MANUAL

OF

OPERATIONAL PROCEDURES

FOR

FLOOD MITIGATION

Comment [r1]: While it is to be a Flood Mitigation Manual, there is no aim of flood mitigation. Why not go back to Flood Releases.

AT

NORTH PINE DAM

Revision 5

February 2010

Revision No.	Date	Amendment Details
0	10 December 1986	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	26 July 2002	Complete revision and re-issue
4	5 September 2007	Complete revision and re-issue
5	November 2009	Complete revision and re-issue

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1 INTRODUCTION

1.1 Preface

Given its size and location and rapid catchment response to rainfall, it is imperative that North Pine Dam be operated during flood events in accordance with clearly defined procedures to minimise hazard to life and property. This manual outlines these procedures and is an approved Flood Mitigation Manual under Water Supply Act 2008.

The Manual in its current form was developed in 1992 and the basis of this document was a manual written in 1986 covering flood operations at the dam. Four revisions of the Manual have occurred since 1992 to account for updates to the Flood Alert Network and the Real Time Flood Models and to account for institutional and legislative changes.

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The primary objectives of the procedures contained in this Manual are essentially the same as those contained in previous Manual versions. These objectives in order of importance are:

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

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In meeting these objectives, the dam must be operated to account for the potential effects of closely spaced Flood Events. Accordingly, normal procedures require stored floodwaters to be emptied from the dam as quickly as possible while meeting all flood mitigation objectives.

1.2 Meaning of Terms

In this manual, save where a contrary definition appears -

"Act" means the *Water Supply (Safety and Reliability) Act 2008*;

"AEP" means annual exceedance probability, the probability of a specified event being exceeded in any year;

"Agency" includes a person, a local government and a department of state government within the meaning of the Acts Interpretation Act 1954;

"AHD" means Australian Height Datum;

"Chairperson" means the Chairperson of Seqwater;

"Chief Executive" means the Director General of the Department of Environment and Resource Management or nominated delegate;

"Controlled Document" means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Dam" means the dam to which this manual applies, that is North Pine Dam;

"Dam Supervisor" means the senior on-site officer at North Pine Dam;

"Duty Flood Operations Engineer" means the Senior Flood Operations Engineer or Flood Operations Engineer rostered on duty to be in charge of Flood Operations at the dam;

"EL" means elevation in metres Australian Height Datum;

"Flood Event" is a situation where the Duty Flood Operations Engineer expects the water level at the dam to exceed the Full Supply Level;

"Flood Operations Centre" means the Centre used by Flood Operations Engineers to manage Flood Events;

"Flood Operations Engineer" means a person designated to direct flood operations at the dam in accordance with Section 2.4 of this manual;

"FSL" or "Full Supply Level" means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge;

"Gauge" when referred to in (m) means river level referenced to AHD, and when referred to in (m^3/s) means flow rate in cubic metres per second;

"Manual" or "Manual of Operational Procedures for Flood Mitigation at North Pine Dam" means the current version of this manual;

"Senior Flood Operations Engineer" means a person designated in accordance with Section 2.3 of this manual under whose general direction the procedures in this manual must be carried out;

"Seqwater" means the Queensland Bulk Water Supply Authority trading as Seqwater.

1.3 Purpose of Manual

The purpose of this manual is to define procedures for the operation of North Pine Dam during flood events. The procedures have been developed on the basis that the structural safety of the dam is to be protected to the maximum extent practical within the limitation of minimise the downstream impacts associated with releasing flood water from the dam.

Comment [r2]: structural safety gets mentioned a lot. In some instances we could be more specific and use overtopping

Comment [r3]: This should be reworded

1.4 Legal Authority

This manual has been prepared as a Flood Mitigation Manual in accordance with Chapter 4 Part 2 of the Act.

1.5 Application and Effect

The procedures in this manual apply to the operation of North Pine Dam for the purpose of flood mitigation, and operation in accordance with the manual shall give the protection from liability provided by Section 374 of the Act.

Comment [r4]: I know it is a flood mitigation manual but how about flood management in this instance

1.6 Date of Effect

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

The manual shall remain in force for the period of approval as determined by the Chief Executive. This approval may be for a period of up to five years.

Before the approval of the manual expires, Seqwater must review and if necessary update the manual and submit a copy to the chief executive for approval.

1.7 Observance of Manual

This manual contains the operational procedures for North Pine Dam for the purposes of flood mitigation and must be used for the operation of the dam during flood events.

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1.8 Provision to Variation of Manual

If Seqwater is of the opinion that this manual should be amended, altered or varied, it must submit for approval as soon as practical, an appropriate request to the Chief Executive, setting out the circumstances and the exact nature of the amendment, alteration or variation sought. The Chief Executive may accept, reject or modify the request prior to approval.

1.9 Distribution of Manual

Seqwater must regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of controlled hardcopies of the manual are listed in Appendix A. Seqwater must maintain a Register of contact persons for issued controlled hardcopies of the manual and must ensure that each issued document is updated whenever amendments or changes are approved.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, Seqwater is responsible for operating and maintaining the dam in accordance with this manual in order to retain the protection from liability afforded by the Act. Operators, employees, agents, and contractors working for Seqwater must also comply with this manual to obtain the protection of the Act.

2.2 Operational Arrangements

For the purposes of operation of the dam during Flood Events, Seqwater must ensure that:

- Sufficient numbers of suitably qualified personnel are available to operate the dam if a Flood Event occurs.
- Sufficient numbers of suitably qualified personnel are available to operate the Flood Operations Centre if a Flood Event occurs
- A Duty Flood Operations Engineer is on call at all times. The Duty Flood Operations Engineer may be either a Senior Flood Operations Engineer or a Flood Operations Engineer. The Duty Flood Operations Engineer must constantly review weather forecasts and catchment rainfall and must declare a Flood Event if the water level at North Pine Dam is expected to exceed Full Supply Level as a result of prevailing or predicted weather conditions.
- A Senior Flood Operations Engineer is designated to be in the charge of Flood Operations at all times during a Flood Event.
- Release of water at the dam during Flood Events is carried out under the direction of the Duty Flood Operations Engineer.
- All practical attempts are made to liaise with the Chairperson and the Chief Executive if the release of water from the Dams during a Flood Event is likely to endanger life or property.

2.3 Designation and Responsibilities of Senior Flood Operations Engineer

Seqwater must nominate one or more suitably qualified and experienced persons to undertake the role of Senior Flood Operations Engineer. If approved by the Chief Executive, these persons can be authorised in the Schedule of Authorities (see Section 2.6). When rostered on duty during a Flood Event, the responsibilities of the Senior Flood Engineer are as follows:

- Set the overall strategy for management of the Flood Event in accordance with the objectives of this manual.

- Provide instructions to site staff to make releases of water from the dam during Flood Events that are in accordance with this manual.
- Apply reasonable discretion in managing a Flood Event as described in Section 2.8.

Seqwater must ensure that an adequate number of Senior Flood Operations Engineers are available to manage all Flood Events.

2.4 Designation and Responsibilities of Flood Operations Engineer

Seqwater must nominate one or more suitably qualified and experienced persons to undertake the role of Flood Operations Engineer. If approved by the Chief Executive, these persons can be authorised in the Schedule of Authorities (see Section 2.6). When rostered on duty during a Flood Event, the responsibilities of the Flood Operations Engineer are as follows:

- Direct the operation of the dam during a flood event in accordance with the general strategy determined by the Senior Flood Operations Engineer.
- Follow any direction from the Senior Flood Operations Engineer in relation to applying reasonable discretion in managing a Flood Event as described in Section 2.8. Unless otherwise directed, a Flood Operations Engineer is to follow this manual in managing Flood Events and is not to apply reasonable discretion unless directed by the Senior Flood Operations Engineer or the Chief Executive.
- Provide instructions to site staff to make releases of water from the dam during Flood Events that are in accordance with this manual.

Seqwater must ensure that an adequate number of Flood Operations Engineers are available to manage all Flood Events. Seqwater must also ensure that an adequate number of suitably qualified and experienced persons are available to assist the Flood Operations Engineers during all Floods Events.

2.5 Qualification and Experience of Engineers

Qualifications

All engineers referred to in Sections 2.3 and 2.4 must hold a Certificate of Registration as a Registered Professional Engineer of Queensland and must hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

Experience

All engineers referred to in Sections 2.3 and 2.4 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:

    - Investigation, design or construction of major dams;
    - Operation and maintenance of major dams;
    - Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;
    - Applied hydrology with particular reference to flood forecasting and/or flood forecasting systems.

2.6 Schedule of Authorities

Seqwater must maintain a Schedule of Authorities containing a list of the Senior Flood Operations Engineers and Flood Operations Engineers approved by the Chief Executive to direct flood operations at the dams during floods. A copy of the Schedule of Authority must be provided to the Chief Executive by 30 September of each year.

Seqwater shall nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as the need arises. Each new nomination must include a validated statement of qualifications and experience as required by the Chief Executive. Seqwater 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 to manage a Flood Event, Seqwater must temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.7 Training

Seqwater must ensure that operational personnel required for flood operations activities receive adequate training in the various activities involved in flood control operation as required by the Chief Executive.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, it is necessary to depart from the procedures set out in this manual to meet the flood mitigation objectives set out in Section 3,

the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary subject to the following:

- Before exercising discretion under this Section of the manual with respect to flood mitigation operations, the Senior Flood Operations Engineer must make a reasonable attempt to consult with both the Chairperson and Chief Executive.
- The Chief Executive would normally authorise any departures from the manual. However if the Chief Executive cannot be contacted within a reasonable time, departures from the Manual can be authorised by the Chairperson.
- If both the Chairperson and the Chief Executive cannot be contacted within a reasonable time, the Senior Flood Operations Engineer may proceed with the procedures considered necessary and report such action at the earliest opportunity to the Chairperson and Chief Executive.

2.9 Report

Seqwater must prepare a report after each Flood Event. The report must contain details of the procedures used, the reasons therefore and other pertinent information. Seqwater must forward the report to the Chief Executive within six weeks of the completion of the Flood Event.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operation procedures in this manual, the flood release objectives, listed in descending order of importance, are as follows:

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

3.2 Structural Safety of Dam

The structural safety of North Pine Dam must be the first consideration in flood release operations. Failure could have catastrophic consequences due to the magnitude of flood damage that would be caused downstream, and also due to the loss of a water supply source.

The most likely cause of damage is overtopping. North Pine Dam consists of a mass concrete section, and earthen embankment sections. Concrete sections can withstand limited overtopping without damage. Embankment sections on the other hand will washout rapidly if overtopped and cause failure of the dam, resulting in severe flooding downstream. The prevention of overtopping is thus of paramount importance.

The safety of the dam therefore depends primarily on the proper operation of the spillway gates, which are used to control maximum flood levels. Such operation in turn relies on the proper functioning of the mechanical hoist mechanisms and their electric power supply and controls. This equipment is located within the dam structure above full supply level and can become inundated if flood releases are not initiated in a timely manner. The critical levels for the operation of the dam and the consequence of their exceedance are as follows:

Critical Levels for North Pine Dam

Description	AHD (m)	Possible Consequence
Full supply level.	39.60	-
Radial Gate Control Gear.	41.66	Electric motors submerged, use of backup systems required to operate radial gates.
Embankment Crest.	43.28	Breach of embankment by erosion

Extreme Floods and Closely Spaced Large Floods

As indicated in the previous section, techniques for estimating extreme floods show that floods are possible which would overtop the dam. Such an overtopping would most likely result in the destruction of the dam. Such events however require several days of intense rainfall to produce the necessary runoff.

Comment [r5]: this paragraph fits in the previous section

Comment [r6]: Is this really several days.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Pine River system within a short time of each other. Therefore, unless determined otherwise by the Senior Flood Operations Engineer in accordance with Section 2.8, the aim during a Flood Event should be to empty stored floodwaters as quickly as possible while meeting all flood mitigation objectives.

Pre-release of storage at flood producing levels could reduce the risk of overtopping but this may result in discharges exceeding inflows. Such a measure should be taken only after careful consideration of the reliability of precipitation forecasts and of perceived antecedent conditions.

Comment [r7]: Should really think if pre-release is an option

3.3 Minimise disruption to Downstream Populations

Comment [r8]: Replace populations with community

While North Pine Dam provides only limited flood mitigation benefits in terms retaining flood water above Full Supply Level, flood releases can result in the submergence of bridges and public areas. Accordingly, the operation of the dam should not prolong this inundation unnecessarily.

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3.4 Retain the Storage at Full Supply Level at the Conclusion of the Flood Event

As North Pine Dam is a primary urban water supply for South East Queensland, it is important that all opportunities to fill the dam are taken. There should be no reason why the dams should not be full following a Flood Event.

3.5 Minimising Impacts to Riparian Flora and Fauna

During the drain down phase, consideration is to be given to minimising the impacts on riparian flora and fauna. In particular, strategies aimed at reducing fish deaths in the vicinity of the dam walls are to be instigated, provided such procedures do not adversely impact on other flood mitigation objectives.

Additionally, when determining the time interval between successive gate closures, consideration should also be given to reducing potential bank slumping. Rapid draw down of stream levels where banks are saturated should be avoided if this can be managed within the other flood mitigation objectives.

4 FLOOD CLASSIFICATION

For the reference purposes of this manual, four magnitudes of flooding are classified as follows:

1. **Minor Flooding**

Causes inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.

2. **Moderate Flooding**

In addition to the impacts experienced during Minor Flooding, the evacuation of some houses may be required. Main traffic routes may be impacted. The area of inundation is substantial in rural areas requiring the removal of stock.

3. **Major Flooding**

In addition to the impacts experienced during Moderate Flooding, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required. The 1974 flood that impacted on the Ipswich and Brisbane areas is classified as a major flood.

4. **Extreme Flooding**

This causes flooding impacts equal to or in excess of levels previously experienced. In addition to the impacts experienced during Major Floods, the general evacuation of people from significant populated areas is likely to be required.

It should be noted that a flood may not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted. The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia.

5 FLOOD MONITORING AND FORECASTING SYSTEM

5.1 General

A real time flood monitoring and forecasting system has been established in the dam catchment. This system employs radio telemetry to collect, transmit and receive rainfall and stream flow information. The system consists of 30 field stations that automatically record rainfall and/or river heights at selected locations in the dam catchments. Some of the field stations are owned by Seqwater with the remainder belonging to other agencies.

The rainfall and river height data is transmitted to Seqwater's Flood Operations Centre in real time. Once received in the Flood Operations Centre, the data is processed using a Real Time Flood Model (RTFM) to estimate likely dam inflows and evaluate a range of possible inflow scenarios based on forecast and potential rainfall in the dam catchments. The RTFM is a suite of hydrologic and hydraulic computer programs that utilise the real time data to assist in the operation of the dams during flood events. Seqwater is responsible for providing and maintaining the RTFM and for ensuring that sufficient data is available to allow proper operation of the RTFM during a Flood Event.

5.2 Operation

The Senior Flood Operations and Flood Operations Engineers use the RTFM for flood monitoring and forecasting during flood events to operate the dams in accordance with this manual. This is done by optimising releases of water from the dams to minimise the impacts of flooding in accordance with the objectives and procedures contained in this manual.

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

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

A regular process of internal audit and management review must be maintained by Seqwater to achieve these improvements.

Seqwater must also maintain a log of the performance of the data collection network. The log must include all revised field calibrations and changes to the number, type and locations of gauges. Senior Flood Operations and Flood Operations Engineers are to be notified of all significant changes to the Log.

Seqwater must also maintain a log of the performance of the RTFM. Any faults to the computer hardware or software are to be noted and promptly and appropriately attend to.

5.3 Storage of Documentation

The performance of any flood monitoring and forecasting system is reliant on accurate historical data over a long period of time. Seqwater must ensure that all available data and other documentation is appropriately collected and catalogued 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 Seqwater, Bureau of Meteorology and the Local Government within whose boundaries the locations are situated.

Gauge boards that can be read manually must be maintained by Seqwater as part of the equipment of each key field station. Where possible and practical during Flood events, Seqwater is to have procedures in place for manual reading of these gauge boards in the event of failure of field stations.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, the Moreton Bay Regional 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.

Seqwater must ensure that information relevant to the calibration of its field stations is shared with these agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

Seqwater is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Seqwater Flood Operations Centre and site staff at North Pine Dam.

6.2 Dissemination of Information

Agencies other than Seqwater have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public associated with Flood Events. 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 the table below.

The Senior Flood Operations and Flood Operations Engineers must supply information to each of these agencies during Flood Events. The contact information for these Agencies and communication procedures is contained in the Emergency Action Plans for the dam and each agency is to receive updated controlled copies of these documents.

Seqwater must liaise and consult with these agencies with a view to ensuring all information relative to the flood event is consistent and used in accordance with agreed responsibilities.

AGENCY INFORMATION REQUIREMENTS

Agency	Activity	Information Required from Flood Operations Centre	Trigger
Bureau of Meteorology	Issue of flood warnings for Brisbane River basin	Actual and predicted lake levels and discharges	Initial gate operations and thereafter at intervals to suit forecasting requirements
Department of Environment and Resource Management	Review of flood operations and discretionary powers	Actual and predicted lake levels and discharges	Initial gate operations
Moreton Bay Regional Council	Flood level information downstream of North Pine Dam	Actual and predicted lake levels and discharges	Initial gate operations
Brisbane City Council	Flood level information for Brisbane City area	Nil (information obtained from BOM)	

6.3 Release of Information to the Public

Seqwater is responsible for the issue of information regarding storage conditions and current and proposed releases from the dam 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 and the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

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 cause the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

This process must involve all personnel involved in the management of Flood Events, to ensure 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 Personal Training

Seqwater must report to the Chief Executive by 30 September each year on the training and state of preparedness of operations personnel.

7.3 Monitoring and Forecasting System and Communication Networks

Seqwater must provide a report to the Chief Executive by 30 September each year on the state of the Flood Monitoring and Forecasting System and Communication Networks. The report must assess following in terms of hardware, software and personnel:

- 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
- The overall state of preparedness of the system

Seqwater must take any action considered necessary for the proper functioning and improvement of this system.

7.4 Operational Review

After each significant flood event, Seqwater must report to the Chief Executive on the effectiveness of the operational procedures contained in this manual. This report must be submitted within six weeks of any flood event that requires mobilisation of the Flood Operations Centre.

7.5 Five Yearly Review

Prior to the expiry of the approval period, Seqwater must review the manual pursuant to provisions of the Act. The review is to take into account the continued suitability of the communication network and the flood monitoring and forecasting system, as well as hydrological and hydraulic engineering assessments of the operational procedures.

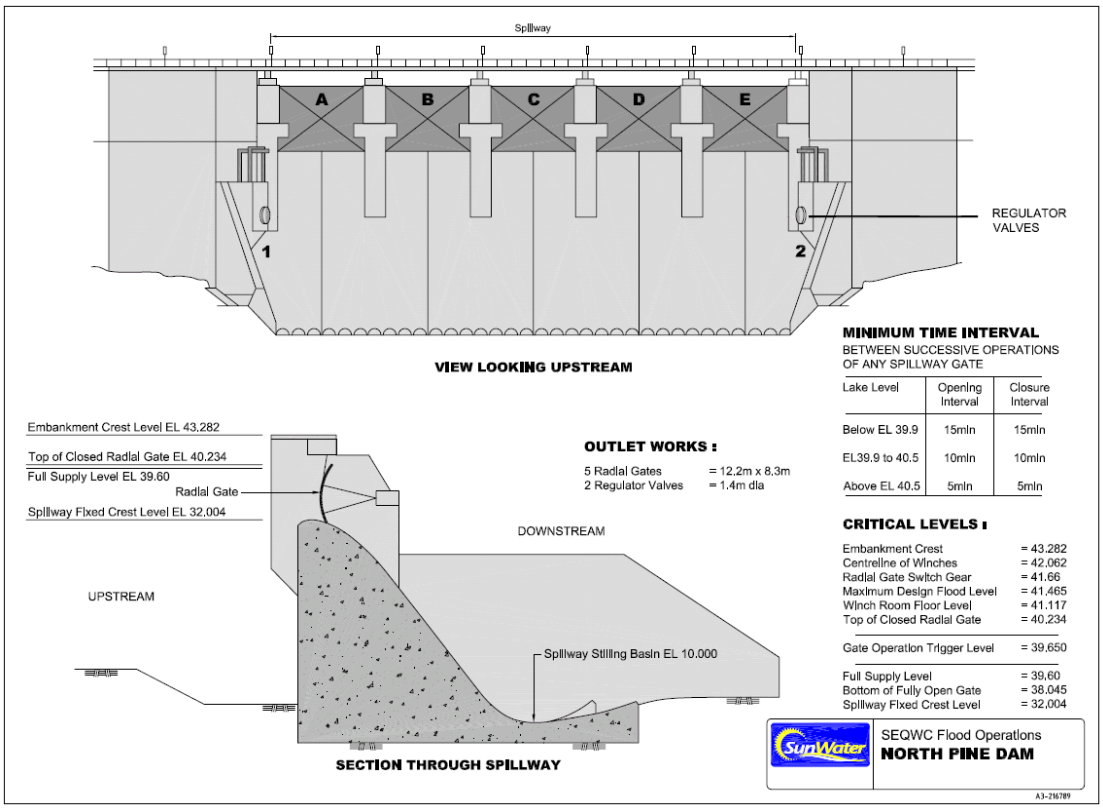
8 FLOOD RELEASE OPERATION

8.1 Introduction

North Pine dam is a water supply dam with only a small flood storage compartment above full supply level. It effectively has no significant provision for flood mitigation and once the dam is full, floods will pass through the reservoir with little mitigation. The peak inflow from critical storms may occur approximately two to four hours after the commencement of heavy rain.

8.2 Flood Release Infrastructure

Radial Gates are the primary infrastructure used to release water during flood events at North Pine Dam. The arrangement of the Radial Gates is shown in the diagram below:



8.3 Initial Action

Once a Flood Event is declared, an assessment is to be made of the magnitude of the Flood Event, including:

- A prediction of the maximum storage levels in the dam.
- A prediction of the peak outflow rate from the dam.

Unless a decision has been made to commence a pre-release of flood water to control the risk of dam overtopping, releases from the radial gates should not commence until the lake level exceeds FSL by 50 millimetres (39.65 m AHD).

Prior to releases from the radial gates commencing the Flood Operations Engineer must ensure that the Grant Street causeway is closed and the Moreton Bay Regional Council has been advised of the impact of the proposed flood releases on Youngs Crossing.

Comment [r9]: Isn't the catchment response so rapid that predicting maximums and peak is a pipedream.

Comment [r10]: predictions?

Comment [r11]: what about inflows?

Comment [r12]: pre-release to control the risk of overtopping.

Comment [r13]: Is this a Flood Operations Engineer job

8.4 Flood Operations Strategies

The flood release objectives for North Pine Dam, listed in descending order of importance, are as follows:

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

North Pine Dam effectively has no significant provision for flood mitigation and once the dam is full ensuring the structural safety of the dam is paramount. Accordingly the flood operation strategy is to pass the flood through the reservoir, while ensuring that peak outflow generally does not exceed peak inflow while aiming to empty stored floodwaters as quickly as possible. To achieve this strategy, the radial gate opening settings shown in Appendix C are normally used to determine flood releases.

Departures from the tables shown in Appendix C are allowed in the following circumstances:

- Pre-release of water is allowed to reduce the risk of dam overtopping.
- Reduction in release rate is allowed once the flood peak has passed to either minimise disruption to populations in areas downstream of the dam or to minimise impacts to riparian flora and fauna.
- At the end of a flood event, additional gate openings may be used to reduce the duration of gate operation and resulting adverse downstream impacts.

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.

Comment [r14]: Use 'the community' rather than 'populations'

Comment [r15]: We have this as an objective but we have no information on what are the critical levels or flows at which disruption occurs.

Comment [r16]: I would like to have this given more emphasis

Comment [r17]: These release rules are very rigid, is that required

Comment [r18]: This just isn't going to happen.

Comment [r19]: During initial opening?

8.5 Gate Closing Strategies

Comment [r20]: What about a Gate Opening Strategy

In general, gate closing commences when the level in North Pine Dam begins to fall and the closing sequence is generally to occur in the reverse order to opening. The final gate closure should occur when the lake level has returned to Full Supply Level. The following requirements must be considered when determining gate closure sequences:

- Where possible, total releases during closure should not produce greater flood levels downstream than occurred during the flood event.
- The maximum discharge from the dam during closure should generally be less than the peak inflow into North Pine Dam experienced during the event.
- The aim should always be to empty stored floodwaters stored above EL 39.65m as quickly as possible after the flood peak has passed through the dam. However, provided a favourable weather outlook is available, this requirement can be relaxed for the volume between EL 39.65m and EL 39.75m, to minimise downstream .

Comment [r21]: words missing – maybe disruption

- To minimise the stranding of fish downstream of the dam, final closure sequences should consider Seqwater policies relating to fish protection at the dam.

There may be a need to take into account base flow when determining final gate closure. This may mean that the lake level temporarily falls below Full Supply Level to provide for a full dam at the end of the Flood Event.

8.6 Gate Operation Sequences

Rapid opening of the radial gates at North Pine dam can cause undesirable rapid rises in downstream river levels. Accordingly, the aim in opening radial gates is to operate the gates one at a time at intervals that will minimise adverse impacts on the river system. The table below shows the target minimum interval for gate operations. This target interval can be reduced if the gates are at risk of being overtopped or the safety of the dam is at risk and operations are generally not allowed to fall more than three openings behind the gate opening settings contained in Appendix C.

TARGET MINIMUM INTERVALS FOR RADIAL GATE OPENING

Lake Level	Opening Interval	Closing Interval
Below EL 39.9m	15 min	15 min
EL 39.9m to 40.5m	10 min	10 min
Above EL 40.5m	5 min	5 min

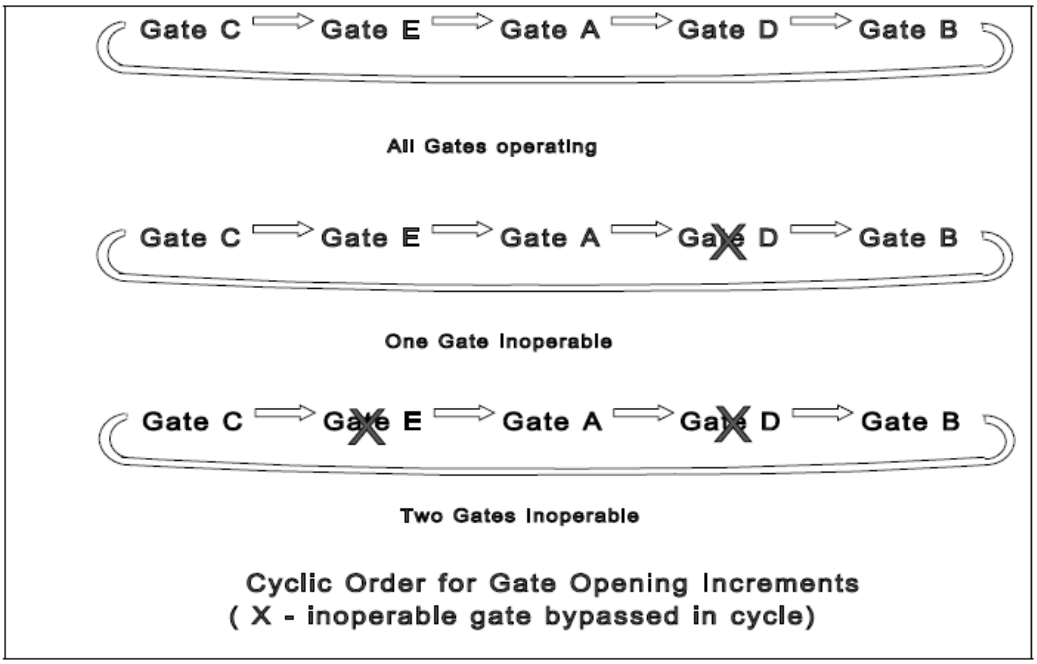
Rapid closure of radial gates is also permissible when there is a requirement to preserve storage or to reduce downstream flooding. When determining gate closure sequences, consideration should also be given to following the calculated natural recession of the flood

in the river to aim to ensure that the recession impacts are not greater than those that would have been experienced had the dam not been constructed.

8.7 Protection of the Spillway

To minimise potential damage to the dissipator and the river-bed and banks downstream, the gates must be opened incrementally in accordance with the cyclic sequences shown below.

Gate Operation Sequence



8.8 Gate Failure or Malfunction Procedures

Where one or more gates are inoperable, the sequencing outlined in section 8.7 (above) still applies, except that the inoperable gates must be ignored in the cycle and their increments passed on to the next gate in the sequence. The cumulative number of increments taken by all gates at any particular lake level thus remains unaltered save that the total number of available gate increments has been reduced by inoperable gates. Appendix C contains tables of gate position settings against lake levels for the situations where all gates are operating and where one gate is inoperable.

8.9 Radial Gate Turbulence Considerations

Unless in the process of lifting the gates clear of the flow, the bottom edge of the radial gates must always be at least 500 millimetres below the release flow surface. Having the bottom edge of the gates closer to the release flow surface than 500 millimetres may cause unusual turbulence that could adversely impact on the gates. This procedure has never been undertaken in practice and should be observed closely when being undertaken. Variations to the procedure are allowed to protect the structural safety of the dam.

Comment [r22]: The bottom of a fully open gate is EL38.045 (this manual) or EL38.405 (previous manual) which is over a metre below full supply level. So getting gates out of the water is never going to be a consideration.

8.10 Lowering Radial Gates that have been lifted Clear of the Release Flow

Comment [r23]: same comment as previous section

When lowering radial gates that have been lifted clear of the release flow, the bottom edge of the gates must be lowered at least 500 millimetres into the flow. Lowering gates into the release flow less than this amount may cause unusual turbulence that could adversely impact on the gates. This procedure has never been undertaken in practice and should be observed closely when being undertaken. Variations to the procedure are allowed to protect the structural safety of the dam.

9 EMERGENCY

9.1 Introduction

While every care has been exercised in the design and construction of the dam, there still remains a low risk that the dam may develop an emergency condition either through flood events or other causes. Experience elsewhere in the world suggests that vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than 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;
- Damage to the dam by earthquake;
- Damage to the dam as an act of war or terrorism; and
- Other rarer mechanisms.

Responses to these and other conditions are included in the North Pine Dam - Emergency Action Plans.

9.2 Overtopping of Dam

Whatever the circumstances, every endeavour must be made to prevent overtopping of North Pine Dam by the progressive opening of operative spillway gates. Overtopping of the dam is likely to result in a dam failure.

9.3 Communications Failure

If communications are lost between the Flood Operations Centre and the dam, the officers in charge at the dam are to adopt the procedures set out below. The Dam Supervisor at North Pine Dam is to assume responsibility for flood releases from the Dam. Once it has been established that communications have been lost, the Dam Supervisor at North Pine Dam is to:-

- Take all practicable measures to restore communications and periodically check the lines of communication for any change;
- Follow the procedures set out below to determine the relevant magnitude and duration of releases from North Pine Dam;
- Log all actions in the Event Log;
- Ensure the dam is at full supply level at the end of the event;
- Remain in the general vicinity of the dam while on duty.

The radial gate opening sequence to be used is as set out in Appendix C. The table below shows the target minimum interval for gate operations. This target interval can be reduced if the gates are at risk of being overtopped or the safety of the dam is at risk and operations are not allowed to fall more than three openings behind the gate opening settings contained in Appendix C.

TARGET MINIMUM INTERVALS FOR RADIAL GATE OPENING

Lake Level	Opening Interval	Closing Interval
Below EL 39.9m	15 min	15 min
EL 39.9m to 40.5m	10 min	10 min
Above EL 40.5m	5 min	5 min

In the event of one or more radial gates becoming jammed, the remaining gates are to be operated to provide the same total opening for a particular storage level, as shown Appendix C. In these circumstances, gates are generally operated in the order of C, E, A, D, B moving through the sequence shown in the tables.

In a loss of communication scenario, the bulkhead gate is not to be used. At the end of the event, the full supply level of the storage is to be achieved.

APPENDIX A
AGENCIES HOLDING CONTROLLED COPIES OF THIS MANUAL

Agency	Responsible Person	Location
Seqwater	Dam Safety and Source Operations Manager	Brisbane
Seqwater	Principal Engineer Dam Safety	Ipswich
Seqwater	Storage Supervisor	North Pine Dam
Seqwater	Operations Coordinator	North Coast
Seqwater	Senior Flood Operations Engineer	Flood Operations Centre, Brisbane
Department of Environment and Natural Resources	Director Dam Safety	Brisbane
Department of Emergency Services	Duty Officer – Disaster Management Service	Brisbane
Moreton Bay Regional Council	Local Disaster Response Coordinator	Caboolture
Brisbane City Council	Local Disaster Response Coordinator	Brisbane
Emergency Management Queensland	Regional Director, Brisbane District	Brisbane

APPENDIX B
KEY REFERENCE GAUGES

Pine Rivers Shire

Gauge	Flood Classification			
	Minor	Moderate	Major	1974 Flood
Grant Street, Whiteside	Any release from dam	- -		-
Railway Bridge, Wyllie Park, Petrie	4.0m	5.0m 6.	0m 5.1	m
Railway Bridge, South Pine River, Bald Hills	- 3.	5m	6.0m	5.18m

Note: Values are in metres AHD

APPENDIX C
RADIAL GATE SETTINGS

Gate Setting	Gate Opening (m)	Top of Gate (EL)	Gate Setting	Gate Opening (m)	Top of Gate (EL)
1	0.152	40.362	13	3.810	41.885
2	0.457	40.547	14	4.115	41.940
3	0.762	40.720	15	4.420	41.984
4	1.067	40.886	16	4.724	42.016
5	1.372	41.041	17	5.029	42.037
6	1.676	41.185	18	5.334	42.047
7	1.981	41.316	19	5.639	42.047
8	2.286	41.349	20	5.944	42.047
9	2.591	41.549	21	6.248	42.047
10	2.896	41.650	22	6.553	42.047
11	3.200	41.740	23	6.858	42.047
12	3.505	41.817			

RADIAL GATE SETTINGS

All Gates Operational						
Level (m AHD)	Gate A	Gate B	Gate C	Gate D	Gate E	Discharge (m^3/sec)
39.600	closed cl	osed cl	osed cl	osed cl	osed	0
39.650	closed cl	osed	1	closed cl	osed	16
39.700	closed	closed 1		closed 1		32
39.715	1 cl	osed	1 cl	osed	1	48
39.730	1	closed	1 1 1			64
39.745	1 1 1 1 1					80
39.760	1 1 2 1 1					104
39.775	1 1 2 1 2					129
39.790	2 1 2 1 2					153
39.805	2 1 2 2 2					177
39.820	2 2 2 2 2					201
39.835	2 2 3 2 2					228
39.850	2 2 3 2 3					254
39.865	3 2 3 2 3					281
39.880	3 2 3 3 3					307
39.895	3 3 3 3 3					334
39.910	3 3 4 3 3					362
39.925	3 3 4 3 4					390
39.940	4 3 4 3 4					417
39.955	4 3 4 4 4					445
39.970	4 4 4 4 4					473
39.985	4 4 5 4 4					500
40.000	4 4 5 4 5					527
40.015	5 4 5 4 5					554
40.030	5 4 5 5 5					581
40.045	5 5 5 5 5					608
40.060	5 5 6 5 5					636
40.075	5 5 6 5 6					664
40.090	6 5 6 5 6					692
40.105	6 5 6 6 6					720
40.120	6 6 6 6 6					748
40.135	6 6 7 6 6					776
40.150	6 6 7 6 7					804
40.165	7 6 7 6 7					832
40.180	7 6 7 7 7					860
40.195	7 7 7 7 7					888
40.210	7 7 8 7 7					916
40.225	7 7 8 7 8					943
40.240	8 7 8 7 8					970
40.255	8 7 8 8 8					998
40.270	8 8 8 8 8					1025
40.285	8 8 9 8 8					1052
40.300	8 8 9 8 9					1079
40.315	9 8 9 8 9					1106
40.330	9 8 9 9 9					1133
40.345	9 9 9 9 9					1160

All Gates Operational						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
40.360 9		9	10	9	9	1187
40.375	9	9 10		9 10		1213
40.390	10 9		10 9		10	1240
40.405	10	9	10 10	10		1266
40.420	10 10	10 10 10				1293
40.435	10 10	11 10 10				1320
40.450	10 10	11 10 11				1347
40.465	11 10	11 10 11				1374
40.480	11 10	11 11 11				1401
40.495	11 11	11 11 11				1428
40.510	11 11	12 11 11				1455
40.525	11 11	12 11 12				1482
40.540	12 11	12 11 12				1510
40.555	12 11	12 12 12				1537
40.570	12 12	12 12 12				1564
40.585	12 12	13 12 12				1593
40.600	12 12	13 12 13				1621
40.615	13 12	13 12 13				1650
40.630	13 12	13 13 13				1678
40.645	13 13	13 13 13				1707
40.660	13 13	14 13 13				1736
40.675	13 13	14 13 14				1765
40.690	14 13	14 13 14				1794
40.705	14 13	14 14 14				1823
40.720	14 14	14 14 14				1852
40.735	14 14	15 14 14				1883
40.750	14 14	15 14 15				1914
40.765	15 14	15 14 15				1946
40.780	15 14	15 15 15				1978
40.795	15 15	15 15 15				2009
40.810	15 15	16 15 15				2044
40.825	15 15	16 15 16				2079
40.840	16 15	16 15 16				2114
40.855	16 15	16 16 16				2148
40.870	16 16	16 16 16				2183
40.885	16 16	17 16 16				2222
40.900	16 16	17 16 17				2260
40.915	17 16	17 16 17				2299
40.930	17 16	17 17 17				2337
40.945	17 17	17 17 17				2376
40.960	17 17	18 17 17				2415
40.975	17 17	18 17 18				2453
40.990	18 17	18 17 18				2491
41.005	18 17	18 18 18				2530
41.020	18 18	18 18 18				2568
41.035	18 18	19 18 18				2601
41.050	18 18	19 18 19				2635

All Gates Operational						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
41.065	19	18 19				2668
41.080	19	18 19	19			2701
41.095	19	19 19	19			2734
41.110	19	19 20	19			2773
41.125	19	19 20	19	20		2806
41.140	20	19 20	19	20		2842
41.155	20	19 20	20	20		2878
41.170	20	20 20	20	20		2913
41.185	20	20 21	20	20		3026
41.200	20	20 21	20	21		3142
41.215	21	20 21	20	21		3260
41.230	21	20 21	21	21		3382
41.245	21	21 21	21	21		3506
41.260	21	21 22	21	21		3515
41.275	21	21 22	21	22		3524
41.290	22	21 22	21	22		3532
41.305	22	21 22	22	22		3541
41.320	22	22 22	22	22		3550
41.335	22	22 23	22	22		3559
41.350	22	22 23	22	23		3567
41.365	23	22 23	22	23		3576
41.380	23	22 23	23	23		3585
41.395	23	23 23	23	23		3594

Gate A Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
39.600	closed c	losed c	losed c	losed c	losed	0
39.650	closed c	losed	1	closed c	losed	16
39.700	closed	closed 1		closed 1		32
39.715 c	losed	closed	1	1	1 48	
39.730	closed	1 1 1 1				64
39.745	closed	1 2 1 1				88
39.760	closed	1 2 1 2				112
39.775	closed	1 2 2 2				137
39.790	closed	2 2 2 2				161
39.805	closed	2 3 2 2				187
39.820	closed	2 3 2 3				213
39.835	closed	2 3 3 3				240
39.850	closed	3 3 3 3				266
39.865	closed	3 4 3 3				294
39.880	closed	3 4 3 4				322
39.895	closed	3 4 4 4				349
39.910	closed	4 4 4 4				377
39.925	closed	4 5 4 4				404
39.940	closed	4 5 4 5				430
39.955	closed	4 5 5 5				457
39.970	closed	5 5 5 5				484
39.985	closed	5 6 5 5				512
40.000	closed	5 6 5 6				539
40.015	closed	5 6 6 6				567
40.030	closed	6 6 6 6				595
40.045	closed	6 7 6 6				623
40.060	closed	6 7 6 7				650
40.075	closed	6 7 7 7				678
40.090	closed	7 7 7 7				706
40.105	closed	7 8 7 7				732
40.120	closed	7 8 7 8				759
40.135	closed	7 8 8 8				786
40.150	closed	8 8 8 8				812
40.165	closed	8 9 8 8				839
40.180	closed	8 9 8 9				866
40.195	closed	8 9 9 9				893
40.210	closed	9 9 9 9				920
40.225 c	losed	9	10	9	9	946
40.240	closed	9 1	0	9 1	0 972	
40.255	closed	9	10 1	0 1	0	998
40.270	closed	10 1	0 1	0 1	0 1	024
40.285	closed	10 1	1 1	0 1	0 1	050
40.300	closed	10 1	1 1	0 1	1 1	077
40.315	closed	10 1	1 1	1 1	1 1	103
40.330	closed	11 1	1 1	1 1	1 1	130
40.345	closed	11 1	2 1	1 1	1 1	156

Gate A Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
40.360	closed	11 1	2 1	1 1	2 1	183
40.375	closed	11 1	2 1	2 1	2 1	210
40.390	closed	12 1	2 1	2 1	2 1	237
40.405	closed	12 1	3 1	2 1	2 1	264
40.420	closed	12 1	3 1	2 1	3 1	292
40.435	closed	12 1	3 1	3 1	3 1	320
40.450	closed	13 1	3 1	3 1	3 1	348
40.465	closed	13 1	4 1	3 1	3 1	377
40.480	closed	13 1	4 1	3 1	4 1	405
40.495	closed	13 1	4 1	4 1	4 1	433
40.510	closed	14 1	4 1	4 1	4 1	462
40.525	closed	14 1	5 1	4 1	4 1	492
40.540	closed	14 1	5 1	4 1	5 1	523
40.555	closed	14 1	5 1	5 1	5 1	554
40.570	closed	15 1	5 1	5 1	5 1	585
40.585	closed	15 1	6 1	5 1	5 1	619
40.600	closed	15 1	6 1	5 1	6 1	653
40.615	closed	15 1	6 1	6 1	6 1	687
40.630	closed	16 1	6 1	6 1	6 1	721
40.645	closed	16 1	7 1	6 1	6 1	759
40.660	closed	16 1	7 1	6 1	7 1	797
40.675	closed	16 1	7 1	7 1	7 1	834
40.690	closed	17 1	7 1	7 1	7 1	872
40.705	closed	17 1	8 1	7 1	7 1	911
40.720	closed	17 1	8 1	7 1	8 1	949
40.735	closed	17 1	8 1	8 1	8 1	988
40.750	closed	18 1	8 1	8 1	8 2	026
40.765	closed	18 1	9 1	8 1	8 2	060
40.780	closed	18 1	9 1	8 1	9 2	094
40.795	closed	18 1	9 1	9 1	9 2	127
40.810	closed	19 1	9 1	9 1	9 2	161
40.825	closed	19 2	0 1	9 1	9 2	277
40.840	closed	19 2	0 1	9 2	0 2	395
40.855	closed	19 2	0 2	0 2	0 2	516
40.870	closed	20 2	0 2	0 2	0 2	639
40.885	closed	20 2	1 2	0 2	0 2	645
40.900	closed	20 2	1 2	0 2	1 2	650
40.915	closed	20 2	1 2	1 2	1 2	655
40.930	closed	21 2	1 2	1 2	1 2	660
40.945	closed	21 2	2 2	1 2	1 2	667
40.960	closed	21 2	2 2	1 2	2 2	674
40.975	closed	21 2	2 2	2 2	2 2	680
40.990	closed	22 2	2 2	2 2	2 2	687
41.005	closed	22 2	3 2	2 2	2 2	694
41.020	closed	22 2	3 2	2 2	3 2	701
41.035	closed	22 2	3 2	3 2	3 2	708
41.050	closed	23 2	3 2	3 2	3 2	715

Gate A Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
41.065	closed	23 2	3 2	3 2	3 2	722
41.080	closed	23 2	3 2	3 2	3 2	729
41.095	closed	23 2	3 2	3 2	3 2	736
41.110	closed	23 2	3 2	3 2	3 2	742
41.125	closed	23 2	3 2	3 2	3 2	749
41.140	closed	23 2	3 2	3 2	3 2	756
41.155	closed	23 2	3 2	3 2	3 2	763
41.170	closed	23 2	3 2	3 2	3 2	770
41.185	closed	23 2	3 2	3 2	3 2	777
41.200	closed	23 2	3 2	3 2	3 2	784
41.215	closed	23 2	3 2	3 2	3 2	791
41.230	closed	23 2	3 2	3 2	3 2	798
41.245	closed	23 2	3 2	3 2	3 2	805
41.260	closed	23 2	3 2	3 2	3 2	812
41.275	closed	23 2	3 2	3 2	3 2	819
41.290	closed	23 2	3 2	3 2	3 2	826
41.305	closed	23 2	3 2	3 2	3 2	833
41.320	closed	23 2	3 2	3 2	3 2	840
41.335	closed	23 2	3 2	3 2	3 2	847
41.350	closed	23 2	3 2	3 2	3 2	854
41.365	closed	23 2	3 2	3 2	3 2	861
41.380	closed	23 2	3 2	3 2	3 2	868
41.395	closed	23 2	3 2	3 2	3 2	875

Gate B Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
39.600	closed c	losed c	losed c	losed c	losed	0
39.650	closed c	losed	1	closed c	losed	16
39.700	closed	closed 1		closed 1		32
39.715	1 c	losed	1 c	losed	1	48
39.730	1	closed	1 1 1			64
39.745	1	closed	2 1 1			88
39.760	1	closed	2 1 2			112
39.775	2	closed	2 1 2			137
39.790	2	closed	2 2 2			161
39.805	2	closed	3 2 2			187
39.820	2	closed	3 2 3			213
39.835	3	closed	3 2 3			240
39.850	3	closed	3 3 3			266
39.865	3	closed	4 3 3			294
39.880	3	closed	4 3 4			322
39.895	4	closed	4 3 4			349
39.910	4	closed	4 4 4			377
39.925	4	closed	5 4 4			404
39.940	4	closed	5 4 5			430
39.955	5	closed	5 4 5			457
39.970	5	closed	5 5 5			484
39.985	5	closed	6 5 5			512
40.000	5	closed	6 5 6			539
40.015	6	closed	6 5 6			567
40.030	6	closed	6 6 6			595
40.045	6	closed	7 6 6			623
40.060	6	closed	7 6 7			650
40.075	7	closed	7 6 7			678
40.090	7	closed	7 7 7			706
40.105	7	closed	8 7 7			732
40.120	7	closed	8 7 8			759
40.135	8	closed	8 7 8			786
40.150	8	closed	8 8 8			812
40.165	8	closed	9 8 8			839
40.180	8	closed	9 8 9			866
40.195	9	closed	9 8 9			893
40.210	9	closed	9 9 9			920
40.225 9		closed	10	9	9	946
40.240	9	closed	10	9 1	0 972	
40.255	10 c	losed 1	0	9	10	998
40.270	10	closed	10 1	0 1	0 1	024
40.285	10	closed	11 1	0 1	0 1	050
40.300	10	closed	11 1	0 1	1 1	077
40.315	11	closed	11 1	0 1	1 1	103
40.330	11	closed	11 1	1 1	1 1	130
40.345	11	closed	12 1	1 1	1 1	156

Gate B Stuck or Inoperable						
Level (m AHD)	Gate A	Gate B	Gate C	Gate D	Gate E	Discharge (m^3/sec)
40.360	11	closed	12 1	1 1	2 1	183
40.375	12	closed	12 1	1 1	2 1	210
40.390	12	closed	12 1	2 1	2 1	237
40.405	12	closed	13 1	2 1	2 1	264
40.420	12	closed	13 1	2 1	3 1	292
40.435	13	closed	13 1	2 1	3 1	320
40.450	13	closed	13 1	3 1	3 1	348
40.465	13	closed	14 1	3 1	3 1	377
40.480	13	closed	14 1	3 1	4 1	405
40.495	14	closed	14 1	3 1	4 1	433
40.510	14	closed	14 1	4 1	4 1	462
40.525	14	closed	15 1	4 1	4 1	492
40.540	14	closed	15 1	4 1	5 1	523
40.555	15	closed	15 1	4 1	5 1	554
40.570	15	closed	15 1	5 1	5 1	585
40.585	15	closed	16 1	5 1	5 1	619
40.600	15	closed	16 1	5 1	6 1	653
40.615	16	closed	16 1	5 1	6 1	687
40.630	16	closed	16 1	6 1	6 1	721
40.645	16	closed	17 1	6 1	6 1	759
40.660	16	closed	17 1	6 1	7 1	797
40.675	17	closed	17 1	6 1	7 1	834
40.690	17	closed	17 1	7 1	7 1	872
40.705	17	closed	18 1	7 1	7 1	911
40.720	17	closed	18 1	7 1	8 1	949
40.735	18	closed	18 1	7 1	8 1	988
40.750	18	closed	18 1	8 1	8 2	026
40.765	18	closed	19 1	8 1	8 2	060
40.780	18	closed	19 1	8 1	9 2	094
40.795	19	closed	19 1	8 1	9 2	127
40.810	19	closed	19 1	9 1	9 2	161
40.825	19	closed	20 1	9 1	9 2	277
40.840	19	closed	20 1	9 2	0 2	395
40.855	20	closed	20 1	9 2	0 2	516
40.870	20	closed	20 2	0 2	0 2	639
40.885	20	closed	21 2	0 2	0 2	645
40.900	20	closed	21 2	0 2	1 2	650
40.915	21	closed	21 2	0 2	1 2	655
40.930	21	closed	21 2	1 2	1 2	660
40.945	21	closed	22 2	1 2	1 2	667
40.960	21	closed	22 2	1 2	2 2	674
40.975	22	closed	22 2	1 2	2 2	680
40.990	22	closed	22 2	2 2	2 2	687
41.005	22	closed	23 2	2 2	2 2	694
41.020	22	closed	23 2	2 2	3 2	701
41.035	23	closed	23 2	2 2	3 2	708
41.050	23	closed	23 2	3 2	3 2	715

Gate B Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
41.065	23	closed	23 2	3 2	3 2	722
41.080	23	closed	23 2	3 2	3 2	729
41.095	23	closed	23 2	3 2	3 2	736
41.110	23	closed	23 2	3 2	3 2	742
41.125	23	closed	23 2	3 2	3 2	749
41.140	23	closed	23 2	3 2	3 2	756
41.155	23	closed	23 2	3 2	3 2	763
41.170	23	closed	23 2	3 2	3 2	770
41.185	23	closed	23 2	3 2	3 2	777
41.200	23	closed	23 2	3 2	3 2	784
41.215	23	closed	23 2	3 2	3 2	791
41.230	23	closed	23 2	3 2	3 2	798
41.245	23	closed	23 2	3 2	3 2	805
41.260	23	closed	23 2	3 2	3 2	812
41.275	23	closed	23 2	3 2	3 2	819
41.290	23	closed	23 2	3 2	3 2	826
41.305	23	closed	23 2	3 2	3 2	833
41.320	23	closed	23 2	3 2	3 2	840
41.335	23	closed	23 2	3 2	3 2	847
41.350	23	closed	23 2	3 2	3 2	854
41.365	23	closed	23 2	3 2	3 2	861
41.380	23	closed	23 2	3 2	3 2	868
41.395	23	closed	23 2	3 2	3 2	875

Gate C Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
39.600	closed c	losed c	losed c	losed c	losed	0
39.650	closed c	losed c	losed c	losed	1	16
39.700	1	closed c	losed c	losed	1	32
39.715 1		closed	closed	1	1	48
39.730	1 1		closed	1 1		64
39.745	1 1		closed	1 2		88
39.760	2 1		closed	1 2		112
39.775	2 1		closed	2 2		137
39.790	2 2		closed	2 2		161
39.805	2 2		closed	2 3		187
39.820	3 2		closed	2 3		213
39.835	3 2		closed	3 3		240
39.850	3 3		closed	3 3		266
39.865	3 3		closed	3 4		294
39.880	4 3		closed	3 4		322
39.895	4 3		closed	4 4		349
39.910	4 4		closed	4 4		377
39.925	4 4		closed	4 5		404
39.940	5 4		closed	4 5		430
39.955	5 4		closed	5 5		457
39.970	5 5		closed	5 5		484
39.985	5 5		closed	5 6		512
40.000	6 5		closed	5 6		539
40.015	6 5		closed	6 6		567
40.030	6 6		closed	6 6		595
40.045	6 6		closed	6 7		623
40.060	7 6		closed	6 7		650
40.075	7 6		closed	7 7		678
40.090	7 7		closed	7 7		706
40.105	7 7		closed	7 8		732
40.120	8 7		closed	7 8		759
40.135	8 7		closed	8 8		786
40.150	8 8		closed	8 8		812
40.165	8 8		closed	8 9		839
40.180	9 8		closed	8 9		866
40.195	9 8		closed	9 9		893
40.210	9 9		closed	9 9		920
40.225	9	9	closed	9 1	0 946	
40.240	10	9	closed	9 1	0 972	
40.255 1	0	9	closed	10	10	998
40.270	10 1	0	closed	10 1	0 1	024
40.285	10 1	0	closed	10 1	1 1	050
40.300	11 1	0	closed	10 1	1 1	077
40.315	11 1	0	closed	11 1	1 1	103
40.330	11 1	1	closed	11 1	1 1	130
40.345	11 1	1	closed	11 1	2 1	156

Gate C Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
40.360	12 1	1	closed	11 1	2 1	183
40.375	12 1	1	closed	12 1	2 1	210
40.390	12 1	2	closed	12 1	2 1	237
40.405	12 1	2	closed	12 1	3 1	264
40.420	13 1	2	closed	12 1	3 1	292
40.435	13 1	2	closed	13 1	3 1	320
40.450	13 1	3	closed	13 1	3 1	348
40.465	13 1	3	closed	13 1	4 1	377
40.480	14 1	3	closed	13 1	4 1	405
40.495	14 1	3	closed	14 1	4 1	433
40.510	14 1	4	closed	14 1	4 1	462
40.525	14 1	4	closed	14 1	5 1	492
40.540	15 1	4	closed	14 1	5 1	523
40.555	15 1	4	closed	15 1	5 1	554
40.570	15 1	5	closed	15 1	5 1	585
40.585	15 1	5	closed	15 1	6 1	619
40.600	16 1	5	closed	15 1	6 1	653
40.615	16 1	5	closed	16 1	6 1	687
40.630	16 1	6	closed	16 1	6 1	721
40.645	16 1	6	closed	16 1	7 1	759
40.660	17 1	6	closed	16 1	7 1	797
40.675	17 1	6	closed	17 1	7 1	834
40.690	17 1	7	closed	17 1	7 1	872
40.705	17 1	7	closed	17 1	8 1	911
40.720	18 1	7	closed	17 1	8 1	949
40.735	18 1	7	closed	18 1	8 1	988
40.750	18 1	8	closed	18 1	8 2	026
40.765	18 1	8	closed	18 1	9 2	060
40.780	19 1	8	closed	18 1	9 2	094
40.795	19 1	8	closed	19 1	9 2	127
40.810	19 1	9	closed	19 1	9 2	161
40.825	19 1	9	closed	19 2	0 2	277
40.840	20 1	9	closed	19 2	0 2	395
40.855	20 1	9	closed	20 2	0 2	516
40.870	20 2	0	closed	20 2	0 2	639
40.885	20 2	0	closed	20 2	1 2	645
40.900	21 2	0	closed	20 2	1 2	650
40.915	21 2	0	closed	21 2	1 2	655
40.930	21 2	1	closed	21 2	1 2	660
40.945	21 2	1	closed	21 2	2 2	667
40.960	22 2	1	closed	21 2	2 2	674
40.975	22 2	1	closed	22 2	2 2	680
40.990	22 2	2	closed	22 2	2 2	687
41.005	22 2	2	closed	22 2	3 2	694
41.020	23 2	2	closed	22 2	3 2	701
41.035	23 2	2	closed	23 2	3 2	708
41.050	23 2	3	closed	23 2	3 2	715

Gate C Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
41.065	23 2	3	closed	23 2	3 2	722
41.080	23 2	3	closed	23 2	3 2	729
41.095	23 2	3	closed	23 2	3 2	736
41.110	23 2	3	closed	23 2	3 2	742
41.125	23 2	3	closed	23 2	3 2	749
41.140	23 2	3	closed	23 2	3 2	756
41.155	23 2	3	closed	23 2	3 2	763
41.170	23 2	3	closed	23 2	3 2	770
41.185	23 2	3	closed	23 2	3 2	777
41.200	23 2	3	closed	23 2	3 2	784
41.215	23 2	3	closed	23 2	3 2	791
41.230	23 2	3	closed	23 2	3 2	798
41.245	23 2	3	closed	23 2	3 2	805
41.260	23 2	3	closed	23 2	3 2	812
41.275	23 2	3	closed	23 2	3 2	819
41.290	23 2	3	closed	23 2	3 2	826
41.305	23 2	3	closed	23 2	3 2	833
41.320	23 2	3	closed	23 2	3 2	840
41.335	23 2	3	closed	23 2	3 2	847
41.350	23 2	3	closed	23 2	3 2	854
41.365	23 2	3	closed	23 2	3 2	861
41.380	23 2	3	closed	23 2	3 2	868
41.395	23 2	3	closed	23 2	3 2	875

Gate D Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
39.600	closed c	losed c	losed c	losed c	losed	0
39.650	closed c	losed	1	closed c	losed	16
39.700	closed	closed 1		closed 1		32
39.715	1 c	losed	1 c	losed	1	48
39.730 1		1	1	closed	1	64
39.745 1		1	2	closed	1	88
39.760 1		1	2	closed	2	112
39.775 2		1	2	closed	2	137
39.790 2		2	2	closed	2	161
39.805 2		2	3	closed	2	187
39.820 2		2	3	closed	3	213
39.835 3		2	3	closed	3	240
39.850 3		3	3	closed	3	266
39.865 3		3	4	closed	3	294
39.880 3		3	4	closed	4	322
39.895 4		3	4	closed	4	349
39.910 4		4	4	closed	4	377
39.925 4		4	5	closed	4	404
39.940 4		4	5	closed	5	430
39.955 5		4	5	closed	5	457
39.970 5		5	5	closed	5	484
39.985 5		5	6	closed	5	512
40.000 5		5	6	closed	6	539
40.015 6		5	6	closed	6	567
40.030 6		6	6	closed	6	595
40.045 6		6	7	closed	6	623
40.060 6		6	7	closed	7	650
40.075 7		6	7	closed	7	678
40.090 7		7	7	closed	7	706
40.105 7		7	8	closed	7	732
40.120 7		7	8	closed	8	759
40.135 8		7	8	closed	8	786
40.150 8		8	8	closed	8	812
40.165 8		8	9	closed	8	839
40.180 8		8	9	closed	9	866
40.195 9		8	9	closed	9	893
40.210 9		9	9	closed	9	920
40.225 9		9	10	closed	9	946
40.240	9	9	10 c	losed 1	0	972
40.255	10	9	10 c	losed 1	0	998
40.270	10 1	0 1	0	closed	10 1	024
40.285	10 1	0 1	1	closed	10 1	050
40.300	10 1	0 1	1	closed	11 1	077
40.315	11 1	0 1	1	closed	11 1	103
40.330	11 1	1 1	1	closed	11 1	130
40.345	11 1	1 1	2	closed	11 1	156

Gate D Stuck or Inoperable						
Level (m AHD)	Gate A	Gate B	Gate C	Gate D	Gate E	Discharge (m^3/sec)
40.360	11 1	1 1	2	closed	12 1	183
40.375	12 1	1 1	2	closed	12 1	210
40.390	12 1	2 1	2	closed	12 1	237
40.405	12 1	2 1	3	closed	12 1	264
40.420	12 1	2 1	3	closed	13 1	292
40.435	13 1	2 1	3	closed	13 1	320
40.450	13 1	3 1	3	closed	13 1	348
40.465	13 1	3 1	4	closed	13 1	377
40.480	13 1	3 1	4	closed	14 1	405
40.495	14 1	3 1	4	closed	14 1	433
40.510	14 1	4 1	4	closed	14 1	462
40.525	14 1	4 1	5	closed	14 1	492
40.540	14 1	4 1	5	closed	15 1	523
40.555	15 1	4 1	5	closed	15 1	554
40.570	15 1	5 1	5	closed	15 1	585
40.585	15 1	5 1	6	closed	15 1	619
40.600	15 1	5 1	6	closed	16 1	653
40.615	16 1	5 1	6	closed	16 1	687
40.630	16 1	6 1	6	closed	16 1	721
40.645	16 1	6 1	7	closed	16 1	759
40.660	16 1	6 1	7	closed	17 1	797
40.675	17 1	6 1	7	closed	17 1	834
40.690	17 1	7 1	7	closed	17 1	872
40.705	17 1	7 1	8	closed	17 1	911
40.720	17 1	7 1	8	closed	18 1	949
40.735	18 1	7 1	8	closed	18 1	988
40.750	18 1	8 1	8	closed	18 2	026
40.765	18 1	8 1	9	closed	18 2	060
40.780	18 1	8 1	9	closed	19 2	094
40.795	19 1	8 1	9	closed	19 2	127
40.810	19 1	9 1	9	closed	19 2	161
40.825	19 1	9 2	0	closed	19 2	277
40.840	19 1	9 2	0	closed	20 2	395
40.855	20 1	9 2	0	closed	20 2	516
40.870	20 2	0 2	0	closed	20 2	639
40.885	20 2	0 2	1	closed	20 2	645
40.900	20 2	0 2	1	closed	21 2	650
40.915	21 2	0 2	1	closed	21 2	655
40.930	21 2	1 2	1	closed	21 2	660
40.945	21 2	1 2	2	closed	21 2	667
40.960	21 2	1 2	2	closed	22 2	674
40.975	22 2	1 2	2	closed	22 2	680
40.990	22 2	2 2	2	closed	22 2	687
41.005	22 2	2 2	3	closed	22 2	694
41.020	22 2	2 2	3	closed	23 2	701
41.035	23 2	2 2	3	closed	23 2	708
41.050	23 2	3 2	3	closed	23 2	715

Gate D Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
41.065	23 2	3 2	3	closed	23 2	722
41.080	23 2	3 2	3	closed	23 2	729
41.095	23 2	3 2	3	closed	23 2	736
41.110	23 2	3 2	3	closed	23 2	742
41.125	23 2	3 2	3	closed	23 2	749
41.140	23 2	3 2	3	closed	23 2	756
41.155	23 2	3 2	3	closed	23 2	763
41.170	23 2	3 2	3	closed	23 2	770
41.185	23 2	3 2	3	closed	23 2	777
41.200	23 2	3 2	3	closed	23 2	784
41.215	23 2	3 2	3	closed	23 2	791
41.230	23 2	3 2	3	closed	23 2	798
41.245	23 2	3 2	3	closed	23 2	805
41.260	23 2	3 2	3	closed	23 2	812
41.275	23 2	3 2	3	closed	23 2	819
41.290	23 2	3 2	3	closed	23 2	826
41.305	23 2	3 2	3	closed	23 2	833
41.320	23 2	3 2	3	closed	23 2	840
41.335	23 2	3 2	3	closed	23 2	847
41.350	23 2	3 2	3	closed	23 2	854
41.365	23 2	3 2	3	closed	23 2	861
41.380	23 2	3 2	3	closed	23 2	868
41.395	23 2	3 2	3	closed	23 2	875

Gate E Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
39.600	closed clos	ed clos	ed clos	ed clos	ed	0
39.650	closed clos	ed	1	closed clos	ed	16
39.700	1 clos	ed	1 clos	ed	closed	32
39.715	1 clos	ed	1	1 clos	ed	48
39.730	1 1	1	1		closed	64
39.745	1 1	2	1		closed	88
39.760	2 1	2	1		closed	112
39.775	2 1	2	2		closed	137
39.790	2 2	2	2		closed	161
39.805	2 2	3	2		closed	187
39.820	3 2	3	2		closed	213
39.835	3 2	3	3		closed	240
39.850	3 3	3	3		closed	266
39.865	3 3	4	3		closed	294
39.880	4 3	4	3		closed	322
39.895	4 3	4	4		closed	349
39.910	4 4	4	4		closed	377
39.925	4 4	5	4		closed	404
39.940	5 4	5	4		closed	430
39.955	5 4	5	5		closed	457
39.970	5 5	5	5		closed	484
39.985	5 5	6	5		closed	512
40.000	6 5	6	5		closed	539
40.015	6 5	6	6		closed	567
40.030	6 6	6	6		closed	595
40.045	6 6	7	6		closed	623
40.060	7 6	7	6		closed	650
40.075	7 6	7	7		closed	678
40.090	7 7	7	7		closed	706
40.105	7 7	8	7		closed	732
40.120	8 7	8	7		closed	759
40.135	8 7	8	8		closed	786
40.150	8 8	8	8		closed	812
40.165	8 8	9	8		closed	839
40.180	9 8	9	8		closed	866
40.195	9 8	9	9		closed	893
40.210	9 9	9	9		closed	920
40.225	9	9	10	9 clos	ed 94	6
40.240	10 9		10 9		closed	972
40.255 10		9	10	10	closed	998
40.270	10 10	10 10			closed	1024
40.285	10 10	11 10			closed	1050
40.300	11 10	11 10			closed	1077
40.315	11 10	11 11			closed	1103
40.330	11 11	11 11			closed	1130
40.345	11 11	12 11			closed	1156

Gate E Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
40.360	12 11	12 11			closed	1183
40.375	12 11	12 12			closed	1210
40.390	12 12	12 12			closed	1237
40.405	12 12	13 12			closed	1264
40.420	13 12	13 12			closed	1292
40.435	13 12	13 13			closed	1320
40.450	13 13	13 13			closed	1348
40.465	13 13	14 13			closed	1377
40.480	14 13	14 13			closed	1405
40.495	14 13	14 14			closed	1433
40.510	14 14	14 14			closed	1462
40.525	14 14	15 14			closed	1492
40.540	15 14	15 14			closed	1523
40.555	15 14	15 15			closed	1554
40.570	15 15	15 15			closed	1585
40.585	15 15	16 15			closed	1619
40.600	16 15	16 15			closed	1653
40.615	16 15	16 16			closed	1687
40.630	16 16	16 16			closed	1721
40.645	16 16	17 16			closed	1759
40.660	17 16	17 16			closed	1797
40.675	17 16	17 17			closed	1834
40.690	17 17	17 17			closed	1872
40.705	17 17	18 17			closed	1911
40.720	18 17	18 17			closed	1949
40.735	18 17	18 18			closed	1988
40.750	18 18	18 18			closed	2026
40.765	18 18	19 18			closed	2060
40.780	19 18	19 18			closed	2094
40.795	19 18	19 19			closed	2127
40.810	19 19	19 19			closed	2161
40.825	19 19	20 19			closed	2277
40.840	20 19	20 19			closed	2395
40.855	20 19	20 20			closed	2516
40.870	20 20	20 20			closed	2639
40.885	20 20	21 20			closed	2645
40.900	21 20	21 20			closed	2650
40.915	21 20	21 21			closed	2655
40.930	21 21	21 21			closed	2660
40.945	21 21	22 21			closed	2667
40.960	22 21	22 21			closed	2674
40.975	22 21	22 22			closed	2680
40.990	22 22	22 22			closed	2687
41.005	22 22	23 22			closed	2694
41.020	23 22	23 22			closed	2701
41.035	23 22	23 23			closed	2708
41.050	23 23	23 23			closed	2715

Gate E Stuck or Inoperable						
Level (m AHD)	**Gate A**	**Gate B**	**Gate C**	**Gate D**	**Gate E**	**Discharge (m^3/sec)**
41.065	23 23	23 23			closed	2722
41.080	23 23	23 23			closed	2729
41.095	23 23	23 23			closed	2736
41.110	23 23	23 23			closed	2742
41.125	23 23	23 23			closed	2749
41.140	23 23	23 23			closed	2756
41.155	23 23	23 23			closed	2763
41.170	23 23	23 23			closed	2770
41.185	23 23	23 23			closed	2777
41.200	23 23	23 23			closed	2784
41.215	23 23	23 23			closed	2791
41.230	23 23	23 23			closed	2798
41.245	23 23	23 23			closed	2805
41.260	23 23	23 23			closed	2812
41.275	23 23	23 23			closed	2819
41.290	23 23	23 23			closed	2826
41.305	23 23	23 23			closed	2833
41.320	23 23	23 23			closed	2840
41.335	23 23	23 23			closed	2847
41.350	23 23	23 23			closed	2854
41.365	23 23	23 23			closed	2861
41.380	23 23	23 23			closed	2868
41.395	23 23	23 23			closed	2875

APPENDIX E
NORTH PINE DAM AUXILIARY EQUIPMENT

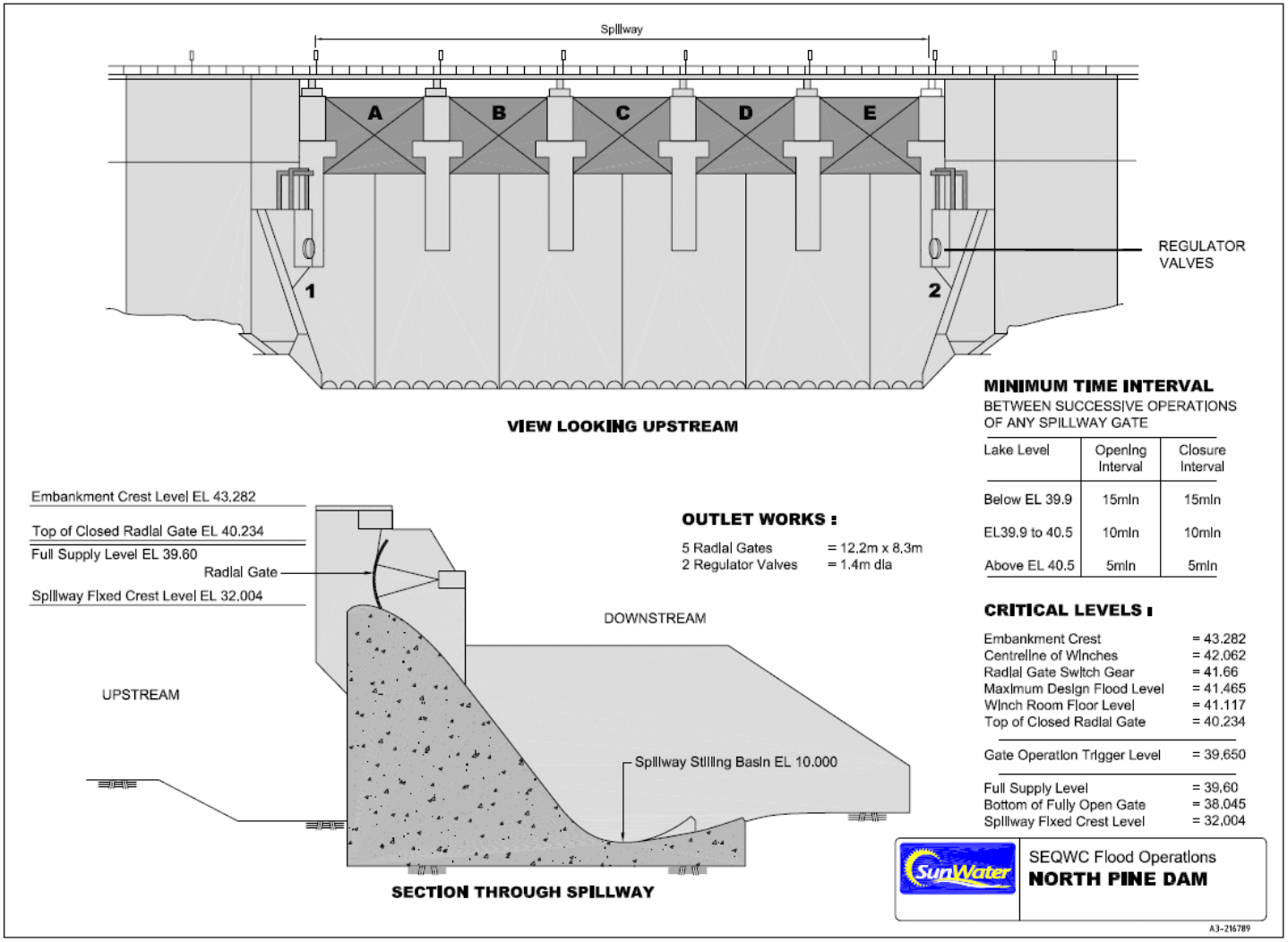
[redacted]

APPENDIX F

HYDROLOGIC INVESTIGATIONS

APPENDIX G
NORTH PINE DAM
PLANS, MAPS AND PHOTOGRAPHS


North Pine Dam
Narangba
Armstrong Creek
Kurwongbah
Dakabin
Lake Kurwongbah
Kallangur
Whiteside
Petrie Park
Petrie
Samsonvale
Mt Samson
Lawnton
Joyner
Warner
Bray Park
Dayboro Rd
Mt Samson Rd
Whiteside Rd
Samsonvale Rd
Winn Rd
Lakeside Motor Racing Circuit
Kurwongbah Golf Course
Alma Park Zoo
Kallangur Park
Sporting Complex


Spillway
A
B
C
D
E
1
2
REGULATOR VALVES
VIEW LOOKING UPSTREAM
Embankment Crest Level EL 43.282
Top of Closed Radial Gate EL 40.234
Full Supply Level EL 39.60
Radial Gate
Spillway Fixed Crest Level EL 32.004
UPSTREAM
DOWNSTREAM
Spillway Stilling Basin EL 10.000
SECTION THROUGH SPILLWAY
OUTLET WORKS :
5 Radial Gates = 12.2m x 8.3m
2 Regulator Valves = 1.4m dia
MINIMUM TIME INTERVAL
BETWEEN SUCCESSIVE OPERATIONS OF ANY SPILLWAY GATE
Lake Level | Opening Interval | Closure Interval
Below EL 39.9 | 15min | 15min
EL39.9 to 40.5 | 10min | 10min
Above EL 40.5 | 5min | 5min
CRITICAL LEVELS :
Embankment Crest = 43.282
Centreline of Winches = 42.062
Radial Gate Switch Gear = 41.66
Maximum Design Flood Level = 41.465
Winch Room Floor Level = 41.117
Top of Closed Radial Gate = 40.234
Gate Operation Trigger Level = 39.650
Full Supply Level = 39.60
Bottom of Fully Open Gate = 38.045
Spillway Fixed Crest Level = 32.004
SunWater
SEQWC Flood Operations
NORTH PINE DAM
A3-216789