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
7	6 June 2007	Complete Revision

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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 2004 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 2004 version of the manual have arisen out of the completion of the spillway upgrade 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 including the auxiliary spillway.

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;**

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"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 Water;**
"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 (m3/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.

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For the purpose of this Manual , the Corporation adopts th e policy that the community is to be protected to t he maximum extent practical against flood h azards recognising the limitations on being able to:

- ide ntify 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 m anual has been prepared as a Flood Mitigation M anual i n accordance with the provisions of Part 6 Division 2 of the Act.

1.5 APPLICATION AND EFFECT

The pr ocedures i n t his Manua l appl y to the oper ation of Wivenhoe Dam and Somerset Dam for the purpose of flood m itigation, and operation in accordance with the manual shall give the pr otection fr om l iability pr ovided by Section 500 of *Water Act 2000.*

1.6 DATE OF EFFECT

The procedures in this M anual shall have effect on and from the date on which this version of the Manual is approved by gazette notice.

The Manual shall rem ain in force for the peri od 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 Corporat ion 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 pr ocedures for Wivenhoe Dam and Somerset Dam for the purposes of fl ood m itigation, and must be appl ied 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 t he procedur es in this M anual shoul d be amended, altered or varied, it m ust subm it 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

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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 m anuals are used in the direction of flood mitigation activities. Agencies having copies of Co ntrolled D ocuments are listed in A ppendix B . T he Corporation must maintain a Register of Contact Pers ons for Controlled Documents and ensure that each issued docum ent is updated whenever am endments or changes are approved.

Before using thi s Manual for the di rection of flood cont rol, the Headworks Operator must ensure that it is the current version of the Controlled Document.

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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.

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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.

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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.

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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

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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.

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2.6 RESPONSIBILITIES OF THE SENIOR FLOOD OPERATIONS ENGINEER

The Senior Flood Operations Engineer is responsible for the over all 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:

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- 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.

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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.

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3. FLOOD MITIGATION OBJECTIVES

3.1 GENERAL

To meet t he purpose of the flood operational procedur es in this Ma nual, the following objectives, listed in descending order of importance, are as follows:

1. Ensure the structural safety of the dams;
2. Provide optimum protection of urbanised areas from inundation;
3. Operate th e existing spillway an d the Somerset Dam so as to minimise th e frequency of operation of the fuse plug spillway at Wivenhoe.
4. Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
5. Minimise disruption and impact upon Wivenhoe Power Station;
6. Minimise disruption to navigation in the Brisbane River.

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3.2 STRUCTURAL SAFETY OF DAMS

The structural safety of the dams must be t he 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 param ount im portance. Structural failure of Wivenhoe Dam would have catastrophic consequences.

Wivenhoe Dam is predominant ly a central core rockfil l dam . Such dam s are not resistant to overtopping and are suscepti ble to breaching should such an event occur. Over topping is consi dered a maj or threat to the sec urity of Wivenhoe Dam . Works were undertaken between May 2004 and December 2005 to bui ld an auxiliary spillway to cope with the 1:100, 000 AEP flood event without overtopping of the dam . The auxili ary spill way consists o f a th ree bay fi xed cr est spillway that includes er odible fuse plug embankm ents that are designed to initia te at v arying trigger levels.

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The auxili ary spillway works in conjunction wi th the exi sting gated spi llway. T he design intent of th e au xiliary sp illway is to try and ensure that the existing spil lway gates are ful ly opened by the tim e the first fuse plug bay is initia ted. This is on the basis that the dischar ges through the exi sting spillway will res ult in less d amage than allowing discharges through the auxiliary spillway.

The d amage from the initiation of th e fuse plug ba ys will b e co nfined to t he are a immediately bel ow t he spillway return chan nel, with th e routing effects of th e reach

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to Savages Crossing reduci ng the peak i n flooding fu rther d ownstream in th e Brisbane River.

3.2.2 Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. F ailure of Somerset Dam could have catastrophic consequences.

Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the abs ence of any other flooding, if the failure we re to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a m ass concrete dam . Such dams can withstan d limited overtopping without d amage. Stability analyses of the concrete d am indicated that the accepted stability criteria for a gravity dam are exceeded when the storage level in Somerset Dam exceeds EL109.7m, provided that the sector gates are fully raised. This level is lower if the sector gates were operated during a major flood event.

Due to uncertainties in the analysis and subject to further investi gations, it is recommended that Somerset is operated so as not to exceed EL107.46m AHD.

Failure of such structures i s rare but when th ey do occ ur, 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 ex treme floods indicate that floods are possible w hich 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 si gnificant probability of two or more flood producing storms occurring in the Brisbane River system within a short ti me of each other. In order to be prepared to m eet such a situation, the stored fl oodwaters from one storm should be discharge d from the dams after a fl ood as quickly as would be consistent with the other m ajor operating principles . Typically the Senior Flood Operations Engineer should aim to empty stored floodwaters within seven days after the flood peak has passed th rough the lower reaches of the Bri sbane River. In a very la rge floo d, th is time fra me ma y not be achievable beca use of downstream flood conditions and it ma y be necessary to extend th e 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 accou nt in flows into th e river do wnstream of the dams. However they may result in subm ergence of som e bri dges. The level of flooding as a r esult of emptyi ng st ored floodwaters after the peak has passed is to be less than the flood peak unles s accelerated rel ease is necessary to red uce 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.

3.4 LIMITING OPERATION OF THE FUSE PLUG SPILLWAY

The auxiliary spillway constructed at Wivenhoe Dam 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.

3.5 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 dams, 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.

3.6 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.

3.7 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.

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4. FLOOD CLASSIFICATION

For the reference purposes of this Manual, five magnitudes of flooding are classified as follows:

Table 4-1 – Flood Event Descriptions

Event	Description
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)

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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.

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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.

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The Corporation m ust ensure that i nformation relat ive to the calibration of the Corporation's field stations is shared with such agencies.

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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 then intervals to suit forecasting req
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 pre 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 ope
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)	

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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.

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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 Water within 14 days of it being received by the Corporation.

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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 Water 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 Water 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.

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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 down stream 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 constructed in 2004/05 as part of an upgrade to improve flood adequacy consists of a three bay fuse plug spillway located on the right abutment of the main embankment. In association with other works carried out at the dam, the dam crest flood is now assessed as having 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 to provide full protection against the Probable Maximum Flood.

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Pertinent information about the auxiliary spillway, including the initiation level for the specific bays is given in Table 8.1.

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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.

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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.

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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:

a) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

b) 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:

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Table 8-3 - Radial Gate Opening Sequences[1]

Approximate Discharge Range	Gate opening sequence2	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.

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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:-

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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.

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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

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(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 over ridden 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 over ridden 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.

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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, and 4B have been developed for use depending on the expected peak water level in the dam.

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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 over ridden 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 EL 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 over ridden when the gates will be overtopped during normal operation.

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Procedure 4C applies onl construction phase of the auxiliary spillway.¶
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Opening of the gates is to the storage level of Wiver begins to fall. ¶
The minimum time interva gate openings can be red successive gate openings same gate may be used i procedure as considered for ensuring the safety of addition to dam safety iss impact of rapidly increasi from Wivenhoe Dam on d reaches should be consid determining these interva
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The gate opening constra be overridden when the g overtopped during norma

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	QColleges Crossing < 175 m3/sec with care taken not to submerge Twin Bridges prematurely	
1B	67.25 < EL < 67.50	$Q_{Wivenhoe}$ < 380 m^3/sec	QBurtons/Noogoorah < 430 m3/sec with care taken not to submerge Colleges Crossing prematurely	
1C	67.75 < EL < 68.00	$Q_{Wivenhoe}$ < 500 m^3/sec	QKholo < 550 m3/sec with care taken not to submerge Burtons/Noogoorah prematurely	
1D	68.00 < EL < 68.25	$Q_{Wivenhoe}$ < 900 m^3/sec	QMtCrosby < 1900m3/sec with care taken not to submerge Kholo prematurely	
1E	68.25 < EL < 68.50	$Q_{Wivenhoe}$ < 1500 m^3/sec	QMtCrosby < 1900m3/sec with care taken not to submerge Kholo prematurely	
2	68.50 < EL < 74.00	Q_{Lowood} < 3500 m^3/sec	QLowood < peak of Lockyer and QLowood < peak of Bremer	Gates are overtopped
3	68.50 < EL < 74.00	Q_{Lowood} < 3500 m^3/sec	QMoggill < 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.

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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 practica ble having r egard to Section 3, and is to re main at this rate un til 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 fl ood-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 procedur es. This includes an y 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 po ssible suc h cl osures should occur during da ylight h ours on a weekday so that personnel are available for fish rescue.

If the flood storage c ompartments of Wivenhoe Dam and Somerset Dam can be emptied within the prescri bed time of seven days, the release from Wivenhoe Dam s hould be li mited to between 1900 m^3/sec and 3500 m^3/sec. In such circ umstances, 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 operati on of a fuse plug spi llway bay has been triggered prior to its design initiation level being reached, the flood operation procedures are to be modified such that:

- the di scharge from the triggered fuse plug i s 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.

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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 a ll of the fu se plug spill way bays has been triggered a nd a flood event occurs before the fuse plug can be reinstated, the flood operation procedures are to be modified such that:

- the di scharge from the triggered fuse plug i s 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.

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<#>Auxiliary Spillway Area¶
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The embankment forming the temporary road diversion that a coffer dam is to be retained until the construction of the fu has proceeded past EL 74, ar its removal is only to proceed the written approval of a Senio Operations Engineer has beer obtained.¶
¶
<#>Gated Spillway Area¶
¶
The following provisions will a works undertaken within the g spillway:¶
¶
<#>The opening of spillway ga discharge floodwaters is at the discretion of the Senior Flood Operations Engineer;¶
¶
<#>There is to be no obstruct any spillway bay without the w approval of the Senior Flood Operations Engineer;¶
¶
<#>All gates are to be capable being operated at short notice a flood if required. To ensure capability is maintained Table specifies limitations that apply number of bays in which work be occurring at any time. This also nominates a target notice to be provided by the Senior F Operations Engineer for the re of construction material from t spillway bays prior to their use releases. However the Senio Operations Engineer is not constrained to provide this len notice before operating any pa gate if its earlier operation is considered necessary.¶
¶
Table 8.6 – Gated Spillway A Works Restrictions¶
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Dam Level

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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:

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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 relative flood storage between the flood level in Wivenhoe Dam and EL 80 is the same as the relative flood storage between the flood level in Somerset Dam and EL 107.46, the non-spillway crest level in Somerset Dam.

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Table 9-2 - Water Level Correlation Targets

Somerset Lake Level M AHD	Wivenhoe Lake Level m AHD
102.5	72.0
103.5	73.6
104.5	75.2
105.5	76.8
106.5	78.5
107.46	80.0

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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.

9.4.1 Somerset Stability

A Review of the stability analyses carried out for Somerset Dam was carried out by Commerce (2005). Recommendations from this report were:-

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1. Somerset Dam, on the basis of its known condition, satisfies stability criteria for a storage level of RL 109.75.

2. There is concern that cracking observed in the Upper Gallery walls may also exist above or below the Gallery. While such cracked concrete would just satisfy stability criteria for a storage level of RL 109.75, stability reduces rapidly for higher storage levels and failure could occur at RL 110.1. It is recommended that some exploratory drilling be carried out to determine whether such cracks do exist. A similar recommendation was made in GHD (2000).

3. If the WIVOPS flood operation program still requires that the Somerset spillway gates be lowered if Wivenhoe Dam is in danger of being overtopped, then this Report should be reviewed and the spillway examined in detail to ensure these operations can be undertaken successfully. This type of gate operation is not recommended.

Based on the recommendations of this stability analysis the existing duty point of EL107.46 is to be maintained subject to further investigations. It should be noted that the stability of the dam would appear to be acceptable for higher water levels up to approximately EL109.7m AHD. However, no works have been carried out to ensure that the galleries are not flood flor this water level or erosion protection installed along the toe of the existing dam.

The Sector gates at Somerset are not to be closed into the flow if the storage level has exceeded EL107m AHD. The closure of the sluice gates or valves is acceptable to limit flow into Wivenhoe up to as level of EL107.46. Such closure is not to threaten the safety of the dam

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9.4.2 PMF Flood Levels for Somerset

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A review of the flood levels for Wivenhoe and Somerset carried out in 2006 indicated that the Maximum Flood Level for the Probable Maximum Flood is estimated to be EL110.9m AHD. This is above the estimate limit for structural stability determined by the review of the stability analyses by Commerce (2004).

It should be noted therefore that during flood operations Somerset Dam is still subject overtopping risks.

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9.4.3 Impacts on Kilcoy

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A brief assessment of the flood impacts on the area upstream of Somerset Dam has been carried out. Lake levels above EL102.4 will start to impact on the D'aguilar Highway. It is anticipated that Kilcoy will be impacted by Lake Levels above EL105m AHD.

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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 else where 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 has been significantly reduced following the completion of the auxiliary spillway.

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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 must only be initiated with the agreement of the Chief Executive.

It should be noted that the upgrade works carried out in 2005 have

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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 by the use of its sluice gates, even at the risk of overtopping Somerset Dam in order to prevent, if possible, the overtopping of Wivenhoe Dam.

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As noted previously, lowering the sector gates back into the flow at storage levels greater than EL107 is to be avoided.

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10.3 COMMUNICATIONS FAILURE

In the event of normal comm unications being lost between t he Flood O perations Engi neer and either Wivenhoe Dam or Somerset Dam, the dam supervisor at that dam is to maintain contact wi th the dam supervis or at the other dam , to re ceive ins tructions through the remaining communications link.

In the event of normal comm unications being lost between t he Flood O perations Engi neer and both Wivenhoe Dam and Somerset Dam, the da m supervisors at each dam are to adopt the procedures set out below du ring flood events, and are to maintain contact with each other, where possible.

If all communications are lo st be tween the Flood Oper ations Engineer, Wive nhoe 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 co mmunication failure, the minimum gate open ings related to l ake levels up to EL 74 are set out in the T able 10.1 ar e to be maintai ned for both opening and closing operations. Once the lake le vel exceeds E L 74 the gates are to be rai sed 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 relative flood storage between the flood level in Wivenhoe Dam and EL 80 is the same as the relative flood storage 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	72.0
103.5	73.6
104.5	75.2
105.5	76.8
106.5	78.5
107.46	80.0

The constraints applicable to case (i) operation above do not apply to case (ii) operation.

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10.4 EQUIPMENT FAILURE

In the event of equipment fai lure the action to be taken i s indicated in Appendix G for Wivenhoe Dam and Appendix H for Somerset Dam.

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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-

(a) review, and if necessary, update the manual; and

(b) give a copy of it to the chief executive under section 497.

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Protection from liability for complying with flood mitigation manual

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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 sub section (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

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APPENDIX B. AGENCIES HOLDING DOCUMENTS

AGENCIES HOLDING CONTROLLED DOCUMENTS

OF

MANUAL OF OPERATIONAL PROCEDURES

FOR FLOOD MITIGATION FOR

WIVENHOE DAM AND SOMERSET DAM

Flood Management Role	Organisation
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 Water
Dams Operator	SunWater

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The Corporation must keep a register of contact persons of holders of controlled documents (Section 1.9 refers).

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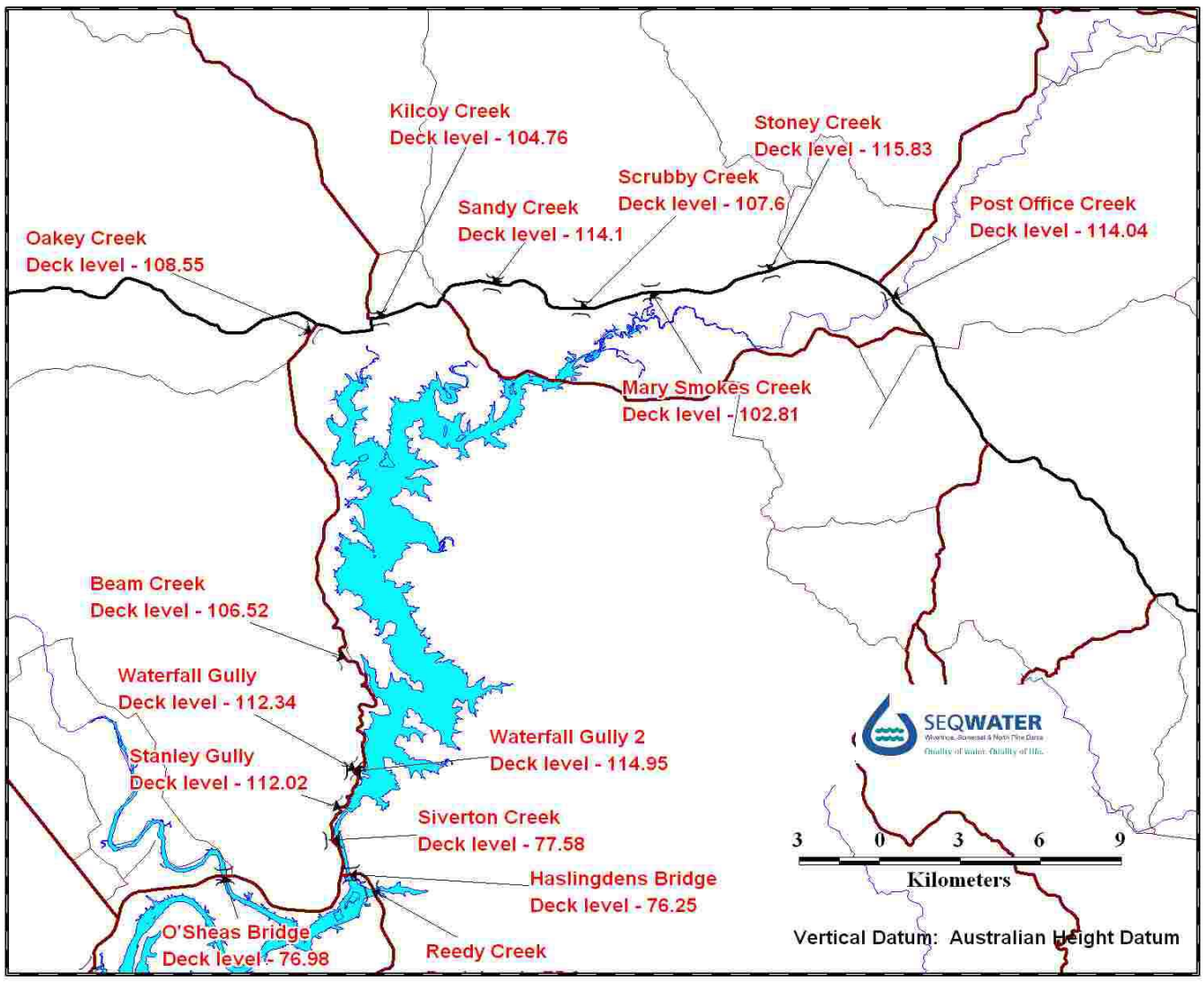
APPENDIX C. BRIDGE DECK LEVELS

Roads Upstream of Somerset Dam



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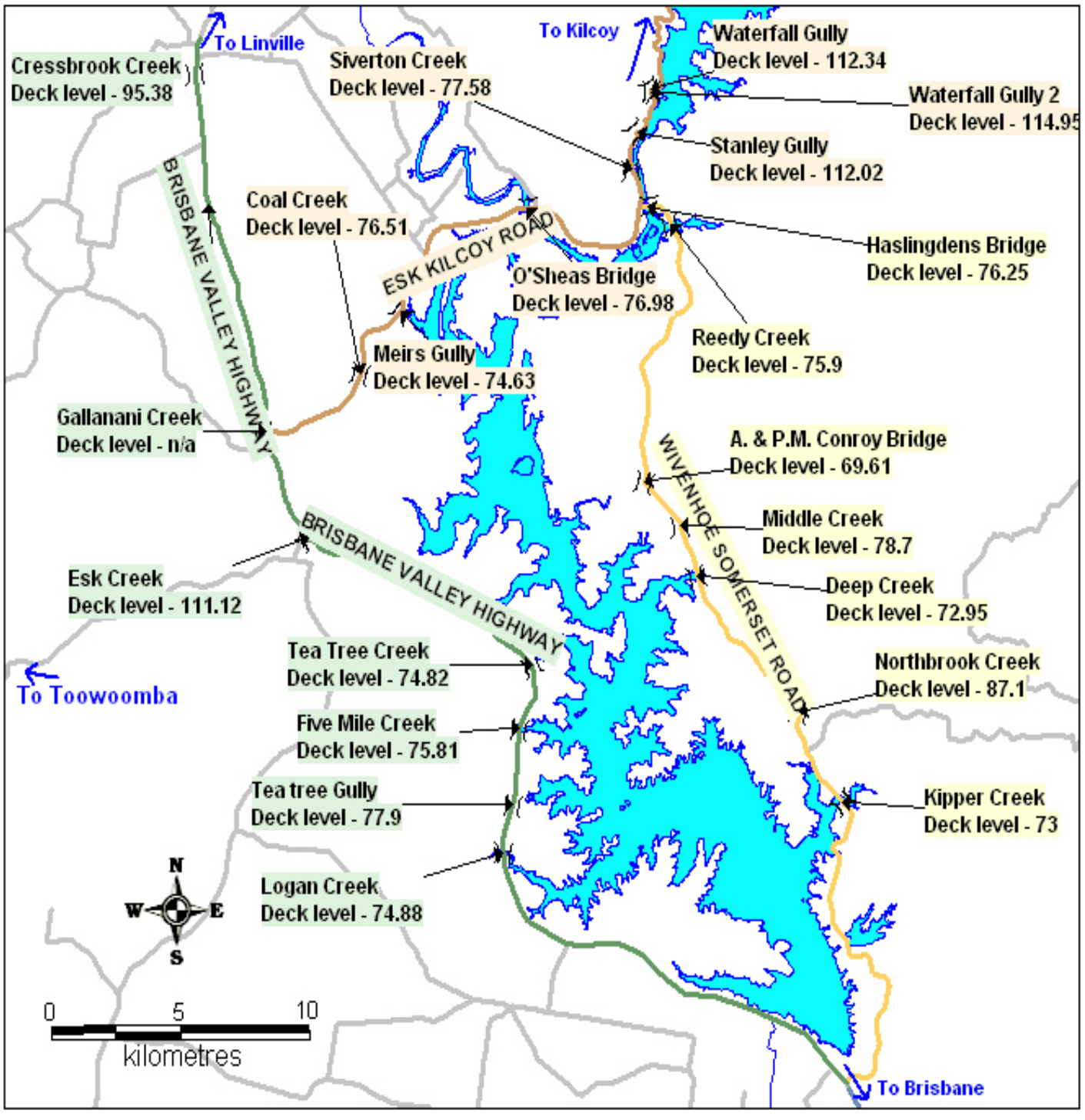
Roads Surrounding Wivenhoe Dam



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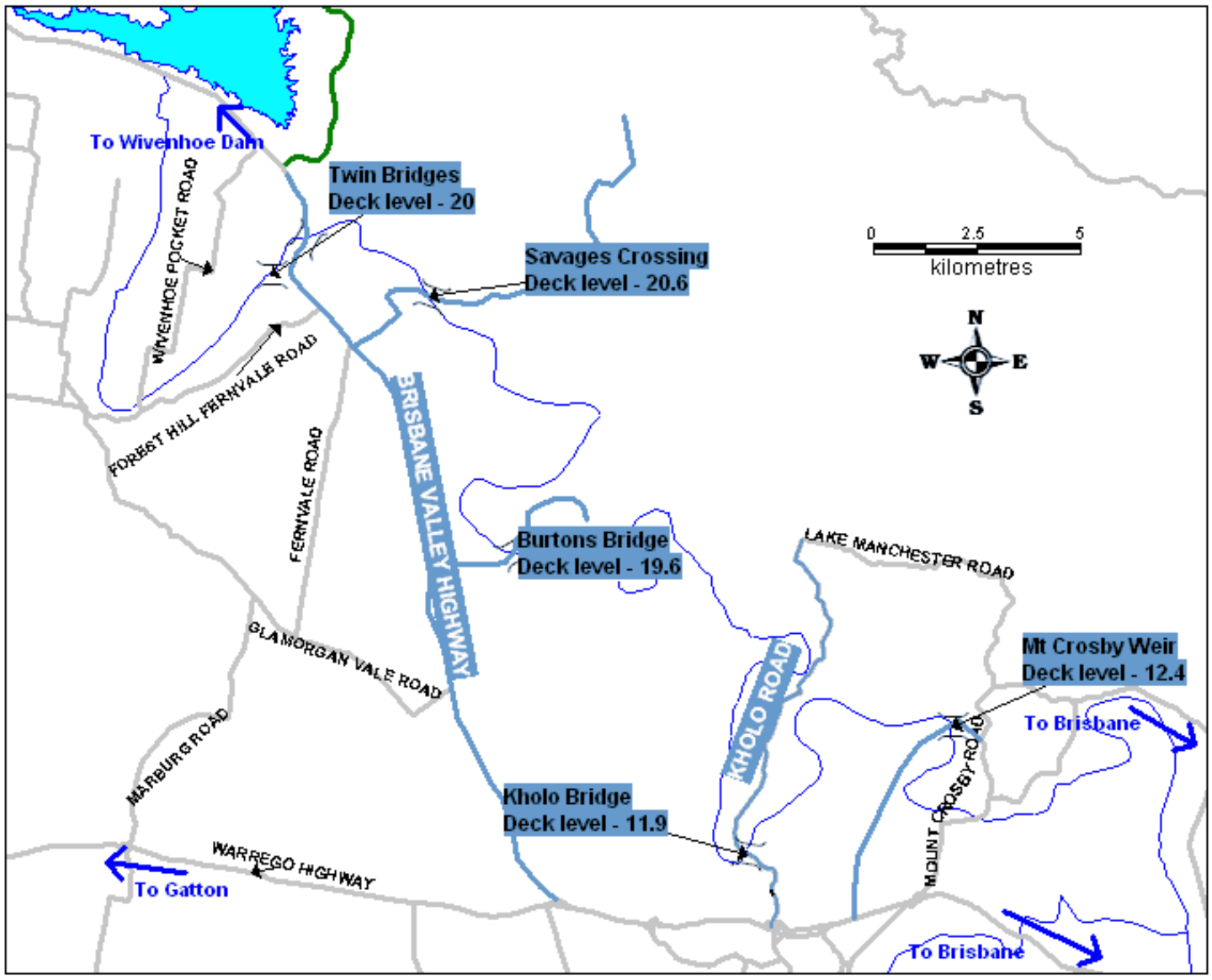
Bridges Downstream of Wivenhoe Dam



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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	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 1	1000	5.0	3300	20.0	6000
Brisbane R at Lowood*	22.74 SD	-	8.6 1		5.9		21.2	
Brisbane R at Savages Crossing*	18.43 AHD	23.79	9.0 1		6.0		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 1	4000	3.0	5000	15.5	6500
Brisbane R at Jindalee Br*	0.00 AHD	14.10	6.0 8		.0		10.0	
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

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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.

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APPENDIX E. WIVENHOE DAM TECHNICAL DATA

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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

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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	51.28	34.2	2 731	13 730
79.5	3 032	1 867	52.22	34.4	2 832	14 230
80.0	3 132	1 966	52.22	34.5	2 891	14 455

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* 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 E.3 need to be added to give the full outflow.

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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
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							

UNCONTROLLED DISCHARGE

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	42	5 482	538	5	93	648	702	756	80	9	863	917	971	1026	1081	1138	1196	1255	1316	1379	1443	1509	1577	1636				
73.2	2	62	124	187	248	309	369	42	7 485	542	5	97	653	707	761	81	5	869	924	978	1034	1090	1147	1206	1266	1327	1391	1456	1523	1592	1663	166	9	UNCONTROLLED	
73.4	6	62	125	188	250	311	371	43	0 488	545	6	02	657	712	767	82	1	876	931	986	1042	1099	1156	1216	1276	1339	1403	1469	1536	1606	1678	170	2	DISCHARGE	
73.6	11	64	126	189	251	313	373	43	3 491	549	6	06	662	717	772	82	7	882	937	993	1050	1107	1166	1225	1287	1350	1414	1481	1550	1620	1693	1736			
73.8	17	69	127	190	253	315	376	43	6 495	553	6	10	666	722	778	83	3	888	944	1001	1058	1116	1175	1235	1297	1361	1426	1494	1563	1635	1708	1770			
74.0	23	74	129	191	254	317	378	43	8 498	556	6	14	671	727	783	83	9	895	951	1008	1065	1124	1184	1245	1307	1372	1438	1506	1576	1648	1723	180	0	1804	
74.2	31	80	133	192	256	319	380	44	1 501	560	6	18	675	732	788	84	5	901	958	1015	1073	1132	1192	1254	1317	1382	1449	1518	1589	1662	1738	181	5	1838	
74.4	39	87	139	195	257	321	383	44	4 504	563	6	22	679	737	793	85	0	907	964	1022	1081	1140	1201	1264	1327	1393	1461	1530	1602	1676	1752	183	1	1873	
74.6	47	94	145	200	259	322	385	44	7 507	567	6	26	684	741	799	85	6	913	971	1029	1089	1149	1210	1273	1337	1404	1472	1542	1615	1690	1767	184	6	1908	
74.8	56	103	153	206	262	324	387	44	9 510	570	6	29	688	746	804	86	2	919	978	1036	1096	1157	1219	1282	1347	1414	1483	1554	1628	1703	1781	186	1	1943	
7	66	112	161	213	267	326	390	45	2 513	574	6	33	692	751	809	86	7	926	984	1044	1104	1165	1227	1291	1357	1425	1494	1566	1640	1717	1795	187	6	1960	1978
5.0																																			
75.2	76	121	169	220	274	330	392	45	5 516	577	6	37	697	756	814	87	3	932	991	1051	1111	1173	1236	1301	1367	1435	1506	1578	1653	1730	1809	189	1	1976	2013
75.4	87	131	178	229	281	336	394	45	7 519	581	6	41	701	760	819	87	8	938	997	1057	1119	1181	1245	1310	1377	1446	1517	1590	1665	1743	1823	190	6	1992	2049
75.6	98	141	188	237	289	343	399	46	0 522	584	6	45	705	765	824	88	4	944	1004	1064	1126	1189	1253	1319	1386	1456	1527	1601	1678	1756	1837	192	1	2007	2085
75.8	109	152	198	247	298	350	405	46	3 525	587	6	49	709	769	829	88	9	949	1010	1071	1133	1197	1261	1328	1396	1466	1538	1613	1690	1769	1851	193	6	2023	2112	21	21
	OVERTOPPING of GATE																																		

76.0	121	164	209	257	307	359	412	46	8 5	8	591	6	52	713	774	834	89	5	955	1016	1078	1141	1205	1270	1337	1405	1476	1549	1624	1702	1782	1	865	195	0	2038	2129	21	58	
76.2	133	175	220	268	317	368	421	47	5	532	594	6	56	718	779	839	90	0	961	1023	1085	1148	1212	1278	1346	1415	1486	1560	1636	1714	1795	1	878	196	5	2053	2145	21	94	
76.4	146	187	232	279	327	378	429	48	3	539	597	6	60	722	783	844	90	6	967	1029	1092	1155	1220	1286	1354	1424	1496	1570	1647	1726	1808	1	892	197	9	2069	2161	22	31	
76.6	159	200	244	290	338	388	439	49	2	546	603	6	64	726	788	849	91	1	973	1035	1098	1162	1228	1295	1363	1434	1506	1581	1658	1738	1820	1	905	199	3	2084	2177	22	68	
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	51	1	564	618	6	74	7	4	797	859	92	1	984	1047	1112	1177	1243	1311	1380	1452	1526	1602	1680	1762	1845	1	932	202	1	2113	2208	23	06	2343
77.2	200	240	283	328	374	422	471	52	2	574	627	6	82	739	801	864	92	7	990	1054	1118	1184	1250	1319	1389	1461	1536	1612	1691	1773	1858	1	945	203	5	2128	2224	23	22	2381
77.4	215	254	297	341	387	435	483	53	3	584	637	6	91	747	806	869	93	2	996	1060	1125	1191	1258	1327	1398	1470	1545	1622	1702	1785	1870	1	958	204	9	2143	2239	23	39	2419
77.6	230	269	311	355	400	447	496	545	595	647	700	756	813	873	937	1001	1066	1	131	1198	1265	1335	1406	147	9	1555	1633	17	13	1796	1882	1	971	206	3	2157	2255	23	55	2457
77.8	245	283	325	369	414	461	508	557	607	658	711	765	821	880	942	1007	1072	1	138	1205	1273	1343	1414	148	8	1564	1643	17	24	1808	1894	1	984	207	6	2172	2270	23	71	2475	24
78.0	260	299	340	383	428	474	522	570	619	670	722	775	831	888	948	1012	1078	1	144	1211	1280	1351	1423	149	7	1574	1653	17	35	1819	1907	1	997	209	0	2186	2285	23	87	2492	25

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
											OVERTOPPING of GATE																											
79.0	342	379	419	460	504	548	594	640	688	736	786	837	889	943	999	1057	1117	1180	1246	1316	1389	1464	1541	1620	1703	1787	1875	1966	2060	2156	2257	2360	2466	2575	2687
																	OVERTOPPING of GATE																			
80.0	431	466	505	545	587	630	675	720	766	813	861	910	961	1013	1068	1124	1182	1243	1306	1372	1441	1513	1589	1668	1751	1838	1929	2023	2121	2221	2325	2432	2542	2655	2772

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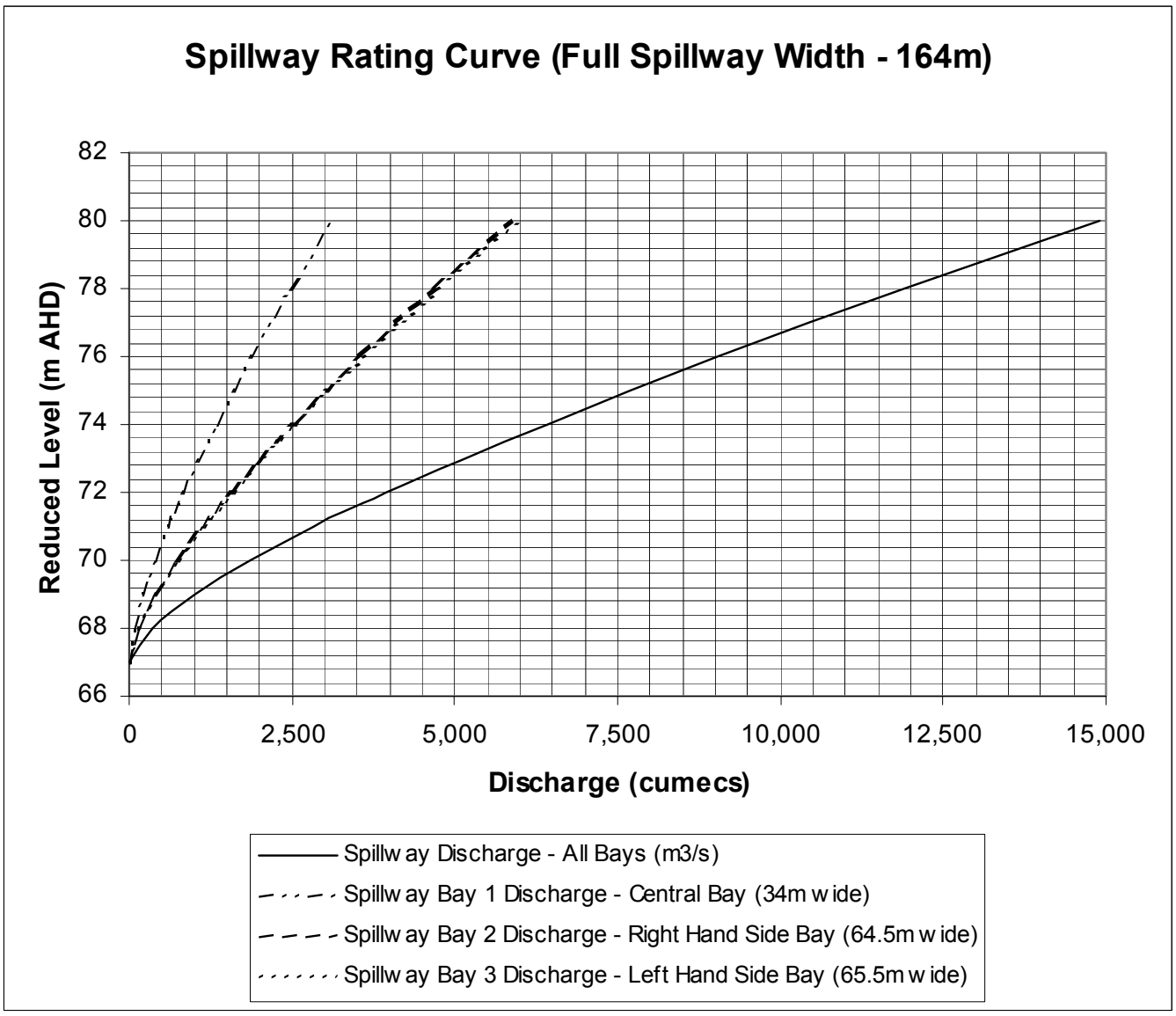
TABLE E.3 – WIVENHOE DAM AUXILIARY SPILLWAY RATING TABLE

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

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Table F-I - 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 Wiv enhoe Dam, and Operations and Maintenance Manuals for Wivenhoe Da m are held by the Cor poration and the Head works 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

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Each radial gate consists of a cylindrical upstream skinplate segment that is attached to the radial arms. The cylindrical axis is horizontal. Each gate rotates about two spherical trunnion bearings that are on this axis.

The position of the gate is controlled by hydraulically driven winches that are located on the piers beside the gates. Wire ropes are attached to the downstream face of the skin plate through a pulley system. The hydraulic motors work off a common pressure manifold and under perfectly matched conditions, will give an equal lifting force to each side of the gate. This system does not sense rope travel and will take up slack rope. It cannot prevent or

correct skewing of the skin plate s egment between the pi ers. If skewing occurs, skids will come into contact with the side seal plates to limit movement.

It is not possi ble to oper ate a winch i ndependently of the other winch attache d to the gate.

When the hydraulic motors are not energised, the gate s are held in posi tion by spring loaded fri ction brakes on the winc hes. There are two brak e bands per winch and each band is capable of supporting half the weight of the gate. O ne winch can support the total weight of a gate on both it s brake band s but not on one.

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G.3. RADIAL GATES OPERATING LIMITATIONS

G.3.1. Opening and Closing Rate

The aperture opening rate of each gate is limited to 500 mm/minute.

Aperture movement is l imited by a programmable timer that stops gate movement after a set period of time.

G.3.2. Alternate Consecutive Operation

To mai ntain symmetry of di scharge in the spill way, either gates 1 and 5 or gates 2 and 4 are to be operated in alte rnate consecuti ve increments. The power for gate operation comes from two independent el ectric hydrau lic pumps, each of which is capable of operating one gate at a time.

The normal hydraulic pressure source for each gate is as follows:

GATES	POWER SOURCE
Radial Gates 1 & 2, and Penstock Gate Hoist	Electric hydraulic pump 1
Radial Gates 3, 4 & 5	Electric hydraulic pump 2

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In the event that an electric hydrauli c pump fail s, hydrauli c pressure can be redirected from the other power source, but concurr ent operation of more than one gate from a single power source is not possible.

G.3.3. Overtopping

While the radi al gates ha ve been designed to withstand overtopping, it should be avoided if possibl e. The reservoir levels and the structural state of th e radial gates when in the closed position are as follows:

Reservoir Level m AHD	Condition	Radial Gate Stress Condition with Gate Closed
73	Top of closed gate	Normal
77	Design Flood Level	33% Overstress
80	Crest Level	Critical

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Once overtopped, the gates become inoperable when the lifting tackle is fouled by debris from the o verflow. The gates r emain structurall y secure until th e reservoir level exceeds EL 77. The ab ility to control floods however may b e lost.

G.3.4. Gate Dropping

Under no ci rcumstances are the gates to be droppe d. The lower ski n plate sections are overstressed i f a freefall of 60 mm is arre sted by the seal plate on the spillway.

If a gate becomes st uck in an open posi tion, i t is to be fr eed by appl ying positive lifting forces. Under no circumstances are the winches to be unl oaded and the direct weight of the gates used to yield the obstruction.

G.3.5. Operation in High Wind

Other than in periods of mitigation of medi um and major floods, the gates are not to be r aised or l owered when cl ear of water, during peri ods of high winds. The gates can however, be he ld on the brakes in any position in the presence of high wind.

The term "high wind" means any wind that causes twisting or movement of the gate. While a precise figure cannot be pl aced on these velocities, further experience over time may allow a figure to be determined.

This limitation is required to prev ent the gate from twisting from s kew on one side to skew on the other side. Whil e the gate is being raised or l owered, skewing cannot be pr evented by the hydrauli c lifting system and any imp act forces encountered may damage the gate.

G.3.6. Maintenance

No more than one gate is to be i noperable at any one time for maintenance. The maintenance is to be schedul ed so that the spillway bay can be cleared of obstructions in a reasonable time to allow its use in the event of major flooding.

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G.4. BULKHEAD GATE OPERATING LIMITATIONS

The bulkhead gate can be used to control discharge in an emergency situation where a radial gate is inoperable. It is transported to, and lowered upstream of the inoperabl e radial gat e by means of the gantry crane. The fol lowing conditions apply:

(a) The bulkhead gate can always be lowered with any type of underfl ow; and

(b) It i s not possible to raise the bulkhead gate once it has been lowered past certain level s dependi ng on upstream condi tions wi thout there bei ng a pool of water between it and the radial gate. (Department of Primary Industries Wivenhoe Dam Design Report, September 1995 refers).

It is thus possible to pr eserve storage by effectiv ely closing the s pillway even with one r adial gate inoperabl e. It wi ll not be possibl e to rai se the bulkhead gate until the radial gate behind has bee n repaired and is again storing water between the bulkhead gate and itself.

The bulkhead gate is not to be used for fl ood regulation until the reservoir level is falling and not likely to rise with in the period needed to repair th e inoperable radial gate.

G.4.1. Opening and Closing Rates

The spillway gantry crane is to be used to raise and lower the bulkhead gate. The crane operates at two speeds, 1.5 and 3.0 m/min. When within the bulkhead gate guides, the bulkhead gate is to be moved only at 1.5 m/min.

G.4.2. Overtopping

In the event that the bulkhead gate is overtopped (reservoir level exceeds EL 69 when bulkhead gate is closed), it cannot be removed unless a pool of water fills the space between it and the radial gate behind. The closed bulkhead becomes critically stressed when the reservoir level overtops it to EL 71.4.

It is not possible to engage the lifting tackle while overtopping is occurring. While there is any risk that the bulkhead gate may be overtopped, the lifting gear is to be left engaged so that the gate can be raised once the downstream radial gate becomes operable.

G.4.3. Discharge Regulation

In the event that a radial gate is inoperable in a partially open position, the bulkhead gate can be used for flow regulation provided that the lower lip of the radial gate is clear of the underflow jet.

Where a pool exists between the bulkhead gate and a radial gate under flow conditions, the bulkhead gate will be subjected to additional pull-down and possibly subjected to vortex-induced vibrations. When this condition occurs, the bulkhead gate is to be lowered to dewater the pool. The bulkhead gate can then be adjusted to regulate the flow provided the underflow jet remains below the lower lip of the radial gate.

G.5. RADIAL GATE OPERATING PROCEDURES

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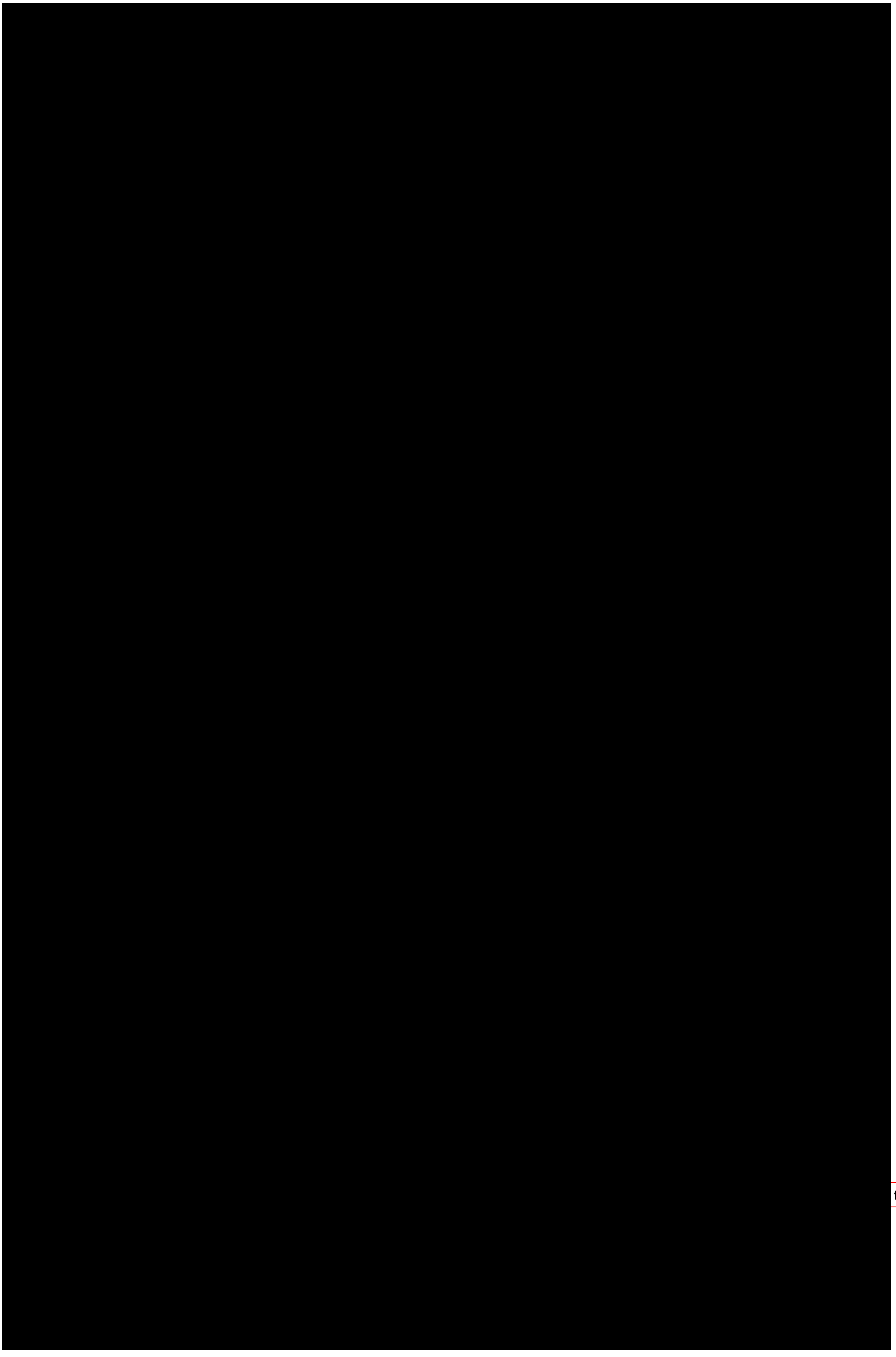

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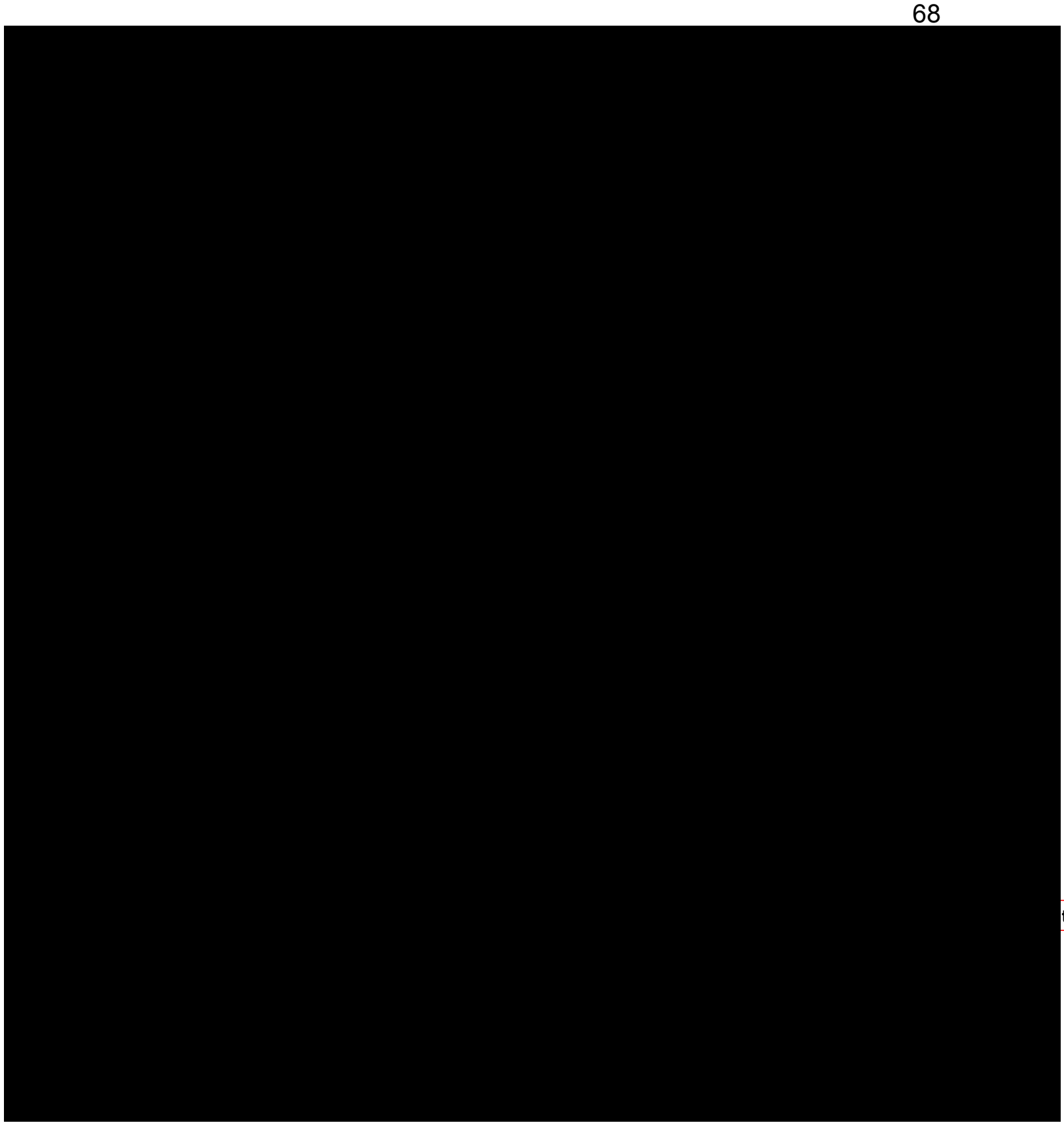

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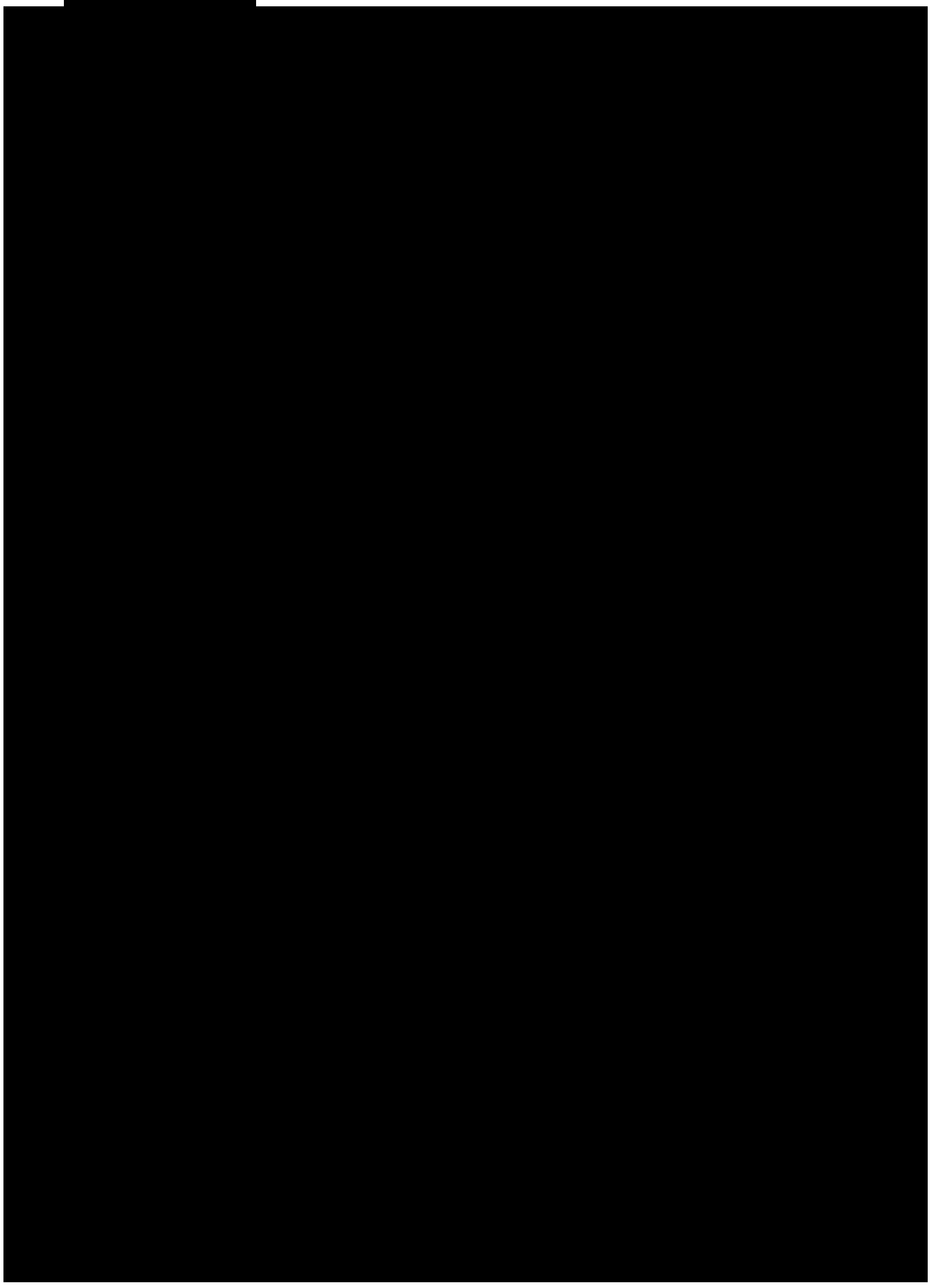

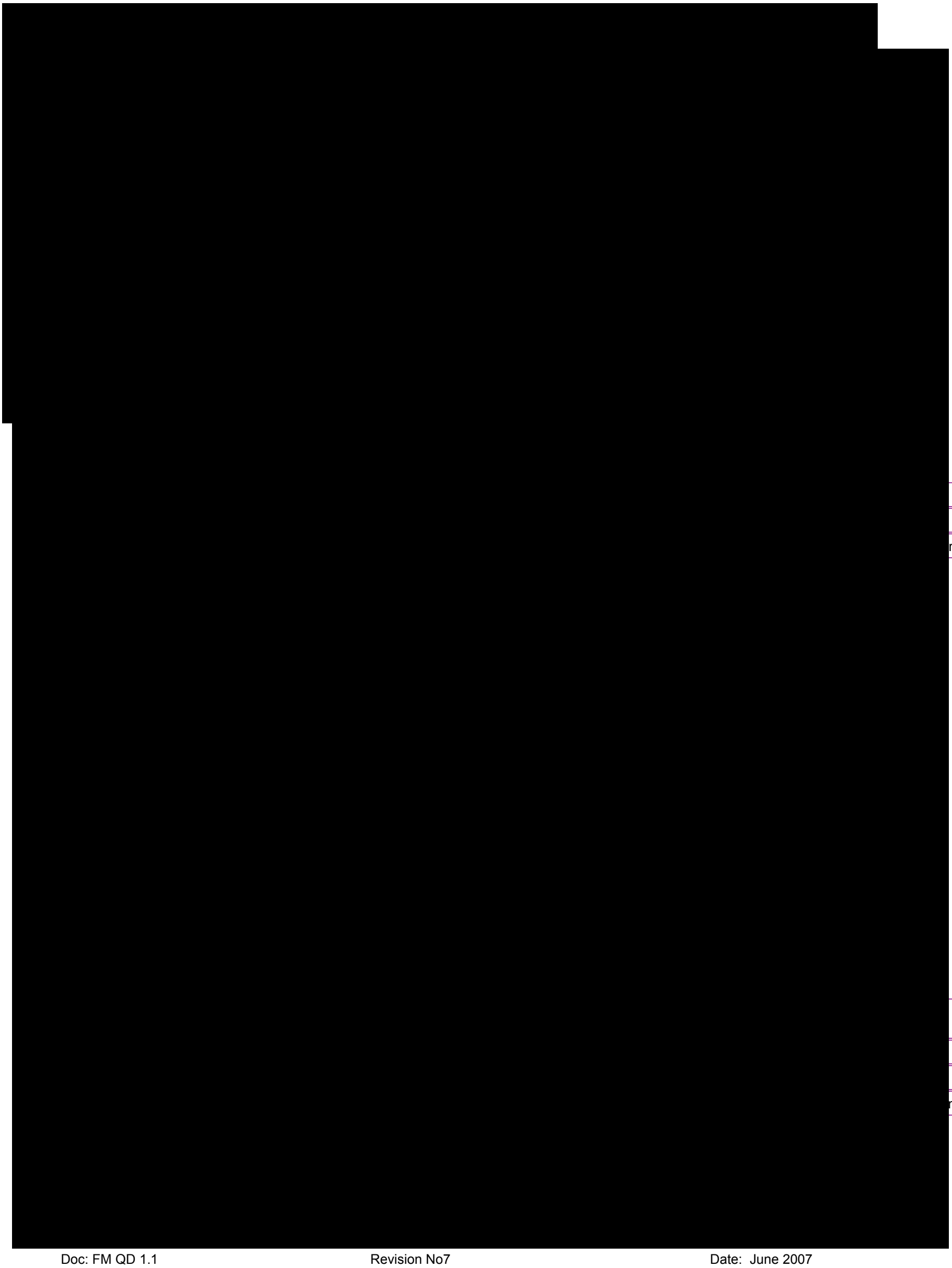

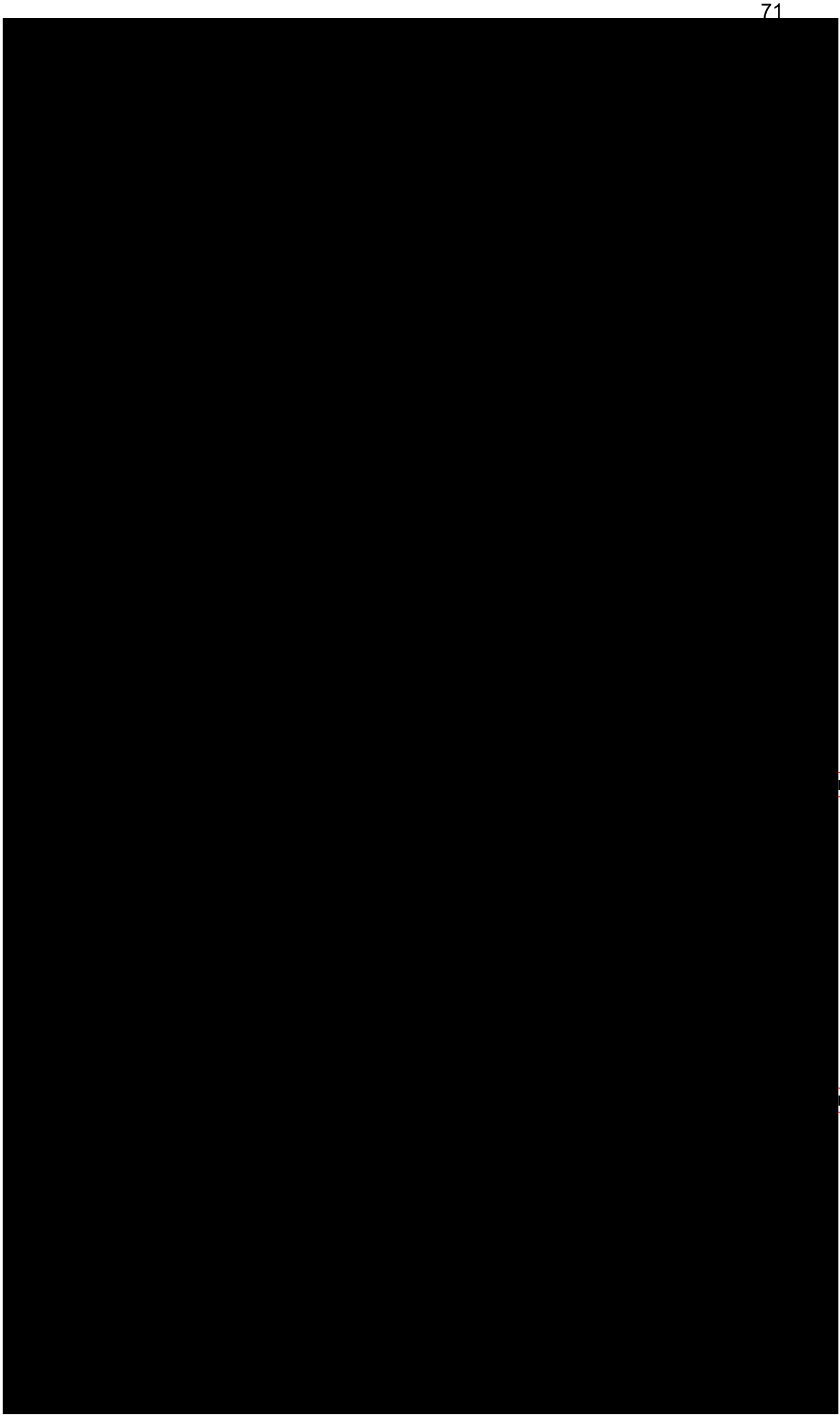

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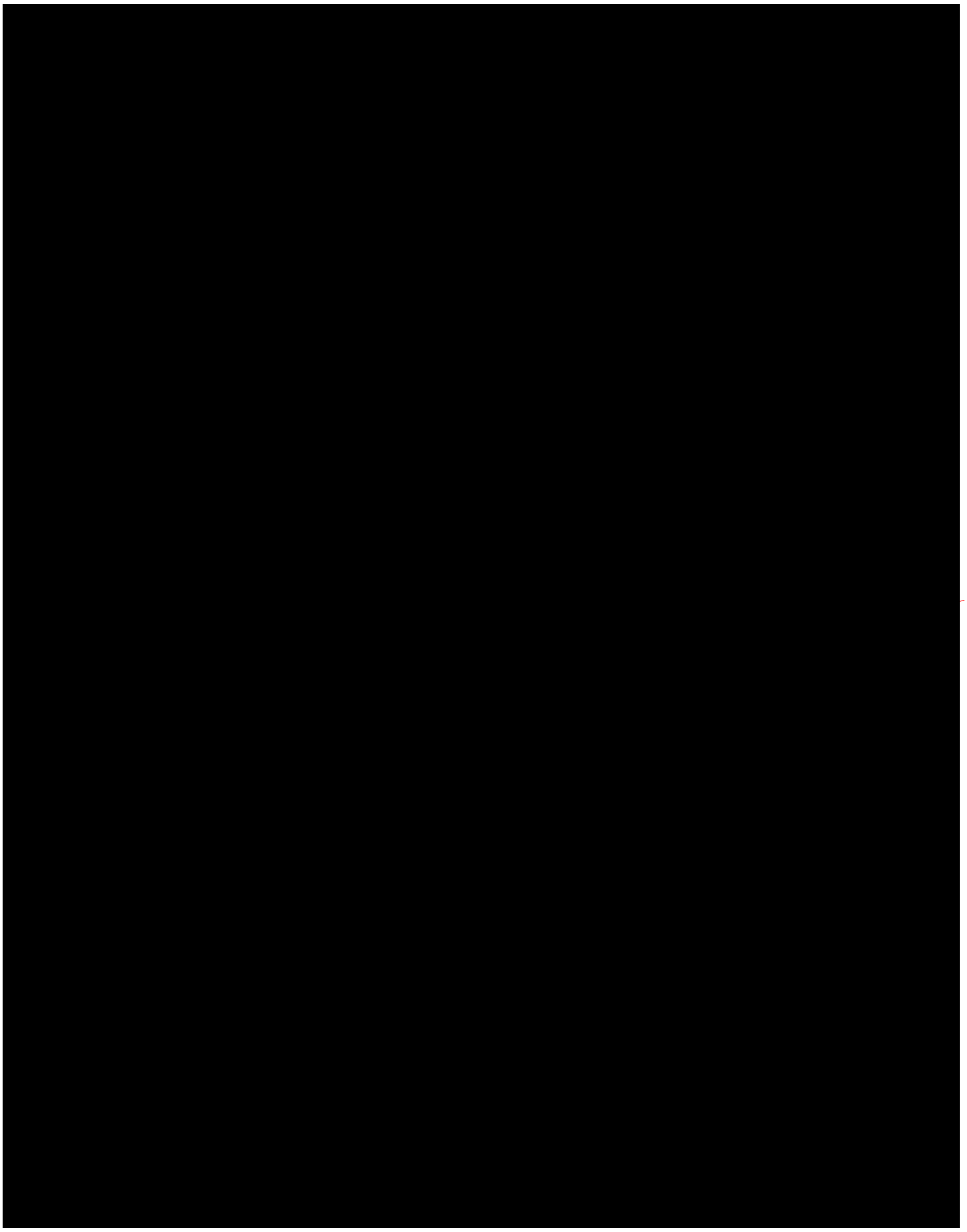

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Table I-4 - Estimated Model Parameters

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

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I.5. W IVENHOE DAM FLOODS

Wivenhoe Dam floods were estimated us ing the rainfall s and runoff routin g model already discussed. Inflows to Wivenhoe Dam, assuming the dam to be in exi stence and full, were calculated, as well as flow at the dam-si te without the dam in the catchment. Two-day stor ms were found to ha ve the critical storm durati on for most cases, t hough the long duration Probabl e Maximu m Precipitations produced very large flood vol umes. Table I-5 lists results for th e two-day duration storms.

Table I -5 - Wivenh oe Dam Fl oods - Design I nflows and Outfl ows for Existing, Stage 1 and Stage 2 Upgrades

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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 est imated us ing the rainfall s and runoff routing model al ready discussed. Inflows to So merset Dam, assuming the dam to be in existence and full , were calculated, as wel l 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 l arge flood volumes. Table I-6 lists results for the forty-eight hour duration storms.

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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 NO T give the maximum Peak Infl ow for a gi ven AEP

* - Overtopped, estimated flow based on no dam failure

I.7 FLOOD CONTROL OPERATION MODEL

Floods in the Bri sbane River catchment above Wivenhoe Dam can originate in either the Stanley River or upper Bri sbane Ri ver catchm ent or both. Both of the dams are capabl e of bei ng operated in a nu mber of ways, each of which will reduce the flow downstream. Ho wever, in order to achieve maxi mum 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 revi ewed the basic hydrologic algorithms in the operati onal models used in the ear lier study and modified them to incorporate additional feat ures rel ating to gate ope nings and closings. The revised de sign flood hydr ology and operati onal mode l algorithm s were the n used to re-examine the original five possible operational procedures for each of Somerset Dam and Wivenhoe Dam, gi ving twenty-five possible combinati ons

to be re-considered. The proced ures previously developed for Wivenhoe Dam were desi gned so that initial rel ease oper ations di d no t adver sely affect later operations i n the event of later rainfall causing th e magni tude of the flood to exceed the original estimate.

The procedures previously developed were also designed to restri ct flooding in the lower catchment to the l owest le vel of the fol lowing categori es 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 dama ge to urban areas due to combined Wivenhoe Dam releases a nd downstream fl ow, Wi venhoe Dam release compon ent of peak flow minimum practicable.

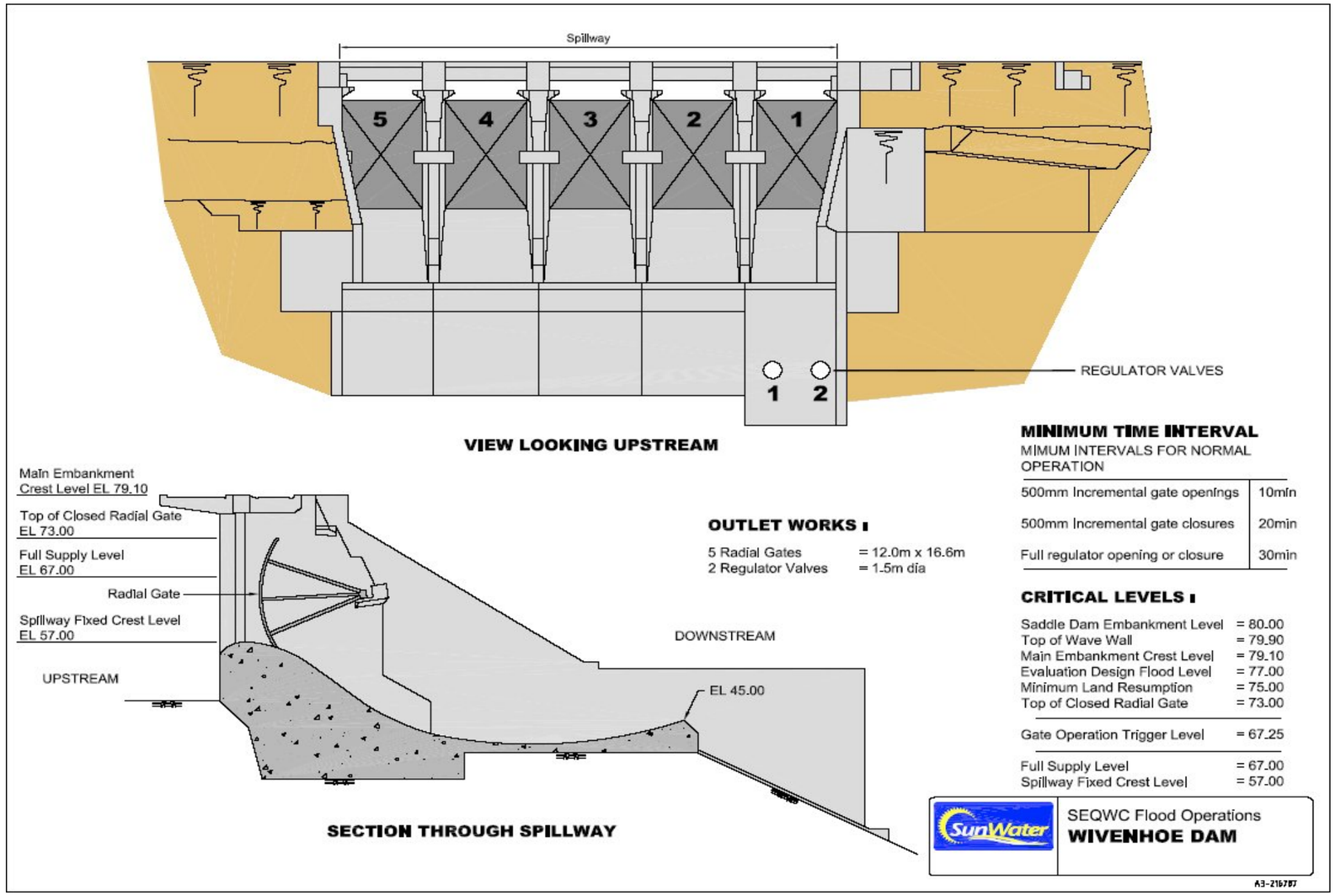
The previ ous flood studies recomme nded that one procedure be sel ected for the operation at Somerset Dam. Thi s procedure had two ad vantages over t he other procedures tested. Fi rstly, it was feasible fo r all magnitude s of Stanl ey River fl oods tested and, sec ondly, it was the si mplest procedure to carry out. The re-analysis confirmed this conclusion.

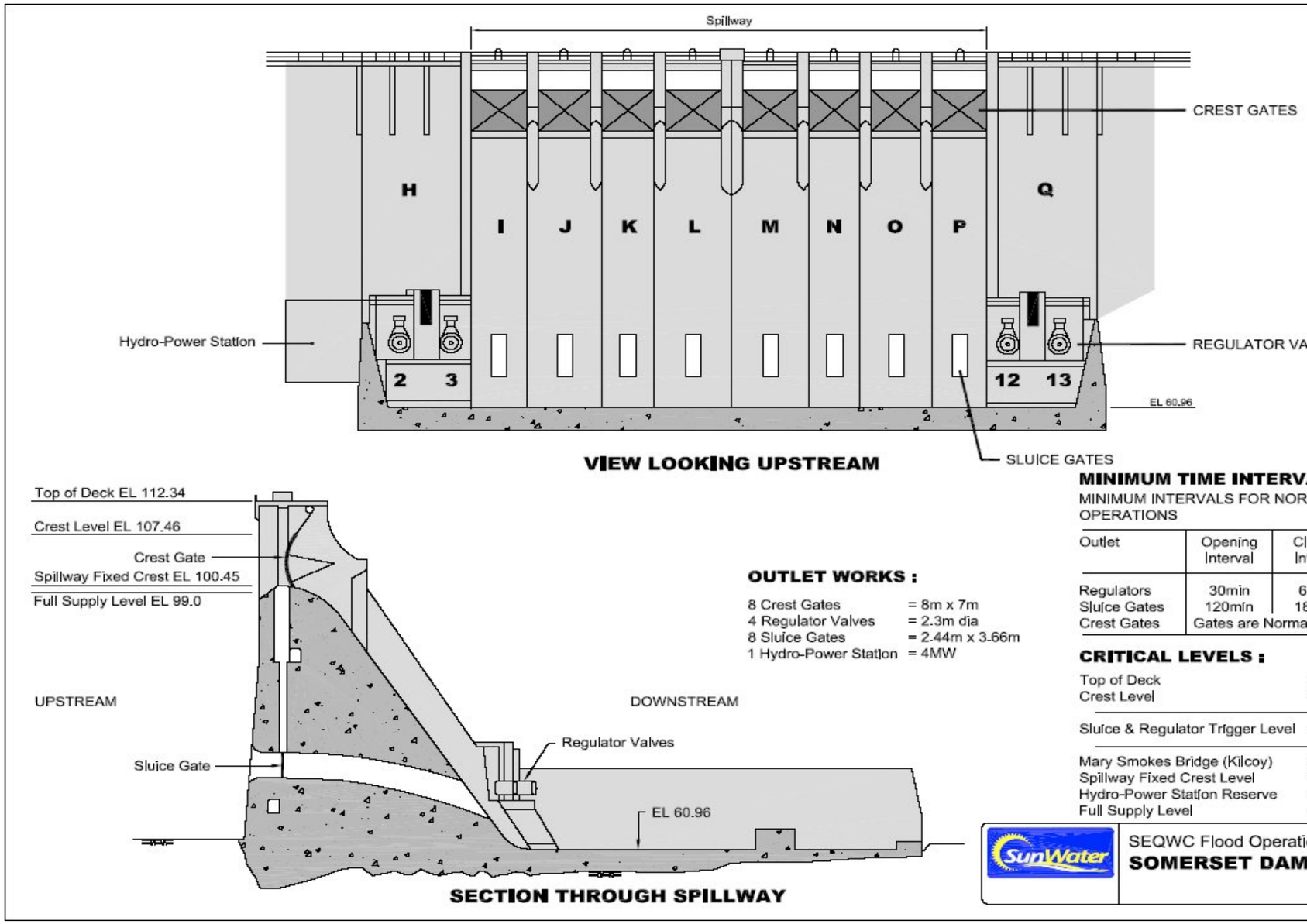
The previ ous flood studies concluded t hat procedures for Wiven hoe Dam be reduced to four by c ombining t wo proced ures i nto one. The resul ting four procedures formed a hierar chy and the procedure to be adopted advances to the next procedure as the flood ma gnitude increases. The re-analysis confirmed this conclusion.

A Real Ti me Flood Operati ons Model for Somerset and Wivenhoe has bee n 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

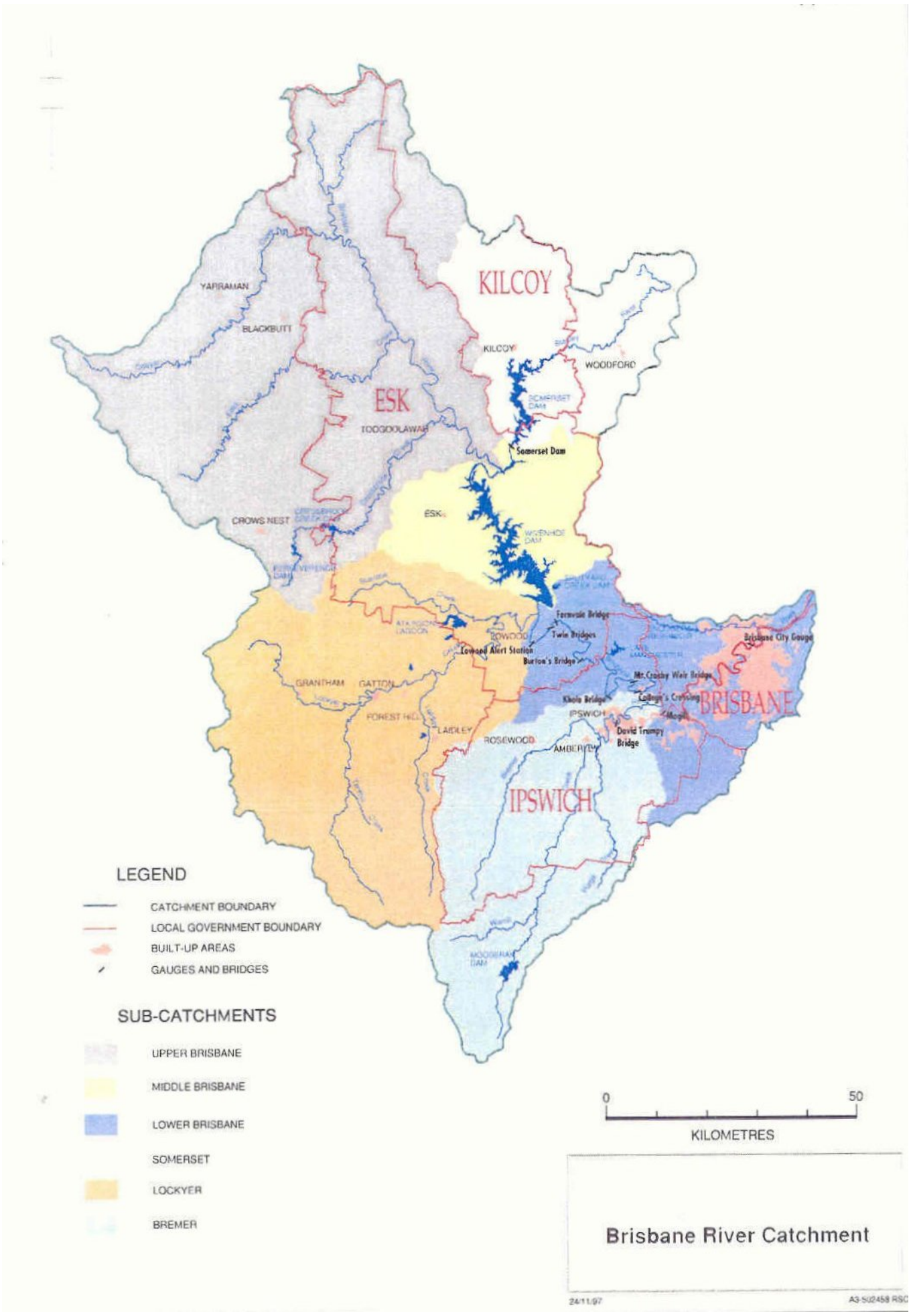
APPENDIX J. DRAWINGS




Spillway
CREST GATES
H
I
J
K
L
M
N
O
P
Q
Hydro-Power Station
2
3
12
13
REGULATOR VALVES
EL 60.96
SLUICE GATES
VIEW LOOKING UPSTREAM
Top of Deck EL 112.34
Crest Level EL 107.46
Crest Gate
Spillway Fixed Crest EL 100.45
Full Supply Level EL 99.0
UPSTREAM
DOWNSTREAM
Sluice Gate
Regulator Valves
EL 60.96
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 Op
CRITICAL LEVELS :
Top of Deck = 112.
Crest Level = 107.
Sluice & Regulator Trigger Level = 102.
Mary Smokes Bridge (Kilcoy) = 102.
Spillway Fixed Crest Level = 100.
Hydro-Power Station Reserve = 99.
Full Supply Level = 99.
SunWater
SEQWC Flood Operations
SOMERSET DAM
A3-2

[redacted]

APPENDIX K. BRISBANE RIVER CATCHMENT



ADDITIONAL PROVISIONS DURING CONSTRUCTION WORKS 2004/05

Auxiliary Spillway Area

The embankment for ming the t emporary road diversion that act s as a coffer dam is to be retained in place until t he construction of the fuse plug has proceeded past EL 74, and then its re moval is only to proceed once the written approval of a Senior Flood Operations Engineer has been obtained.

Gated Spillway Area

The following provisions will apply fo r works undertaken within the gated spillway:

The openi ng of spillway gates to disch arge 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 oper ated at short notice during a flood if required. To ensur e this capabili ty is maintained Table 8.6 specifies limitations that apply to the number of bay s in which works may be occurring at any time. Th is table also nominates a target notice period to be provided by the Senior Fl ood Operations Engineer for the removal of construction m aterial fr om the spillway ba ys prior to their use for releases. However the Seni or Flood Operations Engineer is not constrained to provide this l ength 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.