwater entitlement for one year. One off emergency or long term? At what rate do you release ...430 m^3/sec to keep Burton's open.
1st February 4pm	Seqwater. DERM, QWC	Govt. wants to discuss whether different priorities should be given to drinking water retention and flood mitigation
4th February 12 noon	Seqwater. DERM, QWC	Discussed the impacts of a range of initial storage and gate operating scenarios presented by Seqwater.
17th February 11:15am	DERM, Seqwater	Discussed pre-approval for a variation to the Manual in the event of a flood event to provide a smooth transition between Operational releases up to FSL under ROP and flood releases under the Manual
24th February 9:00am	DERM and Seqwater	Timing of Wivenhoe flood event report What is required in Technical Situation Reports (TSRs)
1st March 3pm	Seqwater, Minister Robertson, DERM	Briefing of Minister Robertson on what is contained in Wivenhoe flood event report
9th March 5:30am	Meeting with Seqwater over issues arising from flood operations arising from Seqwater January flood report	How to seek variations to the Manual under section 2.8 Fatigue management Communication protocol - update
10th March 3:30pm	Meeting DERM and Seqwater	What will be in North Pine flood event report and the issues that it will raise.
18th March 9:30am	DERM and Seqwater	Re: Issues raised on adequacy of North Pine Dam

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123. The copies of my notes of these meetings are attached and marked '**PHA–11**'.

124. My only involvement in the actual temporary reduction in the Full Supply Level once the decision was made was in how it was done. There are several emails which are attached and marked as '**PHA-12**' which illustrate this involvement.

12. Opinion as to what the Full Supply Level of the Dams should be

125. All three dams (i.e Wivenhoe, Somerset and North Pine Dam) are using the FSLs for which they were originally designed. All the design studies and subsequent safety reviews would have been based on these levels. I have no objection if these FSLs are subsequently lowered because that will only improve dam safety and lower the risk of failure. However, I would be very concerned if the FSL was to be raised and would require the dam owner to demonstrate that the dam was capable of accommodating the increased loads. Other than that, I have very little input into the setting of FSLs.

13. How (in terms of regulatory or legislative changes, directives to operators etc.), and why, the amount of water in the Dams was decreased in February 2011

126. I had no involvement in making the decision to temporarily lower the Full Supply Level of Wivenhoe Dam.

14. Details, including verbatim accounts where possible, of all discussions, correspondence or meetings or briefings regarding decreasing the Dams' levels in January and February 2011

127. While I had no involvement in the decision to temporarily lower the Full Supply Level of Wivenhoe Dam, I did attend some meetings where the issue was discussed. These conversations are detailed above in section 11.

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15. Details, including verbatim accounts where possible, of any discussions, correspondence or meetings in December 2010 or January 2011 regarding releasing water from the Dams to take their level below 100%

128. As far as I am aware there were no discussions or correspondence in which I was involved regarding lowering the level of the dams below 100% before the January 2011 flood event. However, I am aware that there were discussions and approval given to temporarily lower the Full Supply Level to 95% towards the end of the January 2011 flood event. This decision was made by DERM's General Manager, Office of the Water Supply Regulator.

16. An account of all briefings within his knowledge prepared by the Department of Environment and Resource Management for the responsible Minister or disaster management authorities or personnel between October 2010 and February 2011

129. A summary of the briefings regarding Seqwater's Wivenhoe and Somerset report, Seqwater's North Pine Dam report and other matters are self explanatory and are attached and marked as **'PHA–13'**.

130. In addition to these briefings, we had contact with Emergency Management Queensland (EMQ) over a couple of dam incidents/failures over the Christmas period. These were in relation to:

- Bazley's Dam on Euri Creek near Bowen. DERM Dam Safety has had ongoing discussions with the dam owner over the potential impacts of the dam. While it was non-referable, it was in poor condition and threatening to fail and inundate downstream crossings. There were email and telephone exchanges over the dam with EMQ and the Bowen police. We also got two of our regional officers to inspect the dam and liaise with the local police. In the event, the dam did not fail as the potential rain did not eventuate. Remedial works are being undertaken to improve the safety of the dam; and
- Pozzebon Dam near Applethorpe: DERM Dam Safety was advised by EMQ that a farm dam was failing near Stanthorpe. The whole region was in flood at the time so there was not much we were able to do at the time. However, again, one of our regional officers was able to get access from Warwick when the flooding subsided. The dam

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had indeed failed and had caused flood water to rise about 0.6 m against the back wall. Investigations are ongoing to determine whether the dam is likely to be referable if it is to be rebuilt.

17. An account of all communications he had, and any briefings given to or received from the Flood Operations Centre between 1 and 19 January 2011 (and provision of all emails, text messages and notes of phone conversations)

131. I have attached a copy of all the emails received from the Flood Operations Centre (see 'PHA-10'). I have also attached comment on the references made in the FOC Event Log to me (see 'PHA-09'). These communications show that I had no involvement in operational decisions on how to operate the dams.

18. Any modelling, calculations or opinions produced or analysed by Mr Allen regarding the draw down expected to occur in the spillway approach at Wivenhoe Dam for the level of releases of water being made between 00:00 11/01/2011 and 12:00 noon 12/01/2011, and the effect of that draw down on the data produced by the automatic gauge situated in the spillway approach at Wivenhoe Dam during that period

132. The Commission has requested that I provide additional comments on the above topic. I take this topic relates to whether the ALERT gauges should have been relied upon during the event or should the manual readings been adopted. I have received the attached summary from Seqwater (**'PHA–14'**) which summarises the situation. I have also done some assessment of my own which indicates that most of the 'error' in using the ALERT gauge readings is associated with the velocity head in the approach channel. This is illustrated in Figure 3 below. As can be seen the bulk of the 'difference' can be seen to result from the influence of the velocity head of the approaching flow. The interpretation of Figure 3 is complicated but I can explain it in the evidence I give before the Commission.

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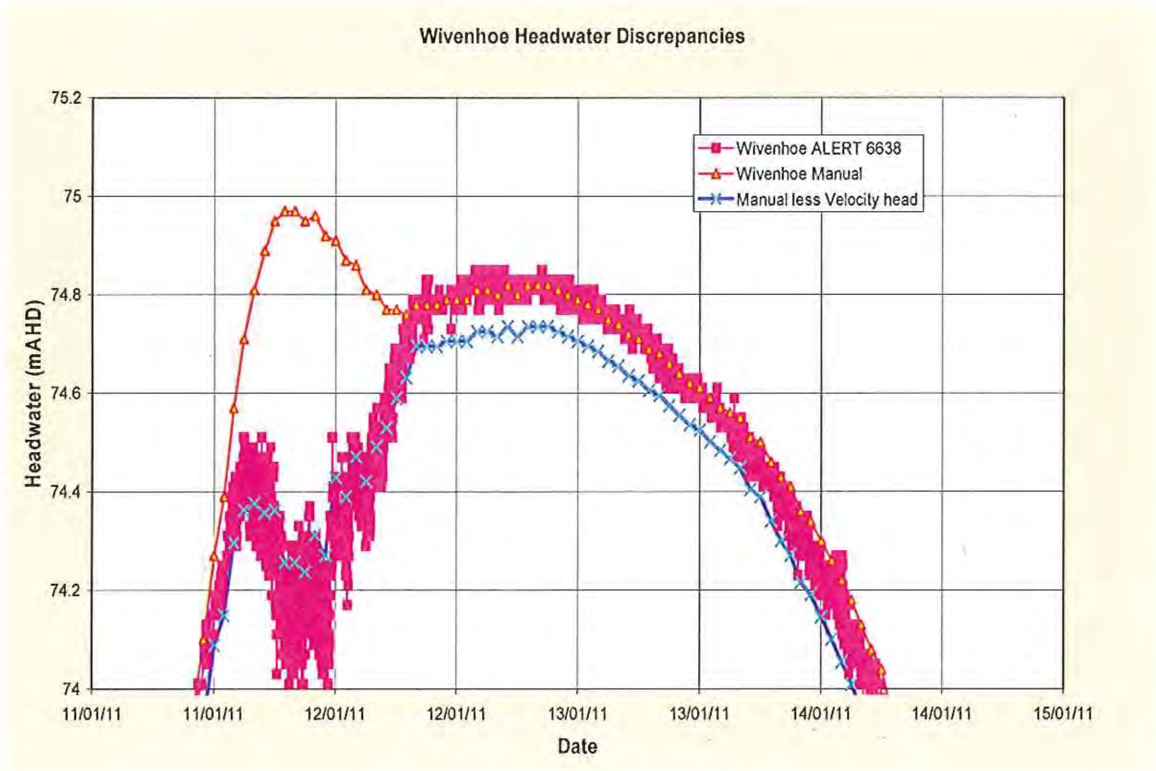

Figure 3 Wivenhoe Dam - H eadwater Gauge Discrepancies

19. Other issues which need to be raised

133. In my role as Director Dam Safety (Water Supply), I am responsible for the regulatory control over referable dams and for the actions related to the Manuals. As such, I am required to undertake a review of the Seqwater Flood Event Reports and to progress any outcomes resulting from them. Therefore, I need to develop a view on a range of issues which are discussed below.

Upgrade of FOC Hydraulic Model

134. During the flood event, the hydraulic model was not available to the Flood Engineers because of software problems. They tried to overcome this by 'borrowing' a model developed by consultants WRM towards the end of the event. It is recommended that the FOC model be brought back to an operational state or that a suitable alternative be developed that can be used by the three main stakeholders - the BoM, the Brisbane City Council and the Flood Operation Centre. If all parties have access to the same model (or a similarly calibrated model) then there will be fewer opportunities for

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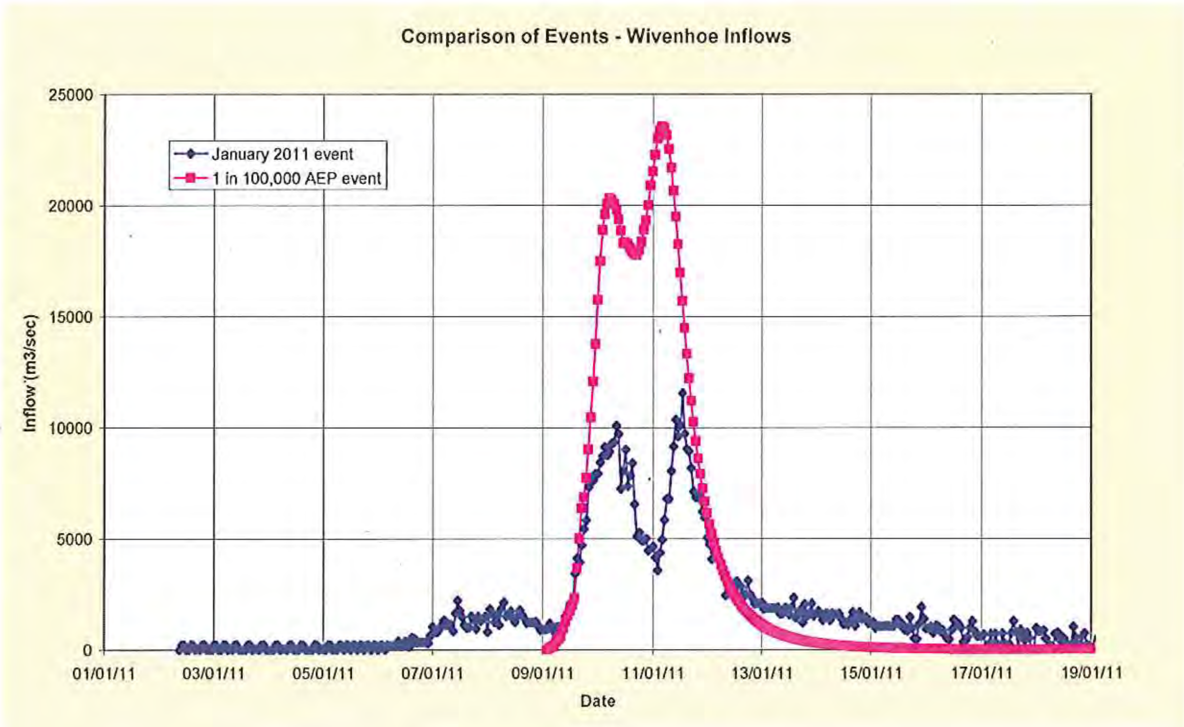
conflicting water level estimates at critical locations and it will be easier to transfer data.

Seqwater Weir Safety Program

135. Seqwater have initiated a weir safety program that is to be commended for trying to promote personal safety in and around weirs. Some aspects of this program might be relevant to general safety in and around fast flowing flood waters. The link to the program is http://www.seqwater.com.au/public/recreation/weir-safety-campaign.

Performance of Flood Operations during January 2011 Flood Event

136. I have prepared the following chart to put the January 2011 flood into perspective. A comparison of the magnitude of the January 2011 flood event with the magnitude of the current flood that Wivenhoe Dam can pass is illustrated in the following figure. It shows that much bigger floods can occur. The 1:100,000 AEP flood event is about 80% of the magnitude of the current Probable Maximum Flood for the site.



Performance of Real Time Flood Modelling System and Data Collection Network

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137. Seqwater is responsible for improving the operation of the RTFM over time by using the following processes:

- Implementing improvements based on flood event audits and reviews;
- Improving RTFM calibration as further data becomes available;
- Updating software in line with modern day standards;
- Improving the coverage and reliability of the data collection network to optimise data availability during flood events; and
- Recommendations by Senior Flood Operations Engineers.

138. A regular process of internal audit and management review must be maintained by Seqwater to achieve these improvements. Seqwater must also maintain a log of the performance of the data collection network.

139. My preliminary conclusions on the performance of the Real Time Flood Model (RTFM) in the recent flood events is that it performed relatively well although the number of stations lost during the event is a concern when considering the potential performance in larger events. Some of the issues Seqwater may need to consider include:

(a) The need for Seqwater to review the locations and robustness of their river height stations to minimise the risk of loss of stations (and data) due to stream bank erosion and instability;

(b) What can be done to minimise the risk of significant quantities of rainfall not being measured;

(c) The need to upgrade the ratings curve at many river height stations to reflect the record flood levels; and

(d) There are several stations nominated in the flood event reports that detail stations that have not yet been incorporated into the report and yet the flood engineers seemed to take them into account (such as Dayboro WWTP). These stations should be incorporated into the modelling systems used in the FOC.

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Amendments to the Operation of the Dams following the January 2011 Flood Event

Manual of Flood Operations for Wivenhoe Dam and Somerset Dam

140. Following the January 2011 flood event, the Manual will need to be reviewed. Specific issues that have been raised by various organisations and will require consideration include:

(a) Whether the 3,500 m^3/sec and 4,000 m^3/sec limits to Procedures 2 and 3 remain valid;
My initial response is that they remain valid. However, this is based on the information currently available to me. Certainly, for a flood such as the January 2011 event, there is a need to drain the flood storage that accumulates early in the event so that the capacity to mitigate later inflows is retained. The Commission of Inquiry may receive additional evidence which may change this view;

(b) How much consideration should the flood engineers give to forecast rainfall?
One of the issues is that the further out the forecasts are, the less accurate they will be. Given the uncertainties associated with rainfall forecasts, there will need to be some acceptance of the consequences when forecasts do not turn out to be accurate.
It becomes a case of 'How aggressively do the Flood Engineers approach the limits for any strategy'. For instance, if the Senior Flood Engineer is applying Strategy W1C, how aggressively should the Engineer approach the limit of the Kholo Bridge becoming untrafficable at 550 m^3/sec? If it is forecast that 100 m^3/sec is likely to be discharged from the Lockyer, can 450 m^3/sec be discharged from Wivenhoe? What if more rain occurs and 150 m^3/sec is then discharged from the Lockyer and Kholo Bridge becomes untrafficable?
It comes down to whether the Flood Engineers are allowed to 'get it wrong'. If they are operating near the limits, they will get it wrong at times and bridges will be inundated or damage will occur which, in hindsight, might have been unnecessary.
This would be a major change with significant consequences;

(c) The floodwater release strategies contained in the Manual reflect an underlying philosophy of a gradually escalating response (in terms of the size of the floodwater release) as the dam levels rise. This recognises that most flood events are much smaller than the January 2011 event.
An alternative approach that has recently been advocated by some people is to move immediately to a strategy involving relatively high floodwater releases (e.g. implement a strategy similar to W2 or W3 in the current manual, once any flood water release

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commences). The rationale for such an approach is that while it would result in increased inconvenience (due to loss of access) and flood damage for relatively frequent (but 'small') flood events it would marginally reduce the magnitude of relatively rare events such as the January 2011 flood.

One consequence of adopting such a strategy would be the adverse community reaction that would build over time. This would arise as people adversely affected by such a strategy would see that the inconvenience/financial loss that they incurred would have been avoided with a 'flood risk preference' similar to that which applies at present. Over time, and in the absence of another flood event such as the January 2011 flood event, which has a probability of occurrence above the dam around 0.5% AEP) community support would be expected to erode for the revised approach.

If it is desired to improve the capacity of Wivenhoe/Somerset to further mitigate rare flood events such as the January 2011 flood event, then measures to increase the flood mitigation storage at Wivenhoe would be more likely to retain long term support (although there could be significant long term cost and water supply security consequences associated with such action).

Raising certain Brisbane River bridges and crossings could also be considered as a way of increasing the maximum allowable discharges under the existing W1 strategy without inconveniencing people through reduced or complete loss of access. The costs involved in raising bridges /crossings are likely to be significant and would need to be compared with the likely flood mitigation benefits. As these benefits only arise in rare flood events, it may be difficult to justify such expenditure on cost – effectiveness grounds.

If bridges/crossings are raised, then there will need to be appropriate changes to the Manual; and

(d) There might also be value in making some provision for declaration of a 'major flood event' which allows Procedure W1 (or elements of it) to be over-ridden to permit greater discharges early in an event.

As discussed elsewhere in this statement, this may result in the additional risk to people on downstream river crossings or additional downstream damages that might not have otherwise eventuated and as such would be a major change to the Manual and the underlying 'risk tolerance' reflected in it.

From a practical point of view, consideration would need to be given as to what criteria might be applied in assessing a 'major flood event' was occurring?

Other Outcomes for Wivenhoe Dam and Somerset Dam

141. One of the issues which arises out of the January flood event for both Somerset Dam and for Wivenhoe Dam is the capacity of Wivenhoe and Somerset dams to safely pass extreme flood events that have their most intense rainfall towards the end of the event. It is not so much an issue for ungated dams because the operator has no choices to make during flood operations.

142. Traditionally designing major dams requires the generation of theoretical design floods which tend to have their most intense rainfalls occurring earlier in the event. If this occurs, much less time is spent in Procedure W1 and there is less early storage of flood waters. 'Back ended' events with the highest rainfall intensities falling at the end of the event may be more serious in terms of maximum reservoir headwaters and higher required discharges.

143. In assessing the impact of extreme floods through storages such as Wivenhoe and Somerset dams, care needs to be taken by the design engineer, to determine how the dam is likely to be actually operated during the event and questions asked as to what decisions would the Flood Engineer make in passing this flood. Care needs to be taken that such questions are answered in hindsight but rather with the uncertainties involved in actual operations.

20. North Pine Dam

144. North Pine Dam is also an 'extreme' hazard dam which requires it to be able to pass an Acceptable Flood Capacity equivalent to the Probable Maximum Flood. A copy of one of the original general arrangement drawings for the dam is attached as 'PHA-15'. This drawing nominates RL 130.00 feet as the FSL which is equivalent to the current FSL of EL 39.6 mAHD.

145. Under the North Pine Dam Manual, the required flood discharges are primarily a function of headwater. This provides a graded response to the magnitude of the flood

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with maximum discharges being required for higher headwater levels associated with extreme floods.

146. As indicated below, the North Pine Dam Manual also sets out a series of prioritised objectives.

In order of importance they are:

- Ensure the structural safety of the dam;
- Minimise disruption to the community in areas downstream of the dam;
- Retain the storage at Full Supply Level at the conclusion of the Flood Event; and
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

147. During the 1974 flood event, the main dam was well progressed with most of the dam constructed except for the gates and some of the central spillway monoliths. It suffered a major incident in January 1982 when, as I understand it, a flood was considered to have finished and the flood engineer left the Flood Operations Centre to go home. While he was doing this, there was an intense rainfall event that filled the flood storage compartment to the point of inundating the electrical switch gear for the lifting winches and meant that the gates could not be operated. This was an extremely dangerous situation which could very easily have resulted in failure of the dam. As it turned out, the rain stopped in time and disaster was averted.

148. After this event, the dam operators were given the authority to operate the gates if there was a 'loss of communications' with the Flood Operations Centre. This was done with the inclusion of 'loss of communications' procedures in both of the Manuals.

Manual of Flood Operations for North Pine Dam

149. Following the January 2011 flood event, the Manual will need to be reviewed. From a dam safety perspective the flood event at North Pine Dam was a far more serious event than the Wivenhoe and Somerset Dams for the reasons stated below. My preliminary assessment of the performance of North Pine Dam during the January 2011 flood event include:

(a) There was a significant discrepancy between the apparent Annual Exceedance Probabilities with the headwater level being of the of the order of 1:5,000 AEP to

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1:10,000 AEP and the probabilities of the rainfall events generating these headwaters being of the order of 1:200 to 1 in 1,000 AEP in the western parts of the catchment. This could mean that the North Pine Dam spillway has a serious inadequacy which requires immediate review;

(b) As part of this review, reviews may also need to be undertaken of the adequacy of the hydrologic models, the rating of the radial gates (especially at large gate openings) and the storage capacity curve at upper storage levels;

(c) The ability of the radial gate opening systems to keep up with the required opening schedule and the flood immunity of the electric operating systems and switchgear;

(d) The current back-up to mains power and the back-up diesel generator is probably not capable of raising the gates quickly enough during major flood events and Seqwater have already initiated a replacement program for this system with higher capacity systems;

(e) One of the other concerns is what will happen if a gate lifting failure occurs during rapid raising of the radial gates. Will the lifting gear be able to be repaired in time to cope with the incoming flow?

(f) I am aware of complaints being made by users of Young's Crossing just downstream of the dam but downstream of the confluence with Sideling Creek. Irrespective of the discharge down Sideling Creek from Lake Kurwongbah, Young's Crossing is inundated with virtually any North Pine Dam gate opening. One option that may need to be considered is raising this crossing although, as for Wivenhoe, there are significant cost implications to implement such a strategy and crossing upgrade decisions fall outside the Manual; and

(g) Depending of the outcomes of these investigations, remedial measures may need to be implemented to improve the spillway adequacy of North Pine Dam. This might include modifications to the gate operating system to ensure that the gates are fully open before flood levels which might impinge on the operations of the switch gear, reducing the Full Supply Level to ensure that the dam can pass the larger design flood.

150. Discussions have already been undertaken with Seqwater about these issues and Seqwater are actively considering these issues. They were requested to submit a program of work to the chief executive on how they plan to undertake these investigations. This was submitted on 31st March 2011.

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151. These issues might have a significant impact on the current proportion of the Acceptable Flood Capacity that North Pine Dam can safely pass. Prior to the January flood event it was thought that the dam would be in Tranche 3 requiring an upgrade before 2025. The above issues might require an earlier upgrade.

152. As I have not yet had time to adequately complete my review of the North Pine Dam flood event report there may be other elements to consider. This review will also consider the conclusions and recommendations resulting from the Floods Commission of Inquiry.

Glossary of Terms

AEP - **Annual exceedence probability** – the probability that a particular flood value will be exceeded in any one year.

AFC - **Acceptable flood capacity** - the overall flood discharge capacity required of a dam determined in accordance with these guidelines including freeboard as relevant, which is required to pass the critical duration storm event without causing failure of the dam.

BoM – Commonwealth Bureau of Meteorology.

FSL – **Full Supply Level** – the level of the water surface when the water storage is at maximum operating level, when not affected by flood.

Fuse plugs – Discharge elements designed to fail in a controlled fashion once a design event has been triggered.

PAR - **Population at Risk** – means the number of persons, calculated under the guidelines referred to in s.342 (I) (b) [of the Water Supply Act], whose safety will be at risk if the dam, or the proposed dam after its construction, fails. Unless otherwise indicated, PAR is the 'incremental PAR' due to the failure event i.e. the difference in the PAR for the same event with dam failure relative to the event without dam failure.

PMF - **Probable Maximum Flood** – the flood resulting from PMP, and where applicable snow melt, coupled with the worst flood-producing catchment conditions that can be realistically expected in the prevailing meteorological conditions.

PMP - **Probable Maximum Precipitation** – the theoretical greatest depth of precipitation for a given duration that is physically possible over a particular catchment area, based on generalised methods.

Referable Dam – A dam, or a proposed dam for which:

(a) A failure impact assessment is required to be carried out [under the Water Supply Act]; and

(b) The assessment states the dam has, or the proposed dam after its construction will have, a category 1 or category 2 failure impact rating; and

[redacted] . . . . [redacted] . . . .

Peter Hugh Allen **Witness**

(c) The chief executive has, under section 349 [of the Water Supply Act], accepted the assessment.

The following are not referable dams:

(a) A dam containing, or a proposed dam that after its construction will contain, hazardous waste; and

(b) A weir, unless the weir has a variable flow control structure on the crest of the weir.

The following are not dams and cannot therefore be referable dams:

(a) A rainwater tank;

(b) A water tank constructed of steel or concrete or a combination of steel and concrete; and

(c) A water tank constructed of fibreglass, plastic or similar material.

I, Peter Hugh Allen, make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of the *Oaths Act 1867*.

Signed [redacted]

Taken and declared before me, at Brisbane this 4th day of April 2011.

[redacted]

Solicitor/~~Barrister/Justice of the Peace/Commissioner for Declarations~~

ADDENDUM TO
STATEMENT OF PETER HUGH ALLEN

I, Peter Hugh Allen, of c/- 41 George Street, Brisbane, Queensland, Public Servant in the State of Queensland state as follows:-

1. Further to my Statement dated and sworn on the 4th day of April 2011, I wish to make the following amendments: -

    (a) In paragraph 21 lines 6 and 7

    omit

    "I have seen correspondence from the early 1980's which refers to a"

    insert

    "the 1980 Manual at page 11 refers to Somerset Dam's permanent water supply level as being "R.L. 325 ft" which is the equivalent of";

    (b) In paragraph 44 line 4

    omit

    "lessoned"

    insert

    "lessons";

    (c) In the table referred to in and beneath paragraph 45 in the "**" footnote

    omit

    "This error was rectified in the current Revision 7";

    (d) In paragraph 47 line 1 before the word "Revisions"

    insert

    "decisions on";

    (e) In paragraph 75 line 11 after the word "Flood"

    insert

    "Damage";

    (f) In Topic 3 "Current Dimensions and Features of the Dams" in the Table "Wivenhoe Dam" section "Auxiliary Spillway (constructed 2005)"at "Base level"

    omit

    "EL57.0"

[redacted]

insert

"EL67.0";

(g) In paragraph 120 at dot point 3

omit

"Developing and";

(h) In paragraph 121 lines 6 and 7

omit

"in documentation from the 1980's"

insert

"in the 1980 Manual at page 11 to Somerset Dam's permanent water supply level as being "R.L. 325 ft" which is equivalent";

(i) In the table on page 41 in the third bottom row

omit

"5:30am"

insert

"5:30pm";

(j) In paragraph 128 line4

omit

"Full Supply Level to 95%"

insert

"storage level to 95% of Full Supply Level"; and

(k) In paragraph 143 line 5 before the word "answered"

insert

"not".

I, Peter Hugh Allen, make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of the *Oaths Act 1867*.

Signed [redacted]

Taken and declared before me, at Brisbane this 11th day of April 2011.

[redacted]

Solicitor/~~Barrister/Justice of the Peace/Commissioner for Declarations~~

Our ref: Doc 1562705

25 March 2011

Mr Peter Allen
Dam Safety Regulator
Department of Environment and Resource Management
GPO Box 2454
BRISBANE QLD 4001

REQUIREMENT TO PROVIDE STATEMENT TO COMMISSION OF INQUIRY

I, Justice Catherine E Holmes, Commissioner of Inquiry, pursuant to section 5(1)(d) of the *Commissions of Inquiry Act 1950* (Qld), require Mr Peter Allen to provide a written statement, under oath or affirmation, to the Queensland Floods Commission of Inquiry, in which the said Mr Allen:

- provides all information in his possession and identifies the source or sources of that information;
- makes commentary and provides opinions he is qualified to give as to the appropriateness of particular actions or decisions and the basis of that commentary or opinion;

In respect of the following topics:

1. a brief history of Wivenhoe and Somerset Dams ('the Dams') – their original construction, dimensions and features and upgrades since construction;

2. information regarding the Manual of Operational Procedures for Flood Mitigation at Wivenhoe and Somerset Dams ('the Manual'), including:

    a. its original creation, the process for creation and the impetus to have a manual;

    b. the process for amendment of the Manual;

    c. the substantive amendments made over the seven revisions;

    d. his involvement in those revisions;

    e. the reasons for those amendments;

    f. any change in operating strategy that required amendments and reasons for that change in operating strategy;

    g. the way the current Manual works in practice;

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Queensland 4001 Australia
Telephone 1300 309 634
Facsimile +61 7 3405 9750
www.floodcommission.qld.gov.au

h. the way weather forecasts provided by the Bureau of Meteorology should be taken into account by those using the Manual;

i. the different weight given to the priorities in the Manual in practice, and how the implementation of those priorities has changed over the seven revisions of the Manual;

j. the ability to draw the dams down below Full Supply Level in the Manual and in what circumstances that would be appropriate,

3. current dimensions and features of the Dams;

4. the adequacy of the capacity of the Dams for the purposes of water security;

5. the adequacy of the capacity of the Dams for the purposes of flood mitigation;

6. any planned future upgrades for the Dams;

7. the water security needs of South East Queensland up to 2050;

8. his role in relation to the Full Supply Levels of the Dams;

9. his role in relation to dam operations at Wivenhoe, Somerset and North Pine Dams;

10. when, how and why the Full Supply Level at the Dams which existed at the time of the January 2011 Flood Event was determined;

11. an account of all discussions, correspondence, meetings or briefings he participated in from 1 September 2010 to 31 March 2011 regarding possible changes to the Full Supply Level of the Dams (and provision of all notes made of all discussions or meetings regarding decreasing the Full Supply Level between 1 September 2010 and 31 March 2011);

12. his opinion as to what the Full Supply Level of the Dams should be;

13. how (in terms of regulatory or legislative changes, directives to operators etc), and why, the amount of water in the Dams was decreased in February 2011;

14. details, including verbatim accounts where possible, of all discussions, correspondence, meetings or briefings regarding decreasing the Dams' levels in January and February 2011;

15. details, including verbatim accounts where possible, of any discussions, correspondence or meetings in December 2010 or January 2011regarding releasing water from the Dams to take their level below 100%;

16. an account of all briefings within his knowledge prepared by the Department of Environment and Resource Management for the responsible Minister or disaster management authorities or personnel between October 2010 and February 2011;

17. an account of all communications he had, and any briefings given to or received from the Flood Operations Centre between 1 and 19 January 2011 (and provision of all emails, text messages and notes of phone conversations).

He may also address other topics relevant to the Terms of Reference of the Commission in the statement, if he wishes.

The statement is to be provided to the Queensland Floods Commission of Inquiry by 12 noon, 1 April 2011.

The statement can be provided by post, email or by arranging delivery to the Commission by emailing info@floodcommission.qld.gov.au.

[redacted]

Commissioner
Justice C E Holmes

Carpenter Stephen

From: Caroline Helman [redacted]
Sent: Thursday, 31 March 2011 11:46 AM
To: Walsh Paul; Carpenter Stephen
Subject: FW: Email in return to Paul Lack re Peter Allen's statement

Dear Paul and Stephen,

Please see email below from Susan Hedge.

Kind regards,
Caroline.

Caroline Helman
A/Senior Principal Lawyer
Qld Floods Commission of Inquiry - State Representation Team
Crown Law
State Law Building
50 Ann Street
Brisbane 4000
Ph: [redacted]
Fax [redacted]
Email [redacted]

From: Susan Hedge
Sent: Thursday, 31 March 2011 11:42 AM
To: Paul Lack; Caroline Helman
Cc: Lisa Hendy; Admin Flood Commission; Jane Moynihan
Subject: Email in return to Paul Lack re Peter Allen's statement

Dear Paul,

I refer to your email this morning to Lisa Hendy regarding Mr Peter Allen's statement.

The topic the Commission wishes to be included in Mr Allen's statement is as follows:

"any modelling, calculations or opinions produced or analysed by Mr Allen regarding the draw down expected to occur in the spillway approach at Wivenhoe Dam for the level of releases of water being made between 00:00 11/01/2011 and 12:00 noon 12/01/2011, and the effect of that draw down on the data produced by the automatic gauge situated in the spillway approach at Wivenhoe Dam during that period"

Given the specific nature of this additional topic, the Commission does not envisage that you will need extra time to prepare the Statement of Mr Allen.

Yours sincerely,

Susan Hedge
Lawyer
Queensland Floods Commission of Inquiry
P [redacted]
E [redacted]

Our ref: Doc 1562705

25 March 2011

Mr Peter Allen
Dam Safety Regulator
Department of Environment and Resource Management
GPO Box 2454
BRISBANE QLD 4001

REQUIREMENT TO PROVIDE STATEMENT TO COMMISSION OF INQUIRY

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- provides all information in his possession and identifies the source or sources of that information;
- makes commentary and provides opinions he is qualified to give as to the appropriateness of particular actions or decisions and the basis of that commentary or opinion;

In respect of the following topics:

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2. information regarding the Manual of Operational Procedures for Flood Mitigation at Wivenhoe and Somerset Dams ('the Manual'), including:

    a. its original creation, the process for creation and the impetus to have a manual;

    b. the process for amendment of the Manual;

    c. the substantive amendments made over the seven revisions;

    d. his involvement in those revisions;

    e. the reasons for those amendments;

    f. any change in operating strategy that required amendments and reasons for that change in operating strategy;

    g. the way the current Manual works in practice;

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h. the way weather forecasts provided by the Bureau of Meteorology should be taken into account by those using the Manual;

i. the different weight given to the priorities in the Manual in practice, and how the implementation of those priorities has changed over the seven revisions of the Manual;

j. the ability to draw the dams down below Full Supply Level in the Manual and in what circumstances that would be appropriate,

3. current dimensions and features of the Dams;

4. the adequacy of the capacity of the Dams for the purposes of water security;

5. the adequacy of the capacity of the Dams for the purposes of flood mitigation;

6. any planned future upgrades for the Dams;

7. the water security needs of South East Queensland up to 2050;

8. his role in relation to the Full Supply Levels of the Dams;

9. his role in relation to dam operations at Wivenhoe, Somerset and North Pine Dams;

10. when, how and why the Full Supply Level at the Dams which existed at the time of the January 2011 Flood Event was determined;

11. an account of all discussions, correspondence, meetings or briefings he participated in from 1 September 2010 to 31 March 2011 regarding possible changes to the Full Supply Level of the Dams (and provision of all notes made of all discussions or meetings regarding decreasing the Full Supply Level between 1 September 2010 and 31 March 2011);

12. his opinion as to what the Full Supply Level of the Dams should be;

13. how (in terms of regulatory or legislative changes, directives to operators etc), and why, the amount of water in the Dams was decreased in February 2011;

14. details, including verbatim accounts where possible, of all discussions, correspondence, meetings or briefings regarding decreasing the Dams' levels in January and February 2011;

15. details, including verbatim accounts where possible, of any discussions, correspondence or meetings in December 2010 or January 2011regarding releasing water from the Dams to take their level below 100%;

16. an account of all briefings within his knowledge prepared by the Department of Environment and Resource Management for the responsible Minister or disaster management authorities or personnel between October 2010 and February 2011;

17. an account of all communications he had, and any briefings given to or received from the Flood Operations Centre between 1 and 19 January 2011 (and provision of all emails, text messages and notes of phone conversations).

He may also address other topics relevant to the Terms of Reference of the Commission in the statement, if he wishes.

The statement is to be provided to the Queensland Floods Commission of Inquiry by 12 noon, 1 April 2011.

The statement can be provided by post, email or by arranging delivery to the Commission by emailing info@floodcommission.qld.gov.au.

[redacted]

Commissioner
Justice C E Holmes

Queensland Government
Natural Resources and Water

DAM SAFETY
OFFICE OF WATER SUPPLY REGULATOR

CURRICULUM VITAE
Peter Allen
March 2011

1.	NAME	Peter Hugh ALLEN
2.	DATE OF BIRTH	[redacted]
3.	NATIONALITY	Australian
4.	EDUCATION	• B.E.(Civil) with First Class Honours and University Medal - University of Queensland 1975 • M.Eng.Sc - University of Queensland 1985
5.	MEMBERSHIP OF PROFESSIONAL SOCIETIES	• Registered Professional Engineer Queensland (Reg No. 2979) • Corporate Member of Institution of Engineers Australia (Membership No. 13696) and NPER-3 registered

6. PROFESSIONAL EXPERIENCE

Period: Feb 2002 *to Date* Position: *Director Dam Safety (Water Supply)*
Period: Oct 2000 *to Feb 2002* Position: *A/Director Dam Safety (Water Supply)*
Period: *April 1998 to Date* Position: *A/Manager Asset Management Policy*

Duties: *Responsible for the development of strategies, policy and guidelines to foster best practice for and the regulation of the construction and ongoing operation and maintenance of large water supply and flood mitigation dams in Queensland. Since February 2002, as Director Dam Safety (Water Supply), he has also been responsible for the management of the regulation of safety of these dams. Activities associated with these responsibilities include:*

- Management of the dam safety regulation of all referable dams in Queensland including the management of the NRW Dam Safety group. Currently the portfolio consists of 105 referable dams (with a known population at risk) and many thousands of other dams. These dams are of all types and range up to 80 metres high. They are owned by a variety of dam owners including the Queensland Government, State Government GOCs, local authorities, water boards and power authorities as well as private owners.
- Dam safety decisions on:
  - (a) Failure Impact Assessments (to determine if a dam has population at risk) and
  - (b) Dam Safety conditions for referable dams setting up dam safety management systems
  - (c) Design standards for new dams for dams being substantially upgraded.
  - (d) Issue of notices to dam owners directing them to undertake remedial works
  - (e) Emergency measures designed to minimise the risk of failure or to reduce the consequences of dam failure.
- Involvement with Review Panels for Dam Safety Reviews or for Design Reviews on a number of dams including Wivenhoe Dam, Traveston and Wyaralong Dams, Hinze Dams together with a large number of SunWater dams.
- The development and implementation of Guidelines for Failure Impact Assessment, the updating of Guidelines for Dam Safety Management of Dams in Queensland.
- Participation in Queensland Government Interdepartmental Committee on Dam Spillway Adequacy and the subsequent development and implementation of Guidelines on Acceptable Flood Capacity for Dams
- Departmental Representative on Australian National Committee on Large Dams (ANCOLD) including roles as Secretary of ANCOLD 2003-2005 and convenor of the ANCOLD 'Conference on Dams', Cairns, October 2000.
- Member of ANCOLD Committees which produced the ANCOLD Guideline on Risk Assessment for Dams (2003) and updated the ANCOLD Dam Safety Management Guidelines (2003), member of the current panel updating the Guidelines for the Design of Dams and

Appurtenant Structures for Earthquake and peer reviewer for the current update of the ANCOLD Guidelines on the Assessment of Consequences of Dam Failure.

- Participation as the Department's representative on the State Disaster Coordination Group together with presentations to Local Authorities and Disaster District Committees across the State on Emergency Action Planning associated with dams
- Provision of advice and training to consultants and dam owners on aspects of dam safety.

Period: *December 1987 to April 1998* Position: *Executive Engineer I & Senior Engineer, Civil Design Group*

Duties: *General design works associated with the design of major water resources development projects including:-*

- Senior Duty Engineer for Flood Operations of Somerset Dam, Wivenhoe Dam and North Pine Dam on behalf of South East Queensland Water Board from 1st July 1996 to 30th June 2000
- Responsible for preliminary design of Boyne River Weir
- Responsible for design of Stage II of Bedford Weir on the Mackenzie River
- Responsible for investigation of four major dam sites as part of review of future development options for Gladstone Area Water Board together with investigations of associated raw water distribution system.
- Responsible for dam safety review of Awoonga Dam on behalf of Gladstone Area Water Board (in progress); Review of structural adequacy of aspects of Julius Dam on Leichhardt River (near Mt Isa); Review of Design Reviews of Koombooloomba Dam and associated Barron River and Tully River weirs.
- Responsible for investigation of a number of weir sites on the Albert and Logan Rivers on behalf of the South East Queensland Water Board.
- Management and supervision of the Brisbane Valley and Pine River Valley Flood Studies from April 1990 through to the commencement of the commissioning phase of the real time flood warning model in December 1994. The study, which was carried out on behalf of the South East Queensland Water Board, involved a team of engineers and hydrologists reviewing the hydrology of Wivenhoe Dam, Somerset Dam and North Pine Dam, the performance of detailed dam break studies on these dams and the preparation of a 'real time' flood management computer model for each of these dams. An external expert review panel reviewed all major aspects of the project
- Convenor of the Brisbane Valley ALERT Working Group on behalf of the Technical Advisory Committee to the South East Queensland Water Board. The working group involved officers from DPI Water Resources, Brisbane City Council, Ipswich City Council and the Bureau of Meteorology in the development of options and proposals for the installation of ALERT rainfall and water level sensors in the Brisbane River valley for use in the real time flood management model being developed as part of the above study.
- Preliminary design investigations and reporting on the augmentation of the Palm Island water supply ... including the investigation of options for raising the existing Solomon Dam, the construction of the Francis Creek Dam and the construction of a submarine pipeline from the mainland.
- Responsibility for the design of Kroombit Dam with its central 250 metre wide RCC spillway and earth and rockfill embankments including the preparation of construction specifications;
- Involvement in the introduction of Quality Assurance procedures into the Water Production Division.
- Presented lectures at Queensland University of Technology on use of finite elements in Seepage and Fluid Mechanics.

Period: *March 1986 to December 1987* Position: *Executive Engineer II, Civil Design Group*

Duties: *General design works associated with the design of major water resources development projects including:-*

- The design supervision and/or design of all major structures for Peter Faust Dam at Proserpine for the duration of the project. Major items included inlet tower, diversion conduit, outlet works, embankment including mesh protection and grout curtain, spillway and access bridges.
- Preparation of contract specifications for Stanwell Pipeline project

Period: *February, 1980 to March 1986* Position: *Civil Engineer, Division I, Civil Design Group*

Duties: *General design works associated with the design of major water resources development projects including:-*

July 1984 - Dec 1985	General investigation into & design of various aspects of the Burdekin Falls dam such as:- investigations into potential thermal cracking problems
Jan 1982 - July 1984	Overall arrangement and detailing of the Burdekin Falls Dam outlet works, the preliminary design of all its elements and the final design of the high pressure radial gates. Also responsible for the design, fabrication and testing of the outlet works hydraulic models.
Oct 1981 - Jan 1982	Relieved in position as Executive Engineer II responsible for technical support of hydrographic staff.
Jan 1980 - Sept 1981	Detailed design and specification preparation for the Wivenhoe Dam radial gates and bulkhead gate with subsequent involvement in the on site commissioning of the gates.

Period: *Jan 1975 to Jan 1980* Position: *Civil Engineer, Division II, on rotation in various Water Resources Commission branches*

Duties: *General design and construction activities commensurate with the responsibilities of a graduate engineer. Work was generally under the supervision and guidance of more senior engineers.*

Feb 1979 - Jan 1980	Design Division, Head Office - design of various prestressed concrete and reinforced elements for Wivenhoe Dam.
Oct 1978 - Feb 1979	Irrigation Division, Farm Advisory Group - designing farm dams and irrigation systems
Oct 1977 - Oct 1978	Design Division, Hydraulics Laboratory - supervision of a number of hydraulic models including the main Wivenhoe Dam spillway model and several weir models
Apr 1977 - Oct 1977	Design Division, Head Office - general design activities related to Wivenhoe Dam such as preliminary design of Wivenhoe radial, penstock and bulkhead gates and prestressed rock anchorage system for the spillway channel excavation
June 1976 - Mar 1977	Irrigation Division, Farm Advisory Group - designing farm dams and irrigation systems
Oct 1975 - June 1976	Construction, Monduran & Glenlyon Dams - general construction supervision activities
Jan 1975 - Oct 1975	Design Division, Head Office - preliminary design activities for Wivenhoe Dam

7. PUBLICATIONS

Allen, P.H. and Malcolm Barker, Shane McGrath and Chris Topham, "ALARP Considerations for Dam Safety – Are We There Yet", ANCOLD Conference on Dams, November 2006.

Allen, P.H. "Requirement for Instrumentation from a Queensland Perspective", ANCOLD Workshop on Instrumentation and Survey, Fremantle, November 2006.

Allen, P.H. and Richard West, John Sullivan and Russell Paton, "Decommissioning of Mount Morgan Dams", ANCOLD Conference on Dams, November 2005.

Allen, P.H. "Risk Assessment – The Queensland Perspective", ANCOLD Workshop on Risk Assessment, Launceston, November 2003.

Allen, P.H. "A New Regulatory Environment for Dams in Queensland", ANCOLD Conference on Dams, November 2001.

Allen, P.H. Don Cock, Garry Grant and John Ruffini, "Real Time Flood Management of the Brisbane River and Pine River Dams During the February 1999 Flood", Australian National Committee on Large Dams (ANCOLD), 1999 ANCOLD Conference on Dams, November 1999.

Allen, P.H. "Dam Break Breach Mechanisms", Australian National Committee on Large Dams (ANCOLD), Bulletin No. 97, August 1994.

Allen, P.H. and Isaacs, L.T. "Contraction Coefficients for Radial Sluice Gates", 1994 Conference on Hydraulics in Civil Engineering, Brisbane.

Allen, P.H. "Peter Faust Dam Flood Warning System", Australian National Committee on Large Dams, ANCOLD Bulletin, Issue 90, April 1992.

Allen, P.H. and Russo, R, Richardson J.K. "Design of Burdekin Falls Dam", Transactions of Institution of Engineers, Australia, Volume CE 27, No. 4, 1985.02 The Engineering Conference, Institution of Engineers, Australia, Brisbane, April 1984.

Several other papers have been written and presented at local venues such as Queensland Division, Institution of Engineers Technical Sessions, the Northern Engineering Conference, the Australian Water Association and the Water Industry Operators Association.

Department of Environment and Resource Management

Water Supply (Safety and Reliability) Act 2008

NR&M LEGAL SERVICES
DELEGATION

REVOKED ON 13 August 2010

BY Water Supply (Chief Executive) Delegation (No. 1) 2010 (WS 015)

Water Supply (Chief Executive) Delegation (No. 1) 2009

1. Citation

This delegation may be cited as the *Water Supply (Chief Executive) Delegation (No. 1) 2009*.

2. Definitions

For the purposes of this delegation –

> ***Act*** means the *Water Supply (Safety and Reliability) Act 2008*
>
> ***chief executive*** means the Director-General of the department administering the Act
>
> **department** means the government entity, as defined under the *Public Service Act 2008*, carrying out the function of administering the Act
>
> ***regulator*** means the chief executive of the department

3. Commencement

This delegation shall commence on the day of execution.

4. Power to Delegate

This delegation is made under section 582[1] of the Act.

5. Powers Delegated

(1) The powers of the chief executive referred to in the section of the Act listed in Columns 1 and 2, Schedule 1 are delegated to the person or persons holding the office of the department referred to by number in Column 3, Schedule 1, subject to any words in Column 4, Schedule 1 which limit the delegation.

(2) The office described by a number in Column 3, Schedule 1 is a reference to the office or offices in Column 2, Schedule 2 corresponding to that number in Column 1, Schedule 2.

[1] Chief executive's power to delegate to "an appropriately qualified public service officer or employee".

6. Entire Document

This delegation is comprised of five (5) pages.

7. Revocation

On commencement this instrument revokes the *Water Supply (Chief Executive) Delegation (No. 2) 2008*.

8. Delegation

This delegation is made by **John Bradley**, Acting Director-General, Department of Environment and Resource Management.

Certified correct for gazettal
Director,
Legal Services [redacted]
21 / 7 /2009

Signed: [redacted]
John Bradley
A/Director-General
Department of Environment and Resource Management

Date : 22 / 7 /2009

SCHEDULE 1

Column 1 Powers Delegated (Section)	Column 2 Section Name	Column 3 Level of Office	Column 4 Limits of Power
52	When water efficiency management plan may be required	2, 3, 5	
53	Content of water efficiency management plan	2	
56	Reporting under water efficiency management plan	2, 3, 5	
57	Amending or replacing water efficiency management plan by chief executive direction	2, 3, 5	
342	What is failure impact assessment	2	
343	When dam must be failure impact assessed	2, 3, 4	
348	Cost of failure impact assessment	2, 3, 4	The delegate may authorise payment up to the limit of the delegate's financial delegation
349	Decision about failure impact assessment	2, 3, 4, 5	
350	Notice accepting failure impact assessment	2, 3, 4, 5	
351	Reviewing failure impact assessment	2, 3, 4, 5	
352	Rejecting failure impact assessment	2, 3, 4, 5	
353	Applying safety conditions for existing referable dams	2, 3, 4	
354	Deciding safety conditions	2, 3, 4	Excluding power to make guidelines
354(2)	Deciding safety conditions (power to make guidelines)	2	
355	Process after deciding safety conditions	2, 3, 4	
356	Changing conditions	2, 3, 4	Excluding power to make guidelines
358	Application of div 4 (emergency powers)	2, 3, 4	
359	Direction to owner of emergency part of land	2, 3, 4	
360	Failure to comply with notice	2, 3, 4	
361	Notice in relation to land other than leased State land	2, 3, 4	
362	Notice in relation to leased State land	2, 3, 4	
363	Emergency powers if imminent danger of dam failure	2, 3, 4	

371	Approving flood mitigation manual	2, 3, 4	
372	Amending flood mitigation manual	2, 3, 4	
373	Regular reviews of flood mitigation manual	2, 3, 4	
402	Appointment and qualifications (authorised officer)	2	
403	Appointment conditions and limit on powers	2	
404	Issue of identity card	2	
429	Dealing with forfeited things	2, 3, 4	
451	Chief executive's power to obtain criminal history report	2, 3, 4	
452	Criminal history is confidential document	2, 3, 4	
465	Who may give compliance notice	2, 3, 4	
466	Compliance notice	2, 3, 4	
467	Chief executive or regulator may take action and recover costs	2, 3, 4, 7	
491	Evidentiary aids	2, 3, 4, 7	
501	Chief executive's or regulator's power to remedy stated public nuisance	2, 3, 4, 5	
513	Requirements for making review application	1, 2, 3, 4	
514	Review decision	1, 2, 3, 4	
515	Notice of review decision	1, 2, 3, 4	
572	Chief executive may make guidelines	2	
574	Documents regulator and chief executive must keep available for inspection and purchase	2, 3, 4	
577	Records kept in registries	2	
584	Non payment of fees and charges	2, 3, 4	
585	Approved forms	2	

SCHEDULE 2

DELEGATION OF CHIEF EXECUTIVE'S POWERS

Level of Office Column 1	Office or Offices Column2
1	Deputy Director-General
2	General Manager, Office of the Water Supply Regulator
3	Director, Water Industry Asset Management & Standards, Office of the Water Supply Regulator
4	Director, Dam Safety (Water Supply), Water Industry Asset Management & Standards, Office of the Water Supply Regulator
5	Manager (Infrastructure Management) Water Industry Asset Management & Standards, Office of the Water Supply Regulator
6	Officers who have been accredited in relation to dam failure impact assessment by the department[1] holding the office • Manager (Infrastructure Management) Water Industry Asset Management & Standards, Office of the Water Supply Regulator • Principal Engineer(Cairns), Water Industry Asset Management & Standards, Office of the Water Supply Regulator • Principal Engineer(Toowoomba), Water Industry Asset Management & Standards, Office of the Water Supply Regulator • Principal Engineer, Dam Safety, Water Industry Asset Management & Standards, Office of the Water Supply Regulator (Position number 71004293)
7	Director, Legal Services

[1] Persons accredited have received training and passed tests and their accreditation has been confirmed in writing by the General Manager, Office of the Water Supply Regulator.

[redacted]

[redacted]

file #377 #354

Department of Environment and Resource Management
NOTE to FILE

SUBJECT: Flood Mitigation Manual, Wivenhoe and Somerset Dams

TIMEFRAME
- The previous manual is due to expire on 25th February 2010.

DECISION
I decided 22nd December 2009 to approve the *Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam Revision 7 November 2009* for a period of five years and to approve this to be gazetted in early 2010.

BACKGROUND
- The approval of the previous version of the Wivenhoe and Somerset Dam Flood Mitigation Manual was published in the Gazette under the provisions of the *Water Act 2000* on 25th February 2005 and this approval was for a period of 5 years.
- Under *s.371* of the *Water Supply (Safety and Reliability) Act 2008*, the chief executive may, by gazette notice, approve a flood mitigation manual for a period of up to five years.
- There has been extensive, ongoing consultation between officers of the Dam Safety group (Peter Allen, Ron Guppy, Ken Nguyen), officers of Seqwater (John Tibaldi, Terry Malone, Rob Drury) and the dam Flood Operations engineers (Rob Ayre and John Ruffini).
- Under the *Water Supply (Chief Executive) Delegation (No.1) 2009*, a flood mitigation manual can be approved by Director Dam Safety (Water Supply).

CURRENT ISSUES
- While the new flood mitigation manual has been upgraded/updated in a number of areas to reflect the current arrangement of Wivenhoe and Somerset Dams and the change in ownership, there are only relatively minor variations in the overall flood operation procedures. A summary of these amendments as provided by Seqwater is attached.
- The most significant change is the variation in the 'target point' for the operation of Somerset Dam. This was amended because testing of the operational procedures demonstrated that the flood immunity of Somerset Dam could be significantly improved if more water was released earlier from Somerset and this resulted in only minor increases in the levels in Wivenhoe Dam.
- The opportunity has also been taken to simplify the 'loss of communication' procedures for Somerset and Wivenhoe. This should make flood operations for both dams far more robust when communications is lost between the Flood Operations Centre and the dam operators.
- The flood immunity of the downstream crossings is largely unaffected by the upgrade operational rules.

RESOURCE/IMPLEMENTATION IMPLICATIONS
- There are no resourcing implications for the Department although the Manual does indemnify the dam owner for civil liability arising from flood operations so long as they are done in accordance with the Manual.

PROPOSED ACTION
- The approval of the Manual will be finalised once it is published in one of the first editions of the Gazette in 2010.

[redacted]

Peter Allen
Director Dam Safety (Water Supply)
22nd December 2009

DOCUMENT DESPATCHED BY DERM
File No. DAM/130/002(237)5
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22 DEC 2009
Action By WIC P. Allen
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Author	Cleared by	Cleared by	Recommended
Name: Peter Allen Position: D DS(WS) Tel No: Date: 21/12/2009	Name: Position: Name: Position:	Name: Position: Name: Position:	Name: Position: Tel No: Date:

File Ref:

ATTACHMENTS

- Manual of Operational Procedures for Flood Events At Wivenhoe Dam And Somerset Dam, Notes on November 2009 Revision
- Somerset-Wivenhoe Interaction Study, Terry Malone & John Tibaldi, October 2009
- Manual of Operational Procedures for Flood Events At Wivenhoe Dam And Somerset Dam, Revision 7, September 2009 [To be stored in Compactus Report Library Box for Wivenhoe Dam #377]

Author	Cleared by	Cleared by	Recommended:
Name: Peter Allen Position:D DS(WS) Tel No: Date:21/12/2009	Name: Position: Name: Position:	Name: Position: Name: Position:	Name: Position: Tel No: Date:

File Ref:

MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION AT WIVENHOE DAM AND SOMERSET DAM

NOTES ON NOVEMBER 2009 REVISION

INTRODUCTION

Seqwater has recently completed a comprehensive review and revision of the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam. This work was very extensive and has resulted in a major rewrite of the Manual. Changes to the Manual can be grouped into four broad categories, which are:

- Administrative Issues.
- Improved Operational Descriptions.
- Review of Manual Objectives.
- Technical Amendments.

Changes within these categories are explained in detail below.

ADMINISTRATIVE ISSUES

Numerous reference changes to the manual were needed to account for the new water management institutional arrangements that were introduced by the Government in 2008. These reference changes resulted from the following:

- Change in relevant legislation to the Water Supply (Safety and Reliability) Act 2008.
- Change in relevant regulatory agency to the Department of Environment and Resource Management.
- Change in dam owner to the Queensland Bulk Water Supply Authority trading as Seqwater.
- Change in Agencies requiring information and holding controlled copies of the Manual in accordance with the Local Government Amalgamations of 2008.

None of these reference changes resulted in any change in operational procedure from the previous version of the Manual.

IMPROVED OPERATIONAL DESCRIPTIONS

Flood Events impacting on Wivenhoe and Somerset dams are caused by actual rainfall events that can vary in intensity, duration and distribution over a catchment area in excess of 10000 square kilometres. Accordingly, there is an infinite number of Flood Event scenarios that the Manual needs to account for. Previously, the operational approach taken in the Manual was procedural in nature. However, given the infinite scenarios to be catered for, it was obviously not possible for the Manual to contain a specific procedure relating to every possible flood event scenario. Therefore, following extensive discussion with both the Regulator and the Flood Operations Engineers and also taking into account the experience of previous flood events, a more practical approach was introduced.

The new approach does not change the original operational intent contained in the previous Manual, but does allow the optimisation of flood mitigation benefits, depending on the understanding of the magnitude of the flood event at any point in time. The approach provides strategies and objectives to guide flood operational decision making. 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).

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.

Flowcharts have been provided in the updated Manual to assist in Strategy selection. Additionally improved detail was provided within each strategy to clarify the intent of the Manual. This improved detail was wholly consistent with the intent and objectives of the previous version. Finally, additional detail was provided to cater for the following scenarios that were not covered in the previous version:

- **Potential to avoid a fuse plug initiation at Wivenhoe Dam by either initiating an early release of water from Wivenhoe Dam or by holding water back in Somerset Dam.** Neither action is allowed to adversely impact on the safety of the dams. In practice, the possibility of such a situation arising is considered extremely unlikely and will only occur if the event is well understood (i.e. no significant further rain is forecast for the event) and the peak flood level in Wivenhoe roughly corresponds to a fuse plug initiation level. However, it was thought that the situation should be covered off in the Manual for completeness.

- **Somerset Dam exceeds full supply level, while Wivenhoe Dam does not.** This scenario is of minor to insignificant risk, because it does not result in releases of water from Wivenhoe Dam. However, the situation was encountered in May 2009 and it was again thought that the situation should be covered off in the Manual for completeness.

REVIEW OF MANUAL OBJECTIVES

The Flood Mitigation Objectives contained in the previous version of the Manual in order of importance were:

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Minimise disruption and impact upon Wivenhoe Power Station;
- Minimise disruption to navigation in the Brisbane River.

Following investigations, it was determined that decisions made during flood events have never given consideration to either minimising disruption and impact upon Wivenhoe Power Station or minimising disruption to navigation in the Brisbane River.

The Wivenhoe Power Station is not adversely impacted to any degree until the Dam Levels exceed EL 74.0 AHD. At these levels, the primary consideration is only the structural safety of the dam and minimising disruption to the power station is not a consideration.

Similarly, at the stage in a flood event where Wivenhoe Dam outflows potentially disrupt navigation in the Brisbane River, the higher level flood objectives dominate decision making processes. Additionally, it is not currently possible to derive a sensible relationship between releases from Wivenhoe Dam and disruption to navigation in the Brisbane River. Recent experience showed that one of the primary disruption mechanisms associated with the Brisbane River navigation is the cancellation of the public transport "CityCat" services. Such cancellations occurred in May 2009, when releases were not being made from Wivenhoe Dam. It is understood that the cancellations at this time were a function of factors associated with debris entering the river system downstream of the dam. Presently, it is not considered possible to incorporate such factors in flood release decision making processes.

Regardless of the difficulties, to provide recognition that in some circumstances considerations of disruption to navigation may be required, the updated Manual allows disruption to navigation in the Brisbane River to be taken into account when considering disruption to rural areas downstream of the dam. The updated manual states however that consideration of navigation is generally secondary to considerations associated with reducing bridge inundation downstream of Wivenhoe Dam.

With consideration to these changes, the Flood Mitigation Objectives contained in the updated version of the Manual in order of importance are:

- Ensure the structural safety of the dams;

- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Retain the storage at Full Supply Level at the conclusion of the Flood Event.
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

The first three objectives are unchanged from the previous version, while the last two objectives were added to reflect current operating practice. Naturally, at the end of an event, a primary objective is to ensure that the dams are at full supply levels. Additionally in the drain down phase of the event, there has always been an objective to minimise impacts to riparian flora and fauna, particularly critical species such as lung fish.

TECHNICAL AMMENDMENTS

To maximise the combined flood mitigation benefits of Wivenhoe and Somerset dams, the operation of the dams during floods is interdependent. To determine the optimal flood mitigation strategy, a Somerset-Wivenhoe Operating Target Line is used as a guide to optimise flood mitigation benefits, while protecting the structural safety of the dams.

The existing Somerset-Wivenhoe Operating Target Line required review because it did not properly account for the raising of Wivenhoe Dam and construction of an Auxiliary Spillway that occurred in 2005. It also did not properly account for the revised failure level of Somerset Dam or for scenarios associated with floods centred on the Somerset Catchment.

A report was prepared to examine these issues in detail and the results of this report are the basis for the bulk of the technical amendments contained in the updated manual, particularly in relation to changes to the Somerset-Wivenhoe Operating Target Line. The report is entitled "Somerset-Wivenhoe Interaction Study (October 2009)". This report should be read to understand the nature and reasons for these amendments.

The other significant technical amendment related to the simplification of the loss of communications procedures. The Wivenhoe Dam minimum gate opening sequence was simplified by providing opening increments in steps of either 50 or 100 millimetres. This made the sequence easier to follow for dam operators and had very little change on dam outflows. The other change to the table was made to correct an inconsistency that allowed dam outflows of greater than 4000 m^3/s at dam levels less that EL 74.0 m AHD. This was considered to be an error in the previous manual as it is inconsistent with the flood manual objectives. Wivenhoe gate opening sequences were also made consistent between "normal communications" and "loss of communications" procedures.

The Somerset Dam Loss of Communication procedure was also simplified to provide straightforward sluice opening and closing procedures in accordance with the Somerset-Wivenhoe Operating Target Line. The simplified procedure was extensively modelled and was found to consistently provide better results in terms of optimising the flood mitigation benefits of the two dams. This modelling is contained in the Somerset-Wivenhoe Interaction Study (October 2009).

MANUAL

OF

OPERATIONAL PROCEDURES

FOR

FLOOD MITIGATION

AT

WIVENHOE DAM

AND

SOMERSET DAM

Revision 7
November 2009

Date & Time	Extract From Log	Comment
Sunday 9 January 2011 7:15 PM	FOC called Director Dam Safety advising him that FOC is now looking at much larger flows and will have to ramp up releases to around 3000 cumecs as by as early as midnight which is likely to have flooding impacts on low-lying areas of Brisbane.	Nothing further to add
Monday 10 January 2011 9:00 PM	Engineer 1 and Engineer 3 spoke to Director Dam Safety regarding strategies for reducing Wivenhoe release to mitigate latest event in Lockyer. He endorsed variation to manual to operate at minimum gate settings to create gap to allow peak of flash flood to pass. Also endorsed concept allowing Wivenhoe HW to rise above 74.0 mAHD briefly (less than 12 hours) providing levels did not rise too high (ie. less than 74.2 mAHD).	At about 19:00 hrs on the evening of Monday 10th January, I was rung by Engineers 1 and 3 from the Flood Operations Centre to discuss the situation at Wivenhoe Dam. They briefed me on what was likely to occur. They indicated that the headwater levels in Wivenhoe (taking the forecast rainfall into account) were potentially going to peak just above the trigger level for Procedure 4 before steadily dropping and that they were thinking of holding off Procedure 4 releases and keeping them at non-damaging flows. They asked me whether I considered this 'reasonable'. I said it sounded reasonable to me but it remained their decision. There was no request to change the provisions of the FMM.
Tuesday 11 January 2011 8:10 AM	Engineer 4 called Director Dam Safety to advise of current Wivenhoe situation - Will exceed EL74m. Ramping up gate opening to a minimum of 3,700 cumecs and gate operations will progress.	Nothing further to add
Tuesday 11 January 2011 4:41 PM	Director Dam Safety phone call. He requested more technical information in the status reports released by Duty Engineers. Director Dam Safety will send through an example of the technical data requested in the report.	Nothing further to add
Saturday 15 January 2011 1:10 PM	Director Dam Safety phoned about the Wivenhoe Flood manual summary. Engineer 2 told Director Dam Safety that the summary is with the other duty engineers for checking before issuing.	Nothing further to add
Saturday 15 January 2011 2:00 PM	Phone hook-up with Engineer 2, Engineer 1, Engineer 4 with Dam Operations Manager, Director Dam Safety, Seqwater CEO, DG DERM and General Manager, Office of Water Supply Regulator DERM to discuss a report for the Minister by COB Sunday.	Nothing further to add
Monday 17 January 2011 10:00 AM	Advise Director Dam Safety about inconsistency between readings from BoM (automatic ALERT gauge data) and actual manually read HW observations	Nothing further to add. Refer to further investigations in Statement.
Wednesday 19 January 2011 5:30 AM	Engineer 4 phoned Director Dam Safety to advise that damage had been reported at Wivenhoe Dam by the recent operations. Initial information indicates that large boulders are piled up in the plunge pool D/S of the flip bucket. The source of these boulders is unknown as releases are still continuing from the gates. Engineer 4 has arranged to inspect the site with Principal Dams and Weirs Planning in a few hours and an invitation was extended to Director Dam Safety as an interested party to attend the inspection. Engineer 4 will provide updates as they come to hand.	Nothing further to add. Arranged for Russ McConnell to inspect that morning.
Wednesday 19 January 2011 10:15 AM	Engineer 4 has discussed the event closure with Director Dam Safety. It was agreed that the flood will be considered closed with the closure of the gates at 1200. At that time, control of the dam will revert to Seqwater. As the low flow channel to the regulator is blocked, the centre gate will be opened to 1 metre to manage on-going inflows with the aim of getting to 95% (EL 66.5)	Nothing further to add

Allen Peter

From: Duty Engineer [redacted]
Sent: Saturday, 8 January 2011 2:22 PM
To: Allen Peter
Subject: Seqwater Situation Report at 12:00 on Saturday 8 January 2011

Peter

I have added you to the distribution list of the Situation Report for Seqwater dams. This is distributed every 12 hours (approximately) during gate releases. Let me know if you do not wish to get this.

Rainfall

No significant rain has fallen over the dam catchments in the past 18 hours.

Advice from BoM indicates that SE Qld can expect further high rainfall totals over the next 4 days.

day:	Rain light at times 5-50mm with higher falls along the coast
Sunday:	Widespread rain with totals between 50-100mm
Monday:	Widespread rain again with totals between 50-100mm
Tuesday:	Rain easing with totals between 25-50mm

Given the saturated conditions of the catchments, significant inflows to Seqwater dams will be generated, especially following the forecast rainfall on Sunday/Monday.

North Pine (Full Supply Level 39.60 m AHD)

At 1200 Saturday, North Pine Lake Level was 39.46 m AHD and is steady. Currently 2 gates are open to release runoff generated from rainfall over the last three days. Given the very high likelihood of significant runoff during the next 4 days, gates will be kept open to match inflows over the next few days, rather than opening and closing at various times with short notice. Lake Kurwongbah spillway flows are also contributing to the adverse impacts experienced at Youngs Crossing.

Youngs Crossing will remain adversely impacted for the duration of the gates being open.

Moreton Bay Regional Council has been advised and concurs with this strategy.

Somerset (Full Supply Level 99.00 m AHD)

At 1000 Saturday, Somerset Dam level peaked at 100.47m AHD and is now slowly falling. At 1200 it is now 100.45m. Somerset Dam is releasing into Wivenhoe through two open sluice gates and over the fixed crest at a rate of about 415 m3/s.

Since the commencement of the event on 02/01/2011, approximately 91,000ML has flowed into Somerset Dam with a further 20,000ML expected based on the recorded rainfall to date. Approximately 29,000ML has been released into Wivenhoe.

Wivenhoe (Full Supply Level 67.00 m AHD)

At 1200 Saturday, Wivenhoe Dam was 68.60 m AHD and rising steadily with all five gates open and releasing about 1,150 m3/s. River levels upstream of Wivenhoe Dam have peaked and are now receding. However the further inflows into the dam has led to elevated levels It is intended to increase the release from Wivenhoe to 1,250 m3/s by 14:00 on Saturday 08/01/2011. This will maintain flows of up to 1,600 m3/s in the mid-Brisbane River throughout the afternoon.

Further assessments will be undertaken to determine increases above this level given the high likelihood of significant inflows in the next few days. The interaction with runoff from the Bremer River and Warrill Creek catchment will also be assessed to determine an appropriate release strategy. Projections based upon the forecast rainfalls suggest flows of up to 1,200 m3/s will emanate from the Bremer River catchment.

Since the commencement of the event on 02/01/2011, approximately 202,000ML has flowed into Wivenhoe Dam (including Somerset releases) with a further 210,000ML expected based on the recorded rainfall to date. Approximately 66,000ML has been released from Wivenhoe via the radial gates, hydro and regulator.

Impacts downstream of Wivenhoe

The projected Wivenhoe release of 1,250m3/s and combined with Lockyer flows and local runoff will mean that all low level crossings downstream of Wivenhoe (Twin Bridges, Savages Crossing, Burtons Bridge, Kholo Bridge and Colleges Crossing) will be adversely impacted for several days. At this stage Fernvale and Mt Crosby Weir Bridge are not expected to be affected, but they could potentially be affected if the predicted rainfall totals eventuate and higher releases from Wivenhoe Dam are considered necessary.

The current available assessments indicate that the combined flow in the lower Brisbane River would only add 50mm to an upper limit of 100mm to the recorded water levels in the City Reach of the Brisbane River. However, it is noted that tides in the lower Brisbane R will be 0.4 to 0.5 metres higher than predicted tides. The tide level at the Port Office Gauge at 1200 Saturday was 1.56 m and rising.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the Wivenhoe operating strategy.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer[redacted]
Sent: Saturday, 8 January 2011 5:53 PM
To: Allen Peter;
Cc:
Subject: FOC Situation Report at 18:00 on Saturday 8 January 2011

Rainfall

( ) rain has fallen over the dam catchments in the past 12 hours. Catchment average rainfall for this period for North Pine Dam is 6 mm; Stanley River has received 12 mm; and the Upper Brisbane River 4 mm. This has resulted in minor increases in runoff into Somerset dam.

Advice from BoM indicates that SE Qld can expect further high rainfall totals over the next 4 days.

The forecast for the Somerset-Wivenhoe catchment for the next 24 hours is 30 to 50 mm, whilst North Pine is expected to receive 40 to 60 mm in the next 24 hours

The outlook for the following days are:-

Sunday: Widespread rain with totals between 50-100mm
Monday: Widespread rain again with totals between 50-150mm
Tuesday: Rain easing with totals between 25-50mm

Given the saturated conditions of the catchments, significant inflows to Seqwater dams will be generated, especially following the forecast rainfall on Sunday/Monday.

North Pine (Full Supply Level 39.60 m AHD)

At 1700 Saturday, North Pine Lake Level was 39.47 m AHD and steady. Currently two gates are open to release runoff generated from rainfall over the last three days. Given the very high likelihood of significant runoff during the next 4 days, gates will be kept open to match inflows over the next few days, rather than opening and closing at various times with short notice. Lake Kurwongbah spillway flows are also contributing to the adverse impacts experienced at Youngs Crossing.

Youngs Crossing will remain adversely impacted for the duration of the gates being open.

Moreton Bay Regional Council has been advised and concurs with this strategy.

Somerset (Full Supply Level 99.00 m AHD)

Somerset Dam level peaked at 100.47m AHD at 10:00 today and is now slowly falling. At 1700 it is now 100.41m. Somerset Dam is releasing into Wivenhoe through two open sluice gates and over the fixed crest at a rate of about 415 m3/s.

Since the commencement of the event on 02/01/2011, approximately 95,000ML has flowed into Somerset Dam with a further 20,000ML expected based on the recorded rainfall to date. Approximately 38,000ML has been released into Wivenhoe.

Wivenhoe (Full Supply Level 67.00 m AHD)

At 1800 Saturday, Wivenhoe Dam was 68.65 m AHD and rising slowly with all five gates open and releasing about 1,250 m3/s. River levels upstream of Wivenhoe Dam have peaked and are now receding. However the further inflows may result from any additional rainfall. The current gate operation strategy will maintain flows of up to 1,600 m3/s in the mid-Brisbane River throughout the evening.

Since the commencement of the event on 02/01/2011, approximately 227,000ML has flowed into Wivenhoe Dam (including Somerset releases) with a further 200,000ML expected based on the recorded rainfall to date. Approximately 93,000ML has been released from Wivenhoe via the radial gates, hydro and regulator.

Impacts downstream of Wivenhoe

The current Wivenhoe release of 1,250m3/s combined with Lockyer flows and local runoff will mean that all low level crossings downstream of Wivenhoe (Twin Bridges, Savages Crossing, Burtons Bridge, Kholo Bridge and Colleges Crossing) will be adversely impacted for several days (until Wednesday 12 January). At this stage Fernvale and Mt Crosby Weir Bridge are not expected to be affected, but they could potentially be affected if the predicted rainfall totals eventuate and higher releases from Wivenhoe Dam are considered necessary.

The current available assessments indicate that the combined flow in the lower Brisbane River would only add 50mm to an upper limit of 100mm to the recorded water levels in the City Reach of the Brisbane River. However, it is noted that tides in the lower Brisbane R will be 0.4 to 0.5 metres higher than predicted tides. The tide level at the Port Office Gauge a '00 Saturday was 0.06 m and falling.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the Wivenhoe operating strategy.

Forecast Scenario – Based upon mid-range rainfall forecasts.

Assessments have been undertaken to determine possible increases to releases given the high likelihood of significant inflows in the next few days. The interaction with runoff from the Bremer River and Warrill Creek catchment is an important consideration as the event magnitude will require the application of Wivenhoe Dam flood operation strategy W2 (Transition strategy between minimizing downstream impacts and maximizing protection to urban areas).

Projections based upon the forecast rainfalls suggest flows of up to 1,200 m3/s will emanate from the Bremer River catchment. If similar rainfall magnitudes occur in the Upper Brisbane and Stanley Rivers then increased releases may be required from both Somerset Dam and Wivenhoe Dam. Preliminary projections suggest that such a forecast will extend the release duration until next Saturday 15 January, but mid-Brisbane River flows will be kept to a maximum of 1,800 m3/s. However, if falls are greater than those forecast releases from Wivenhoe Dam may need to adversely impact Mt Crosby Weir Bridge (1,900 m3/s) and possibly Fernvale Bridge (2,100 m3/s) but will be maintained below 3,500 m3/s.

The assessments will be updated as the event progresses.

R ards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Sunday, 9 January 2011 6:15 AM
To: Allen Peter;
Cc:
Subject: FOC Situation Report at 06:00 on Sunday 9 January 2011

Rainfall

Catchment average rainfall for the past 12 hours is; North Pine Dam (less than 10 mm); Somerset Dam (40 mm); Wivenhoe Dam (less than 10 mm). The bulk of the rain that has fallen in the Somerset Dam catchment has occurred in the last two hours, with recorded falls exceeding 60mm in some areas. The BOM forecast for the next seven days issued at 0450 this morning is:-

Sunday:	Rain periods.
Monday:	Rain periods.
Tuesday:	Rain periods.
Wednesday	A few showers.
Thursday	A shower or two.
Friday	A shower or two.
Saturday	Mostly fine.

A severe whether warning remains current for heavy rainfall in the dam catchment areas. The dam catchments are relatively saturated and significant inflows will be generated if the forecast rainfall eventuates.

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level is currently 39.47 m AHD and steady. Two radial gates remain open to release runoff generated from recent rainfall. Based on rainfall forecasts, the radial gates have been kept open in anticipation of further inflows over the next few days. However unless significant rain falls today, consideration will be given to closing the gates late this afternoon or early tomorrow morning and discussions to finalise a decision on the timing of radial gate closure will be held with the Moreton Bay Regional Council later today. Youngs crossing will remain closed while releases are in progress.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is currently falling slowly, with the current level being 100.27m AHD. However the rain that has fallen in the dam catchment over the last two hours (recorded falls exceed 60mm in some areas) will result in significant inflows later today. The current release rate into Wivenhoe Dam is 35,000ML/day. Since the commencement of the event on 02/01/2011approximately 56,000ML has been released from the dam, with a total of at least 150,000ML to be released based on the currently recorded rainfall. The total release for the event is likely to increase significantly over the next few days based on the current rainfall forecasts. At this stage, releases will continue until at least Tuesday.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

The dam level is currently falling slowly, with the current level being 68.58m AHD. River levels upstream of the dam are receding, however further inflows will result from any additional rainfall. The current gate operation strategy will maintain flows of around 1,600m^3/s in the mid-Brisbane River. The current release rate from Wivenhoe Dam is 116,000ML/day. Since the commencement of the event on 02/01/2011approximately 150,000ML has been released from the dam, with a total of at least 450,000ML to be released based on the currently recorded rainfall. 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 Wednesday.

Impacts downstream of Wivenhoe Dam

The current Wivenhoe Dam release combined with Lockyer flows and local runoff will mean that all low level crossings downstream of Wivenhoe (Twin Bridges, Savages Crossing, Burtons Bridge, Kholo Bridge and Colleges Crossing) will be adversely impacted until at least Wednesday 12 January. At this stage Fernvale and Mt Crosby Weir Bridge are not expected to be affected, but this may be revised if the predicted rainfall totals eventuate and higher releases from Wivenhoe Dam are considered necessary.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the Wivenhoe operating strategy.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer[redacted]
Sent: Sunday, 9 January 2011 5:51 PM
To: Allen Peter;

Cc: Allen Peter
Subject: Situation Report 1700 Sunday 9/1/2011

Rainfall

(ment average rainfall for the past 12 hours is; North Pine Dam (60 mm); Somerset Dam (150 mm); Wivenhoe Dam (80 mm). The bulk of the rain that has fallen in the upper reaches of the Stanley and Brisbane Rivers.

The BOM rainfall forecast for the next few days is:-

Monday:	Very heavy rain periods with totals up to 300mm centred around North Pine.
Tuesday:	Rain periods with totals up to 150mm centred around North Pine.
Wednesday	A few showers less than 10mm
Thursday	A shower or two.
Friday	A shower or two.
Saturday	Mostly fine.

A severe whether warning remains current for heavy rainfall in the dam catchment areas. The dam catchments are relatively saturated and significant inflows will be generated if the forecast rainfall eventuates.

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level is currently 39.65 m AHD and rising at 1600. Following the rain in the 9 hours, the number of open gates has been increased from 2 to 5 which are expected to remain open for the next 12 hours. Youngs Crossing will remain ( )d while releases are in progress.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 100.75 m AHD and rising quickly. Estimated peak inflow to the dam is about 3,000m3/s. Five sluice gates are open releasing about 1,100m3/s (95,000Ml/d) into Wivenhoe Dam. At this stage the dam will reach at least 101.5 during early Tuesday morning.

Since the commencement of the event on 02/01/2011approximately 80,000ML has been released from the dam, with an event total of at least 320,000ML based on the recorded rainfall to date. The event total is expected to increase significantly due to the forecast rain in the next 24 to 48 hours. At this stage, releases will continue until at least Wednesday.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

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 1,600m^3/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.

Impacts downstream of Wivenhoe Dam

The current Wivenhoe Dam release combined with Lockyer flows and local runoff will mean that all low level crossings downstream of Wivenhoe (Twin Bridges, Savages Crossing, Burtons Bridge, Kholo Bridge and Colleges Crossing) will be adversely impacted until at least Saturday 15 January.

At this stage Fernvale and Mt Crosby Weir Bridge will not be affected for the next 24 hours but there is a strong possibility that, if the predicted rainfall totals eventuate in the next 12 to 24 hours, higher releases from Wivenhoe Dam will be necessary. This may adversely impact upon Fernvale and Mt Crosby Weir Bridges as early as Tuesday morning.

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.

[illegible]ierset Regional, Ipswich City and Brisbane City Councils have been advised of the Wivenhoe operating strategy.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Sunday, 9 January 2011 9:04 PM
To: Allen Peter;
Cc:
Subject: Situation Report 2100 9/01/2011
Importance: High

Rainfall

Very heavy rainfall has been recorded in the upper reaches of the Brisbane and Stanley in the last 6 hours with totals up 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.

A severe weather warning remains current for heavy rainfall in the dam catchment areas.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 101.68 m AHD (about 500,000ML currently in storage) and rising quickly. Peak inflow to the dam is estimated to be about 4,000 m3/s based on observed rainfall and could be as high as 5,000m3/s with additional forecast rainfall. Five sluice gates are open releasing about 1,100m3/s (95,000Ml/d) into Wivenhoe Dam. At this stage the dam will reach at least 103.5 early Tuesday morning which will adversely impact areas around Kilcoy.

Since the commencement of the event on 02/01/2011approximately 100,000ML has been released from the dam into Wivenhoe, with an event total of the order of 520,000ML expected. This may increase due to the forecast rain in the next 24 to 48 hours. At this stage, releases will continue until at least Thursday.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

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.

Impacts downstream of Wivenhoe Dam

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.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the updated Wivenhoe operating strategy.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Monday, 10 January 2011 1:14 AM
To: Allen Peter;
Cc:
Subject: FOC Situation Report at 01:00 hrs on Monday 10 January 2011

Rainfall

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 the downstream catchments as the system tracks south.

A severe weather warning remains current for heavy rainfall in the dam catchment areas.

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level was 39.95 m and steady. Five gates are open releasing 445 m3/s. The inflow into the dam since the commencement of the event is 42,000 ML. Estimated event volume is 57,000 ML assuming no further rainfall. Gate operations will continue until at least Tuesday 11 January 2011.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 102.22 m AHD and rising quickly (storing 157,000 ML above FSL). Peak inflow to the dam is estimated to be about 4,200 m3/s based on observed rainfall and could be as high as 5,000m3/s with additional forecast rainfall. Five sluice gates are open releasing about 1,100m3/s (95,000Ml/d) into Wivenhoe Dam. **At** this stage the dam will reach at least 103.5 on Monday afternoon which will adversely impact areas around Kilcoy.

Since the commencement of the event on 02/01/2011approximately 115,000ML has been released from the dam into Wivenhoe, with an event total of the order of 520,000ML expected. This is expected to increase due to the forecast rain in the next 24 to 48 hours. At this stage, releases will continue until at least Thursday.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

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 7,350m3/s and the river has just peaked at 23:00 on Sunday 9 January.

The dam level is rising quickly, with the current level being 69.60m AHD (storing 301,000 ML). Estimated peak inflow to the dam just from the Upper Brisbane R alone may reach as high as 8,800m3/s and, at this stage, the dam will reach at least 73.3 m AHD during Tuesday morning. Given the rapid increase in inflow volumes, it will be necessary to increase the release from Wivenhoe during 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 in the lower Brisbane will be limited to 4,000m3/s if possible.

Fernvale Bridge approaches and Mt Crosby Weir Bridge have been inundated and both bridges are now closed or are in the process of being closed.

The current release rate from Wivenhoe Dam is 1,400m3/s (120,000ML/day). Gate opening will start to be increased during early Monday morning and the release is expected to increase to at least 2,600m3/s.

Since the commencement of the event on 02/01/2011 approximately 240,000ML has been released from the dam, with an event total approaching 1,500,000ML without further rain and as much as 2,100,000ML with forecast rainfall of (both including Somerset outflow). At this stage, releases will continue until at least Sunday 16th January 2011.

Impacts downstream of Wivenhoe Dam

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.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the updated Wivenhoe operating s .egy.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]

Sent: Monday, 10 January 2011 6:30 AM

To: Allen Peter;

Cc:

Subject: FOC Situation Report at 06:00 on Monday 10 January 2011

Rainfall

[ ]rate to heavy rainfall has been recorded in the Upper Brisbane and Stanley Rivers in the last 12 hours with totals up to 90 mm. Totals for the last 24 hours range from 100 to 325mm.

Mt Glorious recorded 100 mm in the last 12 hours.

Rainfall of similar magnitudes is expected in the 12 to 24 hours around the downstream catchments as the system tracks south.

A severe weather warning remains current for heavy rainfall in the dam catchment areas.

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level was 39.97 m and steady. Five gates are open releasing 475 m3/s. The inflow into the dam since the commencement of the event is 52,000 ML. Estimated event volume is 72,000 ML assuming no further rainfall. Gate operations will continue until at least Tuesday 11 January 2011.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level at 05:00 was 102.84 m AHD and rising (storing 193,000 ML above FSL). Peak inflow to the dam is [ ]ated to be about 4,200 m3/s based on observed rainfall and could be as high as 5,000m3/s with additional forecast rainfall. Five sluice gates are open releasing about 1,100m3/s (95,000Ml/d) into Wivenhoe Dam. At this stage the dam lake level will reach about 103.5 mAHD on Monday afternoon. Areas around Kilcoy will continue to be adversely affected.

Since the commencement of the event on 02/01/2011approximately 142,000ML has been released from the dam into Wivenhoe, with an event total of the order of 520,000ML expected. This is expected to increase due to the forecast rain in the next 24 to 48 hours. At this stage, releases will continue until at least Thursday.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

River levels upstream of the dam have peaked and are falling slowly with significant inflow being generated from the intense heavy rainfall. Flows in the Brisbane River at Gregor's Ck have peaked at 7,350m3/s at 23:00 on Sunday 9 January. This peak is bigger than January 1974 and February 1999 at this location.

The dam level is rising quickly, with the current level being 70.77m AHD (storing 450,000 ML). Estimated peak inflow to the dam just from the Upper Brisbane R is around 8,800m3/s and, at this stage, the dam will reach at least 73.3 m AHD during Tuesday morning. Given the rapid increase in inflow volumes, it was necessary to start to increase the release from Wivenhoe during 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 in the lower Brisbane will be limited to 4,000m3/s if possible. This is significantly less than the current estimated combined pre-dam peak inflow of 12,000 m3/s.

Fernvale Bridge approaches and Mt Crosby Weir Bridge have been inundated and both bridges are now closed.

The current release rate from Wivenhoe Dam is 1,753m3/s (150,000ML/day). Gate opening will continue to be increased during Monday and the release is expected to increase to at least 2,600m3/s in the next 12 to 24 hours.

Since the commencement of the event on 02/01/2011 approximately 275,000ML has been released from the dam, with an event total approaching 1,600,000ML without further rain and as much as 2,100,000ML with forecast rainfall of (both including Somerset outflow). At this stage, releases will continue until at least Sunday 16th January 2011.

Impacts downstream of Wivenhoe Dam

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. Currently the estimate peak flow in the lower Brisbane River will be the highest since V enhoe Dam was completed in 1984 but still well below flows the 1974 levels.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the updated Wivenhoe operating strategy.

Outlook

Heavy rainfall continues throughout South East Queensland and the situation could deteriorate rapidly over the next 24 hours. The flood operation centre will continue to monitor the situation and provide every six hours until the situation stabilizes.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Monday, 10 January 2011 12:16 PM
To: Allen Peter;

Cc:

Subject: FOC Situation Report at 12:00 on Monday 10 January 2011

Rainfall

[ ]all has continued in the dam catchments over the last 6 hours, with approximate catchment averages as follows: North Pine (30mm); Wivenhoe Dam (20mm); Somerset Dam (40mm). A severe weather warning remains current for heavy rainfall in the dam catchment areas. The QPF issued by BOM at 10:00 estimates rainfalls for the 24 hours to 10:00 Tuesday as North Pine Dam (75mm to 150mm); Wivenhoe/Somerset Dam Catchments (50mm – 100mm).

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level is 40.00m AHD and relatively steady (storing 9,000ML above FSL). Five gates are open and releasing 500 m3/s. The inflow into the dam since the commencement of the event is 63,000 ML. Estimated event volume is 77,000 ML assuming no further rainfall. Gate operations will continue until at least Wednesday 12 January 2011.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 103.11m AHD and rising (storing 210,000 ML above FSL). Peak inflow to the dam is estimated to be about 4,200 m3/s. Five sluice gates are open releasing about 1,100m3/s (95,000ML/day) into Wivenhoe Dam. At this stage the dam lake level will reach about 103.5m AHD on Monday afternoon. Areas around Kilcoy will continue to be adversely affected.

[ ] the commencement of the event on 02/01/2011approximately 182,000ML has been released from the dam into W...enhoe, with an event total of the order of 520,000ML expected. This is expected to increase due to the forecast rain in the next 24 to 48 hours. At this stage, releases will continue until at least Thursday 13 January 2011.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

The dam level is 71.95m AHD and rising quickly (storing 610,000 ML above FSL). Peak inflow to the dam is estimated to be about 8,800m3/s. Five radial gates are open releasing about 2000m3/s (170,000ML/day) into the Brisbane River. At this stage, the dam will reach about 73.5m AHD during Tuesday morning. Flows in the Brisbane River above the dam at Gregor's Creek peaked at 7,350m3/s and this peak is bigger than both the January 1974 and February 1999 flood events at this location.

The objective for dam operations is to minimise the impact of urban flooding in areas downstream of the dam and the current aim is to keep river flows in the lower Brisbane River below 3,500m3/s if possible. This is significantly less than the current estimated combined pre-dam peak inflow of 12,000m3/s.

Since the commencement of the event on 02/01/2011 approximately 325,000ML has been released from the dam, with an event total approaching 1,600,000ML without further rain and as much as 2,100,000ML with forecast rainfall of (both including Somerset outflow). At this stage, releases will continue until at least Sunday 16 January 2011.

The volume between the expected peak (73.5m AHD) and the level at which the safety of the dam becomes the primary objective in managing flood releases (74.0m AHD) is 75,000ML. The volume between the expected peak (73.5m AHD) and initiation of the first Fuse Plug is 330,000ML.

Impacts downstream of Wivenhoe Dam

The projected Wivenhoe Dam releases combined with Lockyer Creek 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 River will be impacted by the combined flows of Lockyer Creek, 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. Currently the estimate peak flow in the lower Brisbane River will be the highest since Wivenhoe Dam was completed in 1984 but still well below flows the 1974 levels.

Somerset Regional, Ipswich City and Brisbane City Councils have been advised of the updated Wivenhoe operating strategy.

Outlook

H vy rainfall continues throughout South East Queensland and the situation could deteriorate rapidly over the next 24 hours. The flood operation centre will continue to monitor the situation and provide every six hours until the situation stabilizes.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]

Sent: Monday, 10 January 2011 2:58 PM

To: Allen Peter;

Cc:

Subject: RE: FOC Situation Report at 12:00 on Monday 10 January 2011

Rainfall

Significant rainfall has fallen in the Wivenhoe Dam catchment over the last 3 hours, with falls exceeding 100mm. This rainfall will significantly increase inflows into the dam. A severe weather warning remains current for heavy rainfall in the dam catchment areas. The QPF issued by BOM at 10:00 estimates rainfalls for the 24 hours to 10:00 Tuesday as North Pine Dam (75mm to 150mm); Wivenhoe/Somerset Dam Catchments (50mm – 100mm). Potentially significant rain moving towards the dam catchments is currently evident on the BOM radar.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 103.41m AHD and rising. Peak inflow to the dam is estimated to be about 4,200 m3/s. Five sluice gates are open releasing about 1,100m3/s (95,000ML/day) into Wivenhoe Dam. At this stage the dam lake level will reach about 103.5m AHD on Monday afternoon. Areas around Kilcoy will continue to be adversely affected.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

The dam level is 72.41m AHD and rising quickly. The rainfall experienced over the last 2 to 3 hours will result in significant further inflows into the dam and releases from the dam will need to be increased in accordance with Flood Mitigation procedures and to ensure that a fuse plug is not initiated. The initiation of a fuse plug will result in a rapid uncontrolled outflow from the dam of 2,000m3/s being added to the gate release outflow. Outflows into the Brisbane River from both Lockyer Creek and the Bremer River are also increasing.

Five radial gates are currently open at the dam releasing about 2,000m3/s into the Brisbane River and this will need to be increased steadily to an outflow of 2,800m3/s over the next 9 hours (commencing at 1500). At this stage, the dam will reach about 73.8m AHD during Tuesday morning.

The objective for dam operations is currently to minimise the impact of urban flooding in areas downstream of the dam and to keep river flows in the lower Brisbane River below 4,000m3/s if possible. This is significantly less than the current estimated combined pre-dam peak inflow of 12,000m3/s. If further rainfall occurs, dam releases may need to be increased further and this may result in river flows in the lower Brisbane River approaching or exceeding 5,000m3/s.

Impacts downstream of Wivenhoe Dam

The projected Wivenhoe Dam releases combined with Lockyer Creek 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 Sunday 16 January in varying degrees.

Water levels in the lower Brisbane River will be impacted by the combined flows of Lockyer Creek, Bremer River, local runoff and releases from Wivenhoe Dam.

Outlook

Heavy rainfall continues throughout South East Queensland and the situation could deteriorate rapidly over the next 24 hours. The flood operation centre will continue to monitor the situation and provide every six hours until the situation stabilizes.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]

Sent: Monday, 10 January 2011 6:43 PM

To: 'Duty Engineer';
Allen Peter;

Cc:

Subject: FOC Situation Report at 18:00 on Monday 10 January 2011

Rainfall

Only minor rainfall has been experienced in the North Pine Dam and Somerset Dam catchments with a catchment averages of less than 20mm.

However, significant rain has fallen in the Wivenhoe Dam catchment over the last 6 hours, with isolated falls exceeding 100mm. This rainfall has significantly increase inflows into the dam. A severe weather warning remains current for heavy rainfall in the dam catchment areas. The QPF issued by BOM at 10:00 estimates rainfalls for the 24 hours to 10:00 Tuesday as North Pine Dam (25mm to 50mm, with isolated falls to 100mm); Wivenhoe/Somerset Dam Catchments (25mm to 50mm, with isolated falls to 100mm). Potentially significant rain moving towards the dam catchments is currently evident on the BOM radar.

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level is 39.84m AHD and falling slowly (storing 9,000ML above FSL). Five gates are open and releasing 362 m3/s. The inflow into the dam since the commencement of the event is 72,000 ML. Estimated event volume is 84,000 ML assuming no further rainfall. Releases from the dam will continue until at least Wednesday 12 January 2011.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 103.46m AHD and rising slowly. Peak inflow to the dam is estimated to be about 4,200 m3/s. Total discharge into Wivenhoe Dam is currently 1700m3/s and this discharge will decrease slowly in the next 24 hours to be around 1200m3/s late Tuesday. The dam level will peak at 103.5m AHD in the next few hours, unless further significant rainfall is experienced. Areas around Kilcoy will continue to be adversely affected.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

The dam level is 72.92m AHD and rising quickly. Releases from the dam have been increased over the last 3 hours in accordance with Flood Mitigation procedures and to ensure that a fuse plug is not initiated. The initiation of a fuse plug will result in a rapid uncontrolled outflow from the dam of 2,000m3/s being added to the gate release outflow. Outflows into the Brisbane River from both Lockyer Creek and the Bremer River are also increasing. The flash flooding experienced in the upper areas of Lockyer Creek have been examined and are not expected to significantly increase Brisbane River flows above the current projection of 4000m3/s at Moggill.

Five radial gates are currently open at the dam releasing about 2,400m3/s into the Brisbane River and this will need to be increased steadily to an outflow of 2,800m3/s. At this stage, the dam will reach about 73.8m AHD during Tuesday morning.

The objective for dam operations is currently to minimise the impact of urban flooding in areas downstream of the dam and to keep river flows in the lower Brisbane River below 4,000m3/s if possible. This is significantly less than the current estimated combined pre-dam peak inflow of 12,000m3/s. If further rainfall occurs, dam releases may need to be increased further and this may result in river flows in the lower Brisbane River approaching or exceeding 5,000m3/s.

Impacts downstream of Wivenhoe Dam

The projected Wivenhoe Dam releases combined with Lockyer Creek 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 Sunday 16 January in varying degrees.

Water levels in the lower Brisbane River will be impacted by the combined flows of Lockyer Creek, Bremer River, local runoff and releases from Wivenhoe Dam.

Outlook

Heavy rainfall continues throughout South East Queensland and the situation could deteriorate rapidly over the next 24 hours. The flood operation centre will continue to monitor the situation and provide every six hours until the situation stabilizes.

D Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Monday, 10 January 2011 11:56 PM
To: ; Allen Peter;

Cc:

Subject: FOC Situation Report at 00:00 Tuesday 11 Janaury 2011

Rainfall

[ ]all continues in the North Pine Dam, Somerset Dam and Wivenhoe Dam catchments with falls of generally less than 20mm since 18:00 today. However, some isolated falls in the Upper Brisbane River of up to 110 mm have been recorded at Monsildale in this time. This rainfall will increase inflows into the dam.

A severe weather warning remains current for heavy rainfall in the dam catchment areas. The QPF issued by BOM at 16:00 estimates rainfalls for the 24 hours to 10:00 Tuesday as North Pine Dam (25mm to 50mm, with isolated falls to 100mm); Wivenhoe/Somerset Dam Catchments (25mm to 50mm, with isolated falls to 100mm).

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level is 39.80m AHD and falling slowly (storing 4,400ML above FSL). Five gates are open, releasing 153 m3/s. The inflow into the dam since the commencement of the event is 74,000 ML. Estimated event volume is 84,000 ML assuming no further rainfall. Releases from the dam will continue until at least Wednesday 12 January 2011.

Somerset Dam (Full Supply Level 99.00 m AHD)

The dam level is 103.40m AHD and falling slowly. Peak inflow to the dam is estimated to be about 4,200 m3/s. Total discharge into Wivenhoe Dam is currently 1700m3/s and this discharge will decrease slowly in the next 24 hours to be around 1200m3/s late Tuesday. The dam level peaked at 103.52m AHD at 19:00 on Monday 10 January 2011, unless [ ]r significant rainfall is experienced. Areas around Kilcoy will continue to be adversely affected.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

The dam level is 73.22m AHD and rising at about 50 mm/hour. Releases from the dam have been held at a rate of 2,750 m3/s since 19:30 hours. Outflows into the Brisbane River from both Lockyer Creek and the Bremer River are also increasing.

The BoM has provided further advice about the flash flooding experienced in the upper areas of Lockyer Creek. The rainfall responsible for this event was not observed at any rainfall stations but it is considered to be very significant. Flood levels in the Lockyer Creek catchment will exceed maximum recorded levels in some stations in the upper catchment. This flow may result in increases in Brisbane River levels below the junction of Lockyer Creek.

Five radial gates are currently open at the dam releasing about 2,750m3/s into the Brisbane River. At this stage, the dam will reach about 73.8m AHD during Tuesday afternoon.

The objective for dam operations is currently to minimise the impact of urban flooding in areas downstream of the dam and to keep river flows in the lower Brisbane River below 4,000m3/s if possible. This is significantly less than the current estimated combined pre-dam peak inflow of 12,000m3/s. If further rainfall occurs, dam releases may need to be increased further and this may result in river flows in the lower Brisbane River approaching or exceeding 5,000m3/s.

Impacts downstream of Wivenhoe Dam

The projected Wivenhoe Dam releases combined with Lockyer Creek 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 Sunday 16 January in varying degrees.

Water levels in the lower Brisbane River will be impacted by the combined flows of Lockyer Creek, Bremer River, local runoff and releases from Wivenhoe Dam.

The BoM will provide further information regarding the magnitude of the flash flood event occurring in Lockyer Creek early Tuesday morning. Consideration will be given to modifying the releases from Wivenhoe Dam to try to moderate the peak flows emanating from Lockyer Creek.

Outlook

Heavy rainfall continues throughout South East Queensland and the situation could deteriorate over the next 24 hours. The flood operation centre will continue to monitor the situation and provide situation reports every six hours until the situation stabilizes.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Tuesday, 11 January 2011 6:12 AM
To: Allen Peter;
Cc:
Subject: FOC Situation Report at 06:00 on Tuesday 11 January 2011

Rainfall

F all continues in the North Pine Dam, Somerset Dam and Wivenhoe Dam catchments. Isolated falls in the Upper Brisbane River of up to 125 mm have been recorded with widespread falls of 40 to 70 mm in the Somerset Dam catchment. This rainfall will increase inflows into the dam.

There has also been 20 to 60 mm in the Lockyer Creek catchment in the last 12 hours with falls of up to 30 mm in the Bremer River.

A severe weather warning remains current for heavy rainfall in the dam catchment areas. The QPF issued by BOM at 16:00 estimates rainfalls for the 24 hours to 10:00 Tuesday as North Pine Dam (25mm to 50mm, with isolated falls to 100mm); Wivenhoe/Somerset Dam Catchments (25mm to 50mm, with isolated falls to 100mm).

North Pine Dam (Full Supply Level 39.60 m AHD)

The dam level is 39.80m AHD and has commenced rising again (storing 4,400ML above FSL). Five gates are open releasing 177 m3/s. The inflow into the dam since the commencement of the event is 77,000 ML. Estimated event volume is 88,000 ML assuming no further rainfall. Releases from the dam will continue until at least Wednesday 12 January 2011.

Somerset Dam (Full Supply Level 99.00 m AHD)

T... dam level is 103.27m AHD and falling slowly. Peak inflow to the dam is estimated to be about 4,200 m3/s. Total discharge into Wivenhoe Dam is currently 1400 m3/s and this discharge will be decreased in the next few hours to be around 500 m3/s later on Tuesday. This is to ensure that the combined flood mitigation capacity in Somerset and Wivenhoe Dam is maximized.

The dam level peaked at 103.52m AHD at 19:00 on Monday 10 January 2011, (unless further significant rainfall is experienced). Areas around Kilcoy will continue to be adversely affected.

Wivenhoe Dam (Full Supply Level 67.00 m AHD)

The dam level is 73.51m AHD and rising at about 25 mm/hour. Releases from the dam have been held at a rate of 2,750 m3/s since 19:30 hours on Monday 10 January 2011. Outflows into the Brisbane River from both Lockyer Creek and the Bremer River are also increasing.

The BoM has provided further advice about the flash flooding experienced in the upper areas of Lockyer Creek. The rainfall responsible for this event was not observed at any rainfall stations but it is considered to be extreme. Flood levels in the Lockyer Creek catchment will exceed maximum recorded levels in some stations in the upper catchment. This flow will result in increases in Brisbane River levels below the junction of Lockyer Creek.

Five radial gates are currently open at the dam releasing about 2,750m3/s into the Brisbane River. At this stage, the dam will reach just over 74.0m AHD during Tuesday evening.

Above EL 74.0m AHD the objective for dam operations is to maintain the security of the dam and minimise downstream flood flows if possible.

If further rainfall occurs, dam releases may need to be increased further and this may result in river flows in the lower Brisbane River approaching or exceeding 5,000m3/s.

Impacts downstream of Wivenhoe Dam

The projected Wivenhoe Dam releases combined with Lockyer Creek 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 Sunday 16 January in varying degrees.

Water levels in the lower Brisbane River will be impacted by the combined flows of Lockyer Creek, Bremer River, local runoff and releases from Wivenhoe Dam.

The BoM will provide further information regarding the magnitude of the flash flood event occurring in Lockyer Creek early Tuesday morning. Consideration was given to modifying the releases from Wivenhoe Dam to try to moderate the peak flows emanating from Lockyer Creek but the rainfall in the past 12 hours in the catchment above the dam makes this option not possible. Therefore instead of decreasing releases to accommodate the Lockyer Creek flows, the strategy will endeavour to maintain the current releases until Lockyer Creek peaks.

Outlook

Heavy rainfall continues throughout South East Queensland and the situation could deteriorate over the next 24 hours. The flood operation centre will continue to monitor the situation and provide situation reports every six hours until the situation stabilizes.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Tuesday, 11 January 2011 12:11 PM
To: Allen Peter;

Subject: SitRep 1200 11/1/2011

Somerset/Wivenhoe

Our current strategy revolves around trying to prevent initiation of the first fuse plug at EL 75.6m. If this happens we will get a rapid increase of about 2,000m3/s in outflow from the dam in addition to the gate release which could be as high as 4,500 to 5,000m3/s at the time. However, it may be that fuse plug initiation might provide a lower outflow than increasing the gate outflow to protect it. In this case, we would adopt an alternate scenario.

Sluices have been closed at Somerset and this will result in high upstream water levels affecting Kilcoy.

1. With no further rainfall, Wivenhoe will approach 75.0m AHD and there will be an attempt to limit the dam outflow to 4,500m3/s, however this strategy currently being reviewed on an hour by hour basis. The release will be 4,000m3/s by 1300.
2. With 50mm rainfall in the Stanley and Upper Brisbane in the next 12 to 24 hours, the release will need to be significantly increased to be in the order 6,000m3/s.

It should be noted that the flow in the lower Brisbane River in 1974 was about 9,500m3/s

Wivenhoe has lost incoming mains power and are on backup power. Energex are attempting to rectify.

North Pine

Inflows and outflows are increasing very rapid and will exceed 2,000m3/s.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Tuesday, 11 January 2011 2:19 PM
To:
Cc: Allen Peter;
Subject: Wivenhoe Dam Update
Importance: High

Somerset/Wivenhoe

Strategy revolves ensuring dam security and is around trying to prevent initiation of the first fuse plug at EL 75.6m. If this happens we will get a rapid increase of about 2,000m3/s in outflow from the dam in addition to the gate release which could be as high as 10,000m3/s at the time. Sluices have been closed at Somerset and this will result in high upstream water levels affecting Kilcoy.

Wivenhoe Dam is rising very quickly and rapid gate openings are required to manage this increase. Based on the current rate of rise, inflow rate is in excess of 12,000m3/s. The situation is being revised constantly and releases will be increased hourly until the water level starts to stabilize. It is possible that the releases will be as high as 10,000m3/s in the next few hours. Heavy rainfall continues in the catchment especially around the dam.

It should be noted that the flow in the lower Brisbane R in 1974 was about 9,500m3/s

North Pine

Inflows and outflows are at record levels and increasing within inflows nearing 3,000m3/s, and is approaching an extreme event (possibly as high as 1 in 10,000 AEP)

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Wednesday, 12 January 2011 5:49 AM
To: Allen Peter;

Subject: Situation Report 0600 Wed 12/01/2011

No significant rain has fallen over the catchments in the past twelve hours. Less than 10 to 15 millimeters of rainfall is expected over the next 24-48 hours.

\ ,hhoe Dam peaked on the 11th January, Tuesday night at 19:00 at 74.97 mAHD with a corresponding discharge of 7,450 m3/s. The release have now been scaled back to 4,300m3/s at 05:00 am. Wivenhoe Dam is currently 74.77 m AHD and falling slowly.

The releases from Wivenhoe Dam will be temporarily reduced to 2,500 m3/s to allow the peak of Lockyer Creek to enter the Brisbane River, after which they will be increased to maximum of 3,500 m3/s. This release will then be maintained to drain the flood storage component within the required 7 days.

Somerset Dam is at 105.10 mAHD and slowly rising. The dam is discharging 1,230 m3/s over the spillway. The dam is expected to peak this morning near its current level. Sluice gates will be utilised to assist the draining of the flood storage compartment commencing on Thursday.

The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2 million megalitres.

North Pine Dam is currently releasing 105 m3/s through five gates. At 17:00 the lake was 39.78 mAHD. The event has a volume of around 200,000 ML. The peak discharge from the dam was 2,800 m3/s. This is categorised as an extreme event in the order of 1 in 10,000.

The Flood Operations Centre is continuing to monitor rainfalls and water levels through the Brisbane and Pine c-'-hments and reviewing operating strategy every 30 minutes. The FOC is also maintaining close contact with warning .cies and local councils.

The next report will be issued at 08:00 12 January 2011.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer[redacted]

Sent: Tuesday, 11 January 2011 6:00 PM

To: Allen Peter;

Subject: Situation Report 1800 12 Janaury 2011 b

In the last twelve hours totals of up to 370mm have fallen in the area around Wivenhoe Dam. In the last hour, rainfalls between 15 and 30mm have been recorded in the same area. At 1600, the BoM advised that falls between 50 to 100mm are still forecast for the 24hrs to 1600 Wednesday 12 January 2011 for the North Pine and Somerset/Wivenhoe ( )ments.

At 1730 Wivenhoe Dam was 74.92m AHD and rising slowly and releasing about 6,700m3/s.

The current expectation is that the dam will reach a steady state (outflow equals inflow) within the next 3 hours without further significant rainfall. At this time, release from the dam will be about 8,000 m3/s.

If there is no further rainfall, it may be possible to then slowly reduce this release overnight.

The dam is expected to peak below 75.5m AHD which is 100mmm below the first fuse plug initiation level.

Note that the automatic recorder as indicated on the BoM website is affected by drawdown and is not reflecting the actual lake level and tendency.

The Flood Operations Centre is continuing to monitor rainfalls and water levels through the Brisbane and Pine catchments and reviewing operating strategy every 30 minutes. The FOC is also maintaining close contact with warning agencies and local councils.

The next report will be issued at 2100 12 January 2011.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Wednesday, 12 January 2011 3:18 PM
To: 'Duty Engineer'; Allen Peter;

Cc:
Subject: Situation Report 1500 Wed 12/01/2011

Rainfall

Rainfall in the last 12 hours is generally below 5mm with a couple of 10mm falls in the Stanley and North Pine catchments. There is no significant rain expected fin the next 4 days.

Somerset/Wivenhoe

Somerset Dam has peaked at 105.11 mAHD at 06:00 on 12 January 2011. One sluice was opened at 1030 12 January 2011 and the dam is discharging 1,440 m3/s. Sluice gates will be utilised to drain of the flood storage compartment during the next 5 days.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on 11 January 2011 with a corresponding discharge of 7,450 m3/s. Wivenhoe Dam was 74.81 m AHD at 15:00 and steady.

The releases from Wivenhoe Dam have been temporarily reduced to 2,500 m3/s at 07:30 12 January 2011 to allow the peak of Lockyer Creek to enter the Brisbane River. After the downstream peak in the lower Brisbane River has passed, releases will be increased to maximum of 3,500 m3/s. This release will then be maintained to drain the flood storage component within the required 7 days.

The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2 million megalitres.

North Pine

At 15:00 North Pine Dam was 39.74 mAHD falling with all gates open 1 increment, releasing about 80 m3/s. North Pine peaked at 41.11 mAHD at 14:00 on 11 January 1974 with peak release of 2,800 m3/s. The event has a volume of around 200,000 ML. It is expected that gates will be closed on Thursday or Thursday.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels through the Brisbane and Pine catchments and reviewing operating strategy every 30 minutes. The FOC is maintaining close contact with warning agencies and local councils.

The next report will be issued at 18:00 12 January 2011.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Thursday, 13 January 2011 5:45 AM
To:
Allen Peter;

Cc:

Subject: FOC Situation Report 0600 13 January 2011

Rainfall

Rainfall in the last 12 hours is generally below 5mm with isolated falls of up to 15mm in the Stanley, Lockyer and Pine River catchments. There is no significant rain expected fin the next 4 days.

Somerset/Wivenhoe

Somerset Dam peaked at 105.11 mAHD at 06:00 on Wednesday 12 January 2011. The current level is 104.34 mAHD. One sluice was opened at 10:30 on 12 January 2011 and the dam is currently discharging 1,130 m3/s. Sluice gates will be utilised to drain of the flood storage compartment during the next 5 days.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. Wivenhoe Dam was 74.72 m AHD at 06:00 and commence to fall slowly.

The releases from Wivenhoe Dam have been temporarily reduced to 2,500 m3/s at 07:30 on Wednesday 12 January 2011 to allow the peak of Lockyer Creek to enter the Brisbane River. The Brisbane River has peaked at the Port Office Gauge early Thursday morning. Releases from Wivenhoe Dam will be managed to achieve a target flow of around 3,500 m3/s at Moggill. This release will then be maintained to drain the flood storage component within the required 7 days.

The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

North Pine

At 06:00 North Pine Dam was 39.70 mAHD falling with all gates open 1 increment, releasing about 80 m3/s. North Pine peaked at 41.11 mAHD at 14:00 on Tuesday 11 January 2011 with peak release of 2,800 m3/s. The event has a volume of around 200,000 ML. It is expected that all gates will be closed on Friday.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments and reviewing operating strategy. The FOC will continue to maintain close contact with warning agencies and local councils.

The next report will be issued at 18:00 on Thursday 13 January 2011.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]

Sent: Thursday, 13 January 2011 6:43 PM

To:

Allen Peter;

Subject: Situation Report 1830 13 January 2011

Rainfall

There has been no significant rainfall in the last 12 hours and none is expected for the next 5 days.

Somerset/Wivenhoe

Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011. The current level is 103.60 mAHD and falling. Four sluices are open and the dam is currently discharging 1,528 m3/s.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. Wivenhoe Dam was 74.5 mAHD at 18:00 and continuing to fall slowly.

The releases from Wivenhoe Dam are currently 2,888 m3/s and are being managed to achieve a target flow of around 3,500 m3/s at Moggill. This release will then be maintained to drain the flood storage component within the required 7 days.

The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

North Pine

At 18:00 North Pine Dam was 39.60 mAHD and falling with 5 gates open, releasing about 151 m3/s. North Pine peaked at [illegible]11 mAHD at 14:00 on Tuesday 11 January 2011 with a peak release of 2,800 m3/s. The flood event volume is [illegible]ated to be around 200,000 ML.

All gates will be closed at 05:00 Friday to enable MMRC to consider reopening Youngs Crossing.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments and reviewing operating strategy. The FOC will continue to maintain close contact with warning agencies and local councils.

The next report will be issued at 06:00 on Friday 14 January 2011.

Duty Engineer
Flood Operations Centre

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Allen Peter

From: Duty Engineer [redacted]
Sent: Friday, 14 January 2011 5:45 AM
To: Allen Peter;
Subject: FOC Situation Report at 06:00 on Friday 14 Janaury 2011

Rainfall

has been no significant rainfall in the last 12 hours and falls of only 5mm is expected in the next twenty-four hours. Mostly fine conditions are expected over the weekend, but showers will return early next week.

Somerset/Wivenhoe

Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011. The current level is 102.87 mAHD and falling. Four sluices are open and the dam is currently discharging about 1,300 m3/s.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. At 05:00 Wivenhoe Dam was 74.08 mAHD and continuing to fall.

The releases from Wivenhoe Dam are currently about 3,500 m3/s and are being managed to achieve a target flow of around 3,500 m3/s at Moggill. This release will then be maintained to drain the flood storage component by Wednesday.

The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

North Pine

:00 North Pine Dam was 39.40 mAHD and gate operations have ceased. The current level is expected to increase to just over 39.5 mAHD in the next few days due to base-flow. This could be higher if further rainfall occurs.
Fish recovery has commenced and MBRC have been advised that the gates have been closed. MBRC will inspect Youngs Crossing to determine if the crossing can be re-opened.

North Pine peaked at 41.11 mAHD at 14:00 on Tuesday 11 January 2011 with a peak release of 2,800 m3/s. The flood event volume is estimated to be around 200,000 ML.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments. The FOC will continue to maintain close contact with warning agencies and local councils.

The next report will be issued at 18:00 on Friday 14 January 2011.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Tuesday, 18 January 2011 6:17 AM
To:
Allen Peter;

Subject: Situation Report 0615 Tuesday 18 Janaury 2011

Rainfall

..e has been no significant rainfall in the last 24 hours and no significant rainfall is expected in the next twenty-four hours. Mostly fine conditions are expected over the weekend, but showers will return early next week.

Somerset/Wivenhoe

At 16:00 Monday Somerset Dam was 99.02 mAHD and steady. The last sluice gate was closed at 07:00 17/01/2011 and one regulator remains open managing the base-flow into the Dam. Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011.

At 06:00 Tuesday Wivenhoe Dam was 67.82 mAHD and continuing to fall slowly. Releases were held constant overnight at about 2,050 m3/s to assist water supply pumping at Lowood. Following discussions with water supply operators, it has been decided to resume closing gates at 09:00 Tuesday before final closure on Thursday morning. The Dam will be near full supply and releases will be made through the regulator to account for ongoing base-flow.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s.

T' combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

It should be noted that the Seqwater water level gauge currently being reported on the BoM website is currently slightly under reading by about 50mm.

North Pine

At 09:00 North Pine Dam was 39.5 mAHD. All gates are closed. No further gate operations are expected unless additional rainfall falls.

North Pine peaked at 41.11 mAHD at 14:00 on Tuesday 11 January 2011 with a peak release of 2,800 m3/s. The flood event volume is estimated to be around 200,000 ML.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments and is maintaining close contact with warning agencies and local councils. Councils have been informed of the current release strategy.

At 05:00, the Wivenhoe Dam operator reported that the Fernvale Bridge was out of water but water remained over the approaches from Fernvale. He also advised that there were power lines on the bridge and that Energex was advised.

The remaining bridges below Wivenhoe Dam will progressively come out of water over the next few days.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer[redacted]

Sent: Tuesday, 18 January 2011 5:40 PM

To: Allen Peter;

Cc:

Subject: FOC Situation Report at 18:00 on Tuesday 18 January 2011

Rainfall

Severe thunderstorms are passing over Wivenhoe, Somerset and North Pine Dams this afternoon. To 17:00 falls of 20 to 30 mm where recorded at isolated locations including Mt Pechey and Kluvers Lookout.

A severe thunderstorm warning remains in place for the Stanley River Valley near Kilcoy.

Somerset/Wivenhoe

At 16:00 Tuesday Somerset Dam was 98.95 mAHD and steady. The last sluice gate was closed at 07:00 17/01/2011 and one regulator remains open managing the base-flow into the Dam. Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011.

At 16:00 Tuesday Wivenhoe Dam was 66.31 mAHD and continuing to fall slowly. Releases were held constant since 15:00 at about 1,450 m3/s to assist water supply pumping at Lowood. The shutdown sequence is scheduled to re-commence at 03:00 on Wednesday 19 January 2011 morning before final closure on Thursday morning. The Dam will be lowered to 66.5 mAHD (95% capacity) and releases will be made through the regulator to account for ongoing base-flow.

hhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s.

The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

It should be noted that the Seqwater water level gauge currently being reported on the BoM website is currently slightly under reading by about 50mm.

North Pine

At 09:00 North Pine Dam was 39.56 mAHD and rising slowly. All gates are closed. No further gate operations are expected unless additional rainfall falls. This situation will be closely monitored whilst storms remain in the vicinity.

North Pine peaked at 41.11 mAHD at 14:00 on Tuesday 11 January 2011 with a peak release of 2,800 m3/s. The flood event volume is estimated to be around 200,000 ML.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments and is maintaining close contact with warning agencies and local councils. Councils have been informed of the current release strategy.

The remaining bridges below Wivenhoe Dam will progressively come out of water over the next few days.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]

Sent: Wednesday, 19 January 2011 5:28 AM

To: Allen Peter;

Cc:

Subject: FOC Situation Report at 06:00 on Wednesday 19 January 2011

Rainfall

Severe thunderstorms passed over the Wivenhoe, Somerset and North Pine dam catchments yesterday afternoon and evening. Falls of 20mm to 30mm where recorded at isolated locations.

North Pine

A decision was made at 1900 yesterday to drain the dam down to 39.40m AHD overnight to cater for the inflow resulting from yesterday's storms and ensure that Youngs Crossing remains open during the day today. All gates were closed at 0500 today and a fish recovery operation also commenced at this time. Youngs Crossing will be reopened by the MBRC at around 0700. The dam level will rise slowly during the day and further releases may be required again tonight with more rainfall forecast. The current lake level is 39.42m AHD.

Somerset Dam

All regulators were closed at 2000 yesterday. The dam level is currently 98.95m AHD and rising slowly. Further regulator releases will take place today and again over the next few days to maintain the dam at the full supply level. Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011; all sluice gates were closed on Monday 17 January 2011.

Wivenhoe Dam

The Lowood temporary pump station was relocated at 2100 yesterday. This relocation removed the need to continue high flow releases from the dam to ensure treated water supplies to Lowood are maintained. Discussions with BCC last night also concluded that tidal variations are primarily back to normal patterns and having a greater impact on the foundation conditions of Coronation Drive than the tapering of releases from the dam. Accordingly the radial gate close down sequence recommenced at 21:45 last night and all gates will be closed by 1600 today. .The dam level when the last gate is closed will be around 66.90m AHD and a fish recovery operation will continue through most of the day during the close down sequence. Releases will continue through the regulator cone valve and possibly the Mini-Hydro (depending on when it can be re-started) to account for ongoing base-flow once all radial gates are closed.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres. It should be noted that the Seqwater water level gauge currently being reported on the BoM website is currently slightly under reading by about 50mm.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments and is maintaining close contact with warning agencies and local councils. Councils have been informed of the current release strategy. A summary of the bridge status along the Brisbane River between Wivenhoe Dam and

Moggill is as follows, with the exact timing of water coming clear of bridges depending on how the radial gate close down sequence progresses during the day:

- Water is clear of Fernvale Bridge and Mt Crosby Weir Bridge.
- Water should be clear of Burtons Bridge, Kholo Bridge and Savages Crossing tonight.
- Water should be clear of Colleges Crossing tomorrow.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements and a decision will be made on this later today. The earliest that Twin Bridges would be clear of water is late this afternoon.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Wednesday, 19 January 2011 1:45 PM
To: Allen Peter;

Subject: Situation Report 1345 Wednesday 2011

Rainfall

N... .gnificant rainfall has been recorded in Wivenhoe, Somerset and North Pine dam catchments since 0900 Thursday. The forecast rainfall indicates that falls between 15 to 25mm with isolated heavier falls to 50mm are expected in the next 24 hours.

North Pine

A decision was made at 1900 Wednesday to drain the dam down to 39.40m AHD overnight to cater for the inflow resulting from Wednesday's storms and ensure that Youngs Crossing remains open during the day Thursday. All gates were closed at 0500 Thursday and a fish recovery operation also commenced at this time. Youngs Crossing was expected to be reopened by the MBRC at around 0700. The dam level will rise slowly during the day and further releases may be required again tonight with more rainfall forecast. The lake level was 39.43m AHD at 0700.

Somerset Dam

All regulators were closed at 2000 Wednesday. The dam level was 99.00 m AHD at 0700 Thursday and rising slowly. Further regulator releases may take place over the next few days to maintain the dam at the full supply level. Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011; all sluice gates were closed on Monday 17 January 2011.

Wivenhoe Dam

All gates were closed at Wivenhoe at 1200 Thursday, with the dam level at 66.89m AHD at 1300. Following fish recovery and inspections, minor ongoing releases will be made for through the centre gate to account for ongoing small inflows. It is intended to drain down to 95%, approximately 66.5 m AHD.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

Strategy

A summary of the bridge status along the Brisbane River between Wivenhoe Dam and Moggill is as follows, with the exact timing of water coming clear of bridges depending on how the radial gate close down sequence progresses during the day:

- Water is clear of Fernvale Bridge and Mt Crosby Weir Bridge.
- Water should be clear of Burtons Bridge, Kholo Bridge and Savages Crossing tonight.
- Water should be clear of Colleges Crossing tomorrow.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements and a decision will be made on this later Thursday.

The Flood Operations Centre is now closed and control of the dams has reverted to normal Seqwater operations. However, the FOC will continue to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Thursday, 20 January 2011 9:45 AM
To: Allen Peter;

Cc:

Subject: Re-Issue: FOC Situation Report at 09:30 on Thursday 20 January 2011

Please delete the previous situation report and note that Wivenhoe Dam will now not be drained to 66.5 mAHD as previously indicated. Levels will be maintained at, or just below FSL.

Rainfall

Severe thunderstorms again delivered rainfall over Wivenhoe, Somerset and North Pine dam catchments overnight. Catchment average rainfalls of 55 mm occurred in the Pine River, with isolated falls of 93 mm recorded at Mt Glorious.

The forecast rainfall indicates that falls of between 25 to 50mm are expected in the next 24 hours.

North Pine

North Pine Dam commenced gate operations at 01:00 on Thursday 20 January 2011 due to the runoff generated from the overnight storm. Currently five gates are open, releasing 150 m3/s. The lake level was 39.52m AHD at 09:00 and falling slowly.

Youngs Crossing remains closed.

Somerset Dam

All regulators were closed at 20:00 Tuesday 18 January 2011. The dam level was 99.07 m AHD at 06:30 on Thursday and rising slowly. Further regulator releases may take place over the next few days to maintain the dam at Full Supply Level (FSL).

Wivenhoe Dam

All gates were closed at Wivenhoe at 12:00 on Wednesday 19 January 2011. The current lake level is just below FSL and rising slowly due to the overnight storm inflows.

Operational releases will be made for through the centre gate to account for ongoing small inflows and to assist town water supply requirements.

Strategy

A summary of the bridge status along the Brisbane River between Wivenhoe Dam and Moggill is as follows, with the exact timing of water coming clear of bridges depending on the fresh in the Lockyer Creek (peak flow~200-250 m3/s) and any further rainfalls.

- Water is clear of Fernvale Bridge, Mt Crosby Weir Bridge, Kholo Bridge and Burtons Bridge
- Water from the fresh in the Lockyer Creek is likely to keep Savages Crossing and Colleges Crossing inundated for at least the next 24 hours.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements and a decision will be made on this later Friday.

The Flood Operations Centre is re-mobilised for the North Pine Dam operations, but control of the Somerset and Wivenhoe dams has reverted to normal Seqwater operations. However, the FOC will continue to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Thursday, 20 January 2011 3:07 PM
To: Allen Peter;
Cc:

Subject: FOC Situation Report at 15:00 on Thursday 20 January 2011

Rainfall

Severe thunderstorms delivered rainfall over Wivenhoe, Somerset and North Pine dam catchments overnight. Catchment average rainfalls of 55 mm occurred in the Pine River, with falls of 93 mm recorded at Mt Glorious.

Severe thunderstorm warnings issued earlier in the day have been cancelled, but localized storms are still affecting the catchments.

The QPF rainfall forecast indicates that falls of between 15 to 25 mm, with heavier storm falls of 50mm possible in the next 24 hours.

North Pine

North Pine Dam commenced gate operations at 01:00 on Thursday 20 January 2011 due to the runoff generated from the overnight storm. These gate operations ceased at 14:00 on Thursday 20 January 2011 with the lake level at 39.44 mAHD. MBRC have been advised that the operations have ceased and they will open Youngs Crossing by 16:00 today.

MBRC have also been warned that if further rainfall occurs tonight, gate operations may need to recommence again at 21:00.

Somerset Dam

All regulators were closed at 20:00 Tuesday 18 January 2011. The dam level was 99.09 m AHD at 15:00 on Thursday and rising slowly. Further regulator releases may take place over the next few days to maintain the dam at Full Supply Level (FSL).

Wivenhoe Dam

All gates were closed at Wivenhoe at 12:00 on Wednesday 19 January 2011. The current lake level is just below FSL and rising slowly due to the overnight storm inflows.

Operational releases may be made through the centre radial gate to account for ongoing small inflows and to assist town water supply requirements in the next few days.

Strategy

A summary of the bridge status along the Brisbane River between Wivenhoe Dam and Moggill is as follows, with the exact timing of water coming clear of bridges depending on the fresh in the Lockyer Creek (peak flow 250 m3/s) and any further rainfalls.

- Water is clear of Fernvale Bridge, Mt Crosby Weir Bridge, Kholo Bridge and Burtons Bridge
- Water from the fresh in the Lockyer Creek is likely to keep Savages Crossing and Colleges Crossing inundated for at least the next 24 hours.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements

and a decision will be made on this later Friday.

The Flood Operations Centre will monitor the situation in North Pine Dam overnight, but control of the Somerset and Wivenhoe dams has reverted to normal Seqwater operations. Remote monitoring will revert to the On Call Duty Engineer (Rob Ayre) from Friday 21 January 2011.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Wednesday, 19 January 2011 5:28 AM
To: Allen Peter;
Cc:
Subject: FOC Situation Report at 06:00 on Wednesday 19 January 2011

infall

Severe thunderstorms passed over the Wivenhoe, Somerset and North Pine dam catchments yesterday afternoon and evening. Falls of 20mm to 30mm where recorded at isolated locations.

North Pine

A decision was made at 1900 yesterday to drain the dam down to 39.40m AHD overnight to cater for the inflow resulting from yesterday's storms and ensure that Youngs Crossing remains open during the day today. All gates were closed at 0500 today and a fish recovery operation also commenced at this time. Youngs Crossing will be reopened by the MBRC at around 0700. The dam level will rise slowly during the day and further releases may be required again tonight with more rainfall forecast. The current lake level is 39.42m AHD.

Somerset Dam

All regulators were closed at 2000 yesterday. The dam level is currently 98.95m AHD and rising slowly. Further regulator releases will take place today and again over the next few days to maintain the dam at the full supply level. Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011; all sluice gates were closed on Monday 17 January 2011.

Wivenhoe Dam

The Lowood temporary pump station was relocated at 2100 yesterday. This relocation removed the need to continue high flow releases from the dam to ensure treated water supplies to Lowood are maintained. Discussions with BCC last night also concluded that tidal variations are primarily back to normal patterns and having a greater impact on the foundation conditions of Coronation Drive than the tapering of releases from the dam. Accordingly the radial gate close down sequence recommenced at 21:45 last night and all gates will be closed by 1600 today. The dam level when the last gate is closed will be around 66.90m AHD and a fish recovery operation will continue through most of the day during the close down sequence. Releases will continue through the regulator cone valve and possibly the Mini-Hydro (depending on when it can be re-started) to account for ongoing base-flow once all radial gates are closed.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres. It should be noted that the Seqwater water level gauge currently being reported on the BoM website is currently slightly under reading by about 50mm.

Strategy

The Flood Operations Centre is continuing to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments and is maintaining close contact with warning agencies and local councils. Councils have been informed of the current release strategy. A summary of the bridge status along the Brisbane River between Wivenhoe Dam and

Moggill is as follows, with the exact timing of water coming clear of bridges depending on how the radial gate close down sequence progresses during the day:

- Water is clear of Fernvale Bridge and Mt Crosby Weir Bridge.
- Water should be clear of Burtons Bridge, Kholo Bridge and Savages Crossing tonight.
- Water should be clear of Colleges Crossing tomorrow.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements and a decision will be made on this later today. The earliest that Twin Bridges would be clear of water is late this afternoon.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer[redacted]
Sent: Wednesday, 19 January 2011 1:45 PM
To:
Allen Peter;

Subject: Situation Report 1345 Wednesday 2011

Rainfall

No significant rainfall has been recorded in Wivenhoe, Somerset and North Pine dam catchments since 0900 Thursday. The forecast rainfall indicates that falls between 15 to 25mm with isolated heavier falls to 50mm are expected in the next 24 hours.

North Pine

A decision was made at 1900 Wednesday to drain the dam down to 39.40m AHD overnight to cater for the inflow resulting from Wednesday's storms and ensure that Youngs Crossing remains open during the day Thursday. All gates were closed at 0500 Thursday and a fish recovery operation also commenced at this time. Youngs Crossing was expected to be reopened by the MBRC at around 0700. The dam level will rise slowly during the day and further releases may be required again tonight with more rainfall forecast. The lake level was 39.43m AHD at 0700.

Somerset Dam

All regulators were closed at 2000 Wednesday. The dam level was 99.00 m AHD at 0700 Thursday and rising slowly. Further regulator releases may take place over the next few days to maintain the dam at the full supply level. Somerset Dam peaked at 105.11 mAHD at 18:00 on Wednesday 12 January 2011; all sluice gates were closed on Monday 17 January 2011.

Wivenhoe Dam

All gates were closed at Wivenhoe at 1200 Thursday, with the dam level at 66.89m AHD at 1300. Following fish recovery and inspections, minor ongoing releases will be made for through the centre gate to account for ongoing small inflows. It is intended to drain down to 95%, approximately 66.5 m AHD.

Wivenhoe Dam peaked at 74.97 mAHD at 19:00 on Tuesday 11 January 2011 with a corresponding discharge of 7,450 m3/s. The combined flood event volume in Somerset and Wivenhoe Dams is estimated to be in excess of 2.6 million megalitres.

Strategy

A summary of the bridge status along the Brisbane River between Wivenhoe Dam and Moggill is as follows, with the exact timing of water coming clear of bridges depending on how the radial gate close down sequence progresses during the day:

- Water is clear of Fernvale Bridge and Mt Crosby Weir Bridge.
- Water should be clear of Burtons Bridge, Kholo Bridge and Savages Crossing tonight.
- Water should be clear of Colleges Crossing tomorrow.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements and a decision will be made on this later Thursday.

The Flood Operations Centre is now closed and control of the dams has reverted to normal Seqwater operations. However, the FOC will continue to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments.

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]
Sent: Thursday, 20 January 2011 9:45 AM
To: Allen Peter;

Cc:

Subject: Re-Issue: FOC Situation Report at 09:30 on Thursday 20 January 2011

ase delete the previous situation report and note that Wivenhoe Dam will now not be drained to 66.5 mAHD as eviously indicated. Levels will be maintained at, or just below FSL.

Rainfall

Severe thunderstorms again delivered rainfall over Wivenhoe, Somerset and North Pine dam catchments overnight. Catchment average rainfalls of 55 mm occurred in the Pine River, with isolated falls of 93 mm recorded at Mt Glorious.

The forecast rainfall indicates that falls of between 25 to 50mm are expected in the next 24 hours.

North Pine

North Pine Dam commenced gate operations at 01:00 on Thursday 20 January 2011 due to the runoff generated from the overnight storm. Currently five gates are open, releasing 150 m3/s. The lake level was 39.52m AHD at 09:00 and falling slowly.

Youngs Crossing remains closed.

Somerset Dam

regulators were closed at 20:00 Tuesday 18 January 2011. The dam level was 99.07 m AHD at 06:30 on Thursday and rising slowly. Further regulator releases may take place over the next few days to maintain the dam at Full Supply Level (FSL).

Wivenhoe Dam

All gates were closed at Wivenhoe at 12:00 on Wednesday 19 January 2011. The current lake level is just below FSL and rising slowly due to the overnight storm inflows.

Operational releases will be made for through the centre gate to account for ongoing small inflows and to assist town water supply requirements.

Strategy

A summary of the bridge status along the Brisbane River between Wivenhoe Dam and Moggill is as follows, with the exact timing of water coming clear of bridges depending on the fresh in the Lockyer Creek (peak flow~200-250 m3/s) and any further rainfalls.

- Water is clear of Fernvale Bridge, Mt Crosby Weir Bridge, Kholo Bridge and Burtons Bridge
- Water from the fresh in the Lockyer Creek is likely to keep Savages Crossing and Colleges Crossing inundated for at least the next 24 hours.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements and a decision will be made on this later Friday.

The Flood Operations Centre is re-mobilised for the North Pine Dam operations, but control of the Somerset and Wivenhoe dams has reverted to normal Seqwater operations. However, the FOC will continue to monitor rainfalls and water levels throughout the Brisbane and Pine River catchments.

Regards

Duty Engineer
Flood Operations Centre

Allen Peter

From: Duty Engineer [redacted]

Sent: Thursday, 20 January 2011 3:07 PM

To: Allen Peter;

Cc:

Subject: FOC Situation Report at 15:00 on Thursday 20 January 2011

Rainfall

Severe thunderstorms delivered rainfall over Wivenhoe, Somerset and North Pine dam catchments overnight. Catchment average rainfalls of 55 mm occurred in the Pine River, with falls of 93 mm recorded at Mt Glorious.

Severe thunderstorm warnings issued earlier in the day have been cancelled, but localized storms are still affecting the catchments.

The QPF rainfall forecast indicates that falls of between 15 to 25 mm, with heavier storm falls of 50mm possible in the next 24 hours.

North Pine

North Pine Dam commenced gate operations at 01:00 on Thursday 20 January 2011 due to the runoff generated from the overnight storm. These gate operations ceased at 14:00 on Thursday 20 January 2011 with the lake level at 39.44 mAHD. MBRC have been advised that the operations have ceased and they will open Youngs Crossing by 16:00 today.

MBRC have also been warned that if further rainfall occurs tonight, gate operations may need to recommence again at 21:00.

Somerset Dam

All regulators were closed at 20:00 Tuesday 18 January 2011. The dam level was 99.09 m AHD at 15:00 on Thursday and rising slowly. Further regulator releases may take place over the next few days to maintain the dam at Full Supply Level (FSL).

Wivenhoe Dam

All gates were closed at Wivenhoe at 12:00 on Wednesday 19 January 2011. The current lake level is just below FSL and rising slowly due to the overnight storm inflows.

Operational releases may be made through the centre radial gate to account for ongoing small inflows and to assist town water supply requirements in the next few days.

Strategy

A summary of the bridge status along the Brisbane River between Wivenhoe Dam and Moggill is as follows, with the exact timing of water coming clear of bridges depending on the fresh in the Lockyer Creek (peak flow 250 m3/s) and any further rainfalls.

- Water is clear of Fernvale Bridge, Mt Crosby Weir Bridge, Kholo Bridge and Burtons Bridge
- Water from the fresh in the Lockyer Creek is likely to keep Savages Crossing and Colleges Crossing inundated for at least the next 24 hours.
- It is not yet certain when water will be clear of Twin Bridges as this will depend on base flow draining requirements

and a decision will be made on this later Friday.

The Flood Operations Centre will monitor the situation in North Pine Dam overnight, but control of the Somerset and Wivenhoe dams has reverted to normal Seqwater operations. Remote monitoring will revert to the On Call Duty Engineer (Rob Ayre) from Friday 21 January 2011.

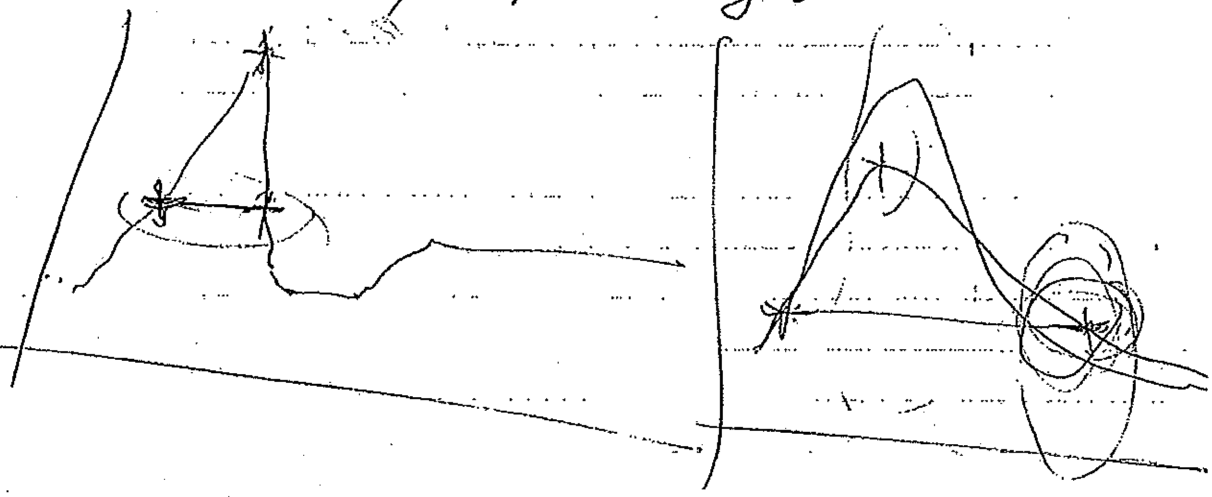
Regards

Duty Engineer
Flood Operations Centre

Meeting with Minister 18/1/11. 9:00 am.

re: Wivenhoe.

- drawdown strategy.
- impact of 80% storage?



Extreme hazard — under ANCOLD guidelines

1.165 million ML water storage
1.450 million ML flood storage

Oct. 2010	760,000 ML
13-16 Dec 2010	70,000 ML
17-24 Dec 2010	150,000 ML
26 - 2 Jan	470,000 ML
6 → Jan.	2.6 million ML

$\boxed{\begin{matrix}75.7\\76.2\\76.7\end{matrix}}$

Seqwater Meeting 1:30pm 25th Jan 2011

Seqwater / Water Grid / QWC / DERM.

The affect of FSL on flood impacts.

What is to be contained in the TSR.

Flood report. — assembling data, drafting Thursday.

John Bradley — reducing storage levels.

→ risk associated with pre-release.

10% is about a year's supply.

— what are the triggers → strong La Nina / neutral / El Nino } How do you set it?

(practicalities??)

what do you do at the end of the season?

What is done in a contingency plan for a ROP?

— the ROP precludes a release.

(1) Does a direction to release to say 75% does it override the ROP?

[Legal Advice]

— element of probability?

— may not always be possible to discharge.

— what levels of discharge can be accommodated?

- Balancing Water Security impact & Flood Impact of reducing level.

Do you modify the trigger levels for a different starting

Jim Priss — Seqwater's project manager.

John Bradley

Minister is proposing to release a redacted version of the flood manual.

Note that this is a redacted version that has been ~~that may be a~~ removal of information amended to

Meeting with the Minister Mon. 31/1/11 8:30am
to see if water can be released from Wivenhoe.

- depends if
- story in CM. this morning.
- Cyclone Anthony / Cyclone Yasi
BoM 8day total rainfall forecast. 5 to 10mm in rainfall

If it is < 1 in 200 AEP event ⇒ Create worse flood conditions.
> 1 in 200 AEP → create benefits.

Get ~~Steve Jacobs~~ to ~~produce~~

Greg Claydon, Rob Drury, Tad Bagdon,

How do you get around the entitlement issue?
If the dam refills there is no long term entitlement loss.
E 25% of ~~entitlement~~ storage to 100% of the entitlement.
A ROP cannot override the provisions of the Water Act.
- Rights of other entitlement owners.
- One off emergency vs long term.
- purpose of release → one off release?? Resource Operations License
- You could absorb 150,000 ML without any impact. which would leave about 60,000 ML — Could work from through to end June when it would be reset. (a modelling perspective
- How do you release — leave Burton's open?? 30,000 ML/day

DS : view

Water Meeting 1/2/2011 4pm:

Update of

Phil Hennessy, Gordon Jardine, Mary Boydel,
Debbie Best, Penny Douglas, John Bradley, Greg Claydon, self
Barry Dennien. Jim Pruss, Peter Borrows.

Govt wants to investigate whether different priorities ~~to~~ should be given to drinking water retention & flood waters should be va by changing top water level.

Seqwater – may need to discuss this with their insurers.
– all media releases need to be peer reviewed

~~RSP rates – provisions exist~~

Peter Borrows – scenarios

1. Adjustments to the release strategy
2. Reduce FSL to 85% + adjusted release rate
3. Reduce FSL to 75% + current manual
4. Reducing FSL to 75% (treated as FSL). – need to adjust
5. Reducing FSL to 50% + current manual

→ Produced a range of benefits for different scenarios. Not yet comp
→ Now run them through the models.
→ Now need to get them peer reviewed / insurance revie
→ may require 2 to 3 days.

:20

Seqwater see their role as an advice role, not a recomm role for a preferred policy adoption.

Seqwater, DERM, QWC. 4/4/2011 12room.
Gric Peter Borrows, Jim Pruss, Debbie Best, self, Penny Douglas,
Mary Bordell, Karen Watsman, John Bradley, Barry Dennien.

PB. — ~~Scenarios~~ 1st phase — range of flows out of dam
2nd phase — consequential levels in River
3rd phase — inundation mapping.

events: (1974) 2011, , 1 in 200 → 1 in 500 events.
each event + 9 different scenarios.
all peer reviewed. — SKM. (Rory Nathan & Peter Hill).

BoM modelling
BCC modelling — probably the 'best' model
— BCC are looking at the recalibration of their model.

Wivenhoe → contain 1 in 100 event
+ have significant benefit up to 1 in 500 event
→ 1974 to about a 1 in 80
→ 2011 was above a 1 in 100.

eg 1 in 500 100% 5,000 m³/sec. (current manual)
75% 3,460 m³/sec. (as new FSL).
75% 3,700 m³/sec. (with current manual)

2011 (1) 100% ~~7500~~ 7500 m³/sec
(2) 75% 4500 m³/sec (adjusted)
(3) 75% Current 5750 m³/sec.

1 in 1000 event (1) 6,000 m³/sec [different durations]
(2) 4,500 m³/sec.
(3) 4,700 m³/sec

Contingency → If this then that follows.
FSL — history of FSL.

scenario review
provision of
variations

Seqwater 11:15 am'
17/2/2011 Interim Program: Re: Operations of Wivenhoe Dam to end March.
Jim Pruss, Toni Lake, Greg Clayton, Lyall Hinrichsen

~~Flood engineer~~
- Seek pre-approval for variation to flood manual in the event of a flood event to provide a smooth transition from ROP releases to flows under Flood Manual.
- To be along the lines of they will have been releasing under the ROP rules. + ~~then~~ it is not logical to reduce flows up to WIB.
- Greg & Lyall dealing with ROP variations.
- To be sent to John Bradley by 3pm today.
- Discharges to be under the control of a Duty Engineer at all times.

Thursday 24/2/11.
Jim Pruss, Rob Drury, Ron Guppy, self.

Get it by 2nd March.

Talk to Bob

Contingency Plans — • Do Seqwater still need it?
• Version I already have from Rob Drury

TSR — Who approves?
Is it OK?

Is it still being used with the Councils?
Who should be given it in the Councils?
Do they have a 24 hr contact?

Do we want to rethink it all now — Does

1/3/2011

Briefing of Stephen Robertson on Flood Event Report.

John Bradley, Peter Borrows, Mike Foster, Jim Pruss, self.
Stephen Robertson + staff + Tim Watson (from Min Jones office).

Operated in accordance with Manual

Reviewers Prof Apelt, Len McDonald Greg Roads

report to be signed off by the flood engineers (expect they will be called to C of I. lead to compromise)

→ problems long term – resourcing FOC.

Twin peaks about twice 74 flood volume.

– Recommending – review of manual (following such a large event)

review rain & river stns.

– identified key things

* rural releases, priorities

– need to look at flood communications

└ Somerset Council don't see it as their ~~[illegible]~~ role to distribute warnings.

– specifics → Manual identifies 4000 in Brisbane. BCC indicates it is 3000m³/sec at the Moggill Gauge.

* Flood Damage Reports for ICC & BCC.

— give a copy to John Bradley.

Damage Curves / NDRA.

* Copy will be given to John Bradley / Stephen Robertson. (notes).

Spoke of stress on flood engineers. John – stress leave

– resources ~~to~~ discussed Rob – end July off.

└ joint approach | Seqwater Borrows | SunWater Boelter | DERM DG John Terry |

ToR

(a) emergency preparedness.
- Statement of how the Dam EAPs operate in with flood plans.

Meeting with Jim Pruss, Terry Malone, Rob Drury, Bob & [illegible]
9th March 2011 8am
Rob Ayre/John Ruffini (8:30).

- Variation to Manual. — If a Duty Eng — express the view [illegible] are seeking a varia[illegible]

- fatigue management.
  - How does Seqwater intend to address it?
  - Discuss it with the Minister
  - More than one @ FOC when important decisions were [illegible]
  - if the rain had ~~been~~ continued on the Wednesday (fatigue ma[illegible] during small [illegible]
  (discussion paper before Christmas — from John Tibaldi)

- Communication Protocol.
  - Rob Drury & Mike Foster to respond in terms of developm[illegible] for the Protocol
  - we will organize a meeting with EMQ/Councils.

Operational forecasts — 12 hrs @ most (Rob Ayre).

Education Packages → may need to be distribution

NP Incorporate flood manual as an appendix.
Letter for extensions has been signed by DG & Seqwater h[illegible] received it —

Rob Drury, Barton Maher, re North Pine Dam.
10th March 2011 3:30pm.

- from an outflow 1:10000 & an inflow ~ 1:200
- 'blown' the flood frequency analysis. └why the disconnect
- NP Report tomorrow.
- URS (Mike Raymond)

- then What do we do about it.

~~As~~ Developing a back-up hydraulic system.

email to Rob re EAPs

Meeting re: NP 9:30 18/3/11
Terry Malone, Rob Ayre, John T, Jim Pruss, Ron Guffey

2011 flood – largest by 2.
to achieve 15% – need to reduce FSL to ≈ 32. (≈40%)
– now estimated about 60% AEP.
– Gate ratings
– growth curves – temporal patterns for short duration events
– Monte Carlo – in combination with starting levels losses etc.

Time line → check structural aspects – comeback to a failure level

Allen Peter

From: Allen Peter
Sent: Friday, 18 February 2011 9:28 AM
To: Reilly Bob; Hinrichsen Lyall
Subject: FW: Technical Report
Attachments: Technical_Situation_Report_W70.docx

Bob & Lyall ... FYI.

Peter Allen
Director Dam Safety (Water Supply)
Office of the Water Supply Regulator

w.derm.qld.gov.au

From:
Sent: Friday, 18 February 2011 8:54 AM
To:
Cc: Allen Peter
Subject: Technical Report

Attached is Technical Report W70 just to confirm planned releases starting Sunday.

Rob

TECHNICAL SITUATION REPORT

TSR Number	W70	Date of TSR release	18.2.11	Time of TSR release	8am

Seqwater status of inflows and dam operations

Current status but could change based on inflows or rainfall.

Current objectives	• Reduce level in Wivenhoe dam to 75%
Strategy	• Initiate low level releases at around 350 to 400cumecs. • This will inundate Twin Bridges, Savages and Colleges Crossings. • Maintain access to Burtons bridge
Key considerations	Storage levels:
	Inflows:
	Rainfall:
	Lockyer/Bremer:
	Brisbane River:

Wivenhoe Dam

Begin release of between 350 and 400cumecs depending on impact on Burtons Bridge at around 6 or 7am Sunday Morning 20th February 2011. Initially start at 350cumecs and monitor Burtons Bridge and increase to around 400cumecs if possible.

Cease releases at 75% FSL.

This will take approximately 9 days.

Seqwater Technical Officer name	
Seqwater Technical Officer position title	Dam Operations Manager
[redacted]	

BoM assessment

(consisting of references to latest Flood Warning for the BrisbaneRiver and other relevant Bureau forecasts and warnings (e.g. weather/rain forecasts, Tropical Cyclone Warning etc) and other updates/comments if needed)

No need to advise BoM of operational flows of this size.

BoM Technical Officer name	
BoM Technical Officer position title	
BoM Technical Officer contact details	[redacted]

Brisbane City Council(BCC) assessment

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy

BCC Technical Officer name	
BCC Technical Officer position title	Disaster Operations Manager
BCC Technical Officer contact details	

Ipswich City Council (ICC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

ICC Technical Officer name	
ICC Technical Officer position title	Local Disaster Response Coordinator
ICC Technical Officer contact details	

Somerset Regional Council (SRC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

SRC Technical Officer name	
SRC Technical Officer position title	Local Disaster Response Coordinator
SRC Technical Officer contact details	

Collated and distributed by (Agency)

Contact Officer signature	
Contact Officer name	
Contact Officer position title	Dam Operations Manager

Next TSR due	Date	21.2.11	Time		or Event	

Allen Peter

From: Allen Peter
Sent: Friday, 18 February 2011 12:51 PM
To:
Cc: Duty Engineer
Subject: FW: Releases

This is the exchange of emails that I referred to.

Peter Allen
Director Dam Safety (Water Supply)
Office of the Water Supply Regulator

..ww.derm.qld.gov.au

From:
Sent: Wednesday, 16 February 2011 11:42 AM
To: Allen Peter
Subject: RE: Releases

Peter,
Thanks for that.
I am confident we don't need the flood centre open given that we will

- Have a Duty Engineer monitoring during the week any rainfall and predictions
- Current predictions are only for 10 to 20mm for next 4 days and 15 to 25mm for the 4 days after that so there is no real rain predicted
- When we release we will have someone monitoring Burtons regularly to check our releases provide sufficient spare capacity in case of rain and any change in the stream capacity due to the floods
- We will have a duty officer monitoring as well during the week and someone local monitoring in case we have any isolated heavy rainfall
- Based on this, if we do have any high rainfall in the Lockyer, we should have time between rain falling and getting down to O'Reilly's to reduce Wivenhoe releases or if not, the travel time to Burtons Bridge will give us time to close. We will talk to Council re this before starting releases.
- Similarly if there is any indications of high rainfall impacting the Bremer.
- Tides are dropping in Brisbane from Sunday.

Hence I am confident we have enough monitoring in place for the release.

As for the report, I can't really say right now but I thought there was still a fair bit of work to do. Will let you know if I get a date sorted.

Thanks Peter.

From: Allen Peter
Sent: Wednesday, 16 February 2011 11:01 AM
To:
Subject: RE: Releases

. ... Do you know when Seqwater will be able to send us a copy of your flood reports for the Flood Mitigation Manuals? I know the Wivenhoe/Somerset report has been substantially written and it is being extensively reviewed but, if I know when we are likely to get it, I can gear up for our formal review of it. I don't need a precise date but some indication would be greatly appreciated.

Many thanks,
Peter

Peter Allen
Director Dam Safety (Water Supply)
Office of the Water Supply Regulator

www.derm.qld.gov.au

From: Allen Peter
Sent: Wednesday, 16 February 2011 9:14 AM
To:
Subject: RE: Releases

I expect that a Duty Engineer will be on duty at all times through the releases. As I understand it, the releases are set to keep Burton's Bridge open. As such, the Duty Engineer will need to monitor the catchments to ensure that this happens or at least sufficient warnings are provided that Burton's and any other bridges can be closed in time if flows out of the Lockyer etc. would be sufficient to close them or the flows from Wivenhoe can't be reduced in time to keep them open.

If this needs the Flood Operations Centre open, then that is what is required. I am, however, prepared to be advised on this requirement. I suspect it will be a case of what rain is forecast for the Lockyer to cause inundation problems for Burton's and how close the total discharge will be to the capacity at Burton's.

Peter Allen
Director Dam Safety (Water Supply)
Office of the Water Supply Regulator

www.derm.qld.gov.au

From:
Sent: Tuesday, 15 February 2011 9:56 AM
To: Allen Peter
Subject: Releases

Peter,
Just to confirm, for the release intended later this week to drop Wivenhoe to 75%, we won't be activating the Flood Centre and will just be treating it as operational releases. Similarly although we will have operators on call and close by, they will not be on site 24hours. They will however be there during working hours and also checking every day over the weekend.

The plan is to only ramp up to release up to around 400cumecs as usual but will check downstream in case the river or bridge inundation levels have changed slightly.

We will also monitor any rainfall in case there are issues with the Lockyer.

Just checking that was the way you saw it working as well.

+--+

Think B4U Print

1 ream of paper = 6% of a tree and 5.4kg CO2 in the atmosphere

3 sheets of A4 paper = 1 litre of water

+--+

Important information: This email and any attached information is intended only for the addressee and may contain confidential and/or privileged information. If you are not the addressee, you are notified that any transmission, distribution, or other use of this information is strictly prohibited. The confidentiality attached to this email is not waived, lost or destroyed by reasons of mistaken delivery to you. If you have received this email in error please contact the sender immediately and delete the material from your email system. QLD Bulk Water Supply Authority ABN75450239876 (Trading as Seqwater).

Allen Peter

From: Lumley Carol on behalf of Reilly Bob
Sent: Friday, 18 February 2011 2:04 PM
To: Allen Peter
Subject: FW: Technical Situation Report
Attachments: Technical_Situation_Report_W70.docx

Peter,

For your info.

cheers,

ol Lumley
.ncipal Planning and Policy Officer, Office of the Water Supply Regulator

www.derm.qld.gov.au
Department of Environment and Resource Management
Level 3 Mineral House, 41 George Street, Brisbane
GPO Box 2454, Brisbane Q 4001

From:
Sent: Friday, 18 February 2011 1:17 PM

Subject: Technical Situation Report

Seqwater has provided the attached Technical Situation Report for the planned releases, commencing Sunday morning.

The media release from last night is below.

Regards,

[x] WaterGrid_logo.jpg

GRID UPDATE
THURSDAY 17 FEBRUARY 2011

DAM RELEASES

Wivenhoe Dam

The controlled gate release to temporarily reduce the level of Wivenhoe Dam to 75 per cent will commence Sunday morning, 20 February 2011.

The release is based on balancing the drinking water supply needs of the community while improving the flood mitigation capability of Wivenhoe for the remainder of the wet season.

It is expected that this controlled release will run for 9 days in order to take best advantage of the current mild weather, falling tides and the limited flows into the Brisbane River from other sources downstream.

. win Bridges, Savages Crossing and Colleges Crossing will likely be closed to all traffic during this time. Local councils are still being consulted on these impacts however there are alternate routes in place for each of the closures. These include Mt Crosby Weir, which is open as an alternative to Colleges Crossing.

While minor tidal flooding along parts of the Brisbane River may occur over the next few days, the Wivenhoe releases will not impact on this.

Note, while a longer release pattern has been considered it has not been recommended by Seqwater, owing to the need to take best advantage of the current weather, tides and flows into the Brisbane River. Also, in order to keep Colleges Crossing open, the release pattern would need to be effectively doubled and would mean that both Twin Bridges and Savages Crossing would be impacted for at least 18 days and longer if there was rainfall in the Brisbane area or at the dam site.

Members of the public seeking information on potential impacts in their local areas should direct inquiries to their local councils in due course.

Dam updates are issued daily while release gates at Wivenhoe Dam are in operation.

Director, Operations
SEQ Water Grid Manager

Visit: Level 15, 53 Albert Street Brisbane
Post: PO Box 16205, City East QLD 4002
ABN: 14783 317 630

Allen Peter

From: Claydon Greg
Sent: Thursday, 17 February 2011 3:08 PM
To: Reilly Bob; Allen Peter
Subject: FW: Draft Revised Interim program - for consideration and feedback prior to lodgement 2011_02_17
Importance: High
Attachments: Revised Interim Program - DRAFT 17 Feb2011.DOC

fyi

Greg Claydon
Executive Director, Strategic Water Initiatives
Water and Ecosystems Outcomes Division
partment of Environment and Resource Management
/el 11, 400 George Street
GPO Box 2454, Brisbane Qld 4001

Website: www.derm.qld.gov.au

From: Claydon Greg
Sent: Thursday, 17 February 2011 2:56 PM
To: Hinrichsen Lyall; Poteri Vass; Faas Petra; Oneill Leanne
Cc: Williams Lynette; Howe Caitlin
Subject: FW: Draft Revised Interim program - for consideration and feedback prior to lodgement
Importance: High

All – I have just spoken to the DG and he would prefer to see the final version of the docs as proposed and endorsed by the Seqwater Board when they come in. When Seqwater actually submits their docs, I suggest that they be printed at mineral house, checked and then we walk them down to the DG at parly house and take him through the docs before he --nsiders signing. Can you let me know when you receive something "final" from Seqwater. Peter Borrows informs me ,t the draft docs as agreed at our level are now being considered by the Board.

Greg Claydon
Executive Director, Strategic Water Initiatives
Water and Ecosystems Outcomes Division
Department of Environment and Resource Management
Level 11, 400 George Street
GPO Box 2454, Brisbane Qld 4001

Website: www.derm.qld.gov.au

From:
Sent: Thursday, 17 February 2011 2:17 PM
To: Faas Petra
Cc: Poteri Vass; Claydon Greg; Hinrichsen Lyall; Wells, Jamie; McCredie, Bill; Carpenter Stephen; Oneill Leanne; Peter Borrows; Mike Foster; Jim Pruss
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement

Importance: High

Petra – as requested here is what Lyle has said he has no further comments on.
I have just done one last tidy up - I have added 5 words at the end of page 2 before 'Wivenhoe Dam' - "the water storage level at".
I will now seek the necessary Board approval I need to formally lodge the plan and execute the deeds. I will do that as soon as I can but note that the final indemnity documents have only just come through to enable that to occur.
Regards

From: Faas Petra
Sent: Thursday, 17 February 2011 2:01 PM
To:
Cc: Poteri Vass; Claydon Greg; Hinrichsen Lyall; Wells, Jamie; McCredie, Bill; Carpenter Stephen; Onelll Leanne
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement
Importance: High

I don't need the Revised Interim Plan to be lodged, but I really need the wording.

The final indemnity documents are ready to go all ticked off by everyone (**attached**) except see the green highlighted part this is the final wording for the Revised Interim Plan. If you could provide it I can just cut and paste.

The Director General is signing at 3pm so we have a very narrow window of time.

Please call me ASAP if any problems.

Please contact me (details below) if you have any questions or if I may be of further assistance.

Regards,

Petra Faas
Principal Lawyer & Team Leader, Commercial Law Team, Legal Services

www.derm.qld.gov.au
Department of Environment and Resource Management
41 George Street, Brisbane Q 4000
GPO Box 2454, Brisbane Q 4001

From: Hinrichsen Lyall
Sent: Thursday, 17 February 2011 1:51 PM
To: Faas Petra
Cc: Poteri Vass; Claydon Greg
Subject: FW: Draft Revised Interim program - for consideration and feedback prior to lodgement

Petra,

Suggest you need to talk to ASAP.

Acting General Manager, Water Allocation and Planning

www.derm.qld.gov.au

Department of Environment and Resource Management
41 George Street, Brisbane Q 4000
GPO Box 2454, Brisbane Q 4001

From:
Sent: Thursday, 17 February 2011 1:46 PM
To: Hinrichsen Lyall
Cc: Claydon Greg; Peter Borrows
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement

Lyall – this was part only of the puzzle and indemnity terms are just being finalised now. When can John Bradley approve the indemnity document as that is pivotal to us getting our approvals lined up to lodge the revised interim program?
Regards

From: Hinrichsen Lyall
Sent: Thursday, 17 February 2011 1:30 PM
To:
Cc: Claydon Greg
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement

When do you expect to send the final RIP?

Lyall Hinrichsen
Acting General Manager, Water Allocation and Planning

www.derm.qld.gov.au

Department of Environment and Resource Management
41 George Street, Brisbane Q 4000
GPO Box 2454, Brisbane Q 4001

From:
Sent: Thursday, 17 February 2011 12:55 PM
To: Hinrichsen Lyall
Cc: Claydon Greg; Allen Peter; Jim Pruss; Mike Foster; Peter Borrows
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement
Importance: High

Lyall – thanks for the below clarification. The draft text for the further cover letter details requested this morning is as follows –
In connection with the above releases –

- a duty engineer will be monitoring rainfall as currently occurs in respect of operational releases;

and

- Seqwater will provide information regarding release volume and timing to –
    - Somerset Regional Council, Ipswich City Council and Brisbane City Council; and
    - the mid Brisbane irrigator community.

  The same information will also be provided to the communication managers of Somerset Regional Council, Ipswich City Council and Brisbane City Council via the Water Grid and will be included on the Water Grid and Seqwater websites as well as the Water Grid information line 1800 613 122. Additionally, the Water Grid will include release information as part of its daily communication updates throughout the duration of the releases.

Please confirm whether you have any additional comments on the draft revised program.

Regards

From: Hinrichsen Lyall
Sent: Thursday, 17 February 2011 12:22 PM
To:
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement

Thanks

The Moreton ROP has been amended to include section (6A), which reads:

Despite anything in subsections 2, 3 or 4, a resource operations licence holder with an approved interim program may submit to the chief executive a revised program for consideration under subsection 7."

Lyall Hinrichsen
Acting General Manager, Water Allocation and Planning

www.derm.qld.gov.au

Department of Environment and Resource Management
41 George Street, Brisbane Q 4000
GPO Box 2454, Brisbane Q 4001

From:
Sent: Thursday, 17 February 2011 12:07 PM
To: Hinrichsen Lyall
Cc: Claydon Greg; Allen Peter; Jim Pruss; Peter Borrows
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement
Importance: High

Lyle – attached is draft Revised Interim program as discussed this morning. We still need your confirmation to complete highlighted wording on first page (ie precise text of the recent amendment). I will let you know later today if there is to be a date change (for February date). Please provide comments back as soon as possible.
I will separately send through the further details as we discussed this morning.

Regards

From: Peter Borrows
Sent: Wednesday, 16 February 2011 3:57 PM
To: Hinrichsen Lyall

Cc: Bradley John; Best Debbie; Claydon Greg; Toni Lake; Jim Pruss; Mike Foster
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement

Hello Lyall.

Changes are –

- Text in front 2 pages
- Revised Program Table - heading for column 2, date at top of table and the Interim Program and Timetable details for the Central Brisbane River Water Supply Scheme and Pine Valleys Water Supply Scheme

Regards, Peter.

Peter Borrows
Chief Executive Officer
Queensland Bulk Water Supply Authority *trading as* Seqwater

cid:image003.png@01CB0654.C3

Level 3, 240 Margaret St, Brisbane City QLD 4000
PO Box 16146, City East QLD 4002
Website | www.seqwater.com.au

cid:image008.png@01CB8736.F84905B0

From: Hinrichsen Lyall
Sent: Wednesday, 16 February 2011 3:37 PM
To: Peter Borrows
Cc: Bradley John; Best Debbie; Claydon Greg; Toni Lake; Jim Pruss; Mike Foster; Poteri Vass; Oneill Leanne
Subject: RE: Draft Revised Interim program - for consideration and feedback prior to lodgement

Thanks Peter,

I note that in the document that you have submitted, the proposed changes have been incorporated into what appears to be the previously approved interim program. Just so I am clear, are the only changes those relating to section 72(3) of the Moreton ROP? While I have not noticed any other changes, I had been advised through our Legal Services team that Seqwater was also intending to submit a number of other "housekeeping" type amendments to the existing plan. If such additional changes have been proposed, it would be useful if these could be highlighted.

Your advice would be appreciated.

Lyall Hinrichsen
Acting General Manager, Water Allocation and Planning

www.derm.qld.gov.au

Department of Environment and Resource Management
41 George Street, Brisbane Q 4000

GPO Box 2454, Brisbane Q 4001

From: Peter Borrows
Sent: Wednesday, 16 February 2011 3:03 PM
To: Hinrichsen Lyall
Cc: Bradley John; Best Debbie; Claydon Greg; Toni Lake; Peter Borrows; Jim Pruss; Mike Foster
Subject: Draft Revised Interim program - for consideration and feedback prior to lodgement

Lyle.

Seqwater notes that the Minister for Natural Resources, Mines and Energy and Minister for Trade announced on 13 February 2011 that, in order to temporarily increase the flood mitigation capacity of Wivenhoe Dam, the water storage level in the dam was to be reduced to and held at 75% of its Full Supply Level (***FSL***) until the end of the wet season on 31 March 2011.

The announcement followed advice from the SEQ Water Grid Manager on 9 February 2011 that the Grid Manager had no objection to Wivenhoe Dam being drawn down to 75% of its FSL from a water security perspective, and that the temporary draw down is unlikely to impact the Grid Manager's ability to comply with its obligations under the *South East Queensland System Operating Plan* or Grid Contracts.

In light of the Grid Manager's advice, the extreme nature of the January 2011 flood event and Seqwater's modelling, Seqwater recommended to DERM that Wivenhoe Dam's storage level be temporarily reduced to 75% of its FSL to temporarily increase its flood mitigation capacity.

We note the Director-General of DERM agreed to implement the above reduction in the water storage level in his letter dated 11 February 2011

Consequently, on 14 February 2011 the Moreton Resource Operations Plan was amended to include a new Section 13(6A) permitting a Resource Operations Licence holder with an approved interim program to submit a revised program to the chief executive for approval.

Seqwater is a Resource Operations Licence holder under the Moreton Resource Operations Plan with an approved interim program, and hereby submits a draft Revised Interim Program for your **consideration and feedback prior to lodgement for chief executive approval** under Section 13(7) of the Moreton Resource Operations Plan. Please note that Seqwater is still seeking approval from its insurers as to the terms of the attached draft revised program prior to lodgement of the program with the chief executive.

The draft Revised Interim Program, if approved, would authorise releases:

- to effect the initial reduction in the level of Wivenhoe Dam to an 'Interim Security Supply Level' being 75% of its FSL, from 14 February 2011 ; and

- thereafter, until 31 March 2011, to bring Wivenhoe Dam back to the Interim Security Supply Level where inflows occur after the initial reduction.

For your information, the above releases would not commence until after program lodgement and approval and after Seqwater has provided notifications to third parties (including Councils) and the other actions referred to in the 11 February 2011 letter from your Department's Director General to Seqwater have been finalised.

Regards, Peter.

Peter Borrows
Chief Executive Officer
Queensland Bulk Water Supply Authority *trading as* Seqwater

cid:image003.png@01CB0654.C3

Level 3, 240 Margaret St, Brisbane City QLD 4000
PO Box 16146, City East QLD 4002
Website | www.seqwater.com.au

cid:image008.png@01CB8736.F84905B0

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Allen Peter

From: Allen Peter
Sent: Friday, 18 February 2011 4:40 PM
To:
Cc:
Subject: RE: Releases 2011_02_18
Attachments: RE: Releases

Thank you for this advice.

I note that what you have listed below is a bit different to what I understood you indicated on 16th February (as in the attached email) in which you indicated that you would 'Have a Duty Engineer monitoring during the week any rainfall and predictions'. I know that it is being undertaken as part of the ROP and that, as such, I have no formal involvement until a)d event is declared. However, I understood these aspects were to be covered off in the accompanying letter for the .ariation to the ROP which I have not seen as yet.

I would still consider it prudent for Seqwater to have someone with the expertise of a Duty Engineer reviewing potential discharges from the Lockyer and adjusting Wivenhoe releases accordingly. The last thing we want is for Burton's to be closed when it was not needed to be closed. Will the Duty Engineers be assuming any responsibility for discharges?

We look forward to receiving your request for a pre-approval for a variation to the flood manual.

Peter Allen
Project Director Dam Safety
Office of the Water Supply Regulator

www.derm.qld.gov.au

From:
Sent: Friday, 18 February 2011 3:20 PM
To: Allen Peter
Cc: F
Subject: Releases

Peter,
As per our phone conversation I thought I would clear up what is happening over releases and to ensure the Duty Engineers are aware of what is being released over the next week or so.

It is not being conducted through the FOC but under approvals through the ROP and as an operational release. That given, if there is a rainfall event that requires the Flood Centre to be mobilised, the FOC would mobilise and take control as usual when decided by the Duty Engineers or levels reach trigger levels as per the manual. Also as discussed there is an option to get pre-approval to continue the release rate we are doing rather than drop back as the manual may dictate. We will consider this next week and run past the Duty Engineers before considering further discussions with you.

We intend to initiate releases about 6am Sunday morning 20th February 2011 ramping up to about 3.5m metres and 330cumecs and check Burtons later that day, increasing releases up to 380 or 400cumecs if Burtons can handle it and still leave a buffer in case of rain.

We will close of Monday/Tuesday next week and will consider how we slow close off.

Councils have been informed.

Allen Peter

From:
Sent: Thursday, 10 February 2011 9:15 AM
To:
Cc: Allen Peter
Subject: FYI - Releases 2011_02_10

The Lockyer flow has starting dropping so we will reinstate the Wivenhoe minor release this morning (about 35cumecs, Council is aware) and also a slow release of Somerset into Wivenhoe.

Allen Peter

From:
Sent: Tuesday, 1 March 2011 4:17 PM
To:
Cc: Allen Peter
Subject: RE: Technical Report W75
Attachments: Technical_Situation_Report_W75.docx

Attached is Technical Report W75 advising of closing strategy.

TECHNICAL SITUATION REPORT

TSR Number	W75	Date of TSR release	1.3.11	Time of TSR release	4.00pm

Seqwater status of inflows and dam operations

Current status but could change based on inflows or rainfall.

Current objectives	• Reduce level in Wivenhoe dam to 75%
Strategy	• Initiate low level releases at around 350 to 400cumecs. • This will inundate Twin Bridges, Savages and Colleges Crossings. • Maintain access to Burtons bridge • **Extend releases until the afternoon of Wednesday 2nd March 2011**
Key considerations	Storage levels:
	Inflows:
	Rainfall:
	Lockyer/Bremer:
	Brisbane River:

Wivenhoe Dam

- Seqwater will now be start closing the gate at Wivenhoe early Wednesday morning 2 March 2011 finishing around 3pm Wednesday afternoon for fish recovery.
- This will get Wivenhoe down to between 75% and 77%.
- Releases then will be made through a minor gate opening releasing around 30cumecs to release down to 75% and also to release any water from Somerset Dam that may be required.
- This should get all crossings out of water by late Thursday.

Impacts

- Somerset Regional Council, Ipswich Regional Council and Brisbane City Council have been consulted and had raised no issues with the extended release strategy.
- Local Councils are responsible for road closures as a result of spilling dams or controlled releases.

Seqwater Technical Officer name	
Seqwater Technical Officer position title	Dam Operations Manager
[redacted]	

BoM assessment

(consisting of references to latest Flood Warning for the BrisbaneRiver and other relevant Bureau forecasts and warnings (e.g. weather/rain forecasts, Tropical Cyclone Warning etc) and other updates/comments if needed)

BoM were advised.

BoM Technical Officer name	
BoM Technical Officer position title	
BoM Technical Officer contact details	[redacted]

Brisbane City Council(BCC) assessment

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy

BCC Technical Officer name	
BCC Technical Officer position title	Disaster Operations Manager
BCC Technical Officer contact details	

Ipswich City Council (ICC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

ICC Technical Officer name	
ICC Technical Officer position title	Local Disaster Response Coordinator
ICC Technical Officer contact details	

Somerset Regional Council (SRC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

SRC Technical Officer name	
SRC Technical Officer position title	Local Disaster Response Coordinator
SRC Technical Officer contact details	

Collated and distributed by (Agency)

Contact Officer signature	
Contact Officer name	
Contact Officer position title	Dam Operations Manager

Next TSR due	Date		Time		or Event	Change

Allen Peter

From:
Sent: Monday, 7 March 2011 3:36 PM
To:
Cc: Allen Peter;

Subject: RE: Technical Report W77

Forgot to mention although it is in the report, that it was discussed with Somerset and Ipswich and both preferred this option.
Impact re BCC is negligible but they have been advised.

From:
Sent: Monday, 7 March 2011 3:32 PM
To:
Cc:

Subject: RE: Technical Report W77

Attached is Technical Report W77 to confirm increased releases to reduce Wivenhoe level.

Releases will be increased (as the Lockyer drops) from 35cumecs up to 100cumecs. This depends to some extent on the capacity of Savages which may have changed after the floods.

It could take up to 2 weeks to reduce Wivenhoe and Somerset however this depends on the ongoing base flows and any further rain or inflows.

Release this afternoon is now about 60cumecs and Savages will be monitored.

TECHNICAL SITUATION REPORT

TSR Number	W77	Date of TSR release	7.3.11	Time of TSR release	11.00am

Seqwater status of inflows and dam operations

Current status but could change based on inflows or rainfall.

Current objectives	• Reduce level in Wivenhoe dam back to 75%
Strategy	• Recent rain has increased Wivenhoe by 4 to 5% with inflows continuing for some time. • Rain has also increased Somerset levels. • Options were a release of up to 400cumecs for 3 or 4 days (with opening and closing sequences) taking out Twin Bridges, Savages and Colleges or a slow release over 2 weeks or so but only affecting Twin Bridges. • Councils preferred the latter and it seems reasonable considering no significant rain is forecast for a week or more. • Increase release from 35cumecs to 100cumecs as the Lockyer flows drop and dependent on the capacity of Savages after the floods. • This should return Wivenhoe to 75% in a couple of weeks if 100 cumecs can be maintained. • Strategy depends on how much continues to flow into Wivenhoe, any further rain in the catchments and any further flows in the Lockyer
Key considerations	Storage levels:
	Inflows:
	Rainfall:
	Lockyer/Bremer:
	Brisbane River:

Wivenhoe and Somerset Dams

- Increase release from Wivenhoe to around 100cumecs as the Lockyer decreases from recent rains, starting increased releases today.
- Start slow release from Somerset in next day or so to drop levels.
- This will only affect Twin Bridges which has minimal impact on Councils.
- Continue for up to around 2 weeks depending on inflows, rain and downstream flows..

Seqwater Technical Officer name	
Seqwater Technical Officer position title	Dam Operations Manager
[redacted]	

BoM assessment

(consisting of references to latest Flood Warning for the BrisbaneRiver and other relevant Bureau forecasts and warnings (e.g. weather/rain forecasts, Tropical Cyclone Warning etc) and other updates/comments if needed)

BoM were advised.

BoM Technical Officer name	
BoM Technical Officer position title	
BoM Technical Officer contact details	[redacted]

Brisbane City Council(BCC) assessment

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy

BCC Technical Officer name	
BCC Technical Officer position title	Disaster Operations Manager
BCC Technical Officer contact details	

Ipswich City Council (ICC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

ICC Technical Officer name	
ICC Technical Officer position title	Local Disaster Response Coordinator
ICC Technical Officer contact details	

Somerset Regional Council (SRC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

SRC Technical Officer name	

SRC Technical Officer position title	Local Disaster Response Coordinator
SRC Technical Officer contact details	

Collated and distributed by (Agency)

Contact Officer signature	
Contact Officer name	
Contact Officer position title	Dam Operations Manager

Next TSR due	Date		Time		or Event	

Allen Peter

From:
Sent: Tuesday, 8 March 2011 8:49 AM
To: Allen Peter;
Cc:
Subject: FW: Technical Report W77
Attachments: Technical_Situation_Report_W77.docx

Peter

Lyall's email below confirms that under the interim program, SEQWater can release at any rate they like provided Wivenhoe Dam is above 75% AND Burton's Bridge remains trafficable.
This would only be up till 31/3/11 of course.

Regards,

From: Hinrichsen Lyall
Sent: Monday, 7 March 2011 5:47 PM
To:
Subject: Fw: Technical Report W77

Not quite sure what PA is on about, but under the IP, they can release at whatever rate they want - provided that the dam remains above 75 perc and the Burton's Bridge remains traficable.

Outside of that, they can make operational releases to meet downstream water requirements - though I doubt that would be needed at this time.

ards,

Lyall Hinrichsen

From: Allen Peter
Sent: Monday, March 07, 2011 05:23 PM
To:
Cc:
Subject: FW: Technical Report W77

Lyall (or Gary if you are still relieving for Lyall),

The attached TSR for Wivenhoe indicates that Seqwater are discharging operational releases of about 100 m3/sec under the ROP. Bob Reilly has asked the question as to whether the operational arrangements under the ROP allow a discharge of this size or are Seqwater restricted to releasing a discharge that would just keep Burton's Bridge open. Are you able to advise?

Peter Allen
Director Dam Safety (Water Supply)
Office of the Water Supply Regulator

Telephone **Mobile** **Facsimile**
Email
www.derm.qld.gov.au

From:
Sent: Monday, 7 March 2011 3:32 PM
To:
Cc: Allen Peter; [redacted]
Subject: RE: Technical Report W77

Attached is Technical Report W77 to confirm increased releases to reduce Wivenhoe level.

Releases will be increased (as the Lockyer drops) from 35cumecs up to 100cumecs. This depends to some extent on the capacity of Savages which may have changed after the floods.

It could take up to 2 weeks to reduce Wivenhoe and Somerset however this depends on the ongoing base flows and any further rain or inflows.

Release this afternoon is now about 60cumecs and Savages will be monitored.

Allen Peter

From:
Sent: Thursday, 24 March 2011 8:20 AM
To:
Cc: Allen Peter;
Subject: RE: Technical Report W78
Attachments: Technical_Situation_Report_W78.docx

Attached is Technical Report W78 just to confirm continuing releases as previous few weeks of round 90-100cumecs to reduce Wivenhoe to 75%.

Rob

TECHNICAL SITUATION REPORT

TSR Number	W78	Date of TSR release	24.3.11	Time of TSR release	8am

Seqwater status of inflows and dam operations

Current status but could change based on inflows or rainfall.

Current objectives	• Reduce level in Wivenhoe dam back to 75% using same strategy as 2 weeks ago
Strategy	• Releases had reduced Somerset to almost 100% and Wivenhoe close to 75% when rain occurred last weekend. • Wivenhoe has gone back up to almost 79 and Somerset to 103%. • Release from Wivenhoe at around 100cumecs as the Lockyer flows drop • This should return Wivenhoe to 75% within 1 to 2 weeks depending on inflows into both dams and further rain. • Will inundate Twin Bridges
Key considerations	Storage levels:
	Inflows:
	Rainfall:
	Lockyer/Bremer:
	Brisbane River:

Wivenhoe and Somerset Dams

- Rainfall of 30 to 60mm occurred over various areas of the catchments over last weekend.
- Releases from Wivenhoe were slowed over the weekend due to flows in the Lockyer, they are now being increased through this week (up from 10 to 70cumecs over last couple days) and will be back to 90 to 100cumecs in a day or so as the Lockyer continues to drop.
- Continue release from Somerset of around 35cumecs until levels approach 100%.
- This will only affect Twin Bridges which has minimal impact on Councils.
- Continue for up to around 2 weeks depending on inflows, rain and downstream flows.
- Discussed with Somerset Council and no real issues.

Seqwater Technical Officer name	
Seqwater Technical Officer position title	Dam Operations Manager
[redacted]	

BoM assessment

(consisting of references to latest Flood Warning for the BrisbaneRiver and other relevant Bureau forecasts and warnings (e.g. weather/rain forecasts, Tropical Cyclone Warning etc) and other updates/comments if needed)

BoM were advised.

BoM Technical Officer name	
BoM Technical Officer position title	
BoM Technical Officer contact details	[redacted]

Brisbane City Council(BCC) assessment

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy

BCC Technical Officer name	
BCC Technical Officer position title	Disaster Operations Manager
BCC Technical Officer contact details	(

Ipswich City Council (ICC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

ICC Technical Officer name	
ICC Technical Officer position title	Local Disaster Response Coordinator
ICC Technical Officer contact details	

Somerset Regional Council (SRC) assessment (if required)

(to include predicted local inundation areas and depths of inundation based on the information)

Council has been advised of the current strategy.

SRC Technical Officer name	
SRC Technical Officer position title	Local Disaster Response Coordinator
SRC Technical Officer contact details	

Collated and distributed by (Agency)

Contact Officer signature	
Contact Officer name	
Contact Officer position title	Dam Operations Manager

Next TSR due	Date		Time		or Event	

CTS No.	Issue	Response
19566/10	Status of Somerset/Wivenhoe Dam Floodwater release (communication) protocol	Written by my GM. I was aware of it's contents and participated in the protocol's development.
22106/10	Request for brief on the progress of the MOU between the State, SEQ Water and councils re: responding to floods and flood releases from Wivenhoe/ DERM writing to all referable dam operators to assess currency of Emergency Action Plans.	Cleared brief when it left Dam Safety unit.
02731/11	Letter to Director General regarding the impact of reducing the full supply level of Wivenhoe Dam on flood damages	Re-directed to ROP area in Water Entities Oversight group of DERM
02809/11	Review of 2007 Report on 'Provision of Contingency Storage in Wivenhoe and Somerset Dam'	Sent to me for information. Discussed operating options for flood releases for a 'raised Wivenhoe Dam'.
03378/11	Seqwater request for an extension to the submission dates for the reports required under the Wivenhoe/Somerset and North Pine Flood Mitigation Manuals.	Discussed issue with GM, Office of Water Supply Regulator and person relieving in my substantive position.
03450/11	Somerset and Wivenhoe January 2011 Flood report	Acceptance letter sent to Seqwater.
03789/11	Jones – PPQ Update on seqwater report on the operation of Somerset Dam and Wivenhoe Dam during the January 2011 Flood Event	PPQ produced
04051/11	Letter to Director General regarding Queensland Floods Commission of Inquiry requesting confirmation that the matters under consideration with respect to the Wivenhoe and Somerset Dams water release strategies be considered with respect to North Pine	Reviewed an early version of brief.
04110/11	Letter to Honourable Justice Catherine Holmes re: North Pine Dam	I reviewed an early version of the letter
04331/11	Seqwater report on the operation of North Pine Dam during the January 2011 Flood Event	Author
04652/11	Update to PPQ (CTS 03789/11)	PPQ updated
04781/11	Minister Jones PPQ Update on Seqwater report on the operation of North Pine Dam during the January 2011 Flood Event	Author

Wivenhoe Headwater Gauge

The headwater level of Wivenhoe Dam is measured is three ways during a flood event:

1. Gauge boards which located at the back of left hand training wall in an area of still water.
2. A float well and shaft encoder (ALERT Id 6637) located about 35 metres upstream of the gates on the left hand side of the approach to the gates.
3. A wet pressure transmitter (ALERT Id 6638) located in the area behind the trash racks on the left hand side of the approach to the gates.

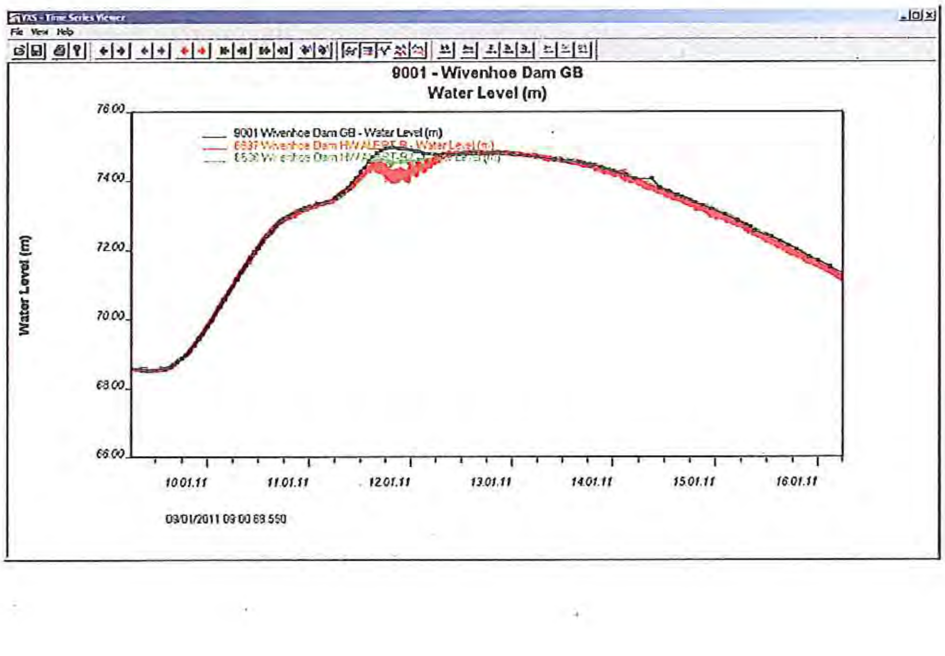
Outside of floods, gauge boards, a short drive from the dam office, are used. These are not used during floods as this would require the operators to leave the site. Normally, gauge board readings were sent in by email at the commencement of each day. During flood events, readings are emailed and faxed at regular hourly intervals. At the peak of the Jan 2001 flood, half hourly readings were phoned directly into the FOC.

ALERT Ids 6637 and 6638 are event based radio telemetry stations which report every event (i.e. incremental change in water level) via radio directly to the FOC, BoM and some Councils.

ALERT gauge 6638 was published on the BoM web site which is updated with the latest information every 15 minutes.

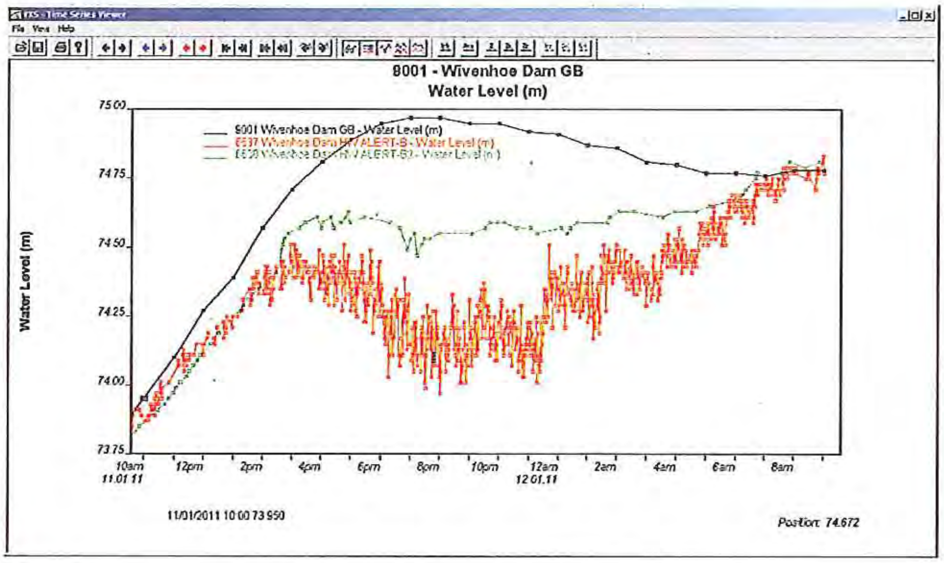
Traditionally, float well and shaft encoders are preferred over pressure transmitters as they have proven to be more reliable than wet pressure transmitters, especially in situations where a wide range levels is monitored.

A comparison of the three water level sensors for the period 10th to 16th January 2011 is shown below.



The figure above clearly shows that there is a significant difference between the gauge board readings and the ALERT gauges during the period around the peak.

The Seqwater Senior Hydrographer advised the FOC of the discrepancy between the gauge board readings and the automatic gauges early in the afternoon of 11th January 2011. Up to this time, there was little difference between the readings. An email was issued to BoM and BCC advising of the discrepancy at 2.26pm 11th January 2011.



The figure above shows the differences between the automatic readings and the gauge board readings for the 11th January 2011.

ALERT gauge 6638, shown in red, is very close to the gauge board readings. However, as the outflows increased during the afternoon of the 11th January, the gauge commenced to oscillate over a range of 200mm in very short time. It under reads the gauge boards by a much as 1 metre around the peak of the outflow.

ALERT gauge 6637, shown in green, is more stable but still under reads the gauge board readings by as much as 0.5 metres around the peak of the outflow.

This picture above was taken at 5.42pm 10th January 2011. At this time, the automatic headwater gauge (ALERT Id 6637) was reading 72.91m and the staff gauge reading was72.92m AHD. Note the laminar nature of the flow around the stilling well and the lack of turbulence. At the time, the outflow was the dam was 2,400m^3/s.

The above picture was taken at 6.41pm 11th January 2011 about the time of the maximum height and release. At this time, the automatic headwater gauge (6637) was oscillating between 74.27 and 74.51m AHD and the staff gauge reading was 74.94m AHD. Release from the dam was about 6,770m3/s. Note the turbulent nature of the flow around the stilling well and the accompanying drawdown on the downstream side of the well. Also note the staff gauge reading (approximately 74.9m AHD) taken about this time.

Given the uncertainty associated with the ALERT gauges during the event, the operation of Wivenhoe Dam during the January 2011 flood was based upon the more reliable gauge board readings.

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SEQ WATER
OPERATIONAL PROCEDURES FOR FLOOD MITIGATION
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Wivenhoe, Somerset & North Pine Dams
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File No.: DAM/130/000(0377)04
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Registered Y/N Doc. Code: 2004/02655
MOVEMENT INSTRUCTIONS MUST BE SHOWN ON FRONT COVER.

FOR REPORT SEE BOX
DAM/600/079(0377)
DS00377

26 October 2004

Mr Peter Allen
Director, Dam Safety (Water Supply)
Water Industry Compliance
Department of Natural Resources, Mines and Energy
GPO Box 2454
BRISBANE QLD 4001

Dear Sir,

AMENDED MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION - WIVENHOE AND SOMERSET DAM

Attached is a copy of the Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam, Revision 5.

This amended manual is submitted for your approval.

Yours sincerely,

[redacted]

PETER BORROWS
Chief Executive Officer

SUPERSEDED

Attach.

South East Queensland Water Corporation Limited | Head Office: Level 3, 240 Margaret Street Brisbane, Queensland 4000 | [redacted] | www.seqwater.com.au

Wivenhoe Dam 'Lake Wivenhoe'
Brisbane Valley Highway
via Fernvale Queensland 4306
Phone: [redacted]
Fax:

Somerset Dam 'Lake Somerset'
Somerset Dam Township
Queensland 4312
Phone: [redacted]
Fax:

North Pine Dam 'Lake Samsonvale'
Forgan Road, Joyner
Queensland 4500
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Fax:

All Correspondence to:
Chief Executive Officer
PO BOX 236 Albert Street
Brisbane Queensland 4002

ABN 11 063 729 765

South East Queensland
WATER CORPORATION
LIMITED

MANUAL

OF

OPERATIONAL PROCEDURES

FOR FLOOD MITIGATION

FOR

WIVENHOE DAM

AND SOMERSET DAM

Revision No.	Date	Amendment Details
0	27 October 1968	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	24 August 1998	Change to page 23
4	6 September 2002	Complete revision and re-issue
5	4 October 2004	Complete revision and re-issue

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Preface

Given their size and location, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise hazard to life and property.

Recognising this, the South East Queensland Water Board Act required a manual be prepared of operational procedures for the dams during floods. With changes to the controlling legislation, the manual became an approved flood mitigation manual under *Water Act 2000* (extract in Appendix A).

This Manual is the result of a review of the 2002 revision of the Manual. The South East Queensland Water Corporation is required to review, update the Manual if necessary, and submit it to the Chief Executive for approval prior to its expiry. Any amendments to the basic operating procedures need to be treated similarly.

Prior to the 1998 version of the manual, an expanded flood monitoring and warning radio telemetry network (ALERT) was installed in the Brisbane River Catchment. Additionally, a computerised flood operational model that allows for rainfall and river modelling in real time based on data from the ALERT system was developed, implemented and fully commissioned. The accuracy and reliability of the system during a flood event has now been proven.

The primary objectives have not varied from those defined in the previous manual. These remain ensuring safety of the dams, their ability to deal with extreme and closely spaced floods, and protection of urban areas. The basic operational procedures have also essentially remained the same. Wivenhoe Dam and Somerset Dam are operated in conjunction so as to maximise the overall flood mitigation capabilities of the two dams. The procedures outlined in this Manual are based on the operation of the dams in tandem.

The changes to the 2002 version of the manual have arisen out of the spillway upgrade process for Wivenhoe Dam with the addition of the three bay right abutment fuse plug spillway. The changes enable Wivenhoe Dam to pass a 1:100,000 AEP flood event. The manual covers the provisions introduced to cover flood operations of the dams during the construction period for the spillway upgrade and for flood operations after theses provisions become operational.

1.2 Meaning of Terms

In this Manual, save where a contrary definition appears -

"Act"
means the *Water Act 2000*;

"AEP"
means annual exceedance probability, the probability of a specified event being exceeded in any year.

"Agency"
includes a person, a local government and a department of state government within the meaning of the Acts Interpretation Act 1954;

"AHD"
means Australian Height Datum;

"Bureau of Meteorology"
means the Commonwealth Bureau of Meteorology;

"Chairperson"
means the Chairperson of the South East Queensland Water Corporation;

"Chief Executive"
means the Chief Executive or Director General of the Department of Natural Resources, Mines & Energy;

"Controlled Document"
means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Corporation"
means the South East Queensland Water Corporation;

"Dams"
means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

"Dam Supervisor"
means the senior on-site officer at Wivenhoe or Somerset Dam as the case may be;

"EL"
means elevation in metres from Australian Height Datum;

"Flood Operations Engineer"
means the person designated at the time to direct the operations of Wivenhoe Dam and Somerset Dam under the general direction of the Senior Flood Operations Engineer and in accordance with the procedures in this Manual;

"FSL" or "FULL SUPPLY LEVEL"
means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"Gauge"
when referred to in (m) means river level referenced to AHD, and
when referred to in (m^3/sec) means flow rate in cubic metres per second;

"Headworks Operator"
for the purposes of this manual the Headworks Operator is the South-East Queensland Water Corporation:

"Manual" or "Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam"
means the current version of this Manual;

"Power Station"
means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"Senior Flood Operations Engineer"
means the senior person designated at the time pursuant to Section 2.1 of this Manual under whose general direction the procedures in this Manual must be carried out;

"South East Queensland Water Corporation"
means the body corporate constituted by that name pursuant to Part III of the South East Queensland Water Board Act 1979. The Board became a government owned corporation in 2000;

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce, so far as practicable, the effects of flooding, by the proper control and regulation in time of headworks under the control of the Corporation, with due regard to the safety of the structures comprising those headworks.

For the purpose of this Manual, the Corporation adopts the policy that the community is to be protected to the maximum extent practical against flood hazards recognising the limitations on being able to:

- identify all potential flood hazards and their likelihood,
- remove or reduce community vulnerability to flood hazards,
- effectively respond to flooding, and
- provide resources in a cost effective manner.

1.4 Legal Authority

This manual has been prepared as a Flood Mitigation Manual in accordance with the provisions of Part 6 Division 2 of the Act.

1.5 Application and Effect

The procedures in this Manual apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall give the protection from liability provided by Section 500 of *Water Act 2000.*

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which this version of the Manual is approved by gazette notice.

The Manual shall remain in force for the period of approval as determined by the chief executive. This approval may be for a period of up to five years.

Before the approval of the Manual expires, the Corporation must review and if necessary update the Manual and submit a copy to the chief executive for approval.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation, and must be applied by the Headworks Operator for the operation of the dams.

1.8 Provision for Variations to Manual

If the Corporation is of the opinion that the procedures in this Manual should be amended, altered or varied, it must submit for approval as soon as practical a request, which is in accordance with the flood mitigation provisions of the *Water Act 2000*, to the Chief Executive setting out the circumstances and the exact nature of the amendment, alteration or variation sought. The Chief Executive may require the Corporation amend the Manual by written notice.

1.9 Distribution of Manual

The Corporation must regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of Controlled Documents are listed in Appendix B. The Corporation must maintain a Register of Contact Persons for Controlled Documents and ensure that each issued document is updated whenever amendments or changes are approved.

Before using this Manual for the direction of flood control, the Headworks Operator must ensure that it is the current version of the Controlled Document.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, the Corporation is responsible for and has the duty for operation and maintenance of Wivenhoe Dam and Somerset Dam, and while it may enter into contracts for the purpose of discharging these responsibilities, for the purposes of this manual the Headworks Operator is the Corporation.

2.1.1 Designation of Senior Flood Operations Engineer

The Headworks Operator must ensure that the procedures set out in this Manual are carried out under the general direction of a suitably qualified and experienced person who shall be referred to hereafter as the Senior Flood Operations Engineer. Only a person authorised in the Schedule of Authorities can give the general direction for carrying out procedures set out in this Manual.

2.1.2 Designation of Flood Operations Engineer

The Headworks Operator must have available or on standby at all times a suitably qualified and experienced Flood Operations Engineer to direct the operation of the dams during floods in accordance with the general strategy determined by the Senior Flood Operations Engineer.

The Headworks Operator must ensure that flood control of the dams is under the direction of a Flood Operations Engineer at all times. Only a person authorised in the Schedule of Authorities can direct the flood operation of the dams.

The Headworks Operator must also employ an adequate number of suitably qualified and experienced persons to assist the Flood Operations Engineer in the operation of the dams during floods.

2.2 Qualifications and Experience of Engineers

2.2.1 Qualifications

All engineers referred to in Section 2.1 must meet all applicable requirements of registration or certification under any relevant State Act, and must hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

2.2.2 Experience

All engineers referred to in Section 2.1 must, to the satisfaction of the Chief Executive, have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

(a) Investigation, design or construction of major dams;

(b) Operation and maintenance of major dams;

(c) Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;

(d) Applied hydrology with particular reference to flood forecasting and flood warning systems.

2.3 Schedule of Authorities

The Corporation must maintain a Schedule of Authorities containing a list of the Senior Flood Operations Engineers and Flood Operations Engineers approved to direct flood operations at the dams during floods. A copy of the Schedule of Authority must be provided to the chief executive by 1st September of each year.

The Headworks Operator shall, as the need arises, nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as Senior Flood Operations Engineers and Flood Operations Engineers. Each new nomination must include a copy of any certificate required under Section 2.2 and a validated statement of qualifications and experience.

The Headworks Operator must obtain the approval for all nominations from the Chief Executive prior to their inclusion in the Schedule of Authorities.

If, in the event of unforseen and emergency situations, no Senior Flood Operations Engineer or no Flood Operations Engineer is available from the Schedule of Authorities, the Headworks Operator must temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.4 Training

The Headworks Operator must ensure that operational personnel required for flood control operations receive adequate training in the various activities involved in flood control operation.

2.5 Dam Operation Arrangements

For the purposes of operation of the dams during times of flood, the Headworks Operator must ensure that:

(a) the operation be carried out under the general direction of the Senior Flood Operations Engineer, and

(b) in the direction of operations which may knowingly endanger life or property, the Senior Flood Operations Engineer must where practical liaise with the Chairperson of the Corporation and the Chief Executive or nominated delegate.

2.6 Responsibilities of the Senior Flood Operations Engineer

The Senior Flood Operations Engineer is responsible for the overall direction of flood operations.

Except insofar as reasonable discretion is provided for in Section 2.8 of this Manual, the Senior Flood Operations Engineer must ensure that the operational procedures for the dam shall be in accordance with this Manual.

2.7 Responsibilities of the Flood Operations Engineer

The Flood Operations Engineer must apply the operational procedures in accordance with this manual and the direction set for flood operations. In so doing, account must be taken of prevailing weather conditions, the probability of follow up storms and the ability of the dam to discharge excess flood waters in the period between rainfall events or in the period from the time of detection of conditions associated with the development storm cells to the likely time of occurrence of the rainfall.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, based on available information and professional experience, it is necessary to depart from the procedures set out in this manual, the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary to meet the situation, provided that the Senior Flood Operations Engineer observes the flood mitigation objectives set out in Section 3 of this Manual when exercising such reasonable discretion.

Before exercising discretion under this Section of the Manual with respect to flood mitigation operations, the Senior Flood Operations Engineer must consult with such of the following persons as are available at the time that the discretion has to be exercised:

the Chairperson of the Corporation, and
the Chief Executive or nominated delegate.

If not able to contact any of the above within a reasonable time, the Senior Flood Operations Engineer may proceed with such other procedures considered as necessary to meet the situation and report such action at the earliest opportunity to the above persons.

2.9 Report

The Senior Flood Operations Engineer must prepare a report to the Headworks Operator after each event that requires flood operation of the dams and the report must contain details of the procedures used, the reasons therefore and other pertinent information. The Headworks Operator must forward the report to the Chief Executive together with any comments within six weeks of the completion of the event referred to.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operational procedures in this Manual, the following objectives, listed in descending order of importance, are as follows:

(a) Ensure the structural safety of the dams;

(b) Provide optimum protection of urbanised areas from inundation;

(c) Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

(d) Minimise disruption and impact upon Wivenhoe Power Station;

(e) Minimise disruption to navigation in the Brisbane River.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

3.2.1 Wivenhoe Dam

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences.

Wivenhoe Dam is predominantly a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered a major threat to the security of Wivenhoe Dam. Works are being undertaken between May 2004 and December 2005 to build an auxiliary spillway to cope with the 1:100,000 AEP flood event without overtopping of the dam.

3.2.2 Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences.

Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves.

3.2.3 Extreme Floods and Closely Spaced Large Floods

Techniques for estimating extreme floods indicate that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam itself. Such events however require several days of intense rainfall to produce the necessary runoff.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other. In order to be prepared to meet such a situation, the stored floodwaters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles. Typically the Senior Flood Operations Engineer should aim to empty stored floodwaters within seven days after the flood peak has passed through the lower reaches of the Brisbane River. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The discharges should be regulated so as to have little impact on the urban reaches of the Brisbane River taking into account inflows into the river downstream of the dams. However they may result in submergence of some bridges. The level of flooding as a result of emptying stored floodwaters after the peak has passed is to be less than the flood peak unless accelerated release is necessary to reduce the risk of overtopping.

3.3 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas on the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by using the flood-gates to control releases from the dams, taking into account flooding derived from the lower Brisbane River catchments.

The auxiliary spillway being constructed at Wivenhoe Dam in 2004 and 2005 incorporates fuse plugs. Triggering of a fuse plug will increase floods levels downstream. Where possible, gate operations at both Wivenhoe and Somerset dams should be formulated to prevent operation of the fuse plug. This is likely to be only possible when the forecast peak water level for Wivenhoe Dam just exceeds the trigger level for the fuse plug and sufficient time is available to alter releases.

3.4 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, bridges and areas upstream of the dams may be temporarily inundated. Downstream of the dam, bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily. The deck levels of bridges potentially inundated during flood events are shown on the Drawings in Appendix D.

3.5 Provision of Pumping Pool for Power Station

The power station is not affected by the reservoir level in Wivenhoe Dam during floods other than the impacts high tail water levels have on the efficiency of the power station. The power station does however require a pumping pool for operation. The loss of storage by dam failure would render the power station inoperative.

3.6 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lower priority. The effect of flood flows upon navigation in the river varies widely.

Large ships can be manoeuvred in the river at considerable flood flows. On the other hand, barges and dredges are affected by low flows which lower salinity thus decreasing the density of the water which in turn causes craft to sit lower in the water, sometimes bottoming. The Moggill Ferry is also affected by low flood flows.

A short emptying period for the flood storage compartment of the dams is consistent with Objectives (c) and (e) of Section 3.1, which are closely related.

4 FLOOD CLASSIFICATION

For the reference purposes of this Manual, five magnitudes of flooding are classified as follows:

Fresh
This causes only very low-level bridges to be submerged.

Minor Flooding
This causes inconvenience such as closing minor roads and the submergence of low-level bridges. Some urban properties are affected.

Moderate Flooding
This causes inundation of low-lying areas and may require the evacuation of some houses and/or business premises. Traffic bridges may be closed.

Major Flooding
This causes flooding of appreciable urban areas. Properties may become isolated. Major disruption occurs to traffic. Evacuation of many houses and business premises may be required.

Extreme Flooding
This causes flooding well in excess of floods in living memory and general evacuation of whole areas are likely to be required.

Usually a flood does not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted.

(The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia)

5 FLOOD MONITORING AND WARNING SYSTEM

5.1 General

A real time flood monitoring and warning system is established in the Brisbane Valley. This system is based upon an event reporting protocol. A radio telemetry system (ALERT) is used to collect, transmit and receive rainfall and streamflow information. The system consists of more than 50 field stations that automatically record rainfall and/or river heights at selected locations in the Stanley and Brisbane River catchments. Some of the field stations are owned by the Corporation with the remainder belonging to other agencies.

The rainfall and river height data is transmitted by radio telemetry, via repeater stations, to base stations at the head office of the Headworks Operator (and the Corporation). There the data is processed in real time by computer programs to assess what is occurring in the catchments in terms of flood flows and what could occur if weather conditions continued, or changed.

Other agencies with their own base stations can, and do, receive data transmissions direct, and so collect and are able to process rainfall and streamflow information appropriate to their needs.

The real time flood model (RTFM) is a suite of hydrologic and hydraulic computer programs that utilise the real time ALERT data to assist in the operation of the dams during flood events.

5.2 Operation

The Headworks Operator is responsible for operating the computer model provided by the Corporation for flood monitoring and forecasting during flood events to optimise flood gate operations and minimise the impacts of flooding.

It is the responsibility of the Corporation to maintain and keep calibrated its own equipment; and to enter into such arrangements with other agencies or to provide such further equipment as the Corporation deems necessary for the Headworks Operator to properly operate the computer model for flood monitoring and forecasting.

A system such as this is expected to improve over time due to:

- improved operation and reliability with experience,
- improved calibration as further data becomes available,
- software upgrades, and
- the number, type and locations of sensors being varied.

A regular process of internal audit and management review must be maintained to achieve this.

A log of the performance of all field equipment necessary to properly operate the computer model must be kept by the Corporation. The log is to also include all revised field calibrations and changes to the number, type and locations of gauges. Entries onto the log are to be notified to the Headworks Operator without delay in writing.

A log of the performance of the system (ALERT and RTFM) must be kept by the Senior Flood Operations Engineer. Any faults to the computer hardware or software, and any faults to field equipment which the Corporation has not advised the Headworks Operator of, are to be notified to the Corporation without delay in writing. The Corporation must promptly attend to the matters under its control and refer other matters to the appropriate agencies.

Whenever the Senior Flood Operations Engineer considers that the performance and functionality of the system can be improved, by whatever means, a recommendation must be made to the Headworks Operator accordingly. The Headworks Operator must promptly consider, act on, or refer such recommendations to the Corporation as it considers appropriate.

5.3 Storage of Documentation

The performance of any flood monitoring and warning system is reliant on accurate historical data over a long period of time. The Senior Flood Operations Engineer must ensure that all available data and other documentation is appropriately collected and catalogued as approved by the Corporation, for future use.

5.4 Key Reference Gauges

Key field station locations have been identified for reference purposes when flood information is exchanged between authorities or given to the public. Should it be deemed desirable to relocate field stations from these locations, or vary flood classification levels, agreement must first be obtained between the Corporation, Headworks Operator, Bureau of Meteorology and the Local Governments within whose boundaries the locations are situated. The locations and gauge readings at which the various classifications of flooding occur are contained in Appendix D.

Gauge boards that can be read manually must be maintained as part of the equipment of each key field station. The Corporation must have procedures to ensure such gauge boards are read in the event of failure of field stations to operate.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, Ipswich City Council and the Brisbane City Council have direct access to the information from field stations for flood assessment purposes. The consultation between agencies is a very important part of the assessment and prediction of flood flows and heights.

The Corporation must ensure that information relative to the calibration of the Corporation's field stations is shared with such agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

The Corporation is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams.

The Headworks Operator is responsible for ensuring that adequate communication exists at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams. Where equipment deficiencies are detected during normal operations, such deficiencies are to be reported within one week to the Corporation for timely corrective action.

6.2 Dissemination of Information

Other agencies have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public. Adequate and timely information is to be supplied to agencies responsible for the operation of facilities affected by flooding and for providing warnings and information to the public. Agency information requirements are generally as shown in Table 6.1.

The Flood Operations Engineer must supply information to each of these agencies during dam releases. For this purpose, the Corporation must maintain a Register of Contact Persons for Information, their means of contact including back up systems, and the specific information, including the timing, to be supplied to each. The Corporation must ensure that each agency receives a copy of the updated Register of Contact Persons for Information whenever amendments are made, but at least every 6 months.

The Corporation, Headworks Operator, Senior Flood Operations Engineer and Flood Operations Engineer must liaise and consult with the agencies with a view to ensuring all information relative to the flood event is consistent, and used and disseminated in accordance with agreed responsibilities.

All enquiries other than provided for in the Register of Contact Persons for Information, either to the Headworks Operator, the Senior Flood Operations Engineer, the Flood Operations Engineer or dam site staff must be referred to the Corporation. The Corporation must provide a mechanism to receive these enquiries from the time it is advised that releases from the dams are likely until flood release operations are completed.

TABLE 6.1 - AGENCY INFORMATION REQUIREMENTS

Agency	Activity	Information Requirement from SEQWC Flood Centre	Trigger
Bureau of Meteorology	Issue of flood warnings for Brisbane River basin	Actual and projected discharges from Wivenhoe Dam Actual and projected discharges from Somerset Dam	Initial gate operations and thereafter at intervals to suit forecasting requirements.
Natural Resources Mines & Energy	Review of flood operations and discretionary powers.	Actual and predicted lake levels and discharges	
Kilcoy Shire Council	Flood level information upstream of Somerset Dam	Actual and predicted lake levels, Somerset Dam	Somerset Dam water level predicted to exceed EL 102
Esk Shire Council	Flood Level information upstream and downstream of Wivenhoe Dam	Actual and predicted lake levels and discharges, Wivenhoe Dam	Initial Wivenhoe Dam gate operation.
Ipswich City Council	Flood level information for Ipswich City area	Nil (information obtained from BoM)	
Brisbane City Council	Flood level information for Brisbane City area	Nil (information obtained from BoM)	

6.3 Release of Information to the Public

The Corporation is responsible for the issue of information regarding storage conditions and current and proposed releases from the dams to the public and the media.

The Bureau of Meteorology has responsibility for issuing flood warnings.

The Emergency Services Response Authorities, under the Disaster Management Act 2003, have responsibility for the preparation of a local counter disaster plan hence the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

This review of the Manual has addressed the mechanisms of delegation and control of the dams in periods of operation of the dams for flood mitigation. It is known overtopping of the dams can result should floods occur which are derived from lesser rainfall than the probable maximum precipitation storm or from the combination of two lesser storms in close proximity. The dams may also overtop in the eventuality that the flood-gate control systems or fuse plugs fail to operate as planned or partially malfunction during the passage of a major flood or combination of floods.

Procedures and systems have been developed that should enable lower risk operation of the dams for flood mitigation purposes. This technology is intended to provide longer warning times and the capability of examining options to optimise the safety of the dams and minimise the hazard potential and risk to the community.

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances.

It is important, therefore, that the Manual contain operational procedures which in themselves cause the Manual's procedures, and the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

The checking and reviewing process must involve the Headworks Operator and all associated operations personnel in order that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based.

Variations to the Manual may be made in accordance with provisions in Section 1.8.

7.2 Personnel Training

The Headworks Operator must report to the Corporation by 30th September each year on the training and state of preparedness of operations personnel. A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources, Mines & Energy within 14 days of it being received by the Corporation.

7.3 Monitoring and Warning System and Communication Networks

The Headworks Operator must provide a report to the Corporation by the 1st May and 1st November of each year; and after each flood event. The report must assess in terms of hardware, software and personnel, the :

- adequacy of the communication and data gathering facilities,

- reliability of the system over the previous period,
- reliability of the system under prolonged flood conditions,
- accuracy of forecasting flood flows and heights, and
- the overall state of preparedness of the system.

The Corporation must review the report, and taking into account its own log of the performance of the field equipment, take any action considered necessary for the proper functioning and improvement of the system. . A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources, Mines & Energy within 14 days of it being received by the Corporation.

7.4 Operational Review

After each significant flood event, the Corporation must review the effectiveness of the operational procedures contained in this manual. The Headworks Operator is required to prepare a report for submission to the Corporation within six weeks of any flood event that requires mobilisation of the Flood Control Centre. A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources, Mines & Energy within 14 days of it being received by the Corporation.

7.5 Five Yearly Review

Prior to the expiry of the approval period, the Corporation must review the Manual pursuant to Section 6 Division 2 of the Act. The review is to take into account the continued suitability of the communication network, and the flood monitoring and warning system as well as hydrological and hydraulic engineering assessments of the operational procedures. The hydrologic investigations performed for the purpose of this manual are discussed in Appendix I.

8 WIVENHOE DAM OPERATIONAL PROCEDURES

8.1 Introduction

Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the dam, depending on the part of the catchment in which the flood originates and depending also on the magnitude of the flood. Maximum overall flood mitigation effect will be achieved by operating Wivenhoe Dam in conjunction with Somerset Dam.

A general plan and cross-section of Wivenhoe Dam, and relevant elevations are included in Appendix J. Storage and discharge data are included in Appendix E.

The reservoir volume above FSL of EL 67.0 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the initial reservoir level below FSL, the magnitude of the flood being regulated and the procedures adopted. Spiltyard Creek Dam is part of the overall Wivenhoe Area Project and it forms the upper pumped storage of the peak power generation scheme. Splityard Creek Dam impounds a volume of 28 700 ML at its normal full supply level (EL 166.5). The contents of Splityard Creek Dam can be emptied into Lake Wivenhoe within 12 hours by releasing water through the power station conduits. This volume of water can affect the level in Wivenhoe Dam by up to 300mm when Wivenhoe Dam is close to FSL. Operation of the power station and therefore also release of water from Splityard Creek Dam to Lake Wivenhoe is outside the control of the Corporation. The operational level of Splityard Creek Dam should be considered when assessing the various trigger levels of Wivenhoe Dam.

The Corporation has acquired land above FSL to a level of EL 75.0 to provide temporary flood storage. Reasonable care must be exercised to confine the flood rises to below this level. This requirement should be ignored in the case of extreme floods that threaten the safety of the dams.

8.2 Auxiliary Spillway

The auxiliary spillway for Wivenhoe Dam being constructed in 2004/05 as part of an upgrade to improve flood adequacy consists of a three bay fuse plug spillway at the right abutment. In association with other works being carried out at the dam, this will give the dam crest flood an annual exceedance probability (AEP) of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam two in the future.

Pertinent information about the auxiliary spillway, including the initiation level for the specific bays is given in Table 8.1.

TABLE 8.1 -RIGHT BANK FUSE PLUG DETAILS

Auxiliary Spillway Component	Spillway Crest Control Type	Spillway Crest Width (m)	Spillway Crest Level (m AHD)	Lake Level at Fuse Plug Initiation (m AHD)
Central fuse plug bay	Ogee	34	67	75.7
Right hand side fuse plug bay	Ogee	64.5	67	76.25
Left hand side fuse plug bay	Ogee	65.5	67	77.2

8.3 Initial Flood Control Action

When indications are received of an imminent flood, the flood control operation of the dam must commence with the storing of all inflow of the Brisbane River in Wivenhoe Dam, whilst an assessment is made of the origin and magnitude of the flood. The spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25.

8.4 Regulator and Gate Operation Sequences

Rapid opening of outlets (spillway gates and regulators) can cause hydraulic surges and other effects in the Brisbane River that can endanger life and property and may sometimes have other adverse effects. Under normal gate operations, the gates and regulators are therefore to be operated one at a time at intervals that will minimise adverse impacts on the river system.

Rapid closure of the gates can affect river-bank stability. Rapid closure of more than one gate at a time should only be used when time is critical and there is a requirement to correct a malfunction to preserve storage or to reduce downstream flooding rapidly. For flood operations where time is not critical, longer closure intervals should be used. The minimum closure intervals specified below are based on the recession limb of natural flood hydrographs such as the January 1974 flood.

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a gate by the immediate opening of a regulator valve (or the reverse operation). This allows for greater control of low flows and enables a smooth transition and closure as slow as possible to prevent the stranding of fish downstream of Wivenhoe Dam.

Except as provided for in procedure 4 of Section 8.4 where it is necessary to prevent operation of a fuse plug or to have the gates clear of the spillway flow prior to the fuse plug operating and as indicated above, the gate opening and closing intervals as shown in Table 8.2 are the most rapid permitted for flood mitigation purposes.

TABLE 8.2 - MINIMUM INTERVALS FOR NORMAL GATE OPERATIONS

500 mm Incremental gate openings	10 minutes
500 mm Incremental gate closures	20 minutes
Full regulator opening or closures	30 minutes

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

Under normal operation, only one gate is to be opened at any one time and the sequences given in Table 8.3 are to be adopted:

TABLE 8.3 – RADIAL GATE OPENING SEQUENCES[1]

Approximate Discharge Range	Gate opening sequence[2]	Comments
(a) Up to 330 m^3/sec	Open Gate 3 up to 3.5 metres	Gates 1, 2, 4 & 5 remain closed
(b) 330 m^3/sec to 575 m^3/sec	Gate 3 at 3.5 metres Open Gates 2 & 4 alternately to 0.5 metre Open Gate 3 to 4.0 metre Open Gates 2 & 4 alternately to 1.0 metre	Gates 1 & 5 remain closed unless discharge from Gates 2 & 4 impinges on side wall of plunge pool proceed to (c)
(c) 575 m^3/sec to 1160 m^3/sec	Gate 3 kept at 4.0 metres Open Gates 1 & 5 alternately one increment followed by Gates 2 & 4 alternately one increment Repeat Step until at the end of the sequence Gates 1 & 5 are open 1.5 metres and Gates 2 & 4 are open 2.5 metres	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not more than 1.0 metre more than Gates 1 & 5
(d) 1160 m^3/sec to 1385 m^3/sec	Open Gate 3 to 4.0 metres Open Gates 1 & 5 alternately to 2.0 metres followed by opening Gates 2 & 4 alternately to 3.0 metres	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not more than 1.0 metre more than Gates 1 & 5
(e) 1385 m^3/sec to 2290 m^3/sec	Open ALL gates to 5.0 metre openings	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not less than Gates 1 & 5 or not more than 1.0 metre more than Gates 1 & 5 Gate 3 is to have an opening not less than Gates 2 & 4 or not more than 1.0 metre more than Gates 2 & 4.
(f) Greater than 2290 m^3/sec	Open ALL gates incrementally in the sequence 3, 2, 4, 1, 5[3]	Flow in spillway to be as symmetrical as possible Gate 3 to have the largest opening Gates 2 & 4 are to have openings greater than Gates 1 & 5

1 Gates are numbered 1 to 5 from the left bank looking downstream.
2 Gate movements are to normally occur in 500 mm increments.
3 When the accelerated opening rate applies, gate opening increments of 1.0 metres may be used.

Gate operating procedures in the event of equipment failure are contained in Appendix G. If one or more gates are inoperable during the course of the flood event, the gate openings of the remaining gates are to be adjusted to compensate. These adjustments should ensure that:

a) the impact of the flow on the sidewalls of the plunge pool should be minimised, and
b) the flow in the spillway is as symmetrical as practicable.

In general, gate closing is to occur in the reverse order. The final gate closure should occur when the lake level has returned to Full Supply Level.

8.5 Flood Control Procedures

When the preliminary estimation of the degree of expected flooding has been made, the operating procedures set out hereunder shall be used at Wivenhoe Dam in line with the Flood Mitigation Objectives.

When considering the discharge to be made from both Wivenhoe Dam under particular procedures, the total discharge for each dam from all sources is to be considered when determining the appropriate openings for gates, valves and sluices.

The flood control procedures to be adopted commence with Procedure 1 and extend through to Procedure 4 as the magnitude of the flood as predicted by the real time flood model increases. Table 8.5 summarises the application for each procedure for the initial filling of Wivenhoe Dam. Once Wivenhoe Dam has peaked and the drainage phase has commenced the indicative limits will not apply.

Procedure 1

Under Procedure 1, water is to be released from Wivenhoe Dam with care being taken not to prematurely submerge the downstream bridges. The limiting condition for Procedure 1 is the submergence of Mt Crosby Weir Bridge that occurs at approximately 1,900 m^3/sec.

The procedure adopted primarily depends on the level in Wivenhoe Dam and the discharge emanating from Lockyer Creek.

For situations where flood rains are occurring on the catchment upstream of Wivenhoe Dam and only minor rainfall is occurring downstream of the dam, releases are to be regulated to limit, as much as appropriate in the circumstances, downstream flooding. Except in the drainage phase releases are not to exceed the values given in Table 8.4:-

TABLE 8.4 – WIVENHOE DAM, PROCEDURE 1 MAXIMUM RELEASE RATES

Lake Level in Wivenhoe Dam	Maximum Release Rate (m^3/sec)
67.00 - 67.25	0
67.25 - 67.50	110
67.50 - 67.75	380
67.75 - 68.00	500
68.00 - 68.25	900
68.25 - 68.50	1900

The following subsets of Procedure 1 were originally developed by the Brisbane City Council to cater for limiting the submergence of the various low-level downstream bridges. The procedures require a great deal of control over releases and knowledge of discharges from Lockyer Creek.

In general, the releases from Wivenhoe Dam are controlled such that the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values to delay the submergence of particular bridges.

Procedure 1A — *Savages Crossing & Colleges Crossing*

For: Lake level between 67.25 and 67.5 m AHD [Maximum Release 110 m^3/sec]

Endeavour to maintain Twin Bridges trafficable by limiting releases at Wivenhoe Dam to a maximum of 50 m^3/sec and by reducing this rate of release if run-off from Lockyer Creek is likely to cause the bridges to be overtopped. The bridges become untrafficable at a flow of about 55 m^3/sec.

Once Twin Bridges are overtopped by run-off from Lockyer Creek, release to be directed towards maintaining College's Crossing trafficable by adjusting the rate of release so that the combined flow rate at College's Crossing is less than 175 m^3/sec.

Procedure 1B — *Noogoorah Bridge (Burtons Bridge)*

For: Lake level between 67.50 and 67.75 m AHD [Maximum Release 380 m^3/sec].

Initially endeavour to maintain College's Crossing trafficable. This becomes untrafficable at a flow of about 175 m^3/sec. No consideration to be given to keeping Twin Bridges trafficable.

Once College's Crossing is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to achieve a combined flow of about 380 m^3/sec at the Noogoorah Bridge Crossing. This bridge becomes untrafficable at a flow of about 430 m^3/sec.

Procedure 1C — *Kholo Bridge*

For: Lake level between 67.75 and 68.00 m AHD [Maximum Release 500 m^3/sec]

Initially endeavour to maintain Noogoorah Bridge trafficable. No consideration to be given to keeping College's Crossing trafficable.

Once Noogoorah Bridge is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to keep Kholo Bridge trafficable. This bridge becomes untrafficable at a flow rate of about 550 m^3/sec.

Procedure 1D — *Mt Crosby Weir Bridge*

For: Lake level between 68.00 and 68.25 m AHD [Maximum Release 900 m^3/sec]

Initially endeavour to maintain Kholo Bridge trafficable. No consideration to be given to keeping Noogoorah Bridge trafficable.

Once Kholo Bridge is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to keep Mt Crosby Bridge trafficable. This bridge becomes untrafficable at a flow of 1,900 m^3/sec.

Procedure 1E — *Mt Crosby Weir Bridge*

For: Lake level between 68.25 and 68.50 m AHD [Maximum Release 1,900 m^3/sec]

Similar to Procedure 1D, but with an upper release limit of 1,900 m^3/sec.

If the level reaches EL 68.5 m AHD in Wivenhoe Dam, operations switch to Procedure 2 or 3 as appropriate.

Procedure 2 may be bypassed if it is clear from the flood modelling that Procedure 3 will be activated.

Procedure 2

Under Procedure 2, water is to be released from Wivenhoe Dam with care being taken not to submerge Fernvale Bridge and Mt Crosby Weir Bridge prematurely. Typically releases will take place on the rising limb of the flow from Lockyer Creek. If this flow is sufficient to submerge Mt Crosby Weir bridge (1,900 m^3/sec), releases are to be increased such that the combined flow from Lockyer Creek and Wivenhoe Dam releases does not exceed either:-

(i) 3,500 m^3/sec at Lowood or
(ii) the greater of the peak flow of Lockyer Creek or the predicted peak flood flow of the Bremer River.

Should the Mt Crosby Weir Bridge be flooded by flows from catchments downstream of Wivenhoe Dam, the upper limit of the combined Lockyer Creek flow and releases from Wivenhoe Dam shall, subject to (i) and (ii) above, not exceed 3,500 m^3/sec at Lowood.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 3

Under Procedure 3, water is to be released from Wivenhoe Dam such that the combined Lockyer Creek flood flow and Wivenhoe Dam release is not to exceed 3,500 m^3/sec at Lowood. The releases are to be regulated such that the total regulated flow at Moggill gauge downstream of the Bremer River junction does not exceed 4,000 m^3/sec [which is the upper limit for non-damaging flows for the urban reaches of the Brisbane River].

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4

This procedure normally comes into effect when the water level in Wivenhoe Dam reaches EL 74. However the Senior Flood Operations Engineer may seek to invoke the discretionary powers of section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.

Under Procedure 4 the release rate is increased as the safety of the dam becomes the priority. Opening of the gates is to occur until the storage level of Wivenhoe Dam begins to fall.

If required, the minimum time interval between gate openings can be reduced or successive gate openings of the same gate may be used in this procedure as considered appropriate. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals

Sub-procedures 4A, 4B and 4C have been developed for use depending on the stage of construction of the auxiliary spillway and the expected peak water level in the dam.

Procedures 4A and 4B are only to be applied once the auxiliary spillway fuse plug is functional. This is expected to be in the latter part of 2005. In the interim, Procedure 4C is applicable.

Procedure 4A

Procedure 4A applies while all indications of the peak flood level in Wivenhoe Dam are it will be insufficient to trigger operation of the first bay of the fuse plug by reaching EL 75.5.

Gate openings are to occur at the minimum intervals and sequences as specified in section 8.3. Opening of the gates is to continue until the storage level of Wivenhoe Dam begins to fall.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4B

Procedure 4B applies once indications are the peak flood level in Wivenhoe Dam will exceed EL75.5 using the minimum gate opening intervals for normal operation as specified in section 8.3 i.e. it is expected that the fuse plug will be triggered under normal operation.

In this procedure the minimum time interval between gate openings is able to be reduced and successive gate openings of the same gate may be made.

If the real time flood model using a 1 metre in 10 minute gate opening procedure, predicts a peak water level in Wivenhoe Dam of less than EL 75.5, the gates may be raised at a rate to maximise flood storage capacity but to prevent the first fuse plug from initiating.

Otherwise the gates are to be raised at a rate to ensure they are out of the water before the initiation of the first fuse plug (if possible). Where practicable, the gates are to be in the fully open position before the dam water level reaches 75.7 m AHD.

In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

The effect of varying the operational procedures at Somerset Dam in keeping the peak flood level at Wivenhoe Dam below EL 75.7 may also be investigated using the real time flood model.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4C

Procedure 4C applies only during the construction phase of the right bank auxiliary spillway.

Opening of the gates is to occur until the storage level of Wivenhoe Dam begins to fall. The minimum time interval between gate openings can be reduced or successive gate openings of the same gate may be used in this procedure as considered appropriate for ensuring the safety of the dam. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

TABLE 8.5 WIVENHOE DAM – NORMAL RELEASE OPERATING PROCEDURES: INITIAL FILLING

Procedure	Reservoir Level	Applicable Limits		
0	EL < 67.25	$Q_{Wivenhoe} = 0\ m^3/sec$ ... i.e No Releases		
1A	67.25 < EL < 67.50	$Q_{Wivenhoe} < 110\ m^3/sec$	$Q_{Colleges\ Crossing} < 175\ m^3/sec$ with care taken not to submerge Twin Bridges prematurely	
1B	67.25 < EL < 67.50	$Q_{Wivenhoe} < 380\ m^3/sec$	$Q_{Burtons/Noogoorah} < 430\ m^3/sec$ with care taken not to submerge Colleges Crossing prematurely	
1C	67.75 < EL < 68.00	$Q_{Wivenhoe} < 500\ m^3/sec$	$Q_{Kholo} < 550\ m^3/sec$ with care taken not to submerge Burtons/Noogoorah prematurely	
1D	68.00 < EL < 68.25	$Q_{Wivenhoe} < 900\ m^3/sec$	$Q_{MtCrosby} < 1900 m^3/sec$ with care taken not to submerge Kholo prematurely	
1E	68.25 < EL < 68.50	$Q_{Wivenhoe} < 1500\ m^3/sec$	$Q_{MtCrosby} < 1900 m^3/sec$ with care taken not to submerge Kholo prematurely	
2	68.50 < EL < 74.00	$Q_{Lowood} < 3500\ m^3/sec$	Q_{Lowood} < peak of Lockyer and Q_{Lowood} < peak of Bremer	Gates are NOT to be overtopped
3	68.50 < EL < 74.00	$Q_{Lowood} < 3500\ m^3/sec$	$Q_{Moggill} < 4000\ m^3/sec$	
4	EL > 74.00[4]	Gates are to be opened until reservoir level begins to fall		

4 Once water level exceeds EL 74.0, operating procedures are dependant on the predicted peak water level.

8.6 Closing Procedures

If at the time the lake level in Wivenhoe Dam begins to fall, the combined flow at Lowood is in excess of 3500 m^3/sec, then the combined flow at Lowood is to be reduced to 3500 m^3/sec as quickly as practicable having regard to Section 3, and is to remain at this rate until final gate closure procedures can commence.

Gate closing procedures should be initiated having regard to the following requirements:

a) Early release of stored water to regain flood-mitigating ability for any subsequent flood inflows as described in Section 3.2.3.

b) The total discharge from Wivenhoe Dam from all sources is to be considered when considering appropriate closing procedures. This includes any discharge from triggered fuse plugs.

c) Gate operation procedures as described in Section 8.4.

d) Establishment of storage at FSL at completion of flood events.

e) Downstream impact of the discharges. To prevent the stranding of fish downstream of the dam, closures below flows of 275 m^3/sec should be undertaken as slow as practicable and if possible such closures should occur during daylight hours on a weekday so that personnel are available for fish rescue.

If the flood storage compartments of Wivenhoe Dam and Somerset Dam can be emptied within the prescribed time of seven days, the release from Wivenhoe Dam should be limited to between 1900 m^3/sec and 3500 m^3/sec. In such circumstances, the release from the dam should be less than the peak flow into the lake. Where possible, total releases during closure should not produce greater flood levels downstream than occurred during the flood event.

8.7 Modification to Flood Operating Procedures if a Fuse Plug triggers prematurely

Where the operation of a fuse plug spillway bay has been triggered prior to its design initiation level being reached, the flood operation procedures are to be modified such that:

- the discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;
- the gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.8 Modification to Flood Operating Procedures if a subsequent flood event occurs prior to the reconstruction of Triggered Fuse Plugs

Where the operation of any or all of the fuse plug spillway bays has been triggered and a flood event occurs before the fuse plug can be reinstated, the flood operation procedures are to be modified such that:

- the discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;

- the gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.9 Additional Provisions during Construction Works 2004/05

8.9.1 Auxiliary Spillway Area

The embankment forming the temporary road diversion that acts as a coffer dam is to be retained in place until the construction of the fuse plug has proceeded past EL 74, and then its removal is only to proceed once the written approval of a Senior Flood Operations Engineer has been obtained.

8.9.2 Gated Spillway Area

The following provisions will apply for works undertaken within the gated spillway:

- The opening of spillway gates to discharge floodwaters is at the sole discretion of the Senior Flood Operations Engineer;
- There is to be no obstruction of any spillway bay without the written approval of the Senior Flood Operations Engineer;
- All gates are to be capable of being operated at short notice during a flood if required. To ensure this capability is maintained Table 8.6 specifies limitations that apply to the number of bays in which works may be occurring at any time. This table also nominates a target notice period to be provided by the Senior Flood Operations Engineer for the removal of construction material from the spillway bays prior to their use for releases. However the Senior Flood Operations Engineer is not constrained to provide this length of notice before operating any particular gate if its earlier operation is considered necessary.

Table 8.6 – Gated Spillway Area Works Restrictions

Dam Level	Season	Maximum number of bays that may be occupied at any time	Comments
Below EL 64.0	Winter (May to September)	3	12 hours notice to clear spillway
Below EL 64.0	Summer (October to April)	2	12 hours notice to clear spillway
Above EL 64.0	Winter (May to September)	2	12 hours notice to clear spillway
Above EL 64.0	Summer (October to April)	2	12 hours notice to clear spillway
Above EL 66.0	Flood Season (January to April)	1	Preferably not gate 1 or 5, 6 hours notice to clear spillway

- A maximum of one gate may be treated as inoperable and remain closed if a flood will severely damage works if it is opened, and the expected flood magnitude can be catered for with 4 gates. The other gates are to be operated in accordance with the existing flood operational procedures but to compensate for the loss of flow in the closed gate. As the flood rises to the top of the closed gate at an EL 73 m AHD, the gate is incrementally raised to prevent it from being overtopped. It is noted that a large flood is required for the lake level to reach EL 73 m AHD.

The Corporation must prepare a Standing Operating Procedure for the conduct of works in the gated spillway whereby the above provisions are met such the capacity to achieve the dam's operational objectives is maintained.

9 SOMERSET DAM OPERATIONAL PROCEDURES

9.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods. Somerset Dam and Wivenhoe Dam are meant to be operated in conjunction to optimise the flood mitigation capacity downstream of Wivenhoe Dam.

A general plan and cross-section of Somerset Dam, and relevant dam operating levels are included in Appendix J.

The discharge capacities for various storage levels of Somerset Dam are listed in Appendix F.

9.2 Initial Flood Control Action

Upon indications being received of a significant inflow, the flood control operation of the dam shall commence with the raising of any closed gates and the closure of all low level regulators and sluices, whilst an assessment is made of the origin and magnitude of the flood.

9.3 Regulator and Gate Operation Procedures

The following minimum intervals must be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes:

TABLE 9.1- MINIMUM INTERVALS, NORMAL OPERATION, SOMERSET DAM

	OPENING	CLOSING
Regulators	30 minutes	60 minutes
Sluice Gates	120 minutes	180 minutes
Crest Gates	Gates are normally open	

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a sluice gate by the immediate opening of one or more regulator valves (or the reverse operation). This allows for greater control of low flows and enables a smooth transition on opening and closing sequences.

9.4 Flood Control Procedure

It is essential that the operating procedures adopted should not endanger the safety of Wivenhoe Dam downstream. Within this constraint, the Senior Flood Operations Engineer must adopt a procedure for the operation of Somerset Dam such that:

a) the structural safety of Somerset Dam is not endangered;

b) the Upper Brisbane River flood flow plus Somerset Dam releases does not cause Wivenhoe Dam to be overtopped.

The normal operating procedure to be used for Somerset Dam is as follows.

The crest gates are raised to enable uncontrolled discharge. The low level regulators and sluices are to be kept closed until either:

(i) the lake level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

In the case of (i) above the opening of the regulators and sluices is not to increase the inflow to Wivenhoe Dam above the peak inflow from the Brisbane River just passed or, if possible, not to cause the Wivenhoe Dam lake level to exceed EL 74.

In the case of (ii) above, the Senior Flood Operations Engineer must direct the operation of the low-level regulators and sluices to ensure the safety of Somerset Dam. If the water level and predicted inflows are such that the safety of Somerset Dam is not an overriding concern, operations are to target a correlation of water levels in Somerset Dam and Wivenhoe Dam as set out in Table 9.2 such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and EL 107.46, the non-spillway crest level in Somerset Dam.

TABLE 9.2 – Water Level Correlation Targets

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

If the flood event emanates from the Stanley River catchment only, without significant runoff in the Upper Brisbane River catchment, the operation of Somerset Dam will proceed on the basis that Wivenhoe Dam has peaked as per (i) above.

The Somerset Dam gates and valves may also be temporarily closed if such action is able to prevent a fuse plug from initiating. Such closure is not to threaten the safety of the dam

10 EMERGENCY FLOOD OPERATIONS

10.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition either through flood events or other causes. Experience elsewhere in the world suggests that vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than the discharge capacity of the dam;
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood.
- Development of a piping failure through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;
- Other uncommon mechanisms.

Responses to these and other conditions are included in separate Emergency Action Plans.

10.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates. The probability of overtopping of Wivenhoe Dam will be significantly reduced following the completion of the auxiliary spillway.

Somerset Dam should, if possible, not be overtopped by flood water but, if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced, for example by the use of its spillway gates, even at the risk of overtopping Somerset Dam in order to prevent, if possible, the overtopping of Wivenhoe Dam.

10.3 Communications Failure

In the event of normal communications being lost between the Flood Operations Engineer and either Wivenhoe Dam or Somerset Dam, the dam supervisor at that dam is to maintain contact with the dam supervisor at the other dam, to receive instructions through the remaining communications link.

In the event of normal communications being lost between the Flood Operations Engineer and both Wivenhoe Dam and Somerset Dam, the dam supervisors at each dam are to adopt the procedures set out below during flood events, and are to maintain contact with each other, where possible.

If all communications are lost between the Engineer, Wivenhoe Dam and Somerset Dam, the officers in charge at each dam are to adopt the procedures set out below.

10.3.1 Wivenhoe Dam Emergency Procedure

In the event of total communication failure, the minimum gate openings related to lake levels up to EL 74 are set out in the Table 10.1 are to be maintained for both opening and closing operations. Once the lake level exceeds EL 74 the gates are to be raised at the rate of 1 metre per 10 minutes till the water level peaks or the gates are fully open.

Table 10.1 Minimum Gate Openings Wivenhoe Dam

Lake Level m AHD	Gate 3 Opening (m)	Gates 2 & 4 Opening (m)	Gates 1 & 5 Opening (m)	Total Discharge m^3/sec
67.0		-	-	0
67.5	0.5	-	-	50
68.0	1.5	-	-	155
68.5	2.5	-	-	260
69.0	3.5	0.5	-	470
69.5	4.0	1.0	-	640
70.0	4.0	1.5	0.5	875
70.5	4.0	2.0	1.0	1115
71.0	4.0	2.5	1.5	1365
71.5	4.5	2.5	2.0	1560
72.0	4.5	3.0	2.5	1820
72.5	5.0	4.0	3.0	2250
73.0	5.0	5.0	5.0	2960
73.5	6.5	6.5	6.5	3850
74.0	8.0	8.0	8.0	4750
>74.0	Gates are to be raised at the rate of 1 metre per 10 minutes till the water level peaks or gates are fully open			
75.7	Gates are to be fully open before the first fuse plug triggers at this level.			

If one or more gates become inoperable, then by reference to Table E-2 the gate openings of operable gates are to be increased in order that the discharges for the lake levels shown in Table 10.1 are achieved.

If, because of compliance with the provisions of Section 8.3 and the high inflow rate, the minimum gate openings cannot be maintained, the time intervals between successive openings shown in Table 8.2 are to be halved.

If the actual gate openings fall more than three settings below the cumulative number of minimum settings of Table 10.1, then successive gate operations are to be carried out as rapidly as possible until the minimum settings are achieved. Under these circumstances, it may be necessary to operate more than one gate at any one time.

10.3.2 Somerset Dam Emergency Procedure

In the event of total communication failure, the spillway gates are to be kept raised to allow uncontrolled discharge. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

The level in Wivenhoe Dam can be determined locally by the Dam Supervisor at Somerset Dam from the tailwater gauge located just downstream of Somerset Dam.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe Dam above the peak level already attained. Section 9.3 on regulator and gate operation interval is to be observed.

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and the non-spillway crest level in Somerset Dam (EL 107.46). Table 10.2 gives the water level correlations. The low level outlets in Somerset Dam are not to be opened if the water level in Wivenhoe Dam exceeds the level set out below for given water levels in Somerset Dam.

TABLE 10.2 – Water Level Correlation Targets

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

10.4 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix G for Wivenhoe Dam and Appendix H for Somerset Dam.

APPENDIX A EXTRACT FROM WATER ACT 2000

Division 2 – Flood Mitigation

Owners of certain dams must prepare flood mitigation manual

496.(1) A regulation may nominate an owner of a dam as an owner who must prepare a manual (a "flood mitigation manual") of operational procedures for flood mitigation for the dam.

(2) The regulation must nominate the time by which the owner must comply with section 497(1).

Approving flood mitigation manual

497.(1) The owner must give the chief executive a copy of the flood mitigation manual for the chief executive's approval.

(2) The chief executive may, by gazette notice, approve the manual.

(3) The approval may be for a period of not more than 5 years.

(4) The chief executive may get advice from an advisory council before approving the manual.

Amending flood mitigation manual

498.(1) The chief executive may require the owner, by notice, to amend the flood mitigation manual.

(2) The owner must comply with the chief executive's request under subsection (1).

(3) The chief executive must, by gazette notice, approve the manual as amended.

(4) The approval of the manual as amended must be for-

(a) the balance of the period of the approval for the manual before amendment; or

(b) a period of not more than 5 years from the day the manual as amended was approved.

(5) The chief executive may get advice from an advisory council before approving the manual as amended.

Regular reviews of flood mitigation manual

499. Before the approval for the flood mitigation manual expires, the owner must-

review, and if necessary, update the manual; and

give a copy of it to the chief executive under section 497.

Protection from liability for complying with flood mitigation manual

500.(1) The chief executive or a member of the council does not incur civil liability for an act done, or omission made, honestly and without negligence under this division.

(2) An owner who observes the operational procedures in a flood mitigation manual approved by the chief executive does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures.

(3) If subsection (1) or (2) prevents civil liability attaching to a person, the liability attaches instead to the State.

(4) In this section-

"owner" includes-

a) a director of the owner or operator of the dam; or

b) an employee of the owner or operator of the dam; or

c) an agent of the owner or operator of the dam

APPENDIX B AGENCIES HOLDING DOCUMENTS

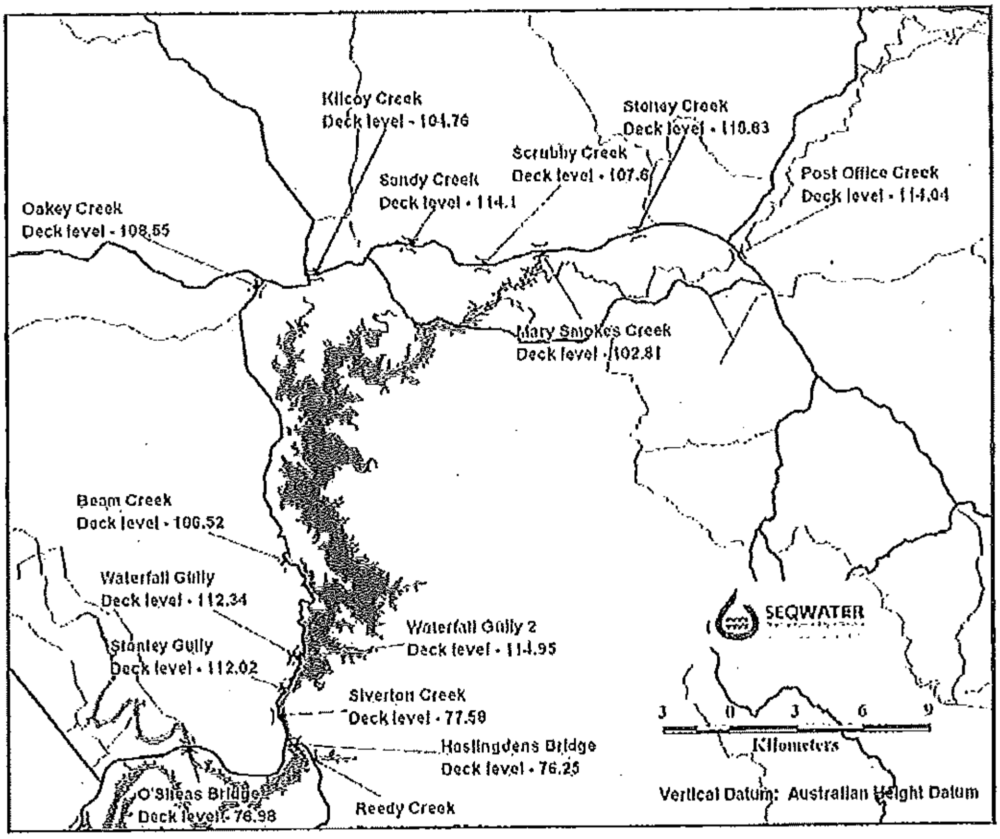
AGENCIES HOLDING CONTROLLED DOCUMENTS OF MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR WIVENHOE DAM AND SOMERSET DAM

Dam Owner	South East Queensland Water Corporation
Emergency Services	Department of Emergency Services, Disaster Management Service Brisbane City Counter Disaster Committee Esk Shire Counter Disaster Committee Ipswich City Counter Disaster Committee Kilcoy Shire Counter Disaster Committee
Severe Weather Warning Authority	Bureau of Meteorology
Primary Response Authorities	Brisbane City Council Esk Shire Council Ipswich City Council Kilcoy Shire Council
Regulator of Dam Safety	Department of Natural Resources, Mines & Energy
Dams Operator	SunWater

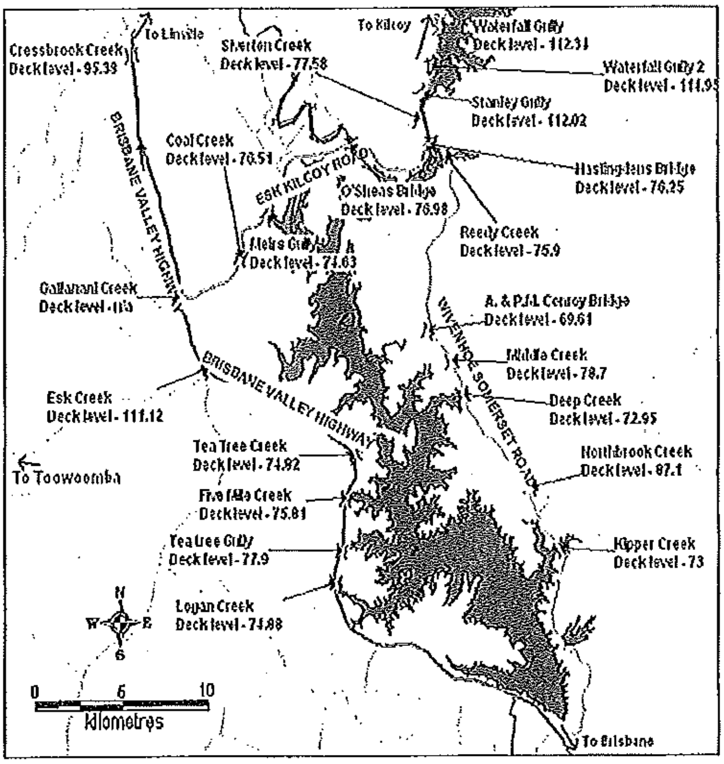
The Corporation must keep a register of contact persons of holders of controlled documents (Section 1.9 refers).

APPENDIX C BRIDGE DECK LEVELS

Roads Upstream of Somerset Dam

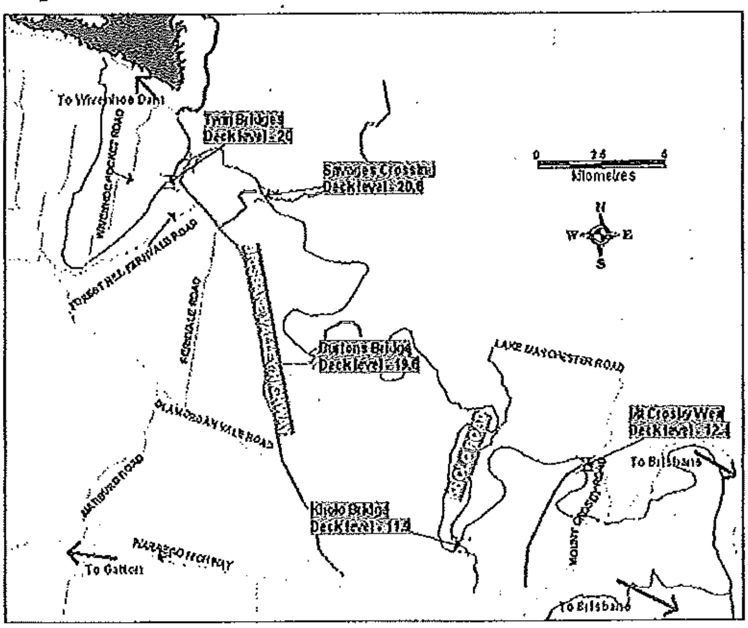


Roads Surrounding Wivenhoe Dam



SEQWATER

Bridges Downstream of Wivenhoe Dam



SEQWATER

APPENDIX D GAUGES AND BRIDGES

Table D.1. KEY REFERENCE GAUGES

Location	GZ	1974 Gauge Height	Minor		Moderate		Major	
			Gauge Height	Flow	Gauge Height	Flow	Gauge Height	Flow
			m	m³/s	m	m³/s	m	m³/s
Stanley R at Somerset Dam*	0.00 AHD	-	103.0		105.0		106.0	
Brisbane R at Lowood	23.68 AHD	22.02	8.0		15.0		20.0	
Brisbane R at Lowood*	22.74 SD	-	8.6	1000	15.9	3300	21.2	6000
Brisbane R at Savages Crossing*	18.43 AHD	23.79	9.0		16.0		21.0	
Brisbane R at Mt Crosby*	0.00 AHD	26.74	11.0		13.0		21.0	
Bremer R at Ipswich*	0.00 AHD	20.70	7.0		9.0		11.7	
Brisbane R at Moggill*	0.00 AHD	19.95	10.0		13.0		15.5	
Brisbane R at Jindalee Br*	0.00 AHD	14.10	6.0	4000	6.0	5000	10.0	8500
Brisbane R at City Gauge*	0.00 AHD	5.45	1.7		2.6		3.5	

* Indicates an automatic gauge
Flows are approximate only and gauge heights are tide dependent in the lower reaches.
A complete list of the latest river heights can be found at http://www.bom.gov.au

Table D.2. SUBMERGENCE FLOWS FOR BRIDGES

AMTD	Bridge Name	Location	Estimated Submergence Flow m^3/sec
140	Twin Bridges	Wivenhoe Pocket Road, Fernvale	50
132	Savage's Crossing	Banks Creek Road, Fernvale	130
87	College's Crossing	Mt Crosby Rd, Karana Downs	175-200*
120	Burton's Bridge	E Summerville Road, Borallon	430
100	Kholo Bridge	Kholo Rd, Ipswich	550
91	Mt.Crosby Weir Bridge	Allawah Rd, Mt Crosby	1900
136	Fernvale Bridge	Brisbane Valley Hwy, Fernvale	2000

* Affected by tides.

APPENDIX E WIVENHOE DAM TECHNICAL DATA

TABLE E1 STORAGE AND UNCONTROLLED GATE DISCHARGES

Lake level m AHD	Storage Capacity 10^6 m^3	*** Flood Capacity 10^6 m^3	** Net Inflow per 1mm rise per hour m^3/sec	* Discharge per Regulator m^3/sec	* Discharge per Spillway Bay m^3/sec	Maximum Available Discharge m^3/sec
57.0	414	-	11.10	24.9	0	50
57.5	453	-	12.04	25.2	4	69
58.0	466	-	12.97	25.4	15	128
58.5	494	-	13.90	25.7	32	211
59.0	523	-	14.84	25.9	53	316
59.5	553	-	15.77	26.2	77	439
60.0	584	-	16.71	26.4	105	579
60.5	616	-	17.64	26.6	136	735
61.0	649	-	18.58	26.9	170	905
61.5	683	-	19.51	27.1	207	1 090
62.0	719	-	20.45	27.3	246	1 290
62.5	756	-	21.38	27.5	288	1 495
63.0	795	-	22.32	27.8	333	1 720
63.5	835	-	23.25	28.0	379	1 950
64.0	877	-	24.19	28.2	428	2 195
64.5	920	-	25.12	28.4	479	2 450
65.0	965	-	26.06	28.7	532	2 720
65.5	1 012	-	26.99	28.9	587	2 995
66.0	1 061	-	27.92	29.1	645	3 280
66.5	1 112	-	28.86	29.3	704	3 580
67.0	1 165	0	29.79	29.5	765	3 885
67.5	1 220	56	30.73	29.7	828	4 200
68.0	1 276	112	31.66	29.9	893	4 525
68.5	1 334	171	32.60	30.1	959	4 860
69.0	1 393	230	33.53	30.3	1 028	5 200
69.5	1 454	290	34.47	30.5	1 098	5 550
70.0	1 517	350	35.40	30.7	1 170	5 910
70.5	1 581	418	36.33	30.9	1 244	6 280
71.0	1 647	485	37.27	31.1	1 319	6 660
71.5	1 714	550	38.20	31.3	1 396	7 040
72.0	1 783	615	39.14	31.5	1 474	7 430
72.5	1 854	683	40.07	31.7	1 554	7 840
73.0	1 926	750	41.01	31.9	1 636	8 240
73.5	2 000	830	41.94	32.1	1 719	8 660
74.0	2 076	910	42.87	32.3	1 804	9 080
74.5	2 153	995	43.81	32.5	1 890	9 520
75.0	2 232	1 080	44.74	32.7	1 978	9 960
75.5	2 313	1 160	45.68	32.9	2 067	10 400
76.0 ****	2 395	1 240	46.61	33.1	2 158	10 860
76.5	2 480	1 258	47.55	33.3	2 250	11 320
77.0	2 566	1 420	48.48	33.4	2 343	11 780
77.5	2 655	1 500	49.41	36.6	2 438	12 260
78.0	2 746	1 580	50.35	33.8	2 535	12 740
78.5	2 839	1 680	51.28	34.0	2 632	13 230
79.0	2 934	1 780	52.22	34.2	2 731	13 730

* This is the maximum discharge of an individual spillway bay or regulator. Total discharge is calculated by adding the contributions of each gate or regulator. There are two (2) regulators to five (5) spillway bays.

** This assumes that all gates and sluices are closed. Discharges through the spillway have to be added to the above figures to calculate the actual inflow into the reservoir.

*** The temporary storage above normal Full Supply Level of EL 67.0.

**** The first fuse plug is designed to trigger at EL75.7. Above this level, fuse plug flows from Table B.3 need to be added to give the full outflow.

TABLE E2 CONTROLLED GATE DISCHARGES

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
67.0	0	49	98	146	194	240	285	329	372	413	453	492	530	567	603	639	675	709	744	765															
67.2	0	49	99	148	196	243	288	333	376	418	458	498	537	574	611	648	684	720	755	790															
67.4	0	50	100	149	198	245	291	336	380	422	464	504	543	582	619	657	693	730	766	802	815														
67.6	0	50	101	151	200	248	294	340	384	427	469	510	550	589	627	665	702	740	777	814	841														
67.8	0	51	102	152	202	250	297	343	388	432	474	515	556	596	635	673	712	750	787	825	863	867													
68.0	0	51	103	154	204	253	300	347	392	436	479	521	562	603	642	682	721	759	798	837	876	893													
68.2	0	52	104	155	206	255	303	350	396	441	484	527	569	610	650	690	729	769	808	848	888	919													
68.4	0	52	105	156	207	257	306	354	400	445	489	532	575	616	657	698	738	778	818	859	899	940	946												
68.6	0	53	105	158	209	260	309	357	404	450	494	539	581	623	665	706	747	788	829	870	911	953	973												
68.8	0	53	106	159	211	262	312	360	408	454	499	543	587	630	672	714	755	797	838	880	923	965	1000												
69.0	0	54	107	160	213	264	315	364	412	458	504	549	593	636	679	722	764	806	848	891	934	977	1022	1028											
69.2	0	54	108	162	215	267	317	367	415	463	509	554	599	643	686	729	772	815	858	901	945	989	1035	1056											
69.4	0	54	109	163	217	269	320	370	419	467	514	560	605	649	693	737	780	824	868	912	956	1001	1047	1084											
69.6	0	55	110	164	218	271	323	373	423	471	518	565	611	656	700	744	789	833	877	922	967	1013	1060	1107	1112										
69.8	0	55	111	166	220	273	326	377	427	475	523	570	616	662	707	752	797	842	887	932	978	1025	1072	1121	1141										
70.0	0	56	112	167	222	276	328	380	430	479	528	575	622	668	714	759	805	850	896	942	989	1036	1085	1134	1170										
70.2	0	56	112	168	224	278	331	383	434	484	532	580	628	674	721	767	813	859	905	952	1000	1048	1097	1147	1198	1199									
70.4	0	56	113	170	225	280	334	386	437	488	537	586	633	680	727	774	821	867	914	962	1010	1059	1109	1160	1212	1229									
70.6	0	57	114	171	227	282	336	389	441	492	542	591	639	687	734	781	828	876	923	972	1020	1070	1121	1173	1226	1258									
70.8	0	57	115	172	229	284	339	392	445	496	546	596	644	693	741	788	836	884	932	981	1031	1081	1133	1185	1239	1289									
71.0	0	58	116	173	230	286	341	395	448	500	551	601	650	699	747	795	844	892	941	991	1041	1092	1144	1198	1252	1309	1319								
71.2	0	58	117	175	232	289	344	398	452	504	555	605	655	705	754	802	851	900	950	1000	1051	1103	1156	1210	1266	1323	1349								
71.4	0	58	117	176	234	291	347	401	455	508	559	610	661	710	760	809	859	908	959	1009	1061	1114	1167	1222	1279	1337	1380								
71.6	0	59	118	177	235	293	349	404	458	512	564	615	666	716	766	816	866	916	967	1019	1071	1124	1179	1234	1292	1350	1410	1411							
71.8	0	59	119	178	237	295	352	407	462	515	568	620	671	722	773	823	874	924	976	1028	1081	1135	1190	1246	1304	1364	1425	1443							
72.0	0	60	120	180	239	297	354	410	465	519	572	625	676	728	779	830	881	932	984	1037	1091	1145	1201	1258	1317	1377	1439	1474							
72.2	0	60	121	181	240	299	357	413	469	523	577	629	682	733	785	837	888	940	993	1046	1100	1156	1212	1270	1330	1391	1454	1506							
72.4	0	60	121	182	242	301	359	416	472	527	581	634	687	739	791	843	895	948	1001	1055	1110	1166	1223	1282	1342	1404	1468	1533	1538						
72.6	0	61	122	183	243	303	361	419	475	531	585	639	692	745	797	850	903	956	1009	1064	1119	1176	1234	1293	1354	1417	1482	1548	1570						
72.8	0	61	123	184	245	305	364	422	478	534	589	643	697	750	803	856	910	963	1018	1073	1129	1186	1245	1305	1367	1430	1496	1563	1603						

UNCONTROLLED DISCHARGE

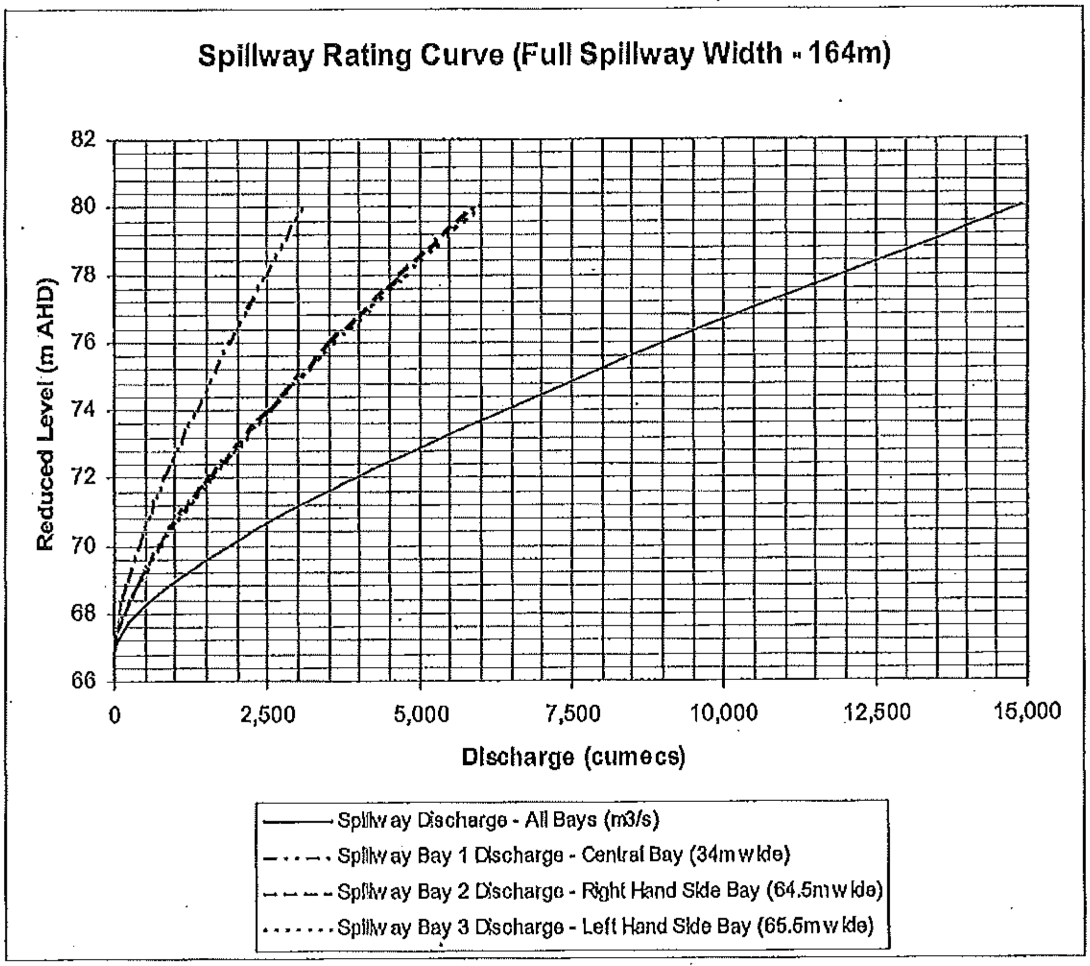
TABLE E2 CONTROLLED GATE DISCHARGES (continued)

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
73.0	0	62	124	185	247	307	366	425	482	538	593	648	702	756	809	863	917	971	1026	1081	1138	1196	1255	1316	1379	1443	1509	1577	1636						
73.2	2	62	124	187	248	309	369	427	485	542	597	653	707	761	815	869	924	978	1034	1090	1147	1206	1266	1327	1391	1456	1523	1592	1663	1669			UNCONTROLLED		
73.4	6	62	125	188	250	311	371	430	488	545	602	657	712	767	821	876	931	986	1042	1099	1156	1216	1276	1339	1403	1469	1536	1606	1678	1702				DISCHARGE	
73.6	11	64	126	189	251	313	373	433	491	549	606	662	717	772	827	882	937	993	1050	1107	1166	1225	1287	1350	1414	1481	1550	1620	1693	1736					
73.8	17	69	127	190	253	315	376	436	495	553	610	666	722	778	833	888	944	1001	1058	1116	1175	1235	1297	1361	1426	1494	1563	1635	1708	1770					
74.0	23	74	129	191	254	317	378	438	498	556	614	671	727	783	839	895	951	1008	1065	1124	1184	1245	1307	1372	1438	1506	1576	1648	1723	1800	1804				
74.2	31	80	133	192	256	319	380	441	501	560	618	675	732	788	845	901	958	1015	1073	1132	1192	1254	1317	1382	1449	1518	1569	1662	1738	1815	1838				
74.4	39	87	139	195	257	321	383	444	504	563	622	679	737	793	850	907	964	1022	1081	1140	1201	1264	1327	1393	1461	1530	1602	1676	1752	1831	1873				
74.6	47	94	145	200	259	322	385	447	507	567	626	684	741	799	856	913	971	1029	1089	1149	1210	1273	1337	1404	1472	1542	1615	1690	1767	1846	1908				
74.8	56	103	153	206	262	324	387	449	510	570	629	688	746	804	862	919	978	1036	1096	1157	1219	1282	1347	1414	1483	1554	1628	1703	1781	1861	1943				
7 5.0	66	112	161	213	267	326	390	452	513	574	633	692	751	809	867	926	984	1044	1104	1165	1227	1291	1357	1425	1494	1566	1640	1717	1795	1876	1960	1978			
75.2	76	121	169	220	274	330	392	455	516	577	637	697	756	814	873	932	991	1051	1111	1173	1236	1301	1367	1435	1506	1578	1653	1730	1809	1891	1976	2013			
75.4	87	131	178	229	281	336	394	457	519	581	641	701	760	819	878	938	997	1057	1119	1181	1245	1310	1377	1446	1517	1590	1665	1743	1823	1906	1992	2049			
75.6	98	141	188	237	289	343	399	460	522	584	645	705	765	824	884	944	1004	1064	1126	1189	1253	1319	1386	1456	1527	1601	1678	1756	1837	1921	2007	2085			
75.8	109	152	198	247	293	350	405	463	525	587	649	709	769	829	889	949	1010	1071	1133	1197	1261	1328	1396	1466	1538	1613	1690	1769	1851	1936	2023	2112	2121		
		OVERTOPPING of GATE																																	
76.0	121	164	209	257	307	359	412	468	528	591	652	713	774	834	895	955	1016	1078	1141	1205	1270	1337	1405	1476	1549	1624	1702	1782	1865	1950	2038	2129	2158		
76.2	133	175	220	268	317	368	421	475	532	594	656	718	779	839	900	961	1023	1085	1148	1212	1278	1346	1415	1486	1560	1636	1714	1795	1878	1965	2053	2145	2194		
76.4	146	187	232	279	327	378	429	483	539	597	660	722	783	844	906	967	1029	1092	1155	1220	1286	1354	1424	1496	1570	1647	1726	1808	1892	1979	2069	2161	2231		
76.6	159	200	244	290	338	388	439	492	546	603	664	726	788	849	911	973	1035	1098	1162	1228	1295	1363	1434	1506	1581	1658	1738	1820	1905	1993	2084	2177	2268		
76.8	173	213	257	302	350	399	449	501	554	610	668	730	792	854	916	978	1041	1105	1170	1235	1303	1372	1443	1516	1591	1669	1750	1833	1919	2007	2099	2153	2289	2306	
			OVERTOPPING of GATE																																
77.0	186	226	270	315	362	410	460	511	564	618	674	734	797	859	921	984	1047	1112	1177	1243	1311	1380	1452	1526	1602	1680	1762	1845	1932	2021	2113	2208	2306	2343	
77.2	200	240	283	323	374	422	471	522	574	627	682	739	801	864	927	990	1054	1118	1184	1250	1319	1389	1461	1536	1612	1691	1773	1858	1945	2035	2128	2224	2322	2381	
77.4	215	254	297	341	387	435	483	533	584	637	691	747	806	869	932	996	1060	1125	1191	1258	1327	1398	1470	1545	1622	1702	1785	1870	1958	2049	2143	2239	2339	2419	
77.6	230	269	311	355	400	447	496	545	595	647	700	756	813	873	937	1001	1066	1131	1198	1265	1335	1406	1479	1555	1633	1713	1796	1882	1971	2063	2157	2255	2355	2457	
77.8	245	283	325	369	414	461	508	557	607	658	711	765	821	880	942	1007	1072	1138	1205	1273	1343	1414	1488	1564	1643	1724	1808	1894	1984	2075	2172	2270	2371	2475	2496
78.0	260	299	340	383	428	474	522	570	619	670	722	775	831	888	948	1012	1078	1144	1211	1280	1351	1423	1497	1574	1653	1735	1819	1907	1997	2090	2186	2285	2387	2492	2535

TABLE E.3 – WIVENHOE DAM AUXILIARY SPILLWAY RATING TABLE

Storage Level (m AHD)	Spillway Discharge - All Bays (m3/s)	Discharge Central Bay (34m wide)	Discharge Right Side Bay (64.5m wide)	Discharge Left Side Bay (65.5m wide)
67	0	0	0	0
68	361	75	142	144
69	1,020	212	401	408
70	1,858	385	731	742
71	2,847	590	1,120	1,137
72	3,961	821	1,558	1,582
74	6,409	1,329	2,521	2,560
76	9,033	1,873	3,553	3,608
78	11,907	2,468	4,683	4,755
80	14,913	3,092	5,865	5,956



APPENDIX F SOMERSET DAM TECHNICAL DATA

Table F-1 STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake level M AHD	Reservoir Capacity 10^6 m^3	Temporary Flood Storage 10^6 m^3	Net Inflow per 1mm rise per hour m^3/sec	* Discharge per Regulator m^3/sec	* Discharge per Sluice m^3/sec	* Discharge per Spillway Bay m^3/sec	Maximum Available Discharge m^3/sec
90.0	120.3	-	5.29	57	163	-	1 529
90.5	129.5	-	5.50	58	165	-	1 550
91.0	139.3	-	4.88	58	167	-	1 572
91.5	149.6	-	5.28	59	170	-	1 593
92.0	160.5	-	5.68	60	172	-	1 614
92.5	172.0	-	6.09	60	174	-	1 635
93.0	184.1	-	6.79	61	176	-	1 655
93.5	196.7	-	7.10	62	179	-	1 676
94.0	210.0	-	7.43	62	181	-	1 695
94.5	224.0	-	7.78	63	183	-	1 715
95.0	238.5	-	8.15	64	185	-	1 735
95.5	253.6	-	8.54	64	187	-	1 754
96.0	269.3	-	8.95	65	189	-	1 773
96.5	285.6	-	9.37	66	191	-	1 792
97.0	302.7	-	9.81	66	193	-	1 810
97.5	320.7	-	10.28	67	195	-	1 829
98.0	339.5	-	10.76	67	197	-	1 847
98.5	359.2	-	11.25	68	199	-	1 865
99.0	379.8	0.0	11.77	69	201	-	1 883
99.5	401.4	21.5	12.31	69	203	-	1 901
100.0	428.9	49.0	13.28	70	205	-	1 918
100.5	447.5	67.6	13.83	70	207	0	1 937
101.0	472.2	92.3	14.39	71	209	4	1 989
101.5	498.0	118.1	14.95	72	211	13	2 076
102.0	524.9	145.1	15.53	72	212	25	2 189
102.5	553.1	173.3	16.11	73	214	40	2 325
103.0	582.6	202.7	16.70	73	216	58	2 482
103.5	613.2	233.4	17.30	74	218	78	2 659
104.0	645.1	265.3	17.90	74	220	100	2 854
104.5	678.3	298.4	18.52	75	221	125	3 067
105.0	712.7	332.8	19.14	75	223	151	3 296
105.5	748.3	368.4	19.78	76	225	180	3 542
106.0	785.2	405.4	20.42	76	226	211	3 803
106.5	823.4	443.6	21.07	77	228	243	4 079
107.0	863.1	483.2	21.73	78	230	278	4 370
107.5	904.0	524.2	22.39	78	232	314	4 675

* This is the maximum discharge of an individual gate or regulator. Total discharge is calculated by adding the contributions of each gate or regulator.

Regulator - Discharge regulator valve of which there are four (4).
Sluice - Sluice gate of which there are eight (8).
Spillway - Overflow section of dam controlled by eight (8) radial gates.
Temporary Flood- The temporary storage above the normal full supply level of El 99 m (AHD) Storage

APPENDIX G WIVENHOE DAM GATE OPERATION CONSIDERATIONS

Full size plans of Wivenhoe Dam, and Operations and Maintenance Manuals for Wivenhoe Dam are held by the Corporation and the Headworks Operator and are available at the site. Operations and Maintenance Manuals relevant to the flood operation of the gates are:

(a) "Master Manual and Drawings."

(b) "Radial and Penstock Gate Hoists and Drawings."

G.1. SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Appendix I shows the general arrangement of the spillway area.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

The main purpose of gating the spillway is to exercise maximum control over the flow in the Brisbane River insofar as river flows in excess of 4 000 m^3/sec cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

G.2. RADIAL GATE OPERATING PRINCIPLE

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

APPENDIX I HYDROLOGIC INVESTIGATIONS

I.1. INTRODUCTION

This appendix describes hydrologic analyses performed as part of the review of design flood hydrology Corporation's dams. This study included an examination of the existing operating procedures for Wivenhoe Dam and Somerset Dam and it includes the use of the latest techniques in design rainfall estimation.

The analyses were carried out using the most appropriate data available in 2001 and it is recommended that they be revised after the occurrence of a large flood or after the adoption of more advanced methods of hydrologic analysis. The work is summarised in a report entitled, 'Brisbane River – Revision of Flood Hydrology', (DNRM, 2001).

The work summarised here supersedes previous work including that completed during the design stages of Wivenhoe Dam, details of which are contained in the design report on Wivenhoe Dam and the Brisbane River and Pine River Flood Study reports. Revision of the estimates of Probable Maximum Precipitation by the Bureau of Meterology in 2003 have increased these figures. The determination of the Probable Maximum Flood and the impacts on Wivenhoe Dam are included in reports entitled, "Preferred Solution Report" – Wivenhoe Alliance 2003. The increase in spillway capacity for Wivenhoe Dam and the resulting effects downstream are included in a report entitled "Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade" – Wivenhoe Alliance 2004.

I.2 METHOD

There are three components in the hydrologic analyses:

(i) a rainfall analysis to determine both rainfall frequency and Probable Maximum Precipitation (PMP) and also large and rare rainfall events using the CRC-FORGE methodology

(ii) a model of the catchment rainfall runoff process; and

(iii) a model of the flood operations of the two dams.

The Bureau of Meteorology completed several studies of the Probable Maximum Precipitation. The Australian generalised method for areas subject to tropical cyclones was used and rainfalls for durations up to seven days were estimated. The Probable Maximum Precipitation was estimated for the whole of the Brisbane River catchment, as well as for various sub-catchments. Concurrent rainfall estimates were provided for the remainder of the catchment outside the sub-catchment for which the Probable Maximum Precipitation was provided. The Probable Maximum Precipitation temporal patterns provided by the Bureau of Meteorology were used for all rainfalls.

The estimation of design rainfalls within the large to rare flood range was performed using the CRC-FORGE methodology as described in Book VI of Australian Rainfall and Runoff (1998). The CRC-FORGE method uses the concept of an expanding region focussed at the site of interest. Design rainfall for frequent events (eg 1 in 50 AEP) are based upon pooled data from a few gauges around the focal point, while design rainfall estimates at the AEP of the limit extrapolation are based upon pooled rainfall data from up to several hundred gauges. Before the data from different sites can be poled, maximum annual rainfalls from each site need to be standardised by dividing by an "index variable".

The rainfall runoff models based on a non-linear runoff routing method were used to estimate the floods. The models were calibrated on recorded storm and flood data. The model calibrations were completed in 1993 and were not modified for the latest re-assessment.

Models to simulate the flood operation of Somerset and Wivenhoe Dams developed during the mid-eighties were modified to incorporate the new structure of the hydrologic models and to more accurately reflect the operational procedures of the dams. These models were then used to calculate dam discharges for a range of design floods generated using the rainfall estimates and the runoff routing models.

I.3. RAINFALL ANALYSIS RESULTS

The rainfall analysis was performed in two parts, the Probable Maximum Precipitation estimate by the Bureau of Meteorology and the estimation of large to rare events using the CRC-FORGE method. These were used both for design studies for the dam and to test the effects of flood operation procedures.

The estimates of rainfall frequency are listed in Tables I-1 and I-2.

Table I-1
Catchment Rainfall (mm) on Wivenhoe Dam Catchment

Annual Exceedence Probability %	24 Hours	48 Hours	72 Hours
1	199	274	319
0.1	276	393	464
0.01	379	550	659
PMP	800	1060	1280

Table I-2
Catchment Rainfall (mm) on Somerset Dam Catchment

Annual Exceedence Probability %	24 Hours	48 Hours	72 Hours
1	302	430	507
0.1	432	649	775
0.01	554	920	1117
0.001	747	1204	1483

I.4. RUNOFF ROUTING MODEL CALIBRATION

Ten floods were used for calibration: July 1965, March 1967, June 1967, January 1968, December 1971, January 1974, January 1976, June 1983, Early April 1989 and Late April 1989. The gauging stations used for model calibration are listed in Table I-3.

The runoff routing model was calibrated for the nineteen major sub-catchments listed in Table I-4. Each of these models was calibrated for as many sites as possible for each of the ten floods. Data were missing for some of the stations for some of the floods. The estimated model parameters are given in Table I-4. In all cases relative delay time parameter (k) used in the model is related to reach length.

Table I-3
Gauging Stations used for Model Calibration

Stream	Site	Number	AMTD (km)	Catchment Area (km^2)
Stanley River	Somerset Dam		7.2	1 335
Cooyar Creek	Damsite	143015	12.2	960
Brisbane River	Linville	143007	282.4	2 005
Emu Creek	Boat Mountain	143010	10.1	920
Brisbane River	Gregor's Creek	143009	251.7	3 885
Cressbrook Creek	Damsite	143013	58.6	325
Brisbane River	Middle Creek	143008	187.2	6 710
Brisbane River	Wivenhoe Dam		150.2	7 020
Brisbane River	Savage's Crossing	143001	130.8	10 180
Bremer River	Walloon	143107	37.2	620
Warrill Creek	Amberley	143108	8.7	920
Lockyer Creek	Lyon's Bridge	143210	27.2	2 540
Brisbane River	City		22.7	13 260

Table I-4
Estimated Model Parameters

Sub-Catchment Name	Model Parameters	
	k	m
Cooyar Creek	43.6	0.8
Brisbane River at Linville	20.6	0.8
Emu Creek at Boat Mountain	37.2	0.8
Brisbane River at Gregors Creek	20.1	0.8
Cressbrook Creek at Cressbrook Dam	34.3	0.8
Stanley River at Somerset Dam	80.7	0.8
Brisbane River at Wivenhoe Dam	108.5	0.8
Lockyer Creek at Helidon	15.0	0.8
Tenthill Creek at Tenthill	19.0	0.8
Lockyer Creek at Lyons Bridge	75.0	0.8
Brisbane River at Savages Crossing	40.0	0.8
Brisbane River at Mount Crosby	47.0	0.8
Bremer River at Walloon	44.0	0.8
Warrill Creek at Kalbar	34.0	0.8
Warrill Creek at Amberley	35.0	0.8
Purga Creek at Loamside	49.0	0.8
Bremer River at Ipswich	15.7	0.8
Brisbane River at Jindalee	20.8	0.8
Brisbane River at Port Office	19.3	0.8

I.5. WIVENHOE DAM FLOODS

Wivenhoe Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Wivenhoe Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the dam-site without the dam in the catchment. Two-day storms were found to have the critical storm duration for most cases, though the long duration Probable Maximum Precipitations produced very large flood volumes. Table I-5 lists results for the two-day duration storms.

Table I-5
Wivenhoe Dam Floods
Design Inflows and Outflows for Existing, Stage 1 and Stage 2 Upgrades

Event (1in X)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s) Existing	Stage 1	Stage 2
200	8,300	2,800	2,800	2,800
500	10,500	3,800	3,800	3,800
1,000	12,100	5,300	5,300	5,300
2,000	14,000	6,600	6,600	6,600
5,000	17,200	8,900	10,500 [c]	10,500 [c]
10,000	20,800	11,700	12,500	12,500
22,000 [a]	25,700	12,400 [a]	17,600	17,600
50,000	34,900	- [b]	24,600	24,600
100,000	43,300	- [b]	28,100 [a]	34,900
PMF	49,000	- [b]	- [b]	37,400 [a]

[a] Dam Crest Flood
[b] Overtops dam wall
[c] Increases due to changes to Procedure 4.

I.6. SOMERSET DAM FLOODS

Somerset Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Somerset Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the site without the dam in the catchment. The forty-eight hour PMP storm event was found to be critical, though the long duration PMP's produced very large flood volumes. Table I-6 lists results for the forty-eight hour duration storms.

Table I-6
Somerset Dam Floods
(for two-day storm duration)+

AEP %	Peak Inflow (m^3/sec)	Peak Outflow (m^3/sec)	Flood Volume (ML)	Peak Lake Level (m AHD)
1	3,500	1,700	421,000	103.5
0.1	4,500	2,600	690,000	104.5
0.01	6,800	4,700	1,042,000	107.5
0.001	9,200	6,300	1,412,000	109.3
PMF*	16,000	9,600	1,952,800	112.0

+ - NB. This duration does NOT give the maximum Peak Inflow for a given AEP
* - Overtopped, estimated flow based on no dam failure

I.7 FLOOD CONTROL OPERATION MODEL

Floods in the Brisbane River catchment above Wivenhoe Dam can originate in either the Stanley River or upper Brisbane River catchment or both. Both of the dams are capable of being operated in a number of ways, each of which will reduce the flow downstream. However, in order to achieve maximum reduction of flooding downstream of Wivenhoe Dam, it was necessary to review the operations at Somerset and Wivenhoe Dams using a flood operations simulation model.

The most recent flood studies have reviewed the basic hydrologic algorithms in the operational models used in the earlier study and modified them to incorporate additional features relating to gate openings and closings. The revised design flood hydrology and operational model algorithms were then used to re-examine the original five possible operational procedures for each of Somerset Dam and Wivenhoe Dam, giving twenty-five possible combinations to be re-considered. The procedures previously developed for Wivenhoe Dam were designed so that initial release operations did not adversely affect later operations in the event of later rainfall causing the magnitude of the flood to exceed the original estimate.

The procedures previously developed were also designed to restrict flooding in the lower catchment to the lowest level of the following categories where practicable:

(i) low level bridges submerged, Fernvale bridge open;

(ii) all bridges except Mt. Crosby Weir and to Fernvale bridges submerged;

(iii) all bridges submerged, no damage to urban areas;

(iv) damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe Dam contributing to peak flow;

(v) extensive damage to urban areas due to combined Wivenhoe Dam releases and downstream flow, Wivenhoe Dam release component of peak flow minimum practicable.

The previous flood studies recommended that one procedure be selected for the operation at Somerset Dam. This procedure had two advantages over the other procedures tested. Firstly, it was feasible for all magnitudes of Stanley River floods tested and, secondly, it was the simplest procedure to carry out. The re-analysis confirmed this conclusion.

The previous flood studies concluded that procedures for Wivenhoe Dam be reduced to four by combining two procedures into one. The resulting four procedures formed a hierarchy and the procedure to be adopted advances to the next procedure as the flood magnitude increases. The re-analysis confirmed this conclusion.

A Real Time Flood Operations Model for Somerset and Wivenhoe has been developed as part of the "Brisbane River and Pine River Flood Studies". This model incorporates the revised operational algorithms.

* Assume no failure of Wivenhoe Dam or Somerset Dam

APPENDIX J DRAWINGS

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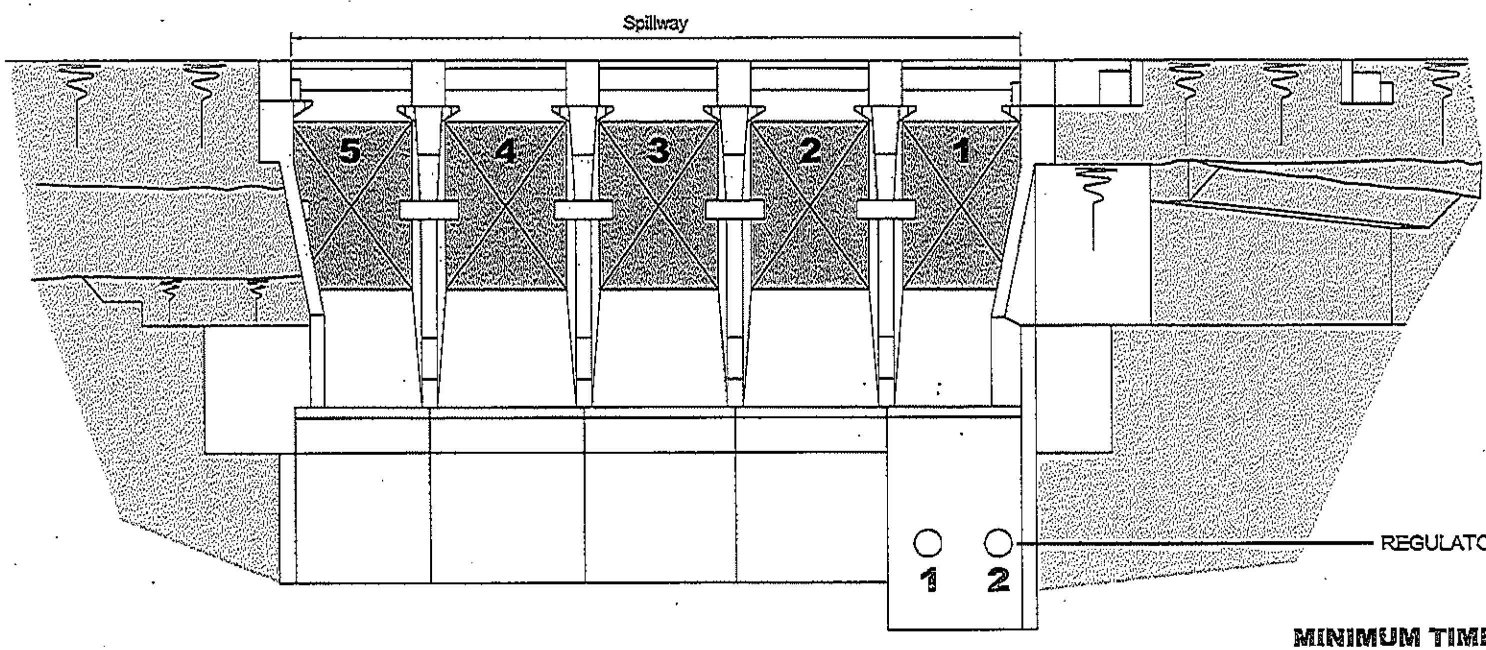
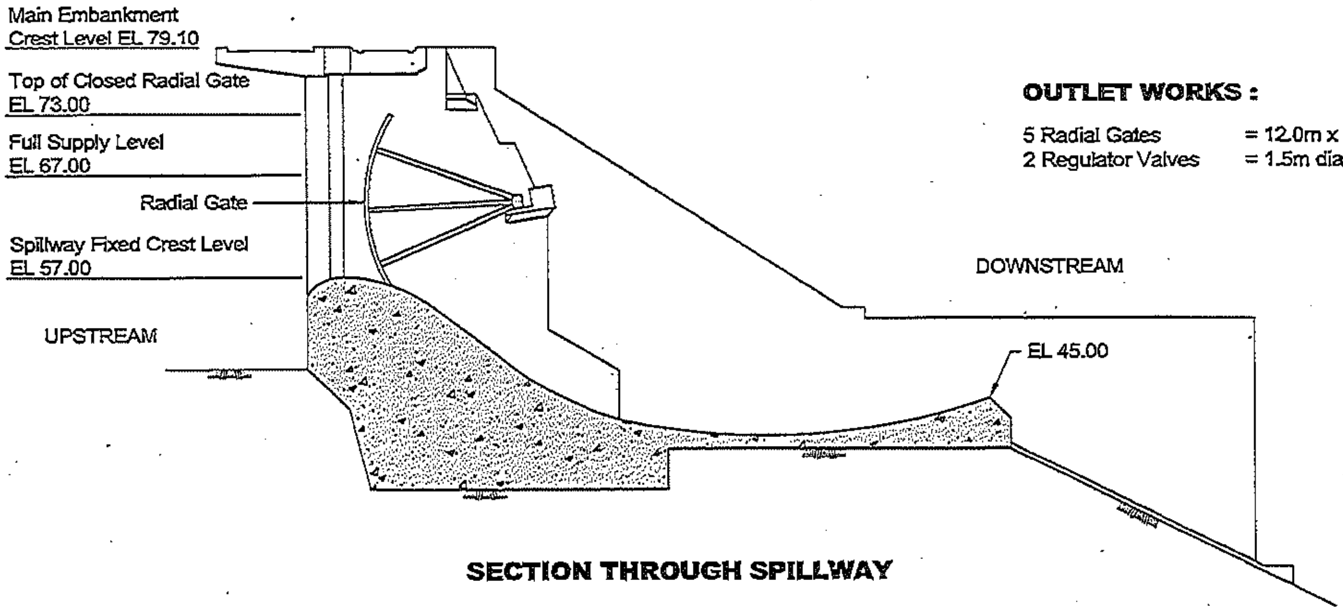


VIEW LOOKING UPSTREAM



SECTION THROUGH SPILLWAY

OUTLET WORKS :

5 Radial Gates = 12.0m x 16.6m
2 Regulator Valves = 1.5m dia

MINIMUM TIME INTERVAL

MIMUM INTERVALS FOR NORMAL OPERATION

500mm Incremental gate openings	10min
500mm Incremental gate closures	20min
Full regulator opening or closure	30min

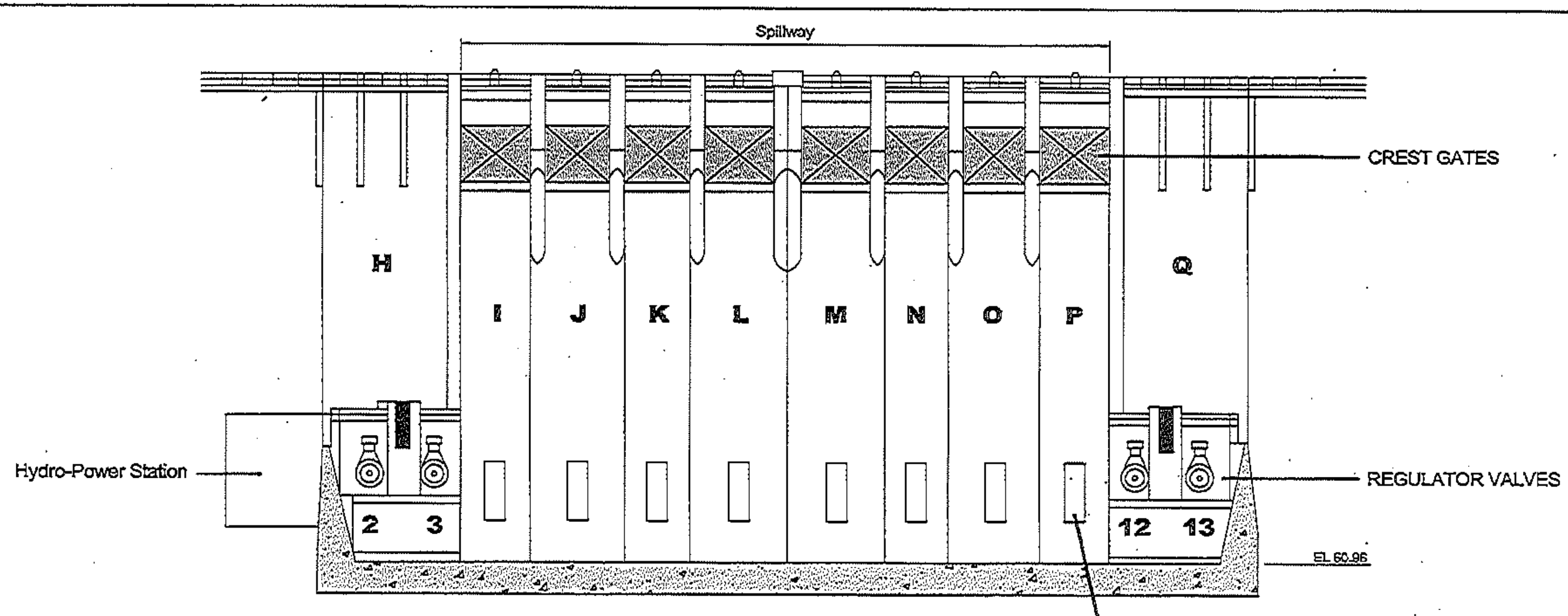
CRITICAL LEVELS :

Saddle Dam Embankment Level	= 80.00
Top of Wave Wall	= 79.90
Main Embankment Crest Level	= 79.10
Evaluation Design Flood Level	= 77.00
Minimum Land Resumption	= 75.00
Top of Closed Radial Gate	= 73.00
Gate Operation Trigger Level	= 67.25
Full Supply Level	= 67.00
Spillway Fixed Crest Level	= 57.00

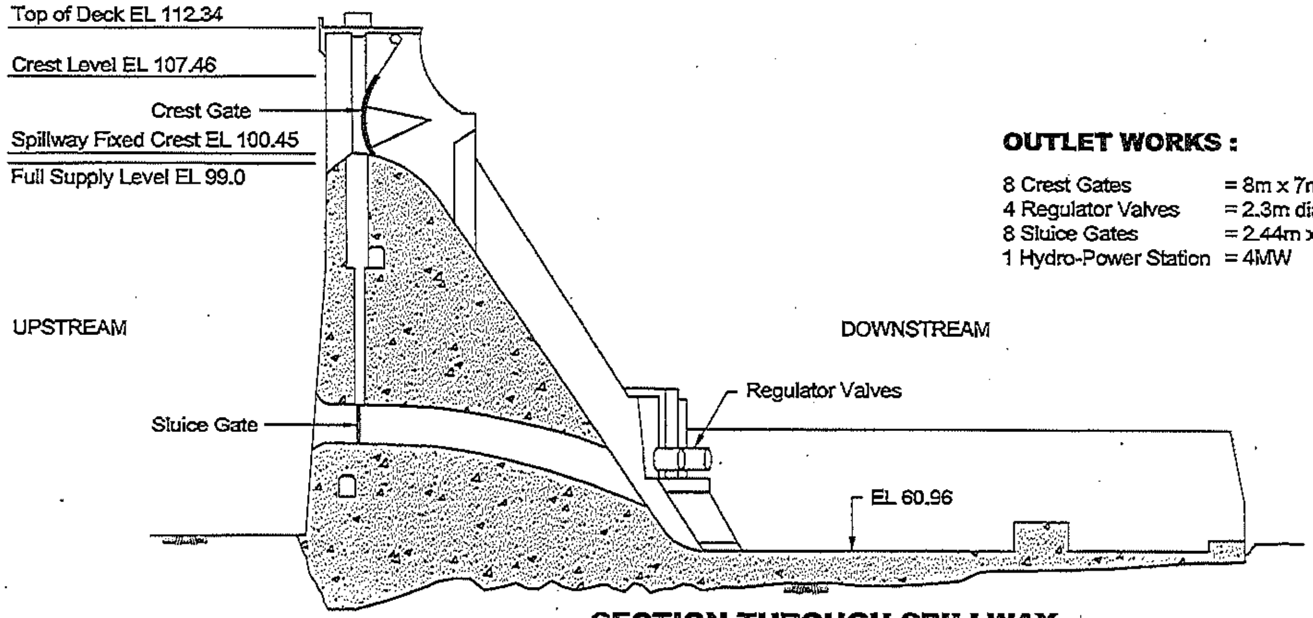
SunWater

SEQWC Flood Operations
WIVENHOE DAM

A3-216787



VIEW LOOKING UPSTREAM



SECTION THROUGH SPILLWAY

OUTLET WORKS :

8 Crest Gates	= 8m x 7m
4 Regulator Valves	= 2.3m dia
8 Sluice Gates	= 2.44m x 3.66m
1 Hydro-Power Station	= 4MW

MINIMUM TIME INTERVAL

MINIMUM INTERVALS FOR NORMAL OPERATIONS

Outlet	Opening Interval	Closure Interval
Regulators	30min	60min
Sluice Gates	120min	180min
Crest Gates	Gates are Normally Open	

CRITICAL LEVELS :

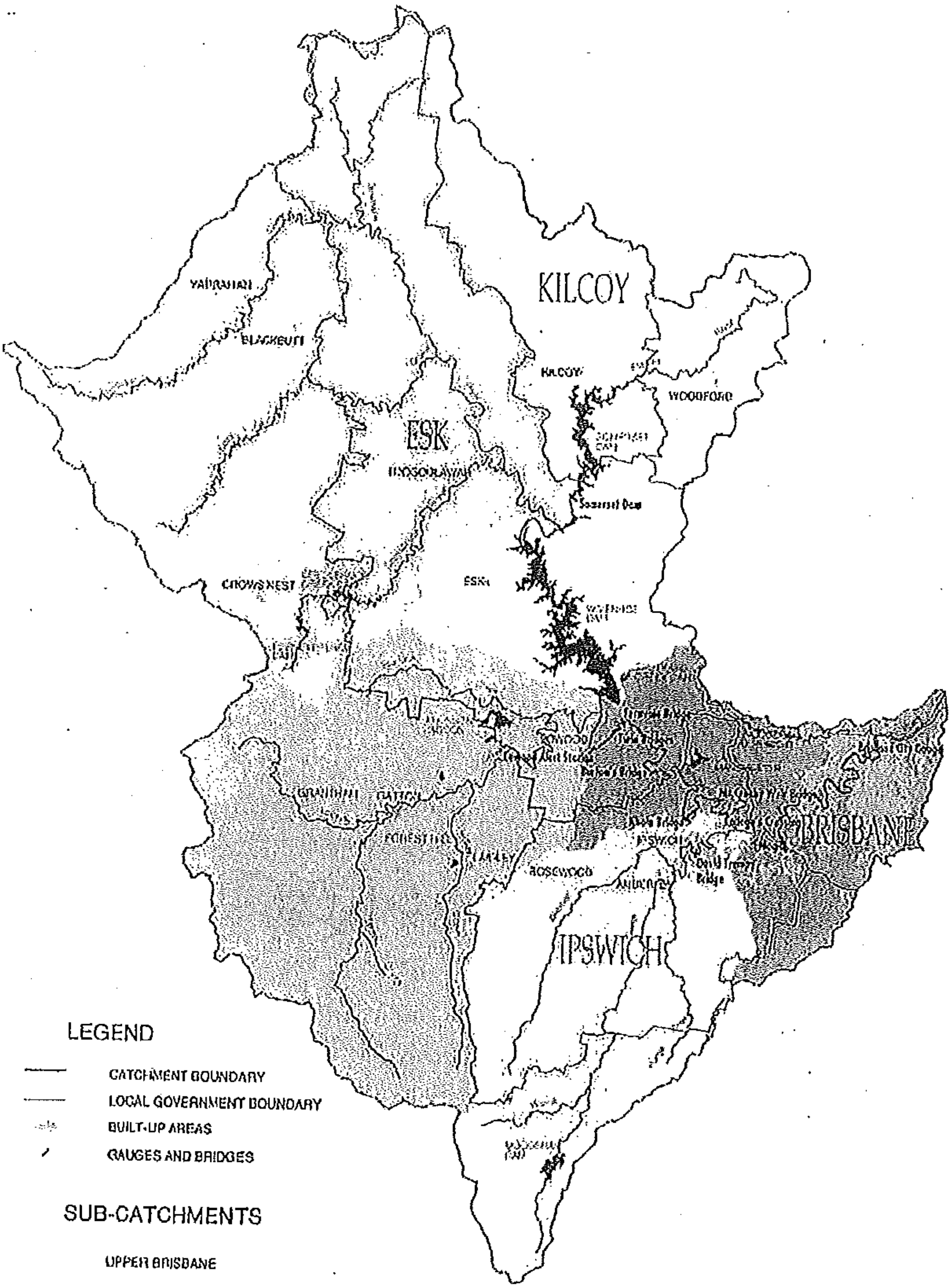
Top of Deck	= 112.34
Crest Level	= 107.46
Sluice & Regulator Trigger Level	= 102.25
Mary Smokes Bridge (Kilcoy)	= 102.00
Spillway Fixed Crest Level	= 100.45
Hydro-Power Station Reserve	= 99.30
Full Supply Level	= 99.00

SunWater

SEQWC Flood Operations
SOMERSET DAM

A3-216788

APPENDIX K BRISBANE RIVER CATCHMENT



LEGEND

CATCHMENT BOUNDARY

LOCAL GOVERNMENT BOUNDARY

BUILT-UP AREAS

GAUGES AND BRIDGES

SUB-CATCHMENTS

UPPER BRISBANE

MIDDLE BRISBANE

LOWER BRISBANE

SOMERSET

LOCKYER

BREMER

0 50
KILOMETRES

Brisbane River Catchment

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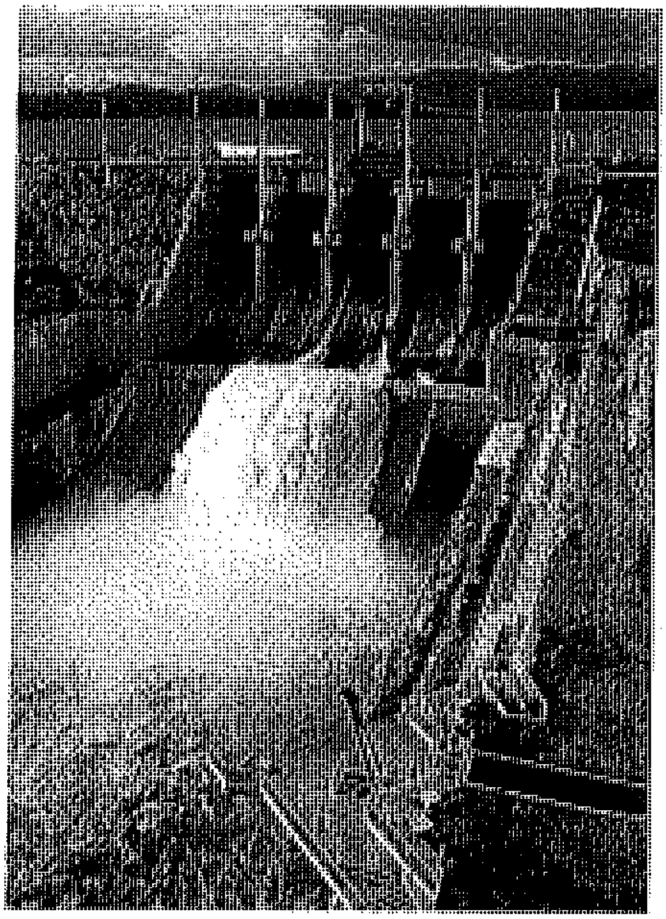
South East Queensland **WATER BOARD**



MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR WIVENHOE DAM AND SOMERSET DAM

October 1997

MANUAL

OF

OPERATIONAL PROCEDURES FOR FLOOD MITIGATION

FOR WIVENHOE DAM AND SOMERSET DAM

I, Howard Hobbs, Minister for Natural Resources in the State of Queensland do hereby approve and issue the following Manual, and declare that the procedures contained herein shall be the operational procedures in relation to Wivenhoe Dam and Somerset Dam.

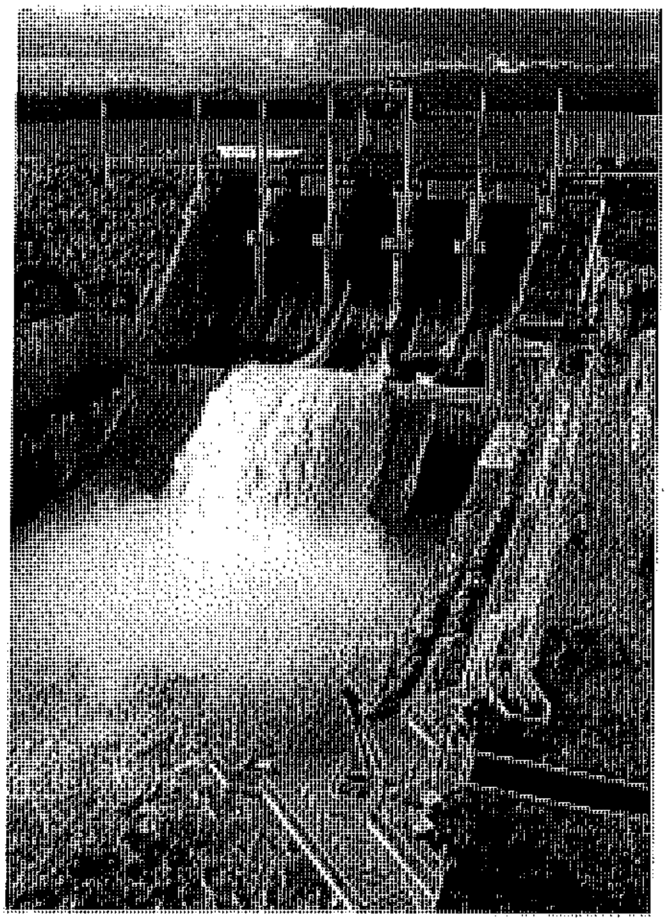
Dated this 13 day of November 1997 at Brisbane.

signed

[redacted]

Howard Hobbs MLA

South East Queensland **WATER BOARD**



MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR WIVENHOE DAM AND SOMERSET DAM

October 1997

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APPENDICES

1 INTRODUCTION

1.1 Preface

Given their size and location, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise hazard to life and property.

Recognising this, the South East Queensland Water Board Act 1979 (Extract in Appendix A) required that its Technical Advisory Committee cause to be prepared a combined manual of operational procedures for Wivenhoe and Somerset Dams for the purpose of flood mitigation.

This Manual is the result of a review of the 1992 revision of the Manual. The Board is required to submit the Manual to the Minister charged with administration of the Act for approval. Any amendments to the basic operating procedures need to be treated similarly.

Since the last revision, an expanded flood monitoring and warning radio telemetry network (ALERT) has been installed in the Brisbane River Catchment. Additionally, a computerised flood operational model which allows for rainfall and river modelling in real time based on data from the ALERT system has been developed and implemented. However the accuracy and reliability of the system during a flood event has not been proven. Thus, while this revision of the manual takes account of the use of these flood operational tools, they are recognised only as tools until their utility and reliability are proven.

The review has not included a formal risk management assessment process. It is intended this shall form part of a broader assessment regarding dam and flood management and then be incorporated into this manual. This is scheduled to commence in the 1997/98 financial year.

The primary objectives have not varied from those defined in the previous manual of ensuring safety of the dams, their ability to deal with extreme and closely spaced floods, and protection of urban areas. The basic operational procedures have also remained the same.

Changes from the previous revision have mostly arisen from the availability of the computer based real time flood monitoring and warning system, modification of river crossings, the further clarification of communications and increased reporting requirements.

1.2 Meaning of Terms

In this Manual, save where a contrary intention appears -

"Act"

means the South East Queensland Water Board Act 1979;

"Agency"

includes a person, a local government and a department of state government within the meaning of the Acts Interpretation Act 1954;

"AHD"

means Australian Height Datum;

"Board" or "South East Queensland Water Board"

means the body corporate constituted by that name pursuant to Part III of the South East Queensland Water Board Act 1979;

"Bureau of Meteorology"

means the Commonwealth Bureau of Meteorology;

"Chairperson"

means the Chairperson of the South East Queensland Water Board;

"Chief Executive"

means the Chief Executive or Director General of the Department of Natural Resources;

"Controlled Document"

means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Dams"

means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

"Dam Supervisor"

means the senior on-site officer at Wivenhoe or Somerset Dam as the case may be;

"EDF"[1] or "Evaluation Design Flood"

means the flood used for the design of a Dam at the time of design;

"EL"

means elevation in metres from Australian Height Datum;

"Flood Operations Engineer"

means the person designated at the time to direct the operations of Wivenhoe Dam and Somerset Dam under the general direction of the Senior Flood Operations Engineer and in accordance with the procedures in this Manual;

"FSL"[1] or "FULL SUPPLY LEVEL"
means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"Gauge"
when referred to in "m" means river level referenced to AHD, and
when referred to in "m^3/s" means flow rate in cubic metres per second;

"Headworks Operator"
means the agency with which the Board has entered into a contract or arrangement with respect to the operation and maintenance of the dams, for the purpose of flood mitigation;

"IFF"[1] or "Imminent Failure Flood"
means the flood which if exceeded would cause failure of a dam;

"Manager Dam Safety "
means the suitably qualified and experienced person fulfilling the function of an advisory committee on referable dams pursuant to Section 19 of the Water Resources Act 1989;

"Manual" or "Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam"
means the current version of this Manual;

"Minister"
means the Minister of the Crown who at the material time is charged with the administration of the Act;

"Power Station"
means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"RDF"1 or
"Recommended Design Flood"
means the flood which a dam should be designed for in accordance with accepted practices;

"Senior Flood Operations Engineer"
means the senior person designated at the time pursuant to Section 2.1 of this Manual under whose general direction the procedures in this Manual shall be carried out;

"Technical Advisory Committee "means the Technical Advisory Committee established pursuant to Section 21 of the South East Queensland Water Board Act 1979, as constituted at the material time.

[1] For reference, these terms and definitions are described in "GUIDELINES ON DESIGN FLOODS FOR DAMS 1986" by the Australian National Committee on Large Dams (ANCOLD).

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce, so far as practicable, the effects of flooding, by the proper control and regulation in time of headworks under the control of the Board, with due regard to the safety of the structures comprising those headworks.

For the purpose of this Manual, the Board adopts the policy that the community is to be protected to the maximum extent possible against flood hazards recognising the limitations on being able to:

- identify all potential flood hazards and their likelihood,
- remove or reduce community vulnerability to flood hazards,
- effectively respond to flooding, and
- provide resources in a cost effective manner.

1.4 Legal Authority

This manual has been prepared in accordance with the provisions of Section 106 of the Act.

1.5 Application and Effect

The procedures in this Manual shall apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall be deemed to meet the relevant dam safety requirements of the Water Resources Act 1989 for the purpose of flood mitigation.

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which the Manual is approved by the Minister.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation, and shall be applied by the Headworks Operator for the operation of the dams.

1.8 Provision for Variations to Manual

If any one of the Chief Executive, the Headworks Operator, or the South East Queensland Water Board (including its Technical Advisory Committee) is of the opinion that this Manual requires amendment, it shall make a submission to the South East Queensland Water Board setting forth those circumstances and the exact nature of the amendment, alteration or variation sought.

If the Board is of the opinion that the procedures in this Manual should be amended, altered or varied, it shall submit for approval as soon as practical a recommendation, which is in accordance with the dam safety provisions of the Water Resources Act, to the Minister setting out the circumstances and the exact nature of the amendment, alteration or variation sought.

It is recognised that minor changes to the Manual are likely to be required from time to time; for example, changes to agreed locations and/or levels at key reference gauges at which various classifications of flooding are considered to occur, Section 5.4 refers.

Minor changes that do not affect the basic operational procedures specified in the Manual may be approved co-jointly by the Board and the Chief Executive without reference to the Minister.

Any amendment, alteration or variation to the procedures in this Manual shall take effect on and from the date on which the recommendations are approved.

1.9 Distribution of Manual

The Board shall regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of Controlled Documents are listed in Appendix B. The Board shall maintain a Register of Contact Persons for Controlled Documents and ensure that each issued document is updated whenever amendments or changes are approved.

Before using this Manual for the direction of flood control, the Headworks Operator must ensure that it is the current version of the Controlled Document.

1.10 Authority to Use Discretion

Where it is reasonable to expect that the safety of either dam will not be reduced, temporary deviations from the procedures detailed in this manual may be made in accordance with Section 2.8.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, the Board is responsible for and has the duty for operation and maintenance of Wivenhoe Dam and Somerset Dam, and may enter into contracts for the purpose of discharging these responsibilities.

All instruments of delegation and contract made in accordance with the Act shall be recorded in the Schedule of Authorities attached to the Manual as Appendix C. Changes to instruments of delegation and contract shall be made in accordance with the Act and incorporated in the Schedule as amendments to the Schedule.

2.1.1 Designation of Senior Flood Operations Engineer

The Headworks Operator shall ensure that the procedures set out in this Manual shall be carried out under the general direction of a suitably qualified and experienced person, as may be required under the provisions of the Water Resources Act 1989, who shall be referred to hereafter as the Senior Flood Operations Engineer. Only a person authorised in the Schedule of Authorities can give the general direction for carrying out procedures set out in this Manual.

2.1.2 Designation of Flood Operations Engineer

The Headworks Operator shall have available or on standby at all times a suitably qualified and experienced Flood Operations Engineer to direct the operation of the dams during floods.

The Headworks Operator shall ensure that flood control of the dams is under the direction of a Flood Operations Engineer at all times. Only a person authorised in the Schedule of Authorities can direct the flood operation of the dams.

The Headworks Operator shall also employ an adequate number of suitably qualified and experienced persons to assist the Flood Operations Engineer in the operation of the dams during floods.

2.2 Qualifications and Experience of Engineers

2.2.1 Qualifications

All engineers referred to in Section 2.1 shall meet all applicable requirements of registration or certification under any relevant State Act, and shall hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

2.2.2 Experience

All engineers referred to in Section 2.1 shall, to the satisfaction of the Chief Executive, have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

(a) Investigation, design or construction of major dams;

(b) Operation and maintenance of major dams;

(c) Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;

(d) Applied hydrology with particular reference to flood forecasting and flood warning systems.

2.3 Schedule of Authorities

For the purpose of directing operation of the dams during floods, a list of suitably qualified and experienced Senior Flood Operations Engineers and Flood Operations Engineers shall be maintained in the Schedule of Authorities (Appendix C).

The Headworks Operator shall, as the need arises, nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as Senior Flood Operations Engineers and Flood Operations Engineers. Each nomination shall include a copy of any certificate required under Section 2.2 and a validated statement of qualifications and experience.

The Headworks Operator shall forward all nominations to the Chief Executive who shall review nominations and make recommendations to the Minister for approval for inclusion in the Schedule of Authorities.

If, in the event of unforseen and emergency situations, no Senior Flood Operations Engineer or no Flood Operations Engineer is available from the Schedule of Authorities, the Headworks Operator shall temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.4 Training

The Headworks Operator shall ensure that operational personnel required for flood control operations receive adequate training in the various activities involved in flood control operation.

2.5 Dam Operation Arrangements

For the purposes of operation of the dams during times of flood, the Headworks Operator shall ensure that:

(a) the operation be carried out under the general direction of the Senior Flood Operations Engineer, and

(b) in the direction of operations which may knowingly endanger life or property, the Senior Flood Operations Engineer shall where practical liaise with the Chairperson of the Board and the Chief Executive or nominated delegate.

2.6 Responsibilities of the Senior Flood Operations Engineer

The Senior Flood Operations Engineer is responsible for the overall direction of flood operations.

Except insofar as reasonable discretion is provided for in Section 2.8 of this Manual, the Senior Flood Operations Engineer shall ensure that the operational procedures for the dam shall be in accordance with this Manual.

2.7 Responsibilities of the Flood Operations Engineer

The Flood Operations Engineer shall apply the operational procedures in accordance with this manual and the direction set for flood operations. In so doing, account shall be taken of prevailing weather conditions, the probability of follow up storms and the ability of the dam to discharge excess flood waters in the period between rainfall events or in the period from the time of detection of conditions associated with the development storm cells to the likely time of occurrence of the rainfall.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, based on available information and professional experience, it is necessary to depart from the procedures set out in this manual, the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary to meet the situation, provided that the Senior Flood Operations Engineer shall observe the objectives set out in Section 3 of this Manual when exercising such reasonable discretion.

Before exercising discretion under this Section of the Manual with respect to flood mitigation objectives, the Senior Flood Operations Engineer shall consult with such of the following persons as are available at the time that the discretion has to be exercised:

the Chairperson of the Board, and

the Chief Executive or nominated delegate.

If not able to contact any of the above within a reasonable time, the Senior Flood Operations Engineer shall proceed with such other procedures considered as necessary to meet the situation and report such action at the earliest opportunity to the above persons.

2.9 Report

The Senior Flood Operations Engineer shall prepare a report to the Headworks Operator after each event that requires flood operation of the dams and the report shall contain details of the procedures used, the reasons therefore and other pertinent information. The Headworks Operator shall forward the report to the Board together with any comments within six weeks of the completion of the event referred to.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operational procedures in this Manual, the following objectives, listed in descending order of importance, are as follows:

(a) Ensure the structural safety of the dams;

(b) Provide optimum protection of urbanised areas from inundation;

(c) Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries;

(d) Minimise disruption and impact upon Wivenhoe Power Station;

(e) Minimise disruption to navigation in the Brisbane River.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

3.2.1 Wivenhoe

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences.

Wivenhoe Dam is predominantly a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered the major threat to the security of Wivenhoe Dam.

3.2.2 Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences.

Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves.

3.3 Extreme Floods and Closely Spaced Large Floods

Techniques for estimating extreme floods indicate that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam itself. Such events however require several days of intense rainfall to produce the necessary runoff. Pre release or accelerated release of storage at damaging flood levels could reduce, but not eliminate the risk of overtopping. Such a measure should be taken only after careful consideration of the reliability of precipitation forecasts and of perceived antecedent conditions.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other.

In order to be prepared to meet such a situation, the stored flood waters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles. Typically the Flood Operations Engineer should aim to empty stored flood waters within seven days after the flood peak has passed through the lower reaches of the Brisbane River. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The discharges should be regulated so as to have little impact on the urban reaches of the Brisbane River taking into account inflows into the river downstream of the dams. However they may result in submergence of some low level bridges. The level of flooding as a result of emptying stored flood waters after the peak has passed is to be less than the flood peak unless accelerated release is necessary to reduce the risk of overtopping.

3.4 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas on the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by using the flood gates to control releases from the dams, taking into account flooding derived from the lower Brisbane River catchments.

3.5 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, some low level bridges and areas upstream of the dams may be temporarily inundated. Downstream of the dam, bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily.

3.6 Provision of Pumping Pool for Power Station

The power station is not effected by the reservoir level in Wivenhoe Dam during floods other than the impacts high tail water levels have on the efficiency of the power station. The power station does however require a pumping pool for operation. The loss of storage by dam failure would render the power station inoperative.

3.7 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lower priority. The effect of flood flows upon navigation in the river varies widely.

Large ships can be manoeuvred in the river at considerable flood flows. On the other hand, barges and dredges are affected by low flows which lower salinity thus decreasing the density of the water which in turn causes craft to sit lower in the water, sometimes bottoming. The Moggill Ferry is also affected by low flood flows.

A short emptying period for the flood storage compartment of the dams is consistent with Objectives (c) and (e) of Section 3.1, which are closely related.

4 FLOOD CLASSIFICATION

For the reference purposes of this Manual, five magnitudes of flooding are classified as follows:

Fresh
This causes only very low level bridges to be submerged.

Minor Flooding
This causes inconvenience such as closing minor roads and the submergence of low level bridges. Some urban properties are effected.

Moderate Flooding
This causes inundation of low-lying areas and may require the evacuation of some houses and/or business premises. Traffic bridges may be closed.

Major Flooding
This causes flooding of appreciable urban Ares. Properties may become isolated. Major disruption occurs to traffic. Evacuation of many houses and business premises may be required.

Extreme Flooding
This causes flooding well in excess of floods in living memory and general evacuation of whole areas are likely to be required.

Usually a flood does not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted.

(The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia)

5 FLOOD MONITORING AND WARNING SYSTEM

5.1 General

A real time flood monitoring and warning system is established in the Brisbane Valley. This system is an event reporting, radio telemetry system (ALERT) used to collect, transmit and receive rainfall and streamflow information. The system consists of more than 50 field stations which automatically record rainfall and/or river heights at selected locations in the Stanley and Brisbane River catchments. Some of the field stations are owned by the Board, some by other agencies.

The rainfall and river height data is transmitted by radio telemetry, via repeater stations, to base stations at the head office of the Headworks Operator (and the Board). There the data is processed in real time by computer programs to assess what is occurring in the catchments in terms of flood flows and what could occur if weather conditions continued, or changed.

Other agencies with their own base stations can, and do, receive data transmissions direct, and so collect and are able to process rainfall and streamflow information appropriate to their needs.

The real time flood model (RTFM) is a suite of hydrologic and hydraulic computer programs that utilise the real time ALERT data to assist in the operation of the dams during flood events.

5.2 Operation

The Headworks Operator is responsible for operating the computer model provided by the Board for flood monitoring and forecasting during flood events to optimise flood gate operations and minimise the impacts of flooding.

It is the responsibility of the Board to maintain and keep calibrated its own equipment; and to enter into such arrangements with other agencies or to provide such further equipment as the Board deems necessary for the Headworks Operator to properly operate the computer model for flood monitoring and forecasting.

A system such as this is expected to improve over time due to:

- improved operation and reliability with experience,
- improved calibration as further data becomes available,
- software upgrades, and
- the number, type and locations of sensors being varied.

A regular process of internal audit and management review shall be maintained to achieve this.

A log of the performance of all field equipment necessary to properly operate the computer model shall be kept by the Board. The log is to also include all revised field calibrations and changes to the number, type and locations of gauges. Entries onto the log are to be notified to the Headworks Operator without delay in writing.

A log of the performance of the system (ALERT and RTFM) shall be kept by the Senior Flood Operations Engineer. Any faults to the computer hardware or software, and any faults to field equipment which the Board has not advised the Headworks Operator of, are to be notified to the Board without delay in writing. The Board shall promptly attend to the matters under its control and refer other matters to the appropriate agencies.

Whenever the Senior Flood Operations Engineer considers that the performance and functionality of the system can be improved, by whatever means, a recommendation shall be made to the Headworks Operator accordingly. The Headworks Operator shall promptly consider, act on, or refer such recommendations to the Board as it considers appropriate.

5.3 Storage of Documentation

The performance of any flood monitoring and warning system is reliant on accurate historical data over a long period of time. The Senior Flood Operations Engineer shall ensure that all available data and other documentation is appropriately collected and catalogued as approved by the Board, for future use. The Board shall keep the master of this documentation with copies being held by the Headworks Operator and the Manager Dam Safety.

5.4 Key Reference Gauges

Key field station locations have been identified for reference purposes when flood information is exchanged between authorities or given to the public. Should it be deemed desirable to relocate field stations from these locations, or vary flood classification levels, agreement shall first be obtained between the Board, Headworks Operator, Bureau of Meteorology and the Local Governments within whose boundaries the locations are situated. The locations and gauge readings at which the various classifications of flooding occur are contained in Appendix D.

Gauge boards which can be read manually shall be maintained as part of the equipment of each key field station. The Board shall have procedures to ensure such gauge boards are read in the event of failure of field stations to operate.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, Ipswich City Council and the Brisbane City Council have direct access to the information from field stations for flood assessment purposes. The consultation between agencies is a very important part of the assessment and prediction of flood flows and heights.

The Board shall ensure that information relative to the calibration of the Board's field stations is shared with such agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

The Board is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams.

The Headworks Operator is responsible for ensuring that adequate communication exists at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams. Where equipment deficiencies are detected during normal operations, such deficiencies are to be reported within one week to the Board for timely corrective action.

6.2 Dissemination of Information

Adequate and timely information is to be supplied to agencies responsible for the operation of facilities affected by flooding and for providing warnings and information to the public. These agencies shall include agencies holding Controlled Documents (Appendix B), and the persons and agencies listed in the Schedule of Authorities (Appendix C). For this purpose, the Board shall maintain a Register of Contact Persons for Information, their means of contact and the type of information to be supplied to each. The Board shall ensure that each agency receives a copy of the updated Register of Contact Persons for Information whenever amendments are made, but at least every 6 months.

The Flood Operations Engineer shall supply information (refer 6.3) to each of these contact persons during dam releases.

All enquiries other than provided for in the Register of Contact Persons for Information, either to the Headworks Operator, the Senior Flood Operations Engineer, the Flood Operations Engineer or dam site staff shall be referred to the Board. The Board shall provide a mechanism to receive these enquiries from the time it is advised that releases from the dams are likely until flood release operations are completed.

Some agencies have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public. The Board, Headworks Operator, Senior Flood Operations Engineer and Flood Operations Engineer shall liaise and consult with those agencies with a view to ensuring all information relative to the flood event is consistent, and used and disseminated in accordance with agreed responsibilities.

6.3 Nature of Information

When, in the opinion of the Flood Operations Engineer, a flood situation is imminent and gate operations are likely, and is of a magnitude that it is likely to cause flows to exceed 2,000 m^3/s at Lowood, the Flood Operations Engineer shall advise those listed in the Register of Contact Persons for Information of :

(a) the current and proposed releases from the dams, and

(b) the estimated flow rates and water heights at the key reference gauges listed in Appendix D.

This information is to be updated at intervals as better and more accurate information becomes available.

6.4 Release of Information to the Public

The Board is responsible for the issue of information regarding storage conditions and current and proposed releases from the dams to the public and the media.

The Bureau of Meteorology has responsibility for issuing flood warnings.

The Emergency Services Response Authorities, under the State Counter Disaster Organisation Act 1975, have responsibility for the preparation of a local counter disaster plan hence the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

This review of the Manual has addressed the mechanisms of delegation and control of the dams in periods of operation of the dams for flood mitigation. It is known overtopping of the dams can result should floods occur which are derived from lesser rainfall than the probable maximum precipitation storm or from the combination of two lesser storms in close proximity. The dams may also overtop in the eventuality that the flood gate control systems fail to operate or partially malfunction during the passage of a major flood or combination of floods.

Procedures and systems have been developed since the last revision which should enable lower risk operation of the dams for flood mitigation purposes. This technology is intended to provide longer warning times and the capability of examining options to optimise the safety of the dams and minimise the hazard potential and risk to the community.

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances.

It is important, therefore, that the Manual contain operational procedures which in themselves cause the Manual's procedures, and the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

The checking and reviewing process must involve the Headworks Operator and all associated operations personnel in order that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based.

Variations to the Manual may be made in accordance with provisions in Section 1.8.

7.2 Personnel Training

The Headworks Operator shall report to the Board by 30th September each year on the training and state of preparedness of operations personnel.

7.3 Monitoring and Warning System

The Headworks Operator shall provide a report to the Board by the 1st May and 1st November of each year; and after each flood event. The report shall assess in terms of hardware, software and personnel, the :

- reliability of the system over the previous period,
- reliability of the system under prolonged flood conditions,
- accuracy of forecasting flood flows and heights, and
- the overall state of preparedness of the system.

The Board shall review the report, and taking into account its own log of the performance of the field equipment, take any action considered necessary for the proper functioning and improvement of the system.

7.4 Communications Networks

The Headworks Operator by the 30 September of each year, after every event that results in flood operation of the dams and at other times as appropriate, shall review the adequacy of the communication and data gathering facilities and make recommendations to the Board regarding improving reliability.

7.5 Operational Review

After each significant flood event, the Board shall review the effectiveness of the operational procedures contained in this manual.

7.6 Five Yearly Review

The Board, at intervals of no greater than five years shall review the Manual pursuant to Section 106 of the Act. The review is to take into account the continued suitability of the communication network, and the flood monitoring and warning system as well as hydrological and hydraulic engineering assessments of the operational procedures. The hydrologic investigations performed for the purpose of this manual are discussed in Appendix I..

8 WIVENHOE DAM

8.1 Introduction

Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the dam, depending on the part of the catchment in which the flood originates and depending also on the magnitude of the flood.

A general plan and cross-section of Wivenhoe Dam, and relevant elevations are included in Appendix J.

Storage and discharge data are included in Appendix E.

The reservoir volume above FSL of EL 67.0 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the initial reservoir level below FSL, the magnitude of the flood being regulated and the procedures adopted.

The Board has acquired land above FSL to a level of EL 75.0 to provide temporary flood storage. Reasonable care shall be exercised to confine the flood rises to below this level. This requirement should be ignored in the case of extreme floods which threaten the safety of the dams.

8.2 Initial Action

When indications are received of an imminent flood, the flood control operation of the dam shall commence with the storing of all inflow of the Brisbane River in Wivenhoe Dam, whilst an assessment is made of the origin and magnitude of the flood. The spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25.

8.3 Regulator and Gate Operation Procedures

Rapid opening of outlets (spillway gates and regulators) can cause hydraulic surges and other effects in the Brisbane River which can endanger life and property and may sometimes have other adverse effects. Under normal gate operations, the gates and regulators are therefore to be operated one at a time at intervals which will minimise adverse impacts on the river system.

Rapid closure of the gates can affect river bank stability. Rapid closure of more than one gate at a time should only be used when time is critical and there is a requirement to correct a malfunction to preserve storage or to reduce downstream flooding rapidly. For flood operations where time is not critical, longer closure intervals should be used. The minimum closure intervals specified below are based on experience from the 1974 flood.

Except as provided for in procedure 4 of Section 8.4, the gate opening and closing intervals as tabled below are the most rapid permitted for flood mitigation purposes.

Table 8.1
WIVENHOE DAM
MINIMUM INTERVALS for Normal Operation

500 mm Incremental gate openings	10 minutes
500 mm Incremental gate closures	20 minutes
Full regulator opening or closures	30 minutes

Gates are numbered 1 to 5 from the left bank looking downstream.

Under normal operation, only one gate is to be opened at any one time and the following procedures are to be adopted:

(a) For flows up to 500 m^3/s, gate 3 is to be used.

(b) For flows between 500 and 1 500 m^3/s, gates 2 and 4 are to be opened alternately in increments, until such time that the discharge jet starts to impinge on the walls of the plunge pool, whereupon gates 1 and 5 are to be operated alternately as well.

(c) Until such time as they are required to increase the capacity of the spillway, gates 1 and 5 are to be opened only sufficiently to deflect the spillway discharge jet away from the plunge pool walls and into the pool.

(d) For discharges greater than 1 500 m^3/s, all gates are to be used to control the flow according to the following procedure.

  (i) Gate 3 is to have the largest aperture.

  (ii) Gates 2 and 4 are to be moved alternately in increments, and both are to have apertures equivalent to or less than that of gate 3.

  (iii) Gates 1 and 5 are to be moved alternately in increments, and both are to have apertures equivalent to or less than those of gates 2 and 4 respectively.

Gate operating procedures in the event of equipment failure are contained in Appendix G.

In general, gate closing is to occur in the reverse order.

8.4 Flood Control Procedures

When the preliminary estimation of the degree of expected flooding has been made, the operating procedures set out hereunder shall be used at Wivenhoe Dam.

As the magnitude of the expected flood increases, the procedures to be adopted commence with Procedure 1 and extend to Procedure 4 as set out in the following table in response to current and predicted inflows both into the dams, and into the Brisbane River from tributaries downstream of the dams.

Provision is made for the releases to be regulated so as to lessen the impact when peak flows from Lockyer Creek, Bremer River and other tributaries enter the Brisbane River. This may result in the releases being decreased for a time even though lake levels are rising.

Provision is also made for the releases from Wivenhoe Dam to be regulated in the early procedures so as not to unduly submerge bridges. The relevant bridges and their estimated submergence flows are included in Appendix D.

Wivenhoe Dam - Normal gate operating Procedures

Procedure	Reservoir level	Applicable Limits		
0	EL ≤ 67.25	$Q_{Wivenhoe} = 0\ m^3/sec$ ... i.e No Releases		$Q_{Moggill} < 4000\ m^3/sec$
1A	67.25 < EL ≤ 67.50	$Q_{Wivenhoe} < 110\ m^3/sec$	$Q_{Colleges\ Crossing} < 175\ m^3/sec$ with care taken not to submerge Twin Bridges prematurely	
1B	67.50 < EL ≤ 67.75	$Q_{Wivenhoe} < 210\ m^3/sec$	$Q_{Burtons/Noogoorah} < 250\ m^3/sec$ with care taken not to submerge Colleges Crossing prematurely	
1C	67.75 < EL ≤ 68.00	$Q_{Wivenhoe} < 500\ m^3/sec$	$Q_{Kholo} < 550\ m^3/sec$ with care taken not to submerge Burtons/Noogoorah prematurely	
1D	68.00 < EL ≤ 68.25	$Q_{Wivenhoe} < 900\ m^3/sec$	$Q_{MtCrosby} < 1900 m^3/sec$ with care taken not to submerge Kholo prematurely	
1E	68.25 < EL ≤ 68.50	$Q_{Wivenhoe} < 1500\ m^3/sec$	$Q_{MtCrosby} < 1900 m^3/sec$ with care taken not to submerge Kholo prematurely	
2	68.50 < EL < 74.00	$Q_{Lowood} < 3500\ m^3/sec$	Q_{Lowood} < peak of Lockyer and Q_{Lowood} < peak of Bremer	
3	68.50 < EL < 74.00	$Q_{Lowood} < 3500\ m^3/sec$	$Q_{Moggill} < 4000\ m^3/sec$	
4	EL ≤ 74.00 or dam safety may be compromised	Gates are to be opened until reservoir level begins to fall	Gate opening interval restrictions NO LONGER apply	Gates are NOT to be overtopped

8.5 Closing Procedures

If at the time the lake level in Wivenhoe Dam begins to fall, the combined flow at Lowood is in excess of 3500 m^3/s, then combined flow at Lowood is to be reduced to 3500m^3/s as quickly as practicable having regard to Section 3.3, and is to remain at this rate until final gate closure procedures can commence.

Gate closing procedures should be initiated having regard to the following requirements:

(a) Early release of stored water to regain flood mitigating ability for any subsequent flood inflows as described in Section 3.3.

(b) Gate operation procedures as described in Section 8.3.

(c) Downstream impact of the discharges.

(d) Establishment of storage at FSL at completion of flood events.

9 SOMERSET DAM

9.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods and optimise the flood mitigation capacity of Wivenhoe Dam.

A general plan and cross-section of Somerset Dam, and relevant dam operating levels are included in Appendix J.

The discharge capacities for various storage levels of Somerset Dam are listed in Appendix F.

9.2 Initial Action

Upon indications being received of a significant inflow, the flood control operation of the dam shall commence with the raising of any closed gates and the closure of all low level regulators and sluices, whilst an assessment is made of the origin and magnitude of the flood.

9.3 Regulator and Gate Operation Procedures

The following minimum intervals shall be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes:

Table 9.1
SOMERSET DAM
MINIMUM INTERNALS FOR NORMAL OPERATIONS

	OPENING	CLOSING
Regulators	30 minutes	60 minutes
Sluice Gates	120 minutes	180 minutes
Crest Gates	Gates are normally open	

9.4 Flood Control Procedure

It is essential that the operating procedures adopted should not endanger the safety of Wivenhoe Dam. Within this constraint, the Senior Flood Operations Engineer shall adopt a procedure for the operation of Somerset Dam such that:

(a) the structural safety of Somerset Dam is not endangered;

(b) the Upper Brisbane River flood flow plus Somerset Dam releases does not cause Wivenhoe Dam to be overtopped.

The normal operating procedure to be used for Somerset Dam is as follows.

The crest gates are raised to enable uncontrolled discharge. The low level regulators and sluices are to be kept closed until either:

(i) the lake level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

In the case of (i) above the opening of the regulators and sluices is not to increase the inflow to Wivenhoe Dam above the peak inflow from the Brisbane River just passed or, if possible, not to cause the Wivenhoe Dam lake level to exceed EL 74.

In the case of (ii) above, the Senior Flood Operations Engineer shall direct the operation of the low level regulators and sluices to ensure the safety of Somerset Dam.

10 EMERGENCY

10.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition either through flood events or other causes. Experience elsewhere in the world suggests that vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than the Evaluation Design Flood (EDF);
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood.
- Development of a pipe through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;
- Other rarer mechanisms.

Responses to these and other conditions are included in separate Emergency Action Plans.

10.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates.

In the event that the probability of overtopping of Wivenhoe Dam is unacceptably high, then as an absolute last resort the saddle dams may be breached. Such actions shall only be initiated with the approval of the Chief Executive.

Somerset Dam should, if possible, not be overtopped by flood water but, if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced, for example by the use of its spillway gates, even at the risk of overtopping Somerset Dam in order to prevent, if possible, the overtopping of Wivenhoe Dam.

10.3 Communications Failure

In the event of normal communications being lost between the Flood Operations Engineer and either Wivenhoe Dam or Somerset Dam, the dam supervisor at that dam is to maintain contact with the dam supervisor at the other dam, to receive instructions through the remaining communications link.

In the event of normal communications being lost between the Flood Operations Engineer and both Wivenhoe Dam and Somerset Dam, the dam supervisors at each dam are to adopt the procedures set out below during flood events, and are to maintain contact with each other, where possible.

If all communications are lost between the Engineer, Wivenhoe Dam and Somerset Dam, the officers in charge at each dam are to adopt the procedures set out below.

10.4 Wivenhoe Dam Emergency Procedure

In the event of total communication failure, the minimum gate openings related to lake level set out in the table below are to be maintained for both opening and closing operations.

Table 10.4 Minimum Gate Openings Wivenhoe Dam

Lake Level m AHD	Gate 3 Opening (m)	Gates 2 & 4 Opening (m)	Gates 1 & 5 Opening (m)	Discharge m^3/s
67.0		-	-	0
67.5	0.5	-	-	50
68.0	1.5	-	-	155
68.5	2.5	-	-	260
69.0	4.5	-	-	460
69.5	4.5	1.0	-	690
70.0	4.5	2.0	-	925
70.5	4.5	3.0	-	1160
71.0	4.5	4.0	-	1400
71.5	4.5	4.0	0.5	1540
72.0	4.5	4.0	1.5	1810
72.5	4.5	4.0	3.0	2200
73.0	5.0	5.0	5.0	2960
73.5	6.5	6.5	6.5	3850
74.0	8.0	8.0	8.0	4750
74.5	10.0	10.0	10.0	6030
75.0	12.5	12.5	12.5	7830
75.5	14.0	14.0	14.0	9150
76.0	Fully Open	Fully Open	Fully Open	10790
76.5	Fully Open	Fully Open	Fully Open	11250
77.0	Fully Open	Fully Open	Fully Open	11720

If one or more gates become inoperable, then by reference to Table E-2 the gate openings of operable gates are to be increased in order that the discharges for the lake levels shown in Table 10.4 are achieved.

If, because of compliance with the provisions of Section 8.3 and the high inflow rate, the minimum gate openings cannot be maintained, the time intervals between successive openings shown in Table 8.1 are to be halved.

If the actual gate openings fall more than three settings below the cumulative number of minimum settings of Table 10.4, then successive gate operations are to be carried out as rapidly as possible until the minimum settings are achieved. Under these circumstances, it may be necessary to operate more than one gate at any one time.

10.5 Somerset Dam Emergency Procedure

In the event of total communication failure, the spillway gates are to be kept raised to allow uncontrolled discharge. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

The level in Wivenhoe Dam can be determined locally by the Dam Supervisor at Somerset Dam from the tailwater gauge located just downstream of Somerset Dam.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe Dam above the peak level already attained. Section 9.3 on regulator and gate operation interval is to be observed.

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and the non-spillway crest level in Somerset Dam (EL 107.46). The low level outlets in Somerset Dam are not to be opened if the water level in Wivenhoe Dam exceeds the level set out below for given water levels in Somerset Dam.

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

10.6 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix G for Wivenhoe Dam and Appendix H for Somerset Dam.

APPENDIX A EXTRACT FROM ACT

EXTRACT FROM SOUTH EAST QUEENSLAND WATER BOARD ACT 1979

Operational procedures for flood mitigation

106.(1) The Technical Advisory Committee shall cause to be prepared a manual of operational procedures in relation to each reservoir or a combined manual in relation to two or more reservoirs under the control of the Board for the purpose of flood mitigation and may from time to time cause to be prepared such amendments thereto as the committee considers necessary.

(1A) Every manual and all amendments thereto prepared under this subsection (1) shall be submitted to the Board which shall submit the same with its recommendations, to the Minister within 40 days after it receives the same.

(2) A manual prepared under subsection (1), or any other amendment of the manual, that is recommended by the Technical Advisory Committee shall not be effective until it is approved by the Minister.

(4) A manual of operational procedures may vest in any person mentioned therein and regulate the function of exercising a reasonable discretion in any manta as part of the flood mitigation procedures.

Board, Headworks Operator bound by manual

107. The operational procedures to be adopted by the Board in respect of the reservoirs under its control for the purpose of flood mitigation shall be as provided by the relevant manual prepared under section 106 as duly amended at the material time and such manual, as duly amended at the material time, shall be observed by the Board and its employees and the Headworks Operator and its employees.

Minister, Board, Headworks Operator not liable for flood damage

108. The Minister, the Board, the Headworks Operator and an employee of the Board or the Headworks Operator shall not be liable for damages claimed in respect of loss or injury alleged to arise from:

(a) the carrying out of flood mitigation procedures of the Board if such procedures were carried out under the general direction of a suitably qualified and experienced engineer in accordance with the operational procedures specified by the relevant manual prepared under section 106; or

(b) the inaccuracy of information released on behalf of the Board or the Headworks Operator or by an employee of the Board or the Headworks Operator concerning anticipated flooding or the anticipated levels of flooding.

APPENDIX B AGENCIES HOLDING DOCUMENTS

AGENCIES HOLDING CONTROLLED DOCUMENTS OF MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR WIVENHOE DAM AND SOMERSET DAM

Dam Owner	South East Queensland Water Board
Emergency Services	Department of Emergency Services, Disaster Management Service Brisbane City Counter Disaster Committee Esk Shire Counter Disaster Committee Ipswich City Counter Disaster Committee Kilcoy Shire Counter Disaster Committee
Severe Weather Warning Authority	Bureau of Meteorology
Primary Response Authorities	Brisbane City Council Esk Shire Council Ipswich City Council Kilcoy Shire Council
Regulator of Dam Safety	Department of Natural Resources
Schedule of Authorities, Appendix C	Agencies and persons listed in Appendix C

The Board shall keep a register of contact persons of holders of controlled documents (Section 1.9 refers).

APPENDIX C SCHEDULE OF AUTHORITIES

AUTHORITY	AGENCY/PERSON	APPROVED BY	APPROVAL DATE	REFERENCE
Headworks Operator	State Water Projects Primary Industry Corporation	Minister	26 June, 1996	Board Contract No. T5-1995/96 expiring 30 June 2001
Senior Flood Operations Engineer	Department of Natural Resources	Minister	Date of approval of this manual	
	Department of Natural Resources			
Flood Operations Engineer	Department of Natural Resources	Minister	Date of approval of this manual	
	Department of Natural Resources	Minister	Date of approval of this manual	
	Department of Natural Resources	Minister	Date of approval of this manual	
	C/- Department of Natural Resources	Minister	Date of approval of this manual	

APPENDIX D GAUGES AND BRIDGES

D.1. KEY REFERENCE GAUGES

BRISBANE CITY

	FLOOD CLASSIFICATION			
Gauge	Minor	Moderate	Major	1974 Flood
Moggill	10.0	13.0	15.5	19.9
Jindalee	6.0	8.0	10.0	14.1
Brisbane City Gauge (B.C.G)	1.7	2.6	3.5	5.5

(Reference: Brisbane City Disaster Management Plan, Flood Management Special Plan 30 July, 1996)

IPSWICH CITY

	FLOOD CLASSIFICATION			
Gauge	Minor	Moderate	Major	1974 Flood
David Trumpy Bridge	7.0	9.0	11.7	20.7
Mt Crosby Weir	11.0	13.0	21.0	26.7
Moggill	10.0	13.0	15.5	19.9

ESK SHIRE

	FLOOD CLASSIFICATION		
Gauge	Minor	Moderate	Major
Lowood Alert Station	8.6	15.9	21.2

KILCOY SHIRE

	FLOOD CLASSIFICATION		
Gauge	Minor	Moderate	Major
Somerset Dam Reservoir Level	103.0	105.0	106.0

Values are in metres AHD

APPENDIX D

D.2. SUBMERGENCE FLOWS FOR BRIDGES

AMTD	Bridge Name	Estimated Submergence Flow m³/s
140	Twin Bridges	50
87	College's Crossing	175-200*
120	Burton's Bridge	250
100	Kholo Bridge	550
91	Mt.Crosby Weir Bridge	1900
136	Fernvale Bridge	2000

* Affected by tides.

Twin Bridges, Wivenhoe Pocket Road, Fernvale
College's Crossing, Mt Crosby Rd, Karana Downs
Burton's Bridge, E Summerville Rd, Borallon
Kholo Bridge, Kholo Rd, Ipswich
Mt Crosby Weir Bridge, Allawah Rd, Mt Crosby
Fernvale Bridge, Brisbane Valley Highway, north of Fernvale

APPENDIX E WIVENHOE DAM TECHNICAL DATA
TABLE E1 STORAGE AND UNCONTROLLED DISCHARGES

Lake level m AHD	Storage Capacity 10^6 m^3	*** Flood Capacity 10^6 m^3	** Net Inflow per 1mm rise per hour m^3/s	* Discharge per Regulator m^3/s	* Discharge per Spillway Bay m^3/s	Maximum Available Discharge m^3/s
57.0	414	-	11.10	24.9	0	50
57.5	453	-	12.04	25.2	4	69
58.0	466	-	12.97	25.4	15	128
58.5	494	-	13.90	25.7	32	211
59.0	523	-	14.84	25.9	53	316
59.5	553	-	15.77	26.2	77	439
60.0	584	-	16.71	26.4	105	579
60.5	616	-	17.64	26.6	136	735
61.0	649	-	18.58	26.9	170	905
61.5	683	-	19.51	27.1	207	1 090
62.0	719	-	20.45	27.3	246	1 290
62.5	756	-	21.38	27.5	288	1 495
63.0	795	-	22.32	27.8	333	1 720
63.5	835	-	23.25	28.0	379	1 950
64.0	877	-	24.19	28.2	428	2 195
64.5	920	-	25.12	28.4	479	2 450
65.0	965	-	26.06	28.7	532	2 720
65.5	1 012	-	26.99	28.9	587	2 995
66.0	1 061	-	27.92	29.1	645	3 280
66.5	1 112	-	28.86	29.3	704	3 580
67.0	1 165	0	29.79	29.5	765	3 885
67.5	1 220	56	30.73	29.7	828	4 200
68.0	1 276	112	31.66	29.9	893	4 525
68.5	1 334	171	32.60	30.1	959	4 860
69.0	1 393	230	33.53	30.3	1 028	5 200
69.5	1 454	290	34.47	30.5	1 098	5 550
70.0	1 517	350	35.40	30.7	1 170	5 910
70.5	1 581	418	36.33	30.9	1 244	6 280
71.0	1 647	485	37.27	31.1	1 319	6 660
71.5	1 714	550	38.20	31.3	1 396	7 040
72.0	1 783	615	39.14	31.5	1 474	7 430
72.5	1 854	683	40.07	31.7	1 554	7 840
73.0	1 926	750	41.01	31.9	1 636	8 240
73.5	2 000	830	41.94	32.1	1 719	8 660
74.0	2 076	910	42.87	32.3	1 804	9 080
74.5	2 153	995	43.81	32.5	1 890	9 520
75.0	2 232	1 080	44.74	32.7	1 978	9 960
75.5	2 313	1 160	45.68	32.9	2 067	10 400
76.0	2 395	1 240	46.61	33.1	2 158	10 860
76.5	2 480	1 258	47.55	33.3	2 250	11 320
77.0	2 566	1 420	48.48	33.4	2 343	11 780
77.5	2 655	1 500	49.41	36.6	2 438	12 260
78.0	2 746	1 580	50.35	33.8	2 535	12 740
78.5	2 839	1 680	51.28	34.0	2 632	13 230
79.0	2 934	1 780	52.22	34.2	2 731	13 730

* This is the maximum discharge of an individual spillway bay or regulator. Total discharge is calculated by adding the contributions of each gate or regulator. There are two (2) regulators to five (5) spillway bays.

** This assumes that all gates and sluices are closed. Discharges through the spillway have to be added to the above figures to calculate the actual inflow into the reservoir.

*** The temporary storage above normal Full Supply Level of EL 67.0.

TABLE E2 CONTROLLED GATE DISCHARGES

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water El. (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
67.0	0	49	98	146	194	240	285	329	372	413	453	492	530	567	603	639	675	709	744	765															
67.2	0	49	99	148	196	243	288	333	376	418	458	498	537	574	611	648	684	720	755	790															
67.4	0	50	100	149	198	245	291	336	380	422	464	504	543	582	619	657	693	730	766	802	815														
67.6	0	50	101	151	200	248	294	340	384	427	469	510	550	589	627	665	702	740	777	814	841														
67.8	0	51	102	152	202	250	297	343	388	432	474	515	556	596	635	673	712	750	787	825	863	867													
68.0	0	51	103	154	204	253	300	347	392	436	479	521	562	603	642	682	721	759	798	837	876	893													
68.2	0	52	104	155	206	255	303	350	396	441	484	527	569	610	650	690	729	769	808	848	888	919													
68.4	0	52	105	156	207	257	306	354	400	445	489	532	575	616	657	698	738	778	818	859	899	940	946												
68.6	0	53	105	158	209	260	309	357	404	450	494	538	581	623	665	706	747	788	829	870	911	953	973												
68.8	0	53	106	159	211	262	312	360	408	454	499	543	587	630	672	714	755	797	838	880	923	965	1000												
69.0	0	54	107	160	213	264	315	364	412	458	504	549	593	636	679	722	764	806	848	891	934	977	1022	1028											
69.2	0	54	108	162	215	267	317	367	415	463	509	554	599	643	686	729	772	815	858	901	945	989	1035	1056											
69.4	0	54	109	163	217	269	320	370	419	467	514	560	605	649	693	737	780	824	868	912	956	1001	1047	1084											
69.6	0	55	110	164	218	271	323	373	423	471	518	565	611	656	700	744	789	833	877	922	967	1013	1060	1107	1112										
69.8	0	55	111	166	220	273	326	377	427	475	523	570	616	662	707	752	797	842	887	932	978	1025	1072	1121	1141										
70.0	0	56	112	167	222	276	328	380	430	479	528	575	622	668	714	759	805	850	896	942	989	1036	1085	1134	1170										
70.2	0	56	112	168	224	278	331	383	434	484	532	580	628	674	721	767	813	859	905	952	1000	1048	1097	1147	1198	1199									
70.4	0	56	113	170	225	280	334	386	437	488	537	586	633	680	727	774	821	867	914	962	1010	1059	1109	1160	1212	1229									
70.6	0	57	114	171	227	282	336	389	441	492	542	591	639	687	734	781	828	876	923	972	1020	1070	1121	1173	1226	1258									
70.8	0	57	115	172	229	284	339	392	445	496	546	596	644	693	741	788	836	884	932	981	1031	1081	1133	1185	1239	1289									
71.0	0	58	116	173	230	286	341	395	448	500	551	601	650	699	747	795	844	892	941	991	1041	1092	1144	1198	1252	1309	1319								
71.2	0	58	117	175	232	289	344	398	452	504	555	605	655	705	754	802	851	900	950	1000	1051	1103	1156	1210	1266	1323	1349								
71.4	0	58	117	176	234	291	347	401	455	508	559	610	661	710	760	809	859	908	959	1009	1061	1114	1167	1222	1279	1337	1380								
71.6	0	59	118	177	235	293	349	404	458	512	564	615	666	716	766	816	866	916	967	1019	1071	1124	1179	1234	1292	1350	1410	1411							
71.8	0	59	119	178	237	295	352	407	462	515	568	620	671	722	773	823	874	924	976	1028	1081	1135	1190	1246	1304	1364	1425	1443							
72.0	0	60	120	180	239	297	354	410	465	519	572	625	676	728	779	830	881	932	984	1037	1091	1145	1201	1258	1317	1377	1439	1474							
72.2	0	60	121	181	240	299	357	413	469	523	577	629	682	733	785	837	888	940	993	1046	1100	1156	1212	1270	1330	1391	1454	1506							
72.4	0	60	121	182	242	301	359	416	472	527	581	634	687	739	791	843	895	948	1001	1055	1110	1166	1223	1282	1342	1404	1468	1533	1538						
72.6	0	61	122	183	243	303	361	419	475	531	585	639	692	745	797	850	903	956	1009	1064	1119	1176	1234	1293	1354	1417	1482	1548	1570						
72.8	0	61	123	184	245	305	364	422	478	534	589	643	697	750	803	856	910	963	1018	1073	1129	1186	1245	1305	1367	1430	1496	1563	1603						

UNCONTROLLED DISCHARGE

TABLE E2 CONTROLLED GATE DISCHARGES

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
73.0	0	62	124	185	247	307	366	425	482	538	593	648	702	756	809	863	917	971	1026	1081	1138	1196	1255	1316	1379	1443	1509	1577	1636						
73.2	2	62	124	187	248	309	369	427	485	542	597	653	707	761	815	869	924	978	1034	1090	1147	1206	1266	1327	1391	1456	1523	1592	1663	1669					
73.4	6	62	125	188	250	311	371	430	488	545	602	657	712	767	821	876	931	986	1042	1099	1156	1216	1276	1339	1403	1469	1536	1606	1678	1702					
73.6	11	64	126	189	251	313	373	433	491	549	606	662	717	772	827	882	937	993	1050	1107	1166	1225	1287	1350	1414	1481	1550	1620	1693	1736					
73.8	17	69	127	190	253	315	376	436	495	553	610	666	722	778	833	888	944	1001	1058	1116	1175	1235	1297	1361	1426	1494	1563	1635	1708	1770					
74.0	23	74	129	191	254	317	378	438	498	556	614	671	727	783	839	895	951	1008	1065	1124	1184	1245	1307	1372	1438	1506	1576	1648	1723	1800	1804				
74.2	31	80	133	192	256	319	380	441	501	560	618	675	732	788	845	901	958	1015	1073	1132	1192	1254	1317	1382	1449	1518	1589	1662	1738	1815	1838				
74.4	39	87	139	195	257	321	383	444	504	563	622	679	737	793	850	907	964	1022	1081	1140	1201	1264	1327	1393	1461	1530	1602	1676	1752	1831	1873				
74.6	47	94	145	200	259	322	385	447	507	567	626	684	741	799	856	913	971	1029	1089	1149	1210	1273	1337	1404	1472	1542	1615	1690	1767	1846	1908				
74.8	56	103	153	206	262	324	387	449	510	570	629	688	746	804	862	919	978	1036	1096	1157	1219	1282	1347	1414	1483	1554	1628	1703	1781	1861	1943				
75.0	66	112	161	213	267	326	390	452	513	574	633	692	751	809	867	926	984	1044	1104	1165	1227	1291	1357	1425	1494	1566	1640	1717	1795	1876	1960	1978			
75.2	76	121	169	220	274	330	392	455	516	577	637	697	756	814	873	932	991	1051	1111	1173	1236	1301	1367	1435	1506	1578	1653	1730	1809	1891	1976	2013			
75.4	87	131	178	229	281	336	394	457	519	581	641	701	760	819	878	938	997	1057	1119	1181	1245	1310	1377	1446	1517	1590	1665	1743	1823	1906	1992	2049			
75.6	98	141	188	237	289	343	399	460	522	584	645	705	765	824	884	944	1004	1064	1126	1189	1253	1319	1386	1456	1527	1601	1678	1756	1837	1921	2007	2085			
75.8	109	152	198	247	298	350	405	463	525	587	649	709	769	829	889	949	1010	1071	1133	1197	1261	1328	1396	1466	1538	1613	1690	1769	1851	1936	2023	2112	2121		
		OVERTOPPING of GATE																																	
76.0	121	164	209	257	307	359	412	468	528	591	652	713	774	834	895	955	1016	1078	1141	1205	1270	1337	1405	1476	1549	1624	1702	1782	1865	1950	2038	2129	2158		
76.2	133	175	220	268	317	368	421	475	532	594	656	718	779	839	900	961	1023	1085	1148	1212	1278	1346	1415	1486	1560	1636	1714	1795	1878	1965	2053	2145	2194		
76.4	146	187	232	279	327	378	429	483	539	597	660	722	783	844	906	967	1029	1092	1155	1220	1286	1354	1424	1496	1570	1647	1726	1808	1892	1979	2069	2161	2231		
76.6	159	200	244	290	338	388	439	492	546	603	664	726	788	849	911	973	1035	1098	1162	1228	1295	1363	1434	1506	1581	1658	1738	1820	1905	1993	2084	2177	2268		
76.8	173	213	257	302	350	399	449	501	554	610	668	730	792	854	916	978	1041	1105	1170	1235	1303	1372	1443	1516	1591	1669	1750	1833	1919	2007	2099	2193	2289	2306	
		OVERTOPPING of GATE																																	
77.0	186	226	270	315	362	410	460	511	564	618	674	734	797	859	921	984	1047	1112	1177	1243	1311	1380	1452	1526	1602	1680	1762	1845	1932	2021	2113	2208	2306	2343	
77.2	200	240	283	328	374	422	471	522	574	627	682	739	801	864	927	990	1054	1118	1184	1250	1319	1389	1461	1536	1612	1691	1773	1858	1945	2035	2128	2224	2322	2381	
77.4	215	254	297	341	387	435	483	533	584	637	691	747	806	869	932	996	1060	1125	1191	1258	1327	1398	1470	1545	1622	1702	1785	1870	1958	2049	2143	2239	2339	2419	
77.6	230	269	311	355	400	447	496	545	595	647	700	756	813	873	937	1001	1066	1131	1198	1265	1335	1406	1479	1555	1633	1713	1796	1882	1971	2063	2157	2255	2355	2457	
77.8	245	283	325	369	414	461	508	557	607	658	711	765	821	880	942	1007	1072	1138	1205	1273	1343	1414	1488	1564	1643	1724	1808	1894	1984	2076	2172	2270	2371	2475	2496
78.0	260	299	340	383	428	474	522	570	619	670	722	775	831	888	948	1012	1078	1144	1211	1280	1351	1423	1497	1574	1653	1735	1819	1907	1997	2090	2186	2285	2387	2492	2535

UNCONTROLLED DISCHARGE

APPENDIX F SOMERSET DAM TECHNICAL DATA

Table F-1
STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake level m AHD	Reservoir Capacity 10^6 m^3	Temporary Flood Storage 10^6 m^3	Net Inflow per 1mm rise per hour m^3/s	Discharge per Regulator* m^3/s	Discharge per Sluice* m^3/s	Discharge per Spillway Bay* m^3/s	Maximum Available Discharge m^3/s
90.0	120.3	-	5.29	57	163	-	1 529
90.5	129.5	-	5.50	58	165	-	1 550
91.0	139.3	-	4.88	58	167	-	1 572
91.5	149.6	-	5.28	59	170	-	1 593
92.0	160.5	-	5.68	60	172	-	1 614
92.5	172.0	-	6.09	60	174	-	1 635
93.0	184.1	-	6.79	61	176	-	1 655
93.5	196.7	-	7.10	62	179	-	1 676
94.0	210.0	-	7.43	62	181	-	1 695
94.5	224.0	-	7.78	63	183	-	1 715
95.0	238.5	-	8.15	64	185	-	1 735
95.5	253.6	-	8.54	64	187	-	1 754
96.0	269.3	-	8.95	65	189	-	1 773
96.5	285.6	-	9.37	66	191	-	1 792
97.0	302.7	-	9.81	66	193	-	1 810
97.5	320.7	-	10.28	67	195	-	1 829
98.0	339.5	-	10.76	67	197	-	1 847
98.5	359.2	-	11.25	68	199	-	1 865
99.0	379.8	0.0	11.77	69	201	-	1 883
99.5	401.4	21.5	12.31	69	203	-	1 901
100.0	428.9	49.0	13.28	70	205	-	1 918
100.5	447.5	67.6	13.83	70	207	0	1 937
101.0	472.2	92.3	14.39	71	209	4	1 989
101.5	498.0	118.1	14.95	72	211	13	2 076
102.0	524.9	145.1	15.53	72	212	25	2 189
102.5	553.1	173.3	16.11	73	214	40	2 325
103.0	582.6	202.7	16.70	73	216	58	2 482
103.5	613.2	233.4	17.30	74	218	78	2 659
104.0	645.1	265.3	17.90	74	220	100	2 854
104.5	678.3	298.4	18.52	75	221	125	3 067
105.0	712.7	332.8	19.14	75	223	151	3 296
105.5	748.3	368.4	19.78	76	225	180	3 542
106.0	785.2	405.4	20.42	76	226	211	3 803
106.5	823.4	443.6	21.07	77	228	243	4 079
107.0	863.1	483.2	21.73	78	230	278	4 370
107.5	904.0	524.2	22.39	78	232	314	4 675

* This is the maximum discharge of an individual gate or regulator. Total discharge is calculated by adding the contributions of each gate or regulator.

Regulator - Discharge regulator valve of which there are four (4).
Sluice - Sluice gate of which there are eight (8).
Spillway - Overflow section of dam controlled by eight (8) radial gates.
Temporary Flood Storage - The temporary storage above the normal full supply level of El 99 m (AHD)

APPENDIX G WIVENHOE DAM GATE OPERATION CONSIDERATIONS

Full size plans of Wivenhoe Dam, and Operations and Maintenance Manuals for Wivenhoe Dam are held by the Board and the Headworks Operator and are available at the site. Operations and Maintenance Manuals relevant to the flood operation of the gates are:

(a) "Master Manual and Drawings."

(b) "Radial and Penstock Gate Hoists and Drawings."

G.1. SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Appendix I shows the general arrangement of the spillway area.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

The main purpose of gating the spillway is to exercise maximum control over the flow in the Brisbane River insofar as river flows in excess of 4 000 m^3/s cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

G.2. RADIAL GATE OPERATING PRINCIPLE

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

APPENDIX I HYDROLOGIC INVESTIGATIONS

I.1. INTRODUCTION

This appendix describes hydrologic analyses performed as part of the Brisbane River and Pine Rivers Flood Studies which have been undertaken since 1990 for as part of the overall safety review of the Board's dams. These studies included an examination of the existing operating procedures for Wivenhoe Dam and Somerset Dam. A detailed report entitled ' Hydrology Report for Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam ' defining the work prior to 1990 is held by the Board and the Headworks Operator. The following reports define work performed during the most recent study "Brisbane River and Pine River Hydrology Reports;

No7 Runoff-Routing Model Calibrations
No8 Design Flood Estimation
No13 Report on Downstream Flooding
No17 Somerset to Wivenhoe Dam Hydraulic Model Calibration
No20 Somerset Dam - Dam Failure Modes
No21 Somerset Dam - Dam Failure Analysis
No22 Wivenhoc Dam Failure Modes
No23 Wivenhoe Dam to Moreton Bay Hydraulic Model Calibration
No24 Wivenhoe Dam - Dam Failure Analysis
No25 Executive Summary Report.

The analyses were carried out using the most appropriate data available in 1993 and it is recommended that they be revised after the occurrence of a large flood or after the adoption of more advanced methods of hydrologic analysis. The work summarised here supersedes previous work including that completed during the design stages of Wivenhoe Dam, details of which are contained in the design report on Wivenhoe Dam.

I.2. METHOD

There are three components in the hydrologic analyses:

(i) a rainfall analysis to determine both rainfall frequency and Probable Maximum Precipitation (PMP)

(ii) a model of the catchment rainfall runoff process; and

(iii) a model of the flood operations of the two dams.

The Bureau of Meteorology completed several studies of the Probable Maximum Precipitation. The Australian generalised method for areas subject to tropical cyclones was used and rainfalls for durations up to seven days were estimated. The Probable Maximum Precipitation was estimated for the whole of the Brisbane River catchment, as well as for various subcatchments. Concurrent rainfall estimates were provided for the remainder of the catchment outside the subcatchment for which the Probable

Maximum Precipitation was provided. The Probable Maximum Precipitation temporal patterns provided by the Bureau of Meteorology were used for all rainfalls.

Rainfall frequency analyses were performed at 37 locations scattered throughout the catchment using the procedure defined in Australian Rainfall and Runoff (1987) which uses a log-pearson III frequency distribution to fit annual series for durations from ten minutes up to seventy-two hours. This methodology provided estimates up to the 1% annual exceedence probability. The extrapolation procedure described in Chapter thirteen of Australian Rainfall and Runoff(1987) was used to determine rainfalls between the 1% annual exceedence probability and PMP.

The rainfall runoff models based on a non-linear runoff routing method were used to estimate the floods. The models were calibrated on recorded storm and flood data.

Models to simulate the flood operation of Somerset and Wivenhoe Dams developed during the mid eighties were modified to incorporate the new structure of the hydrologic models and to more accurately reflect the operational procedures of the dams. These models were then used to calculate dam discharges for a range of design floods generated using the rainfall estimates and the runoff routing models.

I.3. RAINFALL ANALYSIS RESULTS

The rainfall analysis was performed in two parts, the Probable Maximum Precipitation estimate by the Bureau of Meteorology and the rainfall frequency analysis by the Department of Natural Resources. These were used both for design studies for the dam and to test the effects of flood operation procedures.

The estimates of Probable Maximum Precipitation are listed in Table I-1.

Table I-1
Probable Maximum Precipitation (mm)

Duration (days)	Somerset Dam	Wivenhoe Dam	Total Catchment
1	900	670	530
2	1420	870	680
3	1770	1080	830
4	2090	1250	1010
5	2170	1300	1050
6	2220	1330	1070
7	2410	1480	1160

The estimates of rainfall frequency are listed in tables I-2.

Table I-2

Catchment Rainfall (mm) on Wivenhoe Dam Catchment

Annual Exceedence Probability %	1 day	2 day	3 day
1.00	264	341	387
0.10	391	506	590
0.01	551	720	854

Catchment Rainfall (mm) on Somerset Dam Catchment

Annual Exceedence Probability %	1 day	2 day	3 day
1.00	360	475	545
0.10	540	720	860
0.01	700	1050	1200
0.001	860	1350	1560

I.4. RUNOFF ROUTING MODEL CALIBRATION

Ten floods were used for calibration: July 1965, March 1967, June 1967, January 1968, December 1971, January 1974 , January 1976, June 1983, Early April 1989 and Late April 1989. The gauging stations used for model calibration are listed in Table I-3.

The runoff routing model was calibrated for the nineteen major sub-catchments listed in Table I-4. Each of these models was calibrated for as many sites as possible for each of the ten floods. Data were missing for some of the stations for some of the floods. The estimated model parameters are given in Table I-4. In all cases relative delay time parameter (k) used in the model is related to reach length.

Table I-3

Gauging Stations used for Model Calibration

Stream	Site	Number	AMTD (km)	Catchment Area (km^2)
Stanley River	Somerset Dam		7.2	1 335
Cooyar Creek	Damsite	143015	12.2	960
Brisbane River	Linville	143007	282.4	2 005
Emu Creek	Boat Mountain	143010	10.1	920
Brisbane River	Gregor's Creek	143009	251.7	3 885
Cressbrook Creek	Damsite	143013	58.6	325
Brisbane River	Middle Creek	143008	187.2	6 710
Brisbane River	Wivenhoe Dam		150.2	7 020
Brisbane River	Savage's Crossing	143001	130.8	10 180
Bremer River	Walloon	143107	37.2	620
Warrill Creek	Amberley	143108	8.7	920
Lockyer Creek	Lyon's Bridge	143210	27.2	2 540
Brisbane River	City		22.7	13 260

Table I-4

Estimated Model Parameters

Sub-Catchment Name	Model Parmeters	
	(k)	(m)
(1) Cooyar Creek	43.6	0.8
(2) Brisbane River at Linville	20.6	0.8
(3) Emu Creek at Boat Mountain	37.2	0.8
(4) Brisbane River at Gregors Creek	20.1	0.8
(5) Cressbrook Creek at Cressbrook Dam	34.3	0.8
(6) Stanley River at Somerset Dam	80.7	0.8
(7) Brisbane River at Wivenhoe Dam	108.5	0.8
(8) Lockyer Creek at Helidon	15.0	0.8
(9) Tenthill Creek at Tenthill	19.0	0.8
(10) Lockyer Creek at Lyons Bridge	75.0	0.8
(11) Brisbane River at Savages Crossing	40.0	0.8
(12) Brisbane River at Mount Crosby	47.0	0.8
(13) Bremer River at Walloon	44.0	0.8
(14) Warrill Creek at Kalbar	34.0	0.8
(15) Warrill Creek at Amberley	35.0	0.8
(16) Purga Creek at Loamside	49.0	0.8
(17) Bremer River at Ipswich	15.7	0.8
(18) Brisbane River at Jindalee	20.8	0.8
(19) Brisbane River at Port Office	19.3	0.8

MANUAL

OF

OPERATIONAL PROCEDURES

FOR FLOOD MITIGATION

FOR

WIVENHOE DAM

AND SOMERSET DAM

MANUAL

OF

OPERATIONAL PROCEDURES FOR FLOOD MITIGATION

FOR WIVENHOE DAM AND SOMERSET DAM

I, Edmund Casey, Minister for Primary Industries in the State of Queensland do hereby approve and issue the following Manual, and declare that the procedures contained herein shall be the operational procedures in relation to Wivenhoe Dam and Somerset Dam.

Dated this 6th day of October 1992 at Brisbane.

signe[redacted]

E D CASEY

1 INTRODUCTION

1.1 Preface

Given their size and location, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise hazard to life and property.

Recognising this, the South East Queensland Water Board Act 1979-91 requires that its Technical Advisory Committee cause to be prepared a combined manual of operational procedures for the dams for the purpose of flood mitigation.

This Manual has been submitted to the Board which is required to submit same with its recommendations to the Minister charged with administration of the Act for approval. Any amendments to the Manual will have to be treated similarly.

The first Manual so approved specified that its application be for five years and that it then be reviewed. This Manual, which is the result of an extensive review of the first Manual by a Working Group established by the Technical Advisory Committee, will in turn require major reformulation when a computer based time system currently under development is implemented.

Although a large number of detailed changes have been made to the original Manual, the basic procedures for operation of both dams have not been varied. Neither have the primary objectives varied from those defined in the original manual of ensuring safety of the dams, their ability to deal with extreme and closely spaced floods, and protection of urban areas.

The procedures for gate opening at Wivenhoe Dam which are based on river heights at key inflow gauges and on expected downstream inflows also remain essentially the same.

The changes of detail have mostly arisen from a need to recognise the legislative changes regarding the Board and Technical Advisory Committee, changes intended to remove some ambiguities and to update details of, for example, locations of gauging stations.

A significant addition has been the provision for designation by the Headworks Operator of the "Engineer" and of "Operations Engineers" in a Schedule of Authorities, to better reflect the requirements of the referable dam provision of the Water Resources Act, and the requirements for the registration of professional engineers in Queensland. The Engineer and the Operations Engineers are employed by the Headworks Operator which is responsible for the flood operation of the storages.

1.2 Meaning of Terms

In this Manual, save where a contrary intention appears -

"Act"
means the South East Queensland Water Board Act 1979-1991 which is the Brisbane and Area Water Board Act 1979-1988 as amended by the Brisbane and Area Water Board Act Amendment Act 1991.

"A.H.D."
means Australian Height Datum;

"Board" or
"South East Queensland Water Board"
means the body corporate constituted by that name pursuant to Part III of the South East Queensland Water Board Act 1979-1991;

"Brisbane City Council"
means Brisbane City Council under and within the meaning of the City of Brisbane Act 1924;

"Bureau of Meteorology"
means the Commonwealth Bureau of Meteorology;

"Chairperson"
means the Chairperson of the South East Queensland Water Board;

"Commissioner of Water Resources"
means the corporation sole constituted by that name within the meaning of Section 1.4 of the Water Resources Act 1989;

"Controlled Document"
means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Dams"
means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

"EDF"[1] or
"Evaluation Design Flood"
means the flood used for the design of a Dam at the time of design;

"EL"
means elevation in metres from Australian Height Datum;

"Electricity Commissioner"
means the Commissioner under and within the meaning of the Electricity Act 1976;

"Engineer"
means the senior person designated at the time pursuant to Section 2.1.1 of this Manual under whose general direction the procedures in this Manual shall be carried out;

"Gauge height"
means river level as received from the Brisbane Valley Flood Warning Radio Telemetry System, Water Resources Commission Gauges and other gauges;

"Headworks Operator"
means the Body with which the Board has entered into a contract or arrangement with respect to the operation and maintenance of the dams, for the purpose of flood mitigation;

"FSL"[1] or
"FULL SUPPLY LEVEL"
means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"IFF"[1] or
"Imminent Failure Flood"
means the flood which if exceeded would cause failure of a dam;

"Manual" or
"Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam"
means the current version of this Manual;

"Minister"
means the Minister of the Crown who at the material time is charged with the administration of the Act;

"Operations Engineer"
means the person designated at the time pursuant to Section 2.1.1 of this Manual under whose direction the procedures in this Manual shall be carried out;

"Power station"
means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"RDF"[1] or
"Recommended Design Flood"
means the flood which a dam should be designed for in accordance with accepted practices;

"Technical Advisory Committee"
means the Technical Advisory Committee established pursuant to Section 21 of the South East Queensland Water Board Act 1979-1991, as constituted at the material time.

[1] For reference, these terms and definitions are described in "GUIDELINES ON DESIGN FLOODS FOR DAMS 1986" by the Australian National Committee on Large Dams (ANCOLD).

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation.

1.4 Legal Authority

This manual has been prepared in accordance with the provisions of Section 106 of the Act.

1.5 Application and Effect

The procedures in this Manual shall apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall be deemed to meet the relevant dam safety requirements of the Water Resources Act 1989 for the purpose of flood mitigation.

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which the Manual is approved by the Minister.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation, and shall be applied by the Headworks Operator for the operation of the dams.

1.8 Provision for Variations to Manual

If any one of the Commissioner of Water Resources, the Headworks Operator, or the South East Queensland Water Board (including its Technical Advisory Committee) is of the opinion that this Manual requires amendment, it shall make a submission to the South East Queensland Water Board setting forth those circumstances and the exact nature of the amendment, alteration or variation sought.

If the Board is of the opinion that the procedures in this Manual should be amended, altered or varied, it shall submit as soon as practical a recommendation, which is in accordance with the dam safety provisions of the Water Resources Act, to the Minister setting out the circumstances and the exact nature of the amendment, alteration or variation sought.

Any amendment, alteration or variation to the procedures in this Manual shall take effect on and from the date on which the recommendations are approved by the Minister.

1.9 Distribution of Manual

The Board shall regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. The Board shall maintain a register of holders of Controlled Documents and ensure that each issued document is updated whenever amendments are approved by the Minister.

Before using a Manual for the direction of flood control, the user must ensure that it is current and that the Manual is registered as a Controlled Document.

1.10 Authority to Use Discretion

Where it is reasonable to expect that the safety of either dam will not be reduced, temporary deviations from the procedures detailed in this manual may be made in accordance with Section 2.6.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, the Board is responsible for and has the duty for operation and maintenance of Wivenhoe Dam and Somerset Dam, and may enter into arrangements with persons for the purpose of discharging these responsibilities.

All instruments of delegation and contract made in accordance with the Act shall be recorded in the Schedule of Authorities attached to the Manual as Appendix K. Changes to instruments of delegation and contract shall be made in accordance with the Act and incorporated in the Schedule as amendments to the Schedule. The Headworks Operator shall ensure that all persons mentioned in the Schedule are responsible for and have current copies of the Manual, including the Schedule of Authorities.

2.1.1 Designation of Engineer

The procedures set out in this Manual shall be carried out under the general direction of a suitably qualified and experienced person, as may be required under the provisions of the Water Resources Act 1989, who shall be identified and authorised in Appendix K of this manual and be referred to hereafter as the "Engineer".

2.1.2 Designation of Operations Engineers

The Headworks Operator shall employ an adequate number of suitably qualified and experienced "Operations Engineers " to direct the operation of the dams during floods.

The Headworks Operator shall ensure that flood control of the dams is under the direction of an Operations Engineer at all times. Such engineers shall be empowered by the Schedule of Authorities to operate the dams in accordance with this Manual. Only persons empowered by the Schedule can control the flood operation of the dams.

The Headworks Operator shall also employ an adequate number of suitably qualified and experienced engineers to assist the "Operations Engineers " in operation of the dams during floods.

2.2 Qualification of Engineers

All suitably qualified and experienced engineers shall be Registered Professional Engineers of Queensland under the provisions of the Professional Engineers Act 1988 and have experience to the satisfaction of the Commissioner of Water Resources.

All engineers empowered by the Schedule to operate the dams during floods shall be Corporate Members of the Institution of Engineers Australia, or hold equivalent overseas Professional qualifications.

2.2.1 Suitable Experience of Operations Engineers

All engineers empowered by the Schedule of Authorities to operate the dams during floods shall have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

   (a) Investigation, design or construction of major dams;

   (b) Operation and maintenance of major dams;

   (c) Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;

   (d) Applied hydrology with particular reference to flood forecasting and flood warning systems

2.3 Schedule of Authorities

For the purpose of directing operation of the dams during floods, a list of suitably qualified and experienced "Engineers" and "Operations Engneers" shall be maintained in the Schedule of Authorities (Appendix K).

The Headworks Operator shall from time to time nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as Operations Engineers. Each nomination shall include a validated statement of qualifications and experience, a copy of the Certificate of Membership of the Institution of Engineers, Australia, or equivalent and a copy of the Registered Professional Engineer Queensland Certificate.

The Headworks Operator shall, as the need arises, notify the Commissioner of Water Resources of variations to nominations for the Engineer and Operation Engineers in the Schedule of Authorities.

The Commissioner of Water Resources shall review nominations and make recommendations to the Minister for approval.

2.4 Dam Operation Arrangements

For the purposes of operation of the dams during times of flood, the Headworks Operator shall ensure that:

(a) the operation be carried out under the general direction of the Engineer;

(b) in the direction of operations which may knowingly endanger life or property, the Engineer shall where practical liaise with the Board Chairperson and the Commissioner of Water Resources or his delegate.

2.5 Responsibilities of the Engineer

Before adopting an operational procedure to be applied to any flood, the Engineer shall seek and shall take account of all relevant available information.

In evaluating the circumstances, account shall be taken of prevailing weather conditions, the probability of follow up storms, the probability of associated significant rainfall and the ability of either dam to discharge excess flood waters in the period between rainfall events or in the period from the time of detection of conditions associated with the development of storm cells to the likely time of occurrence of the rainfall.

Except insofar as reasonable discretion is provided for in Section 2.6 of this Manual, the Engineer shall ensure that the operational procedures for the dams shall be in accordance with this Manual.

2.6 Reasonable Discretion

If in the opinion of the Engineer, based on available information and professional experience, it is necessary to depart from the procedures set out in this manual, the Engineer is empowered to adopt such other procedures as considered necessary to meet the situation, provided that the Engineer shall observe the objectives set out in Section 4 of this Manual when exercising such reasonable discretion.

Before exercising discretion under this Section of the Manual with respect to flood mitigation objectives, the "Engineer" shall consult with such of the following persons as are available at the time that the discretion has to be exercised:

The Chairperson of the Board;

The Commissioner of Water Resources or nominated delegate.

If not able to contact any of the above within a reasonable time, the "Engineer" shall proceed with the alternative operating procedure and report such action at the earliest opportunity to the above persons.

2.7 Report

The Engineer shall prepare a report to the Board after each event that requires flood operation of the dams and the report shall contain details of the procedures used, the reasons therefor and other pertinent information.

3 COMMUNICATIONS

3.1 Communications between Staff

The Headworks Operator shall be responsible for ensuring that adequate channels of communication exist between the Engineer and site staff at Wivenhoe and Somerset Dams. The Headworks Operator shall from time to time review the adequacy of the communication and data gathering facilities and make recommendations to the Board regarding improving reliability. Where deficiencies are detected during normal operations, such deficiencies are to be reported within a month to the Board for timely corrective action.

3.2 Communications

When, in the opinion of the Engineer, a flood situation is imminent, and is of a magnitude that it is likely to cause flows to exceed 2,000 cubic metres per second at Lowood, the Engineer shall take such measures as are considered necessary to prepare the community for flood releases from the dams. Prior to and during flood releases, for the purpose of having staff on duty for communication purposes and for the provision of information, including assessments of safety of structures, the Engineer shall notify:

(i) The Chairperson of the South East Queensland Water Board, the Flood Operation Centre of the Brisbane City Council, the Commonwealth Bureau of Meteorology, the Department of Transport , and the State Emergency Service of:

  (a) the current and proposed releases from the dams, and

  (b) their estimated likely impacts; and

(ii) The Commissioner of Water Resources of releases where they are expected to exceed 1000 m^3/s at Wivenhoe Dam.

3.3 Dissemination of Flood Information

The Engineer shall ensure that adequate and timely information is supplied to those authorities responsible for operation of facilities affected by flooding and for providing warnings and information to the public. To this end, the Engineer shall supply information to the authorities scheduled in Appendix L during flood releases and emergencies. The Engineer shall assemble and maintain a register of contact persons and their telephone numbers from the scheduled authorities. The Board shall ensure that each registered holder of the Manual (Section 1.9) receives an updated copy of the register whenever amendments are made.

4 FLOOD MITIGATION OBJECTIVES

4.1 General

The primary objective of the flood operation procedures in this Manual is to minimize the hazard to life and property as far as practical. The following objectives, listed in descending order of importance, are as follows:

(a) Ensure the structural safety of the dams;

(b) Ensure available capacity of the dams to deal with extreme floods and closely spaced large floods;

(c) Provide optimum protection of urbanized areas from inundation;

(d) Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries;

(e) Minimise disruption and impact upon Wivenhoe Power Station;

(f) Minimise disruption to navigation in the Brisbane River.

4.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

4.2.1 Wivenhoe Dam

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences due to:

- the magnitude of the damage which would be caused by downstream flooding,
- the loss of a major water supply source for the Brisbane water supply system, and
- the loss of a pumping pool for power generation.

Wivenhoe Dam is predominately a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered the major threat to the security of Wivenhoe Dam.

4.2.2 Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences due to the magnitude of flood damage which would be caused downstream. Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves.

4.3 Extreme Floods and Closely Spaced Large Floods

Some techniques for estimating extreme floods indicate that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam itself. Such events however require several days of intense rainfall to produce the necessary runoff. Accelerated release of storage at damaging flood levels could reduce the risk of overtopping. Such a measure should be taken only after careful consideration of the reliability of precipitation forecasts and of perceived antecedent conditions.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other.

In order to be prepared to meet such a situation the stored flood waters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles. Typically the Engineer should aim to empty stored flood waters within seven days after the flood peak has passed through the lower reaches of the Brisbane River. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The prolonged discharges resulting from the emptying of the flood compartments of the dams have little impact on the urban reaches of the Brisbane River. These reaches of the river can carry a discharge which will not affect buildings and bridges in Brisbane but which will cause the Brisbane Valley Highway to be closed at Fernvale and which will cause the submergence of other roads and bridges.

4.4 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas on the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by using the flood gates to control releases from the dams, taking into account flooding derived from the lower Brisbane River catchments.

4.5 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, some low level bridges and areas upstream of the dams will be temporarily inundated. Downstream of the dam, other low level bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily.

4.6 Provision of Pumping Pool for Power Station

The power station is not effected by the reservoir level in Wivenhoe Dam during floods other than the impacts high tail water levels have on the efficiency of the power station. The power station does however require a pumping pool for operation. The loss of storage by dam failure would render the power station inoperative.

4.7 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lower priority. The effect of flood flows upon navigation in the river varies widely.

Large ships can be manoeuvred in the river at considerable flood flows. On the other hand, coal and coral barges and gravel dredges are affected by low flows which lower salinity thus decreasing the density of the water which in turn causes craft to sit lower in the water, sometimes bottoming. The Moggill Ferry is also affected by low flood flows.

Objectives (b), (d) and (f) of Section 4.1 are closely related and all are satisfied by a short emptying period for the flood storage compartment of the dams.

5 FLOOD CLASSIFICATION

5.1 Categories of Flooding

For the reference purposes of this Manual, five (5) magnitudes of flooding are defined as follows:

MAGNITUDE	COMMUNITY IMPACT	DEFINITION
Small Fresh	Low level bridges submerged, Fernvale Bridge still open	Gauge < 7.8m ≈1 000m³/s
Large Fresh	All bridges submerged except Mt. Crosby Weir Bridge	7.8m < Gauge <10m ≈1 600m³/s
Small Flood	All bridges submerged, no damage to urban areas	10m < Gauge < 15.5m ≈3 400m³/s
Medium Flood	Causes damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe Dam contributing to peak flow	15.5 < Gauge < 20.0m ≈5 600m³/s
Large Flood	Causes extensive damage to urban areas due to combined Wivenhoe Dam releases and downstream flow, Wivenhoe Dam release component of peak flow to be minimised as far as practicable.	Gauge > 20m > 5 600m³/s

Note: "Gauge" refers to the BVRT Lowood Gauge.

These descriptions are to be used as a matter of convenience in describing flood situations. There are no firm divisions between the categories, each merging into the adjacent ones.

The peak flood levels at Lyon's Bridge gauge on Lockyer Creek and Gregor's Creek gauge are frequently related in time; the Lyon's Bridge gauge peak level frequently occurring within twelve to fifteen hours of the peak level at Gregor's Creek gauge. The peak flood levels at Woodford gauge, however, are randomly related in time to the peak levels of the other two gauges.

Information from the Stanley River upstream of the Woodford gauge is not representative of the degree of flooding. Nevertheless, the peak flood level at the Woodford gauge is a good indication of the volume of the flood from the Stanley River catchment which will enter Somerset Dam. The Woodford gauge peak level is also an indicator of the flooding that will occur at Kilcoy. Under the normal operation of Somerset Dam, this flooding is as follows:

Peak Flood Level at Woodford	Typical Flood Volume 10^6 m^3	Impact at or near Kilcoy
5 metres	180	Mary Smokes Ck. Bridge submerged.
8 metres	520	Creek flats inundated
12 metres	1200	A few houses flooded in Kilcoy
17.5 metres	1700	Much of Kilcoy flooded

The flood storage at Somerset Dam above Full Supply Level (EL 99) is 524 x 10^6 m^3.

5.2 Reference Gauges

All of the reference gauge locations shown in Appendix B with the exception of Brisbane City Gauge, Mt Crosby and Woodford gauges are equipped with river height monitors connected to the Brisbane Valley Flood Warning Radio Telemetry System. This system is owned jointly by the Bureau of Meteorology and the South East Queensland Water Board. All data from the system is available to the Headworks Operator and the Bureau of Meteorology.

The locations of the gauges are shown on Fig. B1 of Appendix B.

5.3 Flood Magnitude Prediction

The most important indications of probable flood magnitudes are received from:

- the Woodford gauge on the Stanley River,
- the Gregor's Creek gauge on the upper Brisbane River,
- the Lyon's Bridge gauge on Lockyer Creek,
- the Walloon gauge on the Bremer River and
- the Amberley gauge on Warrill Creek,

together with such rainfall data as may be available from the Brisbane Valley Flood Warning Radio Telemetry System and from the Bureau of Meteorology.

6 REVIEW

6.1 Introduction

This Manual has been compiled to meet the requirements of the Section 106 of the South East Queensland Water Board Act. It is an updated revision of the original Manual, which was known to be deficient in several areas. This Manual has addressed the mechanisms of delegation and control of the dams in periods of operation of the dams for flood mitigation. It has not departed from prescribed operating rules for the flood control gates on each dam. It is known that these rules may result in overtopping of the dams should floods occur which are derived from a probable maximum precipitation storm or from the combination of two lesser storms in close proximity. The dams may also overtop in the eventuality that the flood gate control systems fail to operate or partially malfunction during the passage of a major flood or combination of floods.

Procedures and systems are being developed which should enable lower risk operation of the dams for flood mitigation purposes. This technology is targetted at providing maximum warning times and the capability of examining options to optimise the safety of the dams and minimise the hazard potential and risk to the community. To this end a major reformulation of this Manual will be necessary to implement the systems currently under development.

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances.

It is important, therefore, that the Manual contain operational procedures which in themselves will cause the Manual's procedures, and the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

The checking and reviewing process must involve the Engineer and all associated operations personnel in order that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based.

The Technical Advisory Committee pursuant to Section 106 of the South East Queensland Water Board Act, shall cause to be prepared and submitted to the Board from time to time such amendments to the Manual as the Committee considers necessary.

Variations to the Manual may be made in accordance with provisions in Section 1.8.

6.2 Personnel Training

The Headworks Operator shall ensure that operational personnel required for flood control operations receive adequate training in the various activities involved in flood control operation.

Prior to 1st September each year, operational personnel are to be given instruction in flood control operation. The Engineer shall report to the Board by 30th September each year on the training and state of preparedness of operations personnel.

6.3 Communications Networks

The Headworks Operator shall ensure that all communications networks provided for the safe operation of the dams are maintained and operable.

The Engineer shall report to the Board on the status of the communications networks by 30th September of each year.

6.4 Data Acquisition

The Headworks Operator is to be responsible for ensuring that all data acquisition systems provided for the monitoring of flood events are maintained and operable and for initiating all such necessary actions to remedy any defects in the system.

The Engineer is to report to the Board on the status of the data acquisition systems by 30th September of each year.

6.5 Technical Advisory Committee Report

The Technical Advisory Committee shall review at the request of the Board the Engineer's reports on personnel training, communications and data acquisition, and report to the Board on the state of flood preparedness and on any other matters of concern relating to the requirements of this Manual.

6.6 Five Yearly Review

The Technical Advisory Committee, at intervals of no greater than five years is to cause the Manual to be reviewed by a competent engineer or engineering organisations persuant to Section 106 of the Act. The review is to take into account the continued suitability of the communication network, and data acquisition systems as well as hydrological and hydraulic-engineering assessments of the operational procedures. The hydrologic investigations performed for the purpose of this manual are discussed in Appendix H.

The Technical Advisory Committee shall at the direction or request of the Board report and recommend to the Board on any requirements for amendment to the operational procedures in accordance with the requirements of the Act.

6.7 Operational Audit

After each significant flood event, the Technical Advisory Committee shall cause the effectiveness of the operational procedures contained in this Manual to be reviewed by a competent engineer or engineering organisation.

The Technical Advisory Committee shall report and recommend to the Board on any requirements for amendment to improve the operational procedures.

7 WIVENHOE DAM

7.1 Introduction

Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the dam, depending on the part of the catchment in which the flood originates and depending also on the magnitude of the flood.

Refereing to Appendix H.7, Full Supply Level (FSL) in the reservoir is EL 67.0 and this is the level to which the storage will be returned after a flood event. An Evaluation Design Flood (EDF) would cause the reservoir level to reach EL 77. 0 with routing through the reservoir under normal gate operating conditions. The Imminent Failure Flood (IFF) is the flood which will just reach the level of the top of the dam wall which is at EL 79.9 (including the wave wall). The crests of the saddle dams are at EL 80.0. The existing IFF has an average recurrence interval of one hundred thousand years, which is within the range of accepted Recommended Design Floods (RDF) but which is not at the extreme end of the range. Storms or a series of storms which produce floods larger than the IFF are possible.

The reservoir volume above EL 67 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the magnitude of the flood being regulated.

The Board has aquired land above FSL to a level of EL 75 to provide flood mitigation storage. Reasonable care shall be exercised to confine the flood rises to below the minimum land resumption level (EL 75.0). This requirement should be ignored in the case of extreme floods which threaten the safety of the dams.

7.2 Initial Action

When indications are received of an imminent flood, the flood control operation of the dam shall commence with the storing of all inflow of the Brisbane River in Wivenhoe Dam, whilst an assessment is made of the origin and magnitude of the flood. The spillway gates are not to be opened for flood control purposes prior to the lake level exceeding EL 67.250.

7.3 Outlet Works Operation

Rapid closing or opening of outlets (regulators and spillway gates) can cause hydraulic surges and other effects in the Brisbane River which can endanger life and property and may sometimes have other adverse effects. The regulators and gates are therefore to be operated at slow speeds which will not have adverse impacts on the river system.

The gate opening and closing sequences described below are the most rapid permitted for flood mitigation operations. Rapid closure of the gates can affect river bank stability. Rapid closure should only be used when time is critical and there is a requirement to correct a malfunction to preserve storage or to reduce downstream flooding rapidly. For flood operations where time is not critical slower rates should be used.

(a) Regulators

Minimum interval between successive full openings or closings of regulators shall be 30 minutes.

(b) Spillway Gates

Minimum interval between successive incremental openings shall be 10 minutes, except as provided in Procedure 4 of Section 7.4.4, and for successive incremental gate closings is to be 20 minutes. Each increment of opening or closing is 500 mm.

The storage and discharge data for Wivenhoe Dam gates are contained in Appendix I both in graphical and tabular form.

Gates are numbered 1 to 5 from the left bank looking downstream.

Gates 2, 3 and 4 are to be used as the main regulating gates and are to be operated as follows.

(i) Gate 3 is to be operated first in increments to discharge flow up to 500 m^3/s.

(ii) Gates 2 and 4 are to be operated in alternate consecutive increments to discharge a flow of up to 500 m^3/s each in order to give a total discharge of 1500 m^3/s.

(iii) Thereafter, the bottoms of gates 2, 3 and 4 shall be kept within 0.5m of each other with the bottom of gate 3 always being higher than or at the same level as the bottoms of gates 2 and 4.

Gates 1 and 5 are to be operated in alternate consecutive increments to contain the discharge jets from gates 2, 3 and 4 within the plunge pool until such time that their capacity is required for the passing of major floods. The opening of these gates shall not exceed those of gates 2 and 4.

Further considerations of the operation of the Wivenhoe Dam gates are contained in Appendix F.

7.4 Operating Procedures

It is essential that the operating procedures adopted should not endanger the safety of Wivenhoe Dam. Within this constraint, the Engineer shall adopt a procedure for the operation of Somerset Dam such that:

(a) the structural safety of Somerset Dam is not endangered;

(b) the Upper Brisbane River flood flow plus Somerset Dam releases does not cause Wivenhoe Dam to be overtopped.

When the preliminary estimation of the degree of expected flooding has been made, the operating procedures set out hereunder shall be used at Wivenhoe Dam.

As the magnitude of the expected flooding increases, the procedures to be adopted commence with Procedure 1 and extend through to Procedure 4 in response to flow estimates throughout the Brisbane Valley and to minimise flood impacts. Guideline procedures are summarised in Table C-1 of Appendix C as repeated following:

GUIDELINE PROCEDURES FOR WIVENHOE DAM

Predicted Height @ Gregor's Creek (m)	Predicted Height @ Woodford (m)	Predicted Height @ Lyon's Bridge (m)	Operating Procedure to be used	Resultant Height @ Lowood (m)	Resultant Height @ Brisbane (m)
< 5	< 8	< 16.5	1	< 10	< 1.5
< 5	< 8	16.5 - 19	2	< 15.5	< 2
< 5	< 8	> 19	2	> 15.5	> 2
< 5	8 - 12	< 19	2	< 15.5	< 2
< 5	8 - 12	> 19	2	> 15.5	> 2
< 5	> 12	< 19	3	15.5	2
< 5	> 12	> 19	3	> 15.5	> 2
5 - 8	< 5	< 16.5	1	< 10	< 1.5
5 - 8	< 5	16.5 - 19	2	< 15.5	< 2
5 - 8	< 5	> 19	2	> 15.5	> 2
5 - 8	> 5	< 19	3	15.5	2
5 - 8	> 5	> 19	3	> 15.5	> 2
8 - 12	< 12	< 19	3	15.5	2
8 - 12	< 12	> 19	3	> 15.5	> 2
8 - 12	> 12	ignore	4	> 20	> 3.5
> 12	ignore	ignore	4	>20	> 3.5

7.4.1 Procedure 1

Water is to be released from Wivenhoe Dam with care being taken not to submerge Fernvale Bridge unnecessarily. If the Lockyer Creek flow is sufficient to submerge Fernvale Bridge, the releases are to be regulated such that Mt. Crosby Weir Bridge is not submerged. The approximate submergence flow rate at the Mt Crosby Weir Bridge is 1 900 m^3/s.

For situations where flood rains are occuring on the catchment upstream of Wivenhoe Dam and only minor rainfall is occurring downstream of the dam, releases are to be regulated to limit, as much as is appropriate in the circumstances, downstream flooding. Releases shall preferably not exceed the following values:

Lake level in Wivenhoe Dam	Maximum Release Rate (m^3/s)
67.50	100
67.75	200*
68.00	500
68.25	900
68.50	1500

* Minor variations to this flow should be considered to prevent submergence of Burton's Bridge or College's Crossing.

7.4.2 Procedure 2

Water is to be released from Wivenhoe Dam, with care being taken not to submerge Fernvale Bridge prematurely. Typically, significant releases will take place on the rising limb of the flow from Lockyer Creek. If this flow is sufficient to submerge both Fernvale bridge and Mt. Crosby Weir bridge, the releases are to be increased such that the combined Lockyer Creek flood flow and Wivenhoe Dam releases does not submerge Mt. Crosby Weir Bridge prematurely, and does not exceed the lesser of:

(i) 3,500 m^3/s at Lowood or

(ii) the greater of the peak flood flow of Lockyer Creek, or the predicted peak flood flow of the Bremer River.

Should Mt Crosby Weir Bridge be flooded by flows from catchments downstream of Wivenhoe Dam, the upper limit of the combined Lockyer Creek flow and releases from Wivenhoe Dam shall, subject to the above conditions, not exceed 3 500 m^3/s at Lowood.

7.4.3 Procedure 3

Water is to be released from Wivenhoe Dam such that the combined Lockyer Creek flood flow and Wivenhoe Dam releases is not to exceed 3,500 m^3/s at Lowood. The releases are to be regulated such that the total regulated flow at Moggill gauge downstream of the Bremer River junction does not exceed 4,000 m^3/s (this is the upper limit of non-damaging flows for the urban reaches of the Brisbane River).

7.4.4 Procedure 4

In consideration of Section 4.3, water is to be released from Wivenhoe Dam such that the combined flood flow of Lockyer Creek plus releases from Wivenhoe Dam is not to exceed 3,500 m^3/s at Lowood until the lake level reaches EL 74, or it becomes probable that dam safety may be compromised. The releases are then to be increased until the level behind Wivenhoe Dam begins to fall. The combined flow at Lowood is to be reduced to 3,500 m^3/s as quickly as practicable having regard to Section 4.3, and is to remain at this rate until final gate closure procedures can commence.

The minimum time interval between gate incremental openings can be reduced in this procedure as considered appropriate. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

7.5 Closing Procedures

Gate closing procedures should be initiated having regard to the following requirements:

(a) Early release of stored water to regain flood mitigating ability for any subsequent flood inflows as described in Sections 4.3 and 7.1.

(b) Gate operation procedures as described in Section 7.3.

(c) Downstream impact of the discharges.

(d) Establishment of storage at FSL at completion of flood events.

8 SOMERSET DAM

8.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods and optimise the flood mitigation capacity of Wivenhoe Dam.

A general plan and elevation of Somerset dam is included in Appendix J.1.

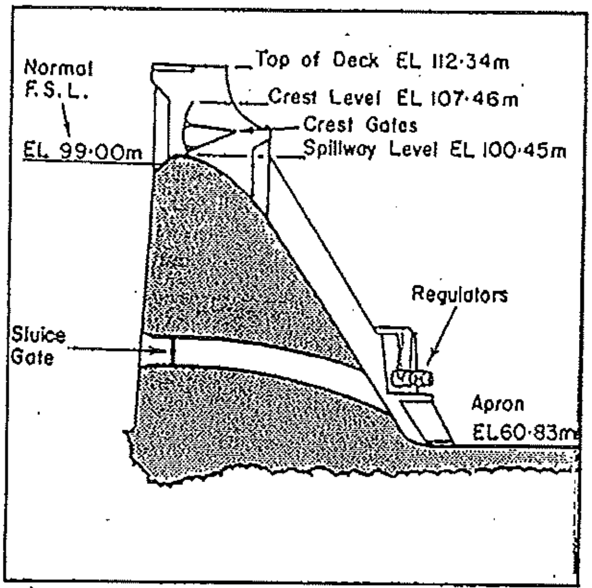


Figure 1 Somerset Dam Section

8.2 Initial Action

Upon indications being received of a significant inflow, the flood control operation of the dam shall commence with the storing of all inflow of the Stanley River in Somerset Dam, whilst an assessment is made of the origin and magnitude of the flood.

8.3 Regulator and Gate Operation

The following minimum intervals shall be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes:

	OPENING MINIMUM INTERVAL	CLOSING MINIMUM INTERVAL
Regulators	30 minutes	60 minutes
Sluice Gates	120 minutes	180 minutes
Crest Gates	Gates are normally open	

The discharge capacities for various storage levels of Somerset Dam are listed in Table J-1 of Appendix J.

8.4 Operating Procedure

The normal operating procedure to be used for Somerset Dam is as follows.

The crest gates are to be raised to enable uncontrolled discharge once the flood storage between FSL (EL 99) and spillway level (EL 100.45) has filled. The low level regulators and sluices are to be kept closed until either:

(a) the inflow to Wivenhoe Dam begins to decrease; or

(b) the level in Somerset Dam exceeds EL 102.25.

In the case of (a) above the opening of the regulators and sluices is not to increase the inflow to Wivenhoe Dam above the peak inflow from the Brisbane River just passed or, if possible, not to cause the Wivenhoe Dam lake level to exceed EL 74.

In the case of (b) above, the Engineer shall direct the operation of the low level regulators and sluices to ensure the stability of the dam.

9 EMERGENCY

9.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition. Experience elsewhere in the world suggests that vigilance is required to guard against emergency conditions such as:

- Occurrence of a much larger flood than the Evaluation Design Flood (EDF);
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood;
- Development of a pipe through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;
- Other rarer mechanisms.

As stated in Section 7.1, the Evaluation Design Flood at Wivenhoe Dam will cause the reservoir level to reach EL 77. The storm which will yield this level has an extremely low probability of exceedance. Possible emergency conditions would develop during the occurrence of a much larger storm or a series of large storms.

Another possible emergency condition would be the failure of one or more of the spillway gates at Wivenhoe Dam during a major flood event.

9.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates.

In the event that the probability of overtopping of Wivenhoe Dam is unacceptably high, then as an absolute last resort the saddle dams may be breached. Such actions shall only be initiated with the approval of the Commissioner of Water Resources.

Somerset Dam should, if possible, not be overtopped by flood water but, if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced, for example by the use of its spillway gates, even at the risk of overtopping Somerset Dam in order to prevent, if possible, the overtopping of Wivenhoe Dam.

9.3 Communications Failure

In the event of normal communications being lost between the Engineer and either Wivenhoe Dam or Somerset Dam, the duty officer in charge at that dam is to maintain contact with the officer in charge at the other dam, to receive instructions through the remaining communications link.

In the event of normal communications being lost between the Engineer and both Wivenhoe Dam and Somerset Dam, the duty officers in charge at each dam are to adopt the procedures set out below during flood events, and are to maintain contact with each other, where possible.

If all communications are lost between the Engineer, Wivenhoe Dam and Somerset Dam, the officers in charge at each dam are to adopt the procedures set out below.

9.4 Somerset Dam Emergency Procedure

In the event of total communication failure, the spillway gates are to be raised to allow uncontrolled discharge once the lake level reaches spillway level. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

The level in Wivenhoe Dam can be determined locally by the site staff at Somerset Dam from the tailwater gauge located just downstream of Somerset Dam.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe Dam above the peak level already attained. Section 8.3 on regulator and gate operation interval is to be observed.

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board below non-spillway crest level in Somerset Dam (EL 107.46). The low level outlets in Somerset Dam are not to be opened if the water level in Wivenhoe Dam exceeds the level set out below for given water levels in Somerset Dam.

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

9.5 Wivenhoe Dam Emergency Procedure

In the event of total communication failure, the minimum gate openings related to lake level set out in the table below are to be maintained for both opening and closing operations.

Table 9.5 Minimum Gate Openings

Lake Level m AHD	Gate 3 Opening (m)	Gates 2 & 4 Opening (m)	Gates 1 & 5 Opening (m)	Discharge m^3/s
67.0		-	-	0
67.5	0.5	-	-	75
68.0	1.5	-	-	175
68.5	2.5	-	-	290
69.0	4.5	-	-	490
69.5	4.5	1.0	-	790
70.0	4.5	2.0	-	1020
70.5	4.5	3.0	-	1290
71.0	4.5	4.0	-	1530
71.5	4.5	4.0	0.5	1750
72.0	4.5	4.0	1.5	2030
72.5	4.5	4.0	3.0	2440
73.0	5.0	5.0	5.0	3200
73.5	6.5	6.5	6.5	4150
74.0	8.0	8.0	8.0	5100
74.5	10.0	10.0	10.0	6300
75.0	12.5	12.5	12.0	8050
75.5	14.0	14.0	14.0	9500
76.0	Fully Open	Fully Open	Fully Open	10850
76.5	Fully Open	Fully Open	Fully Open	11330
77.0	Fully Open	Fully Open	Fully Open	11830

9.6 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix F for Wivenhoe Dam and Appendix G for Somerset Dam.

APPENDIX A. EXTRACT FROM ACT

EXTRACT FROM SOUTH EAST QUEENSLAND WATER BOARD ACT 1979 - 1991

106. Operational procedures for flood mitigation. (1) The Technical Advisory Committee shall cause to be prepared a manual of operational procedures in relation to each reservoir or a combined manual in relation to two or more reservoirs under the control of the Board for the purpose of flood mitigation and may from time to time cause to be prepared such amendments thereto as the committee considers necessary..

Every manual and all amendments thereto prepared under this sub section shall be submitted to the Board which shall submit the same with its recommendations, to the Minister within 40 days after it receives the same.

(2) A manual prepared under subsection (1) and amendments thereof, which may be recommended by the Technical Advisory Committee shall not be effective until:

(a) duly approved by the Minister; and
(b) in the case of a manual prepared in relation to a reservoir within the Wivenhoe Dam project and the reservoir behind Somerset Dam, until the manual prepared in relation to such reservoirs, pursuant to the Wivenhoe Dam and Hydro-electric Works Act 1979 has ceased to be effective.

(3) Repealed.

(4) A manual of operational procedures may vest in any person mentioned therein and regulate the function of exercising a reasonable discretion in any matter as part of the flood mitigation procedures.

107. Board, Headworks Operator bound by manual. The operational procedures to be adopted by the Board in respect of the reservoirs under its control for the purpose of flood mitigation shall be as provided by the relevant manual prepared under section 106 as duly amended at the material time and such manual, as duly amended at the material time, shall be observed by the Board and its employees and the Headworks Operator and its employees.

108. Minister, Board, Headworks Operator not liable for flood damage. The Minister, the Board, the Headworks Operator and an employee Of the Board or the Headworks Operator shall not be liable for damages claimed in respect of loss or injury alleged to arise from:

(a) the carrying out of flood mitigation procedures of the Board if such procedures were carried out under the general direction of a suitably qualified and experienced engineer in accordance with the operational procedures specified by the relevant manual prepared under section 106; or

(b) the inaccuracy of information released on behalf of the Board or the Headworks Operator or by an employee of the Board or the Headworks Operator concerning anticipated flooding or the anticipated levels of flooding.

APPENDIX B. LOCATION OF GAUGES

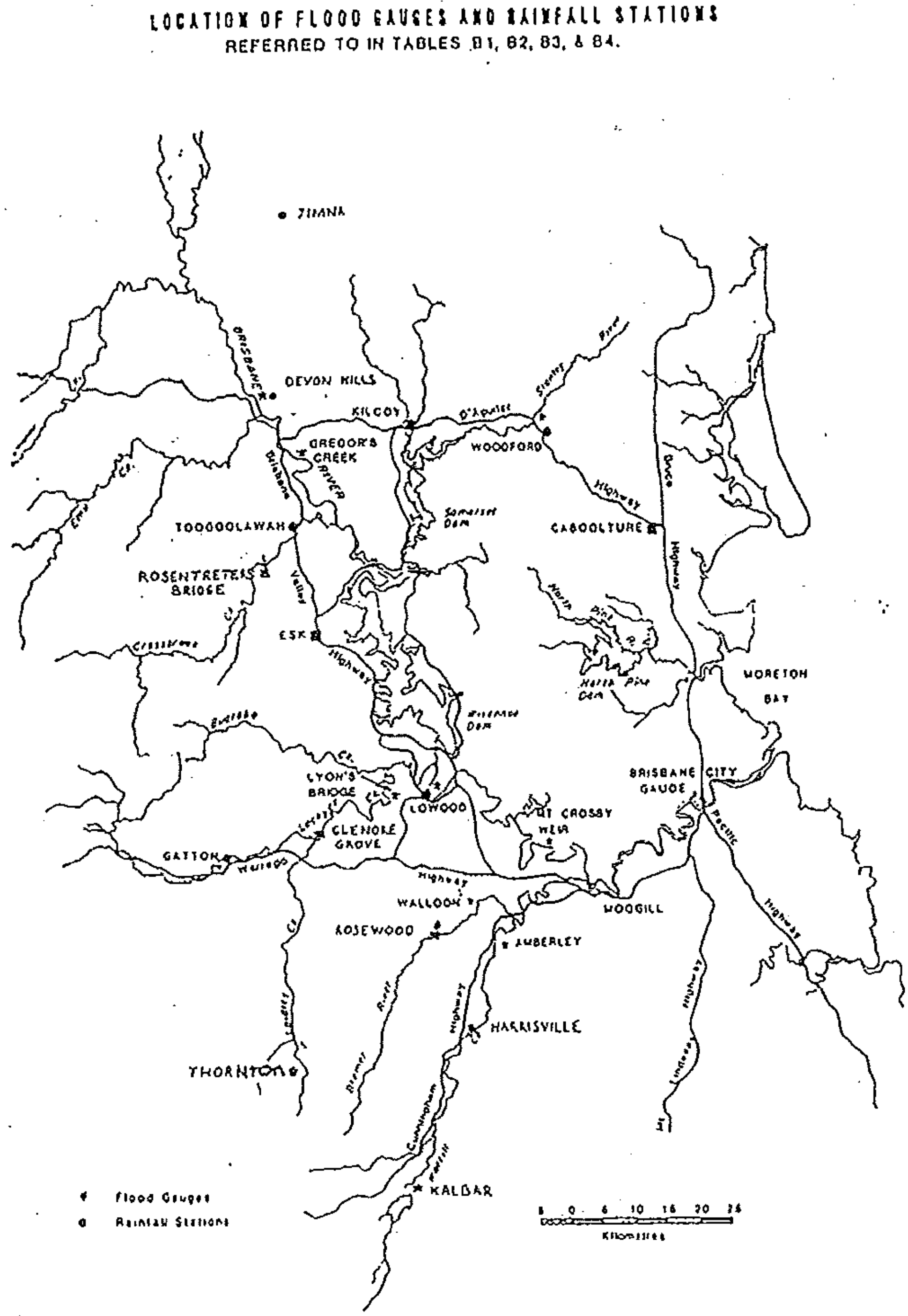


FIGURE B1

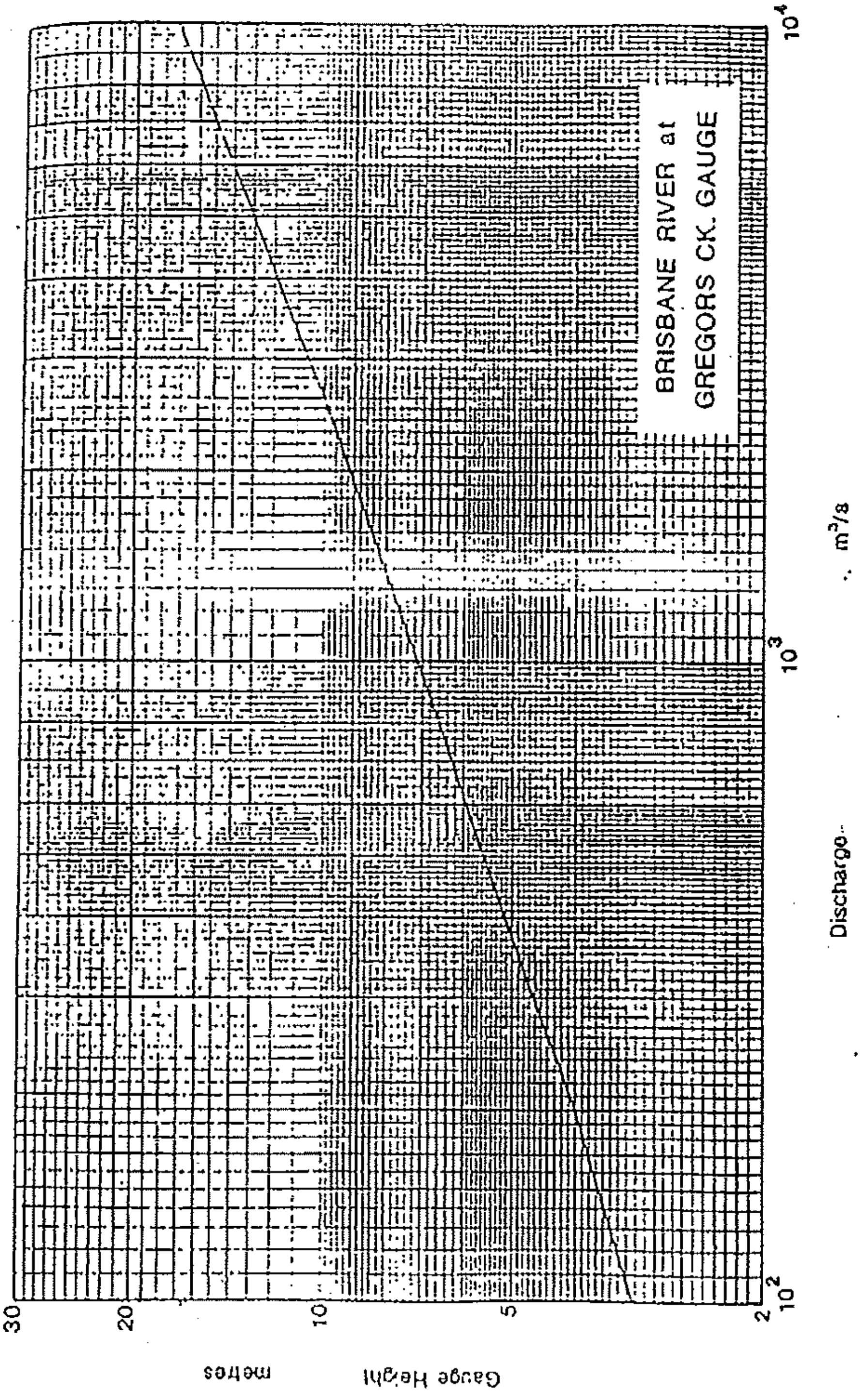
APPENDIX C. GUIDELINE PROCEDURES FOR WIVENHOE DAM

Table C-1

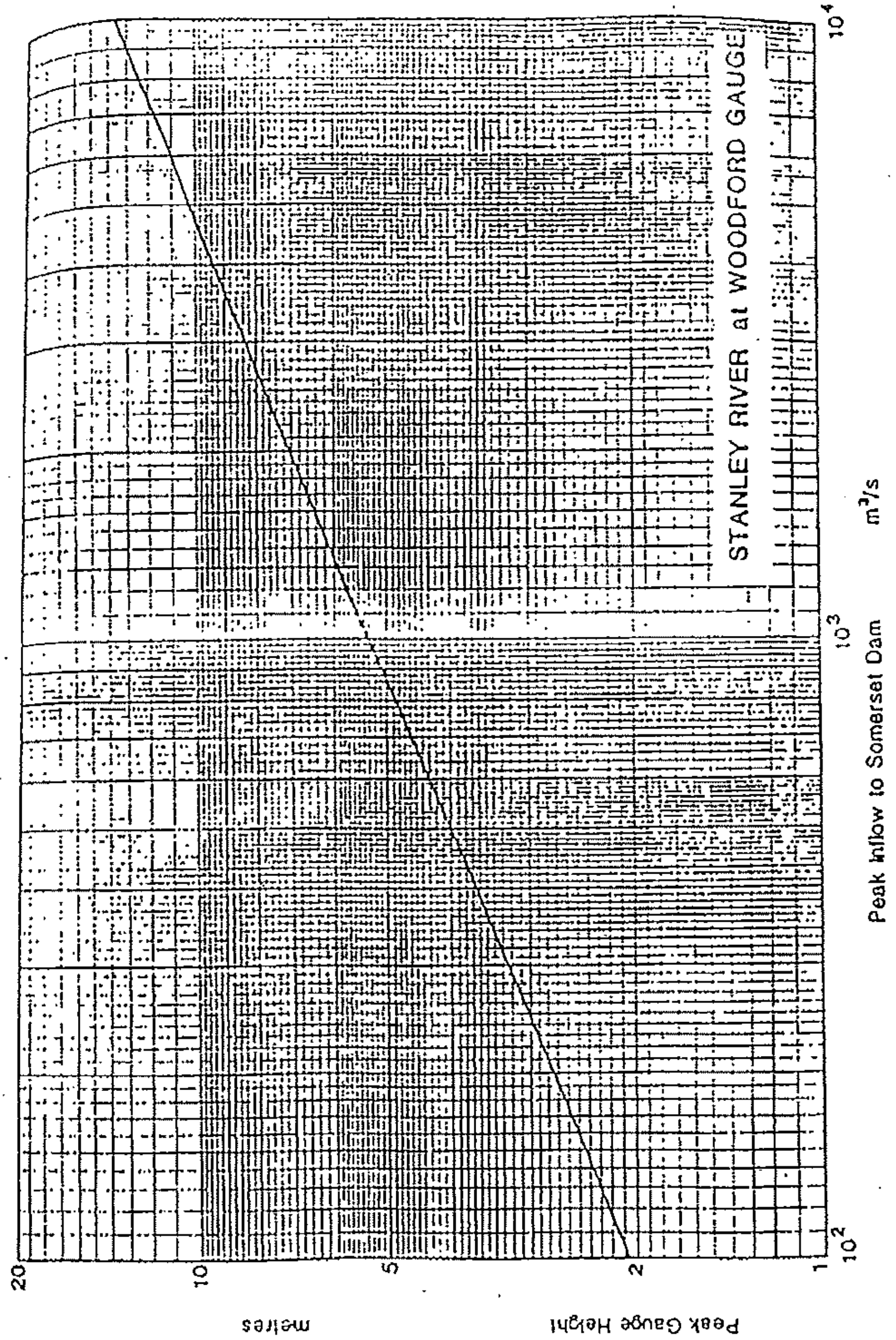
GUIDELINE PROCEDURES FOR WIVENHOE DAM

Predicted Height @ Gregor's Bridge (m)	Predicted Height @ Woodford (m)	Predicted Height @ Lyon's Bridge (m)	Operating Procedure to be used	Resultant Height @ Lowood (m)	Resultant Height @ Brisbane (m)
< 5	< 8	< 16.5	1	< 10	< 1.5
< 5	< 8	16.5 - 19	2	< 15.5	< 2
< 5	< 8	> 19	2	> 15.5	> 2
< 5	8 - 12	< 19	2	< 15.5	< 2
< 5	8 - 12	> 19	2	> 15.5	> 2
< 5	> 12	< 19	3	15.5	2
< 5	> 12	> 19	3	> 15.5	> 2
5 - 8	< 5	< 16.5	1	< 10	< 1.5
5 - 8	< 5	16.5 - 19	2	< 15.5	< 2
5 - 8	< 5	> 19	2	> 15.5	> 2
5 - 8	> 5	< 19	3	15.5	2
5 - 8	> 5	> 19	3	> 15.5	> 2
8 - 12	< 12	< 19	3	15.5	2
8 - 12	< 12	> 19	3	> 15.5	> 2
8 - 12	> 12	ignore	4	> 20	> 3.5
> 12	ignore	ignore	4	> 20	> 3.5

C.1. River Rating - Gregors Creek Gauge



C.2. River Rating - Woodford Gauge



C.3. River Rating - Lyon's Bridge (lockyer Creek) Gauge

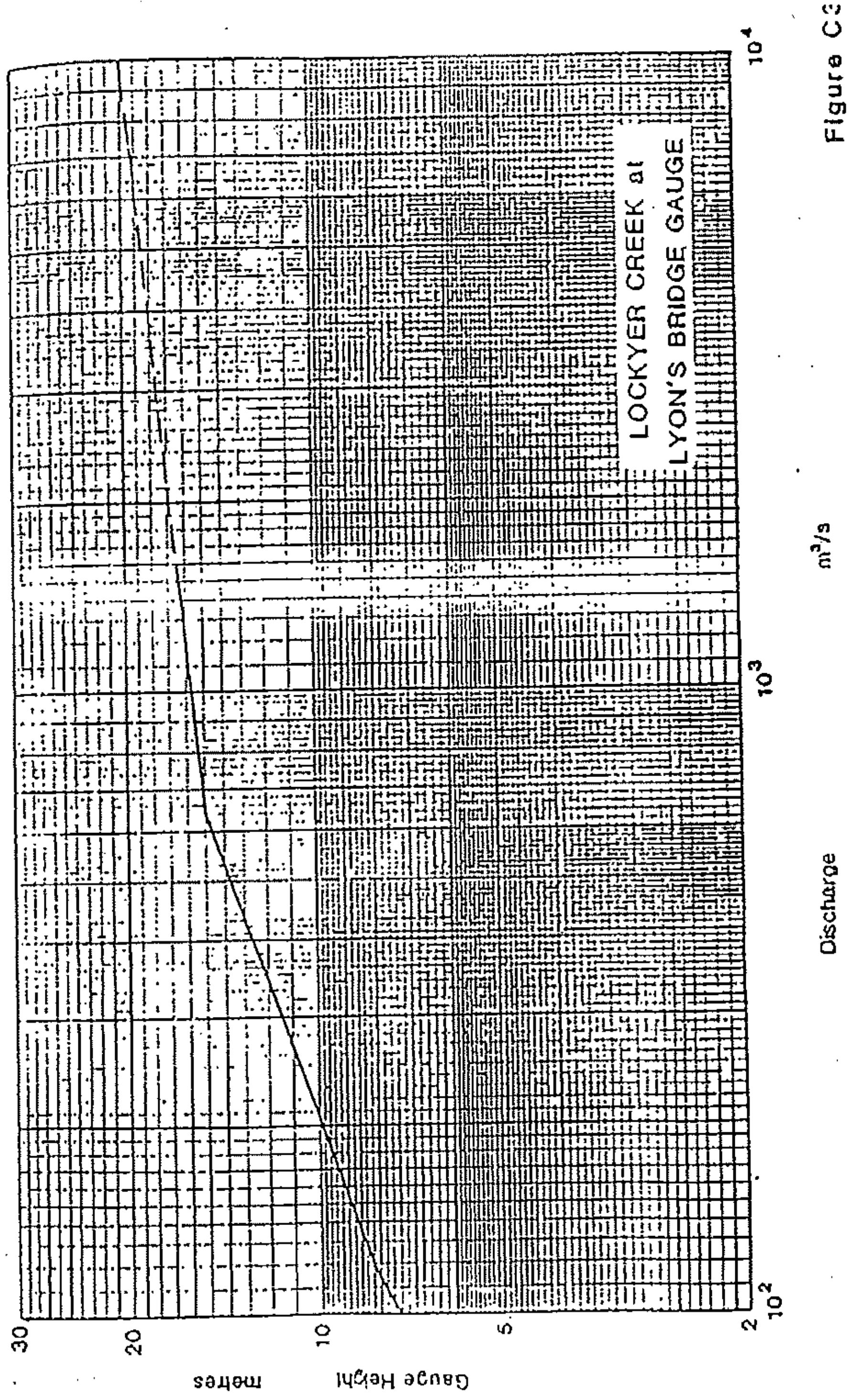


Figure C3

C.4. River Rating - Ipswich (Bremer River) Gauge

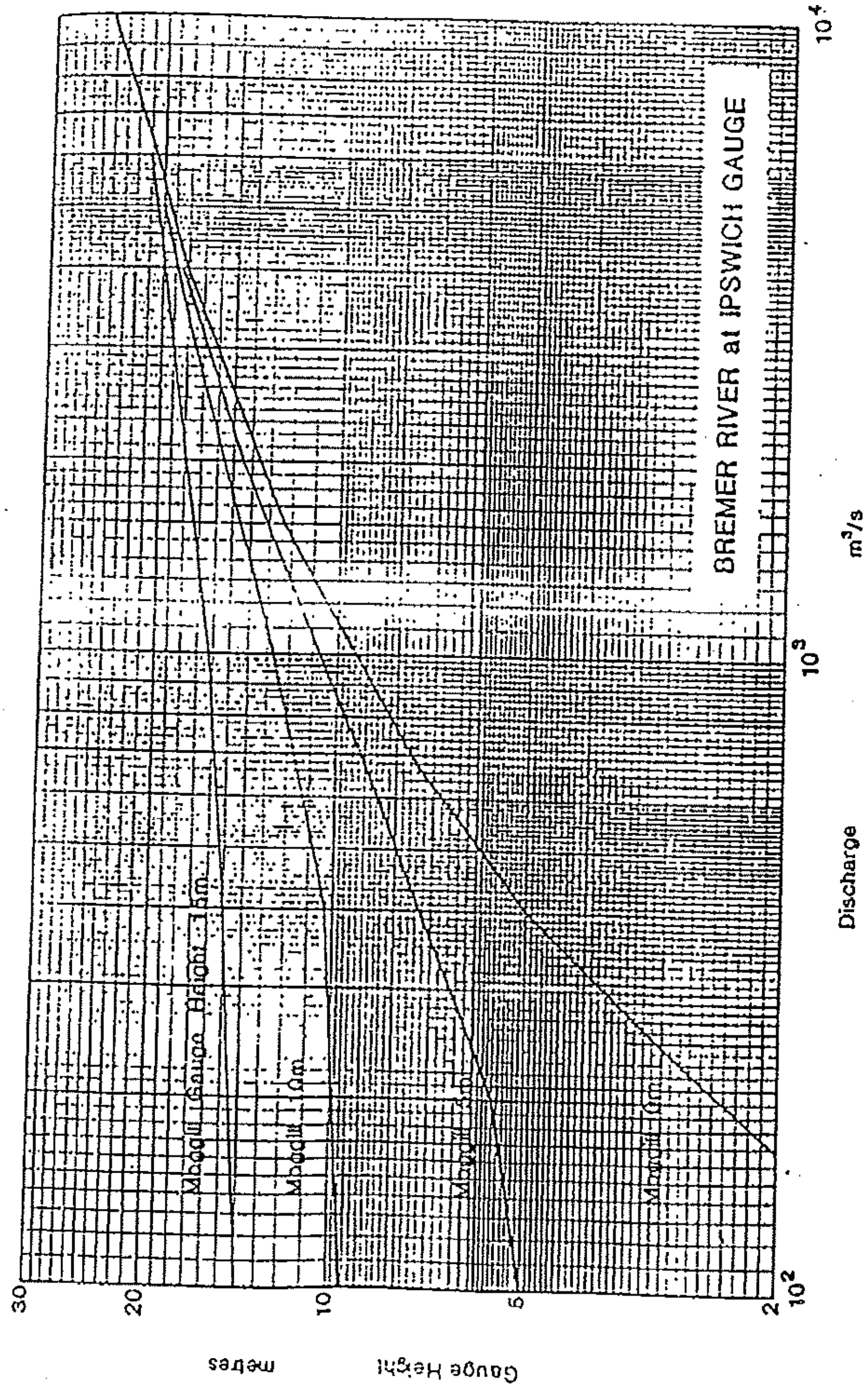


Figure C4

APPENDIX D. SUBMERGENCE FLOWS FOR BRIDGES

Table D-1
SUBMERGENCE FLOWS FOR BRISBANE VALLEY BRIDGES

Number**	Bridge Name	Submergence Flow m^3/s
1	College's Crossing	175-200*
2	Mt.Crosby Weir Bridge	1900
3	Kholo Bridge	550
4	Burton's Bridge	250
5	Savage's Crossing	125
6	Fernvale Bridge	1020
7	Twin Bridges	85
8	O'Shea's Bridge	7500

* Affected by tides.

** See Figure D1 for number of bridge.

D.1. Bridge Locations

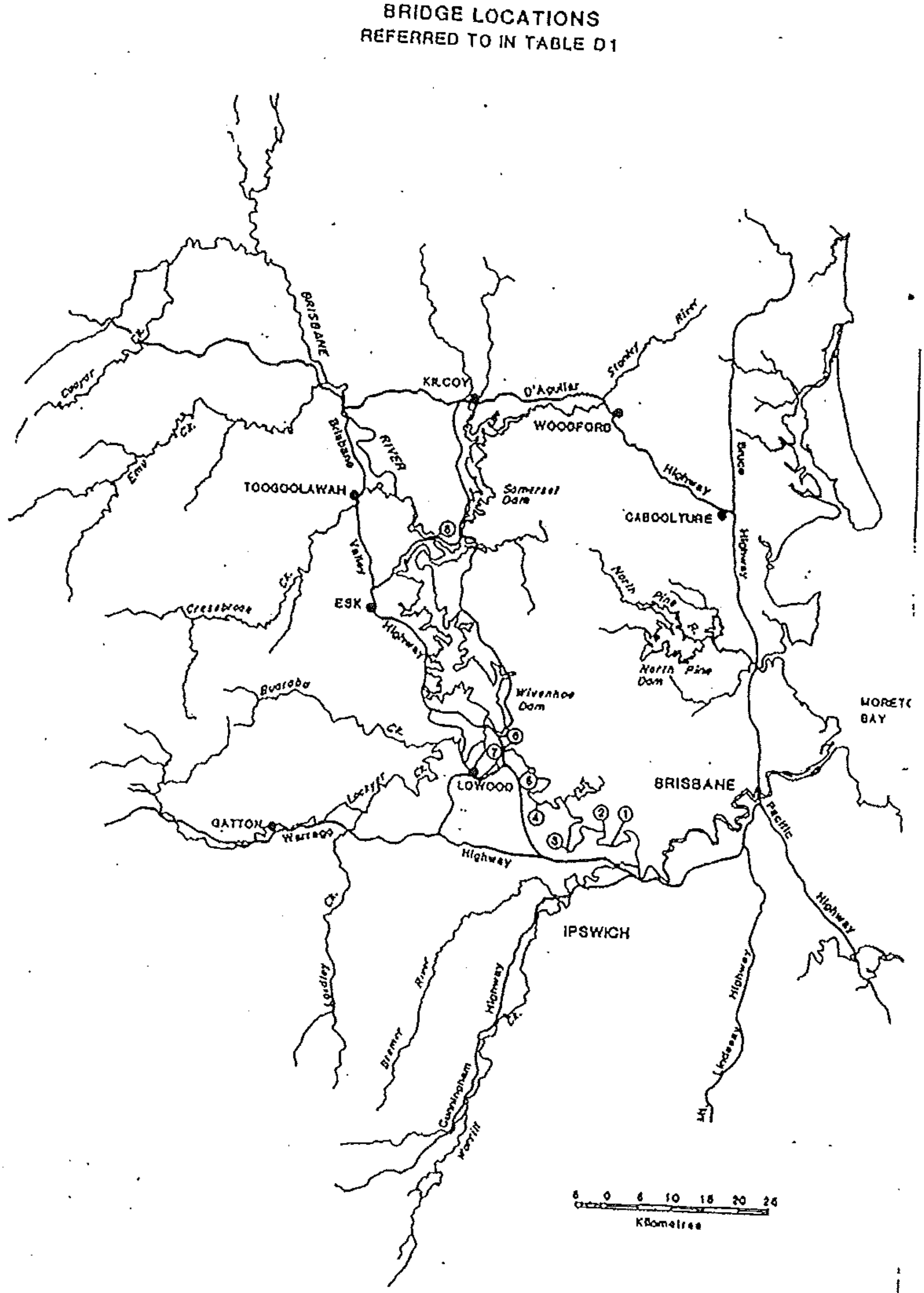


FIGURE D1

D.2. Bridge Deck Levels

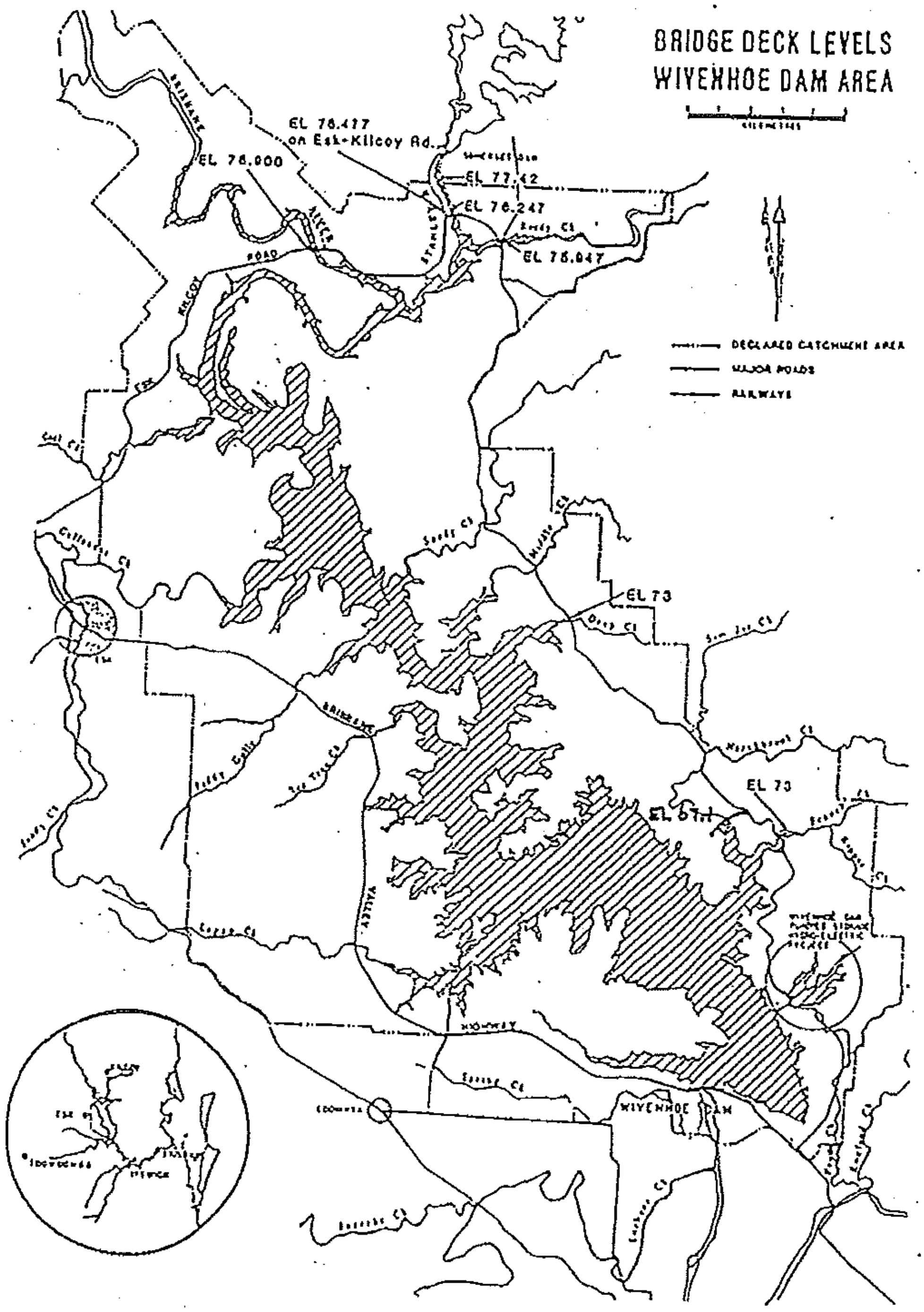


FIGURE D2

APPENDIX E. COMMUNICATION AND DATA ACQUISITION

In order to determine the magnitude and timing of a flood and hence to operate Somerset and Wivenhoe Dams, it is of great importance for the Engineer to have access to a large number of rainfall and river height stations throughout the Brisbane River catchment.

These observations of rainfall or river height are of greatest benefit when they are received by the Engineer as soon as possible after the time of observation. This requires that either an automatic reporting system be established or else gauges be established where observation can be made by local residents who report via telephone to the Engineer. Both these data acquisition mechanisms are presently established in the Brisbane River catchment.

The Brisbane Valley Flood Warning Radio Telemetry System is jointly owned by the Bureau of Meteorology and the South East Queensland Water Board. Information from twelve river height stations and nine rainfall stations is available to the Engineer, on demand, from this system. The elements of the system are shown in Figure El.

There are numerous staff gauges on the Brisbane River and its tributaries which are manually read during flood periods. These gauges are owned and maintained by the Bureau of Meteorology, the Commissioner of Water Resources, the South East Queensland Water Board and the Brisbane City Council. Readings from these locations are available to the Engineer on request. These staff gauges are listed in Table E-1 and the locations are shown in Figure E2.

The Bureau of Meteorology has a network of rainfall stations which report heavy rainfalls at intervals of approximately three hours during flood periods. This data is available to the Engineer on request. Rainfall data from several rain gauges owned by the South East Queensland Water Board and Brisbane City Council are also available on request. The majority of this data is transmitted by telephone. These reporting rain gauges are listed in Table E-2 and the locations are shown in Figure E3.

Communications between the Engineer and Somerset and Wivenhoe Dams is possible via telephone and radio. In flood periods, the telephone system is prone to breakdowns and most communication is via radio. The radio communications available between the Engineer and the dams are shown in Figure E4.

Table E-1
BRISBANE RIVER CATCHMENT STAFF GAUGES

Gauge Name	Stream	AMTD (km)	Catchment Area (km²)	Owner	Range (m)	Reporting Level (m)	Remarks
Peachester	Stanley R.	89.2	104.0	WRC	0-11		Recorder attached.(Telephone Telemetry)
Woodford	Stanley R.	64.0	313.0	CBM	3-13	3	BVRT 3 km u/s. (Telephone Telemetry)
Linville	Brisbane R.	282.0	2005.0	WRC	0-9		Recorder attached.(Telephone Telemetry)
"	"	280.0	2030.0	CBM	1-14	3	
Devon Hills	Brisbane R.			CBM	0-15		BVRT attached.
Gregors Ck.	Brisbane R.	251.0	3885.0	WRC	0-16	2	Recorder attached.(Telephone Telemetry)
"	"	"	"	CBM	0-17		BVRT attached.
Rosentreter's Crossing	Cressbrook Ck.	22.0	480.0	SEQWB			BVRT attached.(Telephone Telemetry)
Helidon	Lockyer Ck.	96.6	375.0	WRC	0-6	3	Recorder attached.
Gatton	Lockyer Ck.	71.0	1550.0	CBM	3-18	5	
Jordan Bridge	Lockyer Ck.	65.0	1580.0	SEQWB	1-12	5	Bridge Deck 6.8 m.
Wilson's Weir	Lockyer Ck.	61.3	1660.0	SEQWB	0-10		WRC Recorder. 0 = Spillway.
Mulgowie	Laidley Ck.	30.9	179.0	WRC	0-9	4	Recorder attached.(Telephone Telemetry)
"	"	"	"	CBM	0-9	4	
Glenore Grove	Lockyer Ck.	52.0	2331.0	CBM	2-15		BVRT attached.
Lyon's Bridge	Lockyer Ck.	26.5	2540.0	WRC	0-12		Recorder attached.(Telephone Telemetry)
"	"	27.2	2525.0	CBM	0-14	4	BVRT attached.
Lowood	Brisbane R.	141.0	10060.0	CBM	0-28		BVRT attached.
Savage's Crossing	Brisbane R.	130.0	10180.0	WRC	0-20	2	Recorder attached.
Noogoora (Burton's Br.)	Brisbane R.	119.0	10240.0	SEQWB	1-22	2	Bridge Deck 4 m.
Cabbage Tree Creek	Brisbane R.	111.0	10520.0	SEQWB	0-27		Read by BCC staff.
Kholo	Brisbane R.	101.0	10540.0	SEQWB	0-30		
Mt. Crosby Weir	Brisbane R.	90.7	10567.0	BCC	5-54		Read by BCC staff.(Telephone Telemetry)
Moggill	Brisbane R.			CBM	0-25		BVRT Attached
Adam's Bridge	Bremer R.	77.1	130.0	WRC	0-7	3	Recorder attached.
Stoke's Crossing	Bremer R.	68.4	180.0	CBM	1-8	4	
Kuss Road	Western Ck.	7.5	200.0	CBM	1-9	2	
Rosewood	Bremer R.	50.0	543.0	CBM	0-9		Recorder attached.(Telephone Telemetry)
Walloon	Bremer R.	37.2	620.0	WRC	0-7	4	Recorder attached. BVRT 3.5 km u/s.
Kalbar	Warrill Ck.	50.0	465.0	CBM	0-13	3	
Harrisville	Warrill Ck.	31.0	725.0	CBM	1-7		Recorder attached.(Telephone Telemetry)
Amberley	Warrill Ck.	8.7	920.0	WRC	0-6		Recorder attached.(Telephone Telemetry) BVRT 1 km u/s.
Ipswich	Bremer R.	16.0	1850.0	ICC	0-24	4	

Notes:
- CBM Commonwealth Bureau of Meteorology
- BCC Brisbane City Council
- BVRT Brisbane Valley Radio Telemetry Network
- ICC Ipswich City Council
- SEQWB South East Queensland Water Board
- WRC Water Resources Commission, Department of Primary Industries.

Table E-2
BUREAU OF METEOROLOGY HEAVY RAINFALL STATIONS

Amberley	Mt. Glorious
Brisbane	Mt. Kilcoy
Crow's Nest	Mt. Mee
Gatton	Mt. Nebo
Harrisville	Peachester
Jimna	Rosewood
Kalbar	Tarome
Kilcoy	Thornton
Laidley	Toogoolawah
Lowood	Woodford
Maleny	Yarraman
Lindfield*	

* Station is sometimes unattended.

BRISBANE CITY COUNCIL HEAVY RAINFALL STATIONS

Enoggera Dam
Gold Creek Dam
Lake Manchecter
Mt. Crosby

SOUTH EAST QUEENSLAND WATER BOARD HEAVY RAINFALL STATIONS

Somerset Dam
Wivenhoe Dam

E.1. Brisbane Valley Radio Telemetry Network

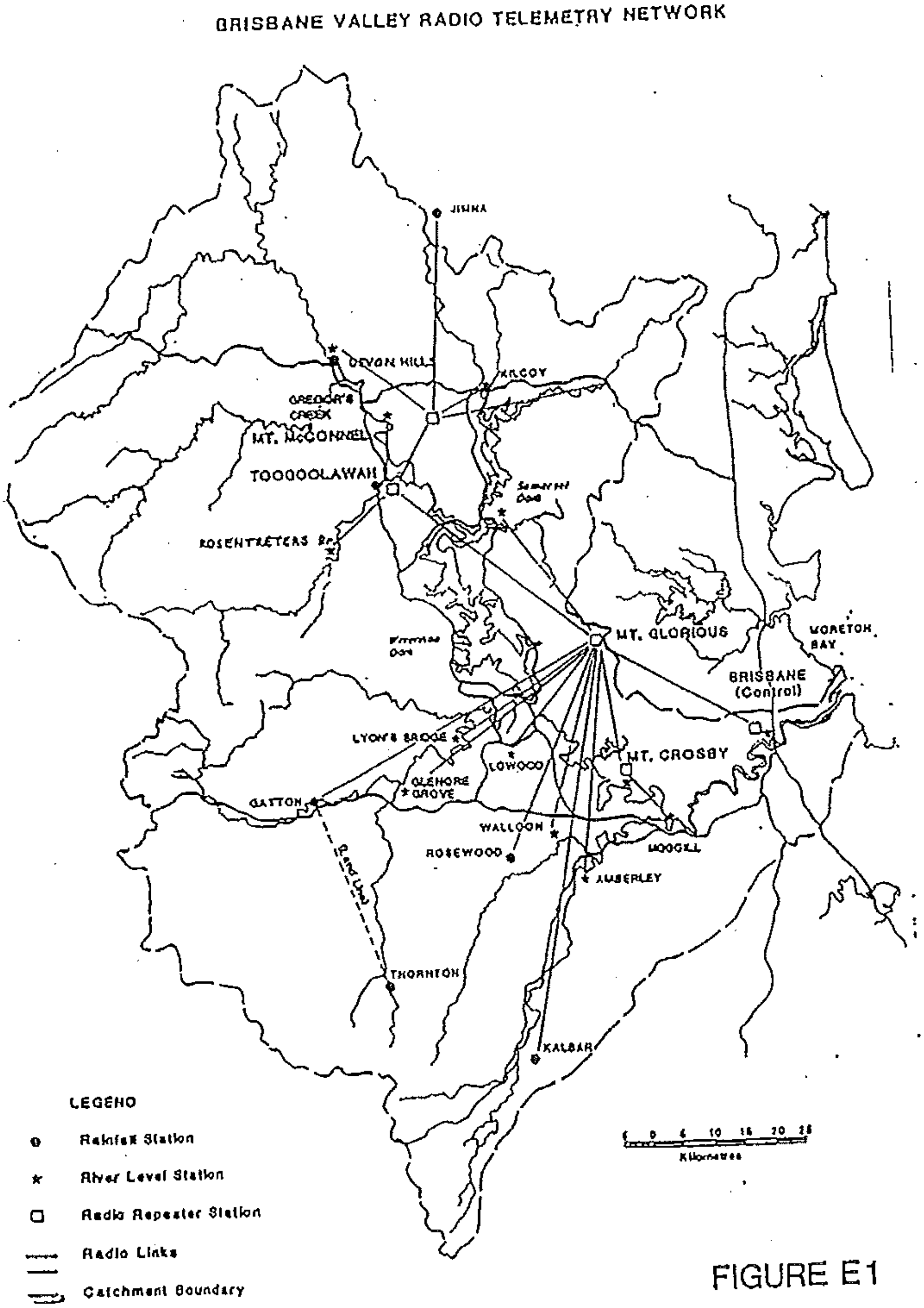


FIGURE E1

E.2. Staff Gauges - Brisbane River Catchment

BRISBANE RIVER CATCHMENT FLOOD GAUGES

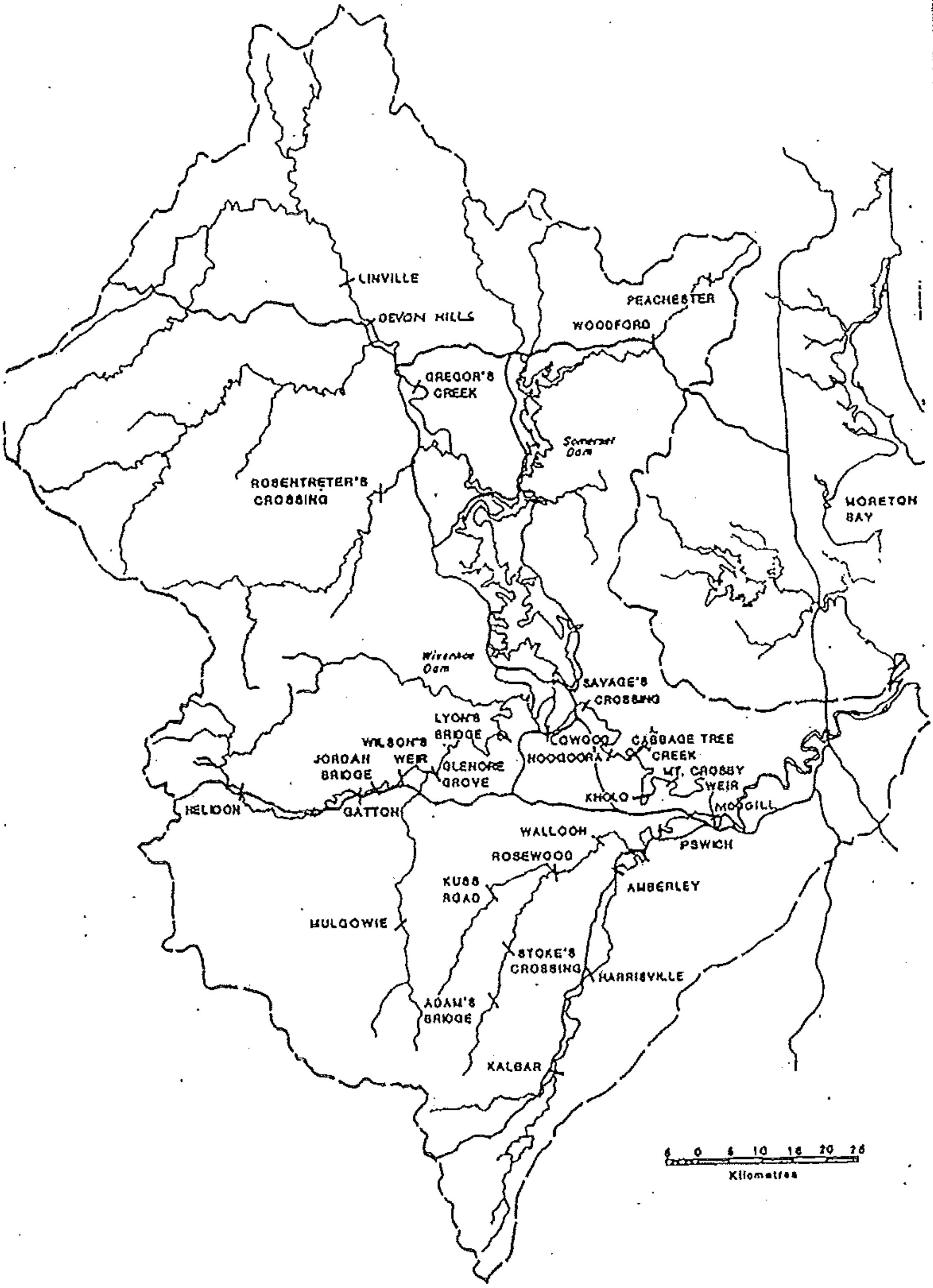


FIGURE E2

E.3. Heavy Rainfall Stations

HEAVY RAINFALL STATIONS

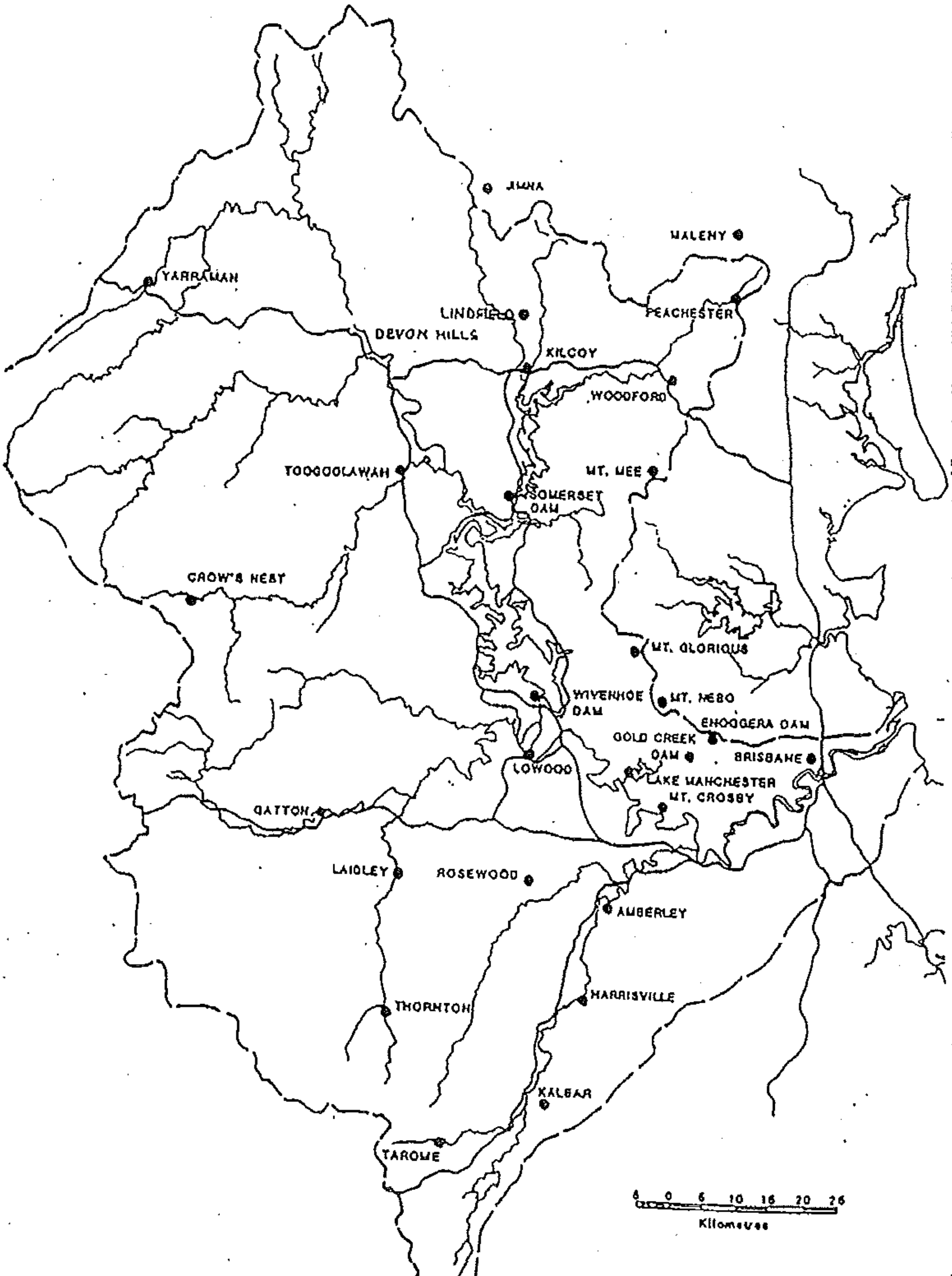


FIGURE E3

E.4. Radio Communication Network

RADIO COMMUNICATION WITH DAMS

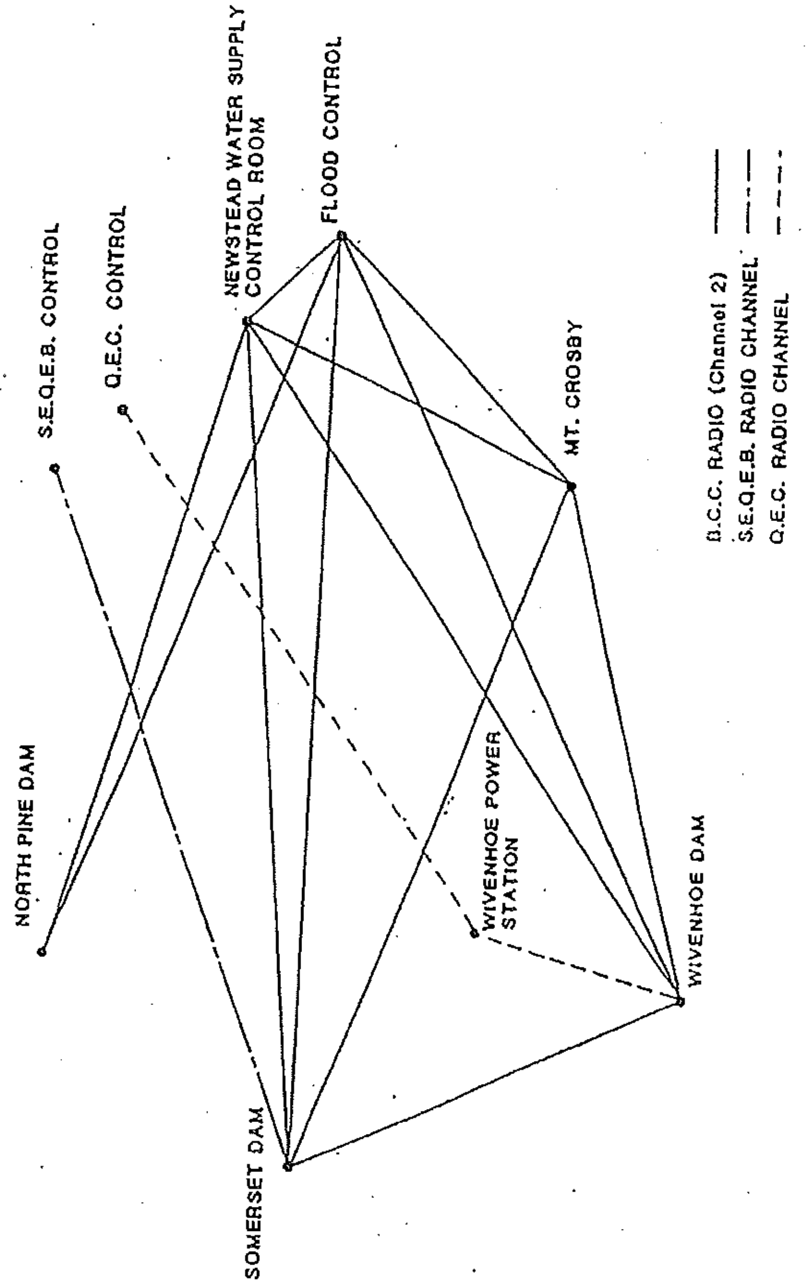


FIGURE E4

APPENDIX F. WIVENHOE DAM GATE OPERATION CONSIDERATIONS

Full size plans of Wivenhoe Dam, and Operations and Maintenance Manuals for Wivenhoe Dam are held by the Headworks Operator and are available at the site. Operations and Maintenance Manuals relevant to the flood operation of the gates are:

(a) "Master Manual and Drawings."

(b) "Radial and Penstock Gate Hoists and Drawings."

F.1. SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Appendix I shows the general arrangement of the spillway area.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool

(ii) The flow in the spillway is to be symmetrical.

The main purpose of gating the spillway is to exercise maximum control over the flow in the Brisbane River insofar as river flows in excess of 4 000 m^3/s cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

F.2. RADIAL GATE OPERATING PRINCIPLE

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

APPENDIX H. HYDROLOGIC INVESTIGATIONS

H.1. INTRODUCTION

This appendix describes hydrologic analyses performed prior to 1986 for the flood design of Wivenhoe Dam and for the testing of operation policies. A detailed report entitled ' Hydrology Report for Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam ' is held by the Queensland Water Resources Commission and the Brisbane City Council. The analyses were carried out using the most appropriate data available in 1983 and it is recommended that they be revised after the occurrence of a large flood or after the adoption of more advanced methods of hydrologic analysis.The work summarised here supersedes that completed earlier during the design stages of Wivenhoe Dam, details of which are contained in the design report on Wivenhoe Dam.

H.2. METHOD

There are three components in the hydrologic analysis:

(i) a rainfall analysis to determine both rainfall frequency and Probable Maximum Precipitation (PMP)

(ii) a model of the catchment rainfall-runoff process; and

(iii) a model of the flood operations of the two dams.

The Bureau of Meteorology completed several studies of the Probable Maximum Precipitation. The Australian generalised method for areas subject to tropical cyclones was used and rainfalls for durations up to seven days were estimated. The Probable Maximum Precipitation was estimated for the whole of the Brisbane River catchment, as well as for various subcatchments.When the Probable Maximum Precipitation was given for a subcatchment, an estimate of general rainfall that could be expected over the remainder of the catchment was also given.

Rainfall frequency analysis was performed on 37 stations scattered throughout the catchment. The log-normal frequency distribution was fitted to annual series of one, two and three day rainfalls for each of these stations independently. These distributions were extrapolated and 1%, 0.1% and 0.01% annual exceedence probability rainfalls extracted.

The Probable Maximum Precipitation temporal patterns provided by the Bureau of Meteorology were used for all rainfalls.

The rainfall runoff model used was the runoff routing method of flood estimation which was calibrated on an extensive set of recorded storm and flood data and then used to estimate floods.

Models to simulate the flood operation of Somerset and Wivenhoe Dams were developed especially and calculated dam discharges were included in the runoff routing model.

H.3. RAINFALL ANALYSIS RESULTS

The rainfall analysis was performed in two parts, the rainfall frequency analysis by the Queensland Water Resources Commission and the Probable Maximum Precipitation estimate by the Bureau of Meteorology. These were used both for design studies for the dam and to test the effects of flood operation procedures.

The frequency analysis was performed on the annual series of one, two and three day maxima, individually for each station in the catchment. Catchment rainfalls were estimated using the log-normal distribution of station rainfalls and are listed in Tables H.1 and H.2.

Table H-1
Catchment Rainfall (mm) on Wivenhoe Dam Catchment

Annual Exceedance Probability %	1 day	2 day	3 day
1.00	217	298	347
0.10	303	419	493
0.01	400	556	657

Table H-2
Catchment Rainfall (mm) Downstream of Wivenhoe Dam

Annual Exceedance Probability %	1 day	2 day	3 day
1.00	197	270	316
0.10	268	371	440
0.01	346	484	579

The Probable Maximum Precipitation study was performed by the Bureau of Meteorology, and rainfalls for durations up to 7 days were estimated using the generalised methods. These estimates are listed in Table H3. The figures in brackets show the general rainfall over the remainder of the Brisbane River catchment that could be possible when the Probable Maximum Precipitation falls on the given subcatchment.

Table H-3
Probable Maximum Precipitation (mm)

Duration (days)	Somerset Dam	Wivenhoe Dam	Total Catchment
1	840 (300)	600 (50)	560
2	1380 (500)	1000 (90)	700
3	1760 (620)	1260 (110)	880
4	2040 (720)	1460 (130)	1040
5	2120 (760)	1520 (130)	1080
6	2160 (780)	1560 (140)	1100
7	2340 (840)	1700 (150)	1200

H.4. RUNOFF ROUTING MODEL CALIBRATION

The runoff routing model was calibrated for the three major sub-catchments:

(1) Brisbane River upstream of Wivenhoe Dam,
(2) Brisbane River downstream of the dam and
(3) Stanley River,

using data from several gauging stations in the first two of the sub-catchments and inflows to Somerset Dam in the third.

Seven floods were used for calibration: July 1965, March 1967, June 1967, January 1968, December 1971, January 1974 and January 1976. The gauging stations used for model calibration are listed in Table H-4.

Table H-4
Gauging Stations used for Model Calibration

Stream	Site	Number	AMTD (km)	Catchment Area (km^2)
Stanley River	Somerset Dam		7.2	1 335
Cooyar Creek	Damsite	143015	12.2	960
Brisbane River	Linville	143007	282.4	2 005
Emu Creek	Boat Mountain	143010	10.1	920
Brisbane River	Gregor's Creek	143009	251.7	3 885
Cressbrook Creek	Damsite	143013	58.6	325
Brisbane River	Middle Creek	143008	187.2	6 710
Brisbane River	Wivenhoe Dam		150.2	7 020
Brisbane River	Savage's Crossing	143001	130.8	10 180
Bremer River	Walloon	143107	37.2	620
Warrill Creek	Amberley	143108	8.7	920
Lockyer Creek	Lyon's Bridge	143210	27.2	2 540
Brisbane River	City		22.7	13 260

The model was calibrated for as many sites as possible for each of the seven floods. Data were missing for some of the stations for some of the floods. The estimated model parametres are given in Table H-5. In all cases relative delay time used in the model is related to reach length.

Table H-5
Runoff Routing Model Parameters

Catchment	K	m
Somerset Dam	94*	0.75
Upstream of Wivenhoe Dam	140	0.75
Downstream of Wivenhoe Dam	270	0.75

* If relative delay times for the whole catchment upstream of Wivenhoe Dam are used for the Somerset Dam model, then the value of K must be 500.

H.5. WIVENHOE DAM FLOODS

Wivenhoe Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Wivenhoe Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the damsite without the dam in the catchment. Two day storms were found to have the critical storm duration for most cases, though the long duration Probable Maximum Precipitations produced very large flood volumes. Table H-6 lists results for the two day duration storms.

Table H-6
Wivenhoe Dam Floods
(for two day storm duration)

AEP %	Flood Volume (10^6 m^3)	Peak Discharge no dam (m^3/s)	Peak Inflow with dam (m^3/s)
1.00	1234	8300	8700
0.10	2044	12900	13400
0.01	3045	19100	19600
PMF	6170	42200	43000

PMF = Probable Maximum Flood due to 2 day PMP

H.6. FLOOD CONTROL OPERATION MODEL

Floods in the Brisbane River catchment above Wivenhoe Dam can originate in either the Stanley River or upper Brisbane River catchment or both. Both of the dams are capable of being operated in a number of ways, each of which will reduce the flow downstream. However, in order to achieve maximum reduction of flooding downstream of Wivenhoe Dam, it was necessary to determine the most effective combination of operations at Somerset and Wivenhoe Dams.

Five possible operational procedures for each of Somerset Dam and Wivenhoe Dam, giving twenty-five possible combinations were considered. The procedures for Wivenhoe Dam were designed so that initial release operations did not adversely affect later operations in the event of later rainfall causing the magnitude of the flood to exceed the original estimate.

The procedures were also designed such that flooding in the lower catchment was restricted to the lowest practicable of the following categories:

(i) small ,fresh - low level bridges submerged, Fernvale bridge open, Lowood gauge < 7.8 m;

(ii) large fresh - all bridges except Mt. Crosby Weir bridge submerged, Lowood gauge < 10m;

(iii) small flood - all bridges submerged, no damage to urban areas, Lowood gauge < 15.5m;

(iv) medium flood - damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe Dam contributing to peak flow, Lowood gauge < 20 m;

(v) large flood - extensive damage to urban areas due to combined Wivenhoe Dam releases and downstream flow, Wivenhoe Dam release component of peak flow minimum practicable, Lowood gauge < 20 m.

One procedure was selected for the operation at Somerset Dam. This procedure had two advantages over the other procedures tested. Firstly, it was feasible for all magnitudes of Stanley River floods tested and, secondly, it was the simplest procedure to carry out.

The procedures for Wivenhoe Dam were reduced to four by combining two procedures into one. The resulting four procedures form a hierarchy and the procedure to be adopted advances to the next procedure as the flood magnitude increases.

The procedure to be adopted at Wivenhoe Dam was related to the peak level at the Gregor's Creek, Woodford, Lyon's Bridge and Ipswich gauges.

H.7. DOWNSTREAM FLOODING

Floods were also calculated for the catchment downstream of Wivenhoe Dam, for three different cases, namely, without Wivenhoe Dam, with no releases made from Wivenhoe Dam (giving only the flood from the downstream catchment) and with Wivenhoe Dam operated according to the operating procedures. These results are shown in Table H-7 for the design storms of two days duration.

Table H-7
Floods at Brisbane (peak discharge - m^3/s)

AEP % 2 day storms	Without Wivenhoe Dam	Lower Catchment FLow	With Dam and Operating Rules
1.00	11500	4500	5500
0.10	19400	8500	10300
0.01	29500	13400	17100
PMF	49400	-	-

APPENDIX I. WIVENHOE DAM TECHNICAL DATA

Table I-1
STORAGE AND DISCHARGE FOR WIVENHOE DAM

Lake level m AHD	Storage Capacity 10^6 m^3	Flood Capacity 10^6 m^3	Inflow per 100mm rise per hour** m^3/s	Discharge* per Regulator m^3/s	Discharge* per Spillway Gate m^3/s	Maximum Available Discharge m^3/s
57.0	390	-	1 110	25	0	50
57.5	418	-	1 204	25	10	100
58.0	446	-	1 297	25	20	151
58.5	477	-	1 391	26	40	252
59.0	507	-	1 484	26	60	352
59.5	539	-	1 573	26	84	472
60.0	570	-	1 671	26	108	593
60.5	603	-	1 765	27	140	753
61.0	635	-	1 858	27	172	914
61.5	668	-	1 951	27	206	1 084
62.0	700	-	2 045	27	240	1 255
62.5	738	-	2 138	28	285	1 480
63.0	776	-	2 232	28	330	1 706
63.5	814	-	2 325	28	375	1 931
64.0	852	-	2 419	28	420	2 157
64.5	898	-	2 512	28	470	2 407
65.0	944	-	2 605	29	520	2 657
65.5	997	-	2 699	29	580	2 958
66.0	1 050	-	2 792	29	640	3 258
66.5	1 100	-	2 886	29	700	3 559
67.0	1 150	0	2 979	30	760	3 859
67.5	1 206	56	3 073	30	825	4 184
68.0	1 262	112	3 166	30	890	4 510
68.5	1 321	171	3 259	30	955	4 835
69.0	1 380	230	3 353	30	1 020	5 161
69.5	1 440	290	3 446	31	1 095	5 536
70.0	1 500	350	3 540	31	1 170	5 912
70.5	1 568	418	3 633	31	1 245	6 287
71.0	1 635	485	3 727	31	1 320	6 662
71.5	1 700	550	3 820	31	1 390	7 013
72.0	1 765	615	3 913	32	1 460	7 363
72.5	1 833	683	4 007	32	1 540	7 763
73.0	1 900	750	4 100	32	1 620	8 164
73.5	1 980	830	4 194	32	1 705	8 589
74.0	2 060	910	4 287	32	1 790	9 015
74.5	2 145	995	4 381	32	1 890	9 515
75.0	2 230	1 080	4 474	33	1 990	10 015
75.5	2 310	1 160	4 567	33	2 085	10 491
76.0	2 390	1 240	4 661	33	2 180	10 996
76.5	2 480	1 258	4 754	33	2 280	11 466
77.0	2 570	1 420	4 848	33	2 380	11 967
77.5	2 650	1 500	4 941	34	2 490	12 517
78.0	2 730	1 580	5 035	34	2 600	13 068
78.5	2 830	1 680	5 128	34	2 740	13 768
79.0	2 930	1 780	5 221	34	2 880	14 468

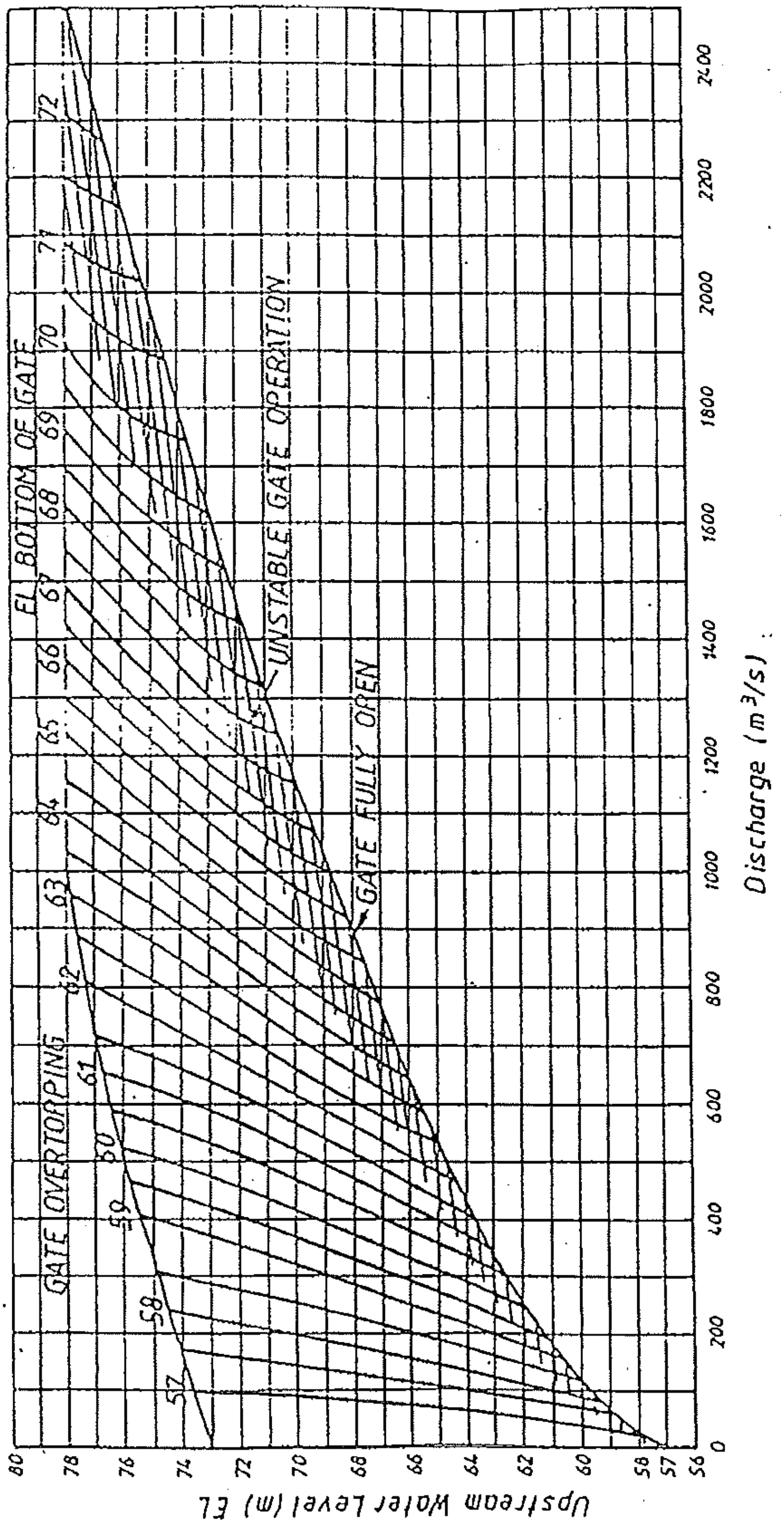
* This is the maximum discharge of an individual gate or regulator with the reservoir head at Lake Level. Total discharge is calculated by adding the contributions of each gate or regulator.

** This assumes that all gates and sluices are closed. Discharges through the spillway have to be added to the above figures to calculate the actual inflow into the reservoir.

[redacted]

[redacted]

I.3. Discharge Rating



WIVENHOE DAM SPILLWAY MODEL
DISCHARGE RATING
1-GATE

FIGURE 13

[redacted]

APPENDIX J. SOMERSET DAM TECHNICAL DATA

A full scale version of the drawing of Somerset Dam as shown in this appendix is held by the Headworks Operator.

Table J-1
STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake level m AHD	Reservoir Capacity 10^6 m^3	Temporary Flood Storage 10^6 m^3	Inflow per 100mm rise per hour** m^3/s	Discharge* per Regulator m^3/s	Discharge* per Sluice m^3/s	Discharge* per Spillway Gate m^3/s	Maximum Available Discharge m^3/s
90.0	111.3	-	472	57	163	-	1 529
90.5	119.8	-	502	58	165	-	1 551
91.0	128.8	-	522	58	167	-	1 572
91.5	138.2	-	561	59	170	-	1 593
92.0	148.3	-	592	60	172	-	1 614
92.5	159.0	-	615	60	174	-	1 635
93.0	170.0	-	669	61	176	-	1 655
93.5	182.0	-	703	62	179	-	1 676
94.0	194.7	-	729	62	181	-	1 696
94.5	207.8	-	800	63	183	-	1 715
95.0	222.2	-	833	64	185	-	1 735
95.5	237.2	-	862	64	187	-	1 754
96.0	252.8	-	937	65	189	-	1 773
96.5	269.6	-	973	65	191	-	1 792
97.0	287.1	-	1 015	66	193	-	1 811
97.5	305.4	-	1 082	67	195	-	1 829
98.0	324.9	-	1 125	67	197	-	1 847
98.5	345.1	-	1 493	68	199	-	1 865
99.0	372	-	1 300	69	200	-	1 876
99.5	394	22	1 330	69	203	-	1 900
100.0	418	46	1 365	70	205	-	1 920
100.5	442	70	1 410	71	207	-	1 940
101.0	467	95	1 460	71	209	6	2 004
101.5	493	121	1 525	72	211	15	2 096
102.0	520	148	1 575	72	212	27	2 200
102.5	548	176	1 635	73	215	41	2 340
103.0	578	206	1 695	73	217	59	2 500
103.5	607	235	1 750	74	218	80	2 680
104.0	639	267	1 805	74	220	99	2 848
104.5	671	299	1 875	75	222	123	3 060
105.0	704	332	1 945	75	223	150	3 284
105.5	739	367	2 005	76	224	178	3 520
106.0	775	403	2 070	76	226	210	3 792
106.5	812	440	2 130	77	228	244	4 084
107.0	854	482	2 200	78	230	278	4 376
107.5	896	524	2 270	78	231	315	4 680

* This is the maximum discharge of an individual gate or regulator with the reservoir head at Lake Level. Total discharge is calculated by adding the contributions of each gate or regulator.

** Assumes that discharge is occuring through the regulators and spillway gates.

NOTES ON TABLE J-1:

Regulator - Discharge regulator valve of which there are four (4).
Sluice - Sluice gate of which there are eight (8).
Spillway - Overflow section of dam controlled by eight (8) radial gates.
Temporary Flood Storage - The temporary storage above the normal full supply level of El 99 m (AHD)

[redacted]

APPENDIX K. SCHEDULE OF AUTHORITIES

Schedule of Delegations

Delegation From	Delegation to	Duty/Power	Approval by	Approval Date
South East Queensland Water Board	Brisbane City Council	Headworks Operator	Minister	Date of Approval for this manual
Headworks Operator	The Engineer	Application of Appropriate Flood Operation Procedures	Minister	Date of Approval of this Manual
The Engineer	Operations Engineers	Operation of the Dams During Floods	Minister	Date of Approval of this Manual

Schedule of the Engineer and Operations Engineers

Name	Professional Engineers Number (RPEQ)	Address	Approved By	Date of Approval
The Engineer				
Operations Engineers				

APPENDIX L. SCHEDULE OF AUTHORITIES TO RECEIVE FLOOD INFORMATION

Schedule of Authorities to Receive
Information on Flood Releases from
Wivenhoe Dam and Somerset Dam

Authority	Contact Position(s)
South East Queensland Water Board	Chairperson (Secretary/Manager)
State Emergency Service	Duty Officer
Bureau of Meteorology	Duty Forecaster
Water Resources Commission	District Manager, Brisbane Office
Esk Shire Council	Shire Engineer
Moreton Shire Council	Shire Engineer
Ipswich City Council	Works Manager
Department of Transport - Roads - Harbours and Marine	 Duty Harbour Master/Port Information Officer
Police Department	Duty Inspector

The names of the contacts persons belonging to the above positions and their phone numbers are to be kept in a register by the Engineer (Section 3.3).

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[redacted]

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[redacted]

MANUAL

OF

OPERATIONAL PROCEDURES FOR FLOOD MITIGATION

FOR WIVENHOE DAM AND SOMERSET DAM

SUPERSEDED

FOR WIVENHOE DAM & SOMERSET DAM / SECOND DR
MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD
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BRISBANE AND AREA WATER BOARD ADVISORY COMMITTEE

MINUTES

FOR THE MEETING CONVENED IN THE LOCAL GOVERNMENT CONFERENCE ROOM, TREASURY BUILDING ON 18th SEPTEMBER, 1985

1. PRESENT

Messrs W. Webber (Chairman)
K. Tibbits
P. Phillips
W. Sharp
G. Cossins

Apology: Mr D. Beattie
Observer: Mr D. Evans
Secretary: Mrs D. Argent

2. MINUTES OF PREVIOUS MEETING

There were no comments on or amendments to the Minutes of the previous meeting.

3. REPORTS

(i) Wivenhoe Dam

The following comments on the Wivenhoe Dom Report were offered.

Page 2, 1.5 - Period of Effectiveness

This should be rewarded as:

"The procedures in this Manual shall hove effect on and from the date on which the Manual is approved by the Minister, or the date published in the Gazette, notifying the handing aver of the heodworks and relinquishing control of the same to the Brisbane and Area Water Board, whichever is the later."

Page 2, 1.6 - Observance of Manual

This should be reworded as:

"This Manual contains the operationol procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation and shall be observed by Brisbane City Council and the Brisbane and Area Woter Board and the employees of each."

Page 18, second paragraph

Delete all words after "Engineer" where it appears in the first line and insert:

> "...shall direct the operation of the low level regulators and sluices to meet the objectives of the Manual."

Page 21, 9.6 - Equipment Failure

This should be reworded to read:

> "In the event of equipment failure the action to be taken is indicated in Appendix F for Wivenhoe Dam and Appendix G for Somerset Dam."

Appendix B, Figure B1

A legend needs to be inserted to indicate "Rainfall Station", "River Level Station" etc. as are indicated on Figure E1.

Appendix C, Table C1

The column headed "Operating Procedure" should be inserted between the two columns headed "Ipswich" and "Lowood".

The first four columns should have a main heading "Predicted Peak Gauge Height (m)" and the last two columns should have a main heading "Resultant Peak Gauge Height (m)".

Appendix E, Table E2

In the first column delete "Bald Knob" and insert "Maleny" before "Moore" where it appears in the first column.

Appendix E, Figure E1

A radio link line is to be added from "Mt Glorious" to "Glenore Grove". New copies of the map are to be supplied by Brisbane City Council.

Appendix E, Figure E3

Change "Bald Knob" to "Maleny".

Appendix F, 2.0 - Radial Gate Operating Principle

In the first paragraph "horizontal" is spelled incorrectly. This is to be corrected.

In the first paragraph it is not clear what is meant by "two spherical trunnion bearings...". This is to be clarified by the Queensland Water Resources Commission.

Appendix F, 3.5 - Operation in High Wind

The term "High Wind" needs to be clarified. This is to be done by Queensland Water Resources Commission.

Appendix F, 4.3 - Discharge Regulation

In the first paragraph, delete "behind" where it appears in the last line and insert "that is, the lip of the radial gate must be clear of the nappe".

It was decided that 4.3 should be redrafted by Queensland Water Resources Commission.

Appendix F, 6.7 - Mechanical Failure of Winch

In paragraph (ii), the second sentence should read:

> "If the gate is in a raised position this event causes the side skids to come into contact with the pier sides."

The last sentence of this paragraph is to be deleted.

Appendix H, Table H1 and Table H2

The headings "Design Catchment Rainfall (mm)" should read "Catchment Rainfall (mm)".

Appendix H, 7.0 - Downstream Flooding

"Rate" in the first line should read "Rare".

(ii) North Pine Dam

The following comments on the North Pine Dam were offered.

Page 2, 1.6 - Observance of Manual

This should be reworded as:

> "This Manual contains the operational procedures for North Pine dam for the purposes of flood mitigation and shall be observed by Brisbane City Council and the Brisbane and Area Water Board and the employees of each."

Page 6, 4.4 - Maintenance of the Full Supply Level

In the second line of the first paragraph, delete "the Pine Rivers Shire" and insert "the shires of Caboolture and Pine Rivers".

Page 11

After 7.2, insert the following paragraph:

> "Prior to the opening of spillway gates to discharge floodwaters, site staff at North Pine dam are to take all reasonable precautions to ensure that the public are not endangered by the released water. The gates on the road approaches to Young's Crossing bridge and the Grant Street causeway immediately below the dam are to be closed before opening the spillway gates."

In the last paragraph on page 11, the second sentence should read:

> "At no time is any gate to be open more than one setting greater or less than any other gate during opening and shut down."

Page 12, 7.4 - Operating Procedure

In paragraph 4, "If the gate settings..." should read "If the actual gate settings...".

In paragraph 5, delete "to successive settings" where it appears in the second line.

Page 13, 8.2 - One Spillway Gate Out of Service

Delete "to successive settings" where it appears in the second and third lines.

Table B1

"Appendix B" is to be inserted on the top right hand corner of "Table B1".

Appendix D

In the fourth column the word "(Closed)" is to be placed on the same line as "Top of Gates".

The word "Nett" should be spelled "Net".

It was decided that Queensland Water Resources Commission will liaise with Brisbane City Council on the above amendments and Brisbane City Council will advise Premier's Department of the final amendments. This is to be done within two weeks in order that a Brisbane and Area Water Board Advisory Committee meeting can be arranged on the 8th or 9th (afternoon) to discuss the further amendments.

The Chairman closed the meeting at 3.50 p.m.

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MANUAL

OF

OPERATIONAL PROCEDURES FOR FLOOD MITIGATION

FOR WIVENHOE DAM AND SOMERSET DAM

I, Russell James HINZE, Minister for Local Government, Main Roads and Racing in the State of Queensland do hereby approve and issue the following manual, and declare that the procedures contained herein shall be the operational procedures in relation to Wivenhoe dam and Somerset dam.

Dated this day of September 1985 at Brisbane.

R.J. HINZE

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Meaning of Terms

In this Manual, save where a contrary intention appears -

"Advisory Committee" or "Brisbane and Area Water Board Advisory Committee" means the Advisory Committee established pursuant to Section 21 of the Brisbane and Area Water Board Act 1979-1984, as constituted at the material time;

"A.H.D." means Australian Height Datum;

"Board" or "Brisbane and Area Water Board" means the body corporate constituted by that name pursuant to Section 9 of the Brisbane and Area Water Board Act 1979-1984;

"Brisbane City Council" means Brisbane City Council under and within the meaning of the City of Brisbane Act 1924-1984;

"Chairman" means the Chairman of the Brisbane and Area Water Board;

"Commissioner of Water Resources" means the corporation sole constituted by that name pursuant to Section 8 of the Water Resources Administration Act 1978;

"Dams" means dams to which this Manual applies, that is Wivenhoe dam and Somerset dam;

"EL" means elevation in metres from Australian Height Datum;

"Electricity Commissioner" means the Commissioner under and within the meaning of the Electricity Act 1976-1984;

"Engineer" means the person designated pursuant to Section 2.3 of this Manual under whose general direction the procedures in this Manual shall be carried out;

"Gauge height" means river level as reported by the Brisbane Valley Flood Warning Radio Telemetry System unless noted otherwise;

"Minister" means the minister of the Crown who at the material time is charged with the administration of the Brisbane and Area Water Board Act 1979-1984;

"Power station" means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe dam and Split-Yard Creek dam.

1.2 Purpose of Manual

The purpose of this Manual is to define standard procedures for the operation of Wivenhoe dam and Somerset dam for the purpose of flood mitigation during the period of construction of Wivenhoe Dam.

1.3 Legal Authority

This manual has been prepared at the direction of the Brisbane and Area Water Board Advisory Committee pursuant to the provisions of the Brisbane and Area Water Board Act 1979-1984.

1.4 Scope of Manual

The procedures in this Manual shall apply to the operation of Wivenhoe dam and Somerset dam for the purpose of flood mitigation.

1.5 Period of Effectiveness

Has been amended per letter dated 18/10/85 [illegible].

The procedures in this Manual shall have effect on and from the date on which the Manual is approved by the Minister, or the date declared by Order in Council effecting the transfer of all property being part of or relevant to the Wivenhoe dam project to the Brisbane and Area Water Board, whichever is the later.

1.6 Observance of Manual

This Manual contains the operational procedures for the purpose of flood mitigation, of the Brisbane City Council and the Brisbane and Area Water Board in respect of Wivenhoe dam and Somerset dam and shall be observed by each of them and the employees of each of them.

1.7 Provision for Variations to Manual

If any one of the Commissioner of Water Resources, the Brisbane City Council, or the Brisbane and Area Water Board is of the opinion that any requirement of this Manual does not meet the requirements of the respective Authority, or for some other reason should be amended, the Authority shall make a submission to the Brisbane and Area Water Board Advisory Committee setting forth those circumstances and the exact nature of the amendment, alteration or variation sought.

If the Advisory Committee then is of the opinion that the procedures in this Manual should be amended, altered or varied, it shall submit a recommendation to the Board setting out the circumstances and the exact nature of the amendment, alteration or variation sought.

If the Board then is of the opinion that the procedures in this Manual should be amended, altered or varied, it shall submit a recommendation to the Minister setting out the circumstances and the exact nature of the amendment, alteration or variation sought.

Any amendment, alteration or variation to the procedures in this Manual shall take effect on and from the date on which the recommendations are approved by the Minister.

1.8 Review of Manual

This Manual shall be reviewed in accordance with the operational procedures defined herein. It is the responsibility of the reader to ensure that this is the current document.

2.0 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Brisbane and Area Water Board Act 1979-1984, the Brisbane and Area Water Board is responsible for and has the duty of operating Wivenhoe dam and Somerset dam, and may enter into arrangements with persons for the purpose of discharging these responsibilities.

2.2 Dam Operation Arrangements

The Board has arranged for the operation of Wivenhoe dam and Somerset dam by the Brisbane City Council subject to the conditions that:

(a) the operation be carried out under the general direction of a suitably qualified and experienced engineer;

(b) in the direction of the operation, the suitably qualified and experienced engineer liaise with those persons responsible for the operation of the Wivenhoe power station.

Brisbane City Council has arranged for the operation of Wivenhoe and Somerset dams to be carried out under the general direction of the Chief Engineer and Manager of the Water Supply and Sewerage Department of the Brisbane City Council.

2.3 Designation of Engineer

The procedures set out in this Manual shall be carried out under the general direction of a suitably qualified and experienced engineer who shall be referred to hereafter as "the Engineer".

Under the administrative arrangements of Section 2.2, the Engineer is the Chief Engineer and Manager of the Water Supply and Sewerage Department of the Brisbane City Council.

2.4 Responsibilities of Engineer

Before adopting an operational procedure to be applied to any flood, the Engineer shall seek and shall take account of all relevant information available to him.

Except insofar as reasonable discretion is provided for in Section 2.5 of this Manual, the Engineer shall ensure that the operational procedures for the dams shall be those specified in this Manual.

2.5 Reasonable Discretion

It is recognized for the purposes of this Manual that no two floods in the Brisbane River system are exactly alike and that the procedures set out in this Manual are based upon the most common behaviour observed in the river system over a period of ninety years. It is therefore necessary that there be reasonable discretion in the determination of the method of operation of the dams to cope with unusual flood occurrences.

This reasonable discretion rests with the Engineer. If, in the opinion of the Engineer, based on information available to him and based on his professional experience, it is necessary to depart from the procedures set out in this Manual, he is empowered to adopt such other procedures as he considers necessary to meet the situation, provided that the Engineer shall observe the objectives set out in this Manual when exercising such reasonable discretion.

Before exercising any discretion under this section of the Manual, the Engineer shall consult with such of the following persons as are available at the time the discretion requires to be exercised:

The Chairman of the Board;

The Co-ordinator-General or a person nominated by him in that behalf;

The Director of Local Government or a person nominated by him in that behalf;

The Commissioner of Water Resources or a person nominated by him in that behalf.

2.6 Report

The Engineer shall prepare a report to the Advisory Committee after each flood (not freshes) and the report shall contain details of the procedures used and the reasons therefore.

3.0 COMMUNICATIONS

3.1 Liaison

It is the duty of the Engineer, the Chairman of the Brisbane and Area Water Board, the Brisbane City Council, the Commissioner of Water Resources and the Electricity Commissioner to ensure that the Engineer is supplied with current information concerning Wivenhoe dam, Somerset dam and Wivenhoe power station through liaison with the representatives of the Engineer, the Chairman, the Commissioner of Water Resources, the Electricity Commissioner and the Brisbane City Council.

3.2 Communications between Engineer and Site Staff

The Engineer shall ensure that adequate channels of communication exist between himself and site staff at Wivenhoe and Somerset dams.

It is the duty of the Engineer, the Chairman of the Brisbane and Area Water Board, the Brisbane City Council, the Commissioner of Water Resources and the Electricity Commissioner to negotiate and consult with each other concerning the provision of adequate communication facilities between the Engineer and the dams at all times including emergency situations when normal communication facilities may be unavailable.

3.3 Staff on Duty

When, in the opinion of the Engineer, a flood situation is imminent, he shall:

(i) ensure that he has staff available to communicate with the dam sites and with other agencies;

(ii) advise the Chairman of the Brisbane and Area Water Board, the Brisbane City Council, the Commissioner of Water Resources and the Electricity Commissioner of the need to have staff on duty for communication purposes and for the provision of information, including assessments of safety of structures.

It shall be the responsibility of the above to ensure that appropriate staff are available for duty.

3.4 Communication with Public

The Engineer shall ensure, if possible, that information is forwarded to those agencies whose duty it is from time to time to provide warnings and information to the public during emergency situations.

4.0 FLOOD MITIGATION OBJECTIVES

4.1 General

The objectives of the procedures in this Manual are governed by the following considerations listed in descending order of importance:

(a) Structural safety of the dams;

(b) Optimum protection of urban development and the power station;

(c) Capacity of the dams to deal with closely spaced floods;

(d) Minimum disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries;

(e) Minimum disruption to navigation in the Brisbane River.

4.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

Wivenhoe Dam

The structural safety of Wivenhoe dam is of paramount importance. Structural failure of Wivenhoe dam could have catastrophic consequences due to the magnitude of the damage which would be caused downstream, the loss of a major water supply source for the Brisbane Water Supply System, and the loss of power generation.

Somerset Dam

The structural safety of Somerset dam also is of paramount importance. Structural failure of Somerset dam could have catastrophic consequences due to the magnitude of the damage which would be caused downstream and to Wivenhoe dam and the power station, and the loss of a major water supply source for the Brisbane Water Supply System.

4.3 Protection of Urban Development

The prime purpose of incorporating flood mitigation measures into Wivenhoe dam and Somerset dam is to alleviate flooding in the urban areas of the flood plain of the lower Brisbane River from Mt. Crosby to Moreton Bay.

The protection of the power station shall be accorded the same priority as the mitigation of flooding in these urban areas.

4.4 Closely Spaced Floods

Historical records show that there is a significant probability of two flood producing storms occurring in the Brisbane River system within a short time of each other. In order to be prepared to meet such a situation the stored flood waters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles.

The prolonged discharges resulting from the emptying of the flood compartments of the dams have little impact on the urban reaches of the Brisbane River. These reaches of the river can carry a discharge which will not affect buildings and bridges in Brisbane but which will cause the Brisbane Valley Highway to be closed at Fernvale and which will cause the submergence of bridges of other main roads and Local Authority roads.

4.5 Disruption to Rural Areas

Rural areas can suffer two types of flooding from the operation of dams for the purpose of flood mitigation. In the first place, a dam can flood land and communications which would never have been flooded if the dam had not existed. This situation is most important upstream of a dam. It applies particularly to Somerset dam and, to a lesser extent, to Wivenhoe dam. Downstream of a dam the operation for the purpose of flood mitigation usually results in a reduction of peak flood levels but the emptying of the flood pondages causes a prolonged flooding of low lying land and bridges compared with the conditions that prevailed before the dam was built; such prolonged flooding can affect a major rural area, not only the riverside properties.

4.6 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lowest priority but it is closely related to minimum feasible flooding of rural areas. The effect of flood flows upon navigation in the river varies widely. Large ships can be manoeuvred in the river at considerable flows whilst coal and coral barges and gravel dredges are affected by lower flows and the Moggill Ferry is affected by low flows.

Objectives (c), (d) and (e) of Section 4.1 are closely related and all are optimized by a short emptying period for the flood pondages of the dams.

5.0 FLOOD CLASSIFICATION

5.1 Categories of Flooding

For the purposes of this Manual, five (5) magnitudes of flooding shall be recognized. These are:

(a) Small fresh - Affects low level bridges e.g. Burton's Bridge.

(b) Large fresh - Affects moderately low level bridges e.g. Fernvale Bridge.

(c) Small flood - Submerges all rural bridges except the new O'Shea's Crossing Bridge - inundates low lying areas of Ipswich and Brisbane.

(d) Medium flood - Causes extensive flooding in Brisbane and Ipswich.

(e) Major flood - Causes extensive damage in Brisbane and Ipswich.

These descriptions are to be used as a matter of convenience in describing flood situations. There are no firm divisions between the categories, each merging into the adjacent ones.

5.2 Definitions of Categories

The five magnitudes of flooding shall be defined according to the Tables B1, B2, B3 and B4 in Appendix B for the reference gauge locations shown therein.

5.3 Reference Gauges

All of the reference gauge locations shown in Appendix B with the exception of Brisbane City Gauge are equipped with river height gauges of the Brisbane Valley Flood Warning Radio Telemetry System. This system is owned jointly by the Bureau of Meteorology and the Brisbane and Area Water Board. All data from the system is available to both organizations. The Brisbane City Gauge readings are remotely indicated to the Bureau of Meteorology and are readily available.

The locations of the gauges are shown on Fig. B1 of Appendix B.

The tables listed in Appendix B give the best present values of gauge readings and flows for the above five flood categories at key locations on the Brisbane River and its tributaries. As relatively few flow gaugings have been made at a number of key locations, the values shown in Appendix B are the best estimates available at present and are subject to amendment following further flow rating measurements or following further hydrological calculations.

The values shown in Appendix B are grouped in accordance with the most common areas of the catchment in which flooding originates.

5.4 Flood Magnitude Prediction

The most important indications of probable flood magnitudes are received from the Woodford gauge on the Stanley River, the Gregor's Creek gauge on the Upper Brisbane River, the Lyon's Bridge gauge on Lockyer Creek, the Walloon gauge on the Bremer River and the Amberley gauge on Warrill Creek, together with such rainfall data as may be available from the Brisbane Valley Flood Warning Radio Telemetry System and from the Bureau of Meteorology.

The peak flood levels at Lyon's Bridge gauge on Lockyer Creek and Gregor's Creek gauge are frequently related in time; the Lyon's Bridge gauge peak level frequently occurring within twelve to fifteen hours of the peak level at Gregor's Creek gauge. The peak flood levels at Woodford gauge, however, are randomly related in time to the peak levels of the other two gauges.

Information from the Stanley River upstream of the Woodford gauge is not representative of the degree of flooding. Nevertheless, the peak flood level at the Woodford gauge is a good indication of the volume of the flood from the Stanley River catchment which will enter Somerset dam. The Woodford gauge peak level is also an indicator of the flooding that will occur at Kilcoy. Under the normal operation of Somerset dam, this flooding is as follows:

Peak Flood Level at Woodford	Typical Flood Volume 10^6 m^3	Flooding at or near Kilcoy
5.0 m	176	Mary Smokes Ck. bridge submerged
8.0 m	525	Creek flats inundated
12.0 m	1 175	A few houses in Kilcoy flooded
17.5 m (PMF)	1 670	Much of Kilcoy flooded

The flood storage at Somerset dam above Full Supply Level (EL 99) is 524 x 10^6 m^3.

6.0 REVIEW

6.1 Introduction

The operational procedures contained within this Manual have been developed using the technical assumptions and the physical conditions prevailing at the time of preparation of the Manual.

It is recognized that with the passage of time neither the technical assumptions nor the physical conditions will remain unchanged. It is also recognized that the relevance of the Manual will diminish with every changing circumstance.

It is important, therefore, that the Manual contain operational procedures which in themselves will cause the Manual's procedures, and the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

The checking and reviewing process must involve the Engineer and all associated operations personnel in order that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based.

The Advisory Committee pursuant to Section 106 of the Brisbane and Area Water Board Act, shall cause to be prepared from time to time such amendments to the Manual as the Advisory Committee considers necessary.

This section sets out procedures to ensure the regular review of the Manual.

6.2 Personnel Training

The Engineer shall ensure that operational personnel required for flood control operations receive adequate training in the various activities involved in flood control operation.

Prior to 1st September each year, operational personnel are to be given instruction in flood control operation. The Engineer shall report to the Advisory Committee by 30th September each year on the training and state of preparedness of operations personnel.

6.3 Communications Networks

The Engineer shall ensure that all communications networks provided for the operation of the dams are maintained and operable.

The Engineer shall report to the Advisory Committee on the status of the communications networks by 30th September of each year.

6.4 Data Acquisition

The Engineer is to ensure that all data acquisition systems provided for the monitoring of flood events are maintained and operable.

The Engineer is to report to the Advisory Committee on the status of the data acquisition systems by 30th September of each year.

6.5 Advisory Committee Report

The Advisory Committee shall examine the Engineer's reports on personnel training, communications and data acquisition, and report and recommend to the Brisbane and Area Water Board on the state of flood preparedness.

6.6 Five Yearly Review

The Advisory Committee, at intervals of no greater than five years, and otherwise after every significant flood event, is to cause the Manual to be reviewed by a competent engineer or engineering organizations. The review is to take into account the continued suitability of the communication network, and data acquisition systems as well as hydrological and hydraulic engineering assessments of the operational procedures as indicated in Appendix H.

The Advisory Committee shall report and recommend to the Brisbane and Area Water Board on any requirements for amendment to the operational procedures in accordance with the requirements of the Brisbane and Area Water Board Act.

7.0 WIVENHOE DAM

7.1 Introduction

Wivenhoe dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the junction with Lockyer Creek, depending on the part of the catchment in which the flood originates and depending also on the magnitude of the flood.

Full Supply Level in the reservoir is EL 67.0 and this is the level to which the storage will be returned after a flood event. Designed Top Water Level in the reservoir is EL 77.0 which is the highest level attained during the routing through the reservoir of the design flood with all systems operating normally.

The reservoir volume between EL 67 and EL 77 is available as temporary flood storage and in normal flood operation procedures the reservoir level will remain within these limits. How high the reservoir rises, i.e. how much of the available flood storage compartment is utilized, will depend on the magnitude of the flood being dealt with. For any but the most extreme floods, the water level in the reservoir should not be allowed to exceed EL 75.

7.2 Initial Action

When indications are received of an imminent flood, the flood control operation of the dam shall commence with the storing of the whole flow of the Brisbane River in Wivenhoe dam, whilst an assessment is made of the origin and magnitude of the flood. The spillway gates are not to be opened prior to the lake level exceeding EL 67.250.

7.3 Regulator and Gate Operation

The following minimum time intervals are to be observed in the opening and closing of regulators and spillway gates.

(a) Regulators

Minimum interval between successive full openings or closings of regulators is to be 30 minutes.

(b) Spillway Gates

Minimum interval between successive incremental openings is to be 10 minutes, except as provided in Procedure 4 of Section 7.4, and for successive incremental gate closings is to be 20 minutes. The incremental opening is 500 mm.

Gates are numbered 1 to 5 from the left bank looking downstream.

Gates 2, 3 and 4 are to be used as the main regulating gates and are to be operated as follows.

(i) Gate 3 is to be opened first in increments to discharge flow up to 500 m^3/s.

(ii) Gates 2 and 4 are to be opened simultaneously in increments to discharge a flow of up to 500 m^3/s each in order to give a total discharge of 1500 m^3/s.

(iii) Thereafter, the bottoms of gates 2, 3 and 4 shall be kept within 0.5m of each other with the bottom of gate 3 always being higher than or at the same level as the bottoms of gates 2 and 4.

Gates 1 and 5 are to be operated simultaneously to contain the discharge jets from gates 2,3 and 4 within the plunge pool until such time that their capacity is required for the passing of major floods. The opening of these gates shall not exceed those of gates 2 and 4.

The discharge capacities for various storage levels at Wivenhoe dam can be calculated from the data in Appendix I.

Further considerations of the operation of the Wivenhoe dam gates are contained in Appendix F.

7.4 Operating Procedures

It is essential that the operating procedures adopted should not endanger the safety of Wivenhoe dam. Within this constraint, the Engineer shall adopt a procedure for the operation of Somerset dam such that:

(a) the structural safety of Somerset dam is not endangered;

(b) the Upper Brisbane River flood flow plus Somerset dam release does not cause Wivenhoe dam to be overtopped.

When the preliminary estimation of the degree of expected flooding has been made, the operating procedures set out hereunder shall be used at Wivenhoe dam.

As the magnitude of the expected flooding increases, the procedures to be adopted commence with Procedure 1 and extend through to Procedure 4. These operating procedures are summarized in Table C1 of Appendix C.

The procedures are designed such that flooding in the lower catchment is to be restricted to the lowest practicable of the following categories:

(i) small fresh - low level bridges submerged, Fernvale bridge open, Lowood gauge < 7.8 m;

(ii) large fresh - all bridges except Mt. Crosby Weir bridge submerged, Lowood gauge < 10m;

(iii) small flood - all bridges submerged, no damage to urban areas, Lowood gauge < 15.5m;

(iv) medium flood - damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe dam contributing to peak flow, Lowood gauge < 20 m;

(v) large flood - extensive damage to urban areas due to combined Wivenhoe dam releases and downstream flow, Wivenhoe dam release component of peak flow minimum practicable, Lowood gauge > 20 m.

Procedure 1

Water is to be released from Wivenhoe dam onto the flow of Lockyer Creek such that Fernvale Bridge is not submerged unnecessarily. If the Lockyer Creek flow is sufficient to submerge Fernvale Bridge, the releases are to be regulated such that Mt. Crosby Weir Bridge is not submerged.

Procedure 2

Water is to be released from Wivenhoe dam onto the rising limb of the Lockyer Creek flood, care being taken not to submerge Fernvale Bridge prematurely. If the flood flow of Lockyer Creek is sufficient to submerge both Fernvale bridge and Mt. Crosby Weir bridge, the releases are to be increased such that the combined Lockyer Creek flood flow and Wivenhoe dam releases does not submerge Mt. Crosby Weir Bridge prematurely, and does not exceed the lesser of:

(i) 3,500 m^3/s;

(ii) the peak flood flow of Lockyer Creek, or the predicted peak flood flow of the Bremer River, whichever is the greater.

Procedure 3

Water is to be released from Wivenhoe dam onto the rising limb of the Lockyer Creek flood, care being taken not to submerge Fernvale Bridge or Mt. Crosby Weir Bridge prematurely. The combined Lockyer Creek flood flow and Wivenhoe dam releases is not to exceed 3,500 m^3/s. The releases are to be regulated such that the total regulated flow at Moggill gauge downstream of the Bremer River junction does not exceed 4,000 m^3/s (this is the upper limit of non-damaging flows for the urban reaches of the Brisbane River).

Procedure 4

Water is to be released from Wivenhoe dam onto the rising limb of the Lockyer Creek flood, care being taken not to submerge Fernvale Bridge or Mt. Crosby Weir Bridge prematurely. The combined flood flow of Lockyer Creek plus releases from Wivenhoe dam is not to exceed 3,500 m^3/s, until the Lockyer Creek flood peak passes the junction with the Brisbane River. The releases are then to be increased until the level behind Wivenhoe dam begins to fall. The combined flow at Lowood is to be reduced to 3,500 m^3/s as quickly as practicable, and is to remain at this level until the flood storage of Wivenhoe dam is emptied.

If the lake level behind Wivenhoe dam exceeds EL 74, the releases are to be increased irrespective of the location of the Lockyer Creek flood peak. The time minimum interval between gate incremental openings is to be reduced to five minutes.

8.0 SOMERSET DAM

8.1 Introduction

Somerset dam is capable of being operated in a number of ways to regulate Stanley River floods and optimize the flood mitigation capacity of Wivenhoe dam.

8.2 Initial Action

Upon indications being received of an imminent flood, the flood control operation of the dam shall commence with the storing of the whole flow of the Stanley River in Somerset dam, whilst an assessment is made of the origin and magnitude of the flood.

8.3 Regulator and Gate Operation

The following shall be observed in the opening and closing of regulators, sluices and crest gates for flood mitigation purposes:

MINIMUM INTERVAL BETWEEN SUCCESSIVE

	OPENINGS	CLOSURES
REGULATORS	Half-Hour	One Hour
SLUICE GATES	Two Hours	Three Hours
CREST GATES	Under the normal operating procedure, the gates are open.	In general, the gates are not normally closed until the reservoir level has fallen below the fixed concrete crest of the spillway at EL 100.45.

The discharge capacities which can be commanded for various storage levels of Somerset dam are listed in Table J1 of Appendix J.

8.4 Operating Procedure

The normal operating procedure to be used for Somerset dam is as follows.

The spillway gates are to be raised to enable uncontrolled discharge once the flood storage between FSL (EL 99) and spillway level (EL 100.45) has filled. The low level regulators and sluices are to be kept closed until either:

(a) the inflow to Wivenhoe dam begins to decrease; or

(b) the level in Somerset dam exceeds EL 102.25.

In the case of (a) above, the opening of the regulators and sluices is not to increase the inflow to Wivenhoe dam above the peak inflow just passed.

In the case of (b) above, the Engineer shall ~~determine the order of opening of the gates~~ direct the operation of the low level outlets regulators + sluices to meet the objectives of this manual.

9.0 EMERGENCY

9.1 Introduction

OK 21/10/85

As indicated in Section 7.1, the ~~designed~~ Top Water Level in the reservoir is EL 77.0 and results from passing the design flood through the storage with all operating systems functioning normally. At this water level, the dam embankment still has 2.2 metres of freeboard.

The design flood was obtained by maximizing the greatest flood of record (the 1893 flood). The freeboard allowance was based on wave run-up caused by a sustained 80 km/hr wind at the maximum design flood reservoir level.

The design flood has an extremely low probability of exceedance (about 0.007%). One possible emergency condition is the unlikely occurrence of an even larger flood.

Another possible cause of an abnormal situation would be the failure of one or more spillway gates to function correctly, but even this is unlikely to present a real emergency in view of the facts that:

(i) With one gate inoperable, the design flood would be passed with a maximum water level still 0.8 metre below the embankment crest; and

(ii) Even with all gates inoperable, the 1974 flood inflow would not cause the embankment to be overtopped.

A real emergency situation can therefore only arise from a combination of an extremely large flood and the simultaneous malfunction of one or more spillway gates, or of course from deliberate sabotage.

9.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe dam by the progressive opening of available spillway gates.

In the event that overtopping of Wivenhoe dam is imminent, or is estimated to be inevitable, then as an absolute last resort the saddle dams may be breeched.

Somerset dam should not, if possible, be overtopped by flood water but, if Wivenhoe dam is threatened by overtopping, the release of water from Somerset dam is to be reduced, even at the risk of overtopping Somerset dam, in order to prevent if possible the overtopping of Wivenhoe dam.

9.3 Communications Failure

In the event of normal communications being lost between the Engineer and either Wivenhoe dam or Somerset dam, the officer in charge at that dam is to maintain contact with the officer in charge at the other dam, to receive instructions through the remaining communications link.

In the event of normal communications being lost between the Engineer and both Wivenhoe dam and Somerset dam, the officers in charge at each dam are to adopt the procedures set out below, and are to maintain contact with each other, where possible.

In the event of all communications being lost between the Engineer, Wivenhoe dam and Somerset dam, the officers in charge at each dam are to adopt the procedures set out below.

9.4 Somerset Dam Emergency Procedure

The spillway gates are to be raised to allow uncontrolled discharge once the lake level reaches spillway level. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe dam begins to drop; or

(ii) the level in Somerset dam exceeds EL 102.25.

The level in Wivenhoe dam can be determined locally by the site staff at Somerset dam from the gauge shown in Figure J2 of Appendix J.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe dam above the peak level already attained. Section 8.3 on regulator and gate operation interval is to be observed. Rates of opening & closing

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board between the flood level and EL 77 is the same as the free-board below non-spillway crest level in Somerset dam (EL 107.46). The low level outlets in Somerset dam are not to be opened if the water level of Wivenhoe lake exceeds the level set out below for given water levels in the Somerset lake.

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

9.5 Wivenhoe Dam Emergency Procedure

The minimum gate openings related to lake level set out in the table below are to be maintained for both opening and closing operations.

Lake Level m AHD	Minimum Gate Opening m Gate 3	Gates 2,4	Gates 1,5	Discharge m^3/s
67.0	-	-	-	-
67.5	0.5	-	-	75
68.0	1.5	-	-	175
68.5	2.5	-	-	290
69.0	4.5	-	-	490
69.5	4.5	1.0	-	790
70.0	4.5	2.0	-	1020
70.5	4.5	3.0	-	1290
71.0	4.5	4.0	-	1530
71.5	4.5	4.0	0.5	1750
72.0	4.5	4.0	1.5	2030
72.5	4.5	4.0	3.0	2440
73.0	5.0	5.0	5.0	3200
73.5	6.5	6.5	6.5	4150
74.0	8.0	8.0	8.0	5100
74.5	10.0	10.0	10.0	6300
75.0	12.5	12.5	12.5	8050
75.5	14.0	14.0	14.0	9500
76.0		Fully Open		10850
76.5		Fully Open		11330
77.0		Fully Open		11830

9.6 Equipment Failure

Refer to Appendix F for equipment failure at Wivenhoe dam and Appendix G for Somerset dam.

In the event of equipment failure, action to be taken is outlined in App. F for W.D. & App. G. for Somerset Dam

APPENDIX 'A'

EXTRACT FROM BRISBANE AND AREA WATER BOARD ACT 1979 - 1984

106. Operational procedures for flood mitigation.

(1) The Advisory Committee shall cause to be prepared a manual of operational procedures in relation to each reservoir or a combined manual in relation to two or more reservoirs under the control of the Board for the purpose of flood mitigation and may from time to time cause to be prepared such amendments thereto as the committee considers necessary.

Every manual and all amendments thereto prepared under this subsection shall be submitted to the Board which shall submit the same, with its recommendations, to the Minister within 40 days after it receives the same.

(2) A manual prepared under subsection (1) and amendments therof, which may be recommended by the Advisory Committee shall not be effective until:

(a) duly approved by the Minister; and

(b) in the case of a manual prepared in relation to a reservoir within the Wivenhoe Dam project and the reservoir behind Somerset Dam, until the manual prepared in relation to such reservoirs, pursuant to the Wivenhoe Dam and Hydro-electric Works Act 1979 has ceased to be effective.

(3) Before he decides to approve of a manual or any amendment of a manual the Minister shall consult on that issue with the Minister of the Crown charged with the administration and control of water resources in Queensland.

(4) A manual of operational procedures may vest in any person mentioned therein and regulate the function of exercising a reasonable discretion in any matter as part of the flood mitigation procedures.

107. Board, Headworks Operator bound by manual.

The operational procedures to be adopted by the Board in respect of the reservoirs under its control for the purpose of flood mitigation shall be as provided by the relevant manual prepared under section 106 as duly amended at the material time and such manual, as duly amended at the material time, shall be observed by the Board and its employees and the Headworks Operator and its employees.

108. Minister, Board, Headworks Operator not liable for flood damage.

The Minister, the Board, the Headworks Operator and an employee of the Board or the Headworks Operator shall not be liable for damages claimed in respect of loss or injury alleged to arise from:

(a) the carrying out of flood mitigation procedures of the Board if such procedures were carried out under the general direction of a suitably qualified and experienced engineer in accordance with the operational procedures specified by the relevant manual prepared under section 106; or

(b) the inaccuracy of information released on behalf of the Board or the Headworks Operator or by an employee of the Board or the Headworks Operator concerning anticipated flooding or the anticipated levels of flooding.

TABLE B1

FLOODS ORIGINATING IN STANLEY RIVER

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	The proposed operational procedures prevent floods of this category occurring due to storms over the Stanley River Catchment.		4.0	7000
Moggill	2.0	500	4.0	1280	10.4	4000			16.5	7000
Amberley	2.0	10	2.6	18	5.2	150			7.0	450
Walloon	2.0	10	2.1	12	5.0	130			6.5	350
Mt. Crosby Weir	8.9	480	11.4	1250	18.0	3700			24.8	6200
Lowood	4.7	450	8.2	1200	16.8	4000			22.0	6800
Lyon's Bridge	6.4	75	8.8	150	13.5	600			14.7	1000
Gregor's Creek	5.6	500	8.6	1720	10.5	3000			14.2	6200
Woodford #	5.0	900	6.8	2000	8.0	3000			10.5	5200

Estimated peak inflow to Somerset dam (not peak discharge at gauge)

TABLE B2

FLOODS ORIGINATING IN UPPER BRISBANE RIVER

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	The proposed operational procedures prevent floods of this category occurring due to storms over the upper Brisbane River Catchment.		4.0	7000
Moggill	2.0	500	4.0	1280	10.4	4000			16.5	7000
Amberley	2.0	10	2.6	18	5.2	150			7.0	450
Walloon	2.0	10	2.1	12	5.0	130			6.5	350
Mt. Crosby Weir	8.9	480	11.4	1250	18.0	3700			24.8	6200
Lowood	4.7	450	8.2	1200	16.8	4000			22.0	6800
Lyon's Bridge	6.4	75	8.8	150	13.5	600			14.7	1000
Gregor's Creek	4.8	320	7.0	950	11.8	4000			16.5	9000
Woodford #	1.5	100	2.5	200	4.8	800			6.0	1500

Estimated peak inflow to Somerset dam (not peak discharge at gauge).

TABLE B3

FLOODS ORIGINATING IN LOCKYER CREEK

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	2.0	500	4.0	1280	10.4	4000	14.0	5500	16.5	7000
Amberley	2.0	10	2.6	18	5.2	150	6.2	280	7.0	450
Walloon	2.0	10	2.1	12	5.0	130	5.7	200	6.5	350
Mt. Crosby Weir	8.9	480	11.4	1250	18.0	3700	22.0	5000	24.8	6200
Lowood	4.7	450	8.2	1200	16.8	4000	20.0	5600	22.0	6800
Lyon's Bridge	11.4	350	14.7	1000	19.0	3500	21.0	5200	22.0	6400
Gregor's Creek	3.1	90	3.9	180	7.6	1200	8.9	1900	9.8	2500
Woodford #	3.0	220	4.0	450	6.3	1700	7.0	2200	7.3	2600

Estimated peak inflows to Somerset dam (not peak discharges at gauge).

TABLE B4

FLOODS ORIGINATING IN BREMER RIVER AND METROPOLITAN REACHES OF BRISBANE RIVER

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	1.8	400	3.4	1000	9.2	3200	12.0	4500	14.6	5800
Amberley	5.3	160	6.8	400	9.4	1200	10.1	1600	11.0	2200
Walloon	4.8	120	6.2	300	7.8	900	8.3	1200	8.8	1600
Mt. Crosby Weir	7.5	80	8.0	200	10.0	800	11.5	1300	11.8	1400
Lowood	1.5	80	2.7	180	6.6	760	8.8	1250	9.5	1400
Lyon's Bridge	2.0	10	3.8	30	5.6	60	8.7	150	9.6	200
Gregor's Creek	2.7	60	3.5	130	5.9	600	7.0	980	7.2	1050
Woodford #	2.0	150	3.5	350	5.2	1000	5.6	1200	6.0	1500

Estimated peak inflows to Somerset dam (not peak discharges at gauge).

LOCATION OF FLOOD GAUGES
REFERRED TO IN TABLES B1, B2, B3, & B4.

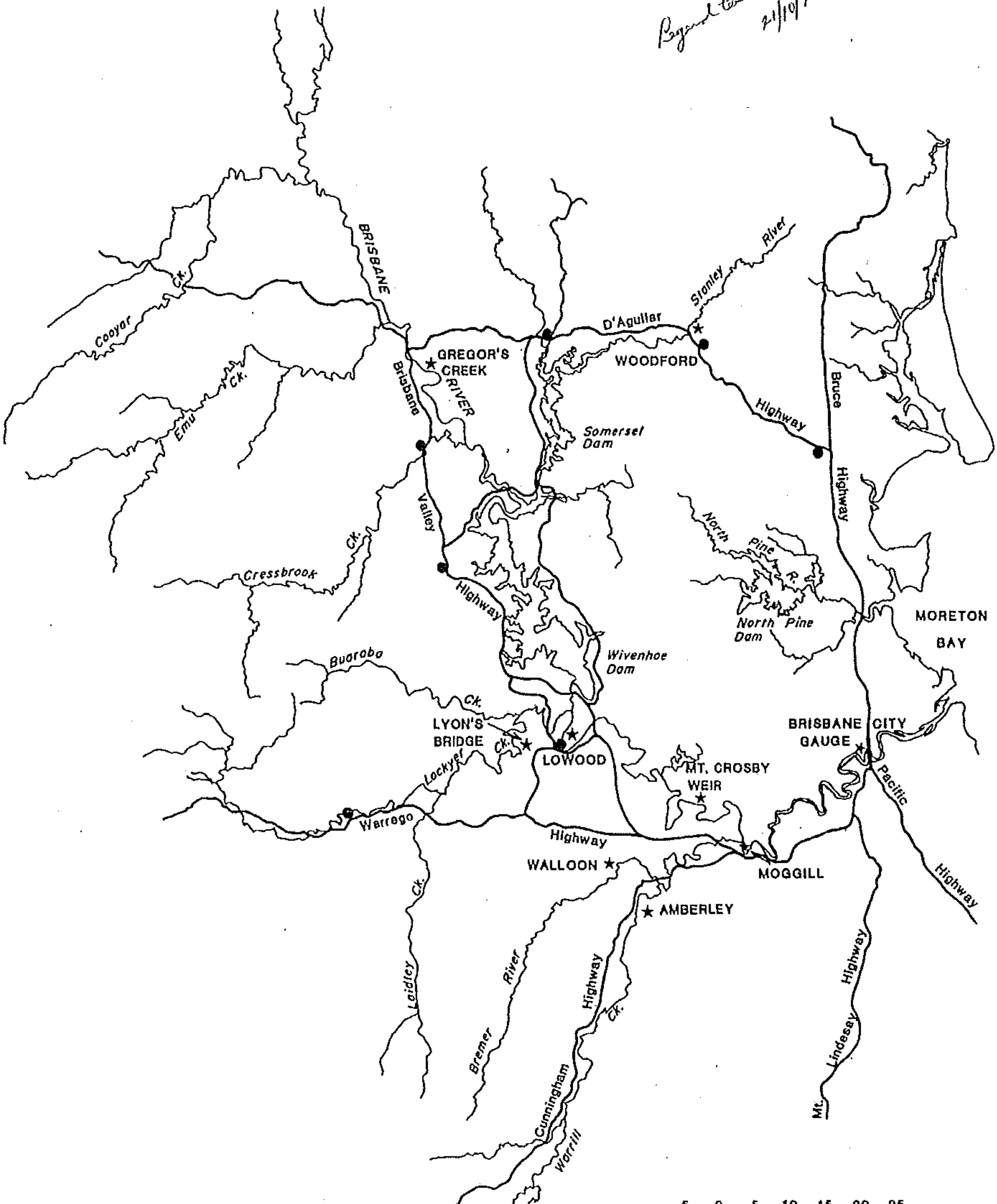


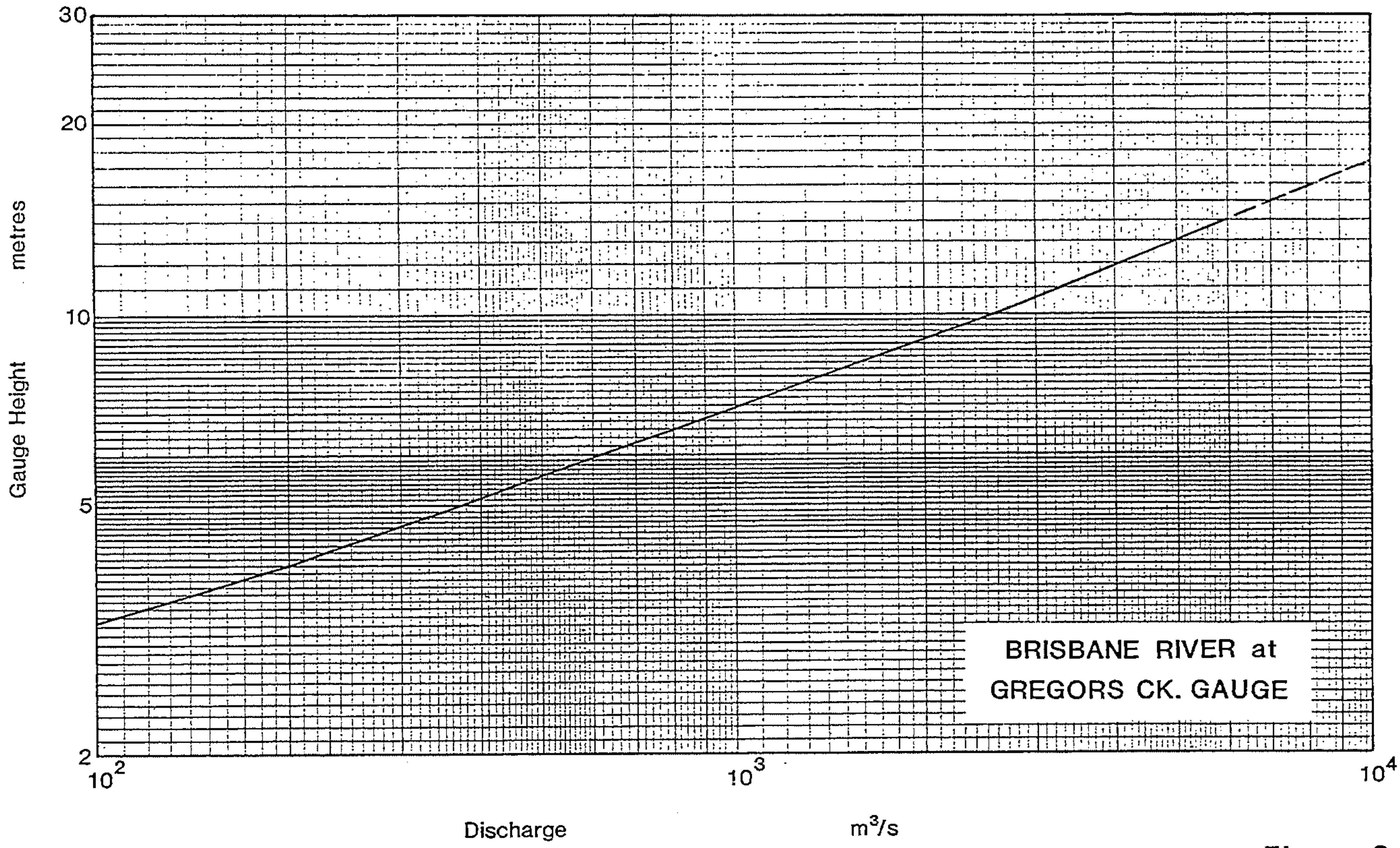
FIGURE B1

APPENDIX 'C'

TABLE C1

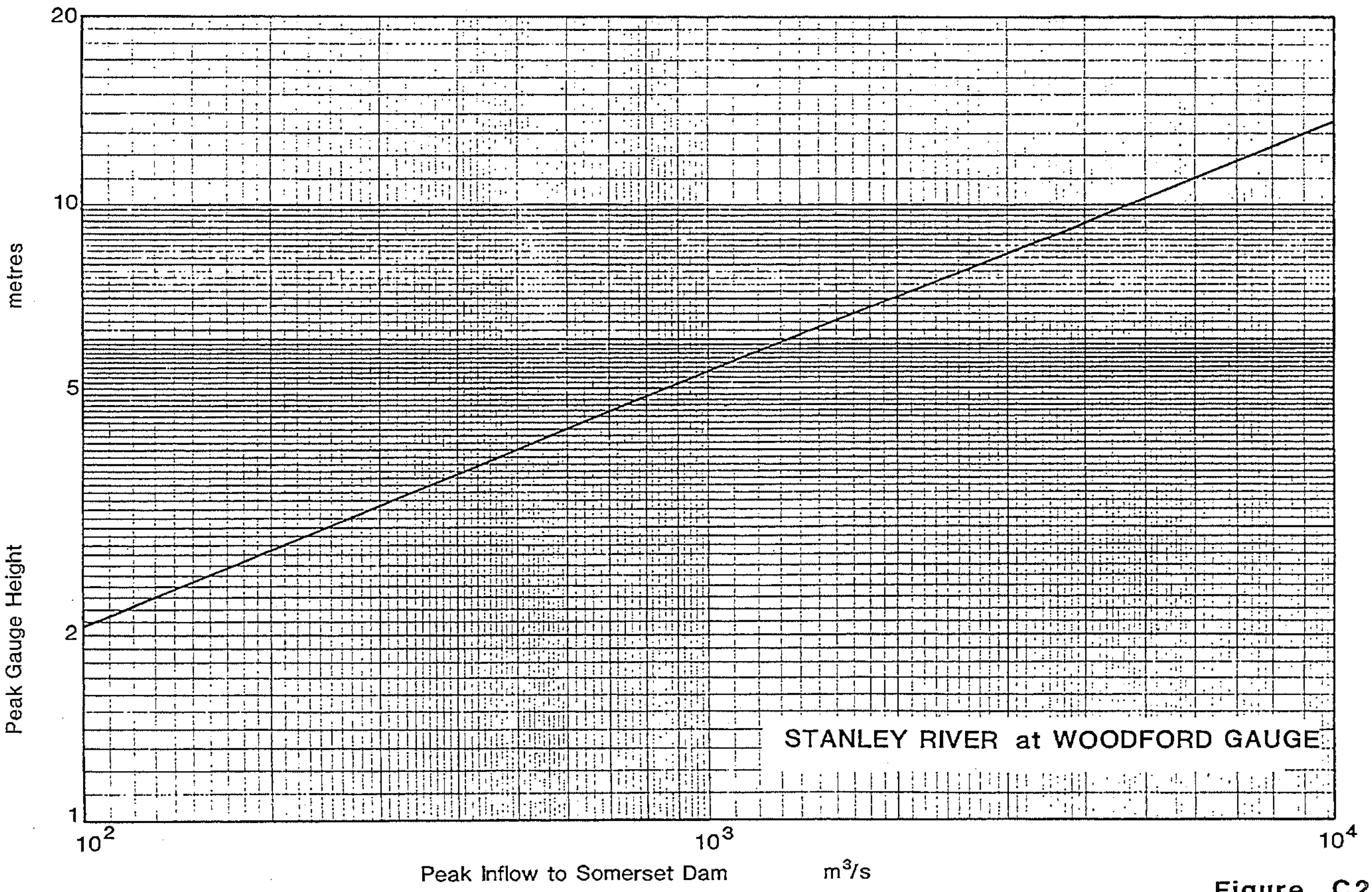
OPERATING PROCEDURES FOR WIVENHOE DAM

Operating Procedure	Predicted Peak Gauge Height (m)				Resultant Gauge Heights	
	Gregor's Ck.	Woodford	Lyon's Br.	Ipswich	Lowood	Brisbane
1	< 5	< 8	< 16.5	all	< 10	< 1.5
2			16.5-19	all	< 15.5	< 2
2			> 19	all	> 15.5	> 2
2		8-12	< 19	all	< 15.5	< 2
2			> 19	all	> 15.5	> 2
3		> 12	< 19	all	15.5	2
3			> 19	all	> 15.5	> 2
1	5-8	< 5	< 16.5	all	< 10	< 1.5
2			16.5-19	all	< 15.5	< 2
2			> 19	all	> 15.5	> 2
3		> 5	< 19	all	15.5	2
3			> 19	all	> 15.5	> 2
3	8-12	< 12	< 19	all	15.5	2
3			> 19	all	> 15.5	> 2
4		> 12	all	all	> 20	> 3.5
4	> 12	all	all	all	> 20	> 3.5



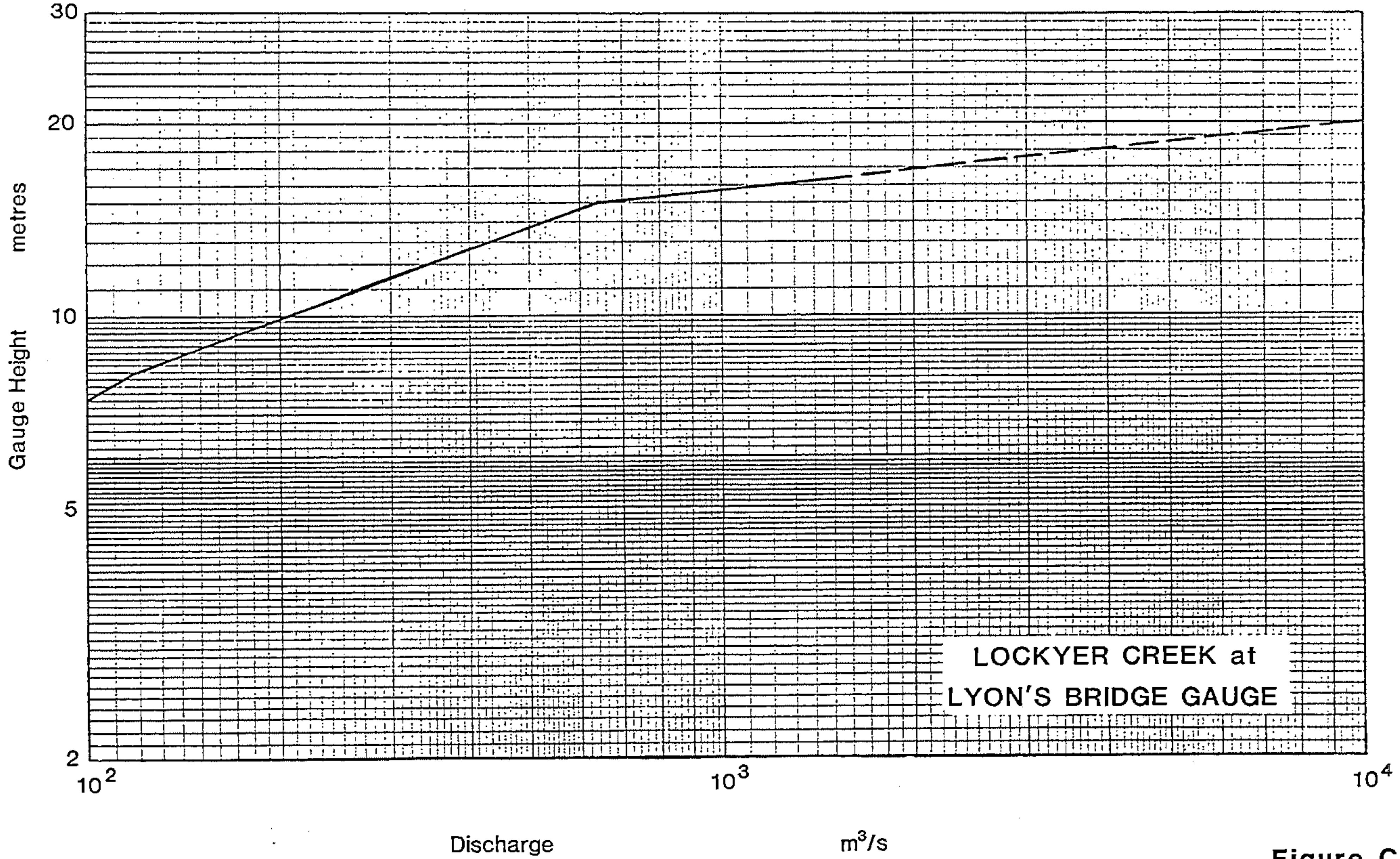
30
20
10
5
2
Gauge Height metres
10^2
10^3
10^4
Discharge m^3/s
BRISBANE RIVER at
GREGORS CK. GAUGE

Figure C1



STANLEY RIVER at WOODFORD GAUGE
Peak Gauge Height metres
20
10
5
2
1
10^2
10^3
10^4
Peak Inflow to Somerset Dam m^3/s

Figure C2



30
20
10
5
2
Gauge Height metres
10^2
10^3
10^4
Discharge m^3/s
LOCKYER CREEK at
LYON'S BRIDGE GAUGE

Figure C3

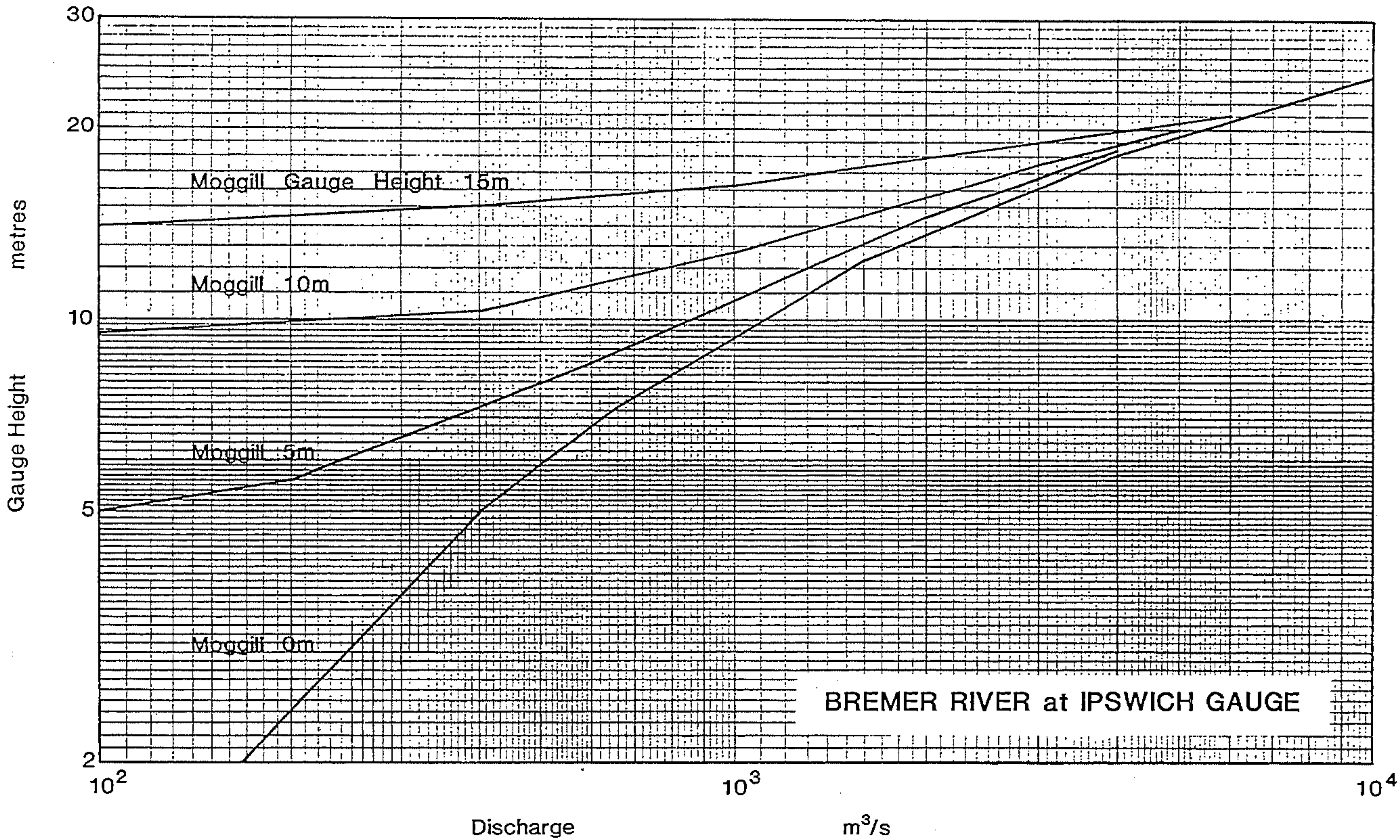

BREMER RIVER at IPSWICH GAUGE
Moggill Gauge Height 15m
Moggill 10m
Moggill 5m
Moggill 0m
30
20
10
5
2
Gauge Height
metres
10^2
10^3
10^4
Discharge
m^3/s

Figure C4

TABLE D1

SUBMERGENCE FLOWS FOR BRISBANE VALLEY BRIDGES

1.	Colledge's Crossing	100 m^3/s
2.	Mt. Crosby Weir Bridge	1600 m^3/s
3.	Kholo Bridge	550 m^3/s
4.	Burton's Bridge	250 m^3/s
5.	Savage's Crossing	150 m^3/s
6.	Fernvale Bridge	1020 m^3/s
7.	Twin Bridges	25 m^3/s
8.	O'Shea's Bridge	7500 m^3/s

Locations of Bridges shown on Figure D1.

BRIDGE LOCATIONS
REFERRED TO IN TABLE D1

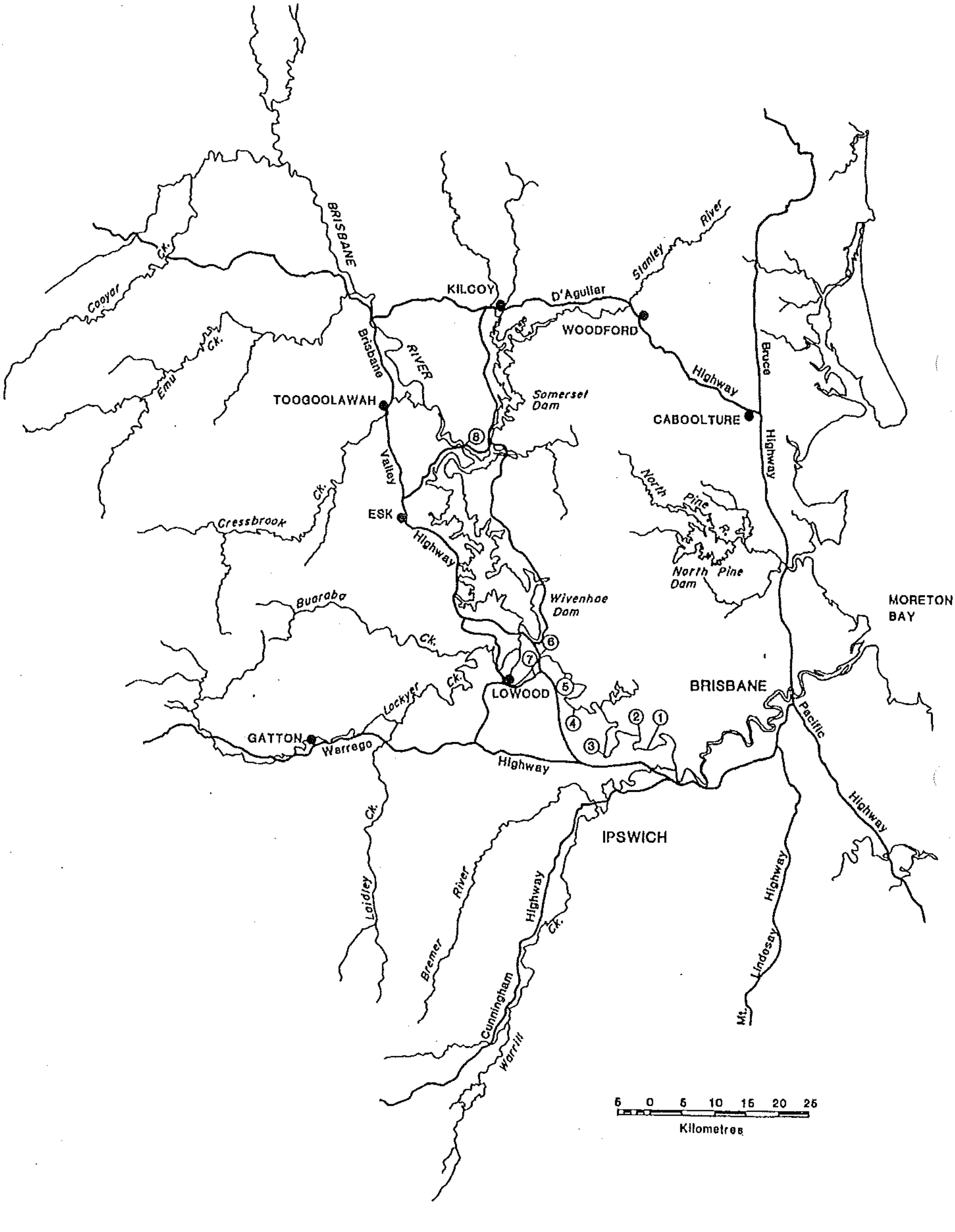


FIGURE D1

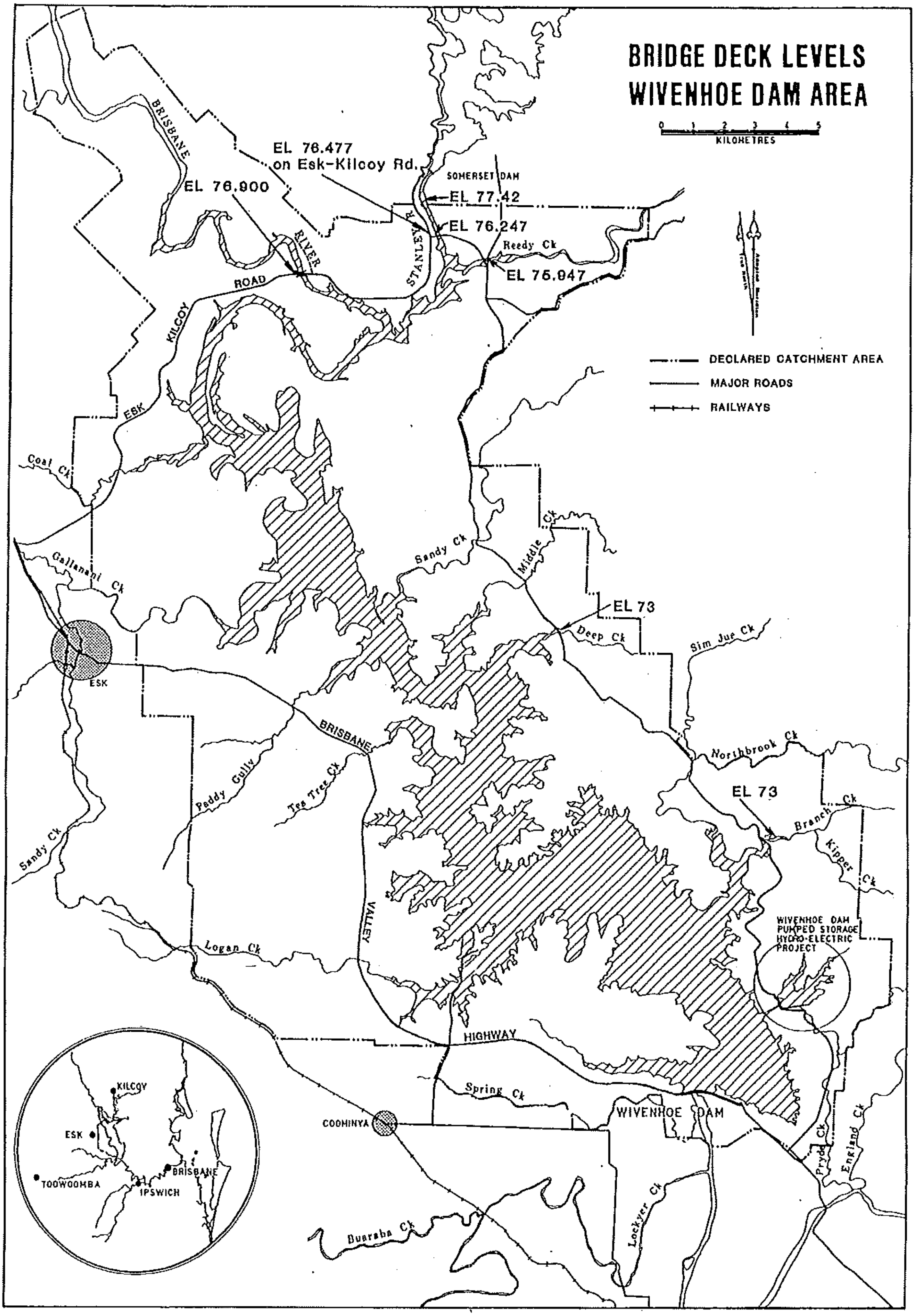

BRIDGE DECK LEVELS
WIVENHOE DAM AREA
0 1 2 3 4 5
KILOMETRES
DECLARED CATCHMENT AREA
MAJOR ROADS
RAILWAYS
EL 76.477
on Esk-Kilcoy Rd.
EL 76.900
EL 77.42
EL 76.247
EL 75.947
EL 73
EL 73
SOMERSET DAM
BRISBANE
RIVER
STANLEY R
Reedy Ck
ROAD
KILCOY
ESK
Coal Ck
Gallanani Ck
Sandy Ck
Middle Ck
Deep Ck
Sim Jue Ck
ESK
BRISBANE
VALLEY
HIGHWAY
Paddy Gully
Tea Tree Ck
Sandy Ck
Northbrook Ck
Branch Ck
Kipper Ck
WIVENHOE DAM
PUMPED STORAGE
HYDRO-ELECTRIC
PROJECT
Logan Ck
Spring Ck
WIVENHOE DAM
COOMINYA
Pryde Ck
Enkland Ck
Lockyer Ck
Buaraba Ck
KILCOY
ESK
TOOWOOMBA
IPSWICH
BRISBANE

FIGURE D2

COMMUNICATIONS AND DATA ACQUISITION

In order to determine the magnitude and timing of a flood and hence to operate Somerset and Wivenhoe dams, it is of great importance for the Engineer to have access to a large number of rainfall and river height stations throughout the Brisbane River catchment.

These observations of rainfall or river height are of greatest benefit when they are received by the Engineer as soon as possible after the time of observation. This requires that either an automatic reporting system be established or else gauges be established where observation can be made by local residents who report via telephone to the Engineer. Both these data acquisition mechanisms are presently established in the Brisbane River catchment.

The Brisbane Valley Flood Warning Radio Telemetry System is jointly owned by the Bureau of Meteorology and the Brisbane and Area Water Board. Information from twelve river height stations and nine rainfall stations is available to the Engineer, on demand, from this system. The elements of the system are shown in Figure E1.

There are numerous staff gauges on the Brisbane River and its tributaries which are manually read during flood periods. These gauges are owned and maintained by the Bureau of Meteorology, the Commissioner of Water Resources, the Brisbane and Area Water Board and the Brisbane City Council. Readings from these locations are available to the Engineer on request. These staff gauges are listed in Table E1 and the locations are shown in Figure E2.

The Bureau of Meteorology has a network of rainfall stations which report heavy rainfalls at intervals of approximately three hours during flood periods. This data is available to the Engineer on request. Rainfall data from several rain gauges owned by the Brisbane and Area Water Board and Brisbane City Council are also available on request. The majority of this data is transmitted by telephone. These reporting rain gauges are listed in Table E2 and the locations are shown in Figure E3.

Communications between the Engineer and Somerset and Wivenhoe dams is possible via telephone and radio. In flood periods, the telephone system is prone to breakdowns and most communication is via radio. The radio communications available between the Engineer and the dams are shown in Figure E4.

TABLE E1

BRISBANE RIVER CATCHMENT STAFF GAUGES

Gauge Name	Stream	AMTD (km)	Catchment Area (km^2)	Owner	Range	Reporting Level	Remarks
Peachester	Stanley R.	89.2	104	QWRC	0-11 m		Recorder attached.
Woodford	Stanley R.	64	313	CBM	3-13 m	3 m	BVRT 3 km u/s.
Linville	Brisbane R.	282.4	2 005	QWRC	0-9 m		Recorder attached.
"	"	280	2 030	CBM	1-14 m	3 m	
Gregors Ck.	Brisbane R.	251.7	3 885	QWRC	0-16 m		Recorder attached.
"	"	"	"	CBM	0-17 m	2 m	BVRT attached.
Rosentreter's Crossing	Cressbrook Ck.	22	480	BAWB			BVRT attached.
Helidon	Lockyer Ck.	96.6	375	QWRC	0-6 m		Recorder attached.
Gatton	Lockyer Ck.	71	1 550	CBM	3-18 m	3 m	
Jordan Bridge	Lockyer Ck.	65	1 580	BAWB	1-12 m	5 m	Bridge Deck 6.8 m.
Wilson's Weir	Lockyer Ck.	61.3	1 660	BAWB	0-10 m	5 m	QWRC Recorder. 0 = spillway.
Mulgowie	Laidley Ck.	30.9	179	QWRC	0-9 m		Recorder attached.
"	"	"	"	CBM	0-9 m	4 m	
Glenore Grove	Lockyer Ck.	52	2 331	CBM	2-15 m	4 m	BVRT attached.
Lyon's Bridge	Lockyer Ck.	27.2	2 540	QWRC	0-12 m		Recorder attached.
"	"	"	2 525	CBM	0-14 m	4 m	BVRT attached.
Lowood	Brisbane R.	141	10 060	CBM	0-28 m	4 m	BVRT attached.
Savage's Crossing	Brisbane R.	130	10 180	QWRC	0-20 m		Recorder attached.

TABLE E1 (CONTD.)

BRISBANE RIVER CATCHMENT STAFF GAUGES

Gauge Name	Stream	AMTD (km)	Catchment Area (km^2)	Owner	Range	Reporting Level	Remarks
Noogoora (Burton's Br.)	Brisbane R.	119	10 240	BAWB	1–22 m	2 m	Bridge Deck 4 m.
Cabbage Tree Ck.	Brisbane R.	111	10 520	BAWB	0–27 m	2 m	Read by BCC staff.
Kholo	Brisbane R.	101	10 545	BAWB	0–30 m		
Mt. Crosby Weir	Brisbane R.	90.7	10 567	BCC	5–54 m		Read by BCC staff.
Adam's Bridge	Bremer R.	77.1	130	QWRC	0–7 m		Recorder attached.
Stoke's Crossing	Bremer R.	68.4	180	CBM	1–8 m	3 m	
Kuss Road	Western Ck.	7.5	200	CBM	1–9 m	4 m	
Rosewood	Bremer R.	50.0	543	CBM	0–9 m	2 m	Recorder attached.
Walloon	Bremer R.	37.2	620	QWRC	0–7 m		Recorder attached. BVRT 3.5 km u/s.
Kalbar	Warrill Ck.	50	465	CBM	0–13 m	4 m	
Harrisville	Warrill Ck.	31	725	CBM	1–7 m	3 m	Recorder attached.
Amberley	Warrill Ck.	8.7	920	QWRC	0–6 m		Recorder attached. BVRT 1 km u/s.
Berry's Lagoon	Bremer R.	26.5	1 810	BAWB	6–20 m		
Ipswich	Bremer R.	16	1 850	ICC	0–24 m	4 m	

TABLE E2

BUREAU OF METEOROLOGY HEAVY RAINFALL STATIONS

Amberley
~~Bald Knob~~
Brisbane
Crow's Nest
Gatton
Harrisville
Jimna
Kalbar
Kilcoy
Laidley
Lowood
Maleny
Moore
Mt. Glorious
Mt. Kilcoy
Mt. Mee
Mt. Nebo
Peachester
Rosewood
Tarome
Thornton
Toogoolawah
Woodford
Yarraman

BRISBANE CITY COUNCIL HEAVY RAINFALL STATIONS

Enoggera Dam
Gold Creek Dam
Lake Manchester
Mt. Crosby

BRISBANE AND AREA WATER BOARD HEAVY RAINFALL STATIONS

Somerset Dam
Wivenhoe Dam

BRISBANE VALLEY RADIO TELEMETRY NETWORK

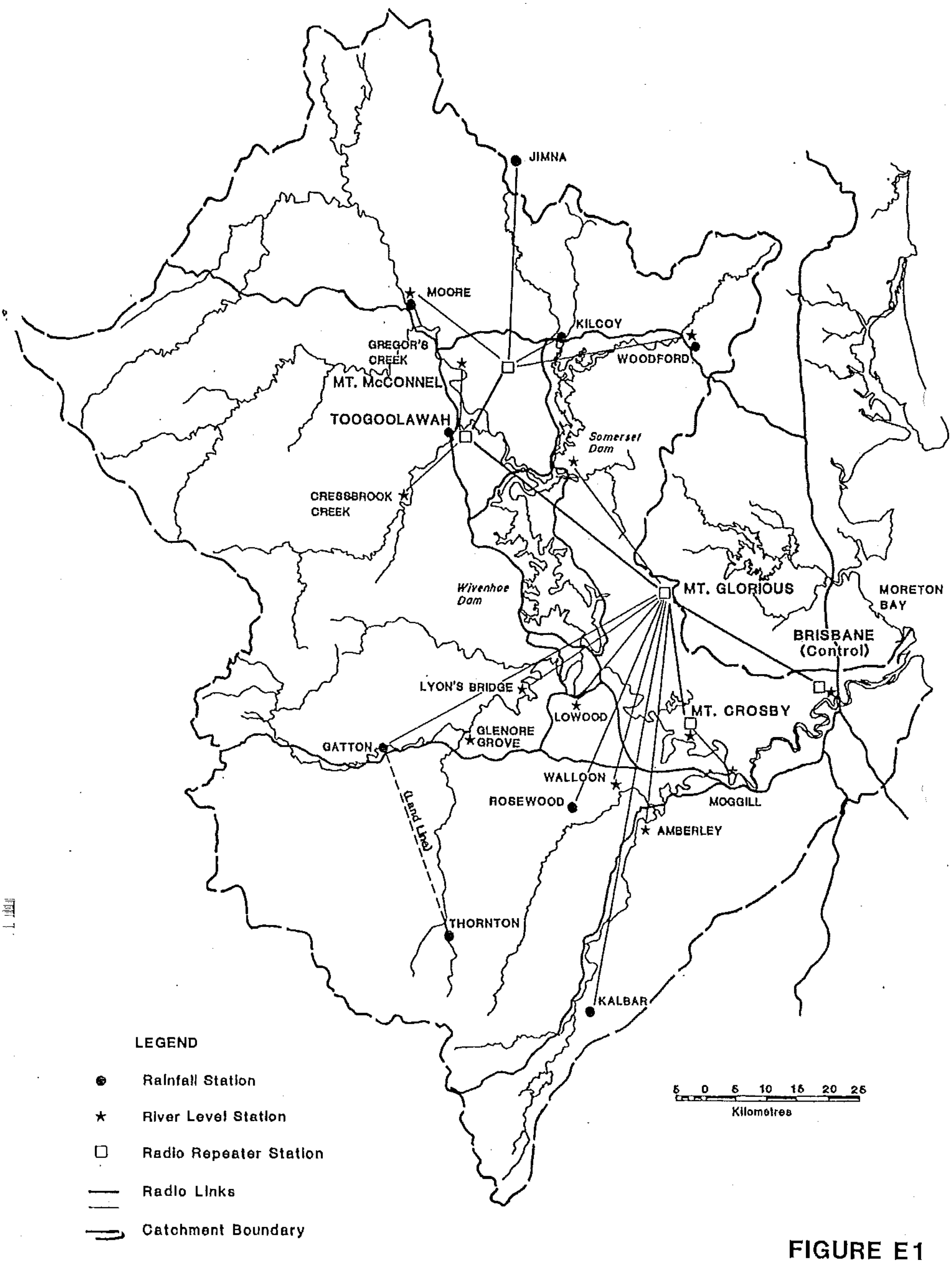


FIGURE E1

BRISBANE RIVER CATCHMENT FLOOD GAUGES

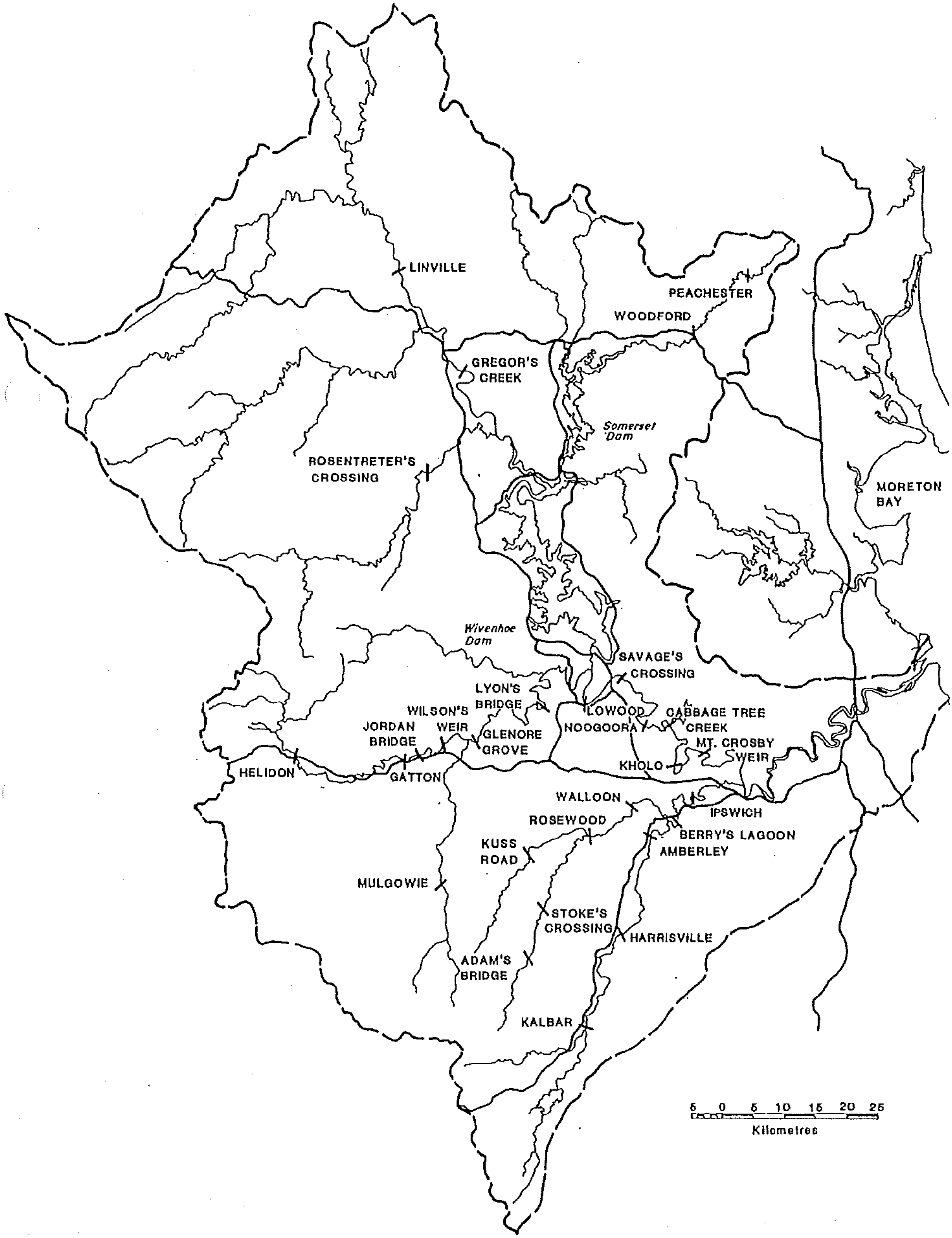


FIGURE E2

HEAVY RAINFALL STATIONS

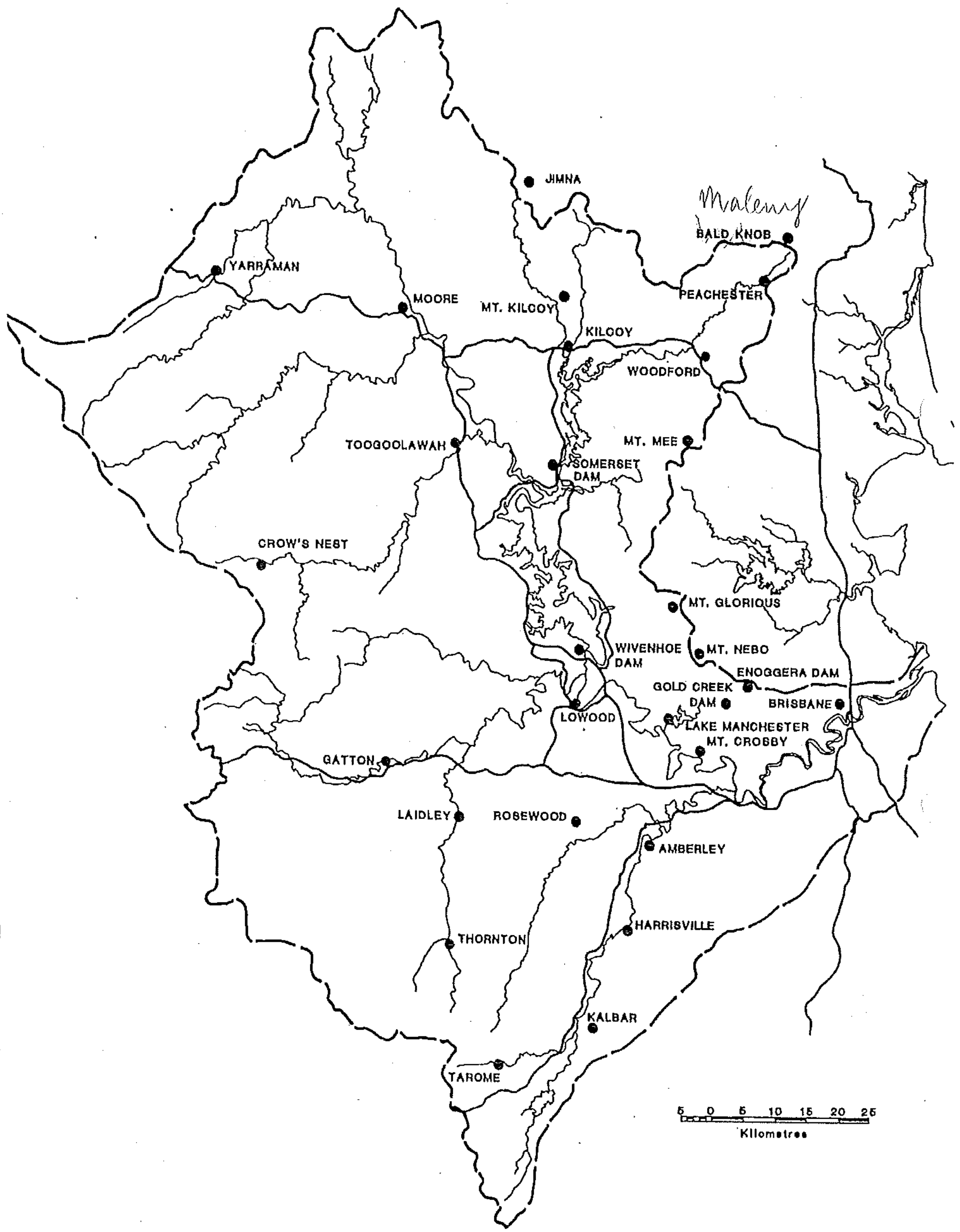


FIGURE E3

RADIO COMMUNICATION WITH DAMS

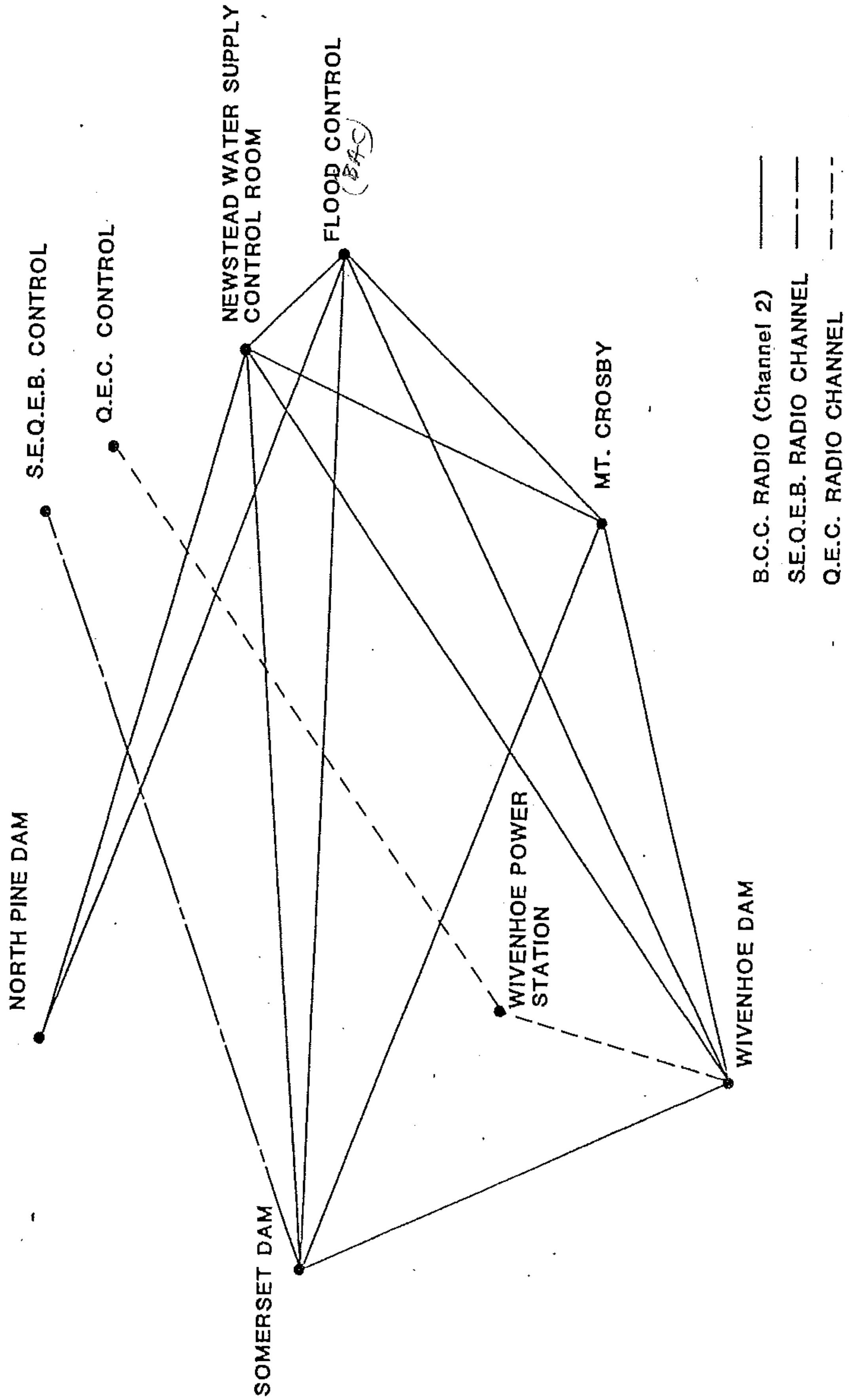


FIGURE E4

APPENDIX 'F'

WIVENHOE DAM GATE OPERATION CONSIDERATIONS

1.0 SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Appendix I shows the general arrangement of the spillway area.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool;

(ii) The flow in the spillway is to be symmetrical.

The main purpose of gating the spillway is to exercise maximum control over the flow in the Brisbane River insofar as river flows in excess of 4 000 m^3/s cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

2.0 RADIAL GATE OPERATING PRINCIPLE

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

HYDROLOGIC INVESTIGATIONS

1.0 INTRODUCTION

This appendix describes the hydrologic analyses performed for the flood design of Wivenhoe dam and for the testing of operation policies. A detailed report entitled "Hydrology Report for Manual of Operational Procedures for Flood Mitigation for Wivenhoe dam and Somerset dam", is held by the Queensland Water Resources Commission and the Brisbane City Council. The analyses were carried out using the most appropriate data available in 1983 and it is recommended that they be revised after the occurrence of a large flood or after the adoption of more advanced methods of hydrologic analysis. The work summarized here supersedes that completed earlier during the design stages of Wivenhoe dam, which is contained in the design report on Wivenhoe dam.

2.0 METHOD

There are three components in the hydrologic analysis:

(i) a rainfall analysis to determine both rainfall frequency and Probable Maximum Precipitation (PMP);

(ii) a model of the catchment rainfall-runoff process; and

(iii) a model of the flood operations of the two dams.

The Bureau of Meteorology completed several studies of the Probable Maximum Precipitation. The Australian generalized method for areas subject to tropical cyclones was used and rainfalls for durations up to seven days were estimated. The Probable Maximum Precipitation was estimated for the whole of the Brisbane River catchment, as well as for various subcatchments. When the Probable Maximum Precipitation was given for a subcatchment, an estimate of general rainfall that could be expected over the remainder of the catchment was also given.

Rainfall frequency analysis was performed on 37 stations scattered throughout the catchment. The log-normal frequency distribution was fitted to annual series of one, two and three day rainfalls for each of these stations independently. These distributions were extrapolated and 1%, 0.1% and 0.01% annual exceedence probability rainfalls extracted.

The Probable Maximum Precipitation temporal patterns provided by the Bureau of Meteorology were used in all design storms.

The rainfall runoff model used was the runoff routing method of flood estimation which was calibrated on an extensive set of recorded storm and flood data and then used to estimate rare event floods.

Models to simulate the flood operation of Somerset and Wivenhoe dams were prepared especially and simulated dam discharges were included in the runoff routing model.

3.0 RAINFALL ANALYSIS RESULTS

The rainfall analysis was performed in two parts, the rainfall frequency analysis by the Queensland Water Resources Commission and the Probable Maximum Precipitation estimate by the Bureau of Meteorology. These were used both for design studies for the dam and to test the effects of flood operation procedures.

The frequency analysis was performed on the annual series of one, two and three day maxima, individually for each station in the catchment. Catchment rainfalls were estimated using the log-normal distribution of station rainfalls and are listed in Tables H1 and H2.

[illegible] ? ?

Table H1
Design Catchment Rainfall (mm)
Wivenhoe Dam Catchment

Annual exceedence probability (%)	1 day	2 day	3 day
1	217	298	347
0.1	303	419	493
0.01	400	556	657

?

Table H2
Design Catchment Rainfall (mm)
Downstream of Wivenhoe Dam

Annual exceedence probability (%)	1 day	2 day	3 day
1	197	270	316
0.1	268	371	440
0.01	346	484	579

The Probable Maximum Precipitation study was performed by the Bureau of Meteorology, and rainfalls for durations up to 7 days were estimated using the generalized methods. These estimates are listed in Table H3. The figures in brackets show the general rainfall over the remainder of the Brisbane River catchment that could be possible when the Probable Maximum Precipitation falls on the given subcatchment.

Table H3
Probable Maximum Precipitation (mm)

Duration (days)	Somerset Dam	Wivenhoe Dam	Total Catchment
1	840 (300)	600 (50)	560
2	1 380 (500)	1 000 (90)	700
3	1 760 (620)	1 260 (110)	880
4	2 040 (720)	1 460 (130)	1 040
5	2 120 (760)	1 520 (130)	1 080
6	2 160 (780)	1 560 (140)	1 100
7	2 340 (840)	1 700 (150)	1 200

4.0 RUNOFF ROUTING MODEL CALIBRATION

The runoff routing model was calibrated on three separate catchments, Brisbane River upstream of Wivenhoe dam, Brisbane River downstream of the dam and Stanley River, using several gauging stations in the first two of the catchments and inflows to Somerset dam in the third.

Seven floods were used for calibration: July 1965, March 1967, June 1967, January 1968, December 1971, January 1974 and January 1976. The gauging stations used for model calibration are listed in Table H4.

Table H4
Gauging Stations used for Model Calibration

Stream	Site	Number	AMTD (km)	Catchment Area (km^2)
Stanley River	Somerset dam	-	7.2	1 335
Cooyar Creek	Damsite	143015	12.2	960
Brisbane River	Linville	143007	282.4	2 005
Emu Creek	Boat Mountain	143010	10.1	920
Brisbane River	Gregor's Creek	143009	251.7	3 885
Cressbrook Creek	Damsite	143013	58.6	325
Brisbane River	Middle Creek	143008	187.2	6 710
Brisbane River	Wivenhoe dam	-	150.2	7 020
Brisbane River	Savage's Crossing	143001	130.8	10 180
Bremer River	Walloon	143107	37.2	620
Warrill Creek	Amberley	143108	8.7	920
Lockyer Creek	Lyon's Bridge	143210	27.2	2 540
Brisbane River	City	-	22.7	13 260

The model was calibrated for as many sites as possible for each of the seven floods. (Data were missing for some of the stations for some of the floods). The estimated model parameters are given in Table H5. In all cases relative delay time used in the model was related to reach length.

Table H5
Runoff Routing Model Parameters

Catchment	K	m
Somerset dam	94*	0.75
Wivenhoe dam	140	0.75
downstream of Wivenhoe dam	270	0.75

* If relative delay times for the whole catchment upstream of Wivenhoe dam are used for the Somerset dam model, then the value of K must be 500.

5.0 WIVENHOE DAM RARE EVENT FLOODS

Wivenhoe dam rare event floods were estimated using the design rainfalls and runoff routing model already discussed. Inflows to Wivenhoe dam, assuming the dam to be in existence and full, were calculated, as well as flow at the damsite without the dam in the catchment. Two day storms were found to have the critical storm duration for most cases, though the long duration Probable Maximum Precipitations produced very large flood volumes. Table H6 lists results for the two day duration storms.

Table H6
Wivenhoe Dam Rare Event Floods
(for two day storm duration)

Annual exceedence probability (%)	Flood Volume (10^6 m^3)	Peak Discharge no dam (m^3/s)	Peak Inflow with dam (m^3/s)
1	1 234	8 300	8 700
0.1	2 044	12 900	13 400
0.01	3 045	19 100	19 600
PMF	6 170	42 200	43 000

PMF = Probable Maximum Design Flood

6.0 FLOOD CONTROL OPERATION MODEL

Floods in the Brisbane River catchment above Wivenhoe dam can originate in either the Stanley River or upper Brisbane River catchment or both. Both of the dams are capable of being operated in a number of ways, each of which will reduce the flow downstream. However, in order to achieve maximum reduction of flooding downstream of Wivenhoe dam, it was necessary to determine the most effective combination of operations at Somerset and Wivenhoe dams.

Five possible operational procedures for each of Somerset dam and Wivenhoe dam, giving twenty-five possible combinations were considered. The procedures for Wivenhoe dam were designed so that initial release operations did not adversely affect later operations in the event of later rainfall causing the magnitude of the flood to exceed the original estimate.

The procedures were also designed such that flooding in the lower catchment was restricted to the lowest practicable of the following categories:

(i) small fresh - low level bridges submerged, Fernvale bridge open, Lowood gauge < 7.8 m;

(ii) large fresh - all bridges except Mt. Crosby Weir bridge submerged, Lowood gauge < 10m;

(iii) small flood - all bridges submerged, no damage to urban areas, Lowood gauge < 15.5m;

(iv) medium flood - damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe dam contributing to peak flow, Lowood gauge < 20 m;

(v) large flood - extensive damage to urban areas due to combined Wivenhoe dam releases and downstream flow, Wivenhoe dam release component of peak flow minimum practicable, Lowood gauge > 20 m.

One procedure was selected for the operation at Somerset dam. This procedure had two advantages over the other procedures tested. Firstly, it was feasible for all magnitudes of Stanley River floods tested and, secondly, it was the simplest procedure to carry out.

The procedures for Wivenhoe dam were reduced to four by combining two procedures into one. The resulting four procedures form a hierachy and the procedure to be adopted advances to the next procedure as the flood magnitude increases.

The procedure to be adopted at Wivenhoe dam was related to the peak level at the Gregor's Creek, Woodford, Lyon's Bridge and Ipswich gauges.

7.0 DOWNSTREAM FLOODING

Rare ~~Rate~~ event floods were also calculated for the catchment downstream of Wivenhoe dam, for three different cases, namely, without Wivenhoe dam, with no releases made from

Wivenhoe dam (giving only the flood from the downstream catchment) and with Wivenhoe dam operated according to the operating procedures. These results are shown in Table H7 for the design storms of two days duration.

Table H7
Floods at Brisbane (peak discharge - m^3/s)

Annual exceedence probability (%)	Without Wivenhoe Dam	Lower Catchment Flow	With Wivenhoe Dam Operating Procedures
1	11 500	4 500	5 500
0.1	19 400	8 500	10 300
0.01	29 500	13 400	17 100
PMF	49 400	-	-

TABLE I1

STORAGE AND DISCHARGE FOR WIVENHOE DAM

Lake Level	Capacity	Inflow	Discharge m^3/s		Total
m AHD	10^6 m^3	m^3/s	One Regulator	One Spillway Gate	Avail. Discharge m^3/s
57.0	390	1 110	25	0	50
57.5	418	1 204	25	10	100
58.0	446	1 297	25	20	151
58.5	477	1 391	26	40	252
59.0	507	1 484	26	60	352
59.5	539	1 578	26	84	472
60.0	570	1 671	26	108	593
60.5	603	1 765	27	140	753
61.0	635	1 858	27	172	914
61.5	668	1 951	27	206	1 084
62.0	700	2 045	27	240	1 255
62.5	738	2 138	28	285	1 480
63.0	776	2 232	28	330	1 706
63.5	814	2 325	28	375	1 931
64.0	852	2 419	28	420	2 157
64.5	898	2 512	28	470	2 407
65.0	944	2 605	29	520	2 657
65.5	997	2 699	29	580	2 958
66.0	1 050	2 792	29	640	3 258
66.5	1 100	2 886	29	700	3 559
67.0	1 150	2 979	30	760	3 859
67.5	1 206	3 073	30	825	4 184
68.0	1 262	3 166	30	890	4 510
68.5	1 321	3 259	30	955	4 835
69.0	1 380	3 353	30	1 020	5 161
69.5	1 440	3 446	31	1 095	5 536
70.0	1 500	3 540	31	1 170	5 912
70.5	1 568	3 633	31	1 245	6 287

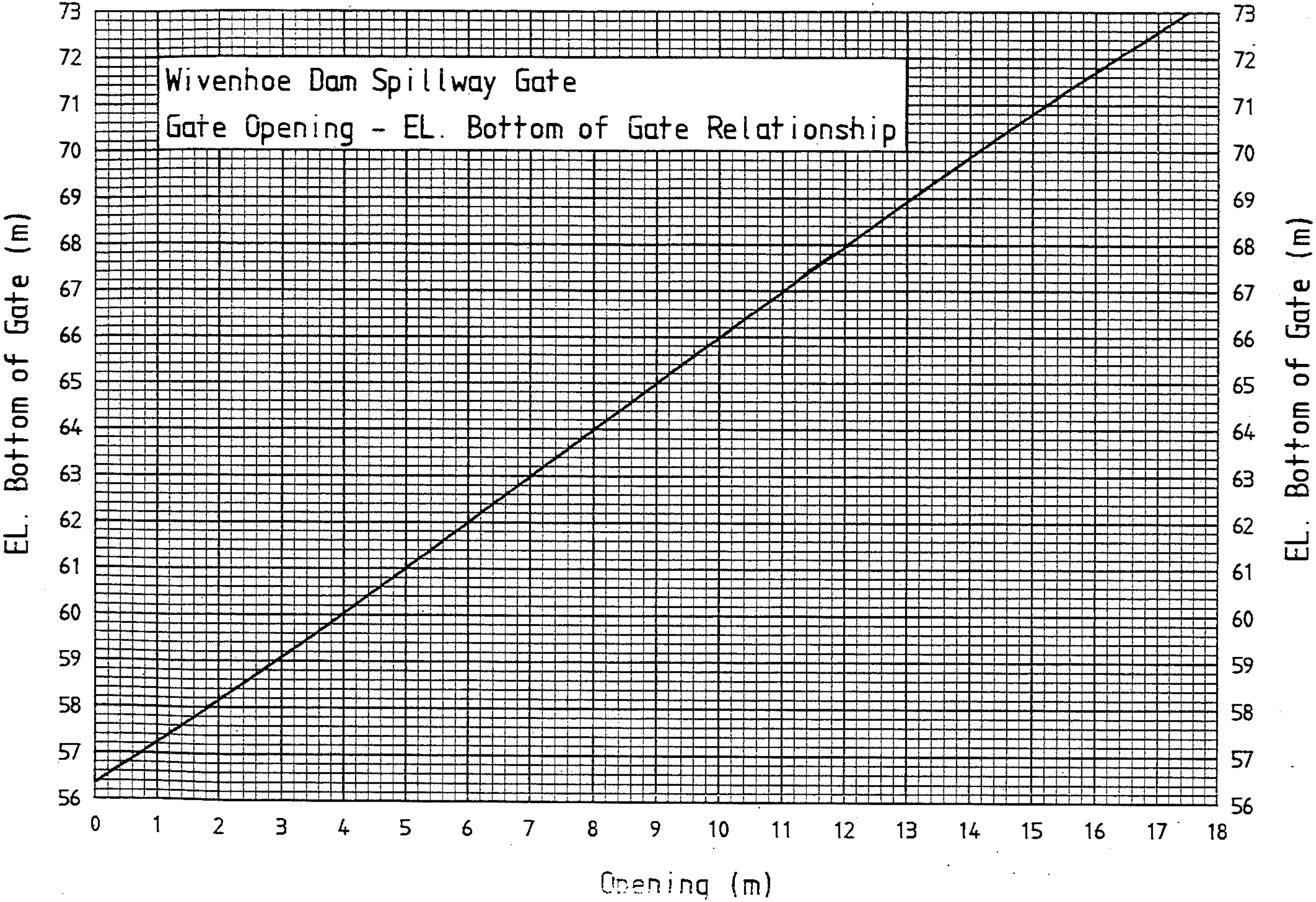
TABLE I1 (CONTD.)

STORAGE AND DISCHARGE FOR WIVENHOE DAM

Lake Level	Capacity	Inflow	Discharge m^3/s		Total
m AHD	10^6 m^3	m^3/s	One Regulator	One Spillway Gate	Avail. Discharge m^3/s
71.0	1 635	3 727	31	1 320	6 662
71.5	1 700	3 820	31	1 390	7 013
72.0	1 765	3 913	32	1 460	7 363
72.5	1 833	4 007	32	1 540	7 763
73.0	1 900	4 100	32	1 620	8 164
73.5	1 980	4 194	32	1 705	8 589
74.0	2 060	4 287	32	1 790	9 015
74.5	2 145	4 381	32	1 890	9 515
75.0	2 230	4 474	33	1 990	10 015
75.5	2 310	4 567	33	2 085	10 491
76.0	2 390	4 661	33	2 180	10 996
76.5	2 480	4 754	33	2 280	11 466
77.0	2 570	4 848	33	2 380	11 967
77.5	2 650	4 941	34	2 490	12 517
78.0	2 730	5 035	34	2 600	13 068
78.5	2 830	5 128	34	2 740	13 768
79.0	2 930	5 221	34	2 880	14 468

NOTES:

Inflow - Net inflow for 0.1 metres per hour rate of rise of lake level.
Regulator - Discharge regulator valve of which there are two (2).
Spillway - Overflow section of dam controlled by five (5) radial gates.



Wivenhoe Dam Spillway Gate
Gate Opening - EL. Bottom of Gate Relationship
EL. Bottom of Gate (m)
EL. Bottom of Gate (m)
Opening (m)
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
0
1
2
3
4
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6
7
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16
17
18

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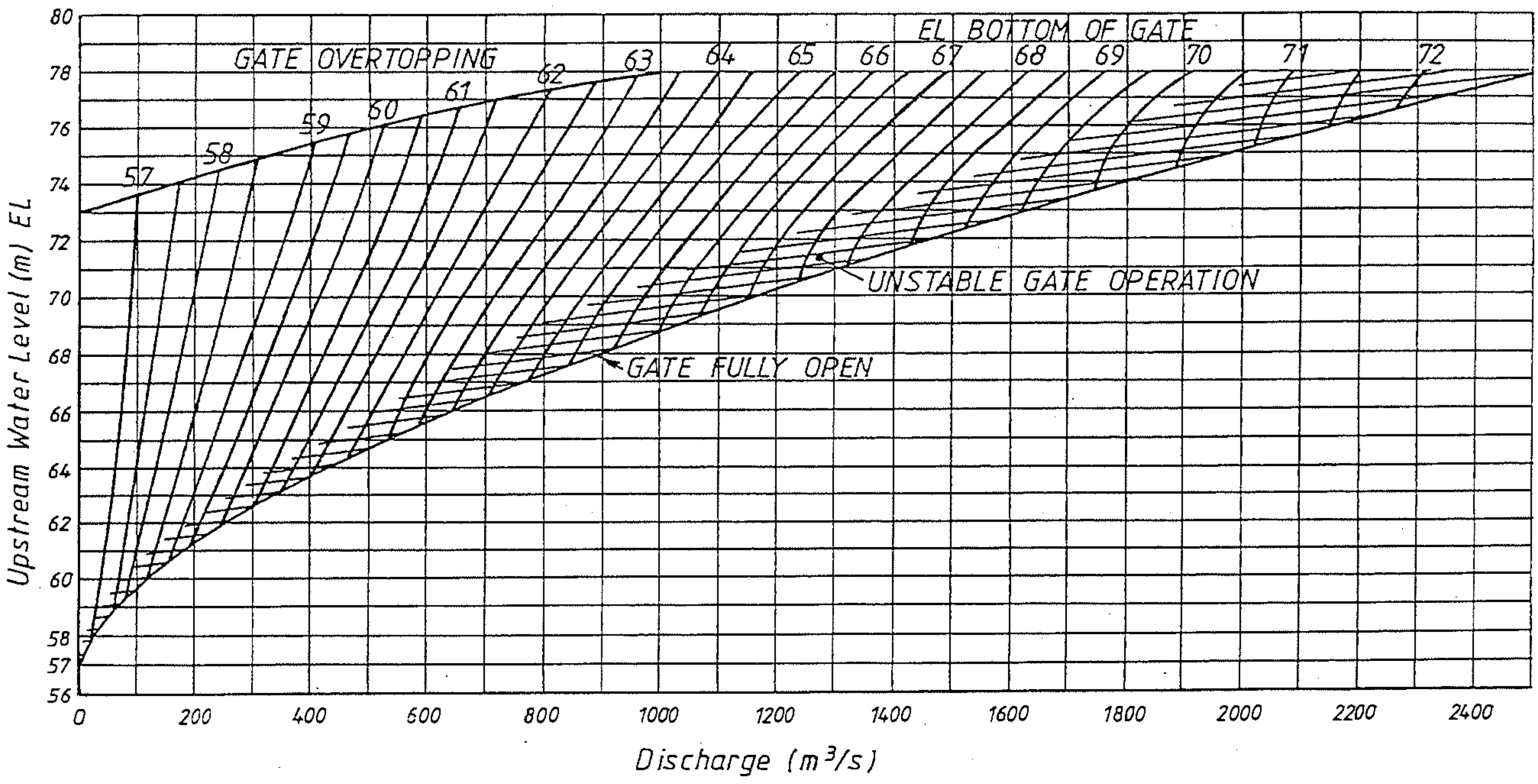

WIVENHOE DAM SPILLWAY MODEL

DISCHARGE RATING
1–GATE

FIGURE 13

A4-12328

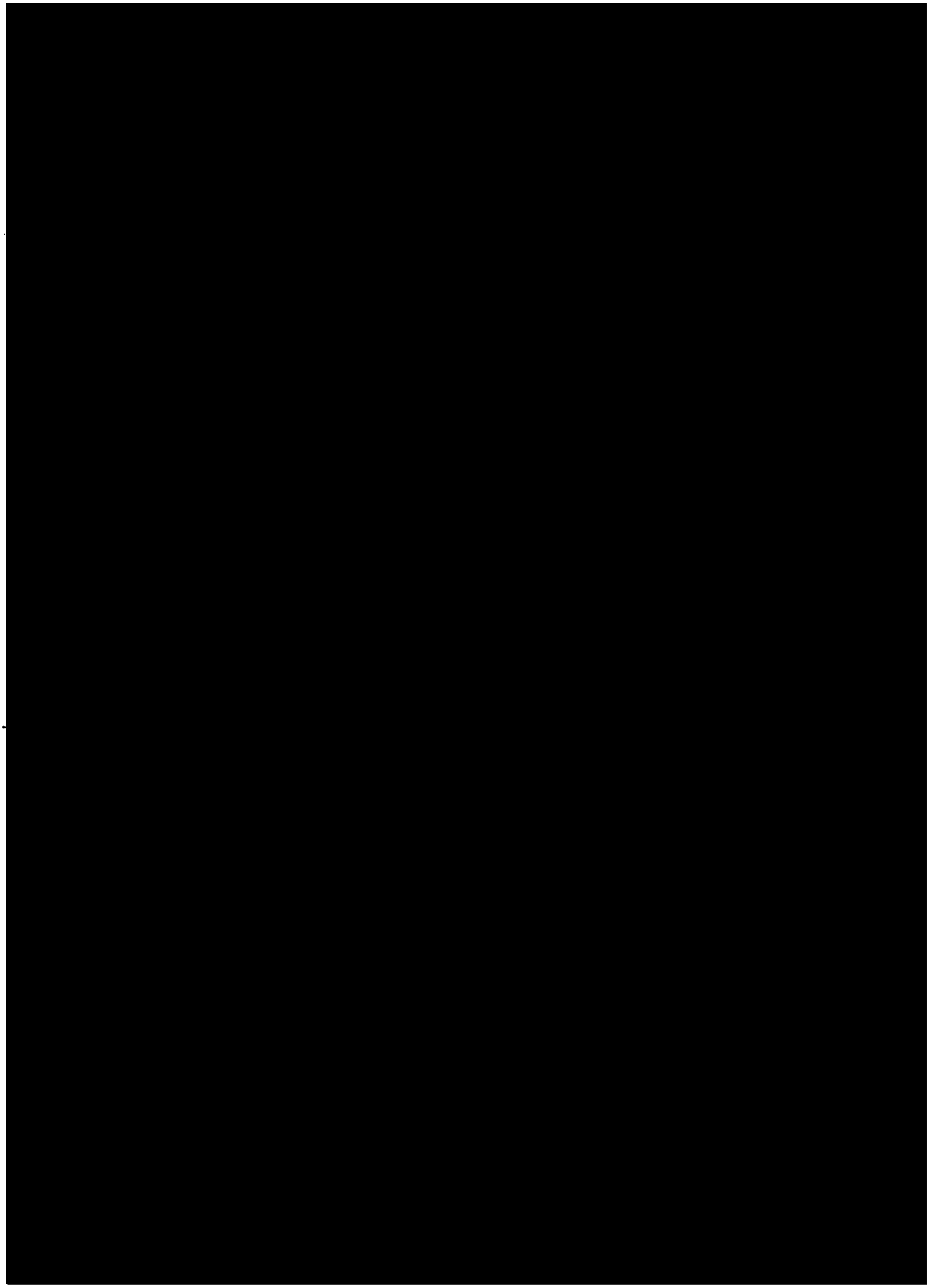

FIGURE 14

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TABLE J1

STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake Level	Capacity	Inflow	Discharge m^3/s			Total Avail. Discharge
m AHD	10^6 m^3	m^3/s	One Regulator	One Sluice	One Spillway Gate	m^3/s
99.0	372	1 300	69	200	–	1 876
99.5	394	1 330	69	203	–	1 900
100.0	418	1 365	70	205	–	1 920
100.5	442	1 410	71	207	–	1 940
101.0	467	1 460	71	209	6	2 004
101.5	493	1 525	72	211	15	2 096
102.0	520	1 575	72	212	27	2 200
102.5	548	1 635	73	215	41	2 340
103.0	578	1 695	73	217	59	2 500
103.5	607	1 750	74	218	80	2 680
104.0	639	1 805	74	220	99	2 848
104.5	671	1 875	75	222	123	3 060
105.0	704	1 945	75	223	150	3 284
105.5	739	2 005	76	224	178	3 520
106.0	775	2 070	76	226	210	3 792
106.5	812	2 130	77	228	244	4 084
107.0	854	2 200	78	230	278	4 376
107.5	896	2 270	78	231	315	4 680

NOTES:

Inflow - Net inflow for 0.1 metres per hour rate of rise of lake level.
Regulator - Discharge regulator valve of which there are four (4).
Sluice - Sluice gate of which there are eight (8).
Spillway - Overflow section of dam controlled by eight (8) radial gates.

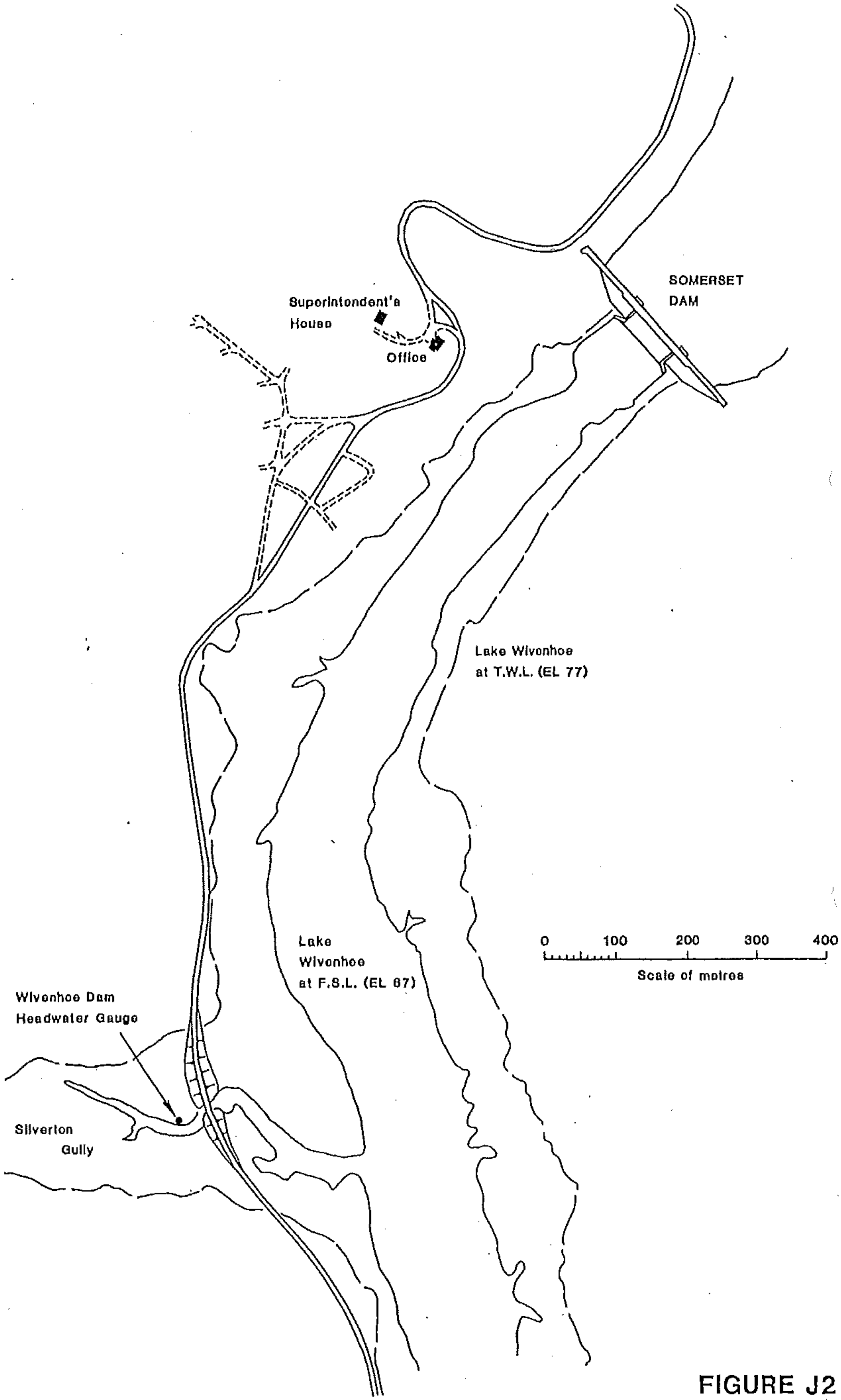
SOMERSET
DAM
Superintendent's
House
Office
Lake Wivenhoe
at T.W.L. (EL 77)
0
100
200
300
400
Scale of metres
Lake
Wivenhoe
at F.S.L. (EL 67)
Wivenhoe Dam
Headwater Gauge
Silverton
Gully

FIGURE J2

MANUAL

OF

OPERATIONAL PROCEDURES FOR FLOOD MITIGATION

FOR WIVENHOE DAM AND SOMERSET DAM

DURING PERIOD OF CONSTRUCTION OF

WIVENHOE DAM

I, John Philip GOLEBY, Minister for Water Resources in the State of Queensland do hereby approve and issue the following manual, and declare that the procedures contained herein shall be the operational procedures in relation to Wivenhoe dam and Somerset dam for the purpose of flood mitigation pending the completion of Wivenhoe dam.

Dated this twenty fourth day of May 1984 at Brisbane.

[redacted]

J.P. GOLEBY

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APPENDICES

1.0 INTRODUCTION

1.1 Meaning of Terms

In this Manual, save where a contrary intention appears -

"Advisory Committee" or "Brisbane and Area Water Board Advisory Committee" means the Advisory Committee established pursuant to Section 21 of the Brisbane and Area Water Board Act 1979-1983, as constituted at the material time;

"Brisbane and Area Water Board" means the body corporate constituted by that name pursuant to Section 9 of the Brisbane and Area Water Board Act 1979-1983;

"Brisbane City Council" means Brisbane City Council under and within the meaning of the City of Brisbane Act 1924-1982;

"Construction engineer" means the Commissioner of Water Resources or his representative;

"Co-ordinator-General" means the corporation sole preserved, continued in existence and constituted under the State Development and Public Works Organization Act 1971-1981 under the name and style The Co-ordinator-General;

"Dams" means dams to which this Manual applies, that is Wivenhoe dam and Somerset dam;

"Engineer" means the person designated pursuant to Section 2.3 of this Manual under whose general direction the procedures in this Manual shall be carried out;

"Power Station" or "hydro-electric power station" means the Wivenhoe Pumped Storage Hydro-electric Power Station associated with Wivenhoe dam and Split-Yard Creek dam;

"The Commissioner of Water Resources" means the corporation sole constituted by that name pursuant to Section 8 of the Water Resources Administration Act 1978;

"The Queensland Electricity Generating Board" means the body corporate constituted by that name pursuant to Section 79 of the Electricity Act 1976;

"The State Electricity Commission" means the corporation sole constituted by that name pursuant to Section 9 of the Electricity Act 1976;

"A.H.D." means Australian Height Datum;

"Minister" means the Minister of the Crown who at the material time is charged with the administration and control of water resources in Queensland.

1.2 Purpose of Manual

The purpose of this Manual is to define standard procedures for the operation of Wivenhoe dam and Somerset dam for the purpose of flood mitigation during the period of construction of Wivenhoe dam.

1.3 Legal Authority

This manual has been prepared,at the direction of the Brisbane and Area Water Board Advisory Committee pursuant to the provisions of the Wivenhoe Dam and Hydro-electric Works Act 1979-1984.

1.4 Scope of Manual

The procedures in this Manual shall apply to the operation of Wivenhoe dam and Somerset dam for the purpose of flood mitigation.

1.5 Period of Effectiveness

The procedures in this Manual shall have effect on and from the date on which the Manual is approved by the Minister. The procedures shall remain in force until the date declared by Order in Council effecting the transfer of all property being part of or relevant to the Wivenhoe Dam Project to the Brisbane and Area Water Board.

1.6 Observance of Flood Manual

This Manual contains the operational procedures for the purpose of flood mitigation, of The Co-ordinator-General, Brisbane City Council and Brisbane and Area Water Board in respect of Wivenhoe dam and Somerset dam and shall be observed by each of them and the delegates and employees of each of them.

1.7 Provision for Variations to Manual

If any one of the Co-ordinator-General, the Commissioner of Water Resources, the Brisbane City Council, or the Brisbane and Area Water Board is of the opinion that any requirement of this Manual does not meet the requirements of the respective Authority, or for some other reason should be amended, the Authority shall make a submission to the Brisbane and Area Water Board Advisory Committee setting forth those circumstances and the exact nature of the amendment, alteration or variation sought.

If the Advisory Committee is of the opinion that the procedures in this Manual should be amended, altered or varied, then it shall submit a recommendation to the Minister setting out the circumstances and the exact nature of the amendment, alteration or variation sought.

Any amendment, alteration or variation to the procedures in this Manual recommended by the Advisory Committee shall take effect on and from the date on which the recommendations are approved by the Minister.

1.8 Use of Imperial Units

Until such time as the method for measuring water level at Somerset dam has been converted to metric values based upon A.H.D., water level at Somerset dam shall be referred to in imperial units based upon Somerset Dam Grid Datum.

2.0 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of Section 6 of the Wivenhoe Dam and Hydro-electric Works Act 1979-1984, the Co-ordinator-General is responsible for and has the duty of operating the works of the Wivenhoe dam project, and may enter into arrangements with persons for the purpose of discharging these responsibilities.

Somerset dam is currently owned and operated for both water supply and flood mitigation purposes by Brisbane City Council.

2.2 Dam Operations Arrangements

The Co-ordinator-General has arranged for the operation of the Wivenhoe dam project by the Brisbane City Council subject to the conditions that:

(a) the operation be carried out under the general direction of a suitably qualified and experienced engineer;

(b) in the direction of the operation, the suitably qualified and experienced engineer liaise with those persons responsible for:

   (i) construction of the Wivenhoe Dam project;

   (ii) construction of the hydro-electric project;

   (iii) operation of the hydro-electic project.

Brisbane City Council has arranged for the operation of Wivenhoe and Somerset dams to be carried out under the general direction of the Chief Engineer and Manager of the Water Supply and Sewerage Department of the Brisbane City Council.

2.3 Designation of Engineer

The procedures set out in this Manual shall be carried out under the general direction of a suitably qualified and experienced engineer who shall be referred to hereafter as "the Engineer".

Under the administrative arrangements of Section 2.2, the Engineer is the Chief Engineer and Manager of the Water Supply and Sewerage Department of the Brisbane City Council.

2.4 Responsibilities of Engineer

Before adopting an operational procedure to be applied to any flood, the Engineer shall seek and shall take account of all relevant information available to him.

Except insofar as reasonable discretion is provided for in Section 2.5 of this Manual, the Engineer shall ensure that the operational procedures for the dams shall be those specified in this Manual.

2.5 Reasonable Discretion

It is recognized for the purposes of this Manual that no two floods in the Brisbane River system are exactly alike and that the procedures set out in this Manual are based upon the most common behaviour observed in the river system over a period of ninety years. It is therefore necessary that there be reasonable discretion in the determination of the method of operation of the dams to cope with unusual flood occurrences.

This reasonable discretion rests with the Engineer. If, in the opinion of the Engineer, based on information available to him and based on his professional experience, it is necessary to depart from the procedures set out in this Manual, he is empowered to adopt such other procedures as he considers necessary to meet the situation, provided that the Engineer shall observe the objectives set out in this Manual when exercising such reasonable discretion.

Where it is an unusual flood occurrence of medium flood category or greater, or the Engineer requests consultation; then prior to the implementation of the procedure, the Engineer shall consult with and have regard to the advice of the Co-ordinator-General and the Commissioner of Water Resources; except when the delay as represented by the process of such consultation, would prevent the timely implementation of the procedure, in which case, as soon as practicable thereafter, the Engineer shall consult with the above on the adopted procedure.

2.6 Report

The Engineer shall prepare a report to the Advisory Committee after each flood, and his report shall contain details of the procedures used and the reasons therefore.

3.0 COMMUNICATIONS

3.1 Liaison

It is the duty of the Engineer, the Co-ordinator-General, Brisbane City Council, the Commissioner of Water Resources and the State Electricity Commissioner to ensure that the Engineer is supplied with current information concerning the road relocation programme, the construction programme at Wivenhoe dam and the construction programme at the hydro-electric project through liaison with the representatives of the Engineer, the Co-ordinator-General, the Commissioner of Water Resources and the State Electricity Commissioner.

3.2 Communications between Engineer and Site Staff.

The Engineer shall endeavour to ensure that adequate channels of communication exist between himself and site staff at Wivenhoe and Somerset dams.

It is the duty of the Engineer, the Co-ordinator-General, Brisbane City Council, the Commissioner of Water Resources and the State Electricity Commissioner to negotiate and consult with each other concerning the provision of adequate communication facilities between the Engineer and the dams at all times including emergency situations when normal communicaton facilities may be unavailable.

3.3 Staff on Duty

When, in the opinion of the Engineer, a flood situation is imminent, he shall:

(i) ensure that he has staff available to communicate with the dam sites and with other agencies;

(ii) advise Brisbane City Council, the Co-ordinator-General, the Commissioner of Water Resources and the State Electricity Commissioner of the need to have staff on duty for communication purposes and for the provision of information, including assessments of safety of structures.

It shall be the responsibility of the above to ensure that appropriate staff are available for duty.

3.4 Communication with Public

The Engineer shall ensure, if possible, that information shall be forwarded to those agencies whose duty it is from time to time to provide warnings and information to the public during emergency situations.

4.0 FLOOD MITIGATION OBJECTIVES

4.1 General

The objectives of the procedures in this Manual are governed by the following considerations listed in descending order of importance:

(a) Structural safety of dams;

(b) Optimum protection of urban development in the Lower Brisbane River;

(c) Capacity of the dams to deal with closely spaced floods;

(d) Minimum disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries;

(e) Minimum disruption to navigation in the Brisbane River.

4.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

Wivenhoe Dam

The structural safety of Wivenhoe dam is of paramount importance. Structural failure of Wivenhoe dam could have catastrophic consequences firstly due to the magnitude of the damage which would be caused downstream, and secondly, due to the loss of a major water supply source for Brisbane and Ipswich and the loss of hydro-electric generation.

Somerset Dam

The structural safety of Somerset dam is of paramount importance. Structural failure of Somerset dam could have catastrophic consequences firstly due to the magnitude of the damage which would be caused downstream and to Wivenhoe dam and the Power Station, and secondly, due to the loss of a major water supply source for Brisbane and Ipswich.

4.3 Protection of Urban Development

The prime purpose of incorporating flood mitigation measures into Wivenhoe dam and Somerset dam is to alleviate flooding in the urban areas of the flood plain of the lower Brisbane River from Mt. Crosby to Moreton Bay.

The protection of the pumped storage power station shall be accorded the same priority as the mitigation of flooding in these urban areas.

4.4 Closely Spaced Floods

Historical records show that there is a significant probability of two flood producing storms occurring in the Brisbane River system within a short time of each other. In order to be prepared to meet such a situation the stored flood waters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles.

The prolonged discharges resulting from the emptying of the flood compartments of the dams have little impact on the urban reaches of the Brisbane River. These reaches of the river can carry a discharge which will not affect buildings and bridges in Brisbane but which will cause the Brisbane Valley Highway to be closed at Fernvale and which will cause the submergence of bridges of other main roads and Local Authority roads.

4.5 Disruption to Rural Areas

Rural areas can suffer two types of flooding from the operation of dams for the purpose of flood mitigation. In the first place, a dam can flood land and communications which would never have been flooded if the dam had not existed. This situation is most important upstream of a dam. It applies particularly to Somerset dam and, to a lesser extent, to Wivenhoe dam. Downstream of a dam the operation for the purpose of flood mitigation usually results in a reduction of peak flood levels but the emptying of the flood pondages causes a prolonged flooding of low lying land and bridges etc. compared with the conditions that prevailed before the dam was built; such prolonged flooding can affect a major rural area, not only the riverside properties.

4.6 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lowest priority but it is closely related to minimum feasible flooding of rural areas. The effect of flood flows upon navigation in the river varies widely. Large ships can be manoeuvred in the river at considerable flows whilst coal and coral barges and gravel dredges are affected by lower flows and the Moggill Ferry is affected by low flows.

Objectives (c), (d) and (e) above are closely related and all are optimized by a short emptying period for the flood pondages of the dams.

5.0 FLOOD CLASSIFICATION

5.1 Categories of Flooding

For the purposes of this Manual, five (5) magnitudes of flooding shall be recognized. These are:

(a) Small fresh - Affects low level bridges e.g. Burton's Bridge.

(b) Large fresh - Affects moderately low level bridges e.g. Fernvale Bridge.

(c) Small flood - Submerges all bridges except the new O'Shea's Crossing Bridge - inundates low lying areas of Ipswich and Brisbane.

(d) Medium flood - Causes extensive flooding in Brisbane and Ipswich.

(e) Major flood - Causes extensive damage in Brisbane and Ipswich.

These descriptions are to be used as a matter of convenience in describing flood situations. There are no firm divisions between the categories, each merging into the adjacent ones.

5.2 Definitions of Categories

The five magnitudes of flooding shall be defined according to the Tables C1, C2 and C3 in Appendix C for the reference gauge locations shown therein.

5.3 Reference Gauges

All of the reference gauge locations shown in Appendix C with the exception of Brisbane City gauge are equipped with river height gauges of the Brisbane Valley Flood Warning Radio Telemetry System. This system is at present owned jointly by the Bureau of Meteorology and Brisbane City Council although the City Council ownership may be transferred to the Brisbane and Area Water Board. All data from the system is available to both organizations. The Brisbane City gauge readings are remotely indicated to the Bureau of Meteorology and are readily available.

The location of the above gauges are shown on Fig. C1 of Appendix C.

The tables listed in Appendix C give the best present values of flood gauge readings and flows for the above five flood categories at key locations on the Brisbane River and its tributaries. As relatively few flow gaugings have been made at a number of key locations, the values shown in Appendix C are the best estimates available at present and are subject to amendment following further flow rating measurements or following further hydrological calculations.

The values shown in Appendix C are grouped in accordance with the most common areas of the catchment in which flooding originates.

5.4 Flood Magnitude

The most important indications of probable flood magnitudes are received from the Woodford gauge on the Stanley River, the Watt's Bridge gauge on the Upper Brisbane River, the Lyon's Bridge gauge on Lockyer Creek, the Amberley gauge on Warrill Creek and the Walloon gauge on the Bremer River, together with such rainfall data as may be available from the Brisbane Valley Flood Warning Radio Telemetry System and from the Bureau of Meteorology.

In the case of the Upper Brisbane River above the Stanley River junction, additional and earlier flood levels may be available from the Gregor's Creek gauge of the Radio Telemetry system and from Moore, should a river height gauge of the Telemetry System be located there in the future. Similarly, advanced warning may be given from Glenore Grove on Lockyer Creek should a river height gauge of the Telemetry System be located there in the future.

Information from the Stanley River upstream of the Woodford gauge is not representative of the degree of flooding.

The peak flood levels at Lyon's Bridge, Amberley, Walloon and Watt's Bridge are frequently related in time. The Lyon's Bridge peak level frequently occurs six to twelve hours after the peak level at Watt's Bridge, while the peak levels at Amberley and Walloon gauges frequently occur six to nine hours before the peak level at Watt's Bridge. The peak flood levels at Woodford, however, are randomly related in time to the peak levels of the other gauges.

It should be noted that, in general, the peak flood levels in Ipswich due to the Bremer River flood are reached several hours before the combined flow of Lockyer Creek, Middle Brisbane River and Wivenhoe dam releases reaches the Bremer River junction.

Nevertheless, the peak flood level at the Woodford gauge is a good indication of the volume of the flood from the Stanley River catchment which will enter Somerset dam. The Woodford peak level is also an indicator of the flooding that will occur at Kilcoy with Somerset dam being operated in its most usual manner as follows:

Peak Flood Level at Woodford	Flood Volume Ml	Flooding at or near Kilcoy
5.0 metres	175 500	Mary Smokes Bridge Submerged
6.8 metres	367 500	Water under houses near Kilcoy
8.0 metres	525 000	Some houses submerged
>8.0 metres	1 085 000 (1893)	More houses submerged

The flood storage at Somerset dam above Permanent Water Supply Level (R.L. 325 ft.) is 538 000 Ml.

6.0 WIVENHOE DAM

6.1 Introduction

In the latter stages of the construction period Wivenhoe dam will be capable of being operated to minimize flooding in the Brisbane River downstream of the junction of Lockyer Creek and the Brisbane River, depending on the part of the catchment in which the flood originates and depending, also, on the height or magnitude of the flood.

During the period of construction prior to the first spillway gate becoming operable, regulation of floods can be exercised at Somerset dam only; no regulation can be exercised at Wivenhoe dam.

Once the first spillway gate is operable, some regulation of floods can be exercised at Wivenhoe dam as set out below.

Sections 6.2 through 6.7 relate to the operating procedures for Wivenhoe dam during the installation of the gates.

Sections 6.8 through 6.11 relate to the operating procedures for Wivenhoe dam after the installation of the gates.

6.2 Installation of Gates

Gates will be erected in the order 2, 4, 3, 5 and 1. (Gates are numbered from left bank looking downstream.) It is noted that gates 2 and 4 and gates 1 and 5 are interchangeable in the method of erection and sequence of operation.

The reservoir water level will be held, where practicable, at or below EL 57 (Spillway crest) until the commencement of erection of the last gate, at which time the bulkhead gate will be lowered to permit permanent storage of water above EL 57 but below EL 67.

The gates already operable and the bulkhead gate will be capable of being used to control major flooding in the Brisbane River during the remainder of the construction period. The bulkhead gate can be used to regulate the flow, the gate being raised or lowered by the gantry crane. The bulkhead gate is not designed to be overtopped and must be raised before the water level reaches EL 69. Adjustments to the opening positions of the other gates will be required to preserve symmetry of flow into the spillway plunge pool and past the spillway piers.

Until such time as the final gate is to be erected, operable gates are to be left in the open position except as required by the flood control procedures below. The provisions of Clause 6.2 of the Special Conditions of Contract, under which the radial gates are being constructed (Appendix G), are to be observed during the installation period.

Prior to the installation of each gate, its associated control equipment, that is the winches and their controls, will be installed and operational, before any components are placed in the spillway bay except that the winch ropes will not be threaded until the outside skinplate segments are fitted.

Once the lifting tackle is operative, the partially assembled radial gates can be raised to clear the spillway. Operable gates i.e. gates which are structurally complete only, may be used for flood control purposes, if necessary prior to commissioning.

As each operable gate is commissioned and accepted by the construction engineer in accordance with the contract conditions, the construction engineer shall notify the Engineer and the operation of that gate for flood control purposes shall thereafter be at the direction of the Engineer, in consultation with the construction engineer's site representative.

6.3 Floods Occurring During Installation of Gates

6.3.1 Gate Operation Objectives

In the event of flooding during erection of the spillway gates, the Engineer shall estimate the maximum likely reservoir rise and inflow. He shall then direct the operation of the operable gates and, in the case of critical floods as defined below, he shall also direct the operation of any partially erected gate, in such manner, that in order of priority:

(a) The structural integrity of the dam is maintained by not allowing any overtopping of the embankment section;

(b) The discharge where possible does not exceed the damaging flood flow of 4 000 m^3/sec in the Brisbane River taking into account flows from Lockyer Creek and Bremer River;

(c) Minimal damage is caused to spillway structures and gates, in order of priority,

   (i) the partially erected gate,

   (ii) the bulkhead gate,

   (iii) spillway structures (concrete works);

(d) Minimal damage is caused to the spillway plunge pool by maintaining where possible symmetrical converging or uniform flip bucket discharge.

6.3.2 Critical and Non-critical Floods

Floods occurring during the installation of the spillway gates are to be classified as:

(a) Critical floods where the reservoir level would exceed EL 69 with the bulkhead gate down and operable gates closed;

(b) Non-critical floods where the reservoir level will not exceed EL 69 with the bulkhead gate down and operable gates closed.

6.4 Initial Action During Installation of Gates

Upon indications being received of an imminent flood, the flood control operation of the dam shall commence with the storing of as much of the flow of the Brisbane River as is practicable in Wivenhoe dam by lowering all operable gates.

Following an assessment of the magnitude and origin of the flood the procedures outlined below are to be adopted.

6.5 Regulator and Gate Operation Interval During Installation of Gates

The following time intervals are to be observed in the opening and closing of regulators and spillway gates.

(a) Regulators

Minimum interval between successive openings or closings of regulators is to be 30 minutes.

(b) Spillway Gates

Minimum interval between successive incremental openings is to be 10 minutes and for successive incremental gate closings is to be 20 minutes.

6.6 Gate Operating Procedures During Installation of Gates

6.6.1 Gate 2 Incomplete

(a) In a critical flood (reservoir level would exceed EL 69 with bulkhead gate down in bay 2), the fabricated components of the radial gate are to be hoisted above the estimated maximum water level and all falsework removed from spillway bay 2. The bulkhead gate is then to be raised before the reservoir level reaches EL 69.

(b) In a non-critical flood no action is necessary.

6.6.2 Gate 2 Installed, Gate 4 Incomplete

(a) In a critical flood (reservoir level would exceed EL 69 with gate 2 closed and the bulkhead gate down in bay 4), gate 2 is to be fully opened. If the reservoir level is still estimated to rise above EL

69 then bay 4 is to be cleared of falsework, the radial gate components hoisted above the estimated maximum water level and the bulkhead gate raised before the reservoir level reaches EL 69.

(b) In a non-critical flood (reservoir level will not exceed EL 69 with gate 2 closed and the bulkhead gate down in bay 4), Gate 2 is to be closed and the bulkhead left in bay 4.

6.6.3 Gates 2 and 4 Installed, Gate 3 Incomplete

(a) In a critical flood, (reservoir level would exceed EL 69 with bays 1 and 5 unrestricted), gates 2 and 4 are to be operated to achieve the outlined flood mitigation objectives. If the reservoir level is still estimated to rise above EL 69 when the gates are fully open, then bay 3 is to be cleared of all falsework, the radial gate assembly hoisted and the bulkhead gate removed before the reservoir level reaches EL 69.

(b) In a non-critical flood (the flood can be safely passed through the ungated bays 1 and 5 and through the gated bays 2 and 4 without raising the reservoir level above EL 69), the bulkhead gate in bay 3 shall be left in position and the gates in bays 2 and 4 operated to control the discharge without allowing the reservoir level to exceed EL 69.

6.6.4 Gates 2, 3 and 4 Installed, Gate 5 Incomplete

(a) In a critical flood, (reservoir level would exceed EL 69 with bay 1 unrestricted), gates 2, 3 and 4 are to be operated using the installed gate operating procedures set out in Section 6.7 below. If the reservoir level is still estimated to rise above EL 69 when the gates are fully open, then bay 5 is to be cleared of all falsework, the radial gate structure raised and the bulkhead gate removed before the reservoir reaches EL 69 or as soon as the spillway discharge jet impinges on the left bank.

(b) In a non-critical flood, the bulkhead gate in bay 5 may be left in position until the spillway discharge jet impinges on the left bank, then bay 5 is to be cleared of all falsework, the radial gate structure raised and the bulkhead gate removed. Gates 2, 3 and 4 are to be operated using the installed gate operating procedures set out in Section 6.7 below.

6.6.5 Gates 2, 3, 4 and 5 Installed, Gate 1 Incomplete

At this time, the four operable gates (2, 3, 4 and 5) will be closed and the bulkhead gate down in bay 1, enabling water to be stored up to full supply level EL 67.

(a) In a critical flood, (reservoir level would exceed EL 69 with gates 2, 3, 4 and 5 closed and the bulkhead gate down in bay 1), gates 2, 3, and 4 are to be operated using the installed gate operating procedure for gates 2, 3 and 4 set out in Section 6.7 below. If the reservoir level is still estimated to rise above EL 69 when the gates are fully open, then bay 1 is to be cleared of all falsework and the radial gate structure raised before the reservoir reaches EL 69. Radial gate 5 is to be opened simultaneously with the raising of the bulkhead gate to maintain symmetry of flow in the spillway plunge pool.

Once the reservoir level falls below EL 68 after the flood has passed, the bulkhead gate is to be lowered in bay 1 and radial gate 5 closed. Gates 2, 3 and 4 are to be used to regulate the discharge until the reservoir level returns to the full supply level of EL 67.

(b) In a non-critical flood, gates 2, 3 and 4 shall be used to maintain the reservoir level below EL 69 until such time that the spilling discharge jet is impinging on the right or left bank of the plunge pool. In this event, Bay 1 is to be cleared of all falsework and the radial gate structure raised and the bulkhead gate is to be raised with gate 5 opened simultaneously to preserve symmetry of discharge.

During the opening of bays 1 and 5, some closure in bays 2, 3 and 4 will be necessary to maintain the discharge below 4 000m^3/s where practicable.

6.7 Gate Operating Procedures for Installed Gates

6.7.1 Gates 2, 3 and 4 Installed

These three gates will be used as the main regulating gates during the latter stages of gate erection and during the normal flood control operation of the dam.

Under the control system installed, gates 2 and 4 can be operated simultaneously. The sequence of operations set out below will always be applicable.

(i) Gate 3 is to be opened in increments first to discharge flows up to 500 m^3/s.

(ii) Gates 2 and 4 are to be opened simultaneously in increments to discharge a flow of up to 500 m^3/s each to give a total discharge of up to 1500 m^3/s.

(iii) Thereafter, the bottoms of gates 2, 3 and 4 shall be kept within 0.5 m of each other with the bottom of gate 3 always being higher than or at the same level as the bottoms of gates 2 and 4. Gates 2 and 4 shall be operated simultaneously.

The maximum discharge from gates 2, 3 and 4 is dependent upon the upstream head and the aperture of the gates. When either gate 1 or 5 or both are inoperable in the closed position, the spillway discharge should be limited where practicable so as not to cause the discharge to impinge on either the left or right walls of the plunge pool. (Approximate discharge 1 500 m^3/s).

6.7.2 Gates 1 and 5 Installed

The spillway gates 1 and 5 will be operated simultaneously under normal conditions. The discharge jets from these gates are deflected into the spillway plunge pool and are capable of containing the divergence of the discharge from gates 2, 3 and 4.

These gates are to be opened sufficiently to contain the discharge jets from gates 2, 3, and 4 within the plunge pool until such time that their capacity is required for the passing of major floods whereupon the openings of these gates shall not exceed those of gates 2, 3 and 4.

6.8 Floods Occurring After Installation of Gates

Once the gates are installed, Wivenhoe dam will be capable of being operated in a number of ways, each of which will reduce flooding in the Brisbane River downstream of the junction of Lockyer Creek and the Brisbane River, depending on the part of the catchment in which the flood originates and depending, also, on the magnitude of the flood.

6.9 Initial Action After Installation of Gates

Upon indications being received of an imminent flood, the flood control operation of the dam shall commence with the storing of the whole flow of the Brisbane River in Wivenhoe dam, whilst an assessment is made of the origin and magnitude of the flood.

6.10 Regulator and Gate Operation Interval After Installation of Gates

The following time intervals are to be observed in the opening and closing of regulators and spillway gates.

(a) Regulators

Minimum interval between successive openings or closings of regulations is to be 30 minutes.

(b) Spillway Gates

Minimum interval between successive incremental openings is to be 10 minutes and for successive incremental gate closings is to be 20 minutes.

Gates 2, 3 and 4 are to be used as the main regulating gates and are to be operated as follows.

(i) Gate 3 is to be opened in increments first to discharge flow up to 500 m^3/s.

(ii) Gates 2 and 4 are to be opened simultaneously in increments to discharge a flow of up to $500m^3/s$ each to give a total discharge of $1500m^3/s$.

(iii) Thereafter, the bottoms of gates 2, 3 and 4 shall be kept within 0.5m of each other with the bottom of gate 3 always being being higher than or at the same level as the bottoms of gates 2 and 4.

Gates 1 and 5 are to be operated simultaneously to contain the discharge jets from gates 2,3 and 4 within the plunge pool until such time that their capacity is required for the passing of major floods. The opening of these gates shall not exceed those of gates 2 and 4.

6.11 Operating Procedures After Installation of Gates

When the preliminary estimation of the degree of expected flooding has been made, the operational procedures setout hereunder shall be used at Wivenhoe dam.

It is essential that the operational procedures adopted should not endanger the safety of Wivenhoe dam. Within this constraint, the Engineer shall in the first instance adopt procedures for the operation of Somerset dam such that:

(a) the structural safety of Somerset dam is not endangered;

(b) the Upper Brisbane River flood flow plus Somerset dam release does not cause Wivenhoe dam to be overtopped.

As the magnitude of the expected flooding increases, the procedures to be adopted commence with Procedure 1 and extend through to Procedure 4. In interpreting the following procedures, two threshold levels at the Lowood gauge are to be noted:

(i) 7.0m - Fernvale Bridge submerged;
(ii) 9.5m - Mt. Crosby Weir Bridge submerged.

Procedure 1

Water is to be released from Wivenhoe dam onto the flow from the Lockyer Creek such that Fernvale Bridge is not submerged.

Procedure 2

Water is to be released from Wivenhoe dam in such a way that Fernvale Bridge is not submerged unnecessarily. If

Fernvale Bridge is submerged by the natural flow of Lockyer Creek, the releases from Wivenhoe dam may be increased in such a way that Mt. Crosby Weir Bridge is not submerged unnecessarily.

Procedure 3

Water may be released from Wivenhoe dam on to the rising limb of the Lockyer Creek flood provided that care is taken not to submerge Fernvale Bridge or Mt. Crosby Weir Bridge prematurely. As the peak of the flood from the Lockyer Creek reaches Lyon's Bridge, the releases from Wivenhoe dam are to be reduced and then resumed after the peak of the flood from the Lockyer Creek has passed the junction of the Brisbane River and Lockyer Creek.

The combined flow of Lockyer Creek and Wivenhoe dam releases are not to cause the inundation of urban areas. If either the Bremer River flood or the Lockyer Creek flood cause the urban areas of Brisbane and Ipswich to be inundated, the releases from Wivenhoe dam are not to contribute to either the depth or the duration of the inundation of these urban areas.

The releases are to be regulated to empty the flood storage as quickly as possible, without causing urban areas to be inundated.

The peak flood flow in the Brisbane River downstream of the Bremer River junction will be due to the unregulated flood flows of Lockyer Creek and the Bremer River, if either of these flood flows is of the small flood category or larger. If the flood flows from these two catchments are in the small or large fresh categories, the peak flow will be due to the combination of Wivenhoe dam releases and the unregulated flood flows. The peak flow however, in this instance, will not exceed the large fresh category.

Procedure 4

Water is released onto the rising limb of the Lockyer Creek flood provided that care is taken not to submerge Fernvale Bridge or Mt. Crosby Weir Bridge prematurely. Once it is evident that Mt. Crosby Weir Bridge will be submerged by the Lockyer Creek flow, the releases are to be increased until the lake level in Wivenhoe dam begins to drop. The releases are then to be reduced as the inflow drops until the combined river flow and releases will not cause inundation of the urban areas. The releases are then to maintain this situation until the lake level in Wivenhoe dam returns to Full Supply Level EL 67.

7.0 SOMERSET DAM

7.1 Introduction

Somerset dam is capable of being operated in a number of ways, each of which will reduce flooding in the Brisbane River downstream of the junction of the Stanley River and the Brisbane River, depending on the part of the catchment in which the flood originates and depending, also, on the height or magnitude of the flood.

7.2 Initial Action

Upon indications being received of an imminent flood, the flood control operation of the dams shall commence with the storing of the whole flow of the Stanley River in Somerset dam, whilst an assessment is made of the origin and magnitude of the flood.

7.3 Regulator and Gate Operation Interval

The following shall be observed in the opening and closing of regulators, sluices and crest gates for flood mitigation purposes:

	Minimum interval between successive	
	OPENINGS	CLOSURES
REGULATORS	Half-Hour	One Hour
SLUICE GATES	Two Hours	Three Hours
CREST GATES		In general, the gates are not normally closed until the reservoir level has fallen below the fixed concrete crest of the spillway at R.L. 330 ft.
Lake Level:		
<R.L. 348 ft.	Two Hours	
>R.L. 348 ft.	Three Hours	

7.4 Operating Procedures

When the preliminary estimation of the degree of expected flooding has been made, the operational procedures setout hereunder shall be used at Somerset dam.

It is essential that the operational procedures adopted should not endanger the safety of Somerset dam. Within this constraint, the Engineer shall in the first instance adopt procedures for the operation of Somerset dam such that the Brisbane River flood flow plus Somerset dam release does not exceed the discharge capacity of Wivenhoe Dam.

As the magnitude of the expected flooding increases, the procedures to be adopted commence with Procedure A and extend through to Procedure D as follows:

Procedure A

Water is to be released from Somerset dam onto the flow from the Upper Brisbane River such that Caboonbah gauge is less than 4.0 metres. Releases are to be limited to two regulators (140 m^3/s) when Watt's Bridge level has dropped to 3.5 metres, provided that the water level in Somerset dam is less than 327.4 ft. (Somerset Dam Grid Datum).

Procedure B

Water is to be released from Somerset dam in such a way that Fernvale Bridge is not submerged unnecessarily. If Fernvale Bridge is submerged by the natural flow of the Brisbane River, the releases from Somerset dam may be increased in such a way that the Lowood peak flood level does not exceed 9.5 metres. (This prevents Mt. Crosby Weir Bridge from being submerged. All other bridges except O'Shea's bridge will be submerged.)

Procedure C

Water may be released from Somerset dam onto the rising limb of the Brisbane River flood. As the peak of the flood from the Upper Brisbane River reaches Watt's Bridge, the releases from Somerset dam are to be shut down and then opened up again after the peak of the flood from the Upper Brisbane River has passed the junction of the Brisbane and Stanley Rivers. The releases are to be regulated to empty the flood storage within four (4) days, without increasing peak flood levels downstream of the junction of the Stanley and Brisbane Rivers.

Procedure C1

Water is to be released from Somerset dam at approximately half the rate of inflow to Somerset dam for the preceding three hours. As the peak of the flood from the Upper Brisbane River approaches Watt's Bridge, the releases are kept constant and are increased after the peak of the flood has passed the junction of the Brisbane and Stanley Rivers. The flood storage of Somerset dam is emptied within four (4) days.

Procedure D

Water is to be released from Somerset dam on to the rising limb of the flood from the Upper Brisbane River. As the peak of the flood from the Upper Brisbane peak approaches Watt's bridge, the releases from Somerset dam are to be reduced, but not completely shut down. Once the peak of the flood from the Upper Brisbane River has passed the junction, the releases from Somerset dam are to be increased as flood contributions from the Upper Brisbane River and Lockyer Creek drop. The releases are then to be regulated to empty the flood storage of Somerset dam within five (5) days, without increasing flood levels in the Brisbane River below the Stanley junction.

Appendix D gives locations, and submergence flows for the bridges on the Brisbane and Stanley Rivers affected by various modes of operation of Somerset dam.

The above operating procedures (A, B, C, C1, and D) are summarized in Table E1 of Appendix E. The discharge capacities which can be commanded for various storage levels of Somerset dam are listed in Table F1 of Appendix F. The operating procedure is indicated for various combinations of predicted peak flood levels at Watt's Bridge, Woodford and Lyon's Bridge flood gauges.

8.0 EMERGENCY PROCEDURE

8.1 Overtopping of Dams

Every endeavour must be made by the progressive opening of crest gates to prevent overtopping of Wivenhoe dam by flood waters.

In the event of Wivenhoe dam being likely to be overtopped, the saddlebanks may be breached in order to reduce the danger to the main embankment.

Somerset dam should not, if possible, be overtopped, by flood water but, if Wivenhoe dam is threatened by overtopping, the release of water from Somerset dam is to be reduced, even at the expense of the overtopping of Somerset dam, in order to prevent the overtopping of Wivenhoe dam.

8.2 Communications Failure

In the event of normal communications being lost between the Engineer and either Wivenhoe dam or Somerset dam, the officer in charge at that dam shall endeavour to maintain contact with the officer in charge at the other dam, in the first instance to receive instructions through the remaining communications link and, failing that, so that the officer in charge of both dams can operate the dams in concert for emergency purposes.

A sufficiently large flood will block road communication between Wivenhoe and Somerset dams. In this event contact is to be maintained, as far as possible, by boat along Lake Wivenhoe.

In the event of all communications being lost between the Engineer and both Wivenhoe dam and Somerset dam, the officers in charge at each dam shall adopt the procedures set out below.

Somerset Dam

The spillway gates are to be raised to allow uncontrolled discharge once the flood storage between FSL and spillway level has filled. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe dam begins to drop; or

(ii) the level in Somerset dam exceeds 336 ft Somerset Grid Datum.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe dam above the peak level caused by the flood flow of the upper Brisbane River. The provisions of Section 7.3 are to be observed for the operation of the sluices and regulators.

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board below Top Water Level in Wivenhoe Dam (EL 77) is the same as the free-board below non-spillway crest level in Somerset dam (353 ft). The low level outlets in Somerset dam are not to be opened if the water level of Wivenhoe lake exceeds the level set out below corresponding to the water level of Somerset lake.

Somerset Lake Level ft Somerset Dam Grid	Wivenhoe Lake Level m AHD
336	72
339	73
343	74
346	75
350	76
353	77

The constraints applicable to case (i) operation do not apply to case (ii) operation.

Wivenhoe Dam

The minimum gate openings related to lake level set out in the table below are to be maintained for both opening and closing operations.

Lake Level m	Minimum Gate Opening m Gate 3	Gate 2,4	Gates 1,5	Discharge m^3/s
67.0	-	-	-	-
67.5	0.5	-	-	75
68.0	1.5	-	-	175
68.5	2.5	-	-	290
69.0	4.5	-	-	490
69.5	4.5	1.0	-	790
70.0	4.5	2.0	-	1020
70.5	4.5	3.0	-	1290
71.0	4.5	4.0	-	1530
71.5	4.5	4.0	0.5	1750
72.0	4.5	4.0	1.5	2030
72.5	4.5	4.0	3.0	2440
73.0	5.0	4.5	4.0	2890
73.5	5.5	5.0	5.0	3310
74.0	6.0	6.0	5.5	3810
74.5	6.5	6.5	6.5	4300
75.0	7.0	7.0	7.0	4750
75.5	8.0	8.0	8.0	5350
76.0	9.0	9.0	9.0	6050
76.5	10.0	10.0	10.0	6750
77.0	11.0	11.0	11.0	7500
above 77.0	Continue to open gates in order at five minute intervals until level begins to fall.			

APPENDIX 'A'

EXTRACT FROM WIVENHOE DAM AND HYDRO-ELECTRIC WORKS ACT 1979 - 1984

32. Operational procedures for flood mitigation.

(1) During the course of construction of the Wivenhoe dam project the Advisory Committee constituted under the Brisbane and Area Water Board Act 1979 shall cause to be prepared a combined manual of operational procedures in relation to the reservoir within the project and the reservoir behind Somerset Dam for the purpose of flood mitigation pending completion of the Wivenhoe dam project.

(2) The manual of operational procedures may vest in any person mentioned therein and regulate the function of exercising a reasonable discretion in any matter as part of the flood mitigation procedures.

33. Approval and observance of flood manual.

(1) The manual prepared under section 32 and amendments thereof, which may be recommended by the Advisory Committee, shall not be effective until approved by the Minister of the crown charged with the administration and control of water resources in Queensland.

(2) Operational procedures for the time being specified in the manual prepared under section 32 that is effective shall be taken to be the flood mitigation procedures of the Co-ordinator-General, Brisbane City Council and Brisbane and Area Water Board in respect of the reservoirs to which the manual relates, pending completion of the Wivenhoe dam project, and shall be observed by each of them and the employees of each of them.

34. Compliance with flood mitigation procedures avoids liability for damage.

No person shall be held liable for damages claimed in respect of loss or injury alleged to arise from -

(a) the carrying out of flood mitigation procedures in accordance with the approved manual (as amended to the material time) prepared under section 32 in relation to the reservoirs concerned; or

(b) the inaccuracy of information released on behalf of Brisbane and Area Water Board, the Co-ordinator-General or an employee of either of them concerning anticipated flooding or the anticipated levels of flooding.

35. Liability for escape of water.

The Co-ordinator-General, Brisbane and Area Water Board or The Queensland Electricity Generating Board shall not be liable, absolutely or vicariously -

(a) for flooding or sending water upon any land by reason of the construction or provision of any works, being part of the Wivenhoe dam project or the hydro-electric project; or

(b) for escape of water from headworks under its control or from works being constructed, provided or controlled by it or on its behalf,

unless it be shown that the flooding, sending of water or escape is due to or arose out of the negligence of such of them as would, but for this section, be so liable, or of its servants or delegate in the construction, maintenance, control or operation of the works or headworks in question or of the flow of water therein.

This section does not apply so as to prejudice the operation of section 34.

APPENDIX 'B'

EXTRACT FROM BRISBANE AND AREA WATER BOARD ACT 1979 - 1983

106. Operational procedures for flood mitigation.

(1) The Advisory Committee shall cause to be prepared a manual of operational procedures in relation to each reservoir that is under the control of the Board for the purpose of flood mitigation and may from time to time cause to be prepared such amendments thereto as the committee considers necessary.

Every manual and all amendments thereto prepared under this subsection shall be submitted to the Board which shall submit the same, with its recommendations, to the Minister within 40 days after it receives the same.

(2) A manual prepared under subsection (1) and amendments therof, which may be recommended by the Advisory Committee shall not be effective until:

(a) duly approved by the Minister; and

(b) in the case of a manual prepared in relation to a reservoir within the Wivenhoe Dam project and the reservoir behind Somerset Dam, until the manual prepared in relation to such reservoirs, pursuant to the Wivenhoe Dam and Hydro-electric Works Act 1979 has ceased to be effective.

(3) Before he decides to approve of a manual or any amendment of a manual the Minister shall consult on that issue with the Minister of the Crown charged with the administration and control of water resources in Queensland.

107. Board, Headworks Operator bound by manual.

The operational procedures to be adopted by the Board in respect of each reservoir under its control for the purpose of flood mitigation shall be as provided by the manual prepared under section 106 in relation to that reservoir as duly amended at the material time and such manual, as duly amended at the material time, shall be observed by the Board and its employees and the Headworks Operator and its employees.

108. Minister, Board, Headworks Operator not liable for flood damage.

The Minister, the Board, the Headworks Operator and an employee of the Board or the Headworks Operator shall not be liable for damages claimed in respect of loss or injury alleged to arise from:

(a) the carrying out of flood mitigation procedures of the Board if such procedures were carried out under the general direction of a suitably qualified and experienced engineer in accordance with the operational procedures specified by the relevant manual prepared under section 106; or

(b) the inaccuracy of information released on behalf of the Board or the Headworks Operator or by an employee of the Board or the Headworks Operator concerning anticipated flooding or the anticipated levels of flooding.

APPENDIX 'C'

TABLE C1

TYPICAL FLOODS IN THE BRISBANE RIVER

I.E. ORIGINATING IN UPPER BRISBANE (SOMERSET DAM CONTRIBUTION TO PEAKS: TYPICAL)

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	2.0	500	4.0	1280	10.4	4000	14.0	5500	16.5	7000
Amberley	2.3	10	3.0	18	5.8	150	6.7	280	7.5	450
Walloon	2.8	10	3.0	12	5.3	130	5.8	200	6.6	350
Mt. Crosby Weir	8.5	480	10.9	1250	19.0	3700	22.2	5000	24.8	6200
Lowood	4.0	450	8.0	1200	16.0	4100	19.2	5600	20.9	6800
Lyon's Bridge	7.8	75	10.2	150	15.5	600	16.5	800	17.3	1000
Watt's Bridge	4.5	320	7.2	950	13.0	3200	14.8	4400	16.1	5350

TABLE C2

FLOODS ORIGINATING IN BREMER AND METROPOLITAN REACHES OF BRISBANE RIVER

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	1.8	400	3.4	1000	9.2	3200	12.0	4500	14.6	5800
Amberley	5.9	160	7.4	400	9.6	1200	10.2	1600	11.1	2200
Walloon	5.2	120	6.4	300	8.3	900	9.1	1200	10.0	1600
Mt. Crosby Weir	7.48	80	7.88	200	9.35	800	11.1	1300	11.6	1400
Lowood	1.3	80	2.3	180	5.8	760	7.7	1250	8.8	1400
Lyon's Bridge	3.5	10	5.5	30	7.2	60	10.2	150	11.3	200
Watt's Bridge	2.2	60	2.9	130	5.6	600	7.5	980	7.8	1050

TABLE C3

FLOODS ORIGINATING ON LOCKYER CREEK

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	2.0	500	4.0	1280	10.4	4000	14.0	5500	16.5	7000
Amberley	2.3	10	3.0	18	5.8	150	6.7	280	7.5	450
Walloon	2.8	10	3.0	12	5.3	130	5.8	200	6.6	350
Mt. Crosby Weir	8.5	480	10.9	1250	19.0	3700	22.2	5000	24.8	6200
Lowood	4.0	450	8.0	1200	16.0	4100	19.2	5600	20.9	6800
Lyon's Bridge	13.4	350	17.3	1000	21.0*	2800	23.5	3500	24.0*	4000
Watt's Bridge	2.5	90	3.6	180	8.1	1200	10.0	1900	11.4	2500

* Estimated gauge height.

LOCATION OF FLOOD GAUGES

REFERRED TO IN TABLES C1, C2, C3

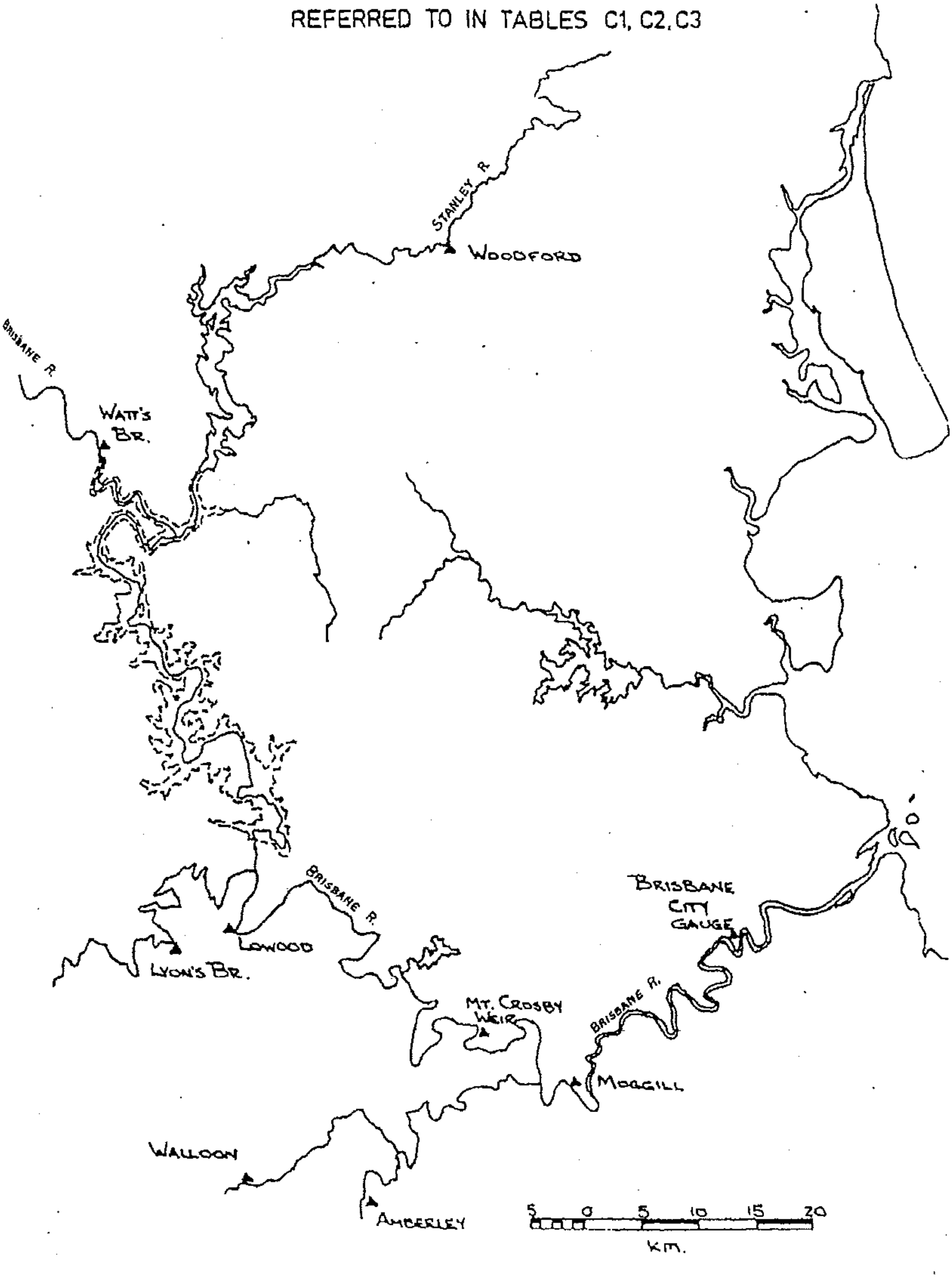

FIG C1

APPENDIX 'D'

TABLE D1

SUBMERGENCE FLOWS FOR BRISBANE VALLEY BRIDGES

1.	College's Crossing	100 m^3/s
2.	Mt. Crosby Weir Bridge	1600 m^3/s
3.	Kholo Bridge	550 m^3/s
4.	Burton's Bridge	250 m^3/s
5.	Savage's Crossing	150 m^3/s
6.	Fernvale Bridge	1020 m^3/s
7.	Twin Bridges	25 m^3/s
8.	O'Shea's Bridge	7500 m^3/s
9.	Watt's Bridge	400 m^3/s

Locations of Bridges shown on Figure D1.

BRIDGE LOCATIONS
REFERRED TO IN TABLE D1

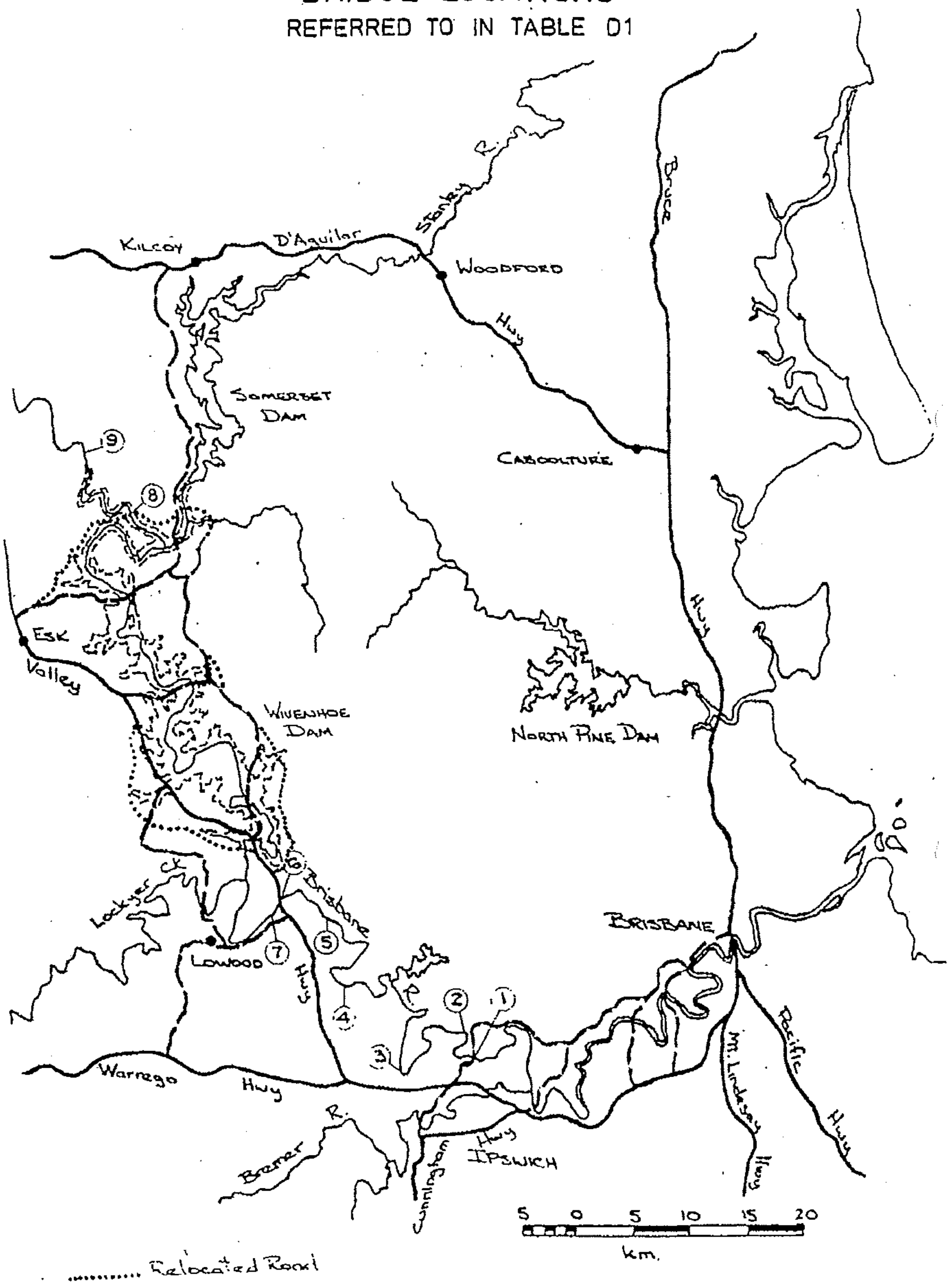

FIG D1

APPENDIX 'E'

TABLE E1

OPERATING PROCEDURES FOR SOMERSET DAM

Predicted Peak Levels (m)			Operating Procedure
Watt's Br. Gauge	Woodford Gauge	Lyon's Br. Gauge	
3.0-4.5	<5.0	<10.0	A
		10.0-15.0	"
		>15.0	"
	5.0-6.8	<10.0	B
		10.0-15.0	"
		>15.0	"
	6.8-8.0	<10.0	C1
		10.0-15.0	"
		>15.0	"
	>8.0	ALL	D
4.5-7.2	<5.0	<10.0	B
		10.0-15.0	"
		>15.0	"
	5.0-6.8	<10.0	B
		10.0-15.0	"
		>15.0	"
	6.8-8.0	<15.0	C
		>15.0	"
	>8.0	ALL	D
7.2-10.0	<5.0	<15.0	C
		>15.0	"
	5.0-6.8	<15.0	C
		>15.0	"
	6.8-8.0	<15.0	C
		>15.0	"
	>8.0	ALL	D
10.0	<5.0	<15.0	C
		>15.0	"
	5.0-6.8	<15.0	C
		>15.0	"
	6.8-8.0	<15.0	C
		>15.0	"
	>8.0	ALL	D

APPENDIX 'F'

TABLE F1

STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake Level Somerset Grid ft.	Capacity Ml	Inflow for 0.1 m/h Rise m^3/s	Discharge m^3/s One Reg.	One Sluice	One Spillway Gate	Total Avail. Discharge m^3/s
325	368 810	1 245	69	200	-	1 876
326	382 480	1 280	69	202	-	1 889
327	396 145	1 320	69	203	-	1 901
328	410 255	1 347	70	204	-	1 913
329	424 810	1 375	70	205	-	1 924
330	439 365	1 405	71	207	-	1 937
331	454 810	1 440	71	208	2	1 964
332	470 250	1 465	71	209	6	2 009
333	486 140	1 515	72	210	12	2 063
334	502 470	1 540	72	211	18	2 124
335	578 800	1 570	72	212	27	2 203
336	536 020	1 605	73	214	35	2 281
337	553 240	1 645	73	215	46	2 376
338	570 955	1 680	73	216	56	2 468
339	589 160	1 720	73	217	67	2 568
340	607 365	1 750	74	218	80	2 678
341	626 560	1 785	74	219	92	2 781
342	645 750	1 820	74	220	106	2 902
343	665 465	1 860	75	221	120	3 025
344	685 690	1 905	75	222	137	3 165
345	705 920	1 950	75	223	153	3 306
346	727 285	1 990	76	224	170	3 451
347	748 650	2 015	76	225	188	3 603
348	770 555	2 060	76	226	207	3 767
349	793 000	2 100	77	227	227	3 935
350	815 455	2 135	77	228	248	4 114
351	841 300	2 185	77	229	266	4 270
352	867 150	2 210	78	230	290	4 473
353	893 040	2 250	78	231	312	4 652

NOTES:

Somerset Grid	- Somerset Dam Grid Datum
ft.	- Imperial feet
Ml	- Megalitres
Column 3	- Inflow rate in m^3/s for a rise of 0.1 m/h rise of reservoir level.
m/h	- metres per hour
Reg.	- Discharge regulator valve of which there are four (4).
Sluice	- Sluice gate of which there are eight (8).
Spillway	- Overflow section of dam controlled by eight (8) radial gates.
m^3/s	- cubic metres per second.

APPENDIX 'G'

QUEENSLAND WATER RESOURCES COMMISSION CONTRACT 2123

Extract from Special Conditions of Contract

(The meanings of terms do not necessarily comply with section 1.1. of the manual.)

ORDER OF CONSTRUCTION

6.2 Order

The Contractor shall so order his works so as to minimize the risk to the works and structures associated with the dam. To this end the Contractor shall programme his works to ensure that the following provisions are met:

(a) In any bay, the Contractor shall have the guides and seal plates installed and the bulkhead gate operable prior to the erection of the radial gates within the bay.

(b) The Contractor shall at the earliest opportunity supply and install the guides, designated S1 having regard to the following conditions beyond his control:

(i) The spillway concrete works are programmed to be completed on or before 30th November 1982 provided embankment closure has been effected. This date may be varied under the provisions of Wivenhoe Dam Stage III Contract No. 2120.

(ii) After completion of the spillway works under Contract 2120, the dam will be capable of storing water and the reservoir level will be allowed to increase to EL 57, where it will be controlled while the reservoir inflow is within the capaity of the river outlet works. The capacity of the river outlet works at reservoir level of EL 57 is approximately 4,320,000 cubic metres per day. During significant inflows the reservoir EL may rise and discharge over the spillway crest. Possible reservoir behavior based on an historical 1 in 5 inflow hydrograph is given in Appendix II.

(c) Installation and commissioning of all hydraulic and control equipment in the winchroom shall be complete prior to the commencement of the installation of the first radial gate in bay S2.

(d) In any bay the Contractor shall have the hydraulic winches and associated control equipment operable prior to the installation of the gate that is to be suspended on the winches.

(e) The Contractor will be permitted to use the bulkhead gate to protect his works subject to the provisions of these sub-clauses. The Contractor is to maintain the bulkhead gate and make good any damage caused to the gate by way of his operations.

(f) At any time no more than one bay is to be obstructed by the bulkhead gate, falsework, any other structures or objects, as required by the Contractor, which in the opinion of the Engineer cannot be removed rapidly to allow the passage of flood waters.

(g) The Contractor shall erect the radial gates in bays designated S2, S4, S3, S5 and S1 in that order.

(h) On completion and commissioning of each gate, the control of the gate will be at the direction of the Engineer. The Contractor shall maintain the gate in an operable condition until the completion of the Contract.

(i) Excepting for the duration of the erection of the gate in bay S1 all completed gates will be held in the open position when not in use. Each completed gate will be exercised by closing and opening once per month by the Contractor in the presence of the Engineer.

(j) Hydraulic winches which have been installed but not connected to their respective radial gate shall be run through a complete operating cycle once per fortnight.

(k) For the erection of the gate for bay S1, all completed gates will be held in the down position and the bulkhead gate installed in bay S1 to enable reservoir pondage above EL 57 to commence.

No. 7141.

MANUAL

FOR

OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR SOMERSET DAM AND WIVENHOE DAM AND SPLIT-YARD CREEK DAM DURING PERIOD OF CONSTRUCTION OF WIVENHOE DAM

I, Neville Thomas Eric HEWITT, Minister for Water Resources in the State of Queensland do hereby approve and issue the following manual, and declare that the procedures contained herein shall be the operational procedures in relation to Somerset Dam, Wivenhoe Dam and Split-Yard Creek Dam pending the completion of Wivenhoe Dam.

Dated this nineteenth day of February 1980 at Brisbane.

[redacted]

N.T.E. HEWITT.

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APPENDICES

1.0 INTRODUCTION

1.1 Meaning of Terms

In this Manual, save where a contrary intention appears -

"Advisory Committee" or "Brisbane and Area Water Board Advisory Committee" means the Advisory Committee established pursuant to Section 21 of the *Brisbane and Area Water Board Act* 1979, as constituted at the material time;

"Brisbane and Area Water Board" means the body corporate constituted by that name pursuant to Section 9 of the *Brisbane and Area Water Board Act* 1979;

"Brisbane City Council" means Brisbane City Council under and within the meaning of the *City of Brisbane Act* 1924-1977;

"Co-ordinator-General" means the corporation sole preserved, continued in existence and constituted under the *State Development and Public Works Organization Act* 1971-1979 under the name and style The Co-ordinator-General;

"Dams" means to which this Manual applies that is Somerset Dam, Wivenhoe Dam, Split-Yard Creek Dam;

"Operator" means the person or his delegate designated pursuant to Section 2.2 of this Manual under whose general direction the procedures contained in this Manual shall be carried out;

"Power station" or "hydro-electric power station" means the Wivenhoe Pumped Storage Hydro-electric Power Station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"The Commissioner of Water Resources" means the corporation sole constituted by that name pursuant to Section 8 of the *Water Resources Administration Act* 1978;

"The Queensland Electricity Generating Board" means the body corporate constituted by that name pursuant to Section 79 of the *Electricity Act* 1976;

"The State Electricity Commission" means the corporation sole constituted by that name pursuant to Section 9 of the *Electricity Act* 1976.

"A.H.D." means Australian Height Datum.

1.2 Purpose of Manual

The purpose of this Manual is to define standard procedures for the operation of Somerset Dam, Wivenhoe Dam and Split-Yard Creek Dam for flood mitigation purposes during the period of construction of Wivenhoe Dam.

Specific procedures for this period are needed in order to provide as much protection as possible for Wivenhoe Dam and the Wivenhoe Pumped Storage Power Station during phases of construction when these structures might be susceptible to flood damage.

At the same time, the procedures must not endanger the safety of Somerset Dam, nor cause any worsening of flood problems in downstream areas, particularly in the Local Authorities of Brisbane City, Ipswich City, and Moreton Shire.

1.3 Legal Authority

Under the provisions of Sections 32-35 of the *Wivenhoe Dam and Hydro-Electric Works Act* 1979 (Appendix 'A') and Sections 106-108 of the *Brisbane and Area Water Board Act* 1979 (Appendix 'B'), the Brisbane and Area Water Board Advisory Committee has caused to be prepared this Manual of operational procedures in relation to each reservoir within the project and the reservoir behind Somerset Dam for the purpose of flood mitigation pending completion of the Wivenhoe Dam Project.

1.4 Scope of Manual

The operational procedures in this Manual shall apply to the operation of Somerset Dam, Wivenhoe Dam, and Split-Yard Creek Dam subject to the following:-

(i) The operational procedures which apply to the operation of Somerset Dam and which are specified in Section 5.1 of this Manual shall be effective throughout the period defined in Section 1.5;

(ii) The operational procedures which apply to Wivenhoe Dam shall become effective following commissioning of the first spillway gate installed;

(iii) The operational procedures which apply to the operation of Split-Yard Creek Dam shall cease to have effect from such time as the Wivenhoe Dam Pumped Storage Power Station and Split-Yard Creek Dam is vested in The Queensland Electricity Generating Board in accordance with Section 17 of *Wivenhoe Dam and Hydro-Electric Works Act* 1979.

1.5 Period of Effectiveness

The procedures contained in this Manual shall have effect on and from the date on which the Manual is approved by the Honourable the Minister for Water Resources, and shall remain in force until the date declared by Order in Council effecting the transfer of all property being part of or relevant to the Wivenhoe Dam Project to Brisbane and Area Water Board in accordance with Section 10 of the *Wivenhoe Dam and Hydro-Electric Works Act* 1979.

1.6 Observance of Flood Manual

This Manual contains the operational procedures for flood mitigation purposes of The Co-ordinator-General, the Commissioner of Water Resources as delegate for the Co-ordinator-General for construction of Wivenhoe Dam and Split-Yard Creek Dam, Brisbane City Council, and Brisbane and Area Water Board in respect of Somerset Dam, Wivenhoe Dam and Split-Yard Creek Dam pending completion of Wivenhoe Dam Project and shall be observed by each of them and the employees of each of them.

1.7 Provision for Variations to Manual

If any one of The Co-ordinator-General, the Commissioner of Water Resources, Brisbane City Council, or Brisbane and Area Water Board is of the opinion that any requirement of this Manual does not meet the requirements of the respective Authority, or for some other reason should be amended, the Authority shall make a submission to the Brisbane and Area Water Board Advisory Committee setting forth those circumstances and the exact nature of the amendment, alteration or variation sought.

If the Advisory Committee is of the opinion that the procedures contained in this Manual should be amended, altered or varied, then it shall submit a recommendation to the Honourable the Minister for Water Resources setting out the circumstances and the exact nature of the amendment, alteration or variation sought.

Any amendment, alteration or variation to the procedures in this Manual recommended by the Advisory Committee shall take effect on and from the date on which the recommendations are approved by the Honourable the Minister for Water Resources.

1.8 Use of Imperial Units

Until such time as the method used for measuring water level at Somerset Dam has been transferred to metric values based upon A.H.D., the operator shall refer to water levels of Somerset Dam by using imperial units based on Somerset Dam Grid Datum.

2.0 CONTROL OF OPERATIONS

2.1 Control by Operator

The control of operations of the dams listed in Section 1.2 of this Manual for the purposes of flood mitigation shall be exercised by the Operator in accordance with the provisions of this Manual.

2.2 Designation of Operator

For the purposes of this Manual, the Operator shall be the Chief Engineer and Manager of the Water Supply and Sewerage Department of the Brisbane City Council or his nominee.

2.3 Responsibilities of Operator

Before adopting an operational procedure to be applied to any flood, the Operator shall seek and shall take account of all relevant information available to him.

Except insofar as the Operator has discretionary powers in accordance with Section 2.4 of this Manual, the Operator shall ensure that the operational procedures for the dams shall be those specified in this Manual.

2.4 Discretionary Powers of Operator

It is recognized for the purposes of this Manual that no two floods in the Brisbane River system are exactly alike and that the operational procedures set out in this Manual are based upon the most common behaviour observed in the river system over a period of ninety years. It is therefore necessary for the Operator to have considerable latitude in the method of operation of Somerset Dam to cope with unusual flood occurrences.

If, in the opinion of the Operator, based on information available to him and based on his professional experience, he deems it necessary to depart from the procedures set out in Part 5 and Appendix E of this Manual, he is empowered to adopt such other procedures as he considers necessary to meet the situation, provided that the Operator shall observe the objectives set out in Part 3 of this Manual when exercising such discretionary powers.

2.5 Report

The Operator shall prepare a report to the Advisory Committee after each flood.

If the Operator exercises his discretionary powers in accordance with Section 2.4 of this Manual, his report shall contain details of the procedures used and the reasons therefor.

3.0 FLOOD MITIGATION OBJECTIVES

3.1 General

The objectives of the flood mitigation procedures stated in this Manual are governed by the following considerations listed in descending order of importance:-

(a) Structural safety of dams;

(b) Optimum protection of urban development in the Lower Brisbane River;

(c) Capacity of the dams to deal with closely spaced floods;

(d) Minimum disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries;

(e) Minimum disruption to navigation in the Brisbane River.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in flood mitigation operations.

3.2.1 Somerset Dam

The structural safety of Somerset Dam is of paramount importance. Structural failure of Somerset Dam could have catastrophic consequences firstly due to the magnitude of the damage which would be caused downstream to Wivenhoe Dam, the Power Station, and the cities of Brisbane and Ipswich and secondly, due to the loss of the major water supply source for Brisbane and Ipswich.

3.2.2 Wivenhoe Dam

Wivenhoe Dam cannot be accorded a fixed priority in the list of objectives stated in Section 3.1. Initially it should be given a priority similar to the reduction of flooding in Brisbane and Ipswich. Under certain circumstances it may be necessary to trade off damage in the urban areas against damage to Wivenhoe Dam. As construction of Wivenhoe Dam proceeds the structural safety of the Dam will assume a greater importance and late in the construction period the Dam will require a priority equivalent to that of Somerset Dam.

The conditions at Wivenhoe Dam at all stages of construction should be taken into account in determining operational procedures.

3.2.3 Split-Yard Creek Dam

Split-Yard Creek Dam is not susceptible to damage from flows in the Brisbane River. Structural failure of this dam could not affect the safety of either Somerset or Wivenhoe Dams and its storage capacity is so small, complete failure of the dam would result in only minor damage to rural areas but could damage bridges or the new Northbrook-Bryden Road.

The emergency spillway discharges into Lake Wivenhoe. The catchment of Split-Yard Creek Dam is so small that the resulting spillway discharge could cause only negligible damage to Wivenhoe Dam during certain parts of the construction phase.

In the circumstances the safety of Split-Yard Creek Dam cannot be accorded any priority in connection with the operation of Somerset Dam or Wivenhoe Dam.

3.3 Protection of Urban Development

3.3.1 Flood Plain - Urban Areas

The prime purpose of incorporating flood mitigation measures into Somerset Dam and Wivenhoe Dam is to alleviate flooding in the urban areas of the flood plain of the lower Brisbane River from Mt. Crosby to Moreton Bay.

3.3.2 Wivenhoe Pumped Storage Power Station

The power station is susceptible to flood damage during the early period of construction. During later periods of construction, the susceptibility decreases. The protection of the power station shall be accorded the same priority as the mitigation of floods in Brisbane and Ipswich.

3.4 Closely Spaced Floods

Historical records show that there is a significant probability of two flood producing storms occurring in the Brisbane River system within a short time of each other. In order to be prepared to meet such a situation the stored flood waters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles.

The prolonged discharges resulting from the emptying of the flood compartments of the dams have little impact on the urban reaches of the Brisbane River. These reaches of the river can carry a discharge which will not affect buildings and bridges in Brisbane but which will cause the Brisbane Valley Highway to be closed at Fernvale and which cause the submergence of bridges of other main roads and Local Authority roads.

3.5 Disruption to Rural Areas

Rural areas can suffer two types of flooding from the flood mitigation operations of dams. In the first place, a flood mitigation dam can flood land and communications which would never have been flooded if the dam had not existed. This situation particularly applies upstream of the dam. Downstream of such a dam the flood mitigation operations usually result in a reduction of peak flood levels but the emptying of the flood pondages causes a prolonged flooding of low lying land and bridges etc. compared with the conditions that prevailed before the dam was built; such prolonged flooding can affect a major rural area, not only the riverside properties.

3.6 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lowest priority but it is closely related to minimum feasible flooding of rural areas. The effect of flood flows upon navigation in the river varies widely. Large ships can be manoeuvered in the river at considerable flows whilst coal and coral barges and gravel dredges are affected by lower flows and the Moggill Ferry is affected by very low flows.

Objectives (c), (d) and (e) in Section 3.1 are closely related and all are optimised by a short emptying period for the flood pondages of the dams.

4.0 FLOOD CLASSIFICATION

4.1 Categories of Flooding

For the purposes of this Manual, five (5) magnitudes of flooding shall be recognized. These are:

(a) Small fresh - Causes no problem to Wivenhoe Dam during construction. Affects low level bridges e.g. Macfarlanes Bridge.

(b) Large fresh - Causes minor damage at Wivenhoe Dam during final stage of construction. Affects moderately low level bridges e.g. Marshalls Bridge; Fernvale Bridge and Wivenhoe Bridge.

(c) Small flood - Submerges all bridges except the new O'Sheas Crossing Bridge - inundate low lying areas of Ipswich and Brisbane.

(d) Medium flood - Causes extensive flooding in Brisbane and Ipswich.

(e) Major flood - Causes extensive damage in Brisbane and Ipswich.

These descriptions are to be used as a matter of convenience in describing flood situations. There are no firm divisions between the categories, each merging into the adjacent ones.

4.2 Definitions of Categories

The five magnitudes of flooding shall be defined according to the Tables C1, C2 and C3 in Appendix C for the reference gauge locations shown therein.

4.3 Reference Gauges

All of the reference gauge locations shown in Appendix C with the exception of Brisbane City gauge, Wivenhoe Damsite and Marshalls Bridge on the Stanley River, are equipped with river height gauges of the Brisbane Valley Flood Warning Radio Telemetry System. This system is at present owned jointly by the Bureau of Meteorology and Brisbane City Council. All data from the system is available to both organisations. The Brisbane City gauge readings are remotely indicated to the Bureau of Meteorology and are readily available. The Wivenhoe Damsite gauge is read by field staff of the Queensland Water Resources Commission and is available depending on radio and telephone reception. The Marshalls Bridge gauge is read by the staff at Somerset Dam. When access to this gauge is cut by flooding at Silverton Gully, levels are read at the reinstated Silverton gauge.

The location of the above gauges are shown on Fig. C1 of Appendix C.

The tables listed in Appendix C give the best present values of flood gauge readings and flows for the above five flood categories at key locations on the Brisbane River and its tributaries. As relatively few flow gaugings have been made at a number of key locations, the values shown in Appendix C are the best estimates at present available and are subject to amendment following further flow rating measurements or following further hydrological calculations.

The values shown in Appendix C are grouped in accordance with the most common areas of the catchment in which flooding originates.

5.0 DAM OPERATING PROCEDURES

5.1 Somerset Dam

5.1.1 Introduction

Somerset Dam is capable of being operated in a number of ways, each of which will reduce flooding in the Brisbane River downstream of the junction of the Stanley and Brisbane Rivers, depending on the part of the catchment in which the flood originates and depending, also, on the height or magnitude of the flood.

5.1.2 Flood Magnitude and Initiation of Procedures

The three most important indications of probable flood magnitudes are received from the Woodford gauge on the Stanley River, the Watts Bridge flood gauge on the Upper Brisbane River and the Lyons Bridge flood gauge on Lockyer Creek, together with such rainfall data as may be available from the Brisbane Valley Flood Warning Radio Telemetry System and from the Bureau of Meteorology.

In the case of the Upper Brisbane River above the Stanley River junction, additional and earlier flood levels may be available from the Gregors Creek gauge of the Radio Telemetry system and from Moore, should a river height gauge of the Telemetry System be located there in the future. Similarly, advanced warning may be given from Glenore Grove on Lockyer Creek should a river height gauge of the Telemetry System be located there in the future.

Information from the Stanley River upstream of the Woodford gauge is not representative of the degree of flooding.

The peak flood levels at Lyons Bridge on Lockyer Creek and Watts Bridge on the Upper Brisbane River are frequently related in time; the Lyons Bridge peak level frequently occurring within six to nine hours of the peak level at Watts Bridge. The peak flood levels at Woodford, however, are randomly related in time to the peak levels of the other two gauges.

Nevertheless, the peak flood level at the Woodford gauge is a good indication of the volume of the flood from the Stanley River catchment which will enter Somerset Dam. The Woodford peak level is also an indicator of the flooding that will occur at Kilcoy with Somerset Dam being operated in its most usual manner as follows:-

Peak Flood Level at Woodford	Flood Volume Ml	Flooding at or near Kilcoy
5.0 metres	175 500	Mary Smokes Bridge Submerged
6.8 metres	367 500	Water under houses near Kilcoy
8.0 metres	525 000	Some houses submerged
>8.0 metres	1 085 000 (1893)	More houses submerged

The flood storage at Somerset Dam above Permanent Water Supply Level (R.L. 325 ft.) is 538 000 Ml.

5.1.3 Initial Action

Upon indications being received of an imminent flood, the flood control operation of the dam shall commence with the storing of the whole flow of the Stanley River in Somerset Dam, whilst an assessment is made of the origin and magnitude of the flood.

5.1.4 Rules for Valve Operations

The following rules shall be observed in the opening and closing of regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes:

	Minimum Interval between successive OPENINGS	Minimum Interval between successive CLOSURES
REGULATORS	Half-Hour	One Hour
SLUICE GATES	Two Hours	Three Hours
CREST GATES		
Lake Level:		
<R.L. 348 ft.	Two Hours	In general, the gates are not normally closed until the reservoir level has fallen below the fixed concrete crest of the spillway at R.L. 325 ft.
>R.L. 348 ft.	Three Hours	

5.1.5 Normal Operating Procedures

When the preliminary estimation of the degree of expected flooding has been made, the operational procedures set out hereunder shall be used at Somerset Dam.

It is essential that the operation procedures adopted should not endanger the safety of Somerset Dam. Within this constraint, the Operator shall in the first instance adopt procedures for the operation of Somerset Dam such that the level of flow at Wivenhoe Dam site does not reach the level at which damage occurs. If this cannot be achieved the Operator shall endeavour to operate Somerset Dam so that the discharge at Wivenhoe Dam site will be contained within the range of flows which will cause only minor damage.

As the magnitude of the expected flooding increases, the procedures to be adopted commence with Procedure A and extend through to Procedure D as follows:

Procedure A:

Water is to be released from Somerset Dam onto the flow from the Upper Brisbane River such that Murrumba Bridge is not submerged (Caboonbah gauge less than 4.0 metres). In order to open Macfarlanes Bridge as soon as possible, releases are to be limited to two regulators (140 cubic metres per second) when Watts Bridge level has dropped to 3.5 metres, provided that the water level in Somerset Dam is less than 327.4 ft. (Somerset Dam Grid Datum).

Procedure B:

Water is to be released from Somerset Dam in such a way that Marshalls, Wivenhoe and Fernvale Bridges are not submerged unnecessarily (Caboonbah gauge less than 7.2 metres). If Fernvale Bridge is submerged by the natural flow of the Brisbane River, the releases from Somerset Dam may be increased in such a way that the Lowood peak flood level does not exceed 9.5 metres. (This prevents Mt. Crosby Weir Bridge from being submerged. All other bridges except O'Sheas Bridge will be submerged.)

Procedure C:

Water may be released from Somerset Dam on to the rising limb of the Brisbane River flood provided that care is taken not to prematurely submerge Macfarlanes Bridge, Murrumba Bridge or Marshalls Bridge. As the peak of the flood from the Upper Brisbane River reaches Watts Bridge, the releases from Somerset Dam are to be shut down and then opened up again after the peak of the flood from the Upper Brisbane River has passed the junction of the Brisbane and Stanley Rivers. The releases are to be regulated to empty the flood storage within four (4) days, without increasing peak flood levels downstream of the junction of the Stanley and Brisbane Rivers.

Procedure C1:

Water is to be released from Somerset Dam at approximately half the rate of inflow to Somerset Dam for the preceding three hours. As the peak of the flood from the Upper Brisbane River approaches Watts Bridge, the releases are kept constant and are increased after peak of the flood has passed the junction of the Brisbane and Stanley Rivers. The flood storage of Somerset Dam is emptied within four (4) days.

Procedure D:

Water is to be released from Somerset Dam on to the rising limb of the flood from the Upper Brisbane River. As the peak of the flood from the Upper Brisbane peak approaches Watts Bridge, the releases from Somerset Dam are to be reduced, but not completely shut down. Once the peak of the flood from the Upper Brisbane River has passed the junction, the releases from Somerset Dam are to be increased as flood contributions from the Upper Brisbane River and Lockyer Creek drop. The releases are then to be regulated to empty the flood storage of Somerset Dam within five (5) days, without increasing flood levels in the Brisbane River below the Stanley junction.

Appendix D gives locations, and submergence flow for the bridges on the Brisbane and Stanley Rivers affected by various modes of operation of Somerset Dam. It should be noted that Northbrook, Macfarlanes, Murrumba and Wivenhoe Bridges will all be submerged by the waters of Wivenhoe Dam and will be abandoned as stage storage increases.

The above operating procedures (A, B, C, C1, and D) are summarised in Table E1 of Appendix E. The discharge capacities which can be commanded for various storage levels of Somerset Dam are listed in Table F1 of Appendix F. The operating procedure is indicated for various combinations of predicted peak flood levels at Watts Bridge, Woodford and Lyons Bridge flood gauges and the resultant flood levels at Wivenhoe Dam site are shown for a range of conditions before the dam is completed.

The bridges likely to be submerged by each of the sets of conditions are also shown.

5.1.6 Emergency Procedure

In the event of all communication being lost between the Operator and Somerset Dam, the officer in charge at Somerset Dam shall carry out the following procedure -

Store all runoff from the Stanley River initially in Somerset Dam and observe the level of the Brisbane River by the backwater level at Marshalls Bridge.

When the water level is two metres below the bridge and rising, start opening regulators at half hour intervals until all are opened. When water is 0.5 metres over the bridge and rising, one sluice is to be opened. From this time on, the level of the Brisbane River is to be observed by backwater in the Stanley River. Additional sluices may be opened up to a limit of four sluices. (Total discharge 1100 cubic metres per second). As the Brisbane River peak appears to be arriving at the junction, as indicated by backwater levels, the releases are to be shut down and opened up again after the peak has passed the junctions. The releases are to be such that the flood storage will be emptied within 4-5 days without producing a secondary peak higher than the flood peak.

It is recognized that the progressive completion of the roads and bridges necessary to replace those that will be flooded by the waters of Wivenhoe Dam will allow the staff at Somerset Dam to gain flood free access to the Brisbane River at O'Sheas Bridge and to the Watts Bridge river height gauge of the Radio Telemetry System. As access is progressively available to these two locations, the above emergency ruling will be amended by substituting the level at O'Sheas Bridge or Watts Bridge as the case may be, for the observations of backwater in the Stanley River to assess the flood levels in the Upper Brisbane River.

Further completion of the deviation roads for Wivenhoe Dam will finally ensure that road access is available between Somerset Dam and Wivenhoe Dam at all times except during the peaks of major floods.

5.2 Wivenhoe Dam

During the period of construction prior to the commissioning of the first spillway gate regulation of floods can be exercised at Somerset Dam only; no regulation can be exercised at Wivenhoe Dam.

Once commissioning of gates commences, some degree of regulation may be exercised at Wivenhoe Dam.

Reference should be made to information supplied by the Commissioner of Water Resources in Appendix G of this Manual.

This information will be updated by the Commissioner of Water Resources from time to time.

5.3 Split-Yard Creek Dam

The Operator is not required to initiate any operational procedures with respect to Split-Yard Creek Dam.

6.0 COMMUNICATIONS

6.1 Information for Operator

It is the responsibility of the Operator to ensure that he is supplied with current information concerning the construction programme at Wivenhoe Dam and the Road Relocation Programme.

(i) <u>Wivenhoe Dam Progress</u>

The Commissioner of Water Resources shall provide the Operator with the following information:

(a) A written progress report on the status of construction at Wivenhoe Dam at intervals not greater than 3 months during the period 1st April to 3rd October and at intervals not greater than a month during the period 1st November to 31st March;

(b) A written report at any intervening period at which a stage of construction is reached whereby the effect of a flood upon the structure would be altered from that previously pertaining;

(c) The reports shall include the estimated discharge below which it is considered that no damage will occur to Wivenhoe Dam, and the estimated discharge below which it is considered that only minor damage will occur;

(d) A report (either oral or written) containing information which, at any time, the Operator considers essential for the purposes of this Manual, or which the Commissioner of Water Resources considers should be brought to the attention of the Operator.

Any oral report shall be confirmed in writing as soon as possible.

(ii) <u>Progress on Road Relocation Programme</u>

The Co-ordinator-General shall advise the Operator concerning the status of the construction programme for the relocation of roads and bridges throughout the area of the Wivenhoe Dam project at intervals of not more than three months and shall advise the Operator of the minimum levels of such roads.

This information shall also be provided at any time upon the request of the Operator.

(iii) Progress on Power Station Construction

The Co-ordinator-General shall advise the Operator concerning the status of the construction programme for the Wivenhoe Dam Pumped Storage Hydro-electric Power Station and shall inform the Operator concerning the effect which floods at various levels shall have upon the works.

This information shall be reported to the Operator at intervals of not more than three months or upon the request of the Operator.

6.2 Communications between Operator and Dams

The Operator shall ensure that adequate channels of communication exist between himself and site staff at all dams covered by this Manual.

It is the duty of the Operator and the Co-ordinator-General, Brisbane City Council, the Commissioner of Water Resources and Brisbane and Area Water Board to negotiate and consult with each other concerning the provision of adequate communication facilities between the Operator and Dams at all times including emergency situations when normal communication facilities may be unavailable. If no agreement can be reached on any matter pursuant to this clause the matter shall be decided by the Co-ordinator-General.

6.3 Staff on Duty

When, in the opinion of the Operator, a flood situation is imminent, he shall:

(i) ensure that he has staff available to communicate with the dam sites and with other agencies;

(ii) advise the Commissioner of Water Resources, the Brisbane City Council, the Co-ordinator-General's Department and the State Electricity Commission of the need for those agencies to have staff on duty for communication purposes and for the provision of information, including assessments of safety of structures.

It shall be the responsibility of the above agencies to ensure that appropriate staff is available for duty.

6.4 Communication with Public

The Operator shall ensure that information shall be forwarded to those agencies whose duty it is from time to time to provide warnings and information to the public during emergency situations.

6.4.1 Liability

The provisions of Section 34 of the *Wivenhoe Dam and Hydro Electric Works Act 1979* shall apply to the Operator, and all other persons carrying out his instructions on providing him with information and data.

APPENDIX 'A'

EXTRACT FROM WIVENHOE DAM AND HYDRO ELECTRIC WORKS ACT 1979

32. Operational procedures for flood mitigation. During the course of construction of the Wivenhoe dam project the Advisory Committee constituted under the *Brisbane and Area Water Board Act 1979* shall cause to be prepared a manual of operational procedures in relation to each reservoir within the project and the reservoir behind Somerset Dam for the purpose of flood mitigation pending completion of the Wivenhoe dam project.

33. Approval and observance of flood manuals. (1) A manual prepared under section 32 and amendments thereof, which may be recommended by the Advisory Committee, shall not be effective until approved by the Minister of the Crown charged with the administration and control of water resources in Queensland.

(2) Operational procedures for the time being specified in a manual prepared under section 32 that is effective shall be taken to be the flood mitigation procedures of the Co-ordinator-General, Brisbane City Council and Brisbane and Area Water Board in respect of each reservoir to which the manual relates, pending completion of the Wivenhoe dam project, and shall be observed by each of them and the employees of each of them.

34. Compliance with flood mitigation procedures avoids liability for damage. No person shall be held liable for damages claimed in respect of loss or injury alleged to arise from -

(a) the carrying out of flood mitigation procedures in accordance with the approved manual (as amended to the material time) prepared under section 32 in relation to the reservoir concerned; or

(b) the inaccuracy of information released on behalf of Brisbane and Area Water Board, the Co-ordinator-General or an employee of either of them concerning anticipated flooding or the anticipated levels of flooding.

35. Liability for escape of water. The Co-ordinator-General, Brisbane and Area Water Board or The Queensland Electricity Generating Board shall not be liable, absolutely or vicariously -

(a) for flooding or sending water upon any land by reason of the construction or provision of any works, being part of the Wivenhoe dam project or the hydro-electric project; or

(b) for escape of water from headworks under its control or from works being constructed, provided or controlled by it or on its behalf,

unless it be shown that the flooding, sending of water or escape is due to or arose out of the negligence of such of them as would, but for this section, be so liable, or of its servants in the construction, maintenance, control or operation of the works or headworks in question or of the flow of water therein.

This section does not apply so as to prejudice the operation of section 34.

APPENDIX 'B'

EXTRACT FROM BRISBANE AND AREA WATER BOARD ACT 1979

106. Operational procedures for flood mitigation. (1) The Advisory Committee shall cause to be prepared a manual of operational procedures in relation to each reservoir that is under the control of the Board for the purpose of flood mitigation and may from time to time cause to be prepared such amendments thereto as the committee considers necessary.

Every manual and all amendments thereto prepared under this subsection shall be submitted to the Board which shall submit the same, with its recommendations, to the Minister within 40 days after it receives the same.

(2) A manual prepared under subsection (1) and amendments thereof, which may be recommended by the Advisory Committee shall not be effective until -

(a) duly approved by the Minister; and

(b) in the case of a manual prepared in relation to a reservoir within the Wivenhoe Dam project and the reservoir behind Somerset Dam, until the manual prepared in relation to such reservoirs, pursuant to the *Wivenhoe Dam and Hydro-electric Works Act 1979* has ceased to be effective.

(3) Before he decides to approve of a manual or any amendment of a manual the Minister shall consult on that issue with the Minister of the Crown charged with the administration and control of water resources in Queensland.

107. Board bound by manual. The operational procedures to be adopted by the Board in respect of each reservoir under its control for the purpose of flood mitigation shall be as provided by the manual prepared under section 106 in relation to that reservoir as duly amended at the material time and such manual, as duly amended at the material time, shall be observed by the Board and its employees.

108. Minister, Board not liable for flood damage. The Minister, the Board and an employee of the Board shall not be liable for damages claimed in respect of loss or injury alleged to arise from -

(a) the carrying out of flood mitigation procedures of the Board if such procedures were carried out under the general direction of a suitably qualified and experienced engineer in accordance with the operational procedures specified by the relevant manual prepared under section 106; or

(b) the inaccuracy of information released on behalf of the Board or by an employee of the Board concerning anticipated flooding or the anticipated levels of flooding.

LOCATION OF FLOOD GAUGES

REFERRED TO IN TABLES C1, C2, C3

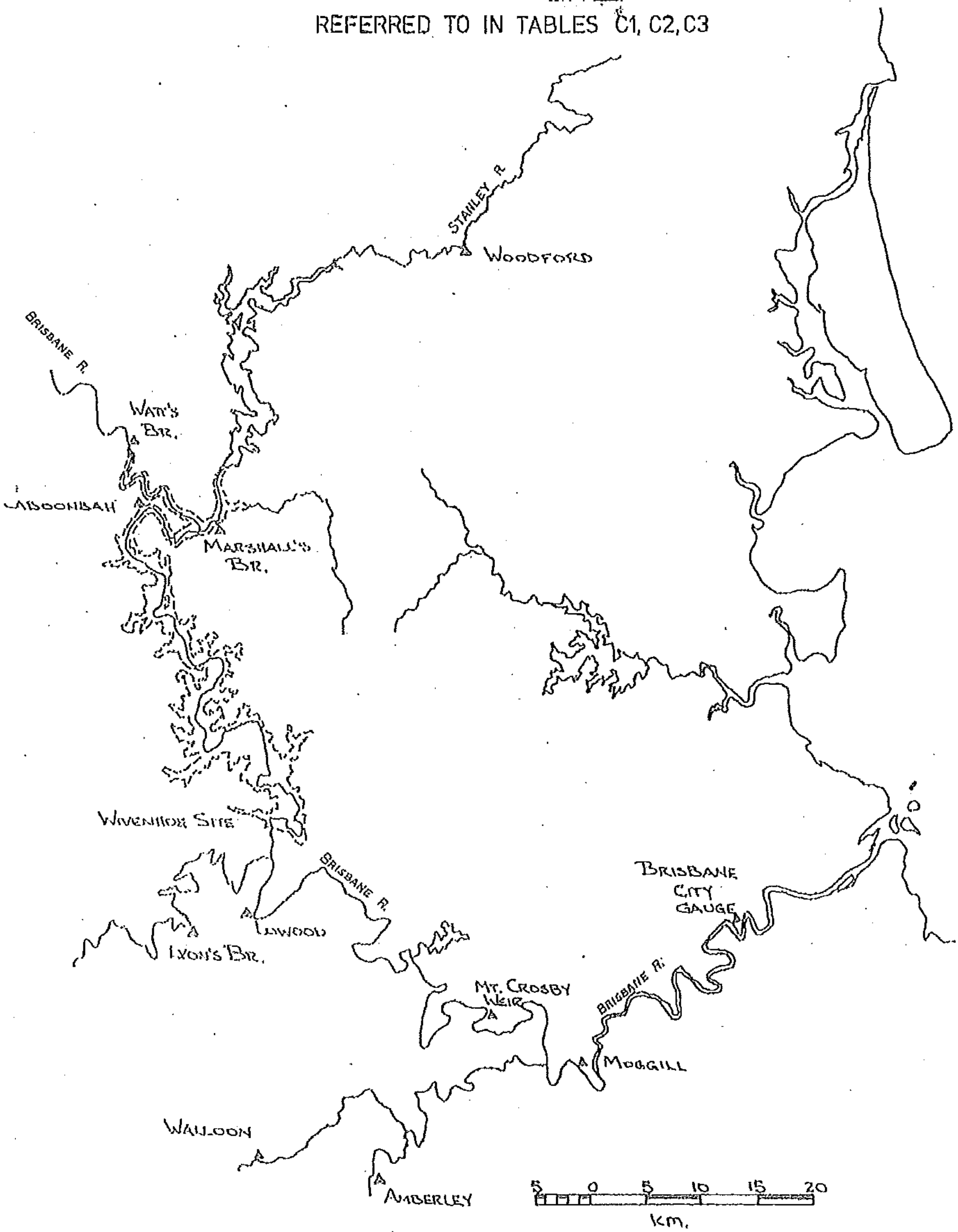


FIG C1

APPENDIX C

TABLE C1

TYPICAL FLOODS IN THE BRISBANE RIVER

I.E. ORIGINATING IN UPPER BRISBANE (SOMERSET DAM CONTRIBUTION TO PEAKS: TYPICAL)

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	cumec	m	cumec	m	cumec	m	cumec	m	cumec
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Mogill	2.0	500	4.0	1280	10.4	4000	14.0	5500	16.5	7000
Amberley	2.3	10	3.0	18	5.8	150	6.7	280	7.5	450
Walloon	2.8	10	3.0	12	5.3	130	5.8	200	6.6	350
Mt. Crosby Weir	8.5	480	10.9	1250	19.0	3700	22.2	5000	24.8	6200
Lowood	4.0	450	8.0	1200	16.0	4100	19.2	5600	20.9	6800
Lyon's Bridge	7.8	75	10.2	150	15.5	600	16.5	800	17.3	1000
Wivenhoe Site	34.2	375	39.5	1050	46.8-49.6	3500	48.6-53.7	4800	51.0-54.5	5800
Caboonbah	3.6	350	7.4	1000	16.3	3300	20.0	4500	22.9	5500
Watts Bridge	4.5	320	7.2	950	13.0	3200	14.8	4400	16.1	5350
Marshall's Bridge		30		50		100		100		150

TABLE C2

FLOODS ORIGINATING IN BREMER AND METROPOLITAN REACHES OF BRISBANE RIVER

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	cumec	m	cumec	m	cumec	m	cumec	m	cumec
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	1.8	400	3.4	1000	9.2	3200	12.0	4500	14.6	5800
Amberley	5.9	160	7.4	400	9.6	1200	10.2	1600	11.1	2200
Walloon	5.2	120	6.4	300	8.3	900	9.1	1200	10.0	1600
Mt. Crosby Weir	7.48	80	7.88	200	9.35	800	11.1	1300	11.6	1400
Lowood	1.3	80	2.3	180	5.8	760	7.7	1250	8.8	1400
Lyon's Bridge	3.5	10	5.5	30	7.2	60	10.2	150	11.3	200
Wivenhoe Site	31.6-34.9	70	32.5-36.3	150	37.5-46.0	700	39.7-50.0	1100	40.2-51.0	1200
Caboonbah	1.3	70	2.0	150	5.5	640	7.6	1050	8.0	1150
Watt's Bridge	2.2	60	2.9	130	5.6	600	7.5	980	7.8	1050
Marshall's Bridge		10		20		40		70		1000

TABLE C3

FLOODS ORIGINATING ON LOCKYER CREEK

Location	Fresh				Flood					
	Small		Large		Small		Medium		Large	
	m	cumec	m	cumec	m	cumec	m	cumec	m	cumec
Brisbane City Gauge	1.1	500	1.2	1280	2.0	4000	3.0	5500	4.0	7000
Moggill	2.0	500	4.0	1280	10.4	4000	14.0	5500	16.5	7000
Amberley	2.3	10	3.0	18	5.8	150	6.7	280	7.5	450
Walloon	2.8	10	3.0	12	5.3	130	5.8	200	6.6	350
Mt. Crosby Weir	8.5	480	10.9	1250	19.0	3700	22.2	5000	24.8	6200
Lowood	4.0	450	8.0	1200	16.0	4100	19.2	5600	20.9	6800
Lyon's Bridge	13.4	350	17.3	1000	21.0*	2800	23.5*	3500	24.0*	4000
Wivenhoe Site	32.0-35.4	100	33.5-37.1	200	42.0-52.0	1300	44.8-58.0	2100	46.0-60.0	2800
Caboonbah	1.5	95	2.4	190	8.5	1250	11.6	1980	13.9	2600
Watt's Bridge	2.5	90	3.6	180	8.1	1200	10.0	1900	11.4	2500
Marshall's Bridge		5		10		50		80		100

* Estimated gauge height.

BRIDGE LOCATIONS
REFERRED TO IN TABLE D1

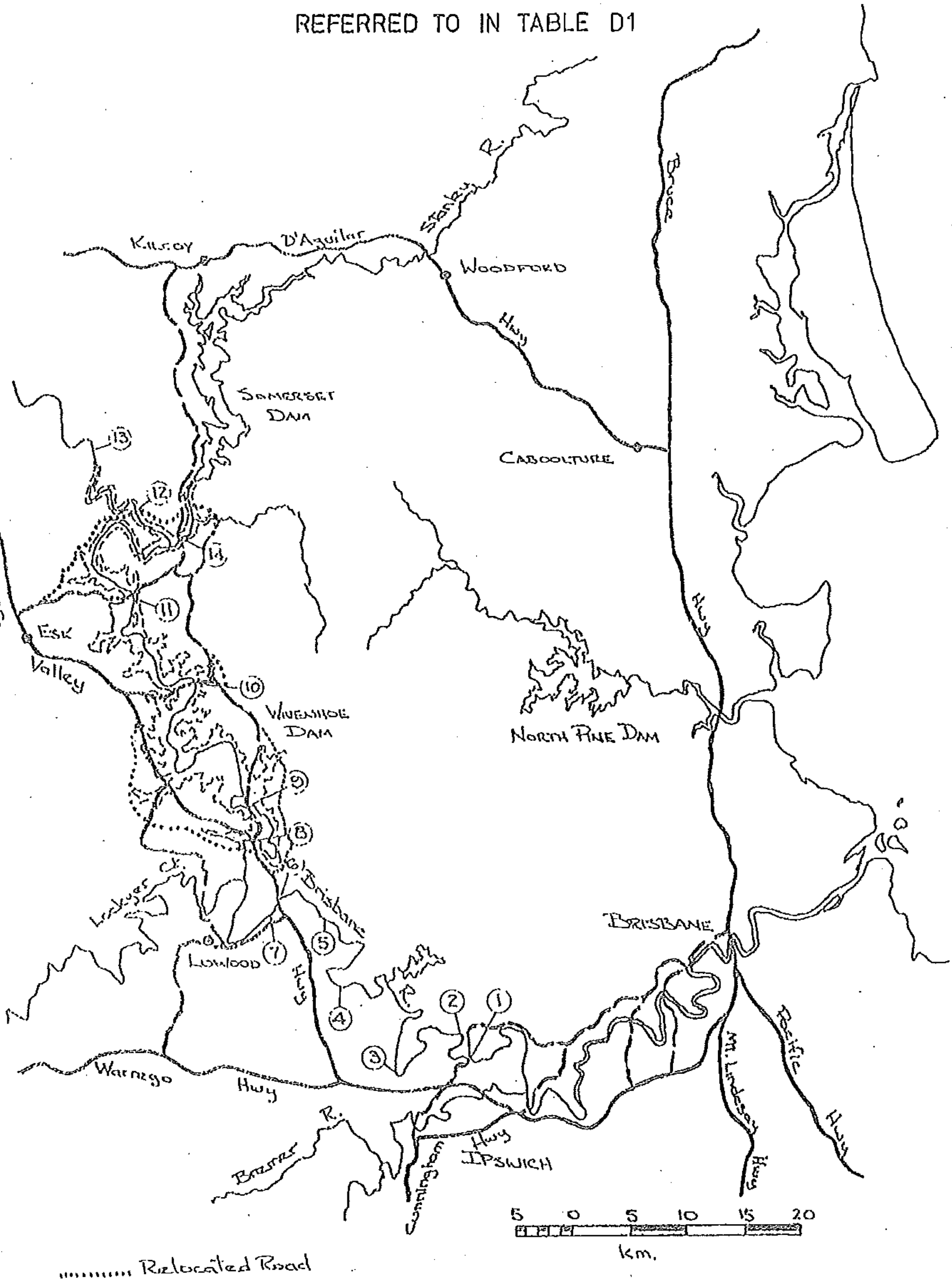


FIG D1
APPENDIX D

APPENDIX 'D'

TABLE D1

SUBMERGENCE FLOWS FOR BRISBANE VALLEY BRIDGES

1.	College's Crossing		100 cumec
2.	Mt. Crosby Weir Bridge		1600 cumec
3.	Kholo Bridge		550 cumec
4.	Noogoora		250 cumec
5.	Savage's Crossing		No Data
6.	Fernvale Bridge		1020 cumec
7.	Twin Bridges		25 cumec
8.	Wivenhoe High Level		≈1000 cumec
9.	Northbrook		250 cumec
10.	Macfarlanes Bridge		310 cumec
11.	Murrumba Bridge		450 cumec
12.	O'Shea's Crossing		≈7500 cumec
13.	Watt's Bridge		400 cumec
14.	Marshall's Bridge no backwater		740 cumec in Stanely River
		450 cumec in Brisbane River	280 cumec in Stanley River
		backwater	850 cumec in Brisbane River

Locations of Bridges shown on Figure D1.

APPENDIX 'E'

TABLE E1

SUMMARY OF OPERATIVE PROCEDURES A, B, C, C1 AND D AS DESCRIBED IN SECTION 5.1.5

Predicted Peak Levels (m.)			Somerset Dam Oper'n	Wivenhoe Damsite H.W.L. (Max.) (m.)				
Watts Br. Gauge	Woodford Gauge	Lyons Br. Gauge		Pre 4/'80	4-11/'80	12/'80 -4/'82	4-10/'82,10-12/'82	Bridges Submerged (Refer to Appendix D)
3.0-4.5	< 5.0	< 10.0	A	34.2	35.2	35.2	Due to the changing conditions at the site during this period the procedure to be used will depend on the diversion capacity available. It may be necessary to store all the run-off in Somerset Dam and release at a low rate over a prolonged time period. Since this is during the dry season, few difficulties should be encountered. The operator of Somerset Dam is to be advised of the diversion capacity at regular intervals.	1,4,5,7,9,10
		10.0-15.0	"	"	"	"		1,3,4,5,7,9,10
		> 15.0	"	34.7	35.6	35.6		"
	5.0-6.8	< 10.0	B	38.3	38.3	38.3		1,3,4,5,7,9,10,11
		10.0-15.0	"	"	"	"		"
		> 15.0	"	38.8	38.8	38.8		"
	6.8-8.0	< 10.0	C1	39.2	39.2	39.2		1,3,4,5,7,9,10,11,(14)
		10.0-15.0	"	"	"	"		1,3,4,5,6,7,9,10,11,(14)
		> 15.0	"	39.5	39.5	39.5		"
	> 8.0	ALL	D	41.8	41.8	41.8		1,(2),3,4,5,6,7,8,9,10, 11,14
4.5-7.2	< 5.0	< 10.0	B	39.2	39.2	39.2		1,3,4,5,(6),7,9,10,11, 13,(14)
		10.0-15.0	"	"	"	"		1,3,4,5,6,7,9,10,11,13,(14)
		15.0	"	39.5	39.5	39.5		"
	5.0-6.8	< 10.0	B	39.2	39.2	39.2		1,3,4,5,(6),7,9,10,11,13, (14)
		10.0-15.0	"	"	"	"		1,(2),3,4,5,6,7,(8),9,10, 11,13,(14)
		> 15.0	"	39.5	39.5	39.5		1-11,13,(14)
	6.8-8.0	< 15.0	C	39.5	39.5	39.5		1-11,13,(14)
		> 15.0	"	39.9	39.9	39.9		"
	> 8.0	ALL	D	41.8	41.8	41.8		1-11,13,14

TABLE E1 CONT.

Predicted Peak Levels (m.)			Somerset Dam Oper'n	Wivenhoe Damsite H.W.L. (Max.) (m.)				Bridges Submerged (Refer to Appendix D)
Watts Br. Gauge	Woodford Gauge	Lyons Br. Gauge		Pre 4/'80	4-11/'80	12/'80 -4/'82	4-10/'82,10-12/'82	
7.2-10.0	<5.0	<15.0	C	43.5	45.0	43.2		1-11,13,14
		>15.0	"	43.8	"	43.6		"
	5.0-6.8	<15.0	C	43.5	45.0	43.2		1-11,13,14
		>15.0	"	43.8	"	43.6		"
	6.8-8.0	<15.0	C	43.5	45.0	43.2		1-11,13,14
		>15.0	"	43.8	"	43.6		"
	>8.0	ALL	D	45.5	47.7	45.2		1-11,13,14
10.0	<5.0	<15.0	C	46.3	48.8	45.9		1-11,13,14
		>15.0	"	46.5	49.5	46.0		"
	5.0-6.8	<15.0	C	46.3	48.8	45.9		1-11,13,14
		>15.0	"	"	49.5	46.0		"
	6.8-8.0	<15.0	C	46.3	48.8	45.9		1-11,13,14
		>15.0	"	46.5	49.5	46.0		"
	>8.0	ALL	D	46.8	49.7	47.0		1-11,13,14

NOTES:

Somerset Dam Oper'n - Operating procedure for Somerset Dam
H.W.L. - Head Water Level
Pre 4/'80 - The period before April 1980
4-11/'80 - The period from April to November 1980
12/'80-4/'82 - The period from December 1980 to April 1982
4-10/'82 - The period from April to beginning of October 1982
10-12/'82 - The period from beginning of October to end of December 1982
( ) - Submergence in doubt

APPENDIX 'F'

TABLE F1

Lake Level Somerset Grid m.	Ft.	Capacity ML	Inflow for 0.1m/h Rise m^3/s	Discharge m^3/s One Reg.	One Sluice	One Spillway Gate	Non Spill	Total Avail. Discharge m^3/s
99.0	325.18	373 600	1 255	68.6	201.1	-	-	1 884
99.5	326.82	396 600	1 308	69.3	203.1	-	-	1 902
100.0	328.46	419 500	1 362	69.8	205	-	-	1 919
100.5	330.10	444 300	1 414	70.4	207	-	-	1 938
101.0	331.74	469 000	1 471	71.0	208.8	-	-	2 002
101.5	333.38	496 100	1 527	71.5	210.7	15.9	-	2 099
102.0	335.02	522 300	1 583	72.1	212.5	28.7	-	2 218
102.5	336.66	551 200	1 641	72.7	214.3	44.0	-	2 357
103.0	338.30	580 000	1 699	73.2	216.1	61.2	-	2 511
103.5	339.94	610 700	1 758	73.8	217.9	80.3	-	2 681
104.0	341.58	641 600	1 817	74.3	219.7	101.2	-	2 864
104.5	343.22	673 400	1 878	74.9	221.4	125.5	-	3 075
105.0	344.86	707 300	1 939	75.4	223.2	153.3	-	3 313
105.5	346.50	742 800	2 000	76.0	224.9	182.4	-	3 562
106.0	348.14	778 300	2 063	76.5	226.7	213.1	-	3 824
106.5	349.78	819 600	2 127	77.0	228.3	245.4	-	4 098
107.0	351.42	862 000	2 191	77.5	230.1	279.4	-	4 385
107.5	353.06	909 000	2 256	78.1	231.7	314.9	1	4 686
108.0	354.70	956 000	2 322	78.6	233.4	352.0	87.4	5 085

NOTES:

Somerset Grid - Somerset Dam Grid Datum

m. - Metres

Ft. - Imperial feet

ML - Megalitres

Column 4 - Inflow rate in m^3/s for a rise of 0.1m/h rise of reservoir level.

m/h - metres per hour

Reg. - Discharge regulator valve of which there are four (4).

Sluice - Sluice gate of which there are eight (8).

Spillway - Overflow section of dam controlled by eight (8) radial gates.

Non Spill - Non spillway section of dam.

m^3/s - cubic metres per second.

APPENDIX 'G'

COPY

QUEENSLAND WATER RESOURCES COMMISSION

12th June, 1979.

The Chief Engineer and Manager,
Water Supply Department,
Brisbane City Council,
BRISBANE Qld. 4000

Dear Sir,

WIVENHOE AND SOMERSET DAMS
MANUAL OF OPERATIONAL PROCEDURES DURING FLOODS

As promised to your Mr. G. Cossins at an informal Committee Meeting on 7th June, 1979, we are forwarding information on Wivenhoe Dam to assist him in producing a draft manual of operational procedures during floods in the Wivenhoe Dam catchment.

Attached to this letter you will find a copy of parts of the Specification for the Stage III construction of Wivenhoe Dam which will be of interest. They relate to the times and methods of closure of the right bank diversion channel and the spillway diversion. The capacity of these channels alone or in combination are given in the attached drawing A3-53325. The attached drawing A3-54746 gives the discharge capacity of the right bank diversion channel combined with the adjacent mesh protected overflow section of the embankment. Also shown on this drawing are the difference between headwater and tailwater level at any discharge and the volume stored between headwater and tailwater. It will be noted that because of the high discharge capacity provided, the difference between headwater and tailwater levels is relatively small and consequently the volume stored is small and is insufficient to cause problems in the event of the partly constructed embankment being breached by floodwaters. Also enclosed herewith is a copy of the rating curve for the Wivenhoe Dam Spillway.

From the point of view of diversion capacity, the construction period for Wivenhoe Dam may be split up into six phases:

(a) Period from the present to April 1980

During this period, the right bank diversion channel will be the only channel available for diversion, but the adjacent section of the embankment has been protected by mesh on the downstream face so as to provide an overflow section approximately 180m wide with a crest at EL 43. The capacity of this diversion combination is shown on drawing A3-54746. It will be noted that the capacity before the crest of the embankment (EL 43) is overtopped is 1 850 m^3/s and that the capacity with only 1 m of water over the crest of the embankment is about 2 200 m^3/s. Overflows exceeding 1 m over the crest of the overflow section are expected to flow over without failure but some damage may be sustained.

(b) Period from April 1980 to November 1980

During this period, the embankment will be built above EL 43 except for the section approximately 50 m adjacent to the right bank diversion channel so that the diversion capacity will be limited to little more than that of the diversion channel alone. The outflow capacity for this case is given conservatively by the curve for the right bank diversion channel on drawing A3-53325.

The capacity with 1 m over the protected embankment (HWL EL 44) is not much over 1 900 m^3/s. However, this reduced capacity occurs during the dry season. During this period the spillway diversion channel will be progressively excavated so that it will provide supplementary diversion during the 1980/81 wet season.

(c) Period from December 1980 to April/May 1982

During this period, both diversion channels are capable of operating. The spillway diversion will only pass water when the headwater comes above EL 33 whereas the right bank diversion channel will operate continuously (bed level EL 26). The capacity of these two channels combined is given in drawing A3-53325. With headwater level at EL 44 the capacity is at least 2 500 m^3/s and with headwater level to EL 56 (the level of the mesh protection beside the right bank channel) the discharge capacity is 9 000 m^3/s.

(d) Closure of Right Bank Diversion Channel
April/May 1982 to September/October, 1982

As explained in the attached Clause 5 of the Specification for the Stage III construction of the dam, closure of the right bank channel will begin by constructing a coffer dam with a crest of EL 35 at its upstream end so as to direct all flow through the spillway diversion. With a headwater level at EL 35, drawing A1-53333 shows that the outflow capacity is only some 75 m^3/s, but the coffer dam has been designed to take overtopping and the downstream toe of the dam in the diversion channel will be built up with mesh protection to withstand overtopping up to a level of EL 53. With headwater level 1 m above EL 53 the discharge capacity of the spillway diversion is nearly 1 600 m^3/s. During this closure phase a major objective in the operation of Somerset Dam during minor floods should be to keep the flows at Wivenhoe Dam below the capacity indicated by drawing A1-53333 which is determined by the level of the closure fill at any given time. The Project Engineer at Wivenhoe Dam would need to inform the Brisbane City Council of the level of the fill at very close intervals.

When the level of the closure fill reaches EL 62, the capacity of the spillway diversion channel will be 3 600 m^3/s with HWL of EL 62. Closure of the spillway diversion channel by concreting the gap can then commence. The closure fill will of course continue to be raised at the same time.

(e) Closure of the Spillway Diversion Channel
September/October 1982 to December 1982

Because of the raising of the closure fill at the same time as the spillway gap is being closed, the outflow capacity of the spillway diversion should not be decreased below the 3 600 m^3/s indicated above. The Project Engineer at Wivenhoe will advise the available outflow capacity at close intervals.

When the gap in the spillway has been concreted to spillway crest level (EL 57), the only remaining openings below crest level are the outlet pipes. These consist of a 3 600 mm dia. pipe with a 1 900 mm branch with a 1 500 mm dia. regulator at the D/S end and a 1 900 mm outlet pipe with a 1 500 mm dia. regulator at the D/S end. The 3 600 mm dia. pipe is initially open at its downstream end and the final closure of the dam consists in blanking off this open end. This should be done by December 1982.

(f) Period from December 1982 to Installation of Gates

It is proposed to have two gates installed and operational by December 1983 and all gates operational by June 1984. During all of 1983 Wivenhoe Dam will therefore behave as a dam with an uncontrolled spillway with crest level of EL 57 and net crest width of 60 m. After June 1984 it will have a fully gate controlled spillway and its operation will be subject to the final manual. Between December 1983 and June 1984 with at least 2 gates operational it will have some control over outflow.

During the gate installation period, the bulkhead gate will be used to protect the gates during critical phases of erection, and any previously commissioned gates should be used in such a manner as to minimise risk of overtopping the bulkhead gate. (The top of the bulkhead gate is at EL 69.) The specification for gate erection will contain a sequence of gate installation which will ensure that risk of damage to partly erected gates will be minimised.

During the gate installation period, when only some of the gates are operational, damage may occur to the plunge-pool downstream of the flip-bucket if the outflow jet is very unsymmetric with respect to the centreline of the spillway, particularly if it is allowed to strike the walls of the plunge-pool. Hydraulic model tests will be performed to indicate the best method of operation under these circumstances.

As gates are commissioned, they will be handed over to the Brisbane Area Water Board's operational staff, who will operate them to mitigate floods while keeping the above guidelines in view.

It should be noted that the above timetable may be changed by circumstances during construction. Any such changes would be notified by the Project Engineer Wivenhoe. It is suggested that reports on the status of the works and capacity of diversion channels should be reported at intervals of one month or more frequently as changes of any consequence occur.

Yours faithfully,

(Signed)
K.D. Nutt

for
W.N. Meredith,
SECRETARY

South East Queensland
WATER CORPORATION
LIMITED

MANUAL

OF

OPERATIONAL PROCEDURES

FOR FLOOD MITIGATION

FOR

WIVENHOE DAM

AND SOMERSET DAM

Revision No.	Date	Amendment Details
0	27 October 1968	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	24 August 1998	Change to page 23
4	6 September 2002	Complete revision and re-issue
5	4 October 2004	Complete revision
6	20 December 2004	Miscellaneous amendments and re-issue

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Preface

Given their size and location, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise hazard to life and property.

Recognising this, the South East Queensland Water Board Act required a manual be prepared of operational procedures for the dams during floods. With changes to the controlling legislation, the manual became an approved flood mitigation manual under *Water Act 2000* (extract in Appendix A).

This Manual is the result of a review of the 2002 revision of the Manual. The South East Queensland Water Corporation is required to review, update the Manual if necessary, and submit it to the Chief Executive for approval prior to its expiry. Any amendments to the basic operating procedures need to be treated similarly.

Prior to the 1998 version of the manual, an expanded flood monitoring and warning radio telemetry network (ALERT) was installed in the Brisbane River Catchment. Additionally, a computerised flood operational model that allows for rainfall and river modelling in real time based on data from the ALERT system was developed, implemented and fully commissioned. The accuracy and reliability of the system during a flood event has now been proven.

The primary objectives have not varied from those defined in the previous manual. These remain ensuring safety of the dams, their ability to deal with extreme and closely spaced floods, and protection of urban areas. The basic operational procedures have also essentially remained the same. Wivenhoe Dam and Somerset Dam are operated in conjunction so as to maximise the overall flood mitigation capabilities of the two dams. The procedures outlined in this Manual are based on the operation of the dams in tandem.

The changes to the 2002 version of the manual have arisen out of the spillway upgrade process for Wivenhoe Dam with the addition of the three bay right abutment fuse plug spillway. The changes enable Wivenhoe Dam to pass a 1:100,000 AEP flood event. The manual covers the provisions introduced to cover flood operations of the dams during the construction period for the spillway upgrade and for flood operations after theses provisions become operational.

1.2 Meaning of Terms

In this Manual, save where a contrary definition appears -

"Act"
means the *Water Act 2000*;

"AEP"
means annual exceedance probability, the probability of a specified event being exceeded in any year.

"Agency"
includes a person, a local government and a department of state government within the meaning of the Acts Interpretation Act 1954;

"AHD"
means Australian Height Datum;

"Bureau of Meteorology"
means the Commonwealth Bureau of Meteorology;

"Chairperson"
means the Chairperson of the South East Queensland Water Corporation;

"Chief Executive"
means the Chief Executive or Director General of the Department of Natural Resources and Mines;

"Controlled Document"
means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Corporation"
means the South East Queensland Water Corporation;

"Dams"
means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

"Dam Supervisor"
means the senior on-site officer at Wivenhoe or Somerset Dam as the case may be;

"EL"
means elevation in metres from Australian Height Datum;

"Flood Operations Engineer"
means the person designated at the time to direct the operations of Wivenhoe Dam and Somerset Dam under the general direction of the Senior Flood Operations Engineer and in accordance with the procedures in this Manual;

"FSL" or "FULL SUPPLY LEVEL"
means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"Gauge"
when referred to in (m) means river level referenced to AHD, and
when referred to in (m^3/sec) means flow rate in cubic metres per second;

"Headworks Operator"
for the purposes of this manual the Headworks Operator is the South-East Queensland Water Corporation and any operator engaged by it, as the context permits

"Manual" or "Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam"
means the current version of this Manual;

"Power Station"
means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"Senior Flood Operations Engineer"
means the senior person designated at the time pursuant to Section 2.1 of this Manual under whose general direction the procedures in this Manual must be carried out;

"South East Queensland Water Corporation"
means South East Queensland Water Corporation Limited, Registered Public Company, ABN 14 008 729 766

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce, so far as practicable, the effects of flooding, by the proper control and regulation in time of headworks under the control of the Corporation, with due regard to the safety of the structures comprising those headworks.

For the purpose of this Manual, the Corporation adopts the policy that the community is to be protected to the maximum extent practical against flood hazards recognising the limitations on being able to:

- identify all potential flood hazards and their likelihood,
- remove or reduce community vulnerability to flood hazards,
- effectively respond to flooding, and
- provide resources in a cost effective manner.

1.4 Legal Authority

This manual has been prepared as a Flood Mitigation Manual in accordance with the provisions of Part 6 Division 2 of the Act.

1.5 Application and Effect

The procedures in this Manual apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall give the protection from liability provided by Section 500 of *Water Act 2000*.

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which this version of the Manual is approved by gazette notice.

The Manual shall remain in force for the period of approval as determined by the chief executive. This approval may be for a period of up to five years.

Before the approval of the Manual expires, the Corporation must review and if necessary update the Manual and submit a copy to the chief executive for approval.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation, and must be applied by the Headworks Operator for the operation of the dams.

1.8 Provision for Variations to Manual

If the Corporation is of the opinion that the procedures in this Manual should be amended, altered or varied, it must submit for approval as soon as practical a request, which is in accordance with the flood mitigation provisions of the *Water Act 2000*, to the Chief Executive setting out the circumstances and the exact nature of the amendment, alteration or variation sought. The Chief Executive may require the Corporation amend the Manual by written notice.

1.9 Distribution of Manual

The Corporation must regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of Controlled Documents are listed in Appendix B. The Corporation must maintain a Register of Contact Persons for Controlled Documents and ensure that each issued document is updated whenever amendments or changes are approved.

Before using this Manual for the direction of flood control, the Headworks Operator must ensure that it is the current version of the Controlled Document.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, the Corporation is responsible for and has the duty for operation and maintenance of Wivenhoe Dam and Somerset Dam.

The Headworks Operator is responsible for operating and maintaining Wivenhoe and Somerset Dams in accordance with this Manual and whilst the South-East Queensland Water Corporation may contract with other parties for the purpose of discharging its responsibilities as Headworks Operator, the Corporation remains responsible to ensure that operators, employees, agents, and contractors comply with this manual in order to retain the protection from liability afforded by Section 500 of the Act. Operators, employees, agents, and contractors also must comply with this Manual to obtain the protection of Section 500 of the Act.

2.1.1 Designation of Senior Flood Operations Engineer

The Headworks Operator must ensure that the procedures set out in this Manual are carried out under the general direction of a suitably qualified and experienced person who shall be referred to hereafter as the Senior Flood Operations Engineer. Only a person authorised in the Schedule of Authorities can give the general direction for carrying out procedures set out in this Manual.

2.1.2 Designation of Flood Operations Engineer

The Headworks Operator must have available or on standby at all times a suitably qualified and experienced Flood Operations Engineer to direct the operation of the dams during floods in accordance with the general strategy determined by the Senior Flood Operations Engineer.

The Headworks Operator must ensure that flood control of the dams is under the direction of a Flood Operations Engineer at all times. Only a person authorised in the Schedule of Authorities can direct the flood operation of the dams.

The Headworks Operator must also employ an adequate number of suitably qualified and experienced persons to assist the Flood Operations Engineer in the operation of the dams during floods.

2.2 Qualifications and Experience of Engineers

2.2.1 Qualifications

All engineers referred to in Section 2.1 must meet all applicable requirements of registration or certification under any relevant State Act, and must hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

2.2.2 Experience

All engineers referred to in Section 2.1 must, to the satisfaction of the Chief Executive, have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

(a) Investigation, design or construction of major dams;

(b) Operation and maintenance of major dams;

(c) Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;

(d) Applied hydrology with particular reference to flood forecasting and flood warning systems.

2.3 Schedule of Authorities

The Corporation must maintain a Schedule of Authorities containing a list of the Senior Flood Operations Engineers and Flood Operations Engineers approved to direct flood operations at the dams during floods. A copy of the Schedule of Authority must be provided to the chief executive by 1st September of each year.

The Headworks Operator shall, as the need arises, nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as Senior Flood Operations Engineers and Flood Operations Engineers. Each new nomination must include a copy of any certificate required under Section 2.2 and a validated statement of qualifications and experience.

The Headworks Operator must obtain the approval for all nominations from the Chief Executive prior to their inclusion in the Schedule of Authorities.

If, in the event of unforseen and emergency situations, no Senior Flood Operations Engineer or no Flood Operations Engineer is available from the Schedule of Authorities, the Headworks Operator must temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.4 Training

The Headworks Operator must ensure that operational personnel required for flood control operations receive adequate training in the various activities involved in flood control operation.

2.5 Dam Operation Arrangements

For the purposes of operation of the dams during times of flood, the Headworks Operator must ensure that:

(a) The operation be carried out under the general direction of the Senior Flood Operations Engineer, and

(b) In the direction of operations which may knowingly endanger life or property, the Senior Flood Operations Engineer must where practical liaise with the Chairperson of the Corporation and the Chief Executive or nominated delegate.

2.6 Responsibilities of the Senior Flood Operations Engineer

The Senior Flood Operations Engineer is responsible for the overall direction of flood operations.

Except insofar as reasonable discretion is provided for in Section 2.8 of this Manual, the Senior Flood Operations Engineer must ensure that the operational procedures for the dam shall be in accordance with this Manual.

2.7 Responsibilities of the Flood Operations Engineer

The Flood Operations Engineer must apply the operational procedures in accordance with this manual and the direction set for flood operations. In so doing, account must be taken of prevailing weather conditions, the probability of follow up storms and the ability of the dams to discharge excess flood waters in the period between rainfall events or in the period from the time of detection of conditions associated with the development storm cells, to the likely time of occurrence of the rainfall.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, based on available information and professional experience, it is necessary to depart from the procedures set out in this manual, the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary to meet the situation, provided that the Senior Flood Operations Engineer observes the flood mitigation objectives set out in Section 3 of this Manual when exercising such reasonable discretion.

Before exercising discretion under this Section of the Manual with respect to flood mitigation operations, the Senior Flood Operations Engineer must consult with such of the following persons as are available at the time that the discretion has to be exercised:

the Chairperson of the Corporation, and
the Chief Executive or nominated delegate.

If not able to contact any of the above within a reasonable time, the Senior Flood Operations Engineer may proceed with such other procedures considered as necessary to meet the situation and report such action at the earliest opportunity to the above persons.

2.9 Report

The Senior Flood Operations Engineer must prepare a report to the Headworks Operator after each event that requires flood operation of the dams and the report must contain details of the procedures used, the reasons therefore and other pertinent information. The Headworks Operator must forward the report to the Chief Executive together with any comments within six weeks of the completion of the event referred to.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operational procedures in this Manual, the following objectives, listed in descending order of importance, are as follows:

(a) Ensure the structural safety of the dams;

(b) Provide optimum protection of urbanised areas from inundation;

(c) Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

(d) Minimise disruption and impact upon Wivenhoe Power Station;

(e) Minimise disruption to navigation in the Brisbane River.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

3.2.1 Wivenhoe Dam

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences.

Wivenhoe Dam is predominantly a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered a major threat to the security of Wivenhoe Dam. Works are being undertaken between May 2004 and December 2005 to build an auxiliary spillway to cope with the 1:100,000 AEP flood event without overtopping of the dam.

3.2.2 Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences.

Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves.

3.2.3 Extreme Floods and Closely Spaced Large Floods

Techniques for estimating extreme floods indicate that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam itself. Such events however require several days of intense rainfall to produce the necessary runoff.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other. In order to be prepared to meet such a situation, the stored floodwaters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles. Typically the Senior Flood Operations Engineer should aim to empty stored floodwaters within seven days after the flood peak has passed through the lower reaches of the Brisbane River. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The discharges should be regulated so as to have little impact on the urban reaches of the Brisbane River taking into account inflows into the river downstream of the dams. However they may result in submergence of some bridges. The level of flooding as a result of emptying stored floodwaters after the peak has passed is to be less than the flood peak unless accelerated release is necessary to reduce the risk of overtopping.

3.3 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas on the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by using the flood-gates to control releases from the dams, taking into account flooding derived from the lower Brisbane River catchments.

The auxiliary spillway being constructed at Wivenhoe Dam in 2004 and 2005 incorporates fuse plugs. Triggering of a fuse plug will increase floods levels downstream. Where possible, gate operations at both Wivenhoe and Somerset dams should be formulated to prevent operation of the fuse plug. This is likely to be only possible when the forecast peak water level for Wivenhoe Dam just exceeds the trigger level for the fuse plug and sufficient time is available to alter releases.

3.4 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, bridges and areas upstream of the dams may be temporarily inundated. Downstream of the dam, bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily. The deck levels of bridges potentially inundated during flood events are shown on the Drawings in Appendix D.

3.5 Provision of Pumping Pool for Power Station

The power station is not affected by the reservoir level in Wivenhoe Dam during floods other than the impacts high tail water levels have on the efficiency of the power station. The power station does however require a pumping pool for operation. The loss of storage by dam failure would render the power station inoperative.

3.6 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lower priority. The effect of flood flows upon navigation in the river varies widely.

Large ships can be manoeuvred in the river at considerable flood flows. On the other hand, barges and dredges are affected by low flows which lower salinity thus decreasing the density of the water which in turn causes craft to sit lower in the water, sometimes bottoming. The Moggill Ferry is also affected by low flood flows.

A short emptying period for the flood storage compartment of the dams is consistent with Objectives (c) and (e) of Section 3.1, which are closely related.

4 FLOOD CLASSIFICATION

For the reference purposes of this Manual, five magnitudes of flooding are classified as follows:

Fresh
This causes only very low-level bridges to be submerged.

Minor Flooding
This causes inconvenience such as closing minor roads and the submergence of low-level bridges. Some urban properties are affected.

Moderate Flooding
This causes inundation of low-lying areas and may require the evacuation of some houses and/or business premises. Traffic bridges may be closed.

Major Flooding
This causes flooding of appreciable urban areas. Properties may become isolated. Major disruption occurs to traffic. Evacuation of many houses and business premises may be required.

Extreme Flooding
This causes flooding well in excess of floods in living memory and general evacuation of whole areas are likely to be required.

Usually a flood does not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted.

(The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia)

5 FLOOD MONITORING AND WARNING SYSTEM

5.1 General

A real time flood monitoring and warning system is established in the Brisbane Valley. This system is based upon an event reporting protocol. A radio telemetry system (ALERT) is used to collect, transmit and receive rainfall and streamflow information. The system consists of more than 50 field stations that automatically record rainfall and/or river heights at selected locations in the Stanley and Brisbane River catchments. Some of the field stations are owned by the Corporation with the remainder belonging to other agencies.

The rainfall and river height data is transmitted by radio telemetry, via repeater stations, to base stations at the head office of the Headworks Operator (and the Corporation). There the data is processed in real time by computer programs to assess what is occurring in the catchments in terms of flood flows and what could occur if weather conditions continued, or changed.

Other agencies with their own base stations can, and do, receive data transmissions direct, and so collect and are able to process rainfall and streamflow information appropriate to their needs.

The real time flood model (RTFM) is a suite of hydrologic and hydraulic computer programs that utilise the real time ALERT data to assist in the operation of the dams during flood events.

5.2 Operation

The Headworks Operator is responsible for operating the computer model provided by the Corporation for flood monitoring and forecasting during flood events to optimise flood gate operations and minimise the impacts of flooding.

It is the responsibility of the Corporation to maintain and keep calibrated its own equipment; and to enter into such arrangements with other agencies or to provide such further equipment as the Corporation deems necessary for the Headworks Operator to properly operate the computer model for flood monitoring and forecasting.

A system such as this is expected to improve over time due to:

- improved operation and reliability with experience,
- improved calibration as further data becomes available,
- software upgrades, and
- the number, type and locations of sensors being varied.

A regular process of internal audit and management review must be maintained to achieve this.

A log of the performance of all field equipment necessary to properly operate the computer model must be kept by the Corporation. The log is to also include all revised field calibrations and changes to the number, type and locations of gauges. Entries onto the log are to be notified to the Headworks Operator without delay in writing.

A log of the performance of the system (ALERT and RTFM) must be kept by the Senior Flood Operations Engineer. Any faults to the computer hardware or software, and any faults to field equipment which the Corporation has not advised the Headworks Operator of, are to be notified to the Corporation without delay in writing. The Corporation must promptly attend to the matters under its control and refer other matters to the appropriate agencies.

Whenever the Senior Flood Operations Engineer considers that the performance and functionality of the system can be improved, by whatever means, a recommendation must be made to the Headworks Operator accordingly. The Headworks Operator must promptly consider, act on, or refer such recommendations to the Corporation as it considers appropriate.

5.3 Storage of Documentation

The performance of any flood monitoring and warning system is reliant on accurate historical data over a long period of time. The Senior Flood Operations Engineer must ensure that all available data and other documentation is appropriately collected and catalogued as approved by the Corporation, for future use.

5.4 Key Reference Gauges

Key field station locations have been identified for reference purposes when flood information is exchanged between authorities or given to the public. Should it be deemed desirable to relocate field stations from these locations, or vary flood classification levels, agreement must first be obtained between the Corporation, Headworks Operator, Bureau of Meteorology and the Local Governments within whose boundaries the locations are situated. The locations and gauge readings at which the various classifications of flooding occur are contained in Appendix D.

Gauge boards that can be read manually must be maintained as part of the equipment of each key field station. The Corporation must have procedures to ensure such gauge boards are read in the event of failure of field stations to operate.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, Ipswich City Council and the Brisbane City Council have direct access to the information from field stations for flood assessment purposes. The consultation between agencies is a very important part of the assessment and prediction of flood flows and heights.

The Corporation must ensure that information relative to the calibration of the Corporation's field stations is shared with such agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

The Corporation is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams.

The Headworks Operator is responsible for ensuring that adequate communication exists at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams. Where equipment deficiencies are detected during normal operations, such deficiencies are to be reported within one week to the Corporation for timely corrective action.

6.2 Dissemination of Information

Other agencies have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public. Adequate and timely information is to be supplied to agencies responsible for the operation of facilities affected by flooding and for providing warnings and information to the public. Agency information requirements are generally as shown in Table 6.1.

The Flood Operations Engineer must supply information to each of these agencies during dam releases. For this purpose, the Corporation must maintain a Register of Contact Persons for Information, their means of contact including back up systems, and the specific information, including the timing, to be supplied to each. The Corporation must ensure that each agency receives a copy of the updated Register of Contact Persons for Information whenever amendments are made, but at least every 6 months.

The Corporation, Headworks Operator, Senior Flood Operations Engineer and Flood Operations Engineer must liaise and consult with the agencies with a view to ensuring all information relative to the flood event is consistent, and used and disseminated in accordance with agreed responsibilities.

All enquiries other than provided for in the Register of Contact Persons for Information, either to the Headworks Operator, the Senior Flood Operations Engineer, the Flood Operations Engineer or dam site staff must be referred to the Corporation. The Corporation must provide a mechanism to receive these enquiries from the time it is advised that releases from the dams are likely until flood release operations are completed.

TABLE 6.1 - AGENCY INFORMATION REQUIREMENTS

Agency	Activity	Information Requirement from SEQWC Flood Centre	Trigger
Bureau of Meteorology	Issue of flood warnings for Brisbane River basin	Actual and projected discharges from Wivenhoe Dam Actual and projected discharges from Somerset Dam	Initial gate operations and thereafter at intervals to suit forecasting requirements.
Natural Resources and Mines	Review of flood operations and discretionary powers.	Actual and predicted lake levels and discharges	
Kilcoy Shire Council	Flood level information upstream of Somerset Dam	Actual and predicted lake levels, Somerset Dam	Somerset Dam water level predicted to exceed EL 102
Esk Shire Council	Flood Level information upstream and downstream of Wivenhoe Dam	Actual and predicted lake levels and discharges, Wivenhoe Dam	Initial Wivenhoe Dam gate operation.
Ipswich City Council	Flood level information for Ipswich City area	Nil (information obtained from BoM)	
Brisbane City Council	Flood level information for Brisbane City area	Nil (information obtained from BoM)	

6.3 Release of Information to the Public

The Corporation is responsible for the issue of information regarding storage conditions and current and proposed releases from the dams to the public and the media.

The Bureau of Meteorology has responsibility for issuing flood warnings.

The Emergency Services Response Authorities, under the Disaster Management Act 2003, have responsibility for the preparation of a local counter disaster plan hence the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

This review of the Manual has addressed the mechanisms of delegation and control of the dams in periods of operation of the dams for flood mitigation. It is known overtopping of the dams can result should floods occur which are derived from lesser rainfall than the probable maximum precipitation storm or from the combination of two lesser storms in close proximity. The dams may also overtop in the eventuality that the flood-gate control systems or fuse plugs fail to operate as planned or partially malfunction during the passage of a major flood or combination of floods.

Procedures and systems have been developed that should enable lower risk operation of the dams for flood mitigation purposes. This technology is intended to provide longer warning times and the capability of examining options to optimise the safety of the dams and minimise the hazard potential and risk to the community.

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances.

It is important, therefore, that the Manual contain operational procedures which in themselves cause the Manual's procedures, and the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

The checking and reviewing process must involve the Headworks Operator and all associated operations personnel in order that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based.

Variations to the Manual may be made in accordance with provisions in Section 1.8.

7.2 Personnel Training

The Headworks Operator must report to the Corporation by 30th September each year on the training and state of preparedness of operations personnel. A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources and Mines within 14 days of it being received by the Corporation.

7.3 Monitoring and Warning System and Communication Networks

The Headworks Operator must provide a report to the Corporation by the 1st May and 1st November of each year; and after each flood event. The report must assess in terms of hardware, software and personnel, the :

- adequacy of the communication and data gathering facilities,
- reliability of the system over the previous period,
- reliability of the system under prolonged flood conditions,
- accuracy of forecasting flood flows and heights, and
- the overall state of preparedness of the system.

The Corporation must review the report, and taking into account its own log of the performance of the field equipment, take any action considered necessary for the proper functioning and improvement of the system. . A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources and Mines within 14 days of it being received by the Corporation.

7.4 Operational Review

After each significant flood event, the Corporation must review the effectiveness of the operational procedures contained in this manual. The Headworks Operator is required to prepare a report for submission to the Corporation within six weeks of any flood event that requires mobilisation of the Flood Control Centre. A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources and Mines within 14 days of it being received by the Corporation.

7.5 Five Yearly Review

Prior to the expiry of the approval period, the Corporation must review the Manual pursuant to Section 6 Division 2 of the Act. The review is to take into account the continued suitability of the communication network, and the flood monitoring and warning system as well as hydrological and hydraulic engineering assessments of the operational procedures. The hydrologic investigations performed for the purpose of this manual are discussed in Appendix I.

8 WIVENHOE DAM OPERATIONAL PROCEDURES

8.1 Introduction

Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the dam, depending on the part of the catchment in which the flood originates and depending also on the magnitude of the flood. Maximum overall flood mitigation effect will be achieved by operating Wivenhoe Dam in conjunction with Somerset Dam.

A general plan and cross-section of Wivenhoe Dam, and relevant elevations are included in Appendix J. Storage and discharge data are included in Appendix E.

The reservoir volume above FSL of EL 67.0 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the initial reservoir level below FSL, the magnitude of the flood being regulated and the procedures adopted. Spiltyard Creek Dam is part of the overall Wivenhoe Area Project and it forms the upper pumped storage of the peak power generation scheme. Splityard Creek Dam impounds a volume of 28 700 ML at its normal full supply level (EL 166.5). The contents of Splityard Creek Dam can be emptied into Lake Wivenhoe within 12 hours by releasing water through the power station conduits. This volume of water can affect the level in Wivenhoe Dam by up to 300mm when Wivenhoe Dam is close to FSL. Operation of the power station and therefore also release of water from Splityard Creek Dam to Lake Wivenhoe is outside the control of the Corporation. The operational level of Splityard Creek Dam should be considered when assessing the various trigger levels of Wivenhoe Dam.

The Corporation has acquired land above FSL to a level of EL 75.0 to provide temporary flood storage. Reasonable care must be exercised to confine the flood rises to below this level. This requirement should be ignored in the case of extreme floods that threaten the safety of the dams.

8.2 Auxiliary Spillway

The auxiliary spillway for Wivenhoe Dam being constructed in 2004/05 as part of an upgrade to improve flood adequacy consists of a three bay fuse plug spillway at the right abutment. In association with other works being carried out at the dam, this will give the dam crest flood an annual exceedance probability (AEP) of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam two in the future.

Pertinent information about the auxiliary spillway, including the initiation level for the specific bays is given in Table 8.1.

TABLE 8.1 -RIGHT BANK FUSE PLUG DETAILS

Auxiliary Spillway Component	Spillway Crest Control Type	Spillway Crest Width (m)	Spillway Crest Level (m AHD)	Fuse Plug Pilot Channel Invert Level (m AHD)	Lake Level corresponding to Fuse Plug Pilot Channel Invert Level* (m AHD)
Central fuse plug bay	Ogee	34	67	75.7	75.7
Right hand side fuse plug bay	Ogee	64.5	67	76.2	76.23+
Left hand side fuse plug bay	Ogee	65.5	67	76.7	76.78++

* Lake Water Level is as per that measured at the Headwater Gauge.
Initiation of Fuse Plug is expected to occur when the Lake Water Level exceeds the Lake Level at Fuse Plug Pilot Channel by 0.10 - 0.15 m

\+ Includes 0.03m of drawdown from the Fuse Plug Pilot Channel Invert to the Lake Water Level

++ Includes 0.08m of drawdown from the Fuse Plug Pilot Channel Invert to the Lake Water Level

8.3 Initial Flood Control Action

When indications are received of an imminent flood, the flood control operation of the dam must commence with the storing of all inflow of the Brisbane River in Wivenhoe Dam, whilst an assessment is made of the origin and magnitude of the flood. The spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25.

8.4 Regulator and Gate Operation Sequences

Rapid opening of outlets (spillway gates and regulators) can cause hydraulic surges and other effects in the Brisbane River that can endanger life and property and may sometimes have other adverse effects. Under normal gate operations, the gates and regulators are therefore to be operated one at a time at intervals that will minimise adverse impacts on the river system.

Rapid closure of the gates can affect river-bank stability. Rapid closure of more than one gate at a time should only be used when time is critical and there is a requirement to correct a malfunction to preserve storage or to reduce downstream flooding rapidly. For flood operations where time is not critical, longer closure intervals should be used. The minimum closure intervals specified below are based on the recession limb of natural flood hydrographs such as the January 1974 flood.

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a gate by the immediate opening of a regulator valve (or the reverse operation). This allows for greater control of low flows and enables a smooth transition and closure as slow as possible to prevent the stranding of fish downstream of Wivenhoe Dam.

Except as provided for in procedure 4 of Section 8.4 where it is necessary to prevent operation of a fuse plug or to have the gates clear of the spillway flow prior to the fuse plug operating and as indicated above, the gate opening and closing intervals as shown in Table 8.2 are the most rapid permitted for flood mitigation purposes.

TABLE 8.2 - MINIMUM INTERVALS FOR NORMAL GATE OPERATIONS

500 mm Incremental gate openings	10 minutes
500 mm Incremental gate closures	20 minutes
Full regulator opening or closures	30 minutes

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

Under normal operation, only one gate is to be opened at any one time and the sequences given in Table 8.3 are to be adopted:

TABLE 8.3 – RADIAL GATE OPENING SEQUENCES[1]

Approximate Discharge Range	Gate opening sequence[2]	Comments
(a) Up to 330 m^3/sec	Open Gate 3 up to 3.5 metres	Gates 1, 2, 4 & 5 remain closed
(b) 330 m^3/sec to 575 m^3/sec	Gate 3 at 3.5 metres Open Gates 2 & 4 alternately to 0.5 metre Open Gate 3 to 4.0 metre Open Gates 2 & 4 alternately to 1.0 metre	Gates 1 & 5 remain closed unless discharge from Gates 2 & 4 impinges on side wall of plunge pool proceed to (c)
(c) 575 m^3/sec to 1160 m^3/sec	Gate 3 kept at 4.0 metres Open Gates 1 & 5 alternately one increment followed by Gates 2 & 4 alternately one increment Repeat Step until at the end of the sequence Gates 1 & 5 are open 1.5 metres and Gates 2 & 4 are open 2.5 metres	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not more than 1.0 metre more than Gates 1 & 5
(d) 1160 m^3/sec to 1385 m^3/sec	Open Gate 3 to 4.0 metres Open Gates 1 & 5 alternately to 2.0 metres followed by opening Gates 2 & 4 alternately to 3.0 metres	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not more than 1.0 metre more than Gates 1 & 5
(e) 1385 m^3/sec to 2290 m^3/sec	Open ALL gates to 5.0 metre openings	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not less than Gates 1 & 5 or not more than 1.0 metre more than Gates 1 & 5 Gate 3 is to have an opening not less than Gates 2 & 4 or not more than 1.0 metre more than Gates 2 & 4.
(f) Greater than 2290 m^3/sec	Open ALL gates incrementally in the sequence 3, 2, 4, 1, 5[3]	Flow in spillway to be as symmetrical as possible Gate 3 to have the largest opening Gates 2 & 4 are to have openings greater than Gates 1 & 5

1 Gates are numbered 1 to 5 from the left bank looking downstream.
2 Gate movements are to normally occur in 500 mm increments.
3 When the accelerated opening rate applies, gate-opening increments of 1.0 metres may be used.

Gate operating procedures in the event of equipment failure are contained in Appendix G. If one or more gates are inoperable during the course of the flood event, the gate openings of the remaining gates are to be adjusted to compensate. These adjustments should ensure that:

a) the impact of the flow on the sidewalls of the plunge pool should be minimised, and
b) the flow in the spillway is as symmetrical as practicable.

In general, gate closing is to occur in the reverse order. The final gate closure should occur when the lake level has returned to Full Supply Level.

8.5 Flood Control Procedures

When the preliminary estimation of the degree of expected flooding has been made, the operating procedures set out hereunder shall be used at Wivenhoe Dam in line with the Flood Mitigation Objectives.

When considering the discharge to be made from both Wivenhoe Dam and Somerset Dam under particular procedures, the total discharge for each dam from all sources is to be considered when determining the appropriate openings for gates, valves and sluices.

The flood control procedures to be adopted commence with Procedure 1 and extend through to Procedure 4 as the magnitude of the flood as predicted by the real time flood model increases. Table 8.5 summarises the application for each procedure for the initial filling of Wivenhoe Dam. Once Wivenhoe Dam has peaked and the drainage phase has commenced the indicative limits will not apply.

Procedure 1

Under Procedure 1, water is to be released from Wivenhoe Dam with care being taken not to prematurely submerge the downstream bridges. The limiting condition for Procedure 1 is the submergence of Mt Crosby Weir Bridge that occurs at approximately 1,900 m^3/sec.

The procedure adopted primarily depends on the level in Wivenhoe Dam and the discharge emanating from Lockyer Creek.

For situations where flood rains are occurring on the catchment upstream of Wivenhoe Dam and only minor rainfall is occurring downstream of the dam, releases are to be regulated to limit, as much as appropriate in the circumstances, downstream flooding. Except in the drainage phase releases are not to exceed the values given in Table 8.4:-

TABLE 8.4 – WIVENHOE DAM, PROCEDURE 1 MAXIMUM RELEASE RATES

Lake Level in Wivenhoe Dam	Maximum Release Rate (m^3/sec)
67.00 - 67.25	0
67.25 - 67.50	110
67.50 - 67.75	380
67.75 - 68.00	500
68.00 - 68.25	900
68.25 - 68.50	1900

The following subsets of Procedure 1 were originally developed by the Brisbane City Council to cater for limiting the submergence of the various low-level downstream bridges. The procedures require a great deal of control over releases and knowledge of discharges from Lockyer Creek.

In general, the releases from Wivenhoe Dam are controlled such that the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values to delay the submergence of particular bridges.

Procedure 1A — Savages Crossing & Colleges Crossing

For: Lake level between 67.25 and 67.5 m AHD [Maximum Release 110 m^3/sec]

Endeavour to maintain Twin Bridges trafficable by limiting releases at Wivenhoe Dam to a maximum of 50 m^3/sec and by reducing this rate of release if run-off from Lockyer Creek is likely to cause the bridges to be overtopped. The bridges become untrafficable at a flow of about 55 m^3/sec.

Once Twin Bridges are overtopped by run-off from Lockyer Creek, release to be directed towards maintaining College's Crossing trafficable by adjusting the rate of release so that the combined flow rate at College's Crossing is less than 175 m^3/sec.

Procedure 1B — Noogoorah Bridge (Burtons Bridge)

For: Lake level between 67.50 and 67.75 m AHD [Maximum Release 380 m^3/sec]

Initially endeavour to maintain College's Crossing trafficable. This becomes untrafficable at a flow of about 175 m^3/sec. No consideration to be given to keeping Twin Bridges trafficable.

Once College's Crossing is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to achieve a combined flow of about 380 m^3/sec at the Noogoorah Bridge Crossing. This bridge becomes untrafficable at a flow of about 430 m^3/sec.

Procedure 1C   *Kholo Bridge*

For: Lake level between 67.75 and 68.00 m AHD [Maximum Release 500 m^3/sec]

Initially endeavour to maintain Noogoorah Bridge trafficable. No consideration to be given to keeping College's Crossing trafficable.

Once Noogoorah Bridge is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to keep Kholo Bridge trafficable. This bridge becomes untrafficable at a flow rate of about 550 m^3/sec.

Procedure 1D   *Mt Crosby Weir Bridge*

For: Lake level between 68.00 and 68.25 m AHD [Maximum Release 900 m^3/sec]

Initially endeavour to maintain Kholo Bridge trafficable. No consideration to be given to keeping Noogoorah Bridge trafficable.

Once Kholo Bridge is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to keep Mt Crosby Bridge trafficable. This bridge becomes untrafficable at a flow of 1,900 m^3/sec.

Procedure 1E   *Mt Crosby Weir Bridge*

For: Lake level between 68.25 and 68.50 m AHD [Maximum Release 1,900 m^3/sec]

Similar to Procedure 1D, but with an upper release limit of 1,900 m^3/sec.

If the level reaches EL 68.5 m AHD in Wivenhoe Dam, operations switch to Procedure 2 or 3 as appropriate.

Procedure 2 may be bypassed if it is clear from the flood modelling that Procedure 3 will be activated.

Procedure 2

Under Procedure 2, water is to be released from Wivenhoe Dam with care being taken not to submerge Fernvale Bridge and Mt Crosby Weir Bridge prematurely. Typically releases will take place on the rising limb of the flow from Lockyer Creek. If this flow is sufficient to submerge Mt Crosby Weir bridge (1,900 m^3/sec), releases are to be increased such that the combined flow from Lockyer Creek and Wivenhoe Dam releases does not exceed either:-

(i) *3,500 m^3/sec at Lowood or*
(ii) *the greater of the peak flow of Lockyer Creek or the predicted peak flood flow of the Bremer River.*

Should the Mt Crosby Weir Bridge be flooded by flows from catchments downstream of Wivenhoe Dam, the upper limit of the combined Lockyer Creek flow and releases from Wivenhoe Dam shall, subject to (i) and (ii) above, not exceed 3,500 m^3/sec at Lowood.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 3

Under Procedure 3, water is to be released from Wivenhoe Dam such that the combined Lockyer Creek flood flow and Wivenhoe Dam release is not to exceed 3,500 m^3/sec at Lowood. The releases are to be regulated such that the total regulated flow at Moggill gauge downstream of the Bremer River junction does not exceed 4,000 m^3/sec [which is the upper limit for non-damaging flows for the urban reaches of the Brisbane River].

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4

This procedure normally comes into effect when the water level in Wivenhoe Dam reaches EL 74. However the Senior Flood Operations Engineer may seek to invoke the discretionary powers of section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.

Under Procedure 4 the release rate is increased as the safety of the dam becomes the priority. Opening of the gates is to occur until the storage level of Wivenhoe Dam begins to fall.

If required, the minimum time interval between gate openings can be reduced or successive gate openings of the same gate may be used in this procedure as considered appropriate. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals

Sub-procedures 4A, 4B and 4C have been developed for use depending on the stage of construction of the auxiliary spillway and the expected peak water level in the dam.

Procedures 4A and 4B are only to be applied once the auxiliary spillway fuse plug is functional. This is expected to be in the latter part of 2005. In the interim, Procedure 4C is applicable.

Procedure 4A

Procedure 4A applies while all indications of the peak flood level in Wivenhoe Dam are that it will be insufficient to trigger operation of the first bay of the fuse plug by reaching EL 75.5.

Gate openings are to occur at the minimum intervals and sequences as specified in section 8.3. Opening of the gates is to continue until the storage level of Wivenhoe Dam begins to fall.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4B

Procedure 4B applies once indications are the peak flood level in Wivenhoe Dam will exceed EL75.5 using the minimum gate opening intervals for normal operation as specified in section 8.3 i.e. it is expected that the fuse plug will be triggered under normal operation.

In this procedure the minimum time interval between gate openings is able to be reduced and successive gate openings of the same gate may be made.

If the real time flood model using a 1 metre in 10 minute gate opening procedure, predicts a peak water level in Wivenhoe Dam of less than EL 75.5, the gates may be raised at a rate to maximise flood storage capacity but to prevent the first fuse plug from initiating.

Otherwise the gates are to be raised at a rate to ensure they are out of the water before the initiation of the first fuse plug (if possible). Where practicable, the gates are to be in the fully open position before the dam water level reaches 75.7 m AHD.

In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

The effect of varying the operational procedures at Somerset Dam in keeping the peak flood level at Wivenhoe Dam below EL 75.7 may also be investigated using the real time flood model.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4C

Procedure 4C applies only during the construction phase of the right bank auxiliary spillway.

Opening of the gates is to occur until the storage level of Wivenhoe Dam begins to fall.
The minimum time interval between gate openings can be reduced or successive gate openings of the same gate may be used in this procedure as considered appropriate for ensuring the safety of the dam. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

TABLE 8.5 WIVENHOE DAM – NORMAL RELEASE OPERATING PROCEDURES: INITIAL FILLING

Procedure	Reservoir Level	Applicable Limits		
0	EL < 67.25	$Q_{Wivenhoe}$ = 0 m^3/sec ... i.e No Releases		
1A	67.25 < EL < 67.50	$Q_{Wivenhoe}$ < 110 m^3/sec	$Q_{Colleges\ Crossing}$ < 175 m^3/sec with care taken not to submerge Twin Bridges prematurely	
1B	67.25 < EL < 67.50	$Q_{Wivenhoe}$ < 380 m^3/sec	$Q_{Burtons/Noogoorah}$ < 430 m^3/sec with care taken not to submerge Colleges Crossing prematurely	
1C	67.75 < EL < 68.00	$Q_{Wivenhoe}$ < 500 m^3/sec	Q_{Kholo} < 550 m^3/sec with care taken not to submerge Burtons/Noogoorah prematurely	
1D	68.00 < EL < 68.25	$Q_{Wivenhoe}$ < 900 m^3/sec	$Q_{MtCrosby}$ < 1900m^3/sec with care taken not to submerge Kholo prematurely	
1E	68.25 < EL < 68.50	$Q_{Wivenhoe}$ < 1500 m^3/sec	$Q_{MtCrosby}$ < 1900m^3/sec with care taken not to submerge Kholo prematurely	
2	68.50 < EL < 74.00	Q_{Lowood} < 3500 m^3/sec	Q_{Lowood} < peak of Lockyer and Q_{Lowood} < peak of Bremer	Gates are NOT to be overtopped
3	68.50 < EL < 74.00	Q_{Lowood} < 3500 m^3/sec	$Q_{Moggill}$ < 4000 m^3/sec	
4	EL > 74.00[4]	Gates are to be opened until reservoir level begins to fall		

4 Once water level exceeds EL 74.0, operating procedures are dependant on the predicted peak water level.

8.6 Closing Procedures

If at the time the lake level in Wivenhoe Dam begins to fall, the combined flow at Lowood is in excess of 3500 m^3/sec, then the combined flow at Lowood is to be reduced to 3500 m^3/sec as quickly as practicable having regard to Section 3, and is to remain at this rate until final gate closure procedures can commence.

Gate closing procedures should be initiated having regard to the following requirements:

a) Early release of stored water to regain flood-mitigating ability for any subsequent flood inflows as described in Section 3.2.3.

b) The total discharge from Wivenhoe Dam from all sources is to be considered when considering appropriate closing procedures. This includes any discharge from triggered fuse plugs.

c) Gate operation procedures as described in Section 8.4.

d) Establishment of storage at FSL at completion of flood events.

e) Downstream impact of the discharges. To prevent the stranding of fish downstream of the dam, closures below flows of 275 m^3/sec should be undertaken as slow as practicable and if possible such closures should occur during daylight hours on a weekday so that personnel are available for fish rescue.

If the flood storage compartments of Wivenhoe Dam and Somerset Dam can be emptied within the prescribed time of seven days, the release from Wivenhoe Dam should be limited to between 1900 m^3/sec and 3500 m^3/sec. In such circumstances, the release from the dam should be less than the peak flow into the lake. Where possible, total releases during closure should not produce greater flood levels downstream than occurred during the flood event.

8.7 Modification to Flood Operating Procedures if a Fuse Plug triggers prematurely

Where the operation of a fuse plug spillway bay has been triggered prior to its design initiation level being reached, the flood operation procedures are to be modified such that:

- the discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;

- the gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.8 Modification to Flood Operating Procedures if a subsequent flood event occurs prior to the reconstruction of Triggered Fuse Plugs

Where the operation of any or all of the fuse plug spillway bays has been triggered and a flood event occurs before the fuse plug can be reinstated, the flood operation procedures are to be modified such that:

- the discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;

- the gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.9 Additional Provisions during Construction Works 2004/05

8.9.1 Auxiliary Spillway Area

The embankment forming the temporary road diversion that acts as a coffer dam is to be retained in place until the construction of the fuse plug has proceeded past EL 74, and then its removal is only to proceed once the written approval of a Senior Flood Operations Engineer has been obtained.

8.9.2 Gated Spillway Area

The following provisions will apply for works undertaken within the gated spillway:

- The opening of spillway gates to discharge floodwaters is at the sole discretion of the Senior Flood Operations Engineer;

- There is to be no obstruction of any spillway bay without the written approval of the Senior Flood Operations Engineer;

- All gates are to be capable of being operated at short notice during a flood if required. To ensure this capability is maintained Table 8.6 specifies limitations that apply to the number of bays in which works may be occurring at any time. This table also nominates a target notice period to be provided by the Senior Flood Operations Engineer for the removal of construction material from the spillway bays prior to their use for releases. However the Senior Flood Operations Engineer is not constrained to provide this length of notice before operating any particular gate if its earlier operation is considered necessary.

Table 8.6 – Gated Spillway Area Works Restrictions

Dam Level	Season	Maximum number of bays that may be occupied at any time	Comments
Below EL 64.0	Winter (May to September)	3	12 hours notice to clear spillway
Below EL 64.0	Summer (October to April)	2	12 hours notice to clear spillway
Above EL 64.0	Winter (May to September)	2	12 hours notice to clear spillway
Above EL 64.0	Summer (October to April)	2	12 hours notice to clear spillway
Above EL 66.0	Flood Season (January to April)	1	Preferably not gate 1 or 5, 6 hours notice to clear spillway

- A maximum of one gate may be treated as inoperable and remain closed if a flood will severely damage works if it is opened, and the expected flood magnitude can be catered for with 4 gates. The other gates are to be operated in accordance with the existing flood operational procedures but to compensate for the loss of flow in the closed gate. As the flood rises to the top of the closed gate at an EL 73 m AHD, the gate is incrementally raised to prevent it from being overtopped. It is noted that a large flood is required for the lake level to reach EL 73 m AHD.

The Corporation must prepare a Standing Operating Procedure for the conduct of works in the gated spillway whereby the above provisions are met such the capacity to achieve the dam's operational objectives is maintained.

9 SOMERSET DAM OPERATIONAL PROCEDURES

9.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods. Somerset Dam and Wivenhoe Dam are meant to be operated in conjunction to optimise the flood mitigation capacity downstream of Wivenhoe Dam.

A general plan and cross-section of Somerset Dam, and relevant dam operating levels are included in Appendix J.

The discharge capacities for various storage levels of Somerset Dam are listed in Appendix F.

9.2 Initial Flood Control Action

Upon indications being received of a significant inflow, the flood control operation of the dam shall commence with the raising of any closed gates and the closure of all low level regulators and sluices, whilst an assessment is made of the origin and magnitude of the flood.

9.3 Regulator and Gate Operation Procedures

The following minimum intervals must be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes:

TABLE 9.1- MINIMUM INTERVALS, NORMAL OPERATION, SOMERSET DAM

	OPENING	CLOSING
Regulators	30 minutes	60 minutes
Sluice Gates	120 minutes	180 minutes
Crest Gates	Gates are normally open	

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a sluice gate by the immediate opening of one or more regulator valves (or the reverse operation). This allows for greater control of low flows and enables a smooth transition on opening and closing sequences.

9.4 Flood Control Procedure

It is essential that the operating procedures adopted should not endanger the safety of Wivenhoe Dam downstream. Within this constraint, the Senior Flood Operations Engineer must adopt a procedure for the operation of Somerset Dam such that:

a) the structural safety of Somerset Dam is not endangered;

b) the Upper Brisbane River flood flow plus Somerset Dam releases does not cause Wivenhoe Dam to be overtopped.

The normal operating procedure to be used for Somerset Dam is as follows.

The crest gates are raised to enable uncontrolled discharge. The low level regulators and sluices are to be kept closed until either:

(i) the lake level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

In the case of (i) above the opening of the regulators and sluices is not to increase the inflow to Wivenhoe Dam above the peak inflow from the Brisbane River just passed or, if possible, not to cause the Wivenhoe Dam lake level to exceed EL 74.

In the case of (ii) above, the Senior Flood Operations Engineer must direct the operation of the low-level regulators and sluices to ensure the safety of Somerset Dam. If the water level and predicted inflows are such that the safety of Somerset Dam is not an overriding concern, operations are to target a correlation of water levels in Somerset Dam and Wivenhoe Dam as set out in Table 9.2 such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and EL 107.46, the non-spillway crest level in Somerset Dam.

TABLE 9.2 – Water Level Correlation Targets

Somerset Lake Level M AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

If the flood event emanates from the Stanley River catchment only, without significant runoff in the Upper Brisbane River catchment, the operation of Somerset Dam will proceed on the basis that Wivenhoe Dam has peaked as per (i) above.

The Somerset Dam gates and valves may also be temporarily closed if such action is able to prevent a fuse plug from initiating. Such closure is not to threaten the safety of the dam

10 EMERGENCY FLOOD OPERATIONS

10.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition either through flood events or other causes. Experience elsewhere in the world suggests that vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than the discharge capacity of the dam;
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood.
- Development of a piping failure through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;
- Other uncommon mechanisms.

Responses to these and other conditions are included in separate Emergency Action Plans.

10.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates. The probability of overtopping of Wivenhoe Dam will be significantly reduced following the completion of the auxiliary spillway.

Somerset Dam should, if possible, not be overtopped by flood water but, if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced, for example by the use of its spillway gates, even at the risk of overtopping Somerset Dam in order to prevent, if possible, the overtopping of Wivenhoe Dam.

10.3 Communications Failure

In the event of normal communications being lost between the Flood Operations Engineer and either Wivenhoe Dam or Somerset Dam, the dam supervisor at that dam is to maintain contact with the dam supervisor at the other dam, to receive instructions through the remaining communications link.

In the event of normal communications being lost between the Flood Operations Engineer and both Wivenhoe Dam and Somerset Dam, the dam supervisors at each dam are to adopt the procedures set out below during flood events, and are to maintain contact with each other, where possible.

If all communications are lost between the Flood Operations Engineer, Wivenhoe Dam and Somerset Dam, the officers in charge at each dam are to adopt the procedures set out below.

10.3.1 Wivenhoe Dam Emergency Procedure

In the event of total communication failure, the minimum gate openings related to lake levels up to EL 74 are set out in the Table 10.1 are to be maintained for both opening and closing operations. Once the lake level exceeds EL 74 the gates are to be raised at the rate of 1 metre per 10 minutes till the water level peaks or the gates are fully open.

Table 10.1 Minimum Gate Openings Wivenhoe Dam

Lake Level m AHD	Gate 3 Opening (m)	Gates 2 & 4 Opening (m)	Gates 1 & 5 Opening (m)	Total Discharge m^3/sec
67.0		-	-	0
67.5	0.5	-	-	50
68.0	1.5	-	-	155
68.5	2.5	-	-	260
69.0	3.5	0.5	-	470
69.5	4.0	1.0	-	640
70.0	4.0	1.5	0.5	875
70.5	4.0	2.0	1.0	1115
71.0	4.0	2.5	1.5	1365
71.5	4.5	2.5	2.0	1560
72.0	4.5	3.0	2.5	1820
72.5	5.0	4.0	3.0	2250
73.0	5.0	5.0	5.0	2960
73.5	6.5	6.5	6.5	3850
74.0	8.0	8.0	8.0	4750
>74.0	Gates are to be raised at the rate of 1 metre per 10 minutes till the water level peaks or gates are fully open			
75.7	Gates are to be fully open before the first fuse plug triggers at this level.			

If one or more gates become inoperable, then by reference to Table E-2 the gate openings of operable gates are to be increased in order that the discharges for the lake levels shown in Table 10.1 are achieved.

If, because of compliance with the provisions of Section 8.3 and the high inflow rate, the minimum gate openings cannot be maintained, the time intervals between successive openings shown in Table 8.2 are to be halved.

If the actual gate openings fall more than three settings below the cumulative number of minimum settings of Table 10.1, then successive gate operations are to be carried out as rapidly as possible until the minimum settings are achieved. Under these circumstances, it may be necessary to operate more than one gate at any one time.

10.3.2 Somerset Dam Emergency Procedure

In the event of total communication failure, the spillway gates are to be kept raised to allow uncontrolled discharge. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

The level in Wivenhoe Dam can be determined locally by the Dam Supervisor at Somerset Dam from the tailwater gauge located just downstream of Somerset Dam.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe Dam above the peak level already attained. Section 9.3 on regulator and gate operation interval is to be observed.

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and the non-spillway crest level in Somerset Dam (EL 107.46). Table 10.2 gives the water level correlations. The low level outlets in Somerset Dam are not to be opened if the water level in Wivenhoe Dam exceeds the level set out below for given water levels in Somerset Dam.

TABLE 10.2 – Water Level Correlation Targets

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

10.4 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix G for Wivenhoe Dam and Appendix H for Somerset Dam.

APPENDIX A EXTRACT FROM WATER ACT 2000

Division 2 – Flood Mitigation

Owners of certain dams must prepare flood mitigation manual

496.(1) A regulation may nominate an owner of a dam as an owner who must prepare a manual (a "flood mitigation manual") of operational procedures for flood mitigation for the dam.

(2) The regulation must nominate the time by which the owner must comply with section 497(1).

Approving flood mitigation manual

497.(1) The owner must give the chief executive a copy of the flood mitigation manual for the chief executive's approval.

(2) The chief executive may, by gazette notice, approve the manual.

(3) The approval may be for a period of not more than 5 years.

(4) The chief executive may get advice from an advisory council before approving the manual.

Amending flood mitigation manual

498.(1) The chief executive may require the owner, by notice, to amend the flood mitigation manual.

(2) The owner must comply with the chief executive's request under subsection (1).

(3) The chief executive must, by gazette notice, approve the manual as amended.

(4) The approval of the manual as amended must be for-

(a) the balance of the period of the approval for the manual before amendment; or

(b) a period of not more than 5 years from the day the manual as amended was approved.

(5) The chief executive may get advice from an advisory council before approving the manual as amended.

Regular reviews of flood mitigation manual

499. Before the approval for the flood mitigation manual expires, the owner must-
review, and if necessary, update the manual; and
give a copy of it to the chief executive under section 497.

Protection from liability for complying with flood mitigation manual

500.(1) The chief executive or a member of the council does not incur civil liability for an act done, or omission made, honestly and without negligence under this division.

(2) An owner who observes the operational procedures in a flood mitigation manual approved by the chief executive does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures.

(3) If subsection (1) or (2) prevents civil liability attaching to a person, the liability attaches instead to the State.

(4) In this section-

"owner" includes-

a) a director of the owner or operator of the dam; or

b) an employee of the owner or operator of the dam; or

c) an agent of the owner or operator of the dam

APPENDIX B AGENCIES HOLDING DOCUMENTS

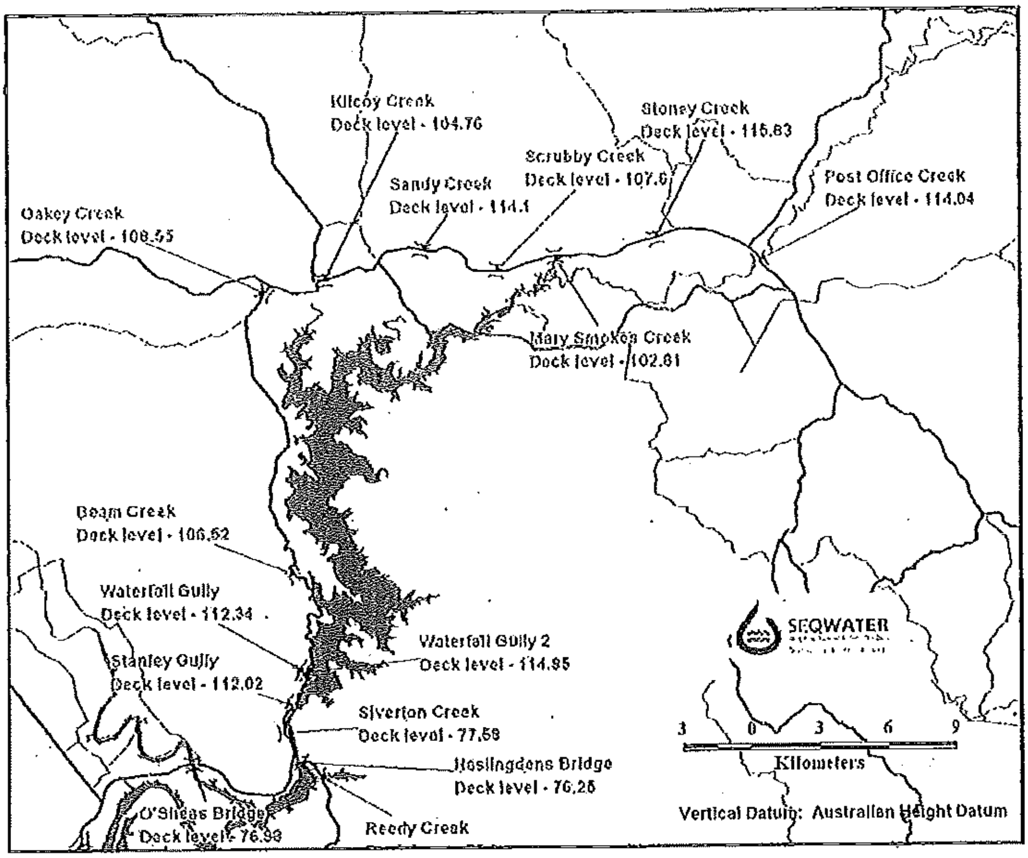
AGENCIES HOLDING CONTROLLED DOCUMENTS OF MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR WIVENHOE DAM AND SOMERSET DAM

Dam Owner	South East Queensland Water Corporation
Emergency Services	Department of Emergency Services, Disaster Management Service Brisbane City Counter Disaster Committee Esk Shire Counter Disaster Committee Ipswich City Counter Disaster Committee Kilcoy Shire Counter Disaster Committee
Severe Weather Warning Authority	Bureau of Meteorology
Primary Response Authorities	Brisbane City Council Esk Shire Council Ipswich City Council Kilcoy Shire Council
Regulator of Dam Safety	Department of Natural Resources and Mines
Dams Operator	SunWater

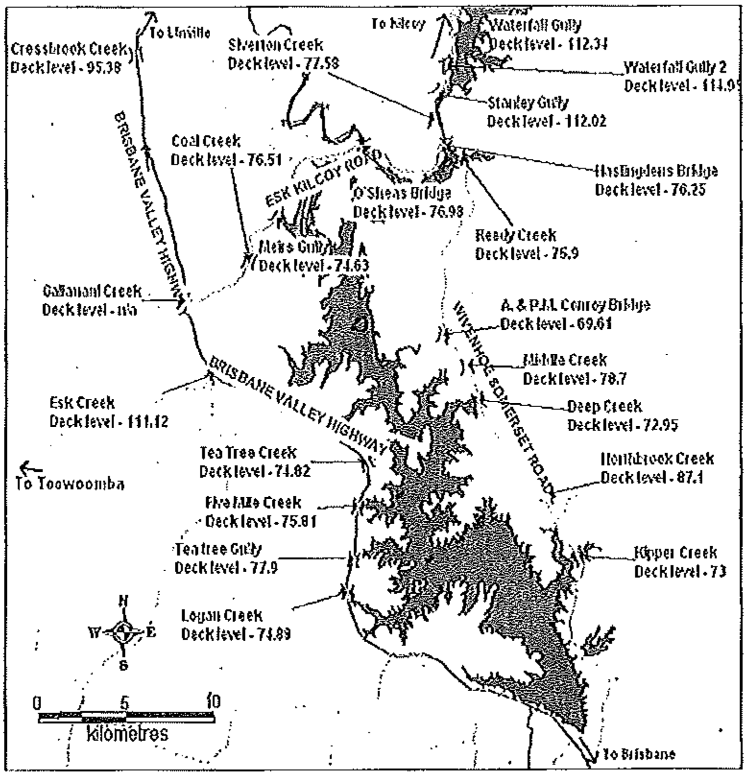
The Corporation must keep a register of contact persons of holders of controlled documents (Section 1.9 refers).

APPENDIX C BRIDGE DECK LEVELS

Roads Upstream of Somerset Dam

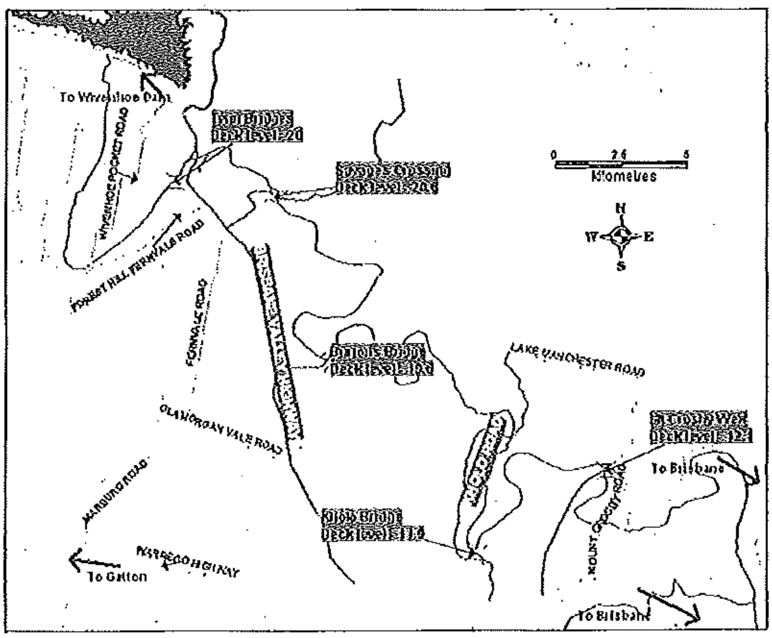


Roads Surrounding Wivenhoe Dam



SEQWATER

Bridges Downstream of Wivenhoe Dam



SEQWATER

APPENDIX D GAUGES AND BRIDGES

Table D.1. KEY REFERENCE GAUGES

Location	GZ	1974 Gauge Height	Minor Gauge Height	Minor Flow	Moderate Gauge Height	Moderate Flow	Major Gauge Height	Major Flow
			m	m^3/s	m	m^3/s	m	m^3/s
Stanley R at Somerset Dam*	0.00 AHD	-	103.0		105.0		106.0	
Brisbane R at Lowood	23.68 AHD	22.02	8.0		15.0		20.0	
Brisbane R at Lowood*	22.74 SD	-	8.6	1000	15.9	3300	21.2	6000
Brisbane R at Savages Crossing*	18.43 AHD	23.79	9.0		16.0		21.0	
Brisbane R at Mt Crosby*	0.00 AHD	26.74	11.0		13.0		21.0	
Bremer R at Ipswich*	0.00 AHD	20.70	7.0		9.0		11.7	
Brisbane R at Moggill*	0.00 AHD	19.95	10.0		13.0		15.5	
Brisbane R at Jindalee Br*	0.00 AHD	14.10	6.0	4000	8.0	5000	10.0	6500
Brisbane R at City Gauge*	0.00 AHD	5.45	1.7		2.6		3.5	

* Indicates an automatic gauge
Flows are approximate only and gauge heights are tide dependent in the lower reaches.
A complete list of the latest river heights can be found at http://www.bom.gov.au

Table D.2. SUBMERGENCE FLOWS FOR BRIDGES

AMTD	Bridge Name	Location	Estimated Submergence Flow m^3/sec
140	Twin Bridges	Wivenhoe Pocket Road, Fernvale	50
132	Savage's Crossing	Banks Creek Road, Fernvale	130
87	College's Crossing	Mt Crosby Rd, Karana Downs	175-200*
120	Burton's Bridge	E Summerville Road, Borallon	430
100	Kholo Bridge	Kholo Rd, Ipswich	550
91	Mt.Crosby Weir Bridge	Allawah Rd, Mt Crosby	1900
136	Fernvale Bridge	Brisbane Valley Hwy, Fernvale	2000

* Affected by tides.

APPENDIX E WIVENHOE DAM TECHNICAL DATA

TABLE E1 STORAGE AND UNCONTROLLED GATE DISCHARGES

Lake level M AHD	Storage Capacity 10^6 m³	*** Flood Capacity 10^6 m³	** Net Inflow per 1mm rise per hour m³/sec	* Discharge per Regulator m³/sec	* Discharge per Spillway Bay m³/sec	Maximum Available Discharge m³/sec
57.0	414	-	11.10	24.9	0	50
57.5	453	-	12.04	25.2	4	69
58.0	466	-	12.97	25.4	15	128
58.5	494	-	13.90	25.7	32	211
59.0	523	-	14.84	25.9	53	316
59.5	553	-	15.77	26.2	77	439
60.0	584	-	16.71	26.4	105	579
60.5	616	-	17.64	26.6	136	735
61.0	649	-	18.58	26.9	170	905
61.5	683	-	19.51	27.1	207	1 090
62.0	719	-	20.45	27.3	246	1 290
62.5	756	-	21.38	27.5	288	1 495
63.0	795	-	22.32	27.8	333	1 720
63.5	835	-	23.25	28.0	379	1 950
64.0	877	-	24.19	28.2	428	2 195
64.5	920	-	25.12	28.4	479	2 450
65.0	965	-	26.06	28.7	532	2 720
65.5	1 012	-	26.99	28.9	587	2 995
66.0	1 061	-	27.92	29.1	645	3 280
66.5	1 112	-	28.86	29.3	704	3 580
67.0	1 165	0	29.79	29.5	765	3 885
67.5	1 220	56	30.73	29.7	828	4 200
68.0	1 276	112	31.66	29.9	893	4 525
68.5	1 334	171	32.60	30.1	959	4 860
69.0	1 393	230	33.53	30.3	1 028	5 200
69.5	1 454	290	34.47	30.5	1 098	5 550
70.0	1 517	350	35.40	30.7	1 170	5 910
70.5	1 581	418	36.33	30.9	1 244	6 280
71.0	1 647	485	37.27	31.1	1 319	6 660
71.5	1 714	550	38.20	31.3	1 396	7 040
72.0	1 783	615	39.14	31.5	1 474	7 430
72.5	1 854	683	40.07	31.7	1 554	7 840
73.0	1 926	750	41.01	31.9	1 636	8 240
73.5	2 000	830	41.94	32.1	1 719	8 660
74.0	2 076	910	42.87	32.3	1 804	9 080
74.5	2 153	995	43.81	32.5	1 890	9 520
75.0	2 232	1 080	44.74	32.7	1 978	9 960
75.5	2 313	1 160	45.68	32.9	2 067	10 400
76.0 ****	2 395	1 240	46.61	33.1	2 158	10 860
76.5	2 480	1 258	47.55	33.3	2 250	11 320
77.0	2 566	1 420	48.48	33.4	2 343	11 780
77.5	2 655	1 500	49.41	36.6	2 438	12 260
78.0	2 746	1 580	50.35	33.8	2 535	12 740
78.5	2 839	1 680	51.28	34.0	2 632	13 230
79.0	2 934	1 780	52.22	34.2	2 731	13 730

* This is the maximum discharge of an individual spillway bay or regulator. Total discharge is calculated by adding the contributions of each gate or regulator. There are two (2) regulators to five (5) spillway bays.

** This assumes that all gates and sluices are closed. Discharges through the spillway have to be added to the above figures to calculate the actual inflow into the reservoir.

*** The temporary storage above normal Full Supply Level of BL 67.0.

**** The first fuse plug is designed to trigger at BL75.7. Above this level, fuse plug flows from Table E.3 need to be added to give the full outflow.

TABLE E2 CONTROLLED GATE DISCHARGES

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
67.0	0	49	98	146	194	240	285	329	372	413	453	492	530	567	603	639	575	709	744	765															
67.2	0	49	99	148	196	243	288	333	376	418	458	498	537	574	611	648	684	720	755	790															
67.4	0	50	100	149	198	245	291	336	380	422	464	504	543	582	619	657	693	730	766	802	815														
67.6	0	50	101	151	200	248	294	340	384	427	469	510	550	589	627	665	702	740	777	814	841														
67.8	0	51	102	152	202	250	297	343	388	432	474	515	556	596	635	673	712	750	787	825	863	867													
68.0	0	51	103	154	204	253	300	347	392	436	479	521	562	603	642	682	721	759	798	837	876	893													
68.2	0	52	104	155	206	255	303	350	396	441	484	527	569	610	650	690	729	769	808	848	888	919													
68.4	0	52	105	156	207	257	306	354	400	445	489	532	575	616	657	698	738	778	818	859	899	940	946												
68.6	0	53	105	158	209	260	309	357	404	450	494	538	581	623	665	706	747	788	829	870	911	953	973												
68.8	0	53	106	159	211	262	312	360	408	454	499	543	587	630	672	714	755	797	838	880	923	965	1000												
69.0	0	54	107	160	213	264	315	364	412	458	504	549	593	636	679	722	764	806	848	891	934	977	1022	1028											
69.2	0	54	108	162	215	267	317	367	415	463	509	554	599	643	686	729	772	815	858	901	945	989	1035	1056											
69.4	0	54	109	163	217	269	320	370	419	467	514	560	605	649	693	737	780	824	868	912	956	1001	1047	1084											
69.6	0	55	110	164	218	271	323	373	423	471	518	565	611	656	700	744	789	833	877	922	967	1013	1060	1107	1112										
69.8	0	55	111	166	220	273	326	377	427	475	523	570	616	662	707	752	797	842	887	932	978	1025	1072	1121	1141										
70.0	0	56	112	167	222	276	328	380	430	479	528	575	622	668	714	759	805	850	896	942	989	1036	1085	1134	1170										
70.2	0	56	112	168	224	278	331	383	434	484	532	580	628	674	721	767	813	859	905	952	1000	1048	1097	1147	1198	1199									
70.4	0	56	113	170	225	280	334	386	437	488	537	586	633	680	727	774	821	867	914	962	1010	1059	1109	1160	1212	1229									
70.6	0	57	114	171	227	282	336	389	441	492	542	591	639	687	734	781	828	876	923	972	1020	1070	1121	1173	1226	1258									
70.8	0	57	115	172	229	284	339	392	445	496	546	596	644	693	741	788	836	884	932	981	1031	1081	1133	1185	1239	1289									
71.0	0	58	116	173	230	286	341	395	448	500	551	601	650	699	747	795	844	892	941	991	1041	1092	1144	1198	1252	1309	1319								
71.2	0	58	117	175	232	289	344	398	452	504	555	605	655	705	754	802	851	900	950	1000	1051	1103	1156	1210	1266	1323	1349								
71.4	0	58	117	176	234	291	347	401	455	508	559	610	661	710	760	809	859	908	959	1009	1061	1114	1167	1222	1279	1337	1380								
71.6	0	59	118	177	235	293	349	404	458	512	564	615	666	716	766	815	866	916	967	1019	1071	1124	1179	1234	1292	1350	1410	1411							
71.8	0	59	119	178	237	295	352	407	462	515	568	620	671	722	773	823	874	924	976	1028	1081	1135	1190	1246	1304	1364	1425	1443							
72.0	0	60	120	180	239	297	354	410	465	519	572	625	676	728	779	830	881	932	984	1037	1091	1145	1201	1258	1317	1377	1439	1474							
72.2	0	60	121	181	240	299	357	413	469	523	577	629	682	733	785	837	888	940	993	1046	1100	1155	1212	1270	1330	1391	1454	1506							
72.4	0	60	121	182	242	301	359	416	472	527	581	634	687	739	791	843	895	948	1001	1055	1110	1166	1223	1282	1342	1404	1468	1533	1538						
72.6	0	61	122	183	243	303	361	419	475	531	585	639	692	745	797	850	903	955	1009	1064	1119	1176	1234	1293	1354	1417	1482	1548	1570						
72.8	0	61	123	184	245	305	364	422	478	534	589	643	697	750	803	856	910	963	1018	1073	1129	1186	1245	1305	1367	1430	1496	1563	1603						

UNCONTROLLED DISCHARGE

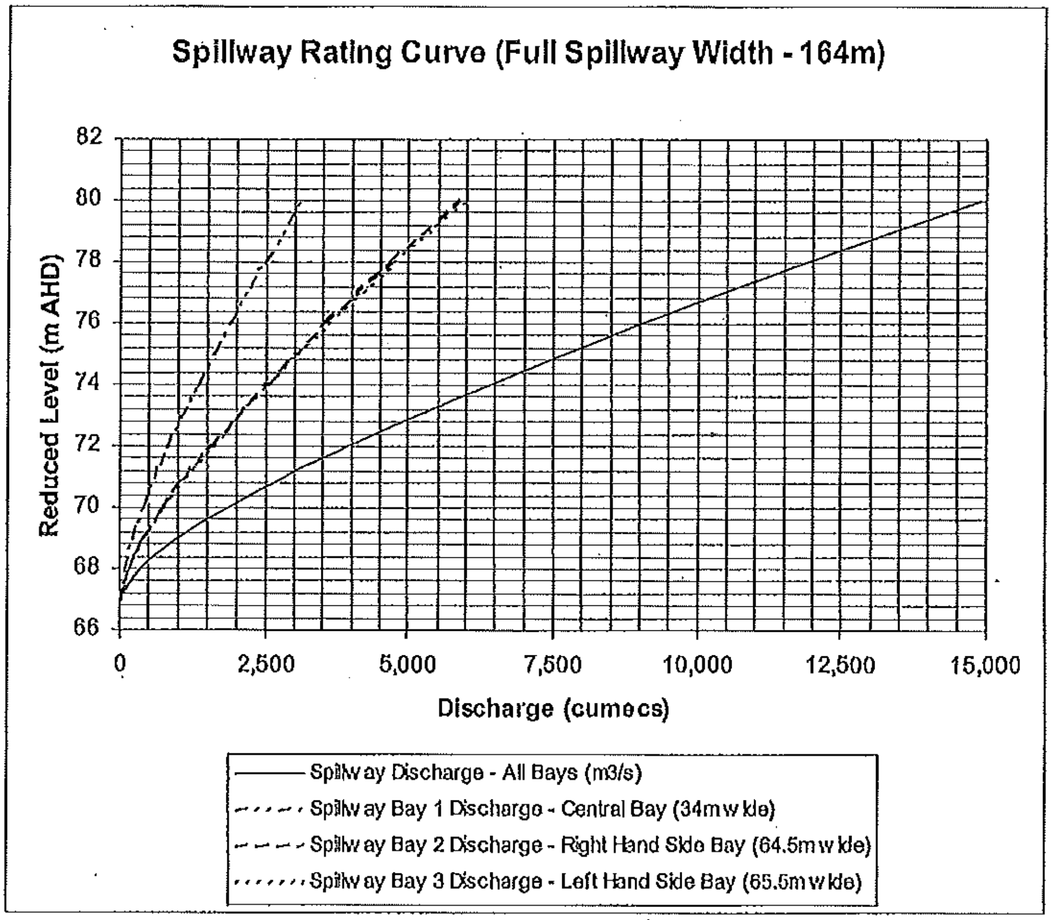
TABLE E2 CONTROLLED GATE DISCHARGES (continued)

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
73.0	0	62	124	185	247	307	366	425	482	538	593	648	702	756	809	863	917	971	1026	1081	1138	1196	1255	1316	1379	1443	1509	1577	1636						
73.2	2	62	124	187	246	309	369	427	485	542	597	653	707	761	815	869	924	978	1034	1090	1147	1206	1266	1327	1391	1456	1523	1592	1663	1669			UNCONTROLLED		
73.4	6	62	125	188	250	311	371	430	488	545	602	657	712	767	621	876	931	986	1042	1099	1156	1216	1276	1339	1403	1469	1536	1606	1678	1702				DISCHARGE	
73.6	11	64	126	169	251	313	373	433	491	549	606	662	717	772	827	882	937	993	1050	1107	1166	1225	1287	1350	1414	1461	1550	1620	1693	1736					
73.8	17	69	127	190	253	315	376	436	495	553	610	666	722	778	833	888	944	1001	1058	1116	1175	1235	1297	1361	1426	1494	1563	1635	1708	1770					
74.0	23	74	129	191	254	317	378	438	498	556	614	671	727	783	839	895	951	1008	1065	1124	1184	1245	1307	1372	1438	1506	1576	1648	1723	1800	1804				
74.2	31	80	133	192	256	319	380	441	501	560	618	675	732	788	845	901	958	1015	1073	1132	1192	1254	1317	1382	1449	1518	1589	1662	1738	1815	1838				
74.4	39	87	139	195	257	321	383	444	504	563	622	679	737	793	850	907	964	1022	1081	1140	1201	1264	1327	1393	1461	1530	1602	1676	1752	1831	1873				
74.6	47	94	145	200	259	322	385	447	507	567	626	684	741	799	856	913	971	1029	1089	1149	1210	1273	1337	1404	1472	1542	1615	1690	1767	1846	1908				
74.8	56	103	153	206	262	324	387	449	510	570	629	688	746	804	862	919	978	1036	1096	1157	1219	1282	1347	1414	1483	1554	1628	1703	1781	1861	1943				
7 5.0	66	112	161	213	267	326	390	452	513	574	633	692	751	809	867	926	984	1044	1104	1165	1227	1291	1357	1425	1494	1566	1640	1717	1795	1876	1960	1978			
75.2	76	121	169	220	274	330	392	455	516	577	637	697	756	814	873	932	991	1051	1111	1173	1236	1301	1367	1435	1506	1578	1653	1730	1809	1891	1976	2013			
75.4	87	131	178	229	281	336	394	457	519	581	641	701	760	819	878	938	997	1057	1119	1181	1245	1310	1377	1446	1517	1590	1665	1743	1823	1906	1992	2049			
75.6	98	141	188	237	289	343	399	460	522	584	645	705	765	824	884	944	1004	1064	1126	1189	1253	1319	1386	1456	1527	1601	1678	1756	1837	1921	2007	2085			
75.8	109	152	198	247	298	350	405	463	525	587	649	709	769	829	889	949	1010	1071	1133	1197	1261	1328	1396	1466	1538	1613	1690	1769	1851	1936	2023	2112	2121		
		OVERTOPPING of GATE																																	
76.0	121	164	209	257	307	359	412	468	528	591	652	713	774	834	895	955	1016	1078	1141	1205	1270	1337	1405	1476	1549	1624	1702	1782	1865	1950	2038	2129	2158		
76.2	133	175	220	268	317	368	421	475	532	594	656	718	779	839	900	961	1023	1085	1148	1212	1278	1346	1415	1486	1560	1636	1714	1795	1878	1965	2053	2145	2194		
76.4	146	187	232	279	327	378	429	483	539	597	660	722	783	844	906	967	1029	1092	1155	1220	1286	1354	1424	1496	1570	1647	1726	1808	1892	1979	2069	2161	2231		
76.6	159	200	244	290	338	368	439	492	546	603	664	726	788	849	911	973	1035	1098	1162	1228	1295	1363	1434	1506	1581	1658	1738	1820	1905	1993	2084	2177	2268		
76.8	173	213	257	302	350	399	449	501	554	610	668	730	792	854	916	978	1041	1105	1170	1235	1303	1372	1443	1516	1591	1669	1750	1833	1919	2007	2099	2193	2289	2306	
			OVERTOPPING of GATE																																
77.0	186	226	270	315	362	410	460	511	564	618	674	734	797	859	921	984	1047	1112	1177	1243	1311	1380	1452	1526	1602	1680	1762	1845	1932	2021	2113	2208	2306	2343	
77.2	200	240	283	328	374	422	471	522	574	627	682	739	801	864	927	990	1054	1118	1184	1250	1319	1389	1461	1536	1612	1691	1773	1858	1945	2035	2128	2224	2322	2381	
77.4	215	254	297	341	387	435	483	533	584	637	691	747	806	869	932	996	1060	1125	1191	1258	1327	1398	1470	1545	1622	1702	1785	1870	1958	2049	2143	2239	2339	2419	
77.6	230	269	311	355	400	447	496	545	595	647	700	756	813	873	937	1001	1065	1131	1198	1265	1335	1406	1479	1555	1633	1713	1796	1882	1971	2063	2157	2255	2355	2457	
77.8	245	283	325	369	414	461	508	557	607	658	711	765	821	880	942	1007	1072	1138	1205	1273	1343	1414	1488	1564	1643	1724	1808	1894	1984	2076	2172	2270	2371	2475	2496
78.0	260	299	340	383	426	474	522	570	619	670	722	775	831	888	948	1012	1078	1144	1211	1280	1351	1423	1497	1574	1653	1735	1819	1907	1997	2090	2186	2285	2387	2492	2535

TABLE E.3 – WIVENHOE DAM AUXILIARY SPILLWAY RATING TABLE

Storage Level (m AHD)	Spillway Discharge - All Bays (m3/s)	Discharge Central Bay (34m wide)	Discharge Right Side Bay (64.5m wide)	Discharge Left Side Bay (65.5m wide)
67	0	0	0	0
68	361	75	142	144
69	1,020	212	401	408
70	1,858	385	731	742
71	2,847	590	1,120	1,137
72	3,961	821	1,558	1,582
74	6,409	1,329	2,521	2,560
76	9,033	1,873	3,553	3,608
78	11,907	2,468	4,683	4,755
80	14,913	3,092	5,865	5,956



APPENDIX F SOMERSET DAM TECHNICAL DATA

Table F-1 STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake level M AHD	Reservoir Capacity 10^6 m^3	Temporary Flood Storage 10^6 m^3	Net Inflow per 1mm rise per hour m^3/sec	* Discharge per Regulator m^3/sec	* Discharge per Sluice m^3/sec	* Discharge per Spillway Bay m^3/sec	Maximum Available Discharge m^3/sec
90.0	120.3	-	5.29	57	163	-	1 529
90.5	129.5	-	5.50	58	165	-	1 550
91.0	139.3	-	4.88	58	167	-	1 572
91.5	149.6	-	5.28	59	170	-	1 593
92.0	160.5	-	5.68	60	172	-	1 614
92.5	172.0	-	6.09	60	174	-	1 635
93.0	184.1	-	6.79	61	176	-	1 655
93.5	196.7	-	7.10	62	179	-	1 676
94.0	210.0	-	7.43	62	181	-	1 695
94.5	224.0	-	7.78	63	183	-	1 715
95.0	238.5	-	8.15	64	185	-	1 735
95.5	253.6	-	8.54	64	187	-	1 754
96.0	269.3	-	8.95	65	189	-	1 773
96.5	285.6	-	9.37	66	191	-	1 792
97.0	302.7	-	9.81	66	193	-	1 810
97.5	320.7	-	10.28	67	195	-	1 829
98.0	339.5	-	10.76	67	197	-	1 847
98.5	359.2	-	11.25	68	199	-	1 865
99.0	379.8	0.0	11.77	69	201	-	1 883
99.5	401.4	21.5	12.31	69	203	-	1 901
100.0	428.9	49.0	13.28	70	205	-	1 918
100.5	447.5	67.6	13.83	70	207	0	1 937
101.0	472.2	92.3	14.39	71	209	4	1 989
101.5	498.0	118.1	14.95	72	211	13	2 076
102.0	524.9	145.1	15.53	72	212	25	2 189
102.5	553.1	173.3	16.11	73	214	40	2 325
103.0	582.6	202.7	16.70	73	216	58	2 482
103.5	613.2	233.4	17.30	74	218	78	2 659
104.0	645.1	265.3	17.90	74	220	100	2 854
104.5	678.3	298.4	18.52	75	221	125	3 067
105.0	712.7	332.8	19.14	75	223	151	3 296
105.5	748.3	368.4	19.78	76	225	180	3 542
106.0	785.2	405.4	20.42	76	226	211	3 803
106.5	823.4	443.6	21.07	77	228	243	4 079
107.0	863.1	483.2	21.73	78	230	278	4 370
107.5	904.0	524.2	22.39	78	232	314	4 675

* This is the maximum discharge of an individual gate or regulator. Total discharge is calculated by adding the contributions of each gate or regulator.

Regulator - Discharge regulator valve of which there are four (4).
Sluice - Sluice gate of which there are eight (8).
Spillway - Overflow section of dam controlled by eight (8) radial gates.
Temporary Flood- The temporary storage above the normal full supply level of El 99 m (AHD) Storage

APPENDIX G WIVENHOE DAM GATE OPERATION CONSIDERATIONS

Full size plans of Wivenhoe Dam, and Operations and Maintenance Manuals for Wivenhoe Dam are held by the Corporation and the Headworks Operator and are available at the site. Operations and Maintenance Manuals relevant to the flood operation of the gates are:

(a) "Master Manual and Drawings."

(b) "Radial and Penstock Gate Hoists and Drawings."

G.1. SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Appendix I shows the general arrangement of the spillway area.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

The main purpose of gating the spillway is to exercise maximum control over the flow in the Brisbane River insofar as river flows in excess of 4 000 m^3/sec cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

G.2. RADIAL GATE OPERATING PRINCIPLE

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

APPENDIX I HYDROLOGIC INVESTIGATIONS

I.1. INTRODUCTION

This appendix describes hydrologic analyses performed as part of the review of design flood hydrology Corporation's dams. This study included an examination of the existing operating procedures for Wivenhoe Dam and Somerset Dam and it includes the use of the latest techniques in design rainfall estimation.

The analyses were carried out using the most appropriate data available in 2001 and it is recommended that they be revised after the occurrence of a large flood or after the adoption of more advanced methods of hydrologic analysis. The work is summarised in a report entitled, 'Brisbane River – Revision of Flood Hydrology', (DNRM, 2001).

The work summarised here supersedes previous work including that completed during the design stages of Wivenhoe Dam, details of which are contained in the design report on Wivenhoe Dam and the Brisbane River and Pine River Flood Study reports. Revision of the estimates of Probable Maximum Precipitation by the Bureau of Meterology in 2003 have increased these figures. The determination of the Probable Maximum Flood and the impacts on Wivenhoe Dam are included in reports entitled, "Preferred Solution Report" – Wivenhoe Alliance 2003. The increase in spillway capacity for Wivenhoe Dam and the resulting effects downstream are included in a report entitled "Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade" – Wivenhoe Alliance 2004.

I.2 METHOD

There are three components in the hydrologic analyses:

(i) a rainfall analysis to determine both rainfall frequency and Probable Maximum Precipitation (PMP) and also large and rare rainfall events using the CRC-FORGE methodology

(ii) a model of the catchment rainfall runoff process; and

(iii) a model of the flood operations of the two dams.

The Bureau of Meteorology completed several studies of the Probable Maximum Precipitation. The Australian generalised method for areas subject to tropical cyclones was used and rainfalls for durations up to seven days were estimated. The Probable Maximum Precipitation was estimated for the whole of the Brisbane River catchment, as well as for various sub-catchments. Concurrent rainfall estimates were provided for the remainder of the catchment outside the sub-catchment for which the Probable Maximum Precipitation was provided. The Probable Maximum Precipitation temporal patterns provided by the Bureau of Meteorology were used for all rainfalls.

The estimation of design rainfalls within the large to rare flood range was performed using the CRC-FORGE methodology as described in Book VI of Australian Rainfall and Runoff (1998). The CRC-FORGE method uses the concept of an expanding region focussed at the site of interest. Design rainfall for frequent events (eg 1 in 50 AEP) are based upon pooled data from a few gauges around the focal point, while design rainfall estimates at the AEP of the limit extrapolation are based upon pooled rainfall data from up to several hundred gauges. Before the data from different sites can be poled, maximum annual rainfalls from each site need to be standardised by dividing by an "index variable".

The rainfall runoff models based on a non-linear runoff routing method were used to estimate the floods. The models were calibrated on recorded storm and flood data. The model calibrations were completed in 1993 and were not modified for the latest re-assessment.

Models to simulate the flood operation of Somerset and Wivenhoe Dams developed during the mid-eighties were modified to incorporate the new structure of the hydrologic models and to more accurately reflect the operational procedures of the dams. These models were then used to calculate dam discharges for a range of design floods generated using the rainfall estimates and the runoff routing models.

I.3. RAINFALL ANALYSIS RESULTS

The rainfall analysis was performed in two parts, the Probable Maximum Precipitation estimate by the Bureau of Meteorology and the estimation of large to rare events using the CRC-FORGE method. These were used both for design studies for the dam and to test the effects of flood operation procedures.

The estimates of rainfall frequency are listed in Tables I-1 and I-2.

Table I-1
Catchment Rainfall (mm) on Wivenhoe Dam Catchment

Annual Exceedence Probability %	24 Hours	48 Hours	72 Hours
1	199	274	319
0.1	276	393	464
0.01	379	550	659
PMP	800	1060	1280

Table I-2
Catchment Rainfall (mm) on Somerset Dam Catchment

Annual Exceedence Probability %	24 Hours	48 Hours	72 Hours
1	302	430	507
0.1	432	649	775
0.01	554	920	1117
0.001	747	1204	1483

I.4. RUNOFF ROUTING MODEL CALIBRATION

Ten floods were used for calibration: July 1965, March 1967, June 1967, January 1968, December 1971, January 1974, January 1976, June 1983, Early April 1989 and Late April 1989. The gauging stations used for model calibration are listed in Table I-3.

The runoff routing model was calibrated for the nineteen major sub-catchments listed in Table I-4. Each of these models was calibrated for as many sites as possible for each of the ten floods.

Data were missing for some of the stations for some of the floods. The estimated model parameters are given in Table I-4. In all cases relative delay time parameter (k) used in the model is related to reach length.

Table I-3
Gauging Stations used for Model Calibration

Stream	Site	Number	AMTD (km)	Catchment Area (km^2)
Stanley River	Somerset Dam		7.2	1 335
Cooyar Creek	Damsite	143015	12.2	960
Brisbane River	Linville	143007	282.4	2 005
Emu Creek	Boat Mountain	143010	10.1	920
Brisbane River	Gregor's Creek	143009	251.7	3 885
Cressbrook Creek	Damsite	143013	58.6	325
Brisbane River	Middle Creek	143008	187.2	6 710
Brisbane River	Wivenhoe Dam		150.2	7 020
Brisbane River	Savage's Crossing	143001	130.8	10 180
Bremer River	Walloon	143107	37.2	620
Warrill Creek	Amberley	143108	8.7	920
Lockyer Creek	Lyon's Bridge	143210	27.2	2 540
Brisbane River	City		22.7	13 260

Table I-4
Estimated Model Parameters

Sub-Catchment Name	Model Parameters	
	k	m
Cooyar Creek	43.6	0.8
Brisbane River at Linville	20.6	0.8
Emu Creek at Boat Mountain	37.2	0.8
Brisbane River at Gregors Creek	20.1	0.8
Cressbrook Creek at Cressbrook Dam	34.3	0.8
Stanley River at Somerset Dam	80.7	0.8
Brisbane River at Wivenhoe Dam	108.5	0.8
Lockyer Creek at Helidon	15.0	0.8
Tenthill Creek at Tenthill	19.0	0.8
Lockyer Creek at Lyons Bridge	75.0	0.8
Brisbane River at Savages Crossing	40.0	0.8
Brisbane River at Mount Crosby	47.0	0.8
Bremer River at Walloon	44.0	0.8
Warrill Creek at Kalbar	34.0	0.8
Warrill Creek at Amberley	35.0	0.8
Purga Creek at Loamside	49.0	0.8
Bremer River at Ipswich	15.7	0.8
Brisbane River at Jindalee	20.8	0.8
Brisbane River at Port Office	19.3	0.8

I.5. WIVENHOE DAM FLOODS

Wivenhoe Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Wivenhoe Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the dam-site without the dam in the catchment. Two-day storms were found to have the critical storm duration for most cases, though the long duration Probable Maximum Precipitations produced very large flood volumes. Table I-5 lists results for the two-day duration storms.

Table I-5
Wivenhoe Dam Floods
Design Inflows and Outflows for Existing, Stage 1 and Stage 2 Upgrades

Event (1in X)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)		
		Existing	Stage 1	Stage 2
200	8,300	2,800	2,800	2,800
500	10,500	3,800	3,800	3,800
1,000	12,100	5,300	5,300	5,300
2,000	14,000	6,600	6,600	6,600
5,000	17,200	8,900	10,500 [c]	10,500 [c]
10,000	20,800	11,700	12,500	12,500
22,000 [a]	25,700	12,400 [a]	17,600	17,600
50,000	34,900	- [b]	24,600	24,600
100,000	43,300	- [b]	28,100 [a]	34,900
PMF	49,000	- [b]	- [b]	37,400 [a]

[a] Dam Crest Flood
[b] Overtops dam wall
[c] Increases due to changes to Procedure 4.

I.6. SOMERSET DAM FLOODS

Somerset Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Somerset Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the site without the dam in the catchment. The forty-eight hour PMP storm event was found to be critical, though the long duration PMP's produced very large flood volumes. Table I-6 lists results for the forty-eight hour duration storms.

Table I-6
Somerset Dam Floods
(for two-day storm duration)+

AEP %	Peak Inflow (m^3/sec)	Peak Outflow (m^3/sec)	Flood Volume (ML)	Peak Lake Level (m AHD)
1	3,500	1,700	421,000	103.5
0.1	4,500	2,600	690,000	104.5
0.01	6,800	4,700	1,042,000	107.5
0.001	9,200	6,300	1,412,000	109.3
PMF*	16,000	9,600	1,952,800	112.0

+ - NB. This duration does NOT give the maximum Peak Inflow for a given AEP
* - Overtopped, estimated flow based on no dam failure

I.7 FLOOD CONTROL OPERATION MODEL

Floods in the Brisbane River catchment above Wivenhoe Dam can originate in either the Stanley River or upper Brisbane River catchment or both. Both of the dams are capable of being operated in a number of ways, each of which will reduce the flow downstream. However, in order to achieve maximum reduction of flooding downstream of Wivenhoe Dam, it was necessary to review the operations at Somerset and Wivenhoe Dams using a flood operations simulation model.

The most recent flood studies have reviewed the basic hydrologic algorithms in the operational models used in the earlier study and modified them to incorporate additional features relating to gate openings and closings. The revised design flood hydrology and operational model algorithms were then used to re-examine the original five possible operational procedures for each of Somerset Dam and Wivenhoe Dam, giving twenty-five possible combinations to be re-considered. The procedures previously developed for Wivenhoe Dam were designed so that initial release operations did not adversely affect later operations in the event of later rainfall causing the magnitude of the flood to exceed the original estimate.

The procedures previously developed were also designed to restrict flooding in the lower catchment to the lowest level of the following categories where practicable:

(i) low level bridges submerged, Fernvale bridge open;

(ii) all bridges except Mt. Crosby Weir and to Fernvale bridges submerged;

(iii) all bridges submerged, no damage to urban areas;

(iv) damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe Dam contributing to peak flow;

(v) extensive damage to urban areas due to combined Wivenhoe Dam releases and downstream flow, Wivenhoe Dam release component of peak flow minimum practicable.

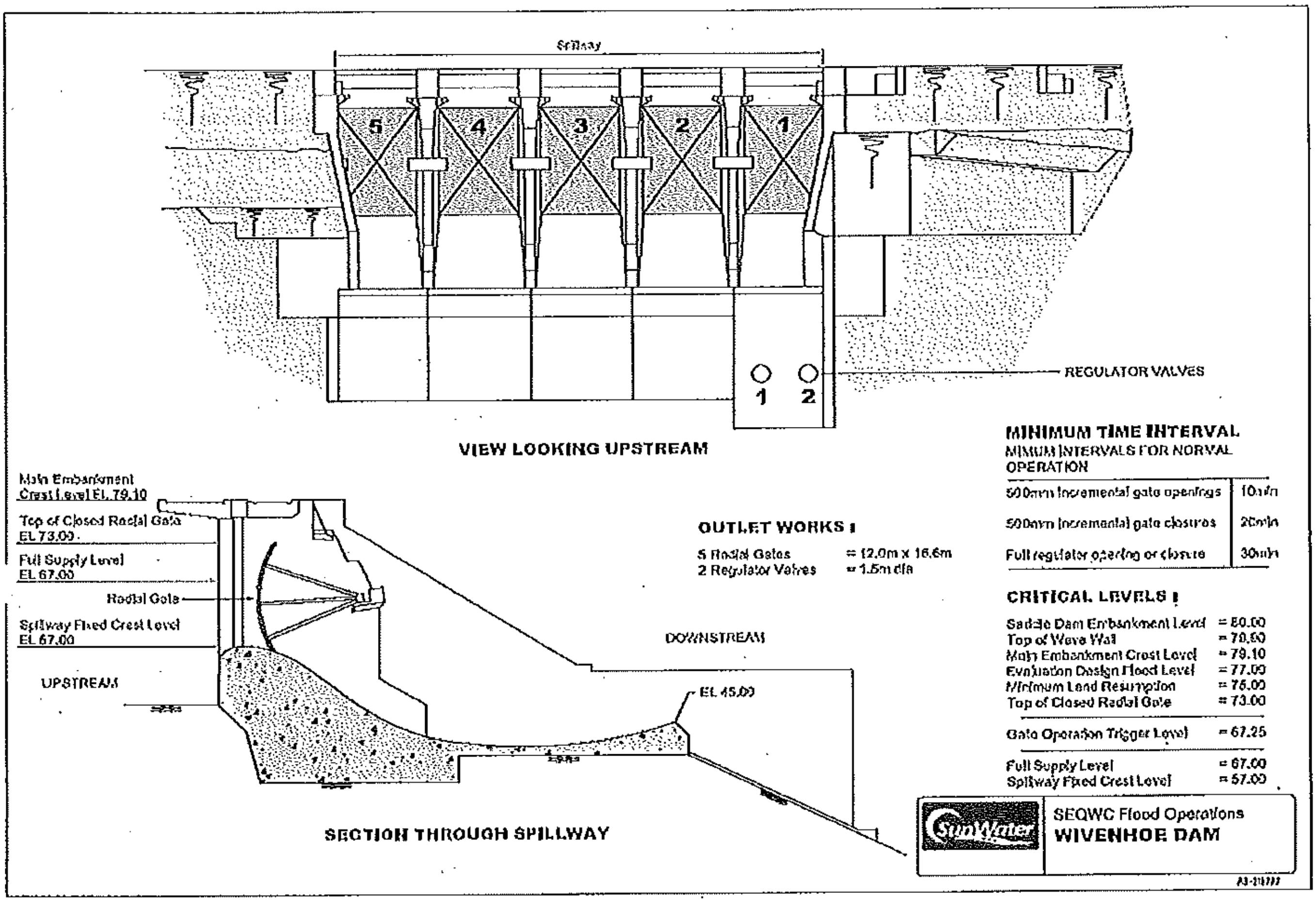
The previous flood studies recommended that one procedure be selected for the operation at Somerset Dam. This procedure had two advantages over the other procedures tested. Firstly, it was feasible for all magnitudes of Stanley River floods tested and, secondly, it was the simplest procedure to carry out. The re-analysis confirmed this conclusion.

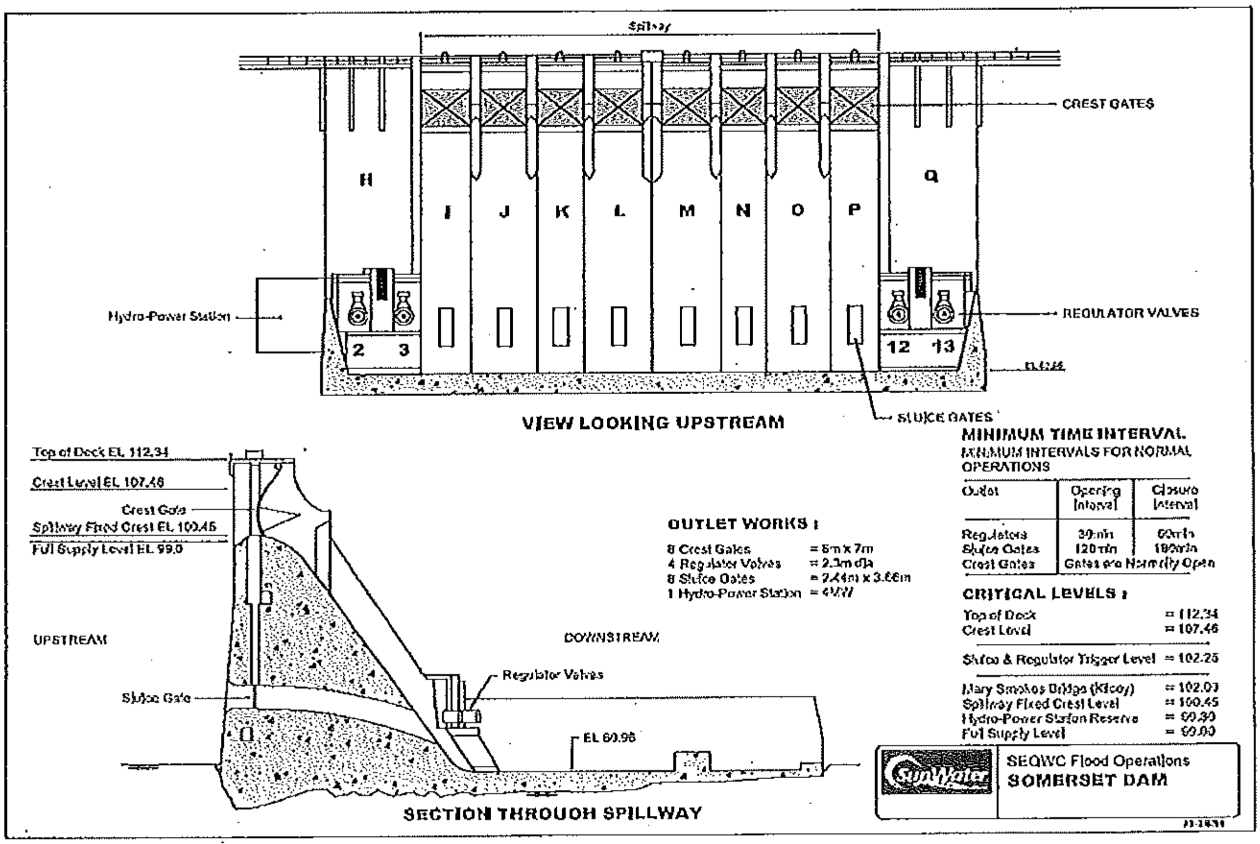
The previous flood studies concluded that procedures for Wivenhoe Dam be reduced to four by combining two procedures into one. The resulting four procedures formed a hierarchy and the procedure to be adopted advances to the next procedure as the flood magnitude increases. The re-analysis confirmed this conclusion.

A Real Time Flood Operations Model for Somerset and Wivenhoe has been developed as part of the "Brisbane River and Pine River Flood Studies". This model incorporates the revised operational algorithms.

* Assume no failure of Wivenhoe Dam or Somerset Dam

APPENDIX J DRAWINGS





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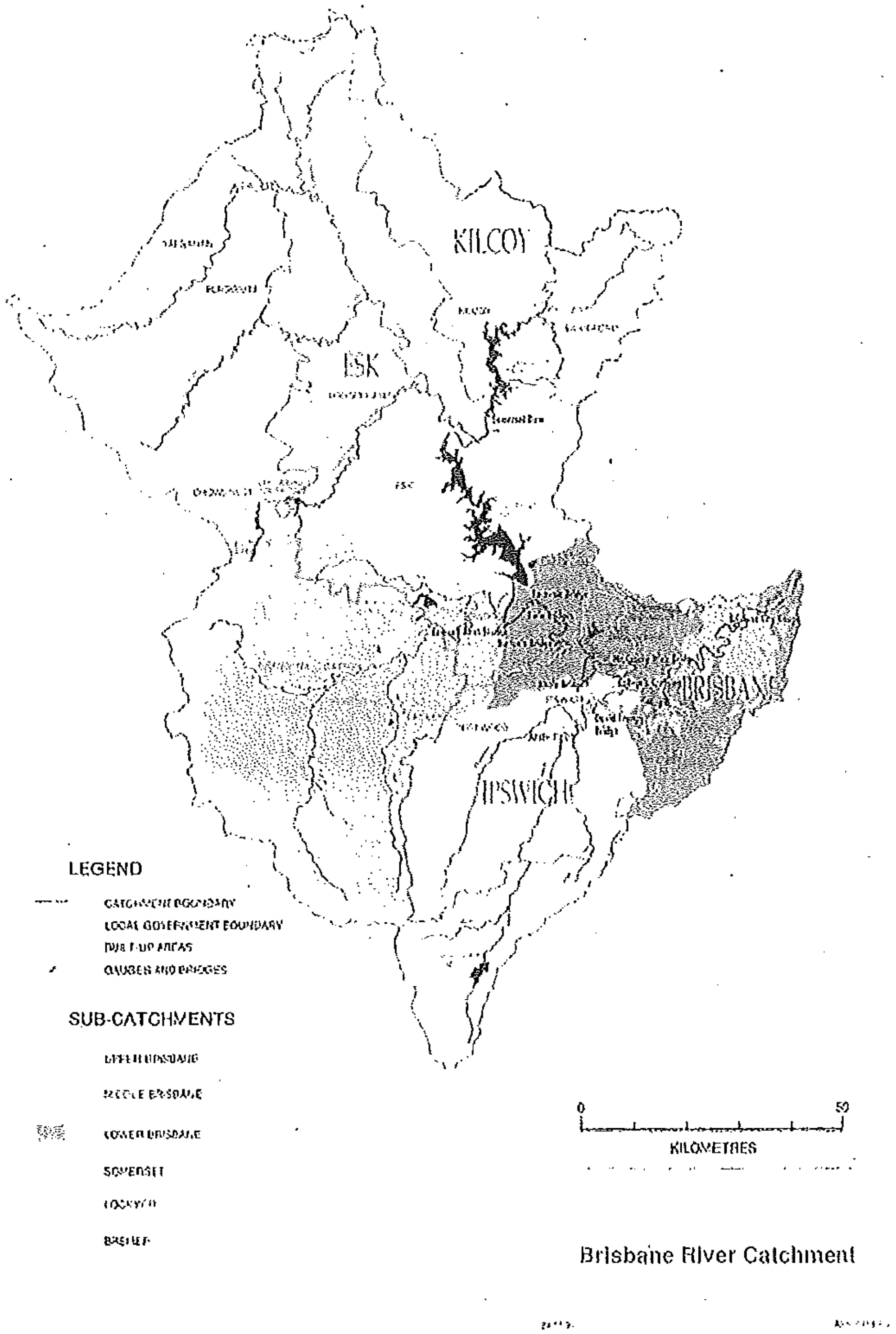
APPENDIX K BRISBANE RIVER CATCHMENT



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MOVEMENT INSTRUCTIONS MUST BE SHOWN ON FRONT COVER.

For report see Box
DAM/600/079(0377)
DS00377

26 October 2004

Mr Peter Allen
Director, Dam Safety (Water Supply)
Water Industry Compliance
Department of Natural Resources, Mines and Energy
GPO Box 2454
BRISBANE QLD 4001

Dear Sir,

AMENDED MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION - WIVENHOE AND SOMERSET DAM

Attached is a copy of the Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam, Revision 5.

This amended manual is submitted for your approval.

Yours sincerely,

[redacted]

PETER BORROWS
Chief Executive Officer

SUPERSEDED

Attach.

South East Queensland
WATER CORPORATION
LIMITED

MANUAL

OF

OPERATIONAL PROCEDURES

FOR FLOOD MITIGATION

FOR

WIVENHOE DAM

AND SOMERSET DAM

Revision No.	Date	Amendment Details
0	27 October 1968	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	24 August 1998	Change to page 23
4	6 September 2002	Complete revision and re-issue
5	4 October 2004	Complete revision and re-issue

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Preface

Given their size and location, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise hazard to life and property.

Recognising this, the South East Queensland Water Board Act required a manual be prepared of operational procedures for the dams during floods. With changes to the controlling legislation, the manual became an approved flood mitigation manual under *Water Act 2000* (extract in Appendix A).

This Manual is the result of a review of the 2002 revision of the Manual. The South East Queensland Water Corporation is required to review, update the Manual if necessary, and submit it to the Chief Executive for approval prior to its expiry. Any amendments to the basic operating procedures need to be treated similarly.

Prior to the 1998 version of the manual, an expanded flood monitoring and warning radio telemetry network (ALERT) was installed in the Brisbane River Catchment. Additionally, a computerised flood operational model that allows for rainfall and river modelling in real time based on data from the ALERT system was developed, implemented and fully commissioned. The accuracy and reliability of the system during a flood event has now been proven.

The primary objectives have not varied from those defined in the previous manual. These remain ensuring safety of the dams, their ability to deal with extreme and closely spaced floods, and protection of urban areas. The basic operational procedures have also essentially remained the same. Wivenhoe Dam and Somerset Dam are operated in conjunction so as to maximise the overall flood mitigation capabilities of the two dams. The procedures outlined in this Manual are based on the operation of the dams in tandem.

The changes to the 2002 version of the manual have arisen out of the spillway upgrade process for Wivenhoe Dam with the addition of the three bay right abutment fuse plug spillway. The changes enable Wivenhoe Dam to pass a 1:100,000 AEP flood event. The manual covers the provisions introduced to cover flood operations of the dams during the construction period for the spillway upgrade and for flood operations after theses provisions become operational.

1.2 Meaning of Terms

In this Manual, save where a contrary definition appears -

"Act"
means the *Water Act 2000*;

"AEP"
means annual exceedance probability, the probability of a specified event being exceeded in any year.

"Agency"
includes a person, a local government and a department of state government within the meaning of the Acts Interpretation Act 1954;

"AHD"
means Australian Height Datum;

"Bureau of Meteorology"
means the Commonwealth Bureau of Meteorology;

"Chairperson"
means the Chairperson of the South East Queensland Water Corporation;

"Chief Executive"
means the Chief Executive or Director General of the Department of Natural Resources, Mines & Energy;

"Controlled Document"
means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Corporation"
means the South East Queensland Water Corporation;

"Dams"
means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

"Dam Supervisor"
means the senior on-site officer at Wivenhoe or Somerset Dam as the case may be;

"EL"
means elevation in metres from Australian Height Datum;

"Flood Operations Engineer"
means the person designated at the time to direct the operations of Wivenhoe Dam and Somerset Dam under the general direction of the Senior Flood Operations Engineer and in accordance with the procedures in this Manual;

"FSL" or "FULL SUPPLY LEVEL"
means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"Gauge"
when referred to in (m) means river level referenced to AHD, and
when referred to in (m^3/sec) means flow rate in cubic metres per second;

"Headworks Operator"
for the purposes of this manual the Headworks Operator is the South-East Queensland Water Corporation:

"Manual" or "Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam"
means the current version of this Manual;

"Power Station"
means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

"Senior Flood Operations Engineer"
means the senior person designated at the time pursuant to Section 2.1 of this Manual under whose general direction the procedures in this Manual must be carried out;

"South East Queensland Water Corporation"
means the body corporate constituted by that name pursuant to Part III of the South East Queensland Water Board Act 1979. The Board became a government owned corporation in 2000;

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce, so far as practicable, the effects of flooding, by the proper control and regulation in time of headworks under the control of the Corporation, with due regard to the safety of the structures comprising those headworks.

For the purpose of this Manual, the Corporation adopts the policy that the community is to be protected to the maximum extent practical against flood hazards recognising the limitations on being able to:

- identify all potential flood hazards and their likelihood,
- remove or reduce community vulnerability to flood hazards,
- effectively respond to flooding, and
- provide resources in a cost effective manner.

1.4 Legal Authority

This manual has been prepared as a Flood Mitigation Manual in accordance with the provisions of Part 6 Division 2 of the Act.

1.5 Application and Effect

The procedures in this Manual apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall give the protection from liability provided by Section 500 of *Water Act 2000.*

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which this version of the Manual is approved by gazette notice.

The Manual shall remain in force for the period of approval as determined by the chief executive. This approval may be for a period of up to five years.

Before the approval of the Manual expires, the Corporation must review and if necessary update the Manual and submit a copy to the chief executive for approval.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation, and must be applied by the Headworks Operator for the operation of the dams.

1.8 Provision for Variations to Manual

If the Corporation is of the opinion that the procedures in this Manual should be amended, altered or varied, it must submit for approval as soon as practical a request, which is in accordance with the flood mitigation provisions of the *Water Act 2000*, to the Chief Executive setting out the circumstances and the exact nature of the amendment, alteration or variation sought. The Chief Executive may require the Corporation amend the Manual by written notice.

1.9 Distribution of Manual

The Corporation must regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of Controlled Documents are listed in Appendix B. The Corporation must maintain a Register of Contact Persons for Controlled Documents and ensure that each issued document is updated whenever amendments or changes are approved.

Before using this Manual for the direction of flood control, the Headworks Operator must ensure that it is the current version of the Controlled Document.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, the Corporation is responsible for and has the duty for operation and maintenance of Wivenhoe Dam and Somerset Dam, and while it may enter into contracts for the purpose of discharging these responsibilities, for the purposes of this manual the Headworks Operator is the Corporation.

2.1.1 Designation of Senior Flood Operations Engineer

The Headworks Operator must ensure that the procedures set out in this Manual are carried out under the general direction of a suitably qualified and experienced person who shall be referred to hereafter as the Senior Flood Operations Engineer. Only a person authorised in the Schedule of Authorities can give the general direction for carrying out procedures set out in this Manual.

2.1.2 Designation of Flood Operations Engineer

The Headworks Operator must have available or on standby at all times a suitably qualified and experienced Flood Operations Engineer to direct the operation of the dams during floods in accordance with the general strategy determined by the Senior Flood Operations Engineer.

The Headworks Operator must ensure that flood control of the dams is under the direction of a Flood Operations Engineer at all times. Only a person authorised in the Schedule of Authorities can direct the flood operation of the dams.

The Headworks Operator must also employ an adequate number of suitably qualified and experienced persons to assist the Flood Operations Engineer in the operation of the dams during floods.

2.2 Qualifications and Experience of Engineers

2.2.1 Qualifications

All engineers referred to in Section 2.1 must meet all applicable requirements of registration or certification under any relevant State Act, and must hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

2.2.2 Experience

All engineers referred to in Section 2.1 must, to the satisfaction of the Chief Executive, have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

(a) Investigation, design or construction of major dams;

(b) Operation and maintenance of major dams;

(c) Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;

(d) Applied hydrology with particular reference to flood forecasting and flood warning systems.

2.3 Schedule of Authorities

The Corporation must maintain a Schedule of Authorities containing a list of the Senior Flood Operations Engineers and Flood Operations Engineers approved to direct flood operations at the dams during floods. A copy of the Schedule of Authority must be provided to the chief executive by 1st September of each year.

The Headworks Operator shall, as the need arises, nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as Senior Flood Operations Engineers and Flood Operations Engineers. Each new nomination must include a copy of any certificate required under Section 2.2 and a validated statement of qualifications and experience.

The Headworks Operator must obtain the approval for all nominations from the Chief Executive prior to their inclusion in the Schedule of Authorities.

If, in the event of unforseen and emergency situations, no Senior Flood Operations Engineer or no Flood Operations Engineer is available from the Schedule of Authorities, the Headworks Operator must temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.4 Training

The Headworks Operator must ensure that operational personnel required for flood control operations receive adequate training in the various activities involved in flood control operation.

2.5 Dam Operation Arrangements

For the purposes of operation of the dams during times of flood, the Headworks Operator must ensure that:

(a) the operation be carried out under the general direction of the Senior Flood Operations Engineer, and

(b) in the direction of operations which may knowingly endanger life or property, the Senior Flood Operations Engineer must where practical liaise with the Chairperson of the Corporation and the Chief Executive or nominated delegate.

2.6 Responsibilities of the Senior Flood Operations Engineer

The Senior Flood Operations Engineer is responsible for the overall direction of flood operations.

Except insofar as reasonable discretion is provided for in Section 2.8 of this Manual, the Senior Flood Operations Engineer must ensure that the operational procedures for the dam shall be in accordance with this Manual.

2.7 Responsibilities of the Flood Operations Engineer

The Flood Operations Engineer must apply the operational procedures in accordance with this manual and the direction set for flood operations. In so doing, account must be taken of prevailing weather conditions, the probability of follow up storms and the ability of the dam to discharge excess flood waters in the period between rainfall events or in the period from the time of detection of conditions associated with the development storm cells to the likely time of occurrence of the rainfall.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, based on available information and professional experience, it is necessary to depart from the procedures set out in this manual, the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary to meet the situation, provided that the Senior Flood Operations Engineer observes the flood mitigation objectives set out in Section 3 of this Manual when exercising such reasonable discretion.

Before exercising discretion under this Section of the Manual with respect to flood mitigation operations, the Senior Flood Operations Engineer must consult with such of the following persons as are available at the time that the discretion has to be exercised:

the Chairperson of the Corporation, and
the Chief Executive or nominated delegate.

If not able to contact any of the above within a reasonable time, the Senior Flood Operations Engineer may proceed with such other procedures considered as necessary to meet the situation and report such action at the earliest opportunity to the above persons.

2.9 Report

The Senior Flood Operations Engineer must prepare a report to the Headworks Operator after each event that requires flood operation of the dams and the report must contain details of the procedures used, the reasons therefore and other pertinent information. The Headworks Operator must forward the report to the Chief Executive together with any comments within six weeks of the completion of the event referred to.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operational procedures in this Manual, the following objectives, listed in descending order of importance, are as follows:

(a) Ensure the structural safety of the dams;

(b) Provide optimum protection of urbanised areas from inundation;

(c) Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

(d) Minimise disruption and impact upon Wivenhoe Power Station;

(e) Minimise disruption to navigation in the Brisbane River.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

3.2.1 Wivenhoe Dam

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences.

Wivenhoe Dam is predominantly a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered a major threat to the security of Wivenhoe Dam. Works are being undertaken between May 2004 and December 2005 to build an auxiliary spillway to cope with the 1:100,000 AEP flood event without overtopping of the dam.

3.2.2 Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences.

Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves.

3.2.3 Extreme Floods and Closely Spaced Large Floods

Techniques for estimating extreme floods indicate that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam itself. Such events however require several days of intense rainfall to produce the necessary runoff.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other. In order to be prepared to meet such a situation, the stored floodwaters from one storm should be discharged from the dams after a flood as quickly as would be consistent with the other major operating principles. Typically the Senior Flood Operations Engineer should aim to empty stored floodwaters within seven days after the flood peak has passed through the lower reaches of the Brisbane River. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The discharges should be regulated so as to have little impact on the urban reaches of the Brisbane River taking into account inflows into the river downstream of the dams. However they may result in submergence of some bridges. The level of flooding as a result of emptying stored floodwaters after the peak has passed is to be less than the flood peak unless accelerated release is necessary to reduce the risk of overtopping.

3.3 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas on the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by using the flood-gates to control releases from the dams, taking into account flooding derived from the lower Brisbane River catchments.

The auxiliary spillway being constructed at Wivenhoe Dam in 2004 and 2005 incorporates fuse plugs. Triggering of a fuse plug will increase floods levels downstream. Where possible, gate operations at both Wivenhoe and Somerset dams should be formulated to prevent operation of the fuse plug. This is likely to be only possible when the forecast peak water level for Wivenhoe Dam just exceeds the trigger level for the fuse plug and sufficient time is available to alter releases.

3.4 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, bridges and areas upstream of the dams may be temporarily inundated. Downstream of the dam, bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily. The deck levels of bridges potentially inundated during flood events are shown on the Drawings in Appendix D.

3.5 Provision of Pumping Pool for Power Station

The power station is not affected by the reservoir level in Wivenhoe Dam during floods other than the impacts high tail water levels have on the efficiency of the power station. The power station does however require a pumping pool for operation. The loss of storage by dam failure would render the power station inoperative.

3.6 Disruption to Navigation

The disruption to navigation in the Brisbane River has been given the lower priority. The effect of flood flows upon navigation in the river varies widely.

Large ships can be manoeuvred in the river at considerable flood flows. On the other hand, barges and dredges are affected by low flows which lower salinity thus decreasing the density of the water which in turn causes craft to sit lower in the water, sometimes bottoming. The Moggill Ferry is also affected by low flood flows.

A short emptying period for the flood storage compartment of the dams is consistent with Objectives (c) and (e) of Section 3.1, which are closely related.

4 FLOOD CLASSIFICATION

For the reference purposes of this Manual, five magnitudes of flooding are classified as follows:

Fresh
This causes only very low-level bridges to be submerged.

Minor Flooding
This causes inconvenience such as closing minor roads and the submergence of low-level bridges. Some urban properties are affected.

Moderate Flooding
This causes inundation of low-lying areas and may require the evacuation of some houses and/or business premises. Traffic bridges may be closed.

Major Flooding
This causes flooding of appreciable urban areas. Properties may become isolated. Major disruption occurs to traffic. Evacuation of many houses and business premises may be required.

Extreme Flooding
This causes flooding well in excess of floods in living memory and general evacuation of whole areas are likely to be required.

Usually a flood does not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted.

(The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia)

5 FLOOD MONITORING AND WARNING SYSTEM

5.1 General

A real time flood monitoring and warning system is established in the Brisbane Valley. This system is based upon an event reporting protocol. A radio telemetry system (ALERT) is used to collect, transmit and receive rainfall and streamflow information. The system consists of more than 50 field stations that automatically record rainfall and/or river heights at selected locations in the Stanley and Brisbane River catchments. Some of the field stations are owned by the Corporation with the remainder belonging to other agencies.

The rainfall and river height data is transmitted by radio telemetry, via repeater stations, to base stations at the head office of the Headworks Operator (and the Corporation). There the data is processed in real time by computer programs to assess what is occurring in the catchments in terms of flood flows and what could occur if weather conditions continued, or changed.

Other agencies with their own base stations can, and do, receive data transmissions direct, and so collect and are able to process rainfall and streamflow information appropriate to their needs.

The real time flood model (RTFM) is a suite of hydrologic and hydraulic computer programs that utilise the real time ALERT data to assist in the operation of the dams during flood events.

5.2 Operation

The Headworks Operator is responsible for operating the computer model provided by the Corporation for flood monitoring and forecasting during flood events to optimise flood gate operations and minimise the impacts of flooding.

It is the responsibility of the Corporation to maintain and keep calibrated its own equipment; and to enter into such arrangements with other agencies or to provide such further equipment as the Corporation deems necessary for the Headworks Operator to properly operate the computer model for flood monitoring and forecasting.

A system such as this is expected to improve over time due to:

- improved operation and reliability with experience,
- improved calibration as further data becomes available,
- software upgrades, and
- the number, type and locations of sensors being varied.

A regular process of internal audit and management review must be maintained to achieve this.

A log of the performance of all field equipment necessary to properly operate the computer model must be kept by the Corporation. The log is to also include all revised field calibrations and changes to the number, type and locations of gauges. Entries onto the log are to be notified to the Headworks Operator without delay in writing.

A log of the performance of the system (ALERT and RTFM) must be kept by the Senior Flood Operations Engineer. Any faults to the computer hardware or software, and any faults to field equipment which the Corporation has not advised the Headworks Operator of, are to be notified to the Corporation without delay in writing. The Corporation must promptly attend to the matters under its control and refer other matters to the appropriate agencies.

Whenever the Senior Flood Operations Engineer considers that the performance and functionality of the system can be improved, by whatever means, a recommendation must be made to the Headworks Operator accordingly. The Headworks Operator must promptly consider, act on, or refer such recommendations to the Corporation as it considers appropriate.

5.3 Storage of Documentation

The performance of any flood monitoring and warning system is reliant on accurate historical data over a long period of time. The Senior Flood Operations Engineer must ensure that all available data and other documentation is appropriately collected and catalogued as approved by the Corporation, for future use.

5.4 Key Reference Gauges

Key field station locations have been identified for reference purposes when flood information is exchanged between authorities or given to the public. Should it be deemed desirable to relocate field stations from these locations, or vary flood classification levels, agreement must first be obtained between the Corporation, Headworks Operator, Bureau of Meteorology and the Local Governments within whose boundaries the locations are situated. The locations and gauge readings at which the various classifications of flooding occur are contained in Appendix D.

Gauge boards that can be read manually must be maintained as part of the equipment of each key field station. The Corporation must have procedures to ensure such gauge boards are read in the event of failure of field stations to operate.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, Ipswich City Council and the Brisbane City Council have direct access to the information from field stations for flood assessment purposes. The consultation between agencies is a very important part of the assessment and prediction of flood flows and heights.

The Corporation must ensure that information relative to the calibration of the Corporation's field stations is shared with such agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

The Corporation is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams.

The Headworks Operator is responsible for ensuring that adequate communication exists at all times between the Flood Operations Engineer and site staff at Wivenhoe and Somerset Dams. Where equipment deficiencies are detected during normal operations, such deficiencies are to be reported within one week to the Corporation for timely corrective action.

6.2 Dissemination of Information

Other agencies have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public. Adequate and timely information is to be supplied to agencies responsible for the operation of facilities affected by flooding and for providing warnings and information to the public. Agency information requirements are generally as shown in Table 6.1.

The Flood Operations Engineer must supply information to each of these agencies during dam releases. For this purpose, the Corporation must maintain a Register of Contact Persons for Information, their means of contact including back up systems, and the specific information, including the timing, to be supplied to each. The Corporation must ensure that each agency receives a copy of the updated Register of Contact Persons for Information whenever amendments are made, but at least every 6 months.

The Corporation, Headworks Operator, Senior Flood Operations Engineer and Flood Operations Engineer must liaise and consult with the agencies with a view to ensuring all information relative to the flood event is consistent, and used and disseminated in accordance with agreed responsibilities.

All enquiries other than provided for in the Register of Contact Persons for Information, either to the Headworks Operator, the Senior Flood Operations Engineer, the Flood Operations Engineer or dam site staff must be referred to the Corporation. The Corporation must provide a mechanism to receive these enquiries from the time it is advised that releases from the dams are likely until flood release operations are completed.

TABLE 6.1 - AGENCY INFORMATION REQUIREMENTS

Agency	Activity	Information Requirement from SEQWC Flood Centre	Trigger
Bureau of Meteorology	Issue of flood warnings for Brisbane River basin	Actual and projected discharges from Wivenhoe Dam Actual and projected discharges from Somerset Dam	Initial gate operations and thereafter at intervals to suit forecasting requirements.
Natural Resources Mines & Energy	Review of flood operations and discretionary powers.	Actual and predicted lake levels and discharges	
Kilcoy Shire Council	Flood level information upstream of Somerset Dam	Actual and predicted lake levels, Somerset Dam	Somerset Dam water level predicted to exceed EL 102
Esk Shire Council	Flood Level information upstream and downstream of Wivenhoe Dam	Actual and predicted lake levels and discharges, Wivenhoe Dam	Initial Wivenhoe Dam gate operation.
Ipswich City Council	Flood level information for Ipswich City area	Nil (information obtained from BoM)	
Brisbane City Council	Flood level information for Brisbane City area	Nil (information obtained from BoM)	

6.3 Release of Information to the Public

The Corporation is responsible for the issue of information regarding storage conditions and current and proposed releases from the dams to the public and the media.

The Bureau of Meteorology has responsibility for issuing flood warnings.

The Emergency Services Response Authorities, under the Disaster Management Act 2003, have responsibility for the preparation of a local counter disaster plan hence the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

This review of the Manual has addressed the mechanisms of delegation and control of the dams in periods of operation of the dams for flood mitigation. It is known overtopping of the dams can result should floods occur which are derived from lesser rainfall than the probable maximum precipitation storm or from the combination of two lesser storms in close proximity. The dams may also overtop in the eventuality that the flood-gate control systems or fuse plugs fail to operate as planned or partially malfunction during the passage of a major flood or combination of floods.

Procedures and systems have been developed that should enable lower risk operation of the dams for flood mitigation purposes. This technology is intended to provide longer warning times and the capability of examining options to optimise the safety of the dams and minimise the hazard potential and risk to the community.

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances.

It is important, therefore, that the Manual contain operational procedures which in themselves cause the Manual's procedures, and the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

The checking and reviewing process must involve the Headworks Operator and all associated operations personnel in order that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based.

Variations to the Manual may be made in accordance with provisions in Section 1.8.

7.2 Personnel Training

The Headworks Operator must report to the Corporation by 30th September each year on the training and state of preparedness of operations personnel. A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources, Mines & Energy within 14 days of it being received by the Corporation.

7.3 Monitoring and Warning System and Communication Networks

The Headworks Operator must provide a report to the Corporation by the 1st May and 1st November of each year; and after each flood event. The report must assess in terms of hardware, software and personnel, the :

- adequacy of the communication and data gathering facilities,

- reliability of the system over the previous period,
- reliability of the system under prolonged flood conditions,
- accuracy of forecasting flood flows and heights, and
- the overall state of preparedness of the system.

The Corporation must review the report, and taking into account its own log of the performance of the field equipment, take any action considered necessary for the proper functioning and improvement of the system. . A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources, Mines & Energy within 14 days of it being received by the Corporation.

7.4 Operational Review

After each significant flood event, the Corporation must review the effectiveness of the operational procedures contained in this manual. The Headworks Operator is required to prepare a report for submission to the Corporation within six weeks of any flood event that requires mobilisation of the Flood Control Centre. A copy of this report must be forwarded to the Chief Executive of the Department of Natural Resources, Mines & Energy within 14 days of it being received by the Corporation.

7.5 Five Yearly Review

Prior to the expiry of the approval period, the Corporation must review the Manual pursuant to Section 6 Division 2 of the Act. The review is to take into account the continued suitability of the communication network, and the flood monitoring and warning system as well as hydrological and hydraulic engineering assessments of the operational procedures. The hydrologic investigations performed for the purpose of this manual are discussed in Appendix I.

8 WIVENHOE DAM OPERATIONAL PROCEDURES

8.1 Introduction

Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the dam, depending on the part of the catchment in which the flood originates and depending also on the magnitude of the flood. Maximum overall flood mitigation effect will be achieved by operating Wivenhoe Dam in conjunction with Somerset Dam.

A general plan and cross-section of Wivenhoe Dam, and relevant elevations are included in Appendix J. Storage and discharge data are included in Appendix E.

The reservoir volume above FSL of EL 67.0 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the initial reservoir level below FSL, the magnitude of the flood being regulated and the procedures adopted. Spiltyard Creek Dam is part of the overall Wivenhoe Area Project and it forms the upper pumped storage of the peak power generation scheme. Splityard Creek Dam impounds a volume of 28 700 ML at its normal full supply level (EL 166.5). The contents of Splityard Creek Dam can be emptied into Lake Wivenhoe within 12 hours by releasing water through the power station conduits. This volume of water can affect the level in Wivenhoe Dam by up to 300mm when Wivenhoe Dam is close to FSL. Operation of the power station and therefore also release of water from Splityard Creek Dam to Lake Wivenhoe is outside the control of the Corporation. The operational level of Splityard Creek Dam should be considered when assessing the various trigger levels of Wivenhoe Dam.

The Corporation has acquired land above FSL to a level of EL 75.0 to provide temporary flood storage. Reasonable care must be exercised to confine the flood rises to below this level. This requirement should be ignored in the case of extreme floods that threaten the safety of the dams.

8.2 Auxiliary Spillway

The auxiliary spillway for Wivenhoe Dam being constructed in 2004/05 as part of an upgrade to improve flood adequacy consists of a three bay fuse plug spillway at the right abutment. In association with other works being carried out at the dam, this will give the dam crest flood an annual exceedance probability (AEP) of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam two in the future.

Pertinent information about the auxiliary spillway, including the initiation level for the specific bays is given in Table 8.1.

TABLE 8.1 -RIGHT BANK FUSE PLUG DETAILS

Auxiliary Spillway Component	Spillway Crest Control Type	Spillway Crest Width (m)	Spillway Crest Level (m AHD)	Lake Level at Fuse Plug Initiation (m AHD)
Central fuse plug bay	Ogee	34	67	75.7
Right hand side fuse plug bay	Ogee	64.5	67	76.25
Left hand side fuse plug bay	Ogee	65.5	67	77.2

8.3 Initial Flood Control Action

When indications are received of an imminent flood, the flood control operation of the dam must commence with the storing of all inflow of the Brisbane River in Wivenhoe Dam, whilst an assessment is made of the origin and magnitude of the flood. The spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25.

8.4 Regulator and Gate Operation Sequences

Rapid opening of outlets (spillway gates and regulators) can cause hydraulic surges and other effects in the Brisbane River that can endanger life and property and may sometimes have other adverse effects. Under normal gate operations, the gates and regulators are therefore to be operated one at a time at intervals that will minimise adverse impacts on the river system.

Rapid closure of the gates can affect river-bank stability. Rapid closure of more than one gate at a time should only be used when time is critical and there is a requirement to correct a malfunction to preserve storage or to reduce downstream flooding rapidly. For flood operations where time is not critical, longer closure intervals should be used. The minimum closure intervals specified below are based on the recession limb of natural flood hydrographs such as the January 1974 flood.

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a gate by the immediate opening of a regulator valve (or the reverse operation). This allows for greater control of low flows and enables a smooth transition and closure as slow as possible to prevent the stranding of fish downstream of Wivenhoe Dam.

Except as provided for in procedure 4 of Section 8.4 where it is necessary to prevent operation of a fuse plug or to have the gates clear of the spillway flow prior to the fuse plug operating and as indicated above, the gate opening and closing intervals as shown in Table 8.2 are the most rapid permitted for flood mitigation purposes.

TABLE 8.2 - MINIMUM INTERVALS FOR NORMAL GATE OPERATIONS

500 mm Incremental gate openings	10 minutes
500 mm Incremental gate closures	20 minutes
Full regulator opening or closures	30 minutes

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

Under normal operation, only one gate is to be opened at any one time and the sequences given in Table 8.3 are to be adopted:

TABLE 8.3 – RADIAL GATE OPENING SEQUENCES[1]

Approximate Discharge Range	Gate opening sequence[2]	Comments
(a) Up to 330 m^3/sec	Open Gate 3 up to 3.5 metres	Gates 1, 2, 4 & 5 remain closed
(b) 330 m^3/sec to 575 m^3/sec	Gate 3 at 3.5 metres Open Gates 2 & 4 alternately to 0.5 metre Open Gate 3 to 4.0 metre Open Gates 2 & 4 alternately to 1.0 metre	Gates 1 & 5 remain closed unless discharge from Gates 2 & 4 impinges on side wall of plunge pool proceed to (c)
(c) 575 m^3/sec to 1160 m^3/sec	Gate 3 kept at 4.0 metres Open Gates 1 & 5 alternately one increment followed by Gates 2 & 4 alternately one increment Repeat Step until at the end of the sequence Gates 1 & 5 are open 1.5 metres and Gates 2 & 4 are open 2.5 metres	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not more than 1.0 metre more than Gates 1 & 5
(d) 1160 m^3/sec to 1385 m^3/sec	Open Gate 3 to 4.0 metres Open Gates 1 & 5 alternately to 2.0 metres followed by opening Gates 2 & 4 alternately to 3.0 metres	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not more than 1.0 metre more than Gates 1 & 5
(e) 1385 m^3/sec to 2290 m^3/sec	Open ALL gates to 5.0 metre openings	Flow in spillway to be as symmetrical as possible Gates 2 & 4 are to have openings not less than Gates 1 & 5 or not more than 1.0 metre more than Gates 1 & 5 Gate 3 is to have an opening not less than Gates 2 & 4 or not more than 1.0 metre more than Gates 2 & 4.
(f) Greater than 2290 m^3/sec	Open ALL gates incrementally in the sequence 3, 2, 4, 1, 5[3]	Flow in spillway to be as symmetrical as possible Gate 3 to have the largest opening Gates 2 & 4 are to have openings greater than Gates 1 & 5

1 Gates are numbered 1 to 5 from the left bank looking downstream.
2 Gate movements are to normally occur in 500 mm increments.
3 When the accelerated opening rate applies, gate opening increments of 1.0 metres may be used.

Gate operating procedures in the event of equipment failure are contained in Appendix G. If one or more gates are inoperable during the course of the flood event, the gate openings of the remaining gates are to be adjusted to compensate. These adjustments should ensure that:

a) the impact of the flow on the sidewalls of the plunge pool should be minimised, and
b) the flow in the spillway is as symmetrical as practicable.

In general, gate closing is to occur in the reverse order. The final gate closure should occur when the lake level has returned to Full Supply Level.

8.5 Flood Control Procedures

When the preliminary estimation of the degree of expected flooding has been made, the operating procedures set out hereunder shall be used at Wivenhoe Dam in line with the Flood Mitigation Objectives.

When considering the discharge to be made from both Wivenhoe Dam under particular procedures, the total discharge for each dam from all sources is to be considered when determining the appropriate openings for gates, valves and sluices.

The flood control procedures to be adopted commence with Procedure 1 and extend through to Procedure 4 as the magnitude of the flood as predicted by the real time flood model increases. Table 8.5 summarises the application for each procedure for the initial filling of Wivenhoe Dam. Once Wivenhoe Dam has peaked and the drainage phase has commenced the indicative limits will not apply.

Procedure 1

Under Procedure 1, water is to be released from Wivenhoe Dam with care being taken not to prematurely submerge the downstream bridges. The limiting condition for Procedure 1 is the submergence of Mt Crosby Weir Bridge that occurs at approximately 1,900 m^3/sec.

The procedure adopted primarily depends on the level in Wivenhoe Dam and the discharge emanating from Lockyer Creek.

For situations where flood rains are occurring on the catchment upstream of Wivenhoe Dam and only minor rainfall is occurring downstream of the dam, releases are to be regulated to limit, as much as appropriate in the circumstances, downstream flooding. Except in the drainage phase releases are not to exceed the values given in Table 8.4:-

TABLE 8.4 – WIVENHOE DAM, PROCEDURE 1 MAXIMUM RELEASE RATES

Lake Level in Wivenhoe Dam	Maximum Release Rate (m^3/sec)
67.00 - 67.25	0
67.25 - 67.50	110
67.50 - 67.75	380
67.75 - 68.00	500
68.00 - 68.25	900
68.25 - 68.50	1900

The following subsets of Procedure 1 were originally developed by the Brisbane City Council to cater for limiting the submergence of the various low-level downstream bridges. The procedures require a great deal of control over releases and knowledge of discharges from Lockyer Creek.

In general, the releases from Wivenhoe Dam are controlled such that the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values to delay the submergence of particular bridges.

Procedure 1A — *Savages Crossing & Colleges Crossing*

For: Lake level between 67.25 and 67.5 m AHD [Maximum Release 110 m^3/sec]

Endeavour to maintain Twin Bridges trafficable by limiting releases at Wivenhoe Dam to a maximum of 50 m^3/sec and by reducing this rate of release if run-off from Lockyer Creek is likely to cause the bridges to be overtopped. The bridges become untrafficable at a flow of about 55 m^3/sec.

Once Twin Bridges are overtopped by run-off from Lockyer Creek, release to be directed towards maintaining College's Crossing trafficable by adjusting the rate of release so that the combined flow rate at College's Crossing is less than 175 m^3/sec.

Procedure 1B — *Noogoorah Bridge (Burtons Bridge)*

For: Lake level between 67.50 and 67.75 m AHD [Maximum Release 380 m^3/sec].

Initially endeavour to maintain College's Crossing trafficable. This becomes untrafficable at a flow of about 175 m^3/sec. No consideration to be given to keeping Twin Bridges trafficable.

Once College's Crossing is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to achieve a combined flow of about 380 m^3/sec at the Noogoorah Bridge Crossing. This bridge becomes untrafficable at a flow of about 430 m^3/sec.

Procedure 1C — *Kholo Bridge*

For: Lake level between 67.75 and 68.00 m AHD [Maximum Release 500 m^3/sec]

Initially endeavour to maintain Noogoorah Bridge trafficable. No consideration to be given to keeping College's Crossing trafficable.

Once Noogoorah Bridge is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to keep Kholo Bridge trafficable. This bridge becomes untrafficable at a flow rate of about 550 m^3/sec.

<u>Procedure 1D</u> Mt Crosby Weir Bridge

For: Lake level between 68.00 and 68.25 m AHD [Maximum Release 900 m^3/sec]

Initially endeavour to maintain Kholo Bridge trafficable. No consideration to be given to keeping Noogoorah Bridge trafficable.

Once Kholo Bridge is flooded by the run-off from Lockyer Creek and the downstream section of the Brisbane River, releases to be set to keep Mt Crosby Bridge trafficable. This bridge becomes untrafficable at a flow of 1,900 m^3/sec.

<u>Procedure 1E</u> Mt Crosby Weir Bridge

For: Lake level between 68.25 and 68.50 m AHD [Maximum Release 1,900 m^3/sec]

Similar to Procedure 1D, but with an upper release limit of 1,900 m^3/sec.

If the level reaches EL 68.5 m AHD in Wivenhoe Dam, operations switch to Procedure 2 or 3 as appropriate.

Procedure 2 may be bypassed if it is clear from the flood modelling that Procedure 3 will be activated.

Procedure 2

Under Procedure 2, water is to be released from Wivenhoe Dam with care being taken not to submerge Fernvale Bridge and Mt Crosby Weir Bridge prematurely. Typically releases will take place on the rising limb of the flow from Lockyer Creek. If this flow is sufficient to submerge Mt Crosby Weir bridge (1,900 m^3/sec), releases are to be increased such that the combined flow from Lockyer Creek and Wivenhoe Dam releases does not exceed either:-

(i) 3,500 m^3/sec at Lowood or
(ii) the greater of the peak flow of Lockyer Creek or the predicted peak flood flow of the Bremer River.

Should the Mt Crosby Weir Bridge be flooded by flows from catchments downstream of Wivenhoe Dam, the upper limit of the combined Lockyer Creek flow and releases from Wivenhoe Dam shall, subject to (i) and (ii) above, not exceed 3,500 m^3/sec at Lowood.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 3

Under Procedure 3, water is to be released from Wivenhoe Dam such that the combined Lockyer Creek flood flow and Wivenhoe Dam release is not to exceed 3,500 m^3/sec at Lowood. The releases are to be regulated such that the total regulated flow at Moggill gauge downstream of the Bremer River junction does not exceed 4,000 m^3/sec [which is the upper limit for non-damaging flows for the urban reaches of the Brisbane River].

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4

This procedure normally comes into effect when the water level in Wivenhoe Dam reaches EL 74. However the Senior Flood Operations Engineer may seek to invoke the discretionary powers of section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.

Under Procedure 4 the release rate is increased as the safety of the dam becomes the priority. Opening of the gates is to occur until the storage level of Wivenhoe Dam begins to fall.

If required, the minimum time interval between gate openings can be reduced or successive gate openings of the same gate may be used in this procedure as considered appropriate. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals

Sub-procedures 4A, 4B and 4C have been developed for use depending on the stage of construction of the auxiliary spillway and the expected peak water level in the dam.

Procedures 4A and 4B are only to be applied once the auxiliary spillway fuse plug is functional. This is expected to be in the latter part of 2005. In the interim, Procedure 4C is applicable.

Procedure 4A

Procedure 4A applies while all indications of the peak flood level in Wivenhoe Dam are it will be insufficient to trigger operation of the first bay of the fuse plug by reaching EL 75.5.

Gate openings are to occur at the minimum intervals and sequences as specified in section 8.3. Opening of the gates is to continue until the storage level of Wivenhoe Dam begins to fall.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4B

Procedure 4B applies once indications are the peak flood level in Wivenhoe Dam will exceed EL75.5 using the minimum gate opening intervals for normal operation as specified in section 8.3 i.e. it is expected that the fuse plug will be triggered under normal operation.

In this procedure the minimum time interval between gate openings is able to be reduced and successive gate openings of the same gate may be made.

If the real time flood model using a 1 metre in 10 minute gate opening procedure, predicts a peak water level in Wivenhoe Dam of less than EL 75.5, the gates may be raised at a rate to maximise flood storage capacity but to prevent the first fuse plug from initiating.

Otherwise the gates are to be raised at a rate to ensure they are out of the water before the initiation of the first fuse plug (if possible). Where practicable, the gates are to be in the fully open position before the dam water level reaches 75.7 m AHD.

In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

The effect of varying the operational procedures at Somerset Dam in keeping the peak flood level at Wivenhoe Dam below EL 75.7 may also be investigated using the real time flood model.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

Procedure 4C

Procedure 4C applies only during the construction phase of the right bank auxiliary spillway.

Opening of the gates is to occur until the storage level of Wivenhoe Dam begins to fall. The minimum time interval between gate openings can be reduced or successive gate openings of the same gate may be used in this procedure as considered appropriate for ensuring the safety of the dam. In addition to dam safety issues, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered in determining these intervals.

The gate opening constraints are to be overridden when the gates will be overtopped during normal operation.

TABLE 8.5 WIVENHOE DAM – NORMAL RELEASE OPERATING PROCEDURES: INITIAL FILLING

Procedure	Reservoir Level	Applicable Limits		
0	EL < 67.25	$Q_{Wivenhoe}$ = 0 m³/sec ... i.e No Releases		
1A	67.25 < EL < 67.50	$Q_{Wivenhoe}$ < 110 m³/sec	$Q_{Colleges\ Crossing}$ < 175 m³/sec with care taken not to submerge Twin Bridges prematurely	
1B	67.25 < EL < 67.50	$Q_{Wivenhoe}$ < 380 m³/sec	$Q_{Burtons/Noogoorah}$ < 430 m³/sec with care taken not to submerge Colleges Crossing prematurely	
1C	67.75 < EL < 68.00	$Q_{Wivenhoe}$ < 500 m³/sec	Q_{Kholo} < 550 m³/sec with care taken not to submerge Burtons/Noogoorah prematurely	
1D	68.00 < EL < 68.25	$Q_{Wivenhoe}$ < 900 m³/sec	$Q_{MtCrosby}$ < 1900m³/sec with care taken not to submerge Kholo prematurely	
1E	68.25 < EL < 68.50	$Q_{Wivenhoe}$ < 1500 m³/sec	$Q_{MtCrosby}$ < 1900m³/sec with care taken not to submerge Kholo prematurely	
2	68.50 < EL < 74.00	Q_{Lowood} < 3500 m³/sec	Q_{Lowood} < peak of Lockyer <u>and</u> Q_{Lowood} < peak of Bremer	Gates are <u>NOT</u> to be overtopped
3	68.50 < EL < 74.00	Q_{Lowood} < 3500 m³/sec	$Q_{Moggill}$ < 4000 m³/sec	
4	EL > 74.00[4]	Gates are to be opened until reservoir level begins to fall		

4 Once water level exceeds EL 74.0, operating procedures are dependant on the predicted peak water level.

8.6 Closing Procedures

If at the time the lake level in Wivenhoe Dam begins to fall, the combined flow at Lowood is in excess of 3500 m^3/sec, then the combined flow at Lowood is to be reduced to 3500 m^3/sec as quickly as practicable having regard to Section 3, and is to remain at this rate until final gate closure procedures can commence.

Gate closing procedures should be initiated having regard to the following requirements:

a) Early release of stored water to regain flood-mitigating ability for any subsequent flood inflows as described in Section 3.2.3.

b) The total discharge from Wivenhoe Dam from all sources is to be considered when considering appropriate closing procedures. This includes any discharge from triggered fuse plugs.

c) Gate operation procedures as described in Section 8.4.

d) Establishment of storage at FSL at completion of flood events.

e) Downstream impact of the discharges. To prevent the stranding of fish downstream of the dam, closures below flows of 275 m^3/sec should be undertaken as slow as practicable and if possible such closures should occur during daylight hours on a weekday so that personnel are available for fish rescue.

If the flood storage compartments of Wivenhoe Dam and Somerset Dam can be emptied within the prescribed time of seven days, the release from Wivenhoe Dam should be limited to between 1900 m^3/sec and 3500 m^3/sec. In such circumstances, the release from the dam should be less than the peak flow into the lake. Where possible, total releases during closure should not produce greater flood levels downstream than occurred during the flood event.

8.7 Modification to Flood Operating Procedures if a Fuse Plug triggers prematurely

Where the operation of a fuse plug spillway bay has been triggered prior to its design initiation level being reached, the flood operation procedures are to be modified such that:

- the discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;
- the gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.8 Modification to Flood Operating Procedures if a subsequent flood event occurs prior to the reconstruction of Triggered Fuse Plugs

Where the operation of any or all of the fuse plug spillway bays has been triggered and a flood event occurs before the fuse plug can be reinstated, the flood operation procedures are to be modified such that:

- the discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;

- the gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.9 Additional Provisions during Construction Works 2004/05

8.9.1 Auxiliary Spillway Area

The embankment forming the temporary road diversion that acts as a coffer dam is to be retained in place until the construction of the fuse plug has proceeded past EL 74, and then its removal is only to proceed once the written approval of a Senior Flood Operations Engineer has been obtained.

8.9.2 Gated Spillway Area

The following provisions will apply for works undertaken within the gated spillway:

- The opening of spillway gates to discharge floodwaters is at the sole discretion of the Senior Flood Operations Engineer;
- There is to be no obstruction of any spillway bay without the written approval of the Senior Flood Operations Engineer;
- All gates are to be capable of being operated at short notice during a flood if required. To ensure this capability is maintained Table 8.6 specifies limitations that apply to the number of bays in which works may be occurring at any time. This table also nominates a target notice period to be provided by the Senior Flood Operations Engineer for the removal of construction material from the spillway bays prior to their use for releases. However the Senior Flood Operations Engineer is not constrained to provide this length of notice before operating any particular gate if its earlier operation is considered necessary.

Table 8.6 – Gated Spillway Area Works Restrictions

Dam Level	Season	Maximum number of bays that may be occupied at any time	Comments
Below EL 64.0	Winter (May to September)	3	12 hours notice to clear spillway
Below EL 64.0	Summer (October to April)	2	12 hours notice to clear spillway
Above EL 64.0	Winter (May to September)	2	12 hours notice to clear spillway
Above EL 64.0	Summer (October to April)	2	12 hours notice to clear spillway
Above EL 66.0	Flood Season (January to April)	1	Preferably not gate 1 or 5, 6 hours notice to clear spillway

- A maximum of one gate may be treated as inoperable and remain closed if a flood will severely damage works if it is opened, and the expected flood magnitude can be catered for with 4 gates. The other gates are to be operated in accordance with the existing flood operational procedures but to compensate for the loss of flow in the closed gate. As the flood rises to the top of the closed gate at an EL 73 m AHD, the gate is incrementally raised to prevent it from being overtopped. It is noted that a large flood is required for the lake level to reach EL 73 m AHD.

The Corporation must prepare a Standing Operating Procedure for the conduct of works in the gated spillway whereby the above provisions are met such the capacity to achieve the dam's operational objectives is maintained.

9 SOMERSET DAM OPERATIONAL PROCEDURES

9.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods. Somerset Dam and Wivenhoe Dam are meant to be operated in conjunction to optimise the flood mitigation capacity downstream of Wivenhoe Dam.

A general plan and cross-section of Somerset Dam, and relevant dam operating levels are included in Appendix J.

The discharge capacities for various storage levels of Somerset Dam are listed in Appendix F.

9.2 Initial Flood Control Action

Upon indications being received of a significant inflow, the flood control operation of the dam shall commence with the raising of any closed gates and the closure of all low level regulators and sluices, whilst an assessment is made of the origin and magnitude of the flood.

9.3 Regulator and Gate Operation Procedures

The following minimum intervals must be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes:

TABLE 9.1- MINIMUM INTERVALS, NORMAL OPERATION, SOMERSET DAM

	OPENING	CLOSING
Regulators	30 minutes	60 minutes
Sluice Gates	120 minutes	180 minutes
Crest Gates	Gates are normally open	

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a sluice gate by the immediate opening of one or more regulator valves (or the reverse operation). This allows for greater control of low flows and enables a smooth transition on opening and closing sequences.

9.4 Flood Control Procedure

It is essential that the operating procedures adopted should not endanger the safety of Wivenhoe Dam downstream. Within this constraint, the Senior Flood Operations Engineer must adopt a procedure for the operation of Somerset Dam such that:

a) the structural safety of Somerset Dam is not endangered;

b) the Upper Brisbane River flood flow plus Somerset Dam releases does not cause Wivenhoe Dam to be overtopped.

The normal operating procedure to be used for Somerset Dam is as follows.

The crest gates are raised to enable uncontrolled discharge. The low level regulators and sluices are to be kept closed until either:

(i) the lake level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

In the case of (i) above the opening of the regulators and sluices is not to increase the inflow to Wivenhoe Dam above the peak inflow from the Brisbane River just passed or, if possible, not to cause the Wivenhoe Dam lake level to exceed EL 74.

In the case of (ii) above, the Senior Flood Operations Engineer must direct the operation of the low-level regulators and sluices to ensure the safety of Somerset Dam. If the water level and predicted inflows are such that the safety of Somerset Dam is not an overriding concern, operations are to target a correlation of water levels in Somerset Dam and Wivenhoe Dam as set out in Table 9.2 such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and EL 107.46, the non-spillway crest level in Somerset Dam.

TABLE 9.2 – Water Level Correlation Targets

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

If the flood event emanates from the Stanley River catchment only, without significant runoff in the Upper Brisbane River catchment, the operation of Somerset Dam will proceed on the basis that Wivenhoe Dam has peaked as per (i) above.

The Somerset Dam gates and valves may also be temporarily closed if such action is able to prevent a fuse plug from initiating. Such closure is not to threaten the safety of the dam

10 EMERGENCY FLOOD OPERATIONS

10.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition either through flood events or other causes. Experience elsewhere in the world suggests that vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than the discharge capacity of the dam;
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood.
- Development of a piping failure through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;
- Other uncommon mechanisms.

Responses to these and other conditions are included in separate Emergency Action Plans.

10.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates. The probability of overtopping of Wivenhoe Dam will be significantly reduced following the completion of the auxiliary spillway.

Somerset Dam should, if possible, not be overtopped by flood water but, if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced, for example by the use of its spillway gates, even at the risk of overtopping Somerset Dam in order to prevent, if possible, the overtopping of Wivenhoe Dam.

10.3 Communications Failure

In the event of normal communications being lost between the Flood Operations Engineer and either Wivenhoe Dam or Somerset Dam, the dam supervisor at that dam is to maintain contact with the dam supervisor at the other dam, to receive instructions through the remaining communications link.

In the event of normal communications being lost between the Flood Operations Engineer and both Wivenhoe Dam and Somerset Dam, the dam supervisors at each dam are to adopt the procedures set out below during flood events, and are to maintain contact with each other, where possible.

If all communications are lost between the Engineer, Wivenhoe Dam and Somerset Dam, the officers in charge at each dam are to adopt the procedures set out below.

10.3.1 Wivenhoe Dam Emergency Procedure

In the event of total communication failure, the minimum gate openings related to lake levels up to EL 74 are set out in the Table 10.1 are to be maintained for both opening and closing operations. Once the lake level exceeds EL 74 the gates are to be raised at the rate of 1 metre per 10 minutes till the water level peaks or the gates are fully open.

Table 10.1 Minimum Gate Openings Wivenhoe Dam

Lake Level m AHD	Gate 3 Opening (m)	Gates 2 & 4 Opening (m)	Gates 1 & 5 Opening (m)	Total Discharge m^3/sec
67.0		-	-	0
67.5	0.5	-	-	50
68.0	1.5	-	-	155
68.5	2.5	-	-	260
69.0	3.5	0.5	-	470
69.5	4.0	1.0	-	640
70.0	4.0	1.5	0.5	875
70.5	4.0	2.0	1.0	1115
71.0	4.0	2.5	1.5	1365
71.5	4.5	2.5	2.0	1560
72.0	4.5	3.0	2.5	1820
72.5	5.0	4.0	3.0	2250
73.0	5.0	5.0	5.0	2960
73.5	6.5	6.5	6.5	3850
74.0	8.0	8.0	8.0	4750
>74.0	Gates are to be raised at the rate of 1 metre per 10 minutes till the water level peaks or gates are fully open			
75.7	Gates are to be fully open before the first fuse plug triggers at this level.			

If one or more gates become inoperable, then by reference to Table E-2 the gate openings of operable gates are to be increased in order that the discharges for the lake levels shown in Table 10.1 are achieved.

If, because of compliance with the provisions of Section 8.3 and the high inflow rate, the minimum gate openings cannot be maintained, the time intervals between successive openings shown in Table 8.2 are to be halved.

If the actual gate openings fall more than three settings below the cumulative number of minimum settings of Table 10.1, then successive gate operations are to be carried out as rapidly as possible until the minimum settings are achieved. Under these circumstances, it may be necessary to operate more than one gate at any one time.

10.3.2 Somerset Dam Emergency Procedure

In the event of total communication failure, the spillway gates are to be kept raised to allow uncontrolled discharge. The regulators and sluices are to be kept closed until either:

(i) the level in Wivenhoe Dam begins to drop or

(ii) the level in Somerset Dam exceeds EL 102.25.

The level in Wivenhoe Dam can be determined locally by the Dam Supervisor at Somerset Dam from the tailwater gauge located just downstream of Somerset Dam.

In the case of (i) above, the opening of the regulators and sluices is not to increase the level in Wivenhoe Dam above the peak level already attained. Section 9.3 on regulator and gate operation interval is to be observed.

In the case of (ii) above, the regulators and sluices are to be operated such that the free-board between the flood level in Wivenhoe Dam and EL 77 is the same as the free-board between the flood level in Somerset Dam and the non-spillway crest level in Somerset Dam (EL 107.46). Table 10.2 gives the water level correlations. The low level outlets in Somerset Dam are not to be opened if the water level in Wivenhoe Dam exceeds the level set out below for given water levels in Somerset Dam.

TABLE 10.2 – Water Level Correlation Targets

Somerset Lake Level m AHD	Wivenhoe Lake Level m AHD
102.5	72
103.5	73
104.5	74
105.5	75
106.5	76
107.46	77

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

10.4 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix G for Wivenhoe Dam and Appendix H for Somerset Dam.

APPENDIX A. EXTRACT FROM WATER ACT 2000

Division 2 – Flood Mitigation

Owners of certain dams must prepare flood mitigation manual

496.(1) A regulation may nominate an owner of a dam as an owner who must prepare a manual (a "flood mitigation manual") of operational procedures for flood mitigation for the dam.

(2) The regulation must nominate the time by which the owner must comply with section 497(1).

Approving flood mitigation manual

497.(1) The owner must give the chief executive a copy of the flood mitigation manual for the chief executive's approval.

(2) The chief executive may, by gazette notice, approve the manual.

(3) The approval may be for a period of not more than 5 years.

(4) The chief executive may get advice from an advisory council before approving the manual.

Amending flood mitigation manual

498.(1) The chief executive may require the owner, by notice, to amend the flood mitigation manual.

(2) The owner must comply with the chief executive's request under subsection (1).

(3) The chief executive must, by gazette notice, approve the manual as amended.

(4) The approval of the manual as amended must be for-

(a) the balance of the period of the approval for the manual before amendment; or

(b) a period of not more than 5 years from the day the manual as amended was approved.

(5) The chief executive may get advice from an advisory council before approving the manual as amended.

Regular reviews of flood mitigation manual

499. Before the approval for the flood mitigation manual expires, the owner must-

review, and if necessary, update the manual; and

give a copy of it to the chief executive under section 497.

Protection from liability for complying with flood mitigation manual

500.(1) The chief executive or a member of the council does not incur civil liability for an act done, or omission made, honestly and without negligence under this division.

(2) An owner who observes the operational procedures in a flood mitigation manual approved by the chief executive does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures.

(3) If subsection (1) or (2) prevents civil liability attaching to a person, the liability attaches instead to the State.

(4) In this section-

"owner" includes-

a) a director of the owner or operator of the dam; or

b) an employee of the owner or operator of the dam; or

c) an agent of the owner or operator of the dam

APPENDIX B AGENCIES HOLDING DOCUMENTS

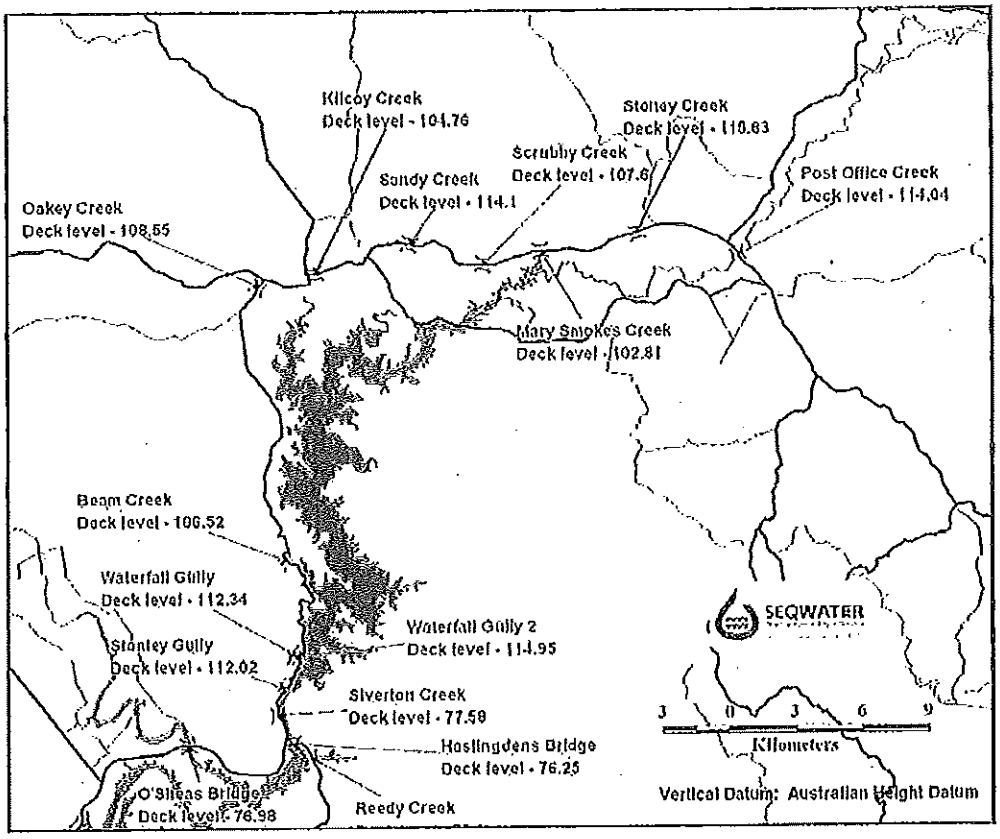
AGENCIES HOLDING CONTROLLED DOCUMENTS OF MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION FOR WIVENHOE DAM AND SOMERSET DAM

Dam Owner	South East Queensland Water Corporation
Emergency Services	Department of Emergency Services, Disaster Management Service Brisbane City Counter Disaster Committee Esk Shire Counter Disaster Committee Ipswich City Counter Disaster Committee Kilcoy Shire Counter Disaster Committee
Severe Weather Warning Authority	Bureau of Meteorology
Primary Response Authorities	Brisbane City Council Esk Shire Council Ipswich City Council Kilcoy Shire Council
Regulator of Dam Safety	Department of Natural Resources, Mines & Energy
Dams Operator	SunWater

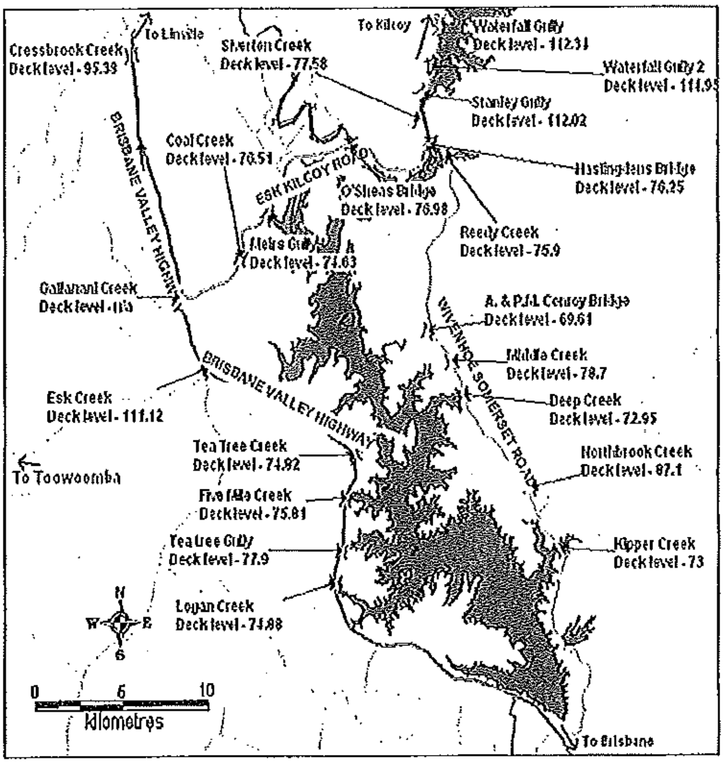
The Corporation must keep a register of contact persons of holders of controlled documents (Section 1.9 refers).

APPENDIX C BRIDGE DECK LEVELS

Roads Upstream of Somerset Dam

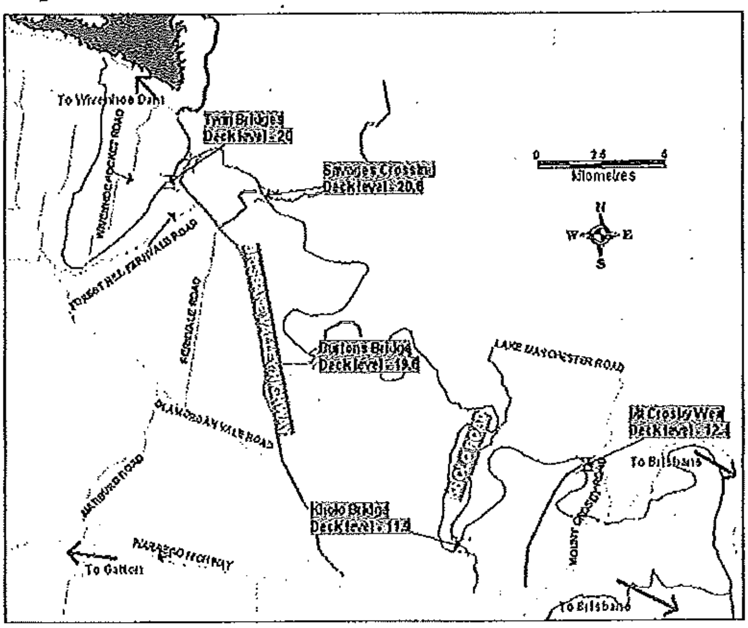


Roads Surrounding Wivenhoe Dam



SEQWATER

Bridges Downstream of Wivenhoe Dam



SEQWATER

APPENDIX D GAUGES AND BRIDGES

Table D.1. KEY REFERENCE GAUGES

Location	GZ	1974 Gauge Height	Minor		Moderate		Major	
			Gauge Height	Flow	Gauge Height	Flow	Gauge Height	Flow
			m	m³/s	m	m³/s	m	m³/s
Stanley R at Somerset Dam*	0.00 AHD	-	103.0		105.0		106.0	
Brisbane R at Lowood	23.68 AHD	22.02	8.0		15.0		20.0	
Brisbane R at Lowood*	22.74 SD	-	8.6	1000	15.9	3300	21.2	6000
Brisbane R at Savages Crossing*	18.43 AHD	23.79	9.0		16.0		21.0	
Brisbane R at Mt Crosby*	0.00 AHD	26.74	11.0		13.0		21.0	
Bremer R at Ipswich*	0.00 AHD	20.70	7.0		9.0		11.7	
Brisbane R at Moggill*	0.00 AHD	19.95	10.0		13.0		15.5	
Brisbane R at Jindalee Br*	0.00 AHD	14.10	6.0	4000	6.0	5000	10.0	8500
Brisbane R at City Gauge*	0.00 AHD	5.45	1.7		2.6		3.5	

* Indicates an automatic gauge
Flows are approximate only and gauge heights are tide dependent in the lower reaches.
A complete list of the latest river heights can be found at http://www.bom.gov.au

Table D.2. SUBMERGENCE FLOWS FOR BRIDGES

AMTD	Bridge Name	Location	Estimated Submergence Flow m^3/sec
140	Twin Bridges	Wivenhoe Pocket Road, Fernvale	50
132	Savage's Crossing	Banks Creek Road, Fernvale	130
87	College's Crossing	Mt Crosby Rd, Karana Downs	175-200*
120	Burton's Bridge	E Summerville Road, Borallon	430
100	Kholo Bridge	Kholo Rd, Ipswich	550
91	Mt.Crosby Weir Bridge	Allawah Rd, Mt Crosby	1900
136	Fernvale Bridge	Brisbane Valley Hwy, Fernvale	2000

* Affected by tides.

APPENDIX E WIVENHOE DAM TECHNICAL DATA

TABLE E1 STORAGE AND UNCONTROLLED GATE DISCHARGES

Lake level m AHD	Storage Capacity 10^6 m^3	*** Flood Capacity 10^6 m^3	** Net Inflow per 1mm rise per hour m^3/sec	* Discharge per Regulator m^3/sec	* Discharge per Spillway Bay m^3/sec	Maximum Available Discharge m^3/sec
57.0	414	-	11.10	24.9	0	50
57.5	453	-	12.04	25.2	4	69
58.0	466	-	12.97	25.4	15	128
58.5	494	-	13.90	25.7	32	211
59.0	523	-	14.84	25.9	53	316
59.5	553	-	15.77	26.2	77	439
60.0	584	-	16.71	26.4	105	579
60.5	616	-	17.64	26.6	136	735
61.0	649	-	18.58	26.9	170	905
61.5	683	-	19.51	27.1	207	1 090
62.0	719	-	20.45	27.3	246	1 290
62.5	756	-	21.38	27.5	288	1 495
63.0	795	-	22.32	27.8	333	1 720
63.5	835	-	23.25	28.0	379	1 950
64.0	877	-	24.19	28.2	428	2 195
64.5	920	-	25.12	28.4	479	2 450
65.0	965	-	26.06	28.7	532	2 720
65.5	1 012	-	26.99	28.9	587	2 995
66.0	1 061	-	27.92	29.1	645	3 280
66.5	1 112	-	28.86	29.3	704	3 580
67.0	1 165	0	29.79	29.5	765	3 885
67.5	1 220	56	30.73	29.7	828	4 200
68.0	1 276	112	31.66	29.9	893	4 525
68.5	1 334	171	32.60	30.1	959	4 860
69.0	1 393	230	33.53	30.3	1 028	5 200
69.5	1 454	290	34.47	30.5	1 098	5 550
70.0	1 517	350	35.40	30.7	1 170	5 910
70.5	1 581	418	36.33	30.9	1 244	6 280
71.0	1 647	485	37.27	31.1	1 319	6 660
71.5	1 714	550	38.20	31.3	1 396	7 040
72.0	1 783	615	39.14	31.5	1 474	7 430
72.5	1 854	683	40.07	31.7	1 554	7 840
73.0	1 926	750	41.01	31.9	1 636	8 240
73.5	2 000	830	41.94	32.1	1 719	8 660
74.0	2 076	910	42.87	32.3	1 804	9 080
74.5	2 153	995	43.81	32.5	1 890	9 520
75.0	2 232	1 080	44.74	32.7	1 978	9 960
75.5	2 313	1 160	45.68	32.9	2 067	10 400
76.0 ****	2 395	1 240	46.61	33.1	2 158	10 860
76.5	2 480	1 258	47.55	33.3	2 250	11 320
77.0	2 566	1 420	48.48	33.4	2 343	11 780
77.5	2 655	1 500	49.41	36.6	2 438	12 260
78.0	2 746	1 580	50.35	33.8	2 535	12 740
78.5	2 839	1 680	51.28	34.0	2 632	13 230
79.0	2 934	1 780	52.22	34.2	2 731	13 730

* This is the maximum discharge of an individual spillway bay or regulator. Total discharge is calculated by adding the contributions of each gate or regulator. There are two (2) regulators to five (5) spillway bays.

** This assumes that all gates and sluices are closed. Discharges through the spillway have to be added to the above figures to calculate the actual inflow into the reservoir.

*** The temporary storage above normal Full Supply Level of EL 67.0.

**** The first fuse plug is designed to trigger at EL75.7. Above this level, fuse plug flows from Table B.3 need to be added to give the full outflow.

TABLE E2 CONTROLLED GATE DISCHARGES

Wivenhoe Dam   Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
67.0	0	49	98	146	194	240	285	329	372	413	453	492	530	567	603	639	675	709	744	765															
67.2	0	49	99	148	196	243	288	333	376	418	458	498	537	574	611	648	684	720	755	790															
67.4	0	50	100	149	198	245	291	336	380	422	464	504	543	582	619	657	693	730	766	802	815														
67.6	0	50	101	151	200	248	294	340	384	427	469	510	550	589	627	665	702	740	777	814	841														
67.8	0	51	102	152	202	250	297	343	388	432	474	515	556	596	635	673	712	750	787	825	863	867													
68.0	0	51	103	154	204	253	300	347	392	436	479	521	562	603	642	682	721	759	798	837	876	893													
68.2	0	52	104	155	206	255	303	350	396	441	484	527	569	610	650	690	729	769	808	848	888	919								UNCONTROLLED					
68.4	0	52	105	156	207	257	306	354	400	445	489	532	575	616	657	698	738	778	818	859	899	940	946								DISCHARGE				
68.6	0	53	105	158	209	260	309	357	404	450	494	539	581	623	665	706	747	788	829	870	911	953	973												
68.8	0	53	106	159	211	262	312	360	408	454	499	543	587	630	672	714	755	797	838	880	923	965	1000												
69.0	0	54	107	160	213	264	315	364	412	458	504	549	593	636	679	722	764	806	848	891	934	977	1022	1028											
69.2	0	54	108	162	215	267	317	367	415	463	509	554	599	643	686	729	772	815	858	901	945	989	1035	1056											
69.4	0	54	109	163	217	269	320	370	419	467	514	560	605	649	693	737	780	824	868	912	956	1001	1047	1084											
69.6	0	55	110	164	218	271	323	373	423	471	518	565	611	656	700	744	789	833	877	922	967	1013	1060	1107	1112										
69.8	0	55	111	166	220	273	326	377	427	475	523	570	616	662	707	752	797	842	887	932	978	1025	1072	1121	1141										
70.0	0	56	112	167	222	276	328	380	430	479	528	575	622	668	714	759	805	850	896	942	989	1036	1085	1134	1170										
70.2	0	56	112	168	224	278	331	383	434	484	532	580	628	674	721	767	813	859	905	952	1000	1048	1097	1147	1198	1199									
70.4	0	56	113	170	225	280	334	386	437	488	537	586	633	680	727	774	821	867	914	962	1010	1059	1109	1160	1212	1229									
70.6	0	57	114	171	227	282	336	389	441	492	542	591	639	687	734	781	828	876	923	972	1020	1070	1121	1173	1226	1258									
70.8	0	57	115	172	229	284	339	392	445	496	546	596	644	693	741	788	836	884	932	981	1031	1081	1133	1185	1239	1289									
71.0	0	58	116	173	230	286	341	395	448	500	551	601	650	699	747	795	844	892	941	991	1041	1092	1144	1198	1252	1309	1319								
71.2	0	58	117	175	232	289	344	398	452	504	555	605	655	705	754	802	851	900	950	1000	1051	1103	1156	1210	1266	1323	1349								
71.4	0	58	117	176	234	291	347	401	455	508	559	610	661	710	760	809	859	908	959	1009	1061	1114	1167	1222	1279	1337	1380								
71.6	0	59	118	177	235	293	349	404	458	512	564	615	666	716	766	816	866	916	967	1019	1071	1124	1179	1234	1292	1350	1410	1411							
71.8	0	59	119	178	237	295	352	407	462	515	568	620	671	722	773	823	874	924	976	1028	1081	1135	1190	1246	1304	1364	1425	1443							
72.0	0	60	120	180	239	297	354	410	465	519	572	625	676	728	779	830	881	932	984	1037	1091	1145	1201	1258	1317	1377	1439	1474							
72.2	0	60	121	181	240	299	357	413	469	523	577	629	682	733	785	837	888	940	993	1046	1100	1156	1212	1270	1330	1391	1454	1506							
72.4	0	60	121	182	242	301	359	416	472	527	581	634	687	739	791	843	895	948	1001	1055	1110	1166	1223	1282	1342	1404	1468	1533	1538						
72.6	0	61	122	183	243	303	361	419	475	531	585	639	692	745	797	850	903	956	1009	1064	1119	1176	1234	1293	1354	1417	1482	1548	1570						
72.8	0	61	123	184	245	305	364	422	478	534	589	643	697	750	803	856	910	963	1018	1073	1129	1186	1245	1305	1367	1430	1496	1563	1603						

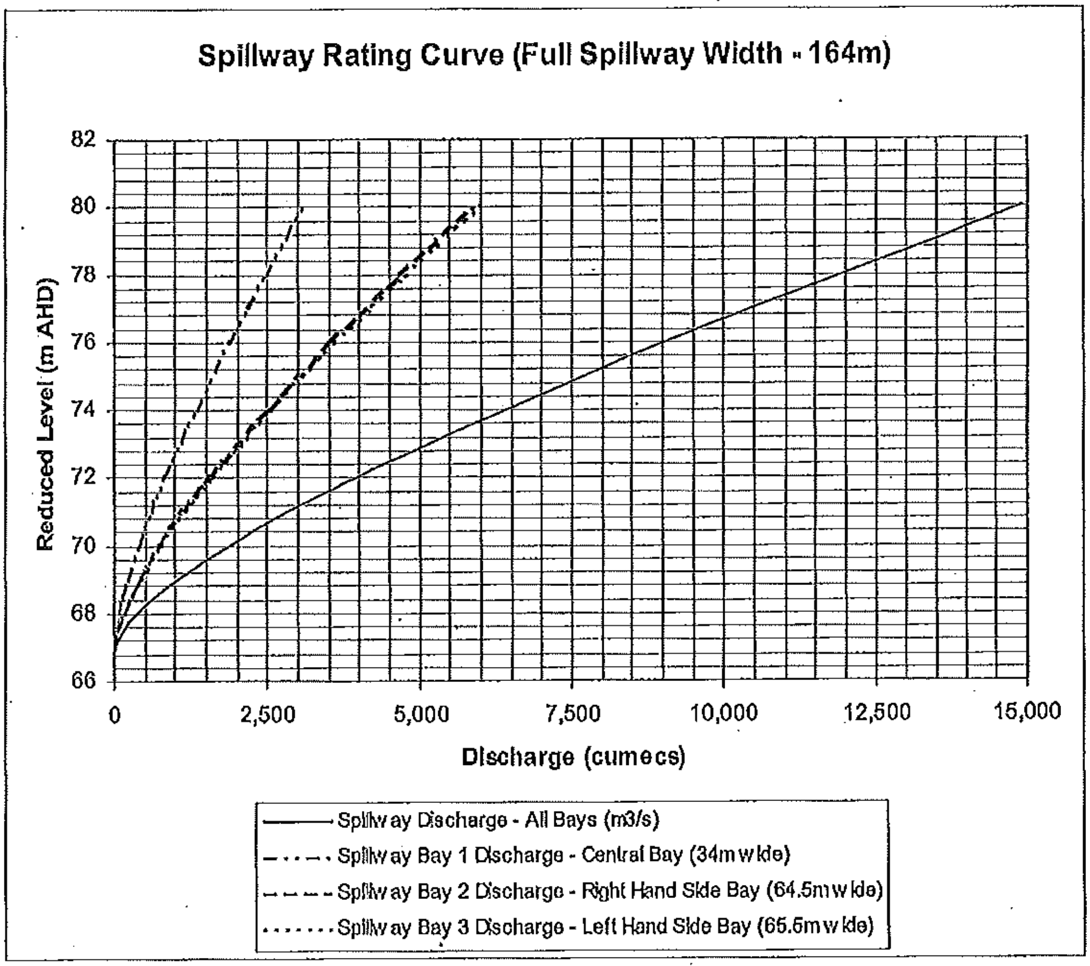
TABLE E2 CONTROLLED GATE DISCHARGES (continued)

Wivenhoe Dam Gate Opening (m of Tangential Travel)

Water EL (m AHD)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
73.0	0	62	124	185	247	307	366	425	482	538	593	648	702	756	809	863	917	971	1026	1081	1138	1196	1255	1316	1379	1443	1509	1577	1636						
73.2	2	62	124	187	248	309	369	427	485	542	597	653	707	761	815	869	924	978	1034	1090	1147	1206	1266	1327	1391	1456	1523	1592	1663	1669			UNCONTROLLED		
73.4	6	62	125	188	250	311	371	430	488	545	602	657	712	767	821	876	931	986	1042	1099	1156	1216	1276	1339	1403	1469	1536	1606	1673	1702				DISCHARGE	
73.6	11	64	126	189	251	313	373	433	491	549	606	662	717	772	827	882	937	993	1050	1107	1166	1225	1287	1350	1414	1481	1550	1620	1693	1736					
73.8	17	69	127	190	253	315	376	436	495	553	610	666	722	778	833	888	944	1001	1058	1116	1175	1235	1297	1361	1426	1494	1563	1635	1708	1770					
74.0	23	74	129	191	254	317	378	438	498	556	614	671	727	783	839	895	951	1008	1065	1124	1184	1245	1307	1372	1438	1506	1576	1648	1723	1800	1804				
74.2	31	80	133	192	256	319	380	441	501	560	618	675	732	788	845	901	958	1015	1073	1132	1192	1254	1317	1382	1449	1518	1589	1662	1738	1815	1838				
74.4	39	87	139	195	257	321	383	444	504	563	622	679	737	793	850	907	964	1022	1081	1140	1201	1264	1327	1393	1461	1530	1602	1676	1752	1831	1873				
74.6	47	94	145	200	259	322	385	447	507	567	626	684	741	799	856	913	971	1029	1089	1149	1210	1273	1337	1404	1472	1542	1615	1690	1767	1846	1908				
74.8	56	103	153	206	262	324	387	449	510	570	629	688	746	804	862	919	978	1036	1096	1157	1219	1282	1347	1414	1483	1554	1628	1703	1781	1861	1943				
7 5.0	66	112	161	213	267	326	390	452	513	574	633	692	751	809	867	926	984	1044	1104	1165	1227	1291	1357	1425	1494	1566	1640	1717	1795	1876	1960	1978			
75.2	76	121	169	220	274	330	392	455	516	577	637	697	756	814	873	932	991	1051	1111	1173	1236	1301	1367	1435	1506	1578	1653	1730	1809	1891	1976	2013			
75.4	87	131	178	229	281	336	394	457	519	581	641	701	760	819	878	938	997	1057	1119	1181	1245	1310	1377	1446	1517	1590	1665	1743	1823	1906	1992	2049			
75.6	98	141	188	237	289	343	399	460	522	584	645	705	765	824	884	944	1004	1064	1126	1189	1253	1319	1386	1456	1527	1601	1678	1756	1837	1921	2007	2085			
75.8	109	152	198	247	298	350	405	463	525	587	649	709	769	829	889	949	1010	1071	1133	1197	1261	1328	1396	1466	1538	1613	1690	1769	1851	1936	2023	2112	2121		
		OVERTOPPING of GATE																																	
76.0	121	164	209	257	307	359	412	468	528	591	652	713	774	834	895	955	1016	1078	1141	1205	1270	1337	1405	1476	1549	1624	1702	1782	1865	1950	2038	2129	2158		
76.2	133	175	220	268	317	368	421	475	532	594	656	718	779	839	900	961	1023	1085	1148	1212	1278	1346	1415	1486	1560	1636	1714	1795	1878	1965	2053	2145	2194		
76.4	146	187	232	279	327	378	429	483	539	597	660	722	783	844	906	967	1029	1092	1155	1220	1286	1354	1424	1496	1570	1647	1726	1808	1892	1979	2069	2161	2231		
76.6	159	200	244	290	338	388	439	492	546	603	664	726	788	849	911	973	1035	1098	1162	1228	1295	1363	1434	1506	1581	1658	1738	1820	1905	1993	2084	2177	2268		
76.8	173	213	257	302	350	399	449	501	554	610	668	730	792	854	916	978	1041	1105	1170	1235	1303	1372	1443	1516	1591	1669	1750	1833	1919	2007	2099	2153	2289	2306	
			OVERTOPPING of GATE																																
77.0	186	226	270	315	362	410	460	511	564	618	674	734	797	859	921	984	1047	1112	1177	1243	1311	1380	1452	1526	1602	1680	1762	1845	1932	2021	2113	2208	2306	2343	
77.2	200	240	283	323	374	422	471	522	574	627	682	739	801	864	927	990	1054	1118	1184	1250	1319	1389	1461	1536	1612	1691	1773	1858	1945	2035	2128	2224	2322	2381	
77.4	215	254	297	341	387	435	483	533	584	637	691	747	806	869	932	996	1060	1125	1191	1258	1327	1398	1470	1545	1622	1702	1785	1870	1958	2049	2143	2239	2339	2419	
77.6	230	269	311	355	400	447	496	545	595	647	700	756	813	873	937	1001	1066	1131	1198	1265	1335	1406	1479	1555	1633	1713	1796	1882	1971	2063	2157	2255	2355	2457	
77.8	245	283	325	369	414	461	508	557	607	658	711	765	821	880	942	1007	1072	1138	1205	1273	1343	1414	1488	1564	1643	1724	1808	1894	1984	2075	2172	2270	2371	2475	2496
78.0	260	299	340	383	428	474	522	570	619	670	722	775	831	888	948	1012	1078	1144	1211	1280	1351	1423	1497	1574	1653	1735	1819	1907	1997	2090	2186	2285	2387	2492	2535

TABLE E.3 – WIVENHOE DAM AUXILIARY SPILLWAY RATING TABLE

Storage Level (m AHD)	Spillway Discharge - All Bays (m3/s)	Discharge Central Bay (34m wide)	Discharge Right Side Bay (64.5m wide)	Discharge Left Side Bay (65.5m wide)
67	0	0	0	0
68	361	75	142	144
69	1,020	212	401	408
70	1,858	385	731	742
71	2,847	590	1,120	1,137
72	3,961	821	1,558	1,582
74	6,409	1,329	2,521	2,560
76	9,033	1,873	3,553	3,608
78	11,907	2,468	4,683	4,755
80	14,913	3,092	5,865	5,956



APPENDIX F SOMERSET DAM TECHNICAL DATA

Table F-1 STORAGE AND DISCHARGE FOR SOMERSET DAM

Lake level M AHD	Reservoir Capacity 10^6 m^3	Temporary Flood Storage 10^6 m^3	Net Inflow per 1mm rise per hour m^3/sec	* Discharge per Regulator m^3/sec	* Discharge per Sluice m^3/sec	* Discharge per Spillway Bay m^3/sec	Maximum Available Discharge m^3/sec
90.0	120.3	-	5.29	57	163	-	1 529
90.5	129.5	-	5.50	58	165	-	1 550
91.0	139.3	-	4.88	58	167	-	1 572
91.5	149.6	-	5.28	59	170	-	1 593
92.0	160.5	-	5.68	60	172	-	1 614
92.5	172.0	-	6.09	60	174	-	1 635
93.0	184.1	-	6.79	61	176	-	1 655
93.5	196.7	-	7.10	62	179	-	1 676
94.0	210.0	-	7.43	62	181	-	1 695
94.5	224.0	-	7.78	63	183	-	1 715
95.0	238.5	-	8.15	64	185	-	1 735
95.5	253.6	-	8.54	64	187	-	1 754
96.0	269.3	-	8.95	65	189	-	1 773
96.5	285.6	-	9.37	66	191	-	1 792
97.0	302.7	-	9.81	66	193	-	1 810
97.5	320.7	-	10.28	67	195	-	1 829
98.0	339.5	-	10.76	67	197	-	1 847
98.5	359.2	-	11.25	68	199	-	1 865
99.0	379.8	0.0	11.77	69	201	-	1 883
99.5	401.4	21.5	12.31	69	203	-	1 901
100.0	428.9	49.0	13.28	70	205	-	1 918
100.5	447.5	67.6	13.83	70	207	0	1 937
101.0	472.2	92.3	14.39	71	209	4	1 989
101.5	498.0	118.1	14.95	72	211	13	2 076
102.0	524.9	145.1	15.53	72	212	25	2 189
102.5	553.1	173.3	16.11	73	214	40	2 325
103.0	582.6	202.7	16.70	73	216	58	2 482
103.5	613.2	233.4	17.30	74	218	78	2 659
104.0	645.1	265.3	17.90	74	220	100	2 854
104.5	678.3	298.4	18.52	75	221	125	3 067
105.0	712.7	332.8	19.14	75	223	151	3 296
105.5	748.3	368.4	19.78	76	225	180	3 542
106.0	785.2	405.4	20.42	76	226	211	3 803
106.5	823.4	443.6	21.07	77	228	243	4 079
107.0	863.1	483.2	21.73	78	230	278	4 370
107.5	904.0	524.2	22.39	78	232	314	4 675

* This is the maximum discharge of an individual gate or regulator. Total discharge is calculated by adding the contributions of each gate or regulator.

Regulator - Discharge regulator valve of which there are four (4).
Sluice - Sluice gate of which there are eight (8).
Spillway - Overflow section of dam controlled by eight (8) radial gates.
Temporary Flood- The temporary storage above the normal full supply level of El 99 m (AHD) Storage

APPENDIX G WIVENHOE DAM GATE OPERATION CONSIDERATIONS

Full size plans of Wivenhoe Dam, and Operations and Maintenance Manuals for Wivenhoe Dam are held by the Corporation and the Headworks Operator and are available at the site. Operations and Maintenance Manuals relevant to the flood operation of the gates are:

(a) "Master Manual and Drawings."

(b) "Radial and Penstock Gate Hoists and Drawings."

G.1. SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Appendix I shows the general arrangement of the spillway area.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

The main purpose of gating the spillway is to exercise maximum control over the flow in the Brisbane River insofar as river flows in excess of 4 000 m^3/sec cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

G.2. RADIAL GATE OPERATING PRINCIPLE

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

APPENDIX I HYDROLOGIC INVESTIGATIONS

I.1. INTRODUCTION

This appendix describes hydrologic analyses performed as part of the review of design flood hydrology Corporation's dams. This study included an examination of the existing operating procedures for Wivenhoe Dam and Somerset Dam and it includes the use of the latest techniques in design rainfall estimation.

The analyses were carried out using the most appropriate data available in 2001 and it is recommended that they be revised after the occurrence of a large flood or after the adoption of more advanced methods of hydrologic analysis. The work is summarised in a report entitled, 'Brisbane River – Revision of Flood Hydrology', (DNRM, 2001).

The work summarised here supersedes previous work including that completed during the design stages of Wivenhoe Dam, details of which are contained in the design report on Wivenhoe Dam and the Brisbane River and Pine River Flood Study reports. Revision of the estimates of Probable Maximum Precipitation by the Bureau of Meterology in 2003 have increased these figures. The determination of the Probable Maximum Flood and the impacts on Wivenhoe Dam are included in reports entitled, "Preferred Solution Report" – Wivenhoe Alliance 2003. The increase in spillway capacity for Wivenhoe Dam and the resulting effeets downstream are included in a report entitled "Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade" – Wivenhoe Alliance 2004.

I.2 METHOD

There are three components in the hydrologic analyses:

(i) a rainfall analysis to determine both rainfall frequency and Probable Maximum Precipitation (PMP) and also large and rare rainfall events using the CRC-FORGE methodology

(ii) a model of the catchment rainfall runoff process; and

(iii) a model of the flood operations of the two dams.

The Bureau of Meteorology completed several studies of the Probable Maximum Precipitation. The Australian generalised method for areas subject to tropical cyclones was used and rainfalls for durations up to seven days were estimated. The Probable Maximum Precipitation was estimated for the whole of the Brisbane River catchment, as well as for various sub-catchments. Concurrent rainfall estimates were provided for the remainder of the catchment outside the sub-catchment for which the Probable Maximum Precipitation was provided. The Probable Maximum Precipitation temporal patterns provided by the Bureau of Meteorology were used for all rainfalls.

The estimation of design rainfalls within the large to rare flood range was performed using the CRC-FORGE methodology as described in Book VI of Australian Rainfall and Runoff (1998). The CRC-FORGE method uses the concept of an expanding region focussed at the site of interest. Design rainfall for frequent events (eg 1 in 50 AEP) are based upon pooled data from a few gauges around the focal point, while design rainfall estimates at the AEP of the limit extrapolation are based upon pooled rainfall data from up to several hundred gauges. Before the data from different sites can be poled, maximum annual rainfalls from each site need to be standardised by dividing by an "index variable".

The rainfall runoff models based on a non-linear runoff routing method were used to estimate the floods. The models were calibrated on recorded storm and flood data. The model calibrations were completed in 1993 and were not modified for the latest re-assessment.

Models to simulate the flood operation of Somerset and Wivenhoe Dams developed during the mid-eighties were modified to incorporate the new structure of the hydrologic models and to more accurately reflect the operational procedures of the dams. These models were then used to calculate dam discharges for a range of design floods generated using the rainfall estimates and the runoff routing models.

I.3. RAINFALL ANALYSIS RESULTS

The rainfall analysis was performed in two parts, the Probable Maximum Precipitation estimate by the Bureau of Meteorology and the estimation of large to rare events using the CRC-FORGE method. These were used both for design studies for the dam and to test the effects of flood operation procedures.

The estimates of rainfall frequency are listed in Tables I-1 and I-2.

Table I-1
Catchment Rainfall (mm) on Wivenhoe Dam Catchment

Annual Exceedence Probability %	24 Hours	48 Hours	72 Hours
1	199	274	319
0.1	276	393	464
0.01	379	550	659
PMP	800	1060	1280

Table I-2
Catchment Rainfall (mm) on Somerset Dam Catchment

Annual Exceedence Probability %	24 Hours	48 Hours	72 Hours
1	302	430	507
0.1	432	649	775
0.01	554	920	1117
0.001	747	1204	1483

I.4. RUNOFF ROUTING MODEL CALIBRATION

Ten floods were used for calibration: July 1965, March 1967, June 1967, January 1968, December 1971, January 1974, January 1976, June 1983, Early April 1989 and Late April 1989. The gauging stations used for model calibration are listed in Table I-3.

The runoff routing model was calibrated for the nineteen major sub-catchments listed in Table I-4. Each of these models was calibrated for as many sites as possible for each of the ten floods. Data were missing for some of the stations for some of the floods. The estimated model parameters are given in Table I-4. In all cases relative delay time parameter (k) used in the model is related to reach length.

Table I-3
Gauging Stations used for Model Calibration

Stream	Site	Number	AMTD (km)	Catchment Area (km^2)
Stanley River	Somerset Dam		7.2	1 335
Cooyar Creek	Damsite	143015	12.2	960
Brisbane River	Linville	143007	282.4	2 005
Emu Creek	Boat Mountain	143010	10.1	920
Brisbane River	Gregor's Creek	143009	251.7	3 885
Cressbrook Creek	Damsite	143013	58.6	325
Brisbane River	Middle Creek	143008	187.2	6 710
Brisbane River	Wivenhoe Dam		150.2	7 020
Brisbane River	Savage's Crossing	143001	130.8	10 180
Bremer River	Walloon	143107	37.2	620
Warrill Creek	Amberley	143108	8.7	920
Lockyer Creek	Lyon's Bridge	143210	27.2	2 540
Brisbane River	City		22.7	13 260

Table I-4
Estimated Model Parameters

Sub-Catchment Name	Model Parameters	
	k	m
Cooyar Creek	43.6	0.8
Brisbane River at Linville	20.6	0.8
Emu Creek at Boat Mountain	37.2	0.8
Brisbane River at Gregors Creek	20.1	0.8
Cressbrook Creek at Cressbrook Dam	34.3	0.8
Stanley River at Somerset Dam	80.7	0.8
Brisbane River at Wivenhoe Dam	108.5	0.8
Lockyer Creek at Helidon	15.0	0.8
Tenthill Creek at Tenthill	19.0	0.8
Lockyer Creek at Lyons Bridge	75.0	0.8
Brisbane River at Savages Crossing	40.0	0.8
Brisbane River at Mount Crosby	47.0	0.8
Bremer River at Walloon	44.0	0.8
Warrill Creek at Kalbar	34.0	0.8
Warrill Creek at Amberley	35.0	0.8
Purga Creek at Loamside	49.0	0.8
Bremer River at Ipswich	15.7	0.8
Brisbane River at Jindalee	20.8	0.8
Brisbane River at Port Office	19.3	0.8

I.5. WIVENHOE DAM FLOODS

Wivenhoe Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Wivenhoe Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the dam-site without the dam in the catchment. Two-day storms were found to have the critical storm duration for most cases, though the long duration Probable Maximum Precipitations produced very large flood volumes. Table I-5 lists results for the two-day duration storms.

Table I-5
Wivenhoe Dam Floods
Design Inflows and Outflows for Existing, Stage 1 and Stage 2 Upgrades

Event (1 in X)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)		
		Existing	Stage 1	Stage 2
200	8,300	2,800	2,800	2,800
500	10,500	3,800	3,800	3,800
1,000	12,100	5,300	5,300	5,300
2,000	14,000	6,600	6,600	6,600
5,000	17,200	8,900	10,500 [c]	10,500 [c]
10,000	20,800	11,700	12,500	12,500
22,000 [a]	25,700	12,400 [a]	17,600	17,600
50,000	34,900	- [b]	24,600	24,600
100,000	43,300	- [b]	28,100 [a]	34,900
PMF	49,000	- [b]	- [b]	37,400 [a]

[a] Dam Crest Flood
[b] Overtops dam wall
[c] Increases due to changes to Procedure 4.

I.6. SOMERSET DAM FLOODS

Somerset Dam floods were estimated using the rainfalls and runoff routing model already discussed. Inflows to Somerset Dam, assuming the dam to be in existence and full, were calculated, as well as flow at the site without the dam in the catchment. The forty-eight hour PMP storm event was found to be critical, though the long duration PMP's produced very large flood volumes. Table I-6 lists results for the forty-eight hour duration storms.

Table I-6
Somerset Dam Floods
(for two-day storm duration)$^{+}$

AEP %	Peak Inflow (m^3/sec)	Peak Outflow (m^3/sec)	Flood Volume (ML)	Peak Lake Level (m AHD)
1	3,500	1,700	421,000	103.5
0.1	4,500	2,600	690,000	104.5
0.01	6,800	4,700	1,042,000	107.5
0.001	9,200	6,300	1,412,000	109.3
PMF*	16,000	9,600	1,952,800	112.0

+ - NB. This duration does NOT give the maximum Peak Inflow for a given AEP
* - Overtopped, estimated flow based on no dam failure

I.7 FLOOD CONTROL OPERATION MODEL

Floods in the Brisbane River catchment above Wivenhoe Dam can originate in either the Stanley River or upper Brisbane River catchment or both. Both of the dams are capable of being operated in a number of ways, each of which will reduce the flow downstream. However, in order to achieve maximum reduction of flooding downstream of Wivenhoe Dam, it was necessary to review the operations at Somerset and Wivenhoe Dams using a flood operations simulation model.

The most recent flood studies have reviewed the basic hydrologic algorithms in the operational models used in the earlier study and modified them to incorporate additional features relating to gate openings and closings. The revised design flood hydrology and operational model algorithms were then used to re-examine the original five possible operational procedures for each of Somerset Dam and Wivenhoe Dam, giving twenty-five possible combinations to be re-considered. The procedures previously developed for Wivenhoe Dam were designed so that initial release operations did not adversely affect later operations in the event of later rainfall causing the magnitude of the flood to exceed the original estimate.

The procedures previously developed were also designed to restrict flooding in the lower catchment to the lowest level of the following categories where practicable:

(i) low level bridges submerged, Fernvale bridge open;

(ii) all bridges except Mt. Crosby Weir and to Fernvale bridges submerged;

(iii) all bridges submerged, no damage to urban areas;

(iv) damage to urban areas due to peak flow from downstream catchment, no releases from Wivenhoe Dam contributing to peak flow;

(v) extensive damage to urban areas due to combined Wivenhoe Dam releases and downstream flow, Wivenhoe Dam release component of peak flow minimum practicable.

The previous flood studies recommended that one procedure be selected for the operation at Somerset Dam. This procedure had two advantages over the other procedures tested. Firstly, it was feasible for all magnitudes of Stanley River floods tested and, secondly, it was the simplest procedure to carry out. The re-analysis confirmed this conclusion.

The previous flood studies concluded that procedures for Wivenhoe Dam be reduced to four by combining two procedures into one. The resulting four procedures formed a hierarchy and the procedure to be adopted advances to the next procedure as the flood magnitude increases. The re-analysis confirmed this conclusion.

A Real Time Flood Operations Model for Somerset and Wivenhoe has been developed as part of the "Brisbane River and Pine River Flood Studies". This model incorporates the revised operational algorithms.

* Assume no failure of Wivenhoe Dam or Somerset Dam

APPENDIX J DRAWINGS

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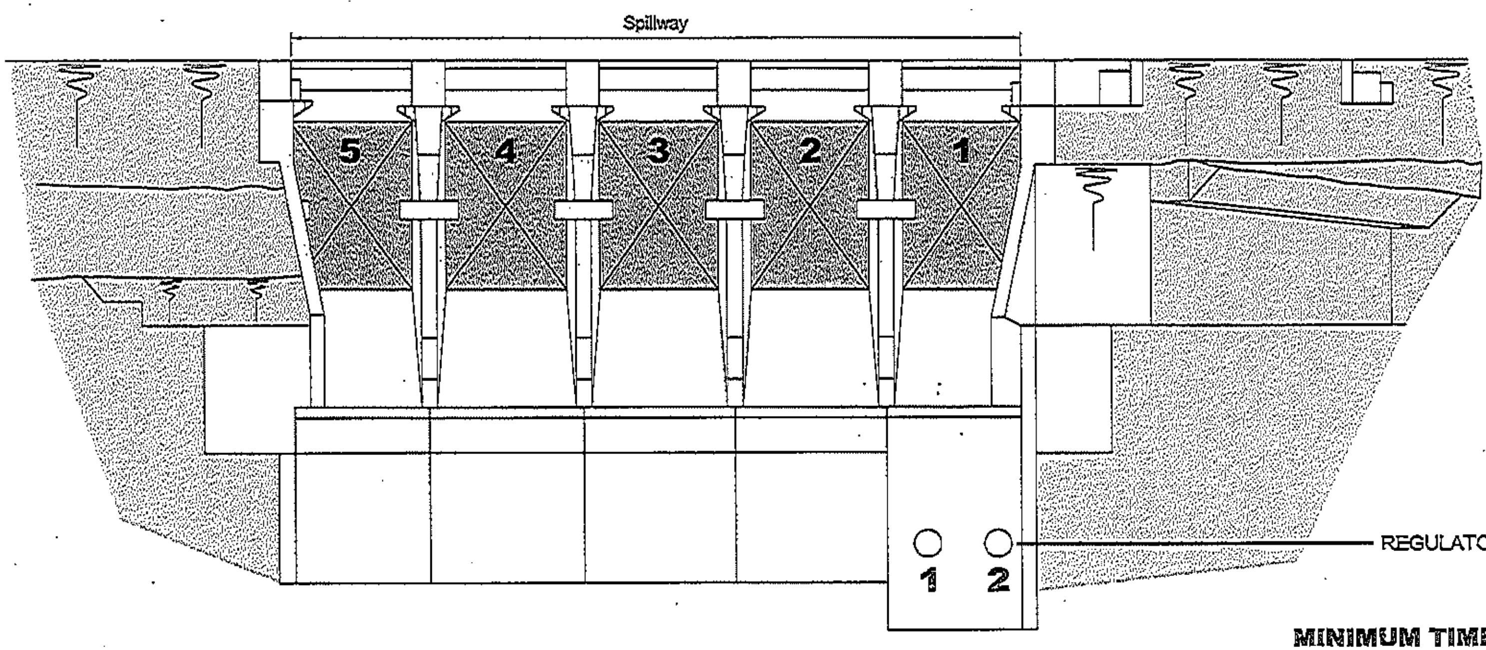
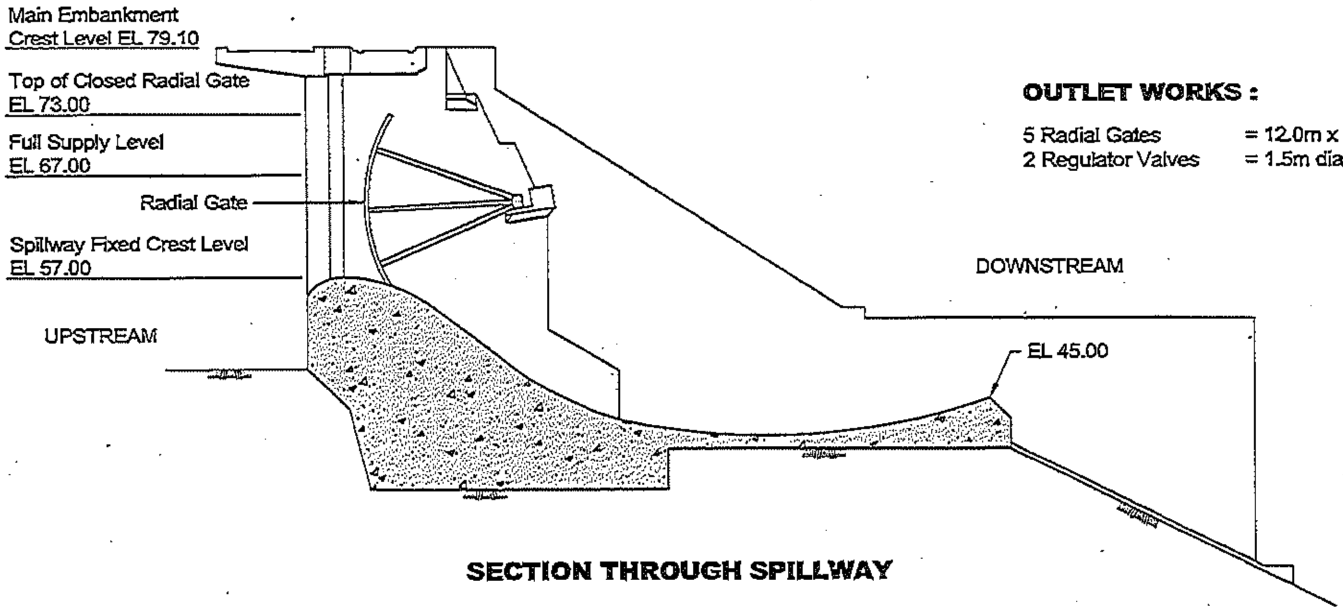


VIEW LOOKING UPSTREAM



SECTION THROUGH SPILLWAY

OUTLET WORKS :

5 Radial Gates	= 12.0m x 16.6m
2 Regulator Valves	= 1.5m dia

MINIMUM TIME INTERVAL

MIMUM INTERVALS FOR NORMAL OPERATION

500mm Incremental gate openings	10min
500mm Incremental gate closures	20min
Full regulator opening or closure	30min

CRITICAL LEVELS :

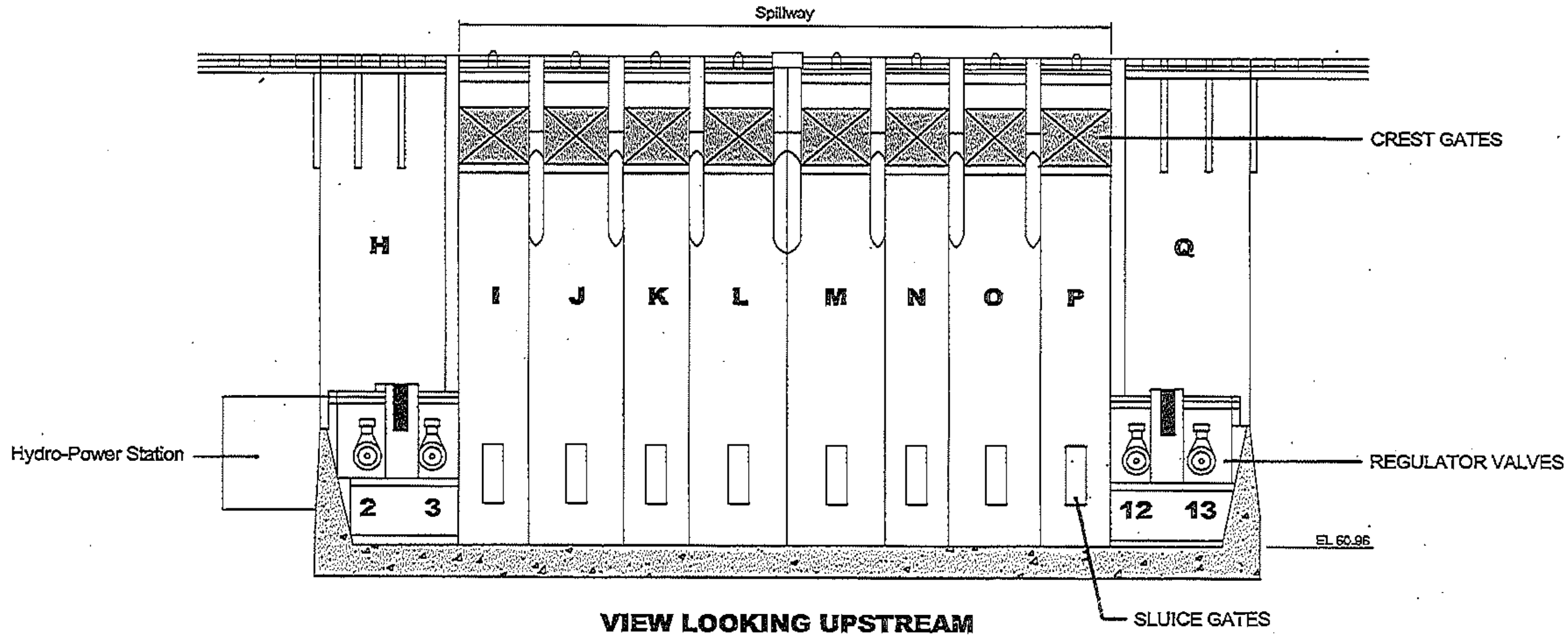
Saddle Dam Embankment Level	= 80.00
Top of Wave Wall	= 79.90
Main Embankment Crest Level	= 79.10
Evaluation Design Flood Level	= 77.00
Minimum Land Resumption	= 75.00
Top of Closed Radial Gate	= 73.00
Gate Operation Trigger Level	= 67.25
Full Supply Level	= 67.00
Spillway Fixed Crest Level	= 57.00

SunWater

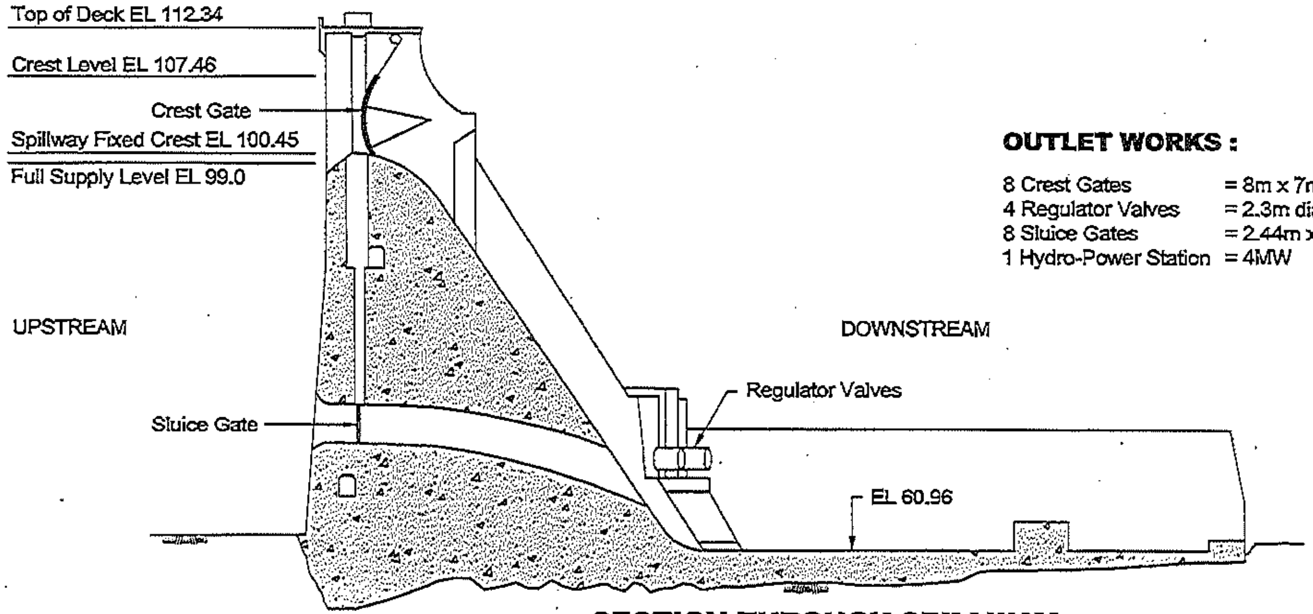
SEQWC Flood Operations

WIVENHOE DAM

A3-216787



VIEW LOOKING UPSTREAM



SECTION THROUGH SPILLWAY

OUTLET WORKS :

8 Crest Gates = 8m x 7m
4 Regulator Valves = 2.3m dia
8 Sluice Gates = 2.44m x 3.66m
1 Hydro-Power Station = 4MW

MINIMUM TIME INTERVAL

MINIMUM INTERVALS FOR NORMAL OPERATIONS

Outlet	Opening Interval	Closure Interval
Regulators	30min	60min
Sluice Gates	120min	180min
Crest Gates	Gates are Normally Open	

CRITICAL LEVELS :

Top of Deck = 112.34
Crest Level = 107.46

Sluice & Regulator Trigger Level = 102.25

Mary Smokes Bridge (Kilcoy) = 102.00
Spillway Fixed Crest Level = 100.45
Hydro-Power Station Reserve = 99.30
Full Supply Level = 99.00

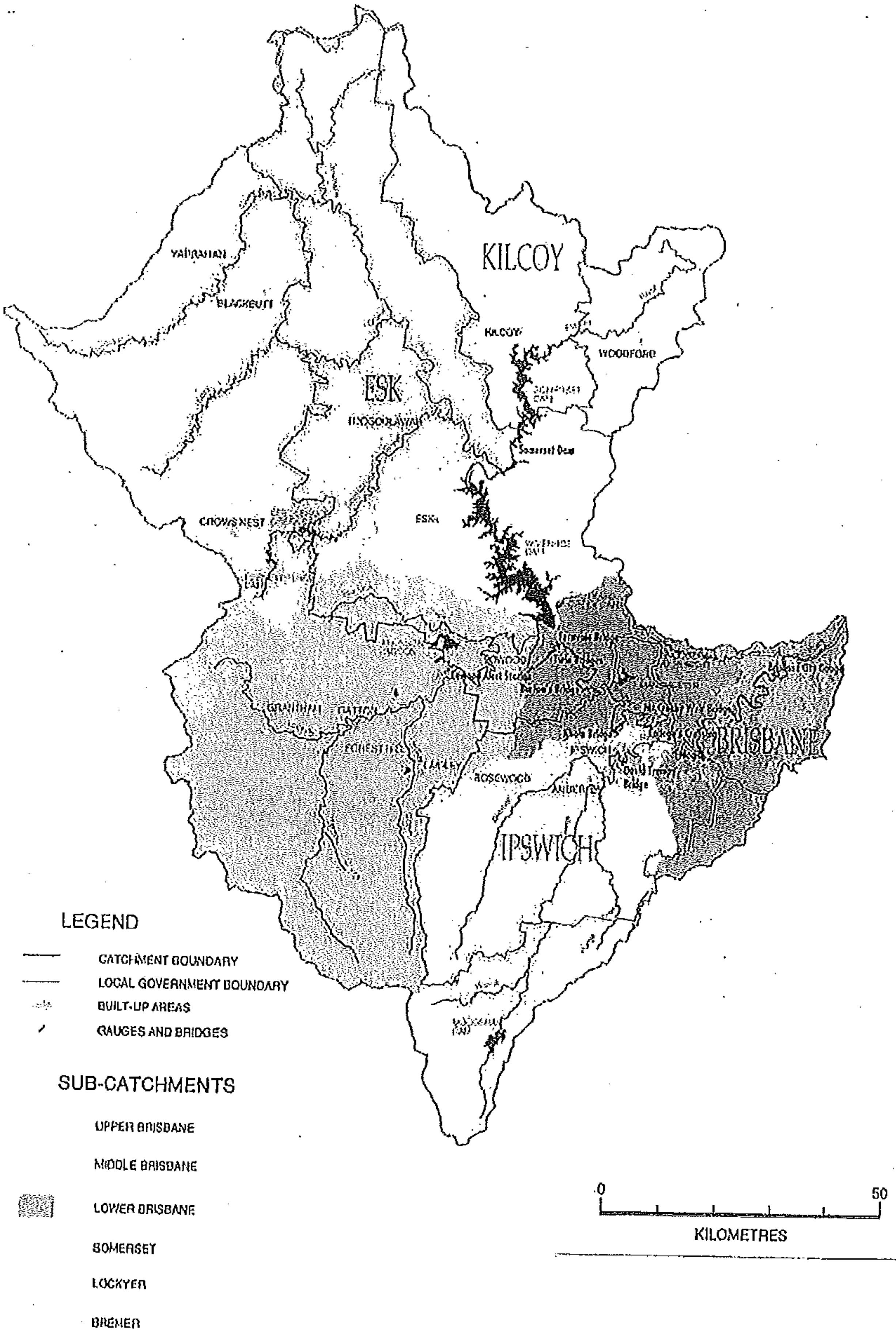
SunWater

SEQWC Flood Operations
SOMERSET DAM

A3-216788

APPENDIX K BRISBANE RIVER CATCHMENT

Appendix K



Brisbane River Catchment