February 2022 Flood Event

Report on the Operation of North Pine Dam

April 2022

Executive Summary

Background

This report has been prepared to describe the 23/02/2022 to 08/03/2022 Flood Event at North Pine Dam, in accordance with the requirements in Chapter 4, Part 2, Division 9 of the *Water Supply (Safety and Reliability) Act 2008* (the Act). Details of North Pine Dam and its operational procedures can be found in the Manual.

Dam operations overview

The operation of North Pine Dam and corresponding selection of strategies and procedures adopted during the Flood Event as defined in the Manual are summarised in Table i and shown graphically in Figure i. More detailed descriptions at relevant intermediate time intervals are presented in Section 4.2.

The periods summarised were selected to assist in describing the operations by reference to the implementation of the strategies and procedures defined in the Manual.

Table i: Chronological summary of flood operating strategies and procedures implemented during the Flood Event

Event	Date and time of decision
Flood event commencement criteria for North Pine Dam met Flood Operations Strategy Procedure 1a selected	23/02/2022 12:22
Releases from North Pine Dam commenced with Flood Operations Strategy Procedure 1a	23/02/2022 13:30
Flood Operations Strategy - Procedure 1b selected	25/02/2022 09:00
Flood Operations Strategy - Procedure 1b 115 FFS model runs completed 72 Gate Operations Model runs completed Gate Directives 6 – 34 issued All gates clear of flow between 26/02/2022 17:00 and 27/02/2022 01:00 Flood Event peak release rate (1,534 m^3/s) and lake level (37.39 m AHD based on automated gauge data) recorded at 26/02/2022 19:00	25/02/2022 09:00 to 28/02/2022 01:45
Flood Operations Strategy exit criteria met. Drain Down Strategy selected	28/02/2022 01:45
Flood Operations Strategy Procedure 1a selected due to increased rainfall	03/03/2022 10:34
Flood Operations Strategy exit criteria met. Drain Down Strategy selected	03/03/2022 22:30
Drain Down Strategy exit criteria met North Pine Dam Flood Event ended (flood releases ended)	08/03/2022 09:00

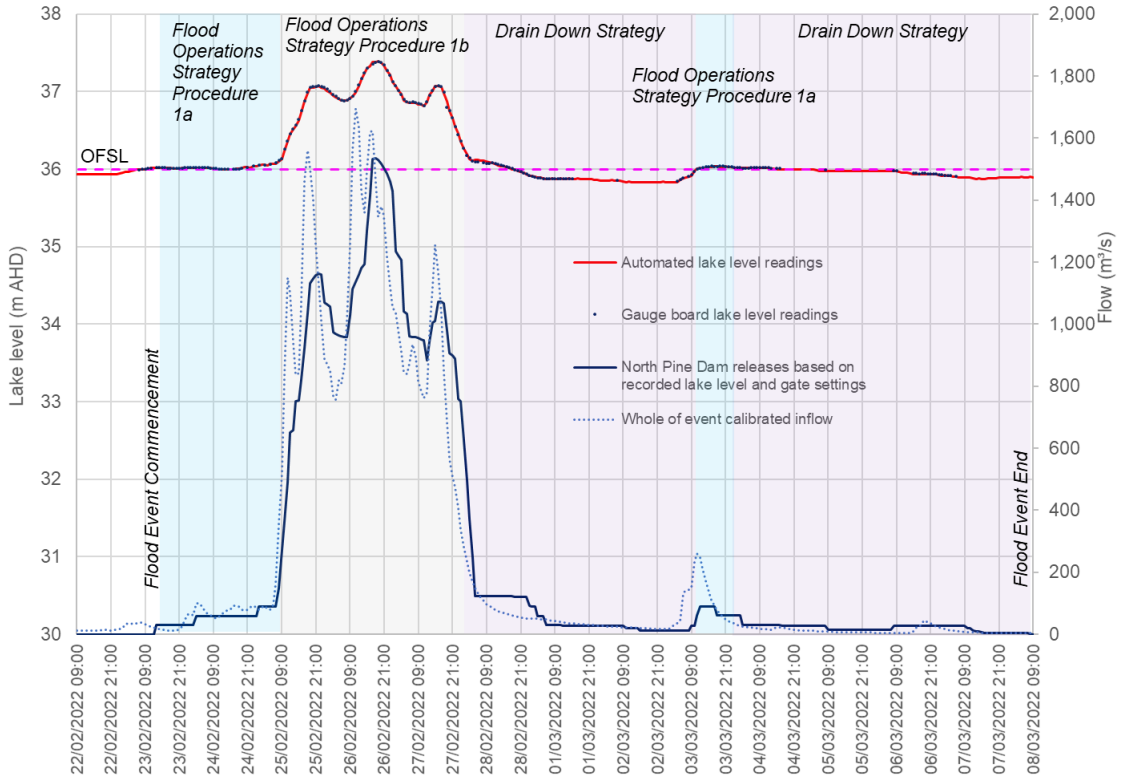

Figure i: North Pine Dam post-event analysis whole of event calibrated inflow, lake level (gauge board and automated readings) and releases

Event data overview

Table ii summarises the key data relevant to the Flood Event.

Table ii: Flood Event data summary

Statistic	Units	Value
Operational full supply level	m AHD	36.00
Accumulated catchment average rainfall between 22/02/2022 09:00 and 08/03/2002 09:00	mm	980
North Pine Dam lake level at 23/02/2022 12:22	m AHD	36.01
Peak lake level in North Pine Dam based on gauge board readings	m AHD	37.39
Peak inflow into North Pine Dam[1]	m³/s	1,702
Peak release from North Pine Dam	m³/s	1,534
Total inflow volume into North Pine Dam[1] between 22/02/2022 09:00 and 08/03/2022 09:00[2]	ML	281,300
Total release volume from North Pine Dam between 22/02/2022 09:00 and 08/03/2022 09:00[2]	ML	281,400
North Pine Dam lake level at 09/03/2022 09:00	m AHD	35.89

[1]Estimate of the peak inflow and inflow volume based on post-event analysis with whole of event model calibration.
[2]These dates correspond with the hydrological modelling start and end times. Refer Section 2.3 for further information.

Figure ii illustrates the actual catchment average rainfall which occurred during the Flood Event from 22/02/2022 09:00 to 08/03/2022 09:00. Figure iii illustrates the recorded and modelled (based on post-event whole of event hydrologic model calibration with the benefit of hindsight) lake level for North Pine Dam. Refer to Section 7.2 for further discussion of the calibration of this model. Figure iv illustrates the North Pine Dam inflow hydrograph based on post-event whole of event calibration (with the benefit of hindsight) and the recorded release hydrograph over the Flood Event.

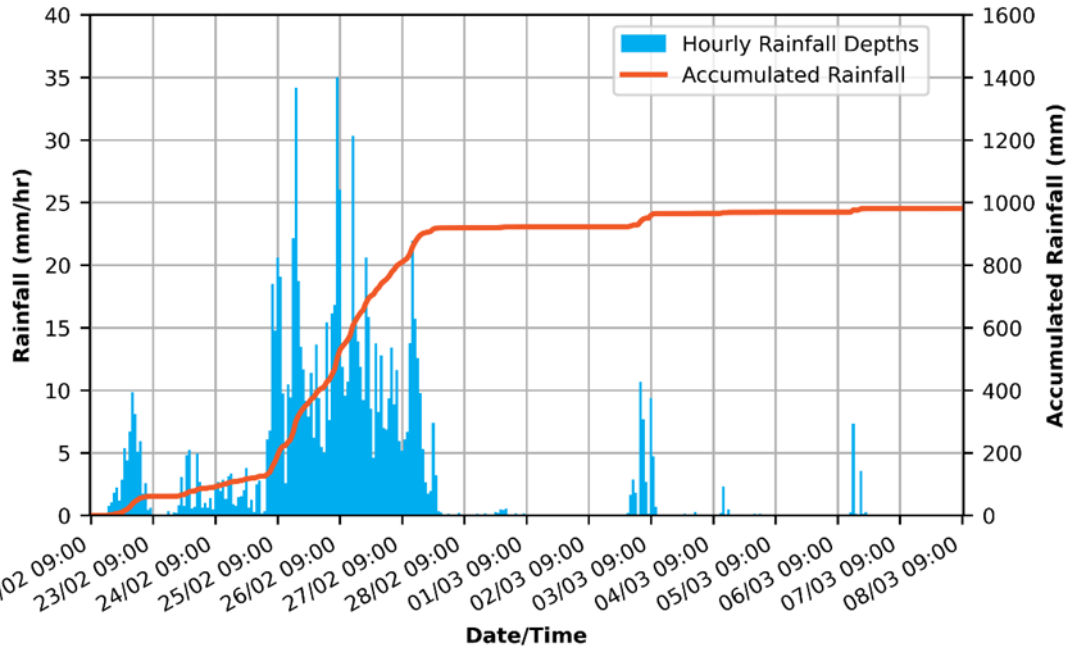

Figure ii: North Pine Dam catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 08/03/2022 09:00

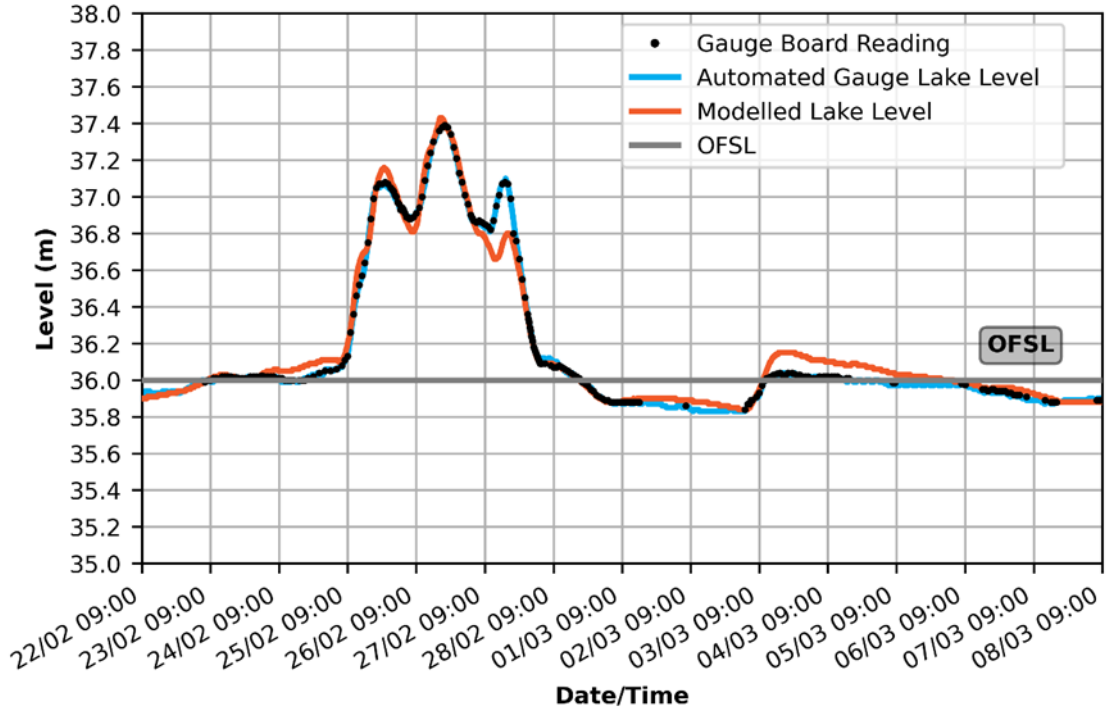

Figure iii: North Pine Dam post-event analysis whole of event calibration modelled lake level compared to automated data and gauge board readings

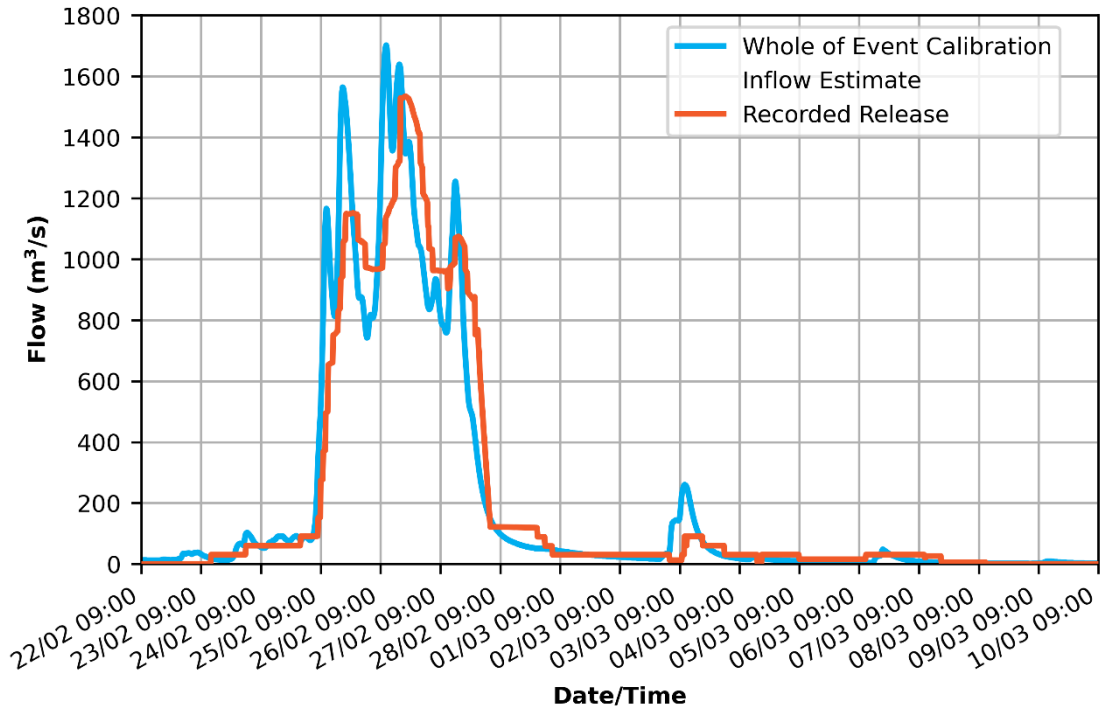

Figure iv: North Pine Dam post-event analysis whole of event calibration modelled inflow hydrograph and recorded release hydrograph (based on recorded lake levels and gate settings)

Communications

To assist with operational decision making and for sharing of information across agencies for coordinated flood response, communications occurred between Seqwater and the Bureau and other stakeholder agencies throughout the Flood Event. The key forms of communication that were used with external stakeholders included:

- Situation Reports issued by Seqwater to stakeholder agencies and internally to Seqwater Communications personnel for information flow to the public. Situation Reports were issued at least twice daily with a total of 32 Situation Reports being issued in total that were directly relevant to North Pine Dam.
- Discussions with stakeholder agencies regarding potential inundation of bridges, actual bridge closures, and re-opening of bridges.
- Advice and datasets were provided by Seqwater to relevant stakeholder agencies of actual and predicted releases (a total of 20 datasets were issued throughout the Flood Event).
- Notifications to inform the public of dam operations including by email, text message and the Seqwater website.

Event magnitude

Table iii shows a comparison between maximum 09:00 to 09:00 three-day catchment average rainfalls and maximum one hour rainfall intensities based on 15-minute catchment average data recorded in this Flood Event compared with the significant historical events of 1974, 2011 and 2013. This data has been sourced from the gridded historical rainfall database collated by Seqwater for the purpose of Seqwater's activities in calibrating the FFS hydrological models.

Table iii: Historical total catchment average rainfall and intensity comparison

	Event			
	1974†	2011†	2013†	2022
Maximum 09:00 to 09:00 three-day rainfall total (mm)	693	479	435	727
Maximum one hour rainfall intensity (mm/hr) based on 15 minute catchment average data	51	56	27	37

The maximum 09:00 to 09:00 three-day catchment average rainfalls for this Flood Event were larger than those observed in the 1974, 2011 or 2013 events. The maximum one hourly rainfall intensity was higher than observed in 2013, but lower than for the 1974 and 2011 events.

Table iv shows a comparison between the peak inflow, peak outflow, inflow volume and outflow volume estimated in this Flood Event for North Pine Dam compared with historic floods.

Table iv: Comparison of historical Flood Event peak flows and volumes from Seqwater, 2013

Event	Peak flows		Flood volumes	
	Inflow (m^3/s)	Outflow (m^3/s)	Inflow (ML)	Outflow (ML)
Jun-83	760†	N/A	36,900	N/A
Apr-88	790	630	178,000	75,900
Mar-89	1,430	1,440	124,000	124,000
Apr-89	1,150	980	94,700	96,000
Dec-91	1,740†	N/A	70,100	0
May-96	N/A	N/A	91,000	0
Feb-99	1,180	0	117,000	0
Feb-01	420	0	43,800	0
Mar-04	460†	0	27,500	0
Nov-08	220†	0	14,100	0
Apr-09	790	0	45,600	0
May-09	910	330	79,400	22,600
Feb-10	380	360	57,700	57,500
Oct-10	1,000	910	69,400	61,300
Jan-11	3,480	2,850	202,000	206,000
Jan-12	850	630	71,300	65,300
Jan-13	1,650	840	101,000	97,000
Dec-21‡	410	370	15,400	15,600
Feb-22*	1,700	1,530	281,300	281,400

†These values are estimates
‡Sourced from Seqwater (2021)
*Based on whole of event calibration described in Section 7.2

This Flood Event was not the flood of record from the perspective of peak inflow or peak outflow, as it is lower than the January 2011 event on both measures and comparable to the peak inflow for the December 1991 event. However, it is the flood of record for inflow and outflow volume by a considerable margin. This is consistent with the maximum 09:00 to 09:00 three-day catchment average rainfall data summarised in Table iii, which was higher than for the 1974, 2011 and 2013 events.

Compliance with the Manual

The operating procedures relevant for this Flood Event are described in the North Pine Dam Manual of Operational Procedures for Flood Mitigation, Revision 11 (November 2021).

Based upon the evidence available from the Strategy Logs, Flood Forecasting System (FFS) simulations, Gate Operations Models, Gate Directives and recorded rainfall and river level data, the flood operations implemented at the Dam during this Flood Event complied with the procedures in the Manual.

Recommendations

Under section 385(1)(j) of the Act, this report must set out any recommended changes to the Manual and Flood Forecasting System that would allow the Manual to deal with a similar flood event more effectively.

It is recommended that Seqwater consider the following potential changes to the Manual and/or Flood Forecasting System:

- Continue to explore improvements in streamflow gauging reliability upstream of North Pine Dam.
- Continue to invest in the ongoing enhancement of the Flood Forecasting System.
- Continue to consider whether additional checks or processes could be implemented to ensure the FFS and Gate Operations Model data aligns to actual gate settings at the Dam. No issues in this regard were identified for North Pine Dam in this Flood Event, however at the time of writing it is understood that a limited number of minor issues have been identified in the flood operations of Somerset Dam and Wivenhoe Dam which are equally applicable to North Pine Dam.
- Whether an additional criterion should be added to the Manual Flood Operations Strategy Procedure 1a to consider fish recovery requirements if the situation arises where releases are ceased temporarily when conditions do not meet criteria to select the Drain Down Strategy.
- Whether the plot labelled ‘‘North Pine Dam Guide Curve’ could be renamed in the Gate Operations Model to reflect that it is a visual check of Flood Operations Strategy Procedure 1b (iv) and (v) rather than additional guidance and a static version of it included in the Manual below Table C.1 as an example of how Appendix C of the Manual is applied in practice.

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Glossary

Act means the *Water Supply (Safety and Reliability) Act 2008* (Qld) including any subordinate legislation made under it.

Actual Lake Level means the Lake Level at the staff headwater gauge with reasonable adjustments (where possible made by an engineer) to take into account prevailing conditions.

ADFD means the Australian Digital Forecast Database containing weather forecast data produced by the Bureau of Meteorology.

AHD means Australian Height Datum.

ALERT means Automated Local Evaluation in Real-Time System, a system of monitoring and displaying rainfall and water level data. It is a combination of field stations, communications networks and data collection software. ALERT sensors automatically transmit rainfall and water level data by radio to designated base stations at prescribed intervals or when a change in reading occurs.

Baseflow means ongoing small flows in rivers and creeks being principally supplied from groundwater (rather than immediately running off from rainfall). Usually insignificant when peak flows are being evaluated, but can be significant in evaluating the final shutdown of Dam releases at the conclusion of a Flood Event.

Bureau means the Bureau of Meteorology. The Bureau of Meteorology is Australia's national weather, climate and water agency. The Bureau of Meteorology operations under the authority of the *Meteorology Act 1955* (Cth) and the *Water Act 2007* (Cth) which provide the legal basis for its activities, while its operation is continually assessed in accordance with the national need for climatic records, water information, scientific understanding of Australian weather and climate and effective service provision to the Australian community.

Communications Protocol means the current version of the Communications Protocol for Flood Releases from Seqwater's Gated Dams (Wivenhoe Dam, Somerset Dam and North Pine Dam).

Dam means North Pine Dam.

Dam Operator means a person with the required qualifications, experience and training who has been approved by Seqwater to fulfil the role of a Dam Operator under Section 3.8 of the Manual.

Duty Senior Flood Operations Engineer or **DSFOE** means a Senior Flood Operations Engineer who is on duty and, whilst on duty, has the responsibilities set out in Section 3.2 of the Manual.

Emergency Action Plan or **EAP** means the current Emergency Action Plan for North Pine Dam prepared and approved in accordance with Chapter 4 Part 1 Division 2A of the Act.

Enviromon is the Bureau of Meteorology data collection software used to collect and display real time rainfall and water level data.

FFS means the Flood Forecasting System. The FFS is described in Section 7 of the Manual.

Flood Event means a flood event that commences in accordance with Section 12.2 or Section 15.3 and ends in accordance with Section 13.2 of the Manual.

FEWS is a software package developed by Deltares that incorporates a hydrological forecast and warning system. FEWS is one component of the FFS.

Flood Operations Centre or **FOC** means the Centre used by Flood Operations Engineers to manage Flood Events.

Flood Operations Engineer means a person with the required qualifications, experience and training (set out in Section 3.8 of the Manual) who has been approved by Seqwater to fulfil the role of a Duty Flood Operations Engineer under the Manual.

Flood Operations Engineers means the collective group of persons who individually have designation as either a Flood Operations Engineer or a Senior Flood Operations Engineer.

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.

Full Supply Level (range of definitions). The following terms are used in this report:

- **Fixed Full Supply Level** or **Fixed FSL** or **FFSL** means the Lake Level associated with the Full Supply Volume used to calculate and report percentage storage volumes in the Dam. For North Pine Dam the Fixed FSL is 39.6 m AHD as set out in the Resource Operations Licence.
- **Operational Full Supply Level** or **Operational FSL** or **OFSL** means the Lake Level defining the top of the Water Supply Compartment. The Operational Full Supply Level for a Dam is determined as follows:

  a. If neither a Temporary Full Supply Level nor a Reduced Full Supply Level is in place, then the Operational Full Supply Level is the Fixed Full Supply Level;

  b. If a Temporary Full Supply Level is in place but no Reduced Full Supply Level is in place, then the Operational Full Supply Level is the Temporary Full Supply Level;

  c. If a Reduced Full Supply Level is in place but no Temporary Full Supply Level is in place, then the Operational Full Supply Level is the Reduced Full Supply Level;

  d. If both a Temporary Full Supply Level and a Reduced Full Supply Level are in place, then the Operational Full Supply Level is the lower of the two levels.

Gate Operations Model means a tool used to derive the Release Plan. The Gate Operations Model is discussed in more detail in Section 7.5 of the Manual.

Gauging Station means a location at which rainfall and/or water level is measured. Water level is measured in metres, either in reference to a local datum or Australian Height Datum. Flow in cubic metres per second (m^3/s) can be inferred using a water level versus discharge rating.

Lake Level means the still water surface elevation in the Dam and when used in the Manual, Lake Level shall mean the Actual Lake Level, unless specifically indicated to the contrary such as by the use of the prefix predicted.

Manual or **Manual of Operational Procedures for Flood Mitigation at North Pine Dam** means the current version of the Manual.

Monitoring Network means the network of rainfall and water level Gauging Stations which provides data in near real-time and enables continuous monitoring of rainfall and stream levels within the Dam catchment. The Monitoring Network is part of the FFS and is described in Section 7.2 of the Manual.

OOA means 'out of action' in relation to the operation of a rainfall or river height gauge that provides catchment data.

Operations Manual means the Pine Valleys Water Supply Scheme Operations Manual and is not used during Flood Events. The function of the Operations Manual is described in Section 1.1 of the Manual.

Predicted means, unless the context requires otherwise, the prediction of the event or circumstance made by a Duty Engineer using the FFS.

Predicted Peak, when referring to a Lake Level, means the Predicted Peak Lake Level that takes into account all the Dam releases (including operational releases made under the Operations Manual) planned from the Dam that are contained in the Release Plan.

Rain on Ground means rain that has already fallen in the catchment up to the time of the analysis and excludes rainfall forecasts.

Rainfall Forecast means a prediction of future rainfall provided by the Bureau; see also Bureau Provided Forecast or BPF.

Release Plan means the planned releases of water from the Dam approved by the DSFOE in accordance with the Manual and is used to issue Dam release directives to the Dam Supervisor. The Release Plan is discussed in more detail in Section 8 of the Manual.

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

URBS means Unified River Basin Simulator.

WISKI means the system that collects and stores data such as telemetry and dam operator readings (gauge boards and gate settings).

Water Supply Compartment means the storage volume in the reservoir up to the Operational Full Supply Level.

Note: Levels in this document related to dams (including lake level) are referenced in metres Australian Height Datum (m AHD). Gauged water levels are referenced in metres to the specific gauge datum.

1. Introduction

1.1 Reporting requirements

This report has been prepared to describe the 23/02/2022 to 08/03/2022 Flood Event at North Pine Dam, in accordance with the requirements in Chapter 4, Part 2, Division 9 of the Act. Details of North Pine Dam and its operational procedures can be found in the Manual.

This report documents the essential information to meet the requirements of the Act. Table 1-1 summaries the sections of the report addressing each of the requirements as listed under the Act.

Table 1-1: Reporting requirements

Section / subsection in Water Supply (Safety and Reliability) Act 2008	Report section addressing requirement
1) A flood event report or a flood event interim report must - (a) describe the flood event to which it relates; and	Executive Summary 1 Introduction 2.1 Lead up to the Flood Event 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis
(b) describe the implementation of the flood mitigation manual for the dam in relation to the flood event, including relevant details of — (i) communications made, strategies used and actions taken in response to the flood event; and (ii) the reasons for the use of the strategies;	Executive Summary 1.3 Flood event time 4 Dam Operations 5 External communications 8.1 Compliance with the Manual 8.6 Effectiveness of the Manual
(c) state the amount of the following that was forecast when the flood event started and measured during the flood event – (i) rainfall in, or affecting, the catchment area of the dam; (ii) inflow to the dam; and	2 Flood Event Data 3.2 Model runs 4.2 Strategy timeline and reasons for selecting 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis Appendix B
(d) state the level of the water surface of the dam that was forecast when the flood event started and the levels measured during the flood event; and	2 Flood Event Data 3.2 Model runs 4 Dam Operations 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis Appendix C
e) state the amount of the outflow from the dam that was - (i) forecast under the flood mitigation manual when the flood event started; and (ii) measured during and after the flood	3.2 Model runs 4.2 Strategy timeline and reasons for selecting 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis Appendix A Appendix B
(f) include an assessment of the adequacy of the forecast system for the dam; and	2 Flood Event Data 3 Flood Modelling 4.2 Strategy timeline and reasons for selecting

Section / subsection in Water Supply (Safety and Reliability) Act 2008	Report section addressing requirement
	7 Post-Event Hydrology Analysis 8.3 Assessment of the Flood Forecasting System
(g) describe any damage to the dam caused by the flood event, including by attaching photographs of the damage; and	8.5 Dam infrastructure performance Appendix D
(h) state whether and to what extent any damage to the dam has been caused or contributed to by the flood event; and	8.5 Dam infrastructure performance Appendix D
(i) include an assessment of whether and to what extent the flood mitigation manual effectively dealt with the flood event; and	4 Dam Operations 8.1 Compliance with the Manual 8.6 Effectiveness of the Manual
(j) recommend any changes to the flood mitigation manual and forecast system that would allow the manual to deal with a similar flood event more effectively; and	8.3 Assessment of the Flood Forecasting System 8.6 Effectiveness of the Manual
(k) include details of any other matter that is relevant to how the flood event was dealt with under the flood mitigation manual; and	Executive Summary 1 Introduction 6 Flood Event Magnitude 8.2 Operational arrangements 8.4 Record keeping
(l) include any other relevant matter prescribed under a regulation.	Not applicable to this Flood Event.
(2) If the owner of the dam carried out or purported to carry out an authorised alternative procedure in relation to the flood event, the flood event report or the flood event interim report must also include the authorisation request information for the procedure.	Not applicable to this Flood Event.
(3) Subsection (1) does not prevent a flood event report from dealing with 2 or more flood events if – (a) the flood events are related; and (b) the chief executive has agreed to the report dealing with the flood events.	Not applicable to this Flood Event.

1.2 Summary of basis of reporting

This report was prepared from the following contemporaneous records generated during the Flood Event:

- The rainfall, river level, rated flow and Dam lake level and release data were sourced after the Flood Event from information archived in the Flood Forecasting System (FFS).
- The FFS model simulations were collated from model runs archived during the Flood Event.
- The summary descriptions of the strategies selected and the reasons for their implementation are based on contemporaneous records of the North Pine Dam Strategy Log, Flood Operations Centre Event Log, Situation Reports, Gate Directives and data from the Gate Operations Model and FFS model runs relevant to each period.
- The description of communications was prepared from documents sent by, or received in the Flood Operations Centre email database. The North Pine Dam Strategy Log and the

Flood Operations Centre Event Log were referred to for time references or miscellaneous communications.

- Interviews with the Seqwater Senior Flood Operations Engineers on duty during the Flood Event were conducted on 23/03/2022 and 24/03/2022. These interviews were used to confirm details of a range of hydrological model runs, flood operating decisions and communications undertaken throughout the Flood Event. Feedback was also sought from the Senior Flood Operations Engineers on their views of the efficiency and suitability of the procedures in the Manual.

Conclusions, opinions and recommendations in this report were based on the observations of the HARC project team that prepared this report.

1.3 Flood event timeline overview

An overview of the key times and dates of the Flood Event are listed in Table 1-2. Further detailed information including context and decisions for changes to Release Plans at intermediate time periods is provided in subsequent sections of this report.

Table 1-2: Key event times

Date	Operating Decision
23/02/2022 12:22	Flood Event commencement criteria met Flood Operations Strategy Procedure 1a selected
23/02/2022 13:30	Releases from North Pine Dam commenced under Flood Operations Strategy Procedure 1a
25/02/2022 09:00	Flood Operations Strategy Procedure 1b selected
26/02/2022 17:00	All gates lifted clear of flow
26/02/2022 19:00	Peak lake level (37.39 m AHD based on automated data) and release (1,534 m^3/s) reached
27/02/2022 01:00	Gates start to be lowered back into flow
28/02/2022 01:45	Flood Operations Strategy Procedure 2a exit criteria met Drain Down Strategy Procedure 1a selected
03/03/2022 10:34	Flood Operations Strategy Procedure 1a selected due to increased rainfall
03/03/2022 22:30	Flood Operations Strategy Procedure 1a exit criteria met Drain Down Strategy Procedure 1a selected
08/03/2022 09:00	Drain Down Strategy exit criteria met Releases from North Pine Dam end Flood Event ended

1.4 Reliance statement

Data and records were supplied by Seqwater to Hydrology and Risk Consulting Pty Ltd (HARC) for the purposes of review and to inform the preparation of this Flood Event Report. The

analysis and opinions expressed in this report are based on the information supplied and HARC has not undertaken independent verification of the raw source data.

The report on dam infrastructure performance addressing sections 385(1)(g) and (h) of the Act and included in Appendix D was provided by Seqwater. This report was prepared by a Registered Professional Engineer of Queensland who is an employee of Seqwater and who has experience in dam safety engineering. The content of the report in Appendix D was outside of the scope of HARC's engagement. HARC has not verified nor expressed any opinion on the content of the report in Appendix D.

This Flood Event Report has been prepared to satisfy the requirements of Chapter 4, Part 2, Division 9 of the Act. The information provided in this report should not be relied upon for any purposes without the user of the report making their own determination of the fitness for purpose of the report for their needs.

2. Flood Event Data

2.1 Lead up to the Flood Event

The Flood Event occurred during the 2021-2022 northern wet season, defined as October to April by the Bureau. Prior to the event, the season had been characterised by above average rainfall recorded across many parts of South East Queensland.

The Bureau issued a climate outlook on 06/01/2022. This outlook stated that February to April 2022 rainfall was likely to be above median for parts of northern and eastern Australia. The key climate driver referenced in the Bureau outlook was the El Niño Southern Oscillation, which was in an active La Niña phase prior to and during the Flood Event. La Niña conditions increase the chances of above average rainfall across large parts of eastern Australia during summer.

2.2 Gauging station network performance

The ALERT gauging station network is used to inform operations at North Pine Dam as well as monitoring of catchments in South East Queensland where other Seqwater referable dams are located. The network consists of 355 rainfall gauges and 245 water level gauges throughout the region.

In the lead up to the Flood Event, a number of rainfall and water level gauges across the network had been flagged as suspect or out of action (OOA). The gauges relevant to the North Pine Dam catchment were:

- The Baxters Creek water level gauge recording equipment which was unable to be verified in the lead up to the Flood Event, due to unsafe site access. This potentially led to the gauge reporting erroneous water level data from 28/02/2022 12:05 and it was deemed to be OOA for the remainder of the Flood Event.
- The Mt Nebo rainfall gauge which failed to transmit data when rainfall was recorded both before and during the Flood Event.

A summary of the gauges relevant to the operation of North Pine Dam that were marked as suspect or OOA in the lead up to the Flood Event is presented in Table 2-1.

Table 2-1: Gauges relevant to the operation of North Pine Dam marked as suspect or out of action (OOA) in the lead up to the Flood Event

Rain ALERT ID	River ALERT ID	Name	Issue
	6712	Baxters Creek AL	Water level unable to verified, reporting erroneous data from 28/02/2022 12:05. The rainfall gauge at the same site was operating correctly.
6620		Mt Nebo AL	Gauge failed to transmit rainfall data in mid-February but appeared to have been rectified by the time the Flood Event started.

A map of the rainfall gauges that were marked as suspect or out of action in the lead up to the Flood Event in Table 2-1 is shown in Figure 2-1.

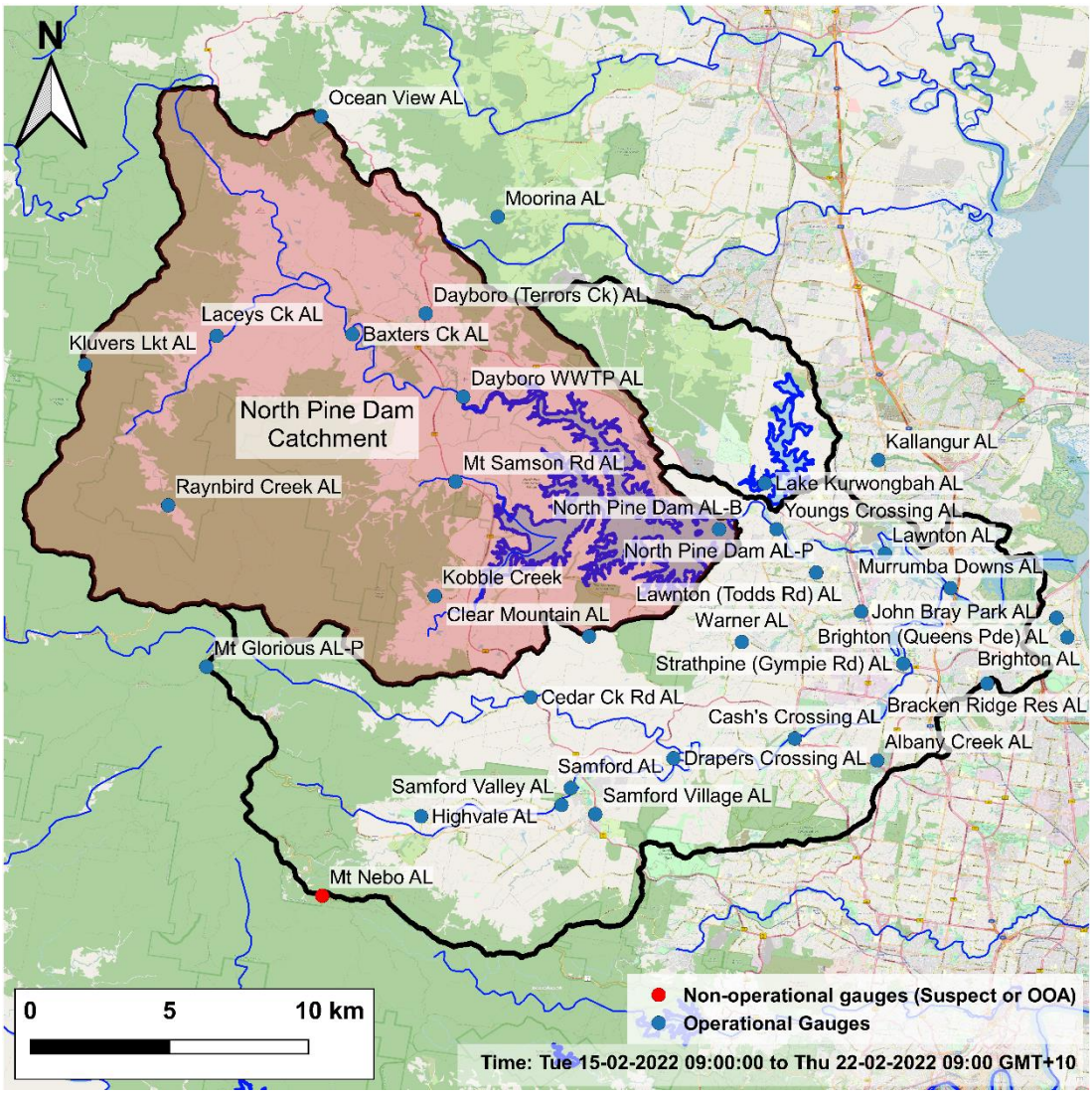


Figure 2-1: Rainfall gauges marked as suspect or out of action in the lead up to the Flood Event

There were further gauges that were identified as suspect or out of action during the Flood Event. Of these, one additional rainfall gauge was relevant to the operation of North Pine Dam, as shown in Table 2-2.

Table 2-2: Gauges relevant to the operation of North Pine Dam marked as suspect during the Flood Event

Rain ALERT ID	River ALERT ID	Name	Issue
6622		Raynbird Creek AL	Gauge transmitting intermittently and marked as suspect on 25/02/2022 11:15

A map of the rainfall gauges that were marked as suspect or out of action during the Flood Event is shown in Figure 2-2.

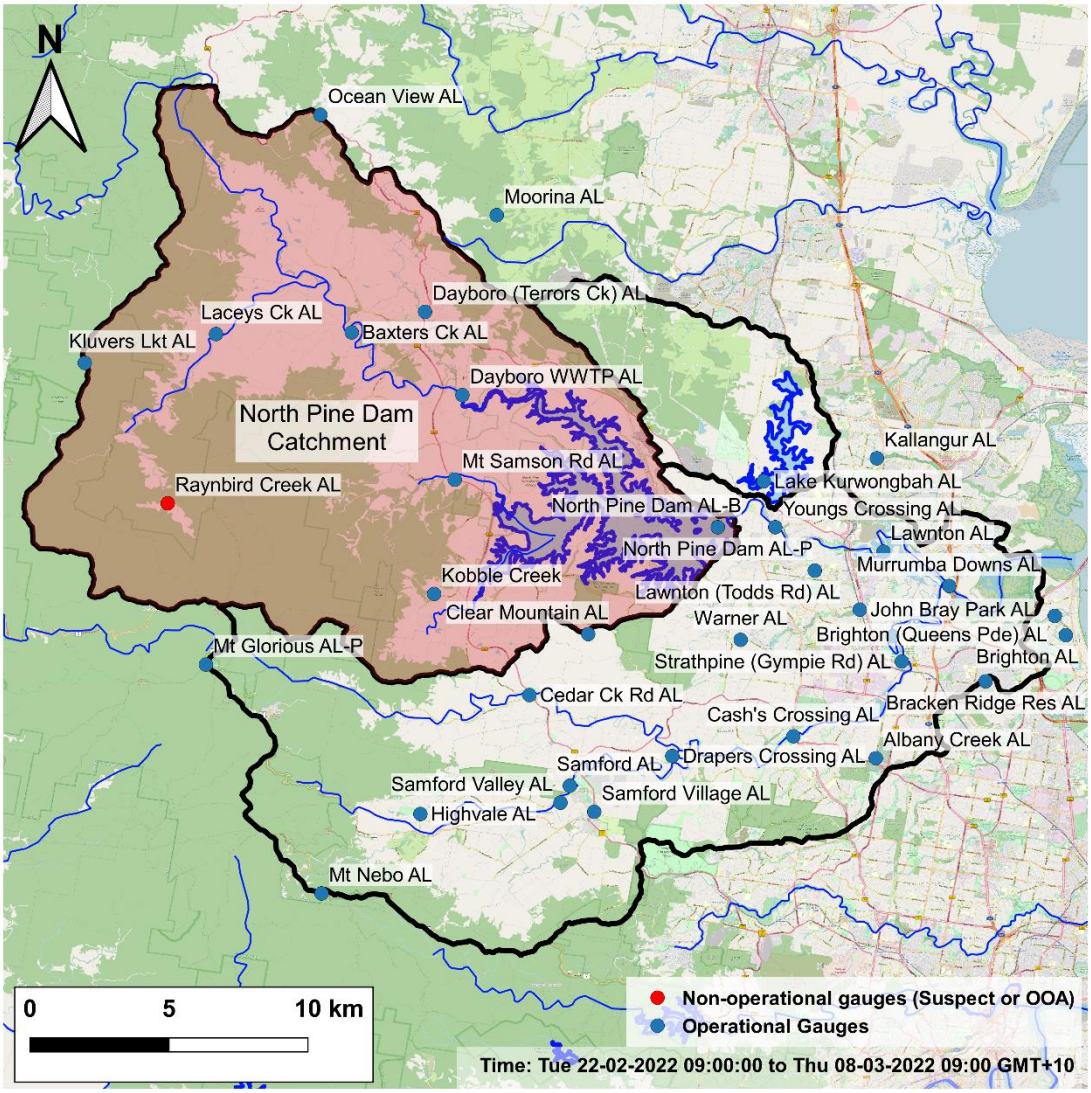


Figure 2-2: Rainfall gauges that were flagged as suspect or out of action during the Flood Event (shown in red)

2.3 Rainfall

This section presents an analysis of the rainfall recorded in the North Pine Dam catchment during the Flood Event. Whilst the Flood Event commenced at 23/02/2022 12:22, the hydrologic modelling undertaken to support dam operations in the Flood Forecasting System (FFS) requires a lead in period prior to the start of the event. By convention, hydrologic model users typically select a start time at 09:00 to align with Bureau daily read rainfall data. The corresponding hydrologic model start time selected for the Flood Event was therefore set by the DSFOE as 22/02/2022 09:00 in order to account for rainfall since this start time. The data that is presented throughout this report typically aligns with that model start time, and covers the period up to 08/03/2022 09:00, corresponding to the end of the Flood Event.

Note that in this section, rainfall data is typically presented as daily values, or as hourly values for the discussion on temporal pattern in Section 2.3.4. The FFS uses the raw rainfall data aggregated to a 15 minute time step as an input to the hydrologic modelling, however this time step was considered to be too short for the purposes of concise data reporting, display and analysis in this Flood Event report.

Data from rainfall gauges across South East Queensland was collected by the Enviromon[1] system in real-time and analysed in the FFS. The recorded gauged rainfall data is represented in the FFS as a point rainfall value and is subsequently gridded to provide coverage over the catchment as an appropriate input to the hydrologic model used to support dam operations decision making under the Manual.

The daily rainfall recorded in the 24 hours to 09:00 for each day of the Flood Event for selected rainfall gauges relevant to the North Pine Dam catchment is summarised in Table 2-3.

Table 2-3: Daily rainfall totals in the 24 hours to 09:00 for selected rainfall gauges relevant to the North Pine Dam catchment (Source: FFS)

Rainfall in the 24 hours to 09:00 on date	Gauge										
	Baxters Ck	Dayboro WWTP	Kluvers Lkt	Lake Kurwongbah	Mt Glorious	Mt Nebo[1]	Mt Mee	Laceys Ck	Mt Samson Rd	Kobble Ck (Ladies Rd)	North Pine Dam
23/02	76	54	64	45	76	35	115	66	69	57	35
24/02	22	37	24	31	56	16	57	18	41	33	17
25/02	99	99	136	43	252	105	173	103	93	65	24
26/02	323	298	326	278	711	367	366	299	314	350	205
27/02	255	267	243	291	463	299	874	228	270	277	219
28/02	37	81	14	363	219	161	55	20	110	155	316
1/03	1	1	2	2	17	11	96	0	1	1	1
2/03	0	0	0	0	0	0	29	0	0	0	0
3/03	36	45	36	49	10	21	26	39	77	25	43
4/03	6	6	3	10	7	5	17	4	9	2	7
5/03	12	0	0	0	0	0	25	2	1	5	0
6/03	0	0	0	0	0	0	0	0	0	0	0
7/03	11	13	7	19	13	0	16	10	10	11	20
8/03	0	0	0	8	0	4	1	0	0	0	0
Total (mm)	**878**	**901**	**855**	**1,139**	**1,824**	**1,024**	**1,850**	**789**	**995**	**981**	**887**

[1] Rainfall gauge marked as suspect in the lead up to the Flood Event

A map of the rainfall gauges with the accumulated rainfall over the duration of the Flood Event is shown in Figure 2-3.

[1] Enviromon collects real time ALERT gauge data.

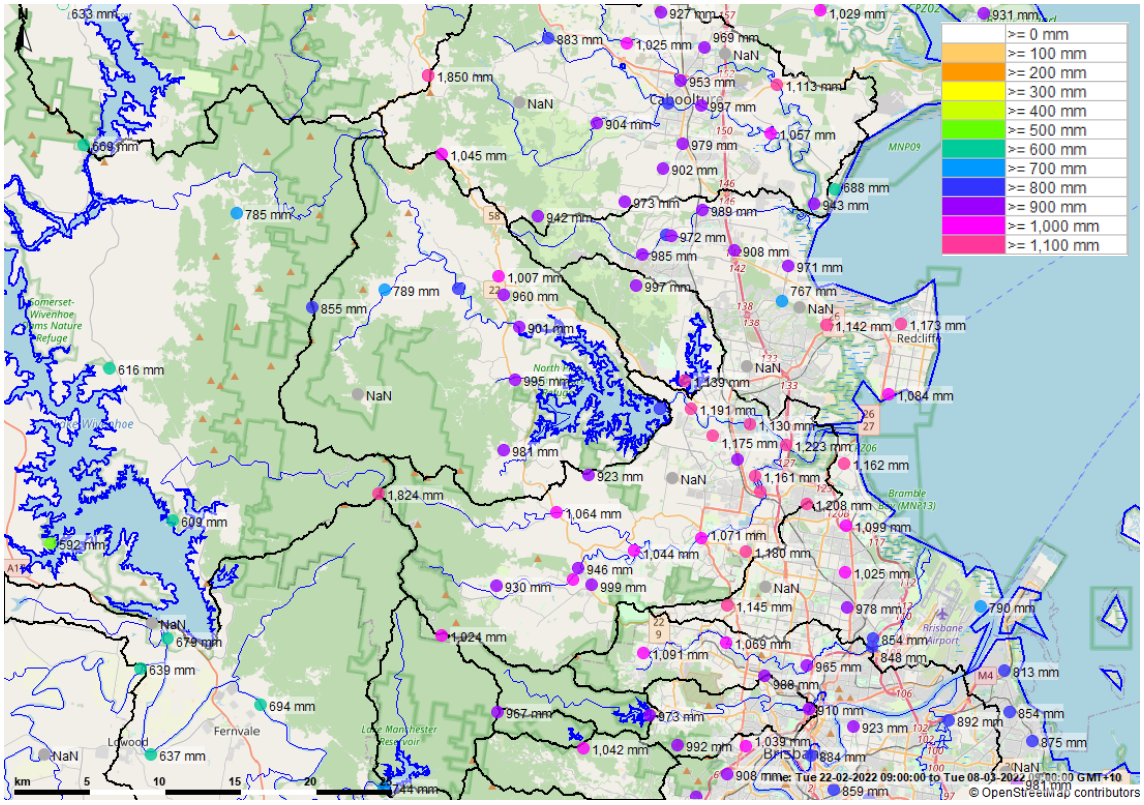


Figure 2-3: Total rainfall recorded at rainfall gauges between 22/02/2022 09:00 and 08/03/2022 09:00 (14 day accumulation)

2.3.1 Catchment average rainfall

The average rainfall for the North Pine Dam catchment was determined by fitting a gridded surface to the recorded gauge rainfalls and using a polygon outline of the catchment to determine the mean rainfall from the grid. The estimated catchment average rainfall for the North Pine Dam catchment between 22/02/2022 09:00 and 08/03/2022 09:00 was calculated to be 980 mm.

The daily catchment average rainfall recorded for the North Pine Dam catchment is shown in Figure 2-4.

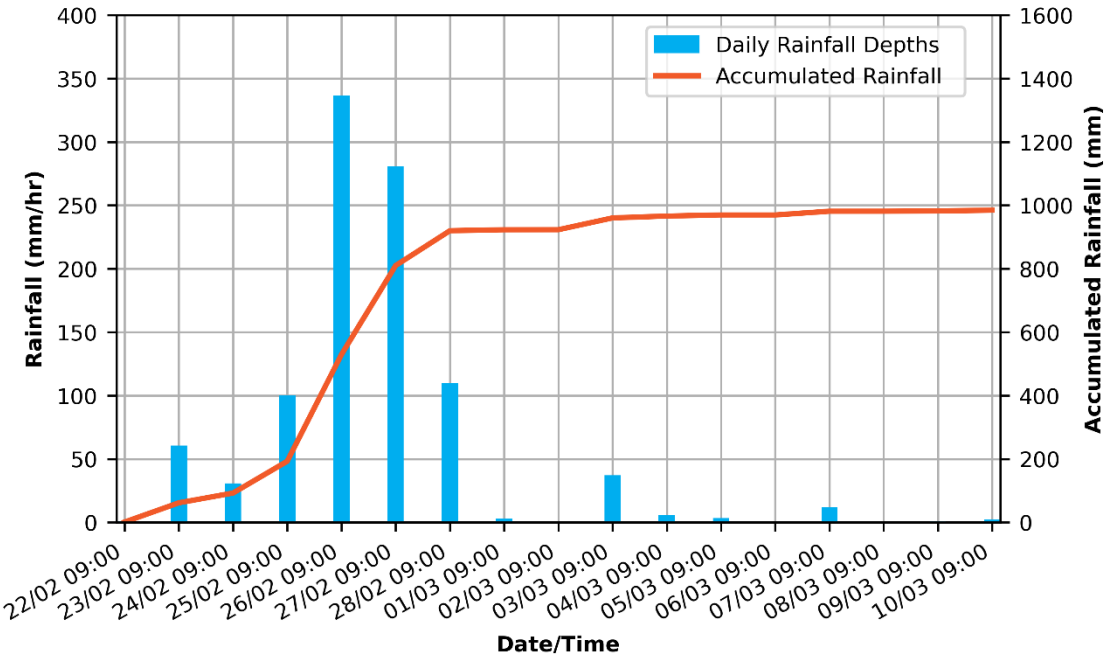


Figure 2-4 North Pine Dam catchment average rainfall from 22/02/2022 09:00 to 08/03/2022 09:00

2.3.2 Spatial distribution of rainfall over the catchment

The spatial distribution of the rainfall over the North Pine Dam catchment accumulated over the period from 22/02/2022 09:00 to 08/03/2022 09:00 was extracted from the processed gridded rainfall data in the FFS and is shown in Figure 2-5.

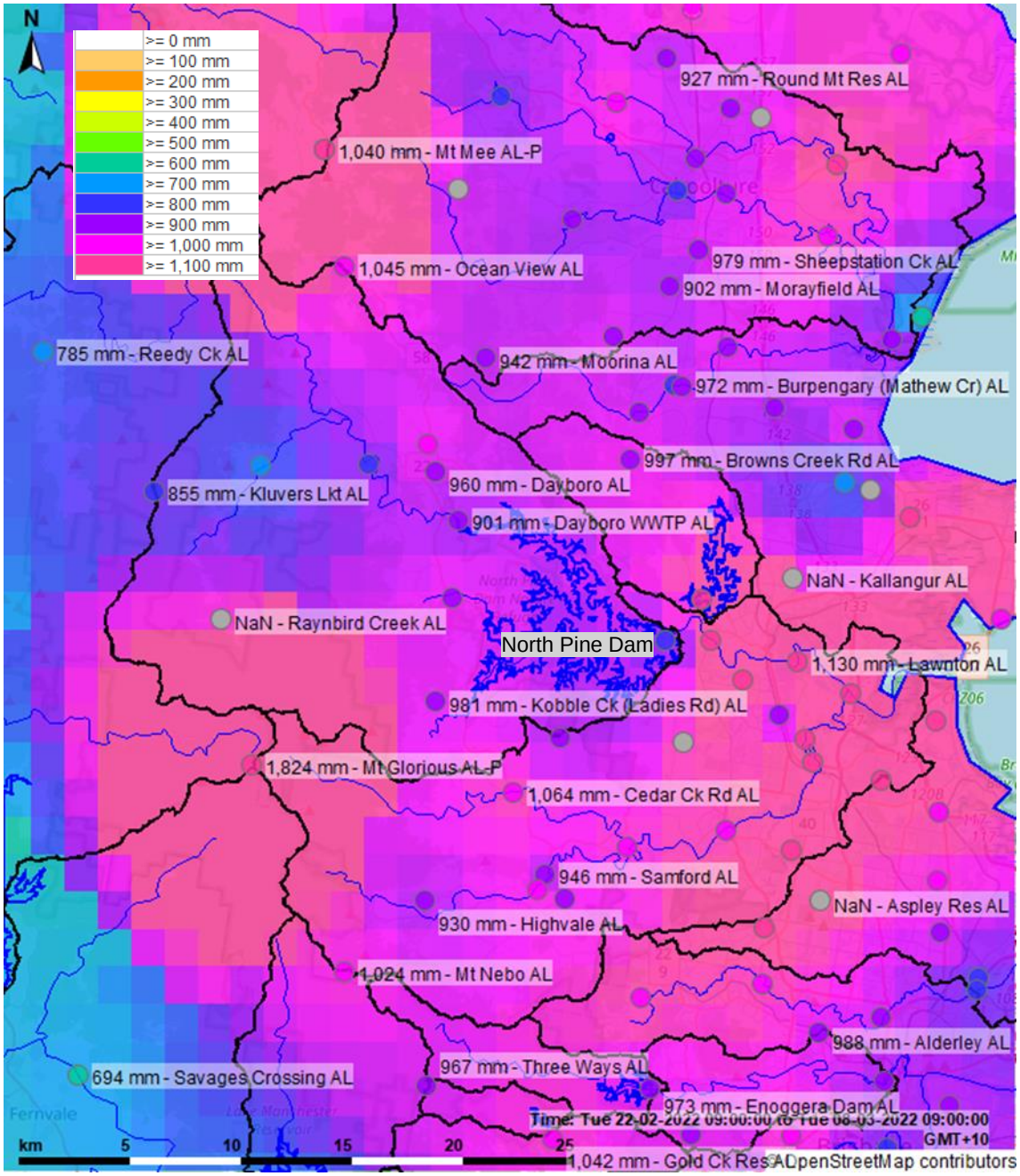


Figure 2-5: Spatial distribution of rainfall for 22/02/2022 09:00 to 08/03/2022 09:00

2.3.3 Daily rainfall totals

The daily rainfall totals recorded in Enviromon were extracted from the FFS for the Pine River basin and processed gridded estimates of the daily rainfall totals for each day of the Flood Event are displayed in Figure 2-6 to Figure 2-19.

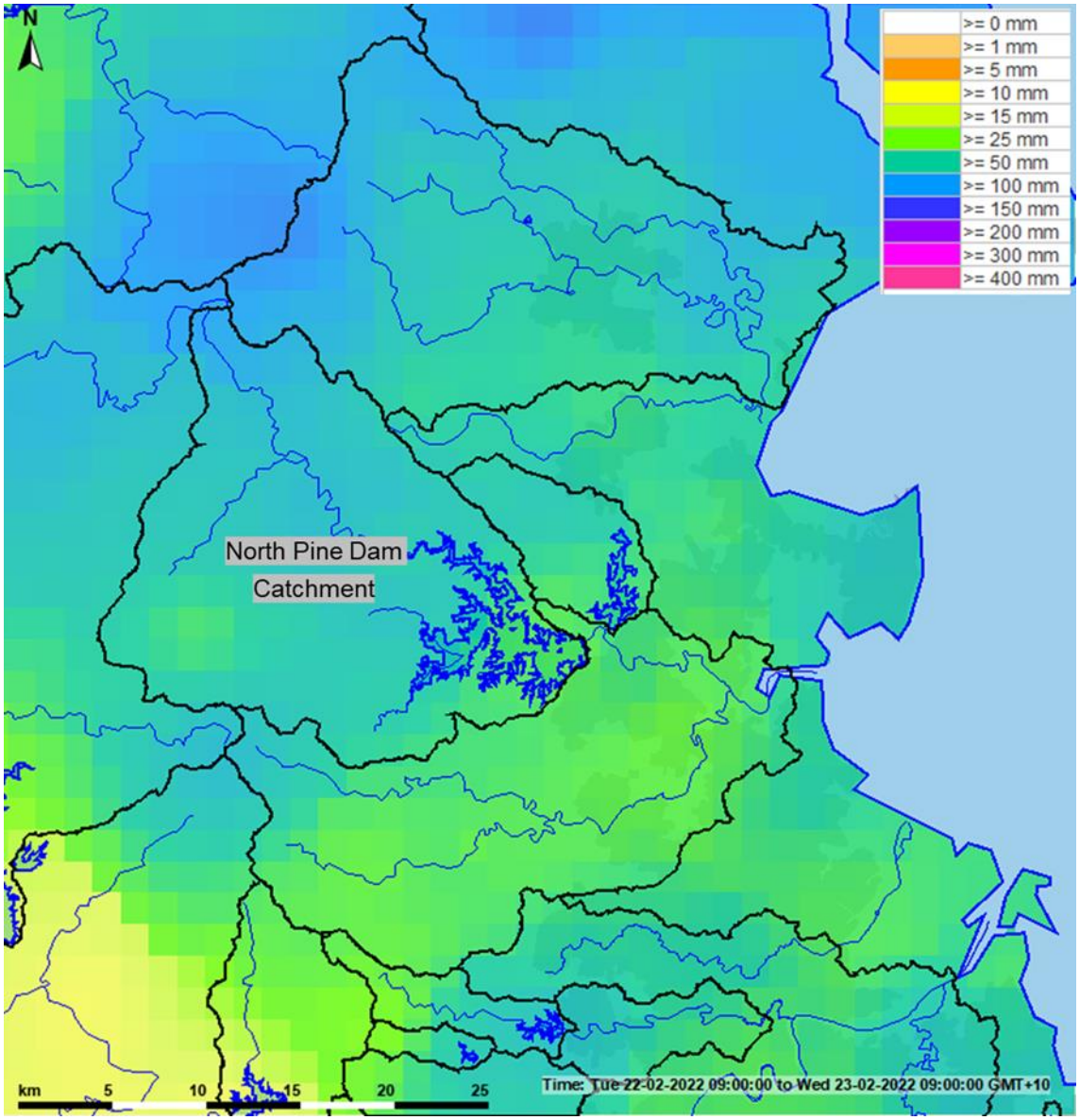


Figure 2-6: Daily rainfall (mm) 24 hours to 23/02/2022 09:00 (Source: FFS)

In the 24 hours to 23/02/2022 09:00, significant rainfall in South East Queensland commenced with widespread rainfall in the Pine River catchment. Rainfall totals of up to 100 mm were recorded at some gauges (for example Mt Mee). The catchment average rainfall in the North Pine Dam catchment was 61 mm.

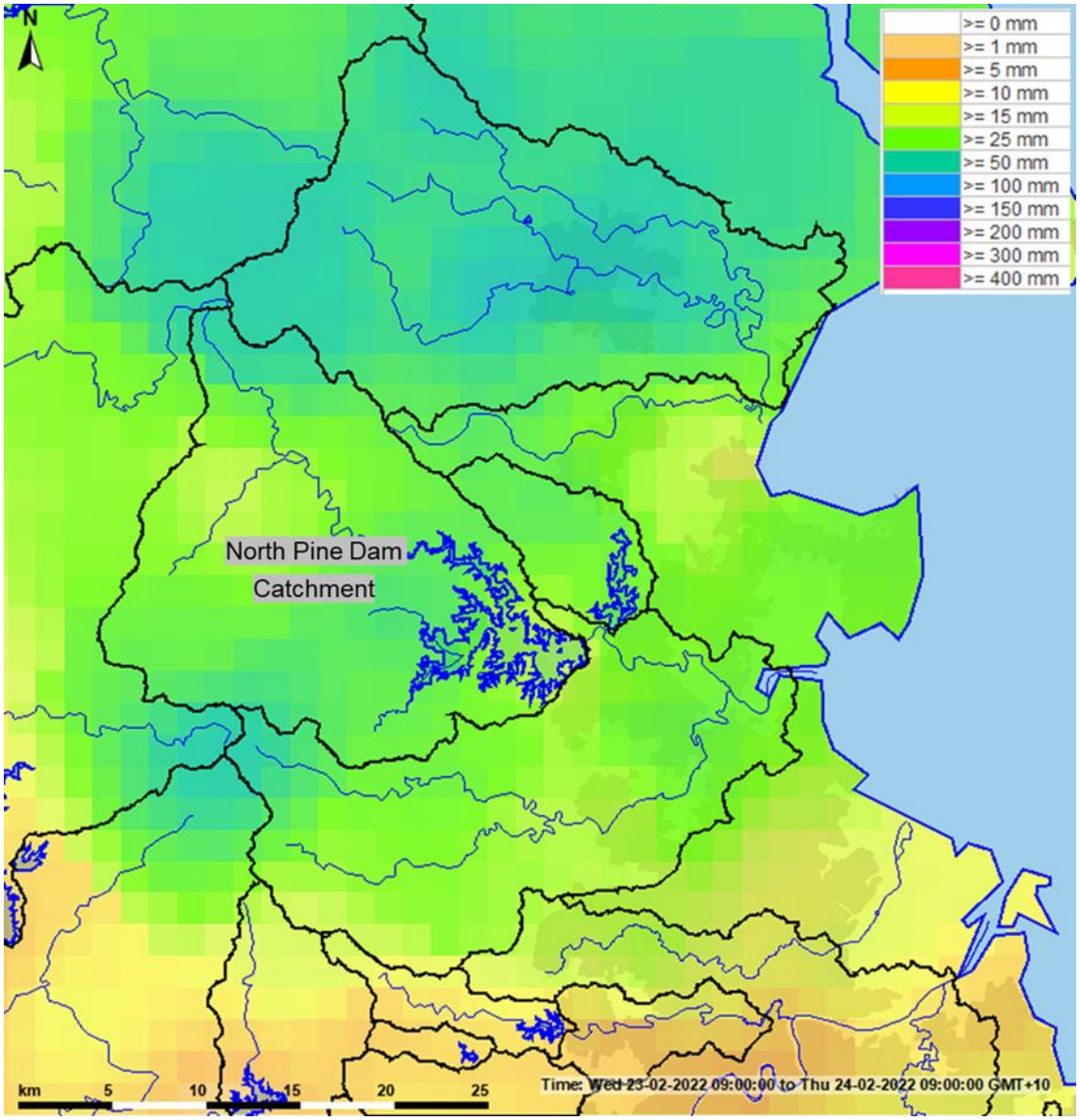


Figure 2-7: Daily rainfall (mm) 24 hours to 24/02/2022 09:00 (Source: FFS)

In the 24 hours to 24/02/2022 09:00, there was widespread rainfall across South East Queensland. In the upper parts of the Pine River catchment, 56 mm was recorded at Mt Glorious and 57 mm at Mt Mee. The catchment average rainfall in the North Pine Dam catchment was 31 mm.

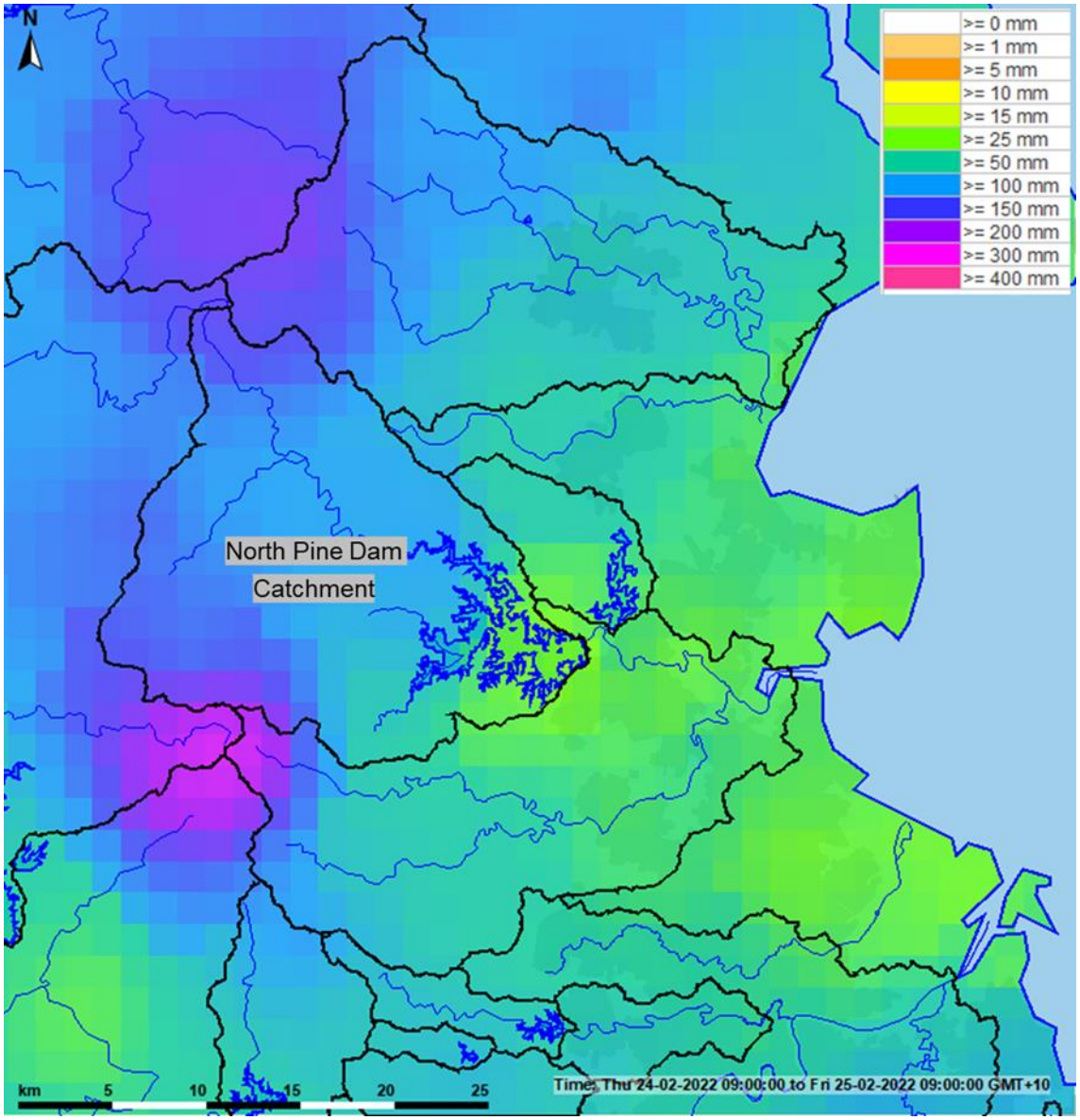


Figure 2-8: Daily rainfall (mm) 24 hours to 25/02/2022 09:00 (Source: FFS)

In the 24 hours to 25/02/2022 09:00, rainfall in South East Queensland further intensified. There was widespread rainfall in the Pine River catchment, with rainfall totals up to 252 mm occurring at Mt Glorious and up to 173 mm at Mt Mee. The catchment average rainfall in the North Pine Dam catchment was 100 mm.

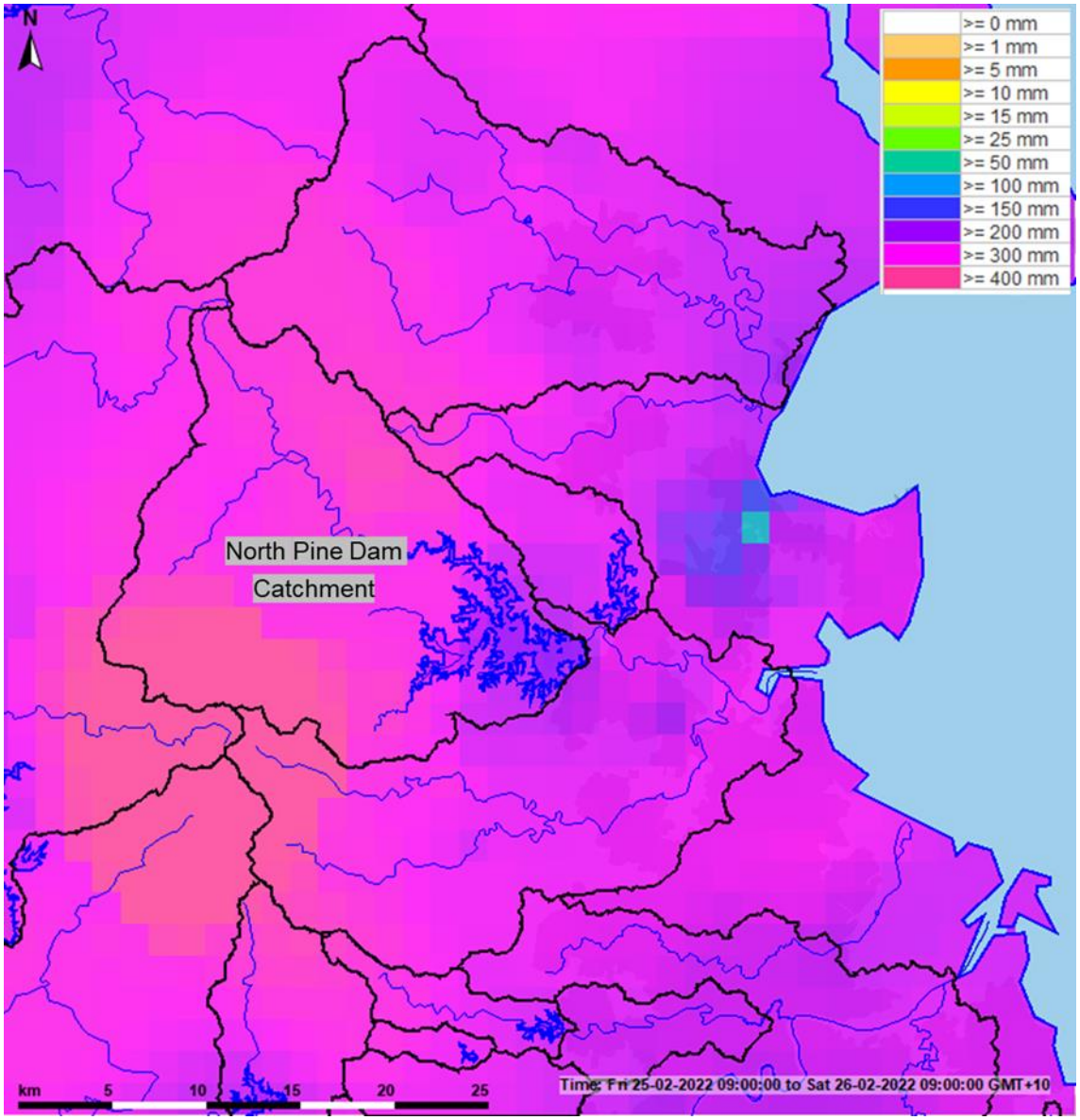


Figure 2-9: Daily rainfall (mm) 24 hours to 26/02/2022 09:00 (Source: FFS)

In the 24 hours to 26/02/2022 09:00, rainfall in South East Queensland further intensified. There was widespread rainfall in the Pine River catchment, with precipitation totals up to 711 mm recorded at Mt Glorious and up to 366 mm recorded at Mt Mee. Rainfall totals were generally higher in the upper parts of the North Pine Dam catchment, likely due to orographic effects. The catchment average rainfall in the North Pine Dam catchment was 337 mm.

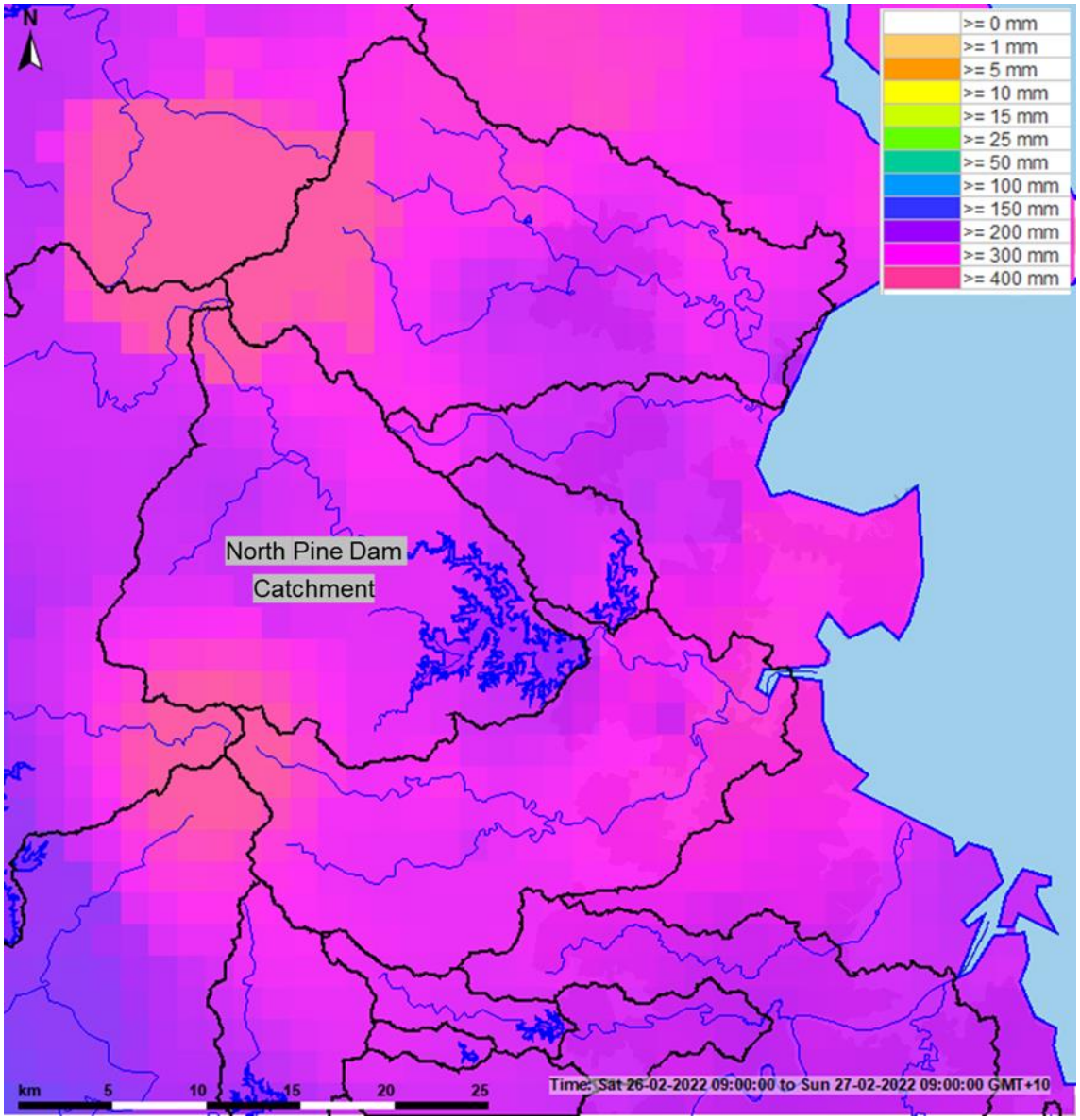


Figure 2-10: Daily rainfall (mm) 24 hours to 27/02/2022 09:00 (Source: FFS)

In the 24 hours to 27/02/2022 09:00, intense widespread rainfall occurred across South East Queensland. There was widespread rainfall in the Pine River catchment with precipitation totals up to 463 mm recorded at Mt Glorious and up to 874 mm recorded at Mt Mee. Rainfall totals were generally higher in the upper parts of the North Pine Dam catchment, likely due to orographic effects. The catchment average rainfall in the North Pine Dam catchment was 281 mm.

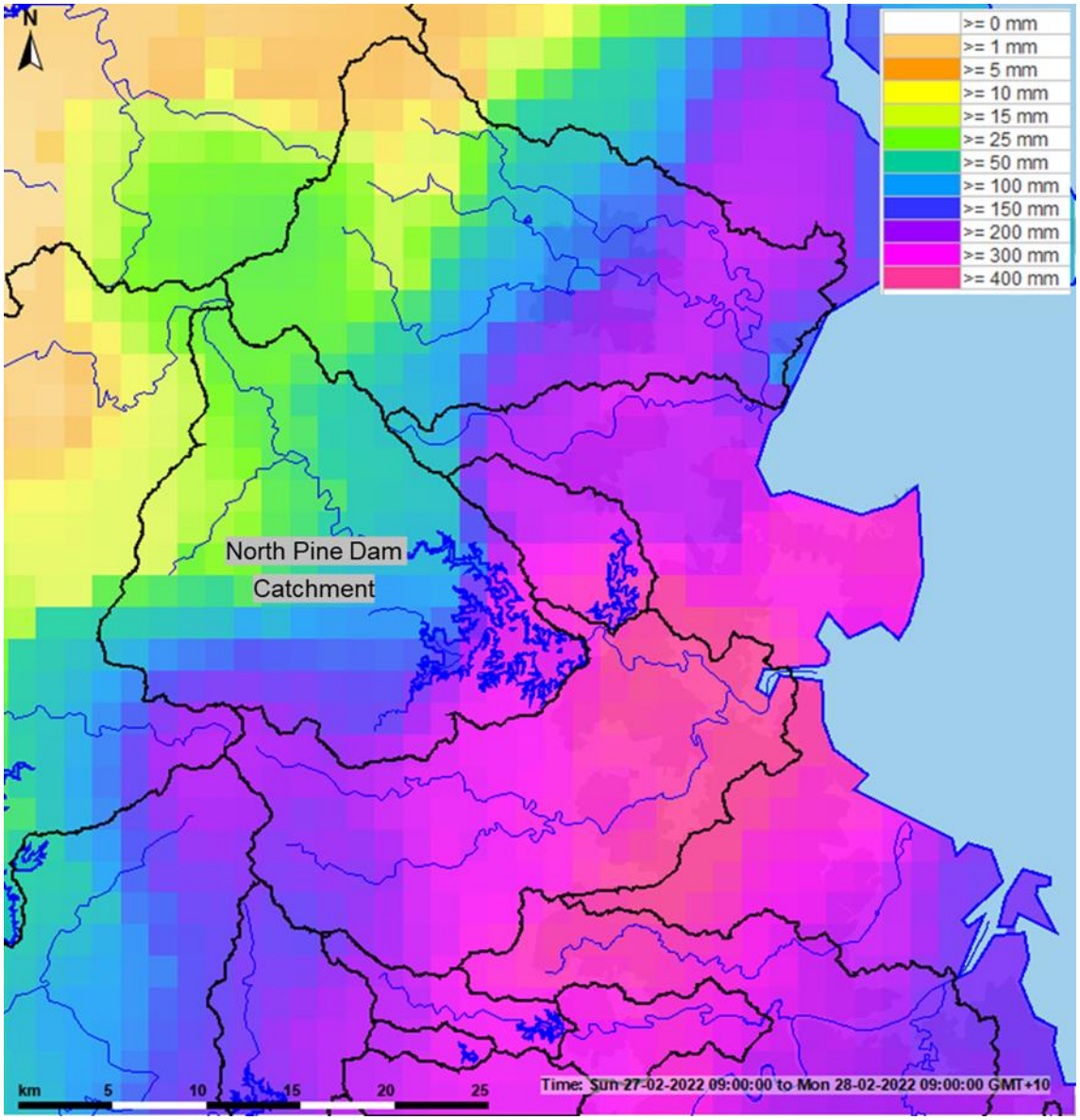


Figure 2-11: Daily rainfall (mm) 24 hours to 28/02/2022 09:00 (Source: FFS)

In the 24 hours to 28/02/2022 09:00, the weather system that had brought intense widespread rainfall to South East Queensland started to move south towards the Gold Coast and northern NSW. The rainfall in the North Pine Dam catchment reduced, as the rainfall system gradually moved southward, out of the catchment. The highest rainfall totals in the Pine River catchment were recorded in the vicinity of the Dam. The catchment average rainfall in the North Pine Dam catchment was 110 mm. Widespread intense rainfall continued across the parts of the catchment flowing into the Pine River downstream of North Pine Dam, including the catchments of Sideling Creek and the South Pine River.

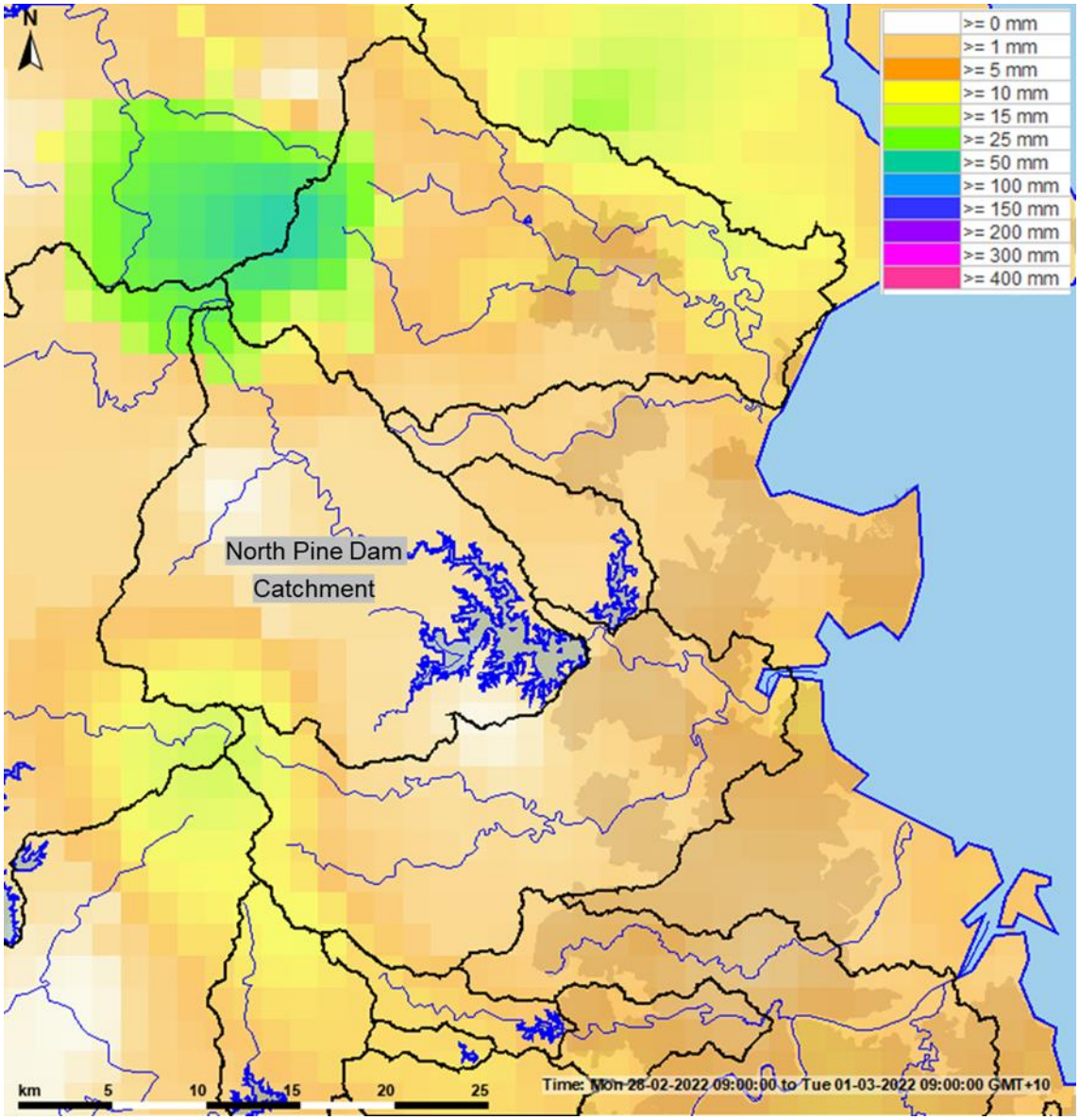


Figure 2-12: Daily rainfall (mm) 24 hours to 01/03/2022 09:00 (Source: FFS)

In the 24 hours to 01/03/2022 09:00, the rainfall subsided significantly in the North Pine Dam catchment, as the centre of the low pressure system continued its move towards and then into northern NSW. There were isolated bursts of precipitation, with up to 96 mm recorded at Mt Mee and up to 17 mm recorded at Mt Glorious. The catchment average rainfall in the North Pine Dam catchment was 3 mm.

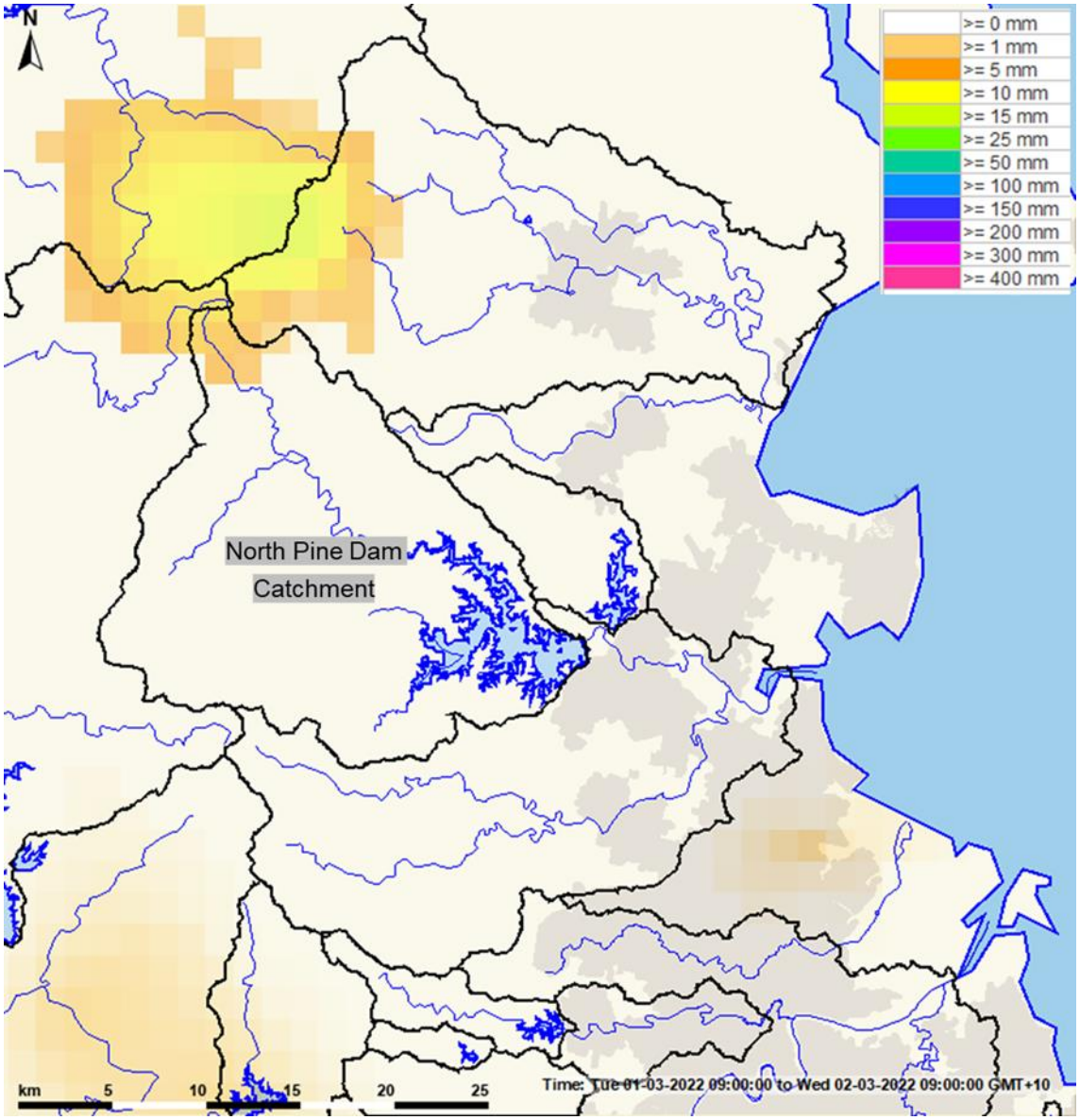


Figure 2-13: Daily rainfall (mm) 24 hours to 02/03/2022 09:00 (Source: FFS)

In the 24 hours to 02/03/2022 09:00, the majority of the Pine River catchment did not record any rainfall. Rainfall of 29 mm was recorded at Mount Mee and it was likely that there were small rainfall totals in the northernmost part of the North Pine Dam catchment.

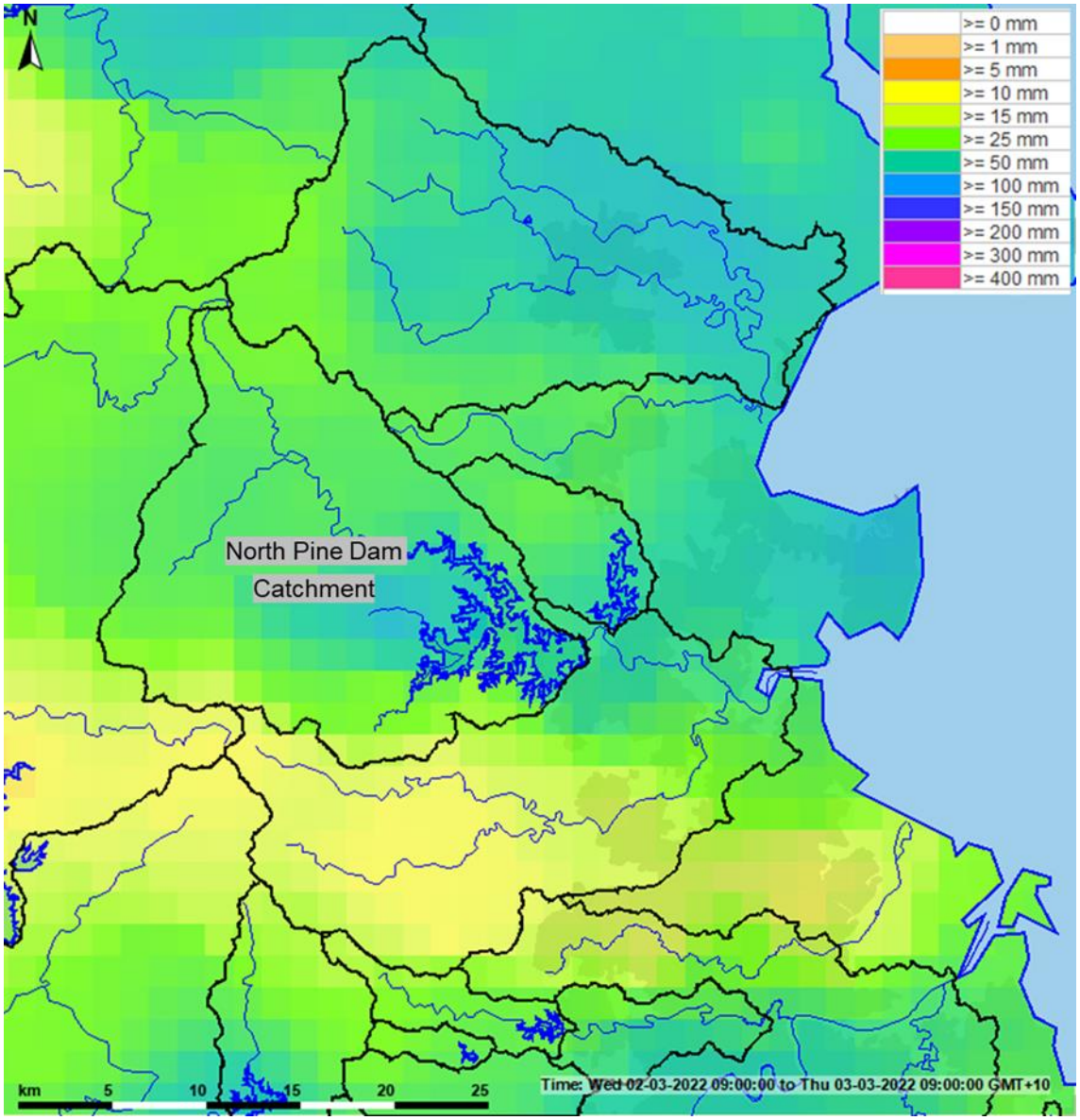


Figure 2-14: Daily rainfall (mm) 24 hours to 03/03/2022 09:00 (Source: FFS)

In the 24 hours to 03/03/2022 09:00, rainfall in South East Queensland re-intensified. There was widespread rainfall recorded in the North Pine Dam catchment, with recorded rainfall totals up to 43 mm near the Dam and up to 50 mm immediately downstream and over Sideling Creek Dam. The catchment average rainfall in the North Pine Dam catchment was 37 mm.

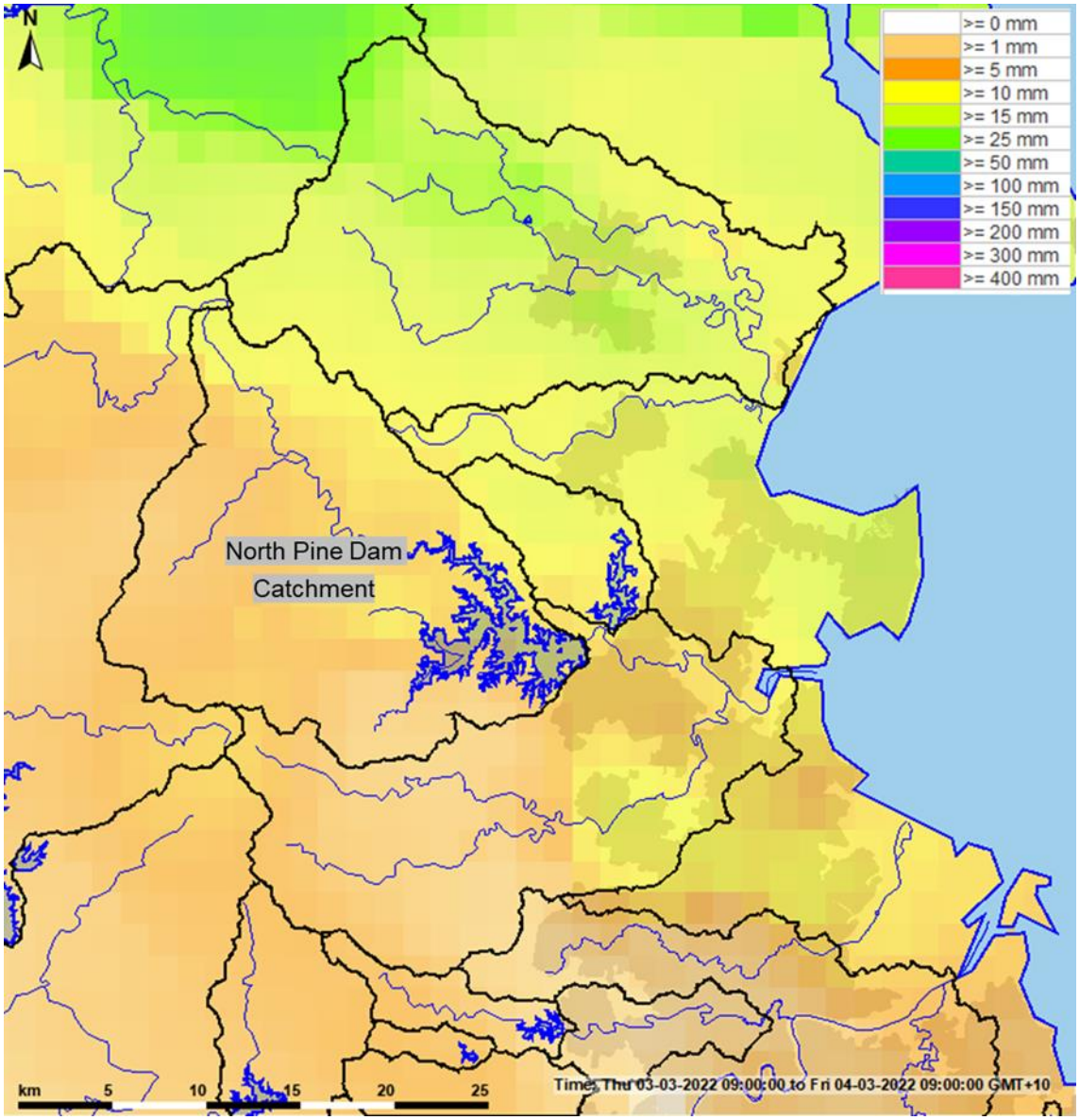


Figure 2-15: Daily rainfall (mm) 24 hours to 04/03/2022 09:00 (Source: FFS)

In the 24 hours to 04/03/2022 09:00, the catchment average rainfall in the North Pine Dam catchment was 6 mm. There were heavier falls in the Sunshine Coast hinterland area.

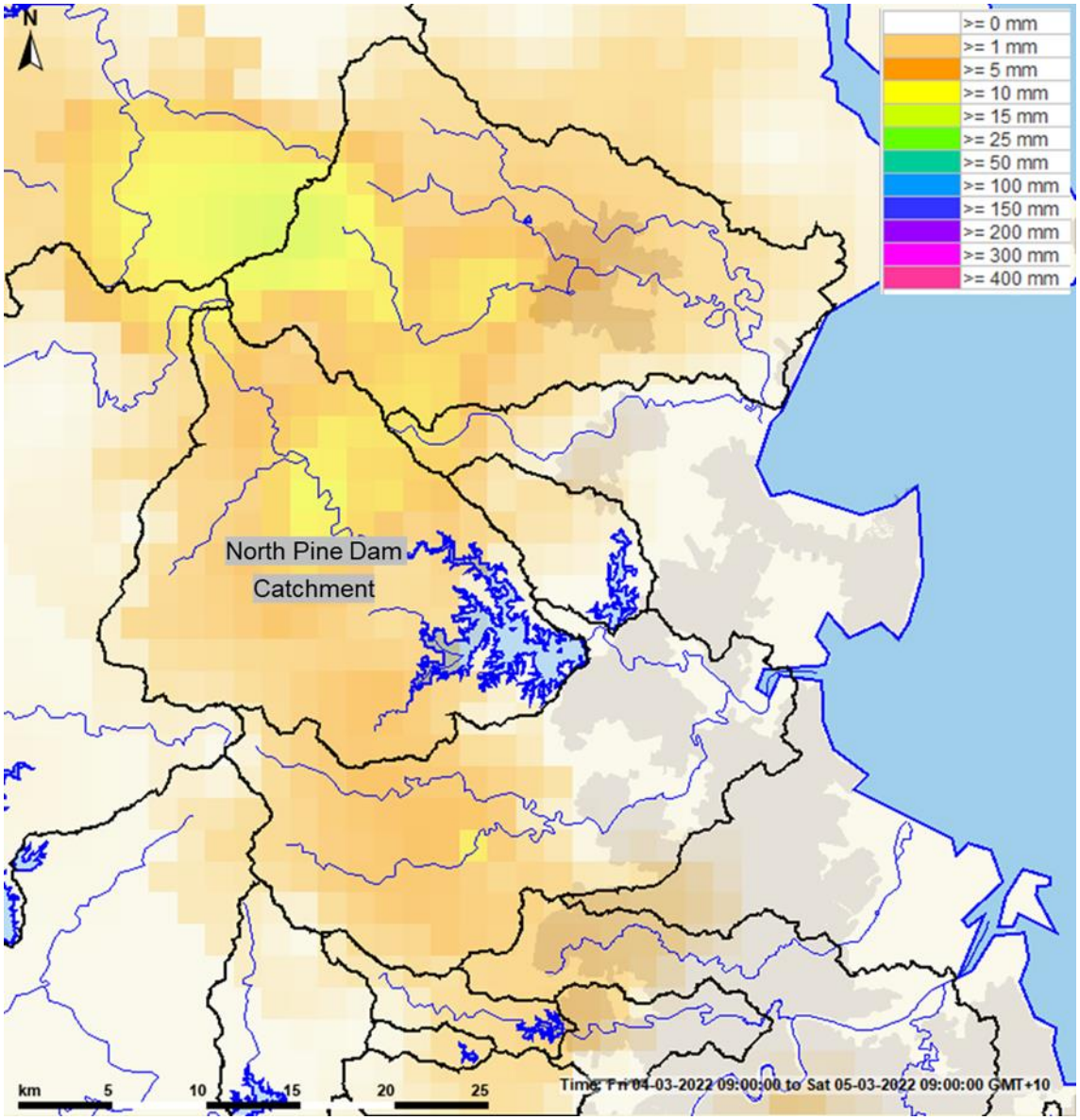


Figure 2-16: Daily rainfall (mm) 24 hours to 05/03/2022 09:00 (Source: FFS)

In the 24 hours to 05/03/2022 09:00, isolated showers were recorded near Baxters Creek (12 mm) and Mt Mee (25 mm). The catchment average rainfall in the North Pine Dam catchment was 3 mm.

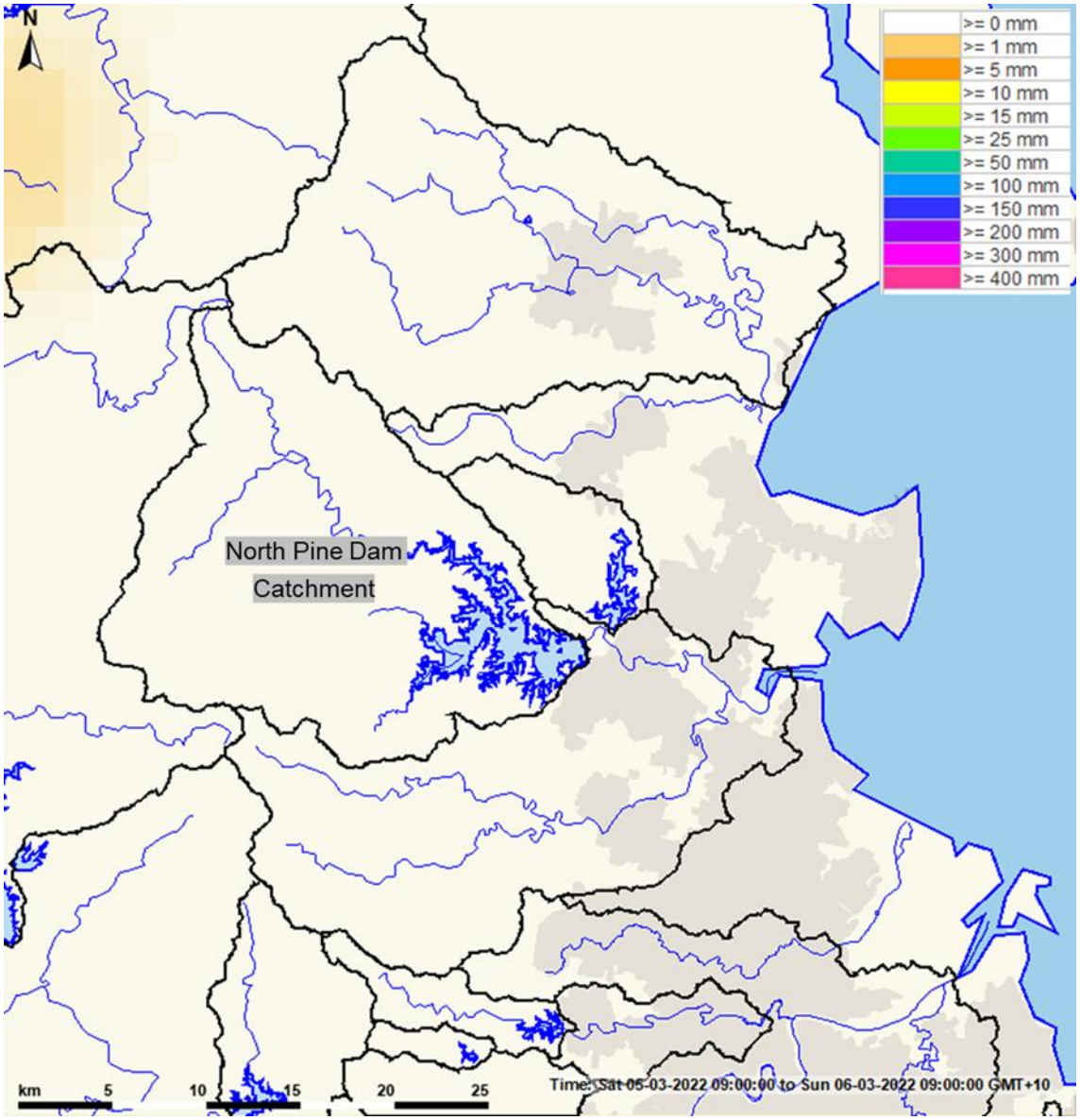


Figure 2-17: Daily rainfall (mm) 24 hours to 06/03/2022 09:00 (Source: FFS)

In the 24 hours to 06/03/2022 09:00, there was no rainfall recorded in the Pine River catchment.

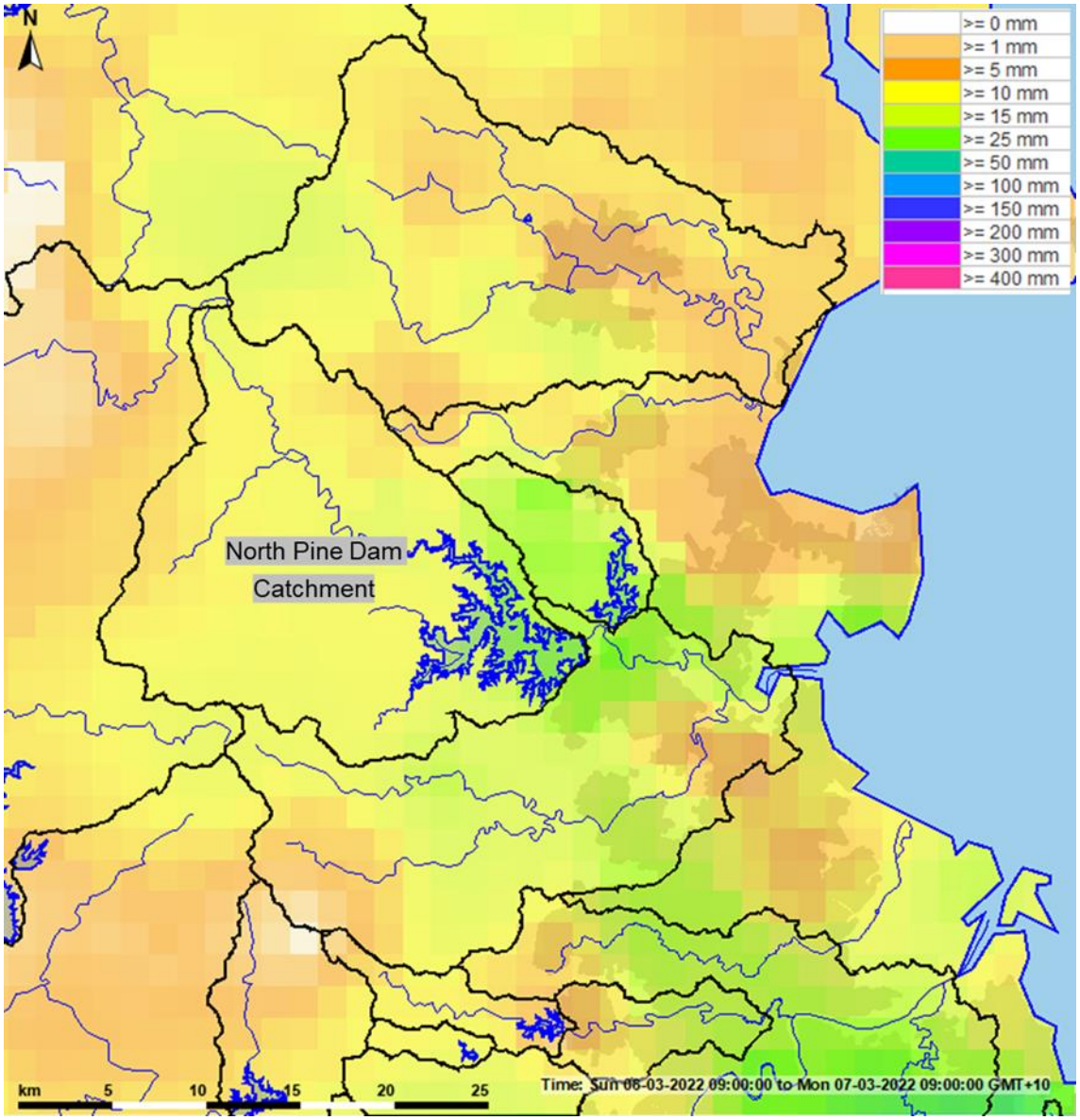


Figure 2-18: Daily rainfall (mm) 24 hours to 07/03/2022 09:00 (Source: FFS)

In the 24 hours to 07/03/2022 09:00, rainfall in South East Queensland intensified again. There was widespread rainfall recorded in the Pine River catchment, with totals of approximately 20 mm recorded at North Pine Dam and Sideling Creek Dam. The catchment average rainfall in the North Pine Dam catchment was 12 mm.

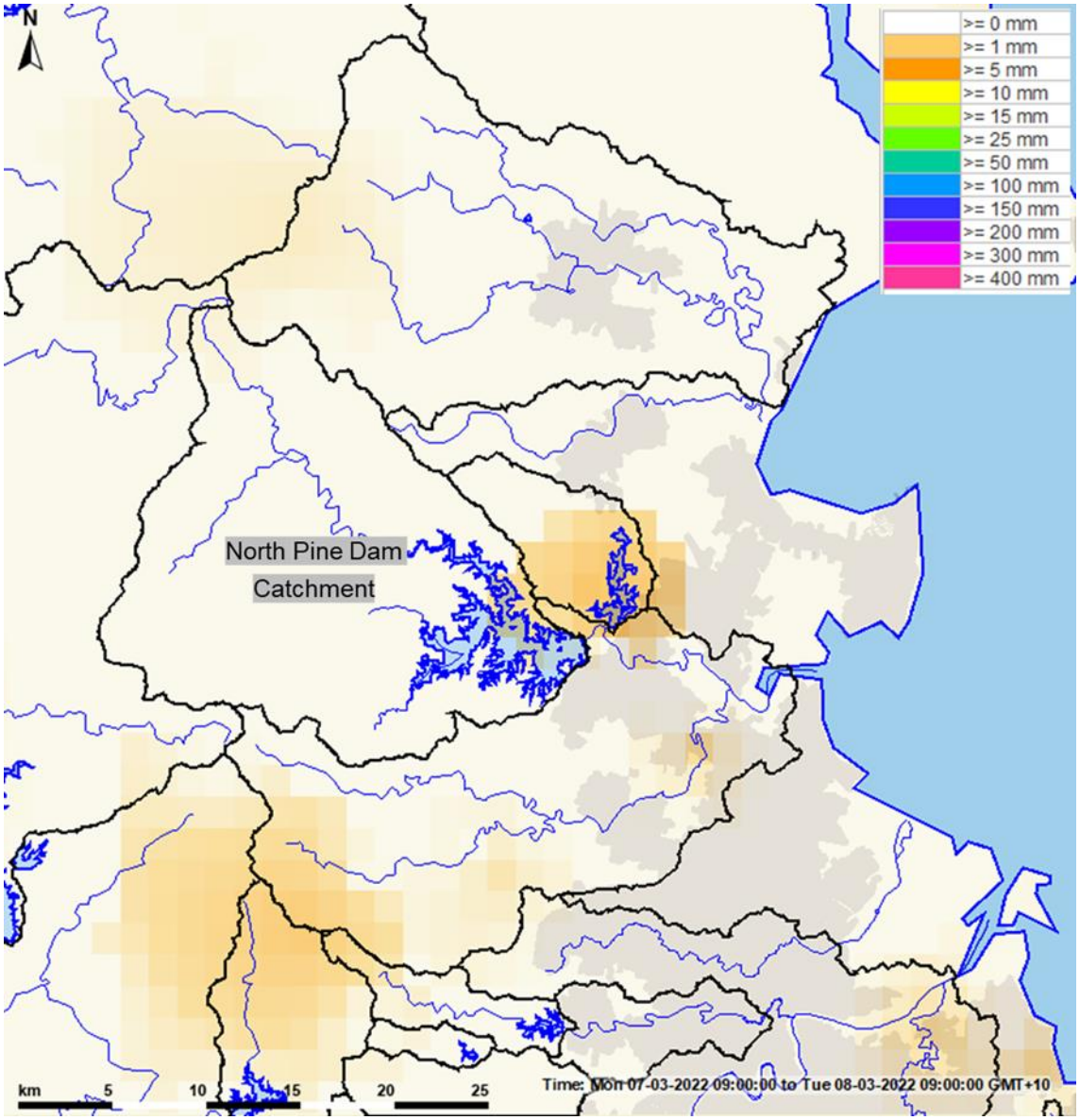


Figure 2-19: Daily rainfall (mm) 24 hours to 08/03/2022 09:00 (Source: FFS)

In the 24 hours to 08/03/2022 09:00, there were relatively light falls in the Pine River catchment. Rainfall of 6 mm was recorded at Sideling Creek Dam and either no or minimal rainfall was recorded at the other gauges across the Pine River basin.

2.3.4 Catchment average temporal pattern

The catchment average hourly rainfall temporal pattern for the North Pine Dam catchment was determined by calculating the average rainfall from the gridded rainfall data. This was calculated in the FFS and is presented in Figure 2-20.

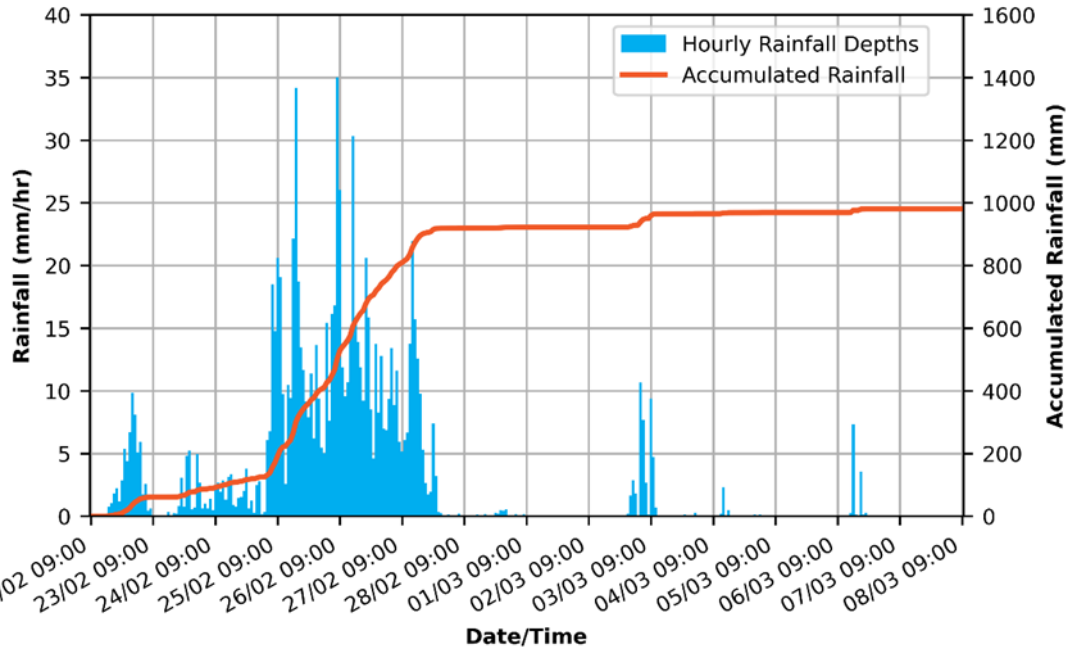


Figure 2-20: North Pine Dam catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 08/03/2022 09:00 (replicated in Figure ii)

Figure 2-20 shows heavy rainfall occurred over the North Pine Dam catchment between 25/02/2022 08:00 and 27/02/2022 18:00. There were also subsequent bursts of rainfall occurring in the North Pine Dam catchment on 03/03/2022 and 06/03/2022. Note that the temporal pattern shown is the catchment average temporal pattern.

2.4 Forecast rainfall

Forecast rainfall data was part of the numerical weather predictions issued by the Bureau and provided to the Flood Operations Centre at least twice per day over the course of the Flood Event. Forecast rainfall information was provided as a gridded dataset for three percentile exceedance values; 50th, 25th and 10th percentiles[2]. In this context, the percentile exceedance values refer to the expected likelihood of those rainfalls occurring at point locations[3]. The data is provided by the Bureau generally twice per day, usually between 04:00 and 06:00 and 16:00 and 18:00, using grids with a three-hour time step. Further information on this forecast rainfall data, and the limitations associated with it, is available in Appendix H of the Manual.

Table 2-4 presents recorded and forecast catchment average rainfall depths for the North Pine Dam catchment in the period of the Flood Event between 22/02/2022 07:00 and 08/03/2022 07:00 for the forecasts that were available in the FFS in the morning of each day. The forecasts

[2] Other forecast precipitation products in this suite included the ADFD mean. The forecasts were available as mm per day, and mm per 3-hours. The mm per 3-hours forecast precipitation data is presented in this report.
[3] Further information in Appendix H of the Manual describes the complexity of point rainfall probability not representing areal rainfall probability.

were presented in this manner to provide a concise summary of the data; Table 2-4 does not represent every rainfall forecast that was issued during the Flood Event. Note that these values are presented from 07:00 each day in order to provide a consistent comparison between forecast and recorded rainfall depths, as forecast rainfall data is not defined to exactly 09:00 each day. As per the description in Section 2.3, the recorded rainfall data has been aggregated to a daily time step for the purposes of comparison in Table 2-4, with the daily aggregation period changed to 07:00 to 07:00. During the Flood Event, the FFS was configured to use recorded rainfall data on a 15-minute time step in the hydrological models.

The rainfall forecast data in Table 2-4 is presented as a range between the 25th and 50th percentile exceedance value grids issued by the Bureau.

Table 2-4: Forecast catchment average rainfall (mm) for North Pine Dam catchment from 23/02/2022 to 08/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00
22/02/2022	0 - 1	1 - 21	14 - 70	7 - 37	0 - 4	0 - 0	-	-	-	-	-	-	-	-
23/02/2022	-	46 - 117	57 - 125	20 - 55	1 - 9	0 - 1	0 - 2	-	-	-	-	-	-	-
24/02/2022	-	-	74 - 148	29 - 110	5 - 31	0 - 3	0 - 2	0 - 1	-	-	-	-	-	-
25/02/2022	-	-	-	40 - 125	14 - 43	1 - 5	0 - 1	0 - 1	0 - 1	-	-	-	-	-
26/02/2022	-	-	-	-	130 - 278	2 - 25	0 - 3	0 - 0	0 - 3	0 - 7	-	-	-	-
27/02/2022	-	-	-	-	-	27 - 87	0 - 7	0 - 0	0 - 1	0 - 5	0 - 5	-	-	-
28/02/2022	-	-	-	-	-	-	1 - 7	0 - 0	0 - 0	1 - 11	2 - 12	0 - 4	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 1	2 - 21	1 - 14	0 - 3	1 - 11	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 3	5 - 52	1 - 14	0 - 3	1 - 11	0 - 1
03/03/2022	-	-	-	-	-	-	-	-	-	22 - 63	1 - 14	0 - 6	2 - 13	0 - 5
04/03/2022	-	-	-	-	-	-	-	-	-	-	1 - 7	0 - 3	0 - 8	0 - 3
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 2	1 - 7	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	13 - 39	0 - 0
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Recorded catchment average rainfall (mm 07:00 to 07:00)	**60**	**29**	**68**	**311**	**331**	**121**	**3**	**0**	**28**	**16**	**3**	**0**	**12**	**0**

2.5 Gauging station hydrographs

This section presents hydrographs of the water levels recorded at gauging stations at North Pine Dam (lake level) and throughout the Dam catchment during the Flood Event. The locations of these gauges are shown in Figure 2-21, with the corresponding level hydrographs shown in Figure 2-23 to Figure 2-22. Note that upstream stations are shown with levels to local gauge datum, and the lake level is shown to Australian Height Datum (AHD).

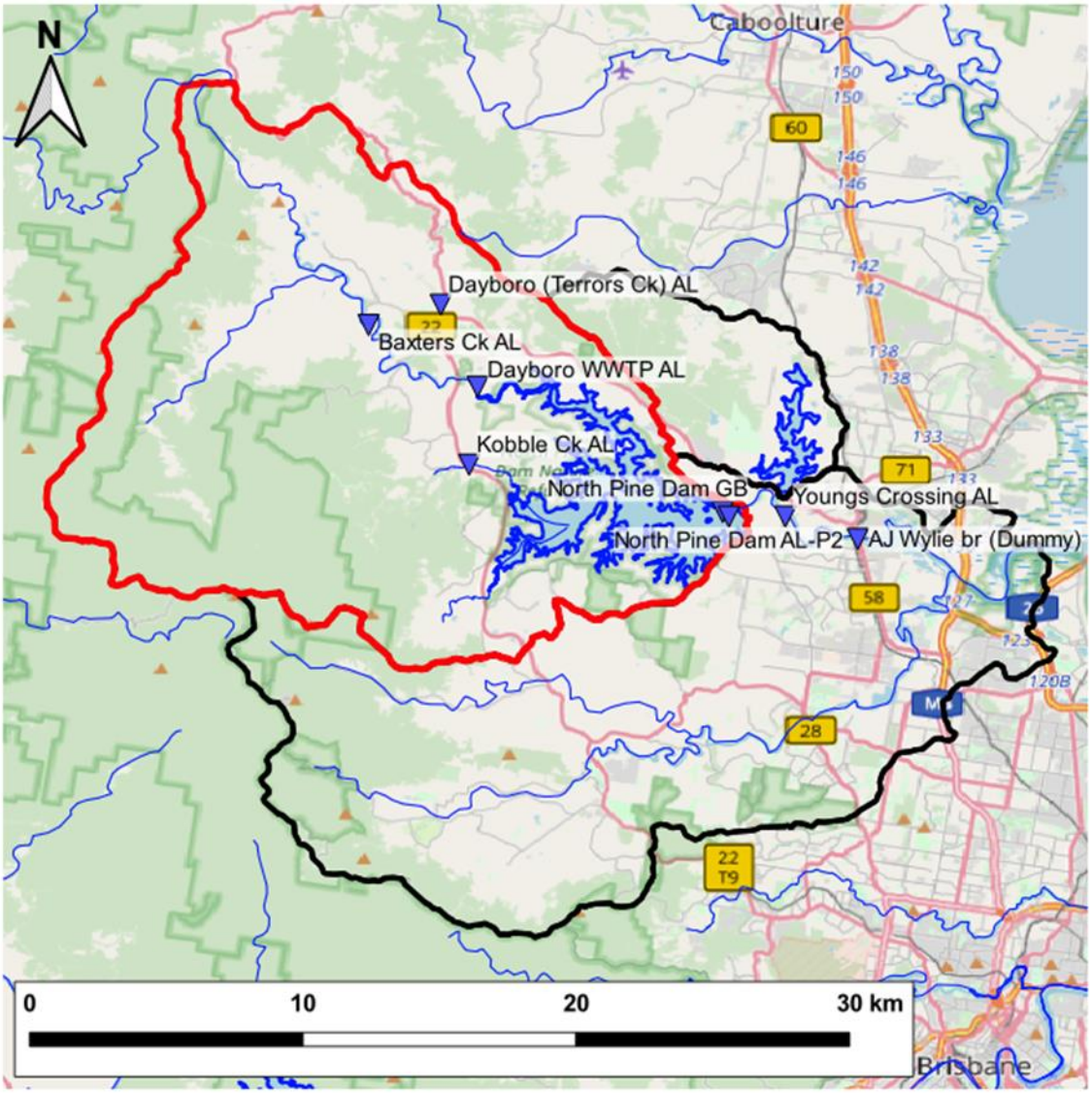


Figure 2-21: North Pine Dam catchment water level gauges

The recorded lake levels at North Pine Dam are shown in Figure 2-22 and tabulated in Appendix C. Figure 2-22 illustrates the automated data from the lake level gauge at the Dam compared to the manually read gauge board data. The average difference between the automated and gauge board data was less than 0.008 m. The most significant differences between the automated and gauge board data was observed on 28/02/2022, when the gauge board data was up to 70 mm below the automated data. Such differences are not unexpected

during flood events and can be caused by measurement error or physical phenomena such as wave action.

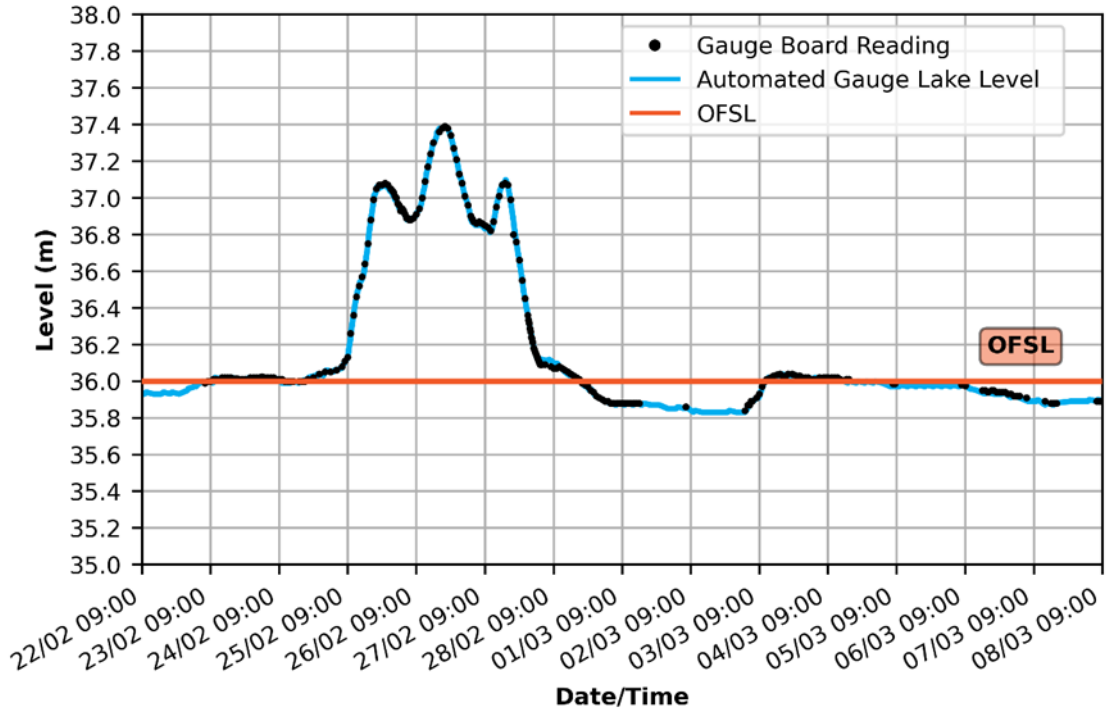


Figure 2-22: North Pine Dam lake level comparing automated water level data and gauge board readings for the period 22/02/2022 09:00 to 08/03/2022 09:00

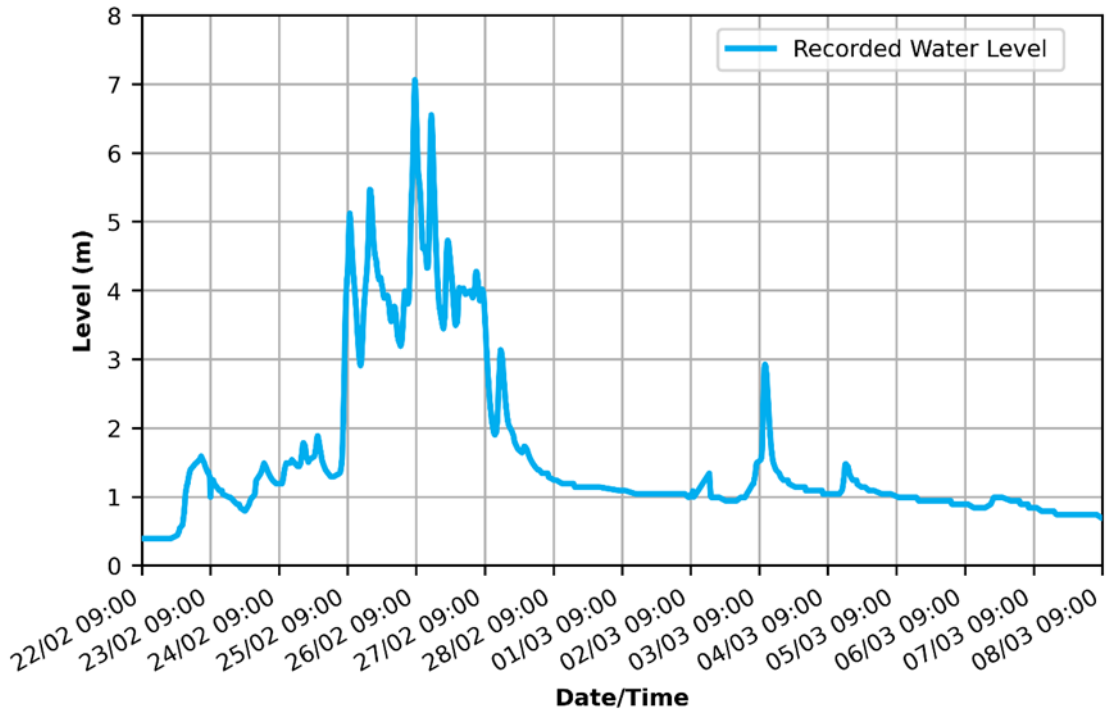


Figure 2-23: Recorded water level data at Terrors Creek for the period 22/02/2022 09:00 to 08/03/2022 09:00

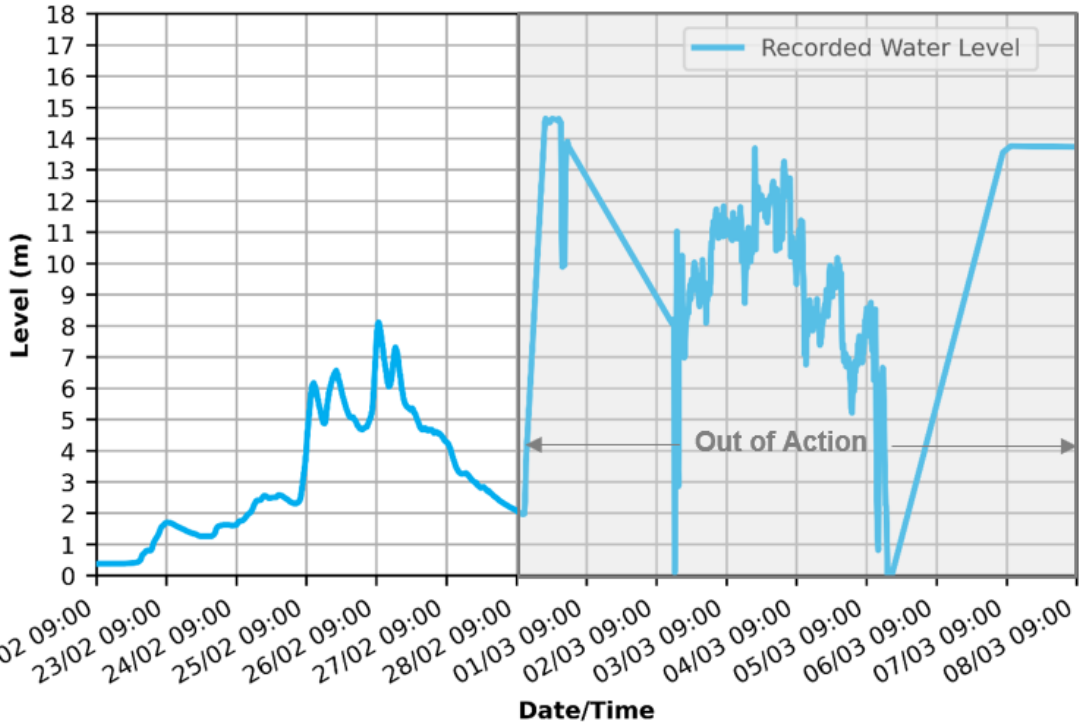


Figure 2-24: Recorded water level data at Baxters Creek for the period 22/02/2022 09:00 to 08/03/2022 09:00

The Baxters Creek gauge was marked as suspect prior to the Flood Event (refer to Table 2-1) and later during the Flood Event (28/02/2022) it was marked as Out of Action when the water level readings appeared to be erroneous.

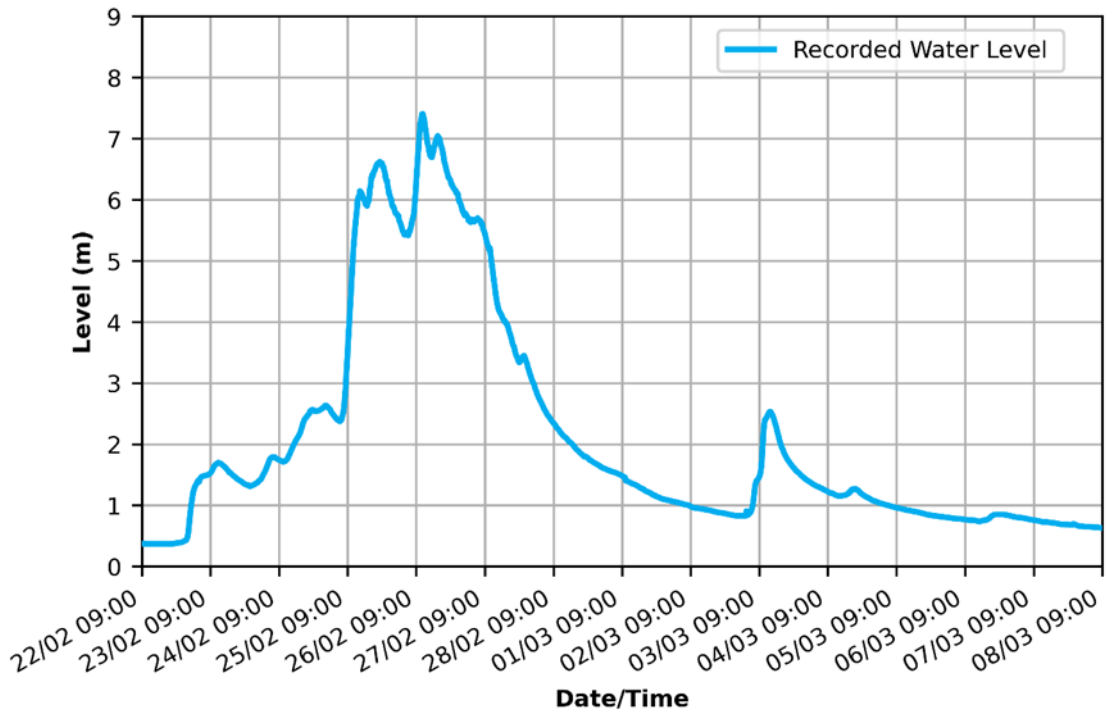


Figure 2-25: Recorded water level data at Dayboro WWTP for the period 22/02/2022 09:00 to 08/03/2022 09:00

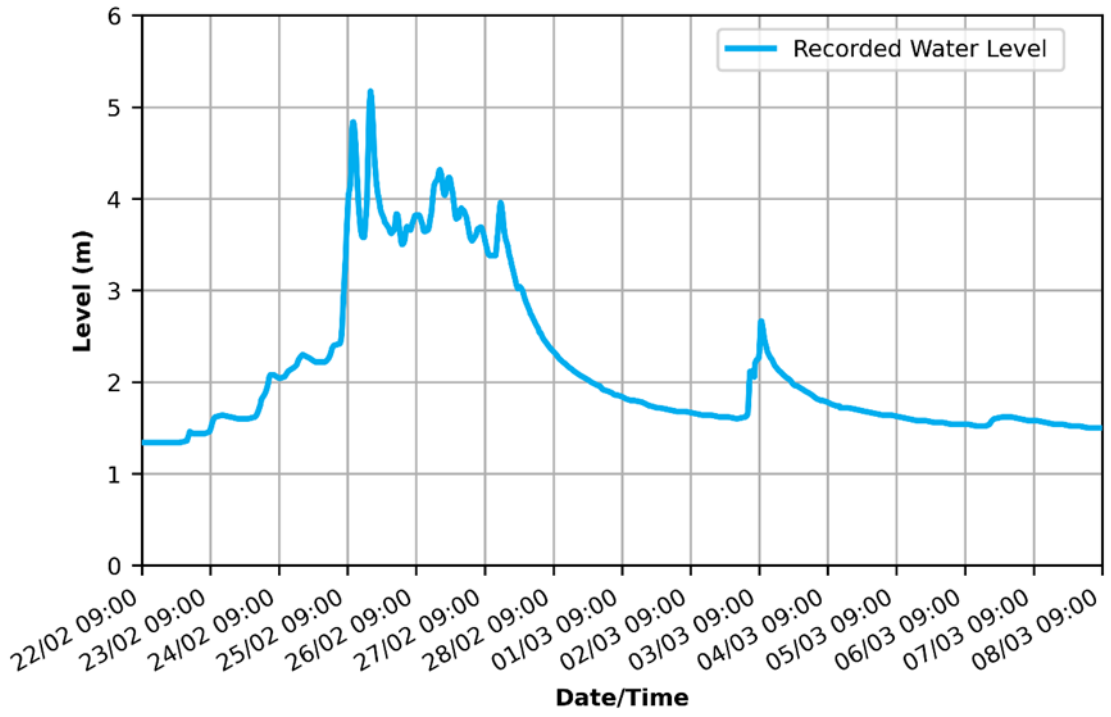


Figure 2-26: Recorded water level data at Kobble Creek for the period 22/02/2022 09:00 to 08/03/2022 09:00

Rated flow data at gauges in the North Pine Dam catchment is shown in Section 7.2.1.

3. Flood Modelling

This section describes the flood modelling platforms and model runs used to estimate catchment flows into North Pine Dam during the Flood Event. The inflows to the dam are independent of dam operation decisions. The modelled lake levels for the dam are dependent on dam inflows and dam releases. The dam releases implementation is described further in Section 4.

3.1 Flood modelling platforms

Two hydrologic modelling platforms were available to the Flood Operations Centre to estimate flows at gauging stations and inflow to the Dam. These are important components of the FFS and are described further below:

- **Seq-FEWS - Primary modelling platform**: Data from Enviromon[4], WISKI[5] and the Bureau[6] are regularly imported into FEWS. The observed data is manually quality controlled. The URBS hydrological models are integrated in FEWS, which allows users to change model parameter values and set inputs to calibrate and execute the models. The output results from the URBS models are imported and stored in FEWS for visualisation and further analysis. The results are then exported for input into the Gate Operations Model.
- **Operational Standalone - Backup modelling platform**: Similar to the primary system, an operational standalone FEWS is available on the network drive and can be quickly deployed on the local workstations at the Flood Operations Centre. This system does not require any backend FEWS services and has similar functionalities as the operational system but imports data from a network drive.

The primary modelling system was used throughout the Flood Event. Further background information about the FFS, FEWS and the North Pine Dam URBS model is provided in Section 7.4 of the Manual.

3.2 Model runs

Estimates of catchment flow hydrographs and lake level predictions in response to Release Plans are required for decision making to apply the procedures in the Manual. These predictions are made with the models in the FFS, calibrated to the available data in real time. This is described further in Sections 7 and 8 of the Manual.

The primary focus of model calibration is the recorded lake level at North Pine Dam. This is because the storage volume and spillway rating data for the Dam together with recorded lake level are the most reliable basis to estimate inflows when compared to the uncertainties in the ratings (relationship between water level and estimated flow rate) of the upstream gauges. The upstream gauges cover only a portion of the catchment that produces inflows into the Dam and

[4] Enviromon collects real time ALERT gauge data.
[5] WISKI collects and stores other data such as telemetry, dam operator readings (gauge boards and gate settings).
[6] The Bureau data feed includes rainfall forecasts.

are also vulnerable to changes in geometry during large floods as the river banks and bed can erode, changing the rated flow for a given river height.

A list of the hydrologic model runs undertaken during the Flood Event is presented in Appendix B. The list of model runs in Appendix B covers those runs which were archived in the FFS as part of dam operation release planning during the Flood Event. Of the 339 archived runs produced during the Flood Event, 187 were imported into the Gate Operations Model and used to develop or check Release Plans. Seventeen of these model runs were associated with key event or Release Plan decisions made throughout the Flood Event. These seventeen model runs are summarised in Table 3-1. The data for each run summarised in Table 3-1 includes predicted peak inflow and lake level at the Dam. Note that predicted peak lake level is influenced by the Release Plan in place at the time, and further discussion on setting of release plans is included in Section 4.2.

The model runs selected and data summarised in Table 3-1 are provided to illustrate the hydrologic modelling used to inform release planning. This table represents a small but representative proportion of the combined inputs and outputs to the large series of model runs undertaken across the Flood Event.

Table 3-1: Summary of selected key FFS model runs used to inform North Pine Dam operational decisions

Run time[1]	FFS ID	Total rainfall to run time (mm)[2]	Predicted Dam peak inflow (m^3/s)	Predicted peak lake level (m AHD)[3]	Predicted Dam peak release (m^3/s)[3]	Associated operational decision[3] (note these decisions occur at a different time to the model run and are described further in Section 4)
23/02/2022 11:15	328	61	51	36.09	0	Flood event determined to commence at 12:22 Selection of Flood Operations Strategy Procedure 1a from the time the Flood Event commenced
25/02/2022 00:45	299	122	74	36.11	91	Predicted inflow and releases steady. Total gate opening 1 m.
25/02/2022 09:00	286	193	556	36.53	285	Rainfall intensifies. Selection of Flood Operations Strategy Procedure 1b.
25/02/2022 10:00	283	212	960	36.56	507	Predicted inflows rise significantly. Total gate opening moves to 6 m.
25/02/2022 14:00	274	244	1,068	36.59	754	Inflows continue to rise. Total gate opening moves to 12 m.
25/02/2022 17:00	258	320	1,440	37.01	1,041	Inflows continue to rise. Total gate opening moves to 14.5 m.
25/02/2022 23:45	245	385	1,580	37.08	1,155	Releases peak and begin to ease slightly.
26/02/2022 05:00	234	436	1,460	37.09	1,156	Additional rainfall recorded, inflows start to rise again.
26/02/2022 10:00	219	542	1,571	37.65	1,165	Inflows and releases rise again. Total gate opening moves to 16.5 m.
26/02/2022 17:00	207	649	1,602	37.36	1,523	Flood Event Peak inflow, lake level and releases. All gates clear of flow.
27/02/2022 08:00	182	806	1,684	37.41	1,544	Additional rainfall recorded, inflows start to rise again.
27/02/2022 19:30	154	909	1,740	37.44	1,556	Lake level peaks again at 37.10 m AHD and then begins to fall sharply.
28/02/2022 01:45	136	921	2,638	38.17	1,876	Inflows ease rapidly. Model calibration updated to prioritise current lake level trend. Selection of Drain Down Strategy Procedure 1a.
28/02/2022 03:00	133	921	1,735	37.51	1,587	Lake level stabilises. Model calibration updated to improve estimates of Flood Event peak lake level and inflow.
03/03/2022 10:00	84	966	1,736	37.53	1,596	Rainfall re-intensifies. Selection of Flood Operations Strategy Procedure 1a.
03/03/2022 22:00	71	967	1,676	37.44	1,558	Rainfall eases. Selection of Drain Down Strategy Procedure 1a.
08/03/2022 07:00	3	982	1,699	37.44	1,557	Flood event ended at 09:00.

[1] Note all models started at 22/02/2022 09:00. The run time tabulated here is the time the model run was undertaken. Model results provide predictions of Dam inflow, lake level and releases up to ten days past this run time based on rain on ground recorded between 22/02/2022 09:00 and the run time.

[2] North Pine Dam catchment average rainfall recorded between 22/02/2022 09:00 and the run time.

[3] Predicted peak lake levels and releases are influenced by the decisions made in the Release Plans. Additional detail on Release Plans and operational decisions is provided in Section 4.

It should be noted that estimates of peak Dam inflow vary across the model runs shown in Table 3-1. The reasons for this are twofold. Firstly, as the event unfolds, additional rain on ground is recorded at gauge sites and used to update the models in conjunction with additional lake level records. Secondly, the calibration of the model (primarily to recorded lake level at North Pine Dam) is continually refined during the Flood Event. The process of model calibration seeks to develop a reasonable match between the simulated lake level hydrograph from the FFS to the complete available recorded lake level hydrograph at the run time. The calibration particularly aims to match to the current conditions and the trend of the recent conditions immediately before the run time. Matching these current and immediately preceding conditions is prioritised to help inform the development of Release Plans which are suitable for the current observed conditions. The result of this prioritisation of the most recent data for calibration is that during the later stages of the Flood Event, the calibration to earlier inflow conditions may deviate from the observed data as an unintended consequence of aiming to provide a better match to the most recent observed data. This is particularly the case during a multi-peaked inflow event as occurred during this Flood Event.

An example of the process of adjusting calibration to focus on current and immediately preceding conditions can be seen by comparing the runs undertaken on 27/02/2022 19:30, 28/02/2022 01:45 and 28/02/2022 03:00 shown in Table 3-1. The estimate of Flood Event peak inflow across these three representative model runs jumps from 1,740 m^3/s to 2,638 m^3/s and then decreases back to 1,735 m^3/s. These runs were undertaken during a period when the lake level was falling rapidly due to decreasing dam inflows and the rate of decrease of inflows was uncertain. Additional calibration effort was undertaken by the Flood Engineer to try to match the immediately preceding trend of lake level. As a consequence, calibration accuracy to the peak inflow and lake level (which had occurred approximately 36 hours prior) was knowingly traded off to help inform release planning based on current and immediately preceding observations. Once predicted inflow and lake level had stabilised somewhat, the Flood Engineer revaluated the calibration and improved the estimate of Flood Event peak inflow. Release planning decisions during this period of the Flood Event are discussed in more detail in Section 4.2. It should also be noted in this context that the whole of event calibration completed with the benefit of hindsight as part of this report (and described in Section 7.2) was also unable to achieve a good match to recorded lake level during this period of the Flood Event. Reference to the daily rainfall analysis shown in Figure 2-11 for the 24 hours to 28/02/2022 09:00 indicates a significant rainfall gradient across the Dam catchment during this time. It is possible that the spatial variability of the rainfall in the 24 hours to 28/02/2022 09:00 was not well represented by the available rainfall gauges, which in turn caused the hydrologic model to underpredict inflow or timing of inflow for the third lake level peak.

Hydrographs showing North Pine Dam inflow and lake level for each of the selected key model runs in Table 3-1 are shown in Figure 3-1 and Figure 3-2. The estimated total flow at the AJ Wyllie Bridge downstream of North Pine Dam is presented in Figure 3-3 to illustrate the data available to assist in communication with stakeholder agencies. Note that the predicted flow at the AJ Wyllie Bridge is not used for operational decision making at North Pine Dam and is used only to assist in meeting communication requirements.

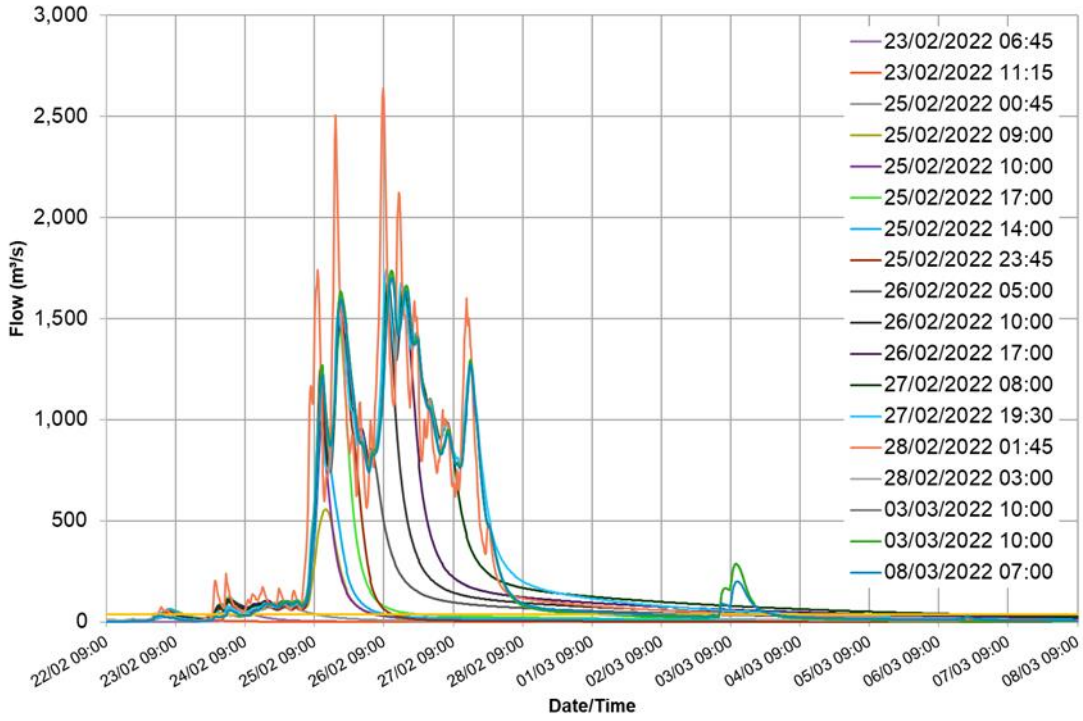


Figure 3-1: Modelled North Pine Dam inflow for each selected key model run

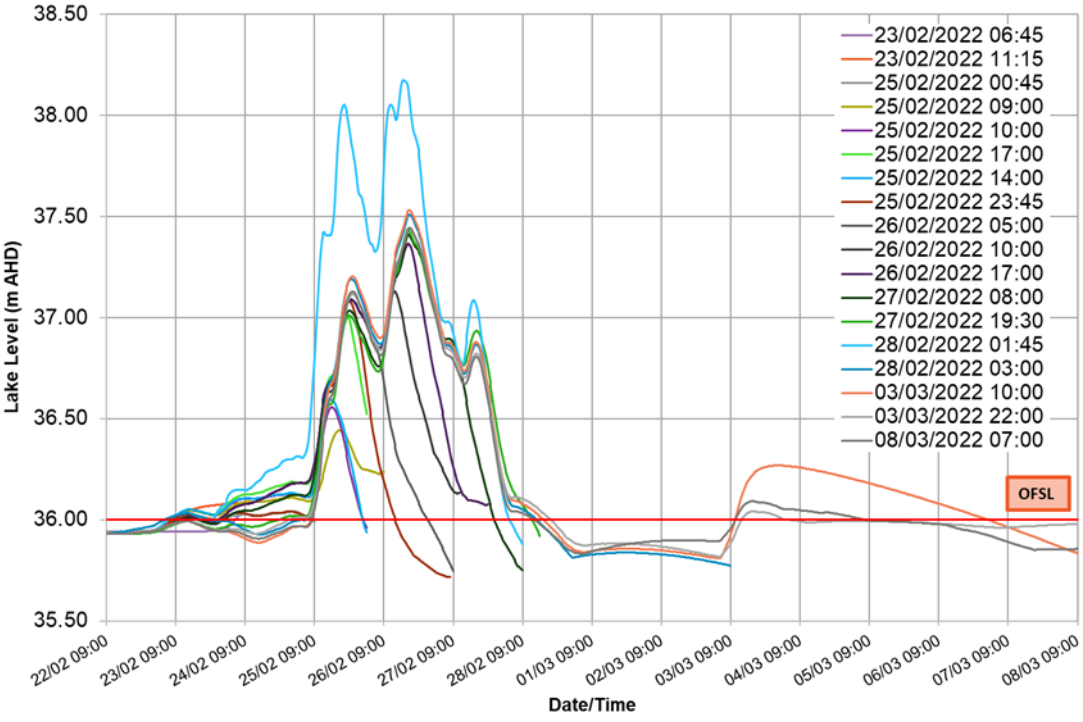


Figure 3-2: Modelled North Pine Dam lake level for each selected key model run

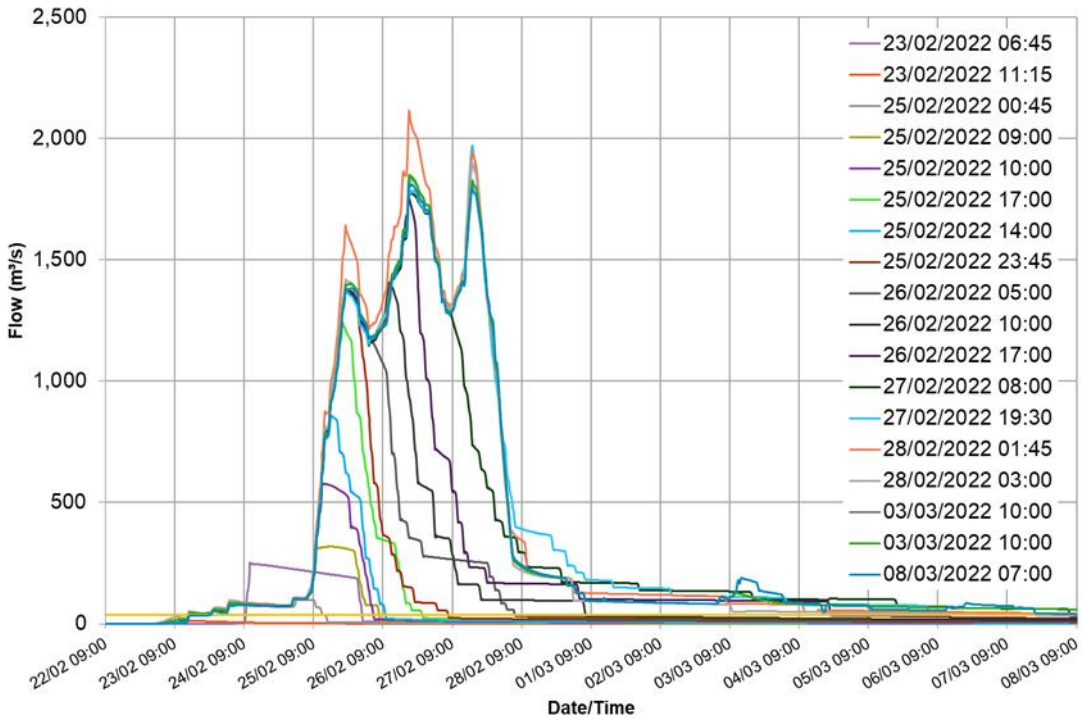


Figure 3-3: Modelled hydrographs at AJ Wylie Bridge for each selected key model run

Figure 3-4 shows modelled lake level from the last archived model run of the Flood Event (run on 08/03/2022 at 07:00 and included as the last row in Table 3-1), compared to recorded lake level. Figure 3-5 shows modelled inflow and recorded release (based on recorded lake level and gate settings) for the same model run. The modelled lake level was generally in good agreement with the recorded data for the rising limb and the first two peaks. The model underpredicted the third lake level peak, as discussed in some detail above. A good match was achieved to recorded data for the receding limb.

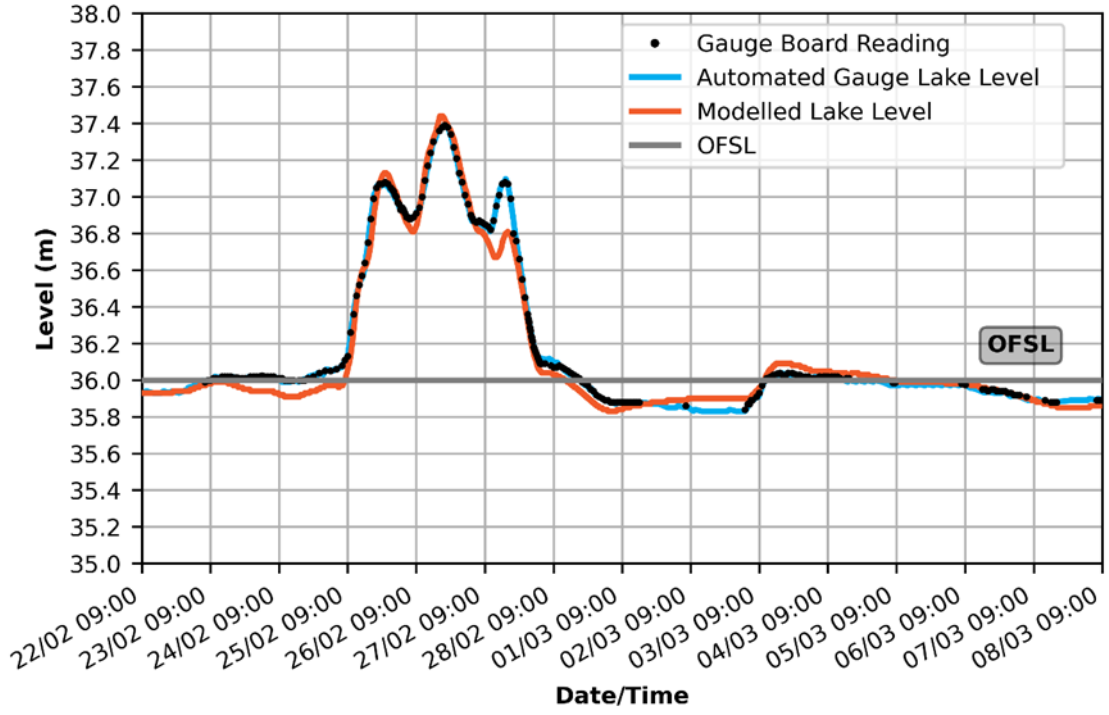


Figure 3-4: North Pine Dam modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 08/03/2022 09:00 sourced from the last archived model run 08/03/2022 07:00

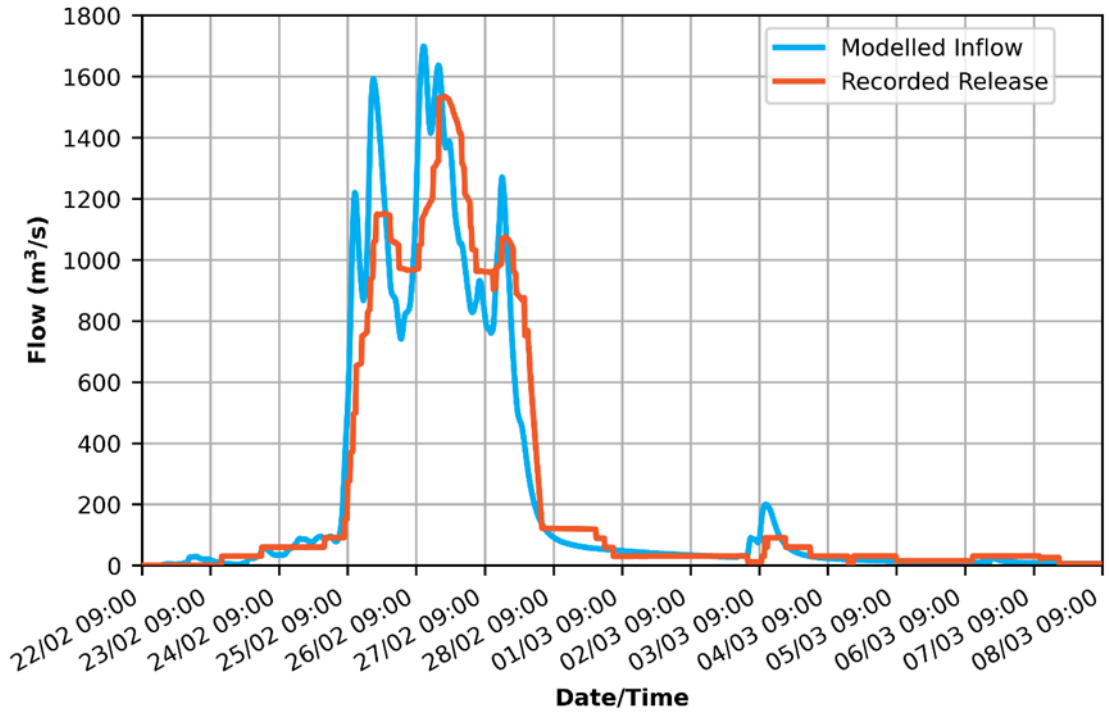


Figure 3-5: North Pine Dam modelled inflow and recorded release (based on recorded lake level and gate settings) hydrographs for the period 22/02/2022 09:00 to 08/03/2022 09:00 sourced from the last archived model run 08/03/2022 07:00

4. Dam Operations

This section describes the operations conducted at North Pine Dam for the Flood Event using the procedures in the Manual.

4.1 Gate operations communications

Communications were maintained between the Seqwater Flood Operations Centre and dam operators at all times during the Flood Event. The primary methods of communication adopted were email and telephone. Gate Directives were generally emailed from the Flood Operations Centre to the Dam Operator, often with a preceding phone call to alert the Dam Operator to the incoming email. It was typical practice during the Flood Event for the Dam Operator to send a return email to the Flood Operations Centre confirming receipt of the Gate Directive, and then subsequent email(s) once each gate setting change listed in the Gate Directive was completed. A range of other ad hoc communications took place between the Dam Operators and Flood Operations Centre staff over the course of the Flood Event. Communications between the Flood Operations Centre and Dam Operators were recorded in the Flood Operations Centre Event Log.

As a result of this, the Loss of Communication procedure described in Section 14.3 of the Manual was not required for this Flood Event. The relevant procedures in the Manual which were applied during the Flood Event were therefore those in Sections 12 and 13.

4.2 Strategy timeline and reasons for selecting

The operation of North Pine Dam including the corresponding selection of strategies and procedures adopted as well as development of Release Plans during the Flood Event are summarised in Table 4-1 and shown graphically in Figure 4-1. A description of the key operating milestones and intermediate decision points is provided further below to contextualise the information presented. The periods summarised were selected to assist in describing the operations and how they were aligned with the strategies and procedures defined in the Manual.

The summary descriptions are based on contemporaneous records of the Strategy Log, Flood Operations Centre Event Log, interviews with the Senior Flood Operations Engineers, Situation Reports, Gate Directives, and data from the Gate Operations Model and FFS model runs relevant to each period. Note that a summary of selected key FFS model runs are summarised in Section 3.2.

Additional data and information that should be read in conjunction with the summary provided in this section of the report are included as Appendices as follows:

- Appendix A: Record of North Pine Dam gate operations.
- Appendix B: Tabulated summary of the FFS modelling runs used to support decision making.

It should be noted that inflow to a dam cannot be measured directly and thus must be calculated from other data sets. The real time estimates of inflows derived with the FFS were used to implement the procedures in the Manual during the Flood Event. Further information on post-event analysis of inflow is presented in Section 7 of this report.

It is important to note that the inflow estimates presented in Figure 4-1 were extracted from the post-event analysis whole of event calibration (refer Section 7.2). This was done for the purpose of plotting a single estimate of inflow on the summary plot shown in Figure 4-1.

Table 4-1: Chronological summary of flood operating strategies and procedures during the Flood Event (replicated in Table i)

Event	Date and time of decision[1]
Flood event commencement criteria for North Pine Dam met Flood Operations Strategy Procedure 1a selected	23/02/2022 12:22
Releases from North Pine Dam commenced with Flood Operations Strategy Procedure 1a	23/02/2022 13:30
Flood Operations Strategy - Procedure 1b selected	25/02/2022 09:00
Flood Operations Strategy - Procedure 1b 115 FFS model runs completed 72 Gate Operations Model runs completed Gate Directives 6 – 34 issued All gates clear of flow between 26/02/2022 17:00 and 27/02/2022 01:00 Flood Event peak release rate (1,534 m³/s) and lake level (37.39 m AHD based on automated gauge data) recorded at 26/02/2022 19:00	25/02/2022 09:00 to 28/02/2022 01:45
Flood Operations Strategy exit criteria met. Drain Down Strategy selected	28/02/2022 01:45
Flood Operations Strategy Procedure 1a selected due to increased rainfall	03/03/2022 10:34
Flood Operations Strategy exit criteria met. Drain Down Strategy selected	03/03/2022 22:30
Drain Down Strategy exit criteria met North Pine Dam Flood Event ended (flood releases ended)	08/03/2022 09:00

[1] Note that time of decision differs to time of model run shown in Table 3-1 because completion of a model run does not necessarily immediately lead to a decision determination.

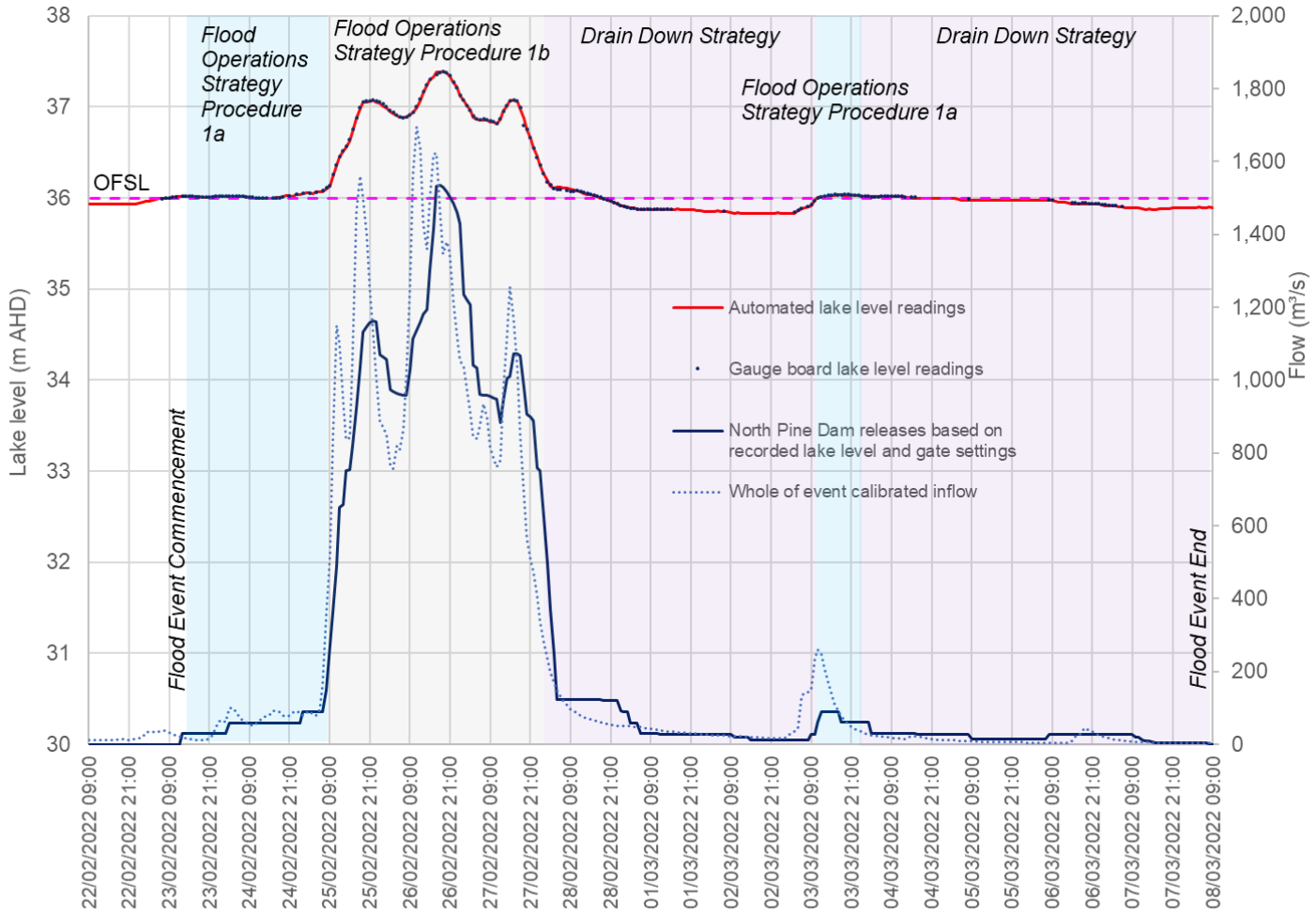


Figure 4-1: North Pine Dam post-event analysis whole of event calibrated inflow, lake level (gauge board and automated readings) and releases (replicated in Figure i)

Flood Event commencement and selection of Flood Operations Strategy Procedure 1a

The criteria to commence the flood event were met at 23/02/2022 12:22 in accordance with Section 12.2 of the Manual on the basis of FFS rain on ground Dam inflow rate and volume predictions indicating that the lake level in North Pine Dam was expected to exceed the OFSL of 36.0 m AHD. The predicted peak lake level in the model run available at this time was 36.09 m AHD (0.09 m above OFSL).

Flood Operations Strategy Procedure 1a was selected as the predicted peak lake level was judged likely to be less than or equal to 36.2 m AHD and releases were not expected to exceed 300 m^3/s.

An initial release rate of 30 m^3/s was implemented at 23/02/2022 13:00 to commence flood operations at North Pine Dam. The lake level recorded at this time was 36.02 m AHD (0.02 m above OFSL). Subsequent Release Plans were prepared under Flood Operations Strategy 1a increasing the release rate to 60 m^3/s (24/02/2022 03:00), 90 m^3/s (25/02/2022 01:00) and then 152 m^3/s (25/02/2022 08:00).

Selection of Flood Operations Strategy Procedure 1b

Flood Operations Strategy Procedure 1b was selected at approximately 25/02/2022 09:00 on the basis of the following:

- The criteria in Procedure 1a could no longer be met;
- The predicted lake level was expected to remain below 39.0 m AHD (3.0 m above OFSL); and
- The Exit criteria for the Flood Operations Strategy were not met.

Flood Operations Strategy Procedure 1b was selected for approximately 65 hours ceasing at 28/02/2022 01:45. Throughout this period multiple inflow peaks occurred resulting in three distinct lake level and release peaks, as can be seen on Figure 4-1.

Release planning during this part of the Flood Event was intensive. 115 hydrologic model runs were completed and archived in the FFS, 72 iterations of the Gate Operations Model were archived and Gate Directives 6 to 34 were issued. Data was extracted from the Gate Operations Models during this period to illustrate the process of release planning in implementing the procedures in the Manual.

There are two key criteria in the Manual that are used to implement Flood Operations Strategy Procedure 1b. The first is criteria 1b(iv), which precludes the peak release in the Release Plan from exceeding the Predicted Peak inflow rate or 300m^3/s (whichever is greater). The second is criteria 1b(v), which requires gate settings to equal or exceed those required by Appendix C of the Manual unless that would result in the release rate exceeding the limit in criteria 1b(iv). The Manual specifies that lake levels and corresponding gate settings and release rates in Appendix C are to be read as applying to the predicted lake level and planned release rate at each point in the Release Plan. This is because the Release Plan must be determined ahead of time of the gate settings being implemented.

Two separate figures have been prepared to illustrate how these criteria were implemented during this Flood Event. Figure 4-2 shows how the criteria in Procedure 1b(iv) was met. To prepare Figure 4-2, the following data was extracted on an hourly time step from the Gate Operations Models on a rolling basis:

- Predicted Flood Event peak inflow (derived in the FFS using rain on ground). This time series in the maximum predicted inflow, and varies as additional rainfall is recorded and the FFS model calibration is adjusted.
- North Pine Dam planned releases. The planned releases are determined in each Gate Operations Model, however not each model iteration is used to develop a Gate Directive. Actual releases are similar to but not identical to planned releases in the Gate Operations Model. This is because the planned releases are calculated based on a modelled water level (which may differ from actual water levels).

These rolling time series were progressively updated from each of the Gate Operations Models. As the run time of successive Gate Operations Models moves forward in time, the rolling time series is replaced with the later data.

Recorded releases based on recorded lake level and gate settings as well as the post-event whole of event calibration estimate of inflow (refer Section 7.2) are also shown on Figure 4-2. The times at which Gate Operations Models were saved as well as when Gate Directives were issued are also shown.

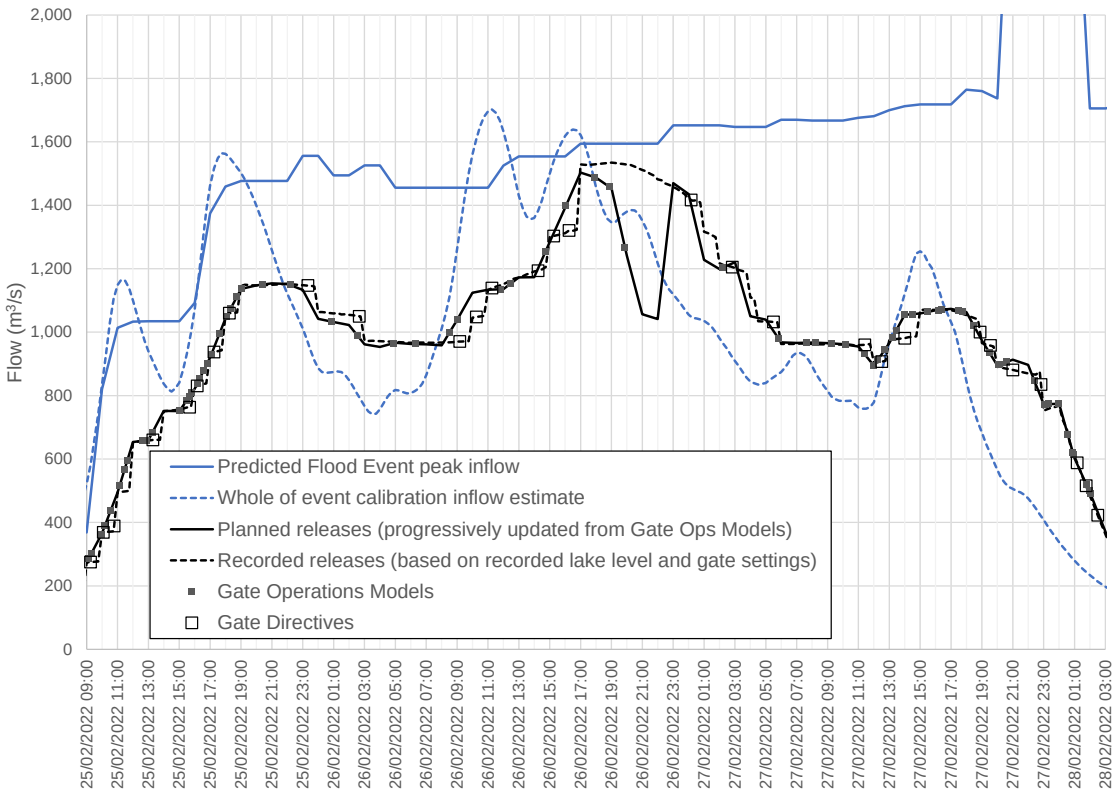


Figure 4-2: North Pine Dam Flood Operations Strategy Procedure 1b planned releases, recorded releases, predicted inflow and whole of event calibration inflow

Figure 4-2 demonstrates that the peak release during the application of Procedure 1b did not exceed the predicted peak inflow. It should be noted that the high predictions of peak inflow between on 27/02/2022 20:00 and 28/02/2022 02:00 were unrealistic because the model calibrations at this time were focusing on attempting to get a better match of the falling water level trend. This was due to the difficulty of the model representation of the third inflow peak, which is discussed further in Section 7. Even with the benefit of hindsight in the post-event analysis, the whole of event model calibration described in Section 7.2 was unable to match lake level well during this period.

Figure 4-3 shows how the criteria in Procedure 1b(v) was met. To prepare Figure 4-3, the planned gate settings and predicted lake level were extracted and prepared on an hourly time step from the Gate Operations Models on a rolling basis, similar to the inputs described for Figure 4-2. The resulting predicted lake level data was then used to evaluate the gate settings determined by applying Appendix C in the Manual for the predicted lake level.

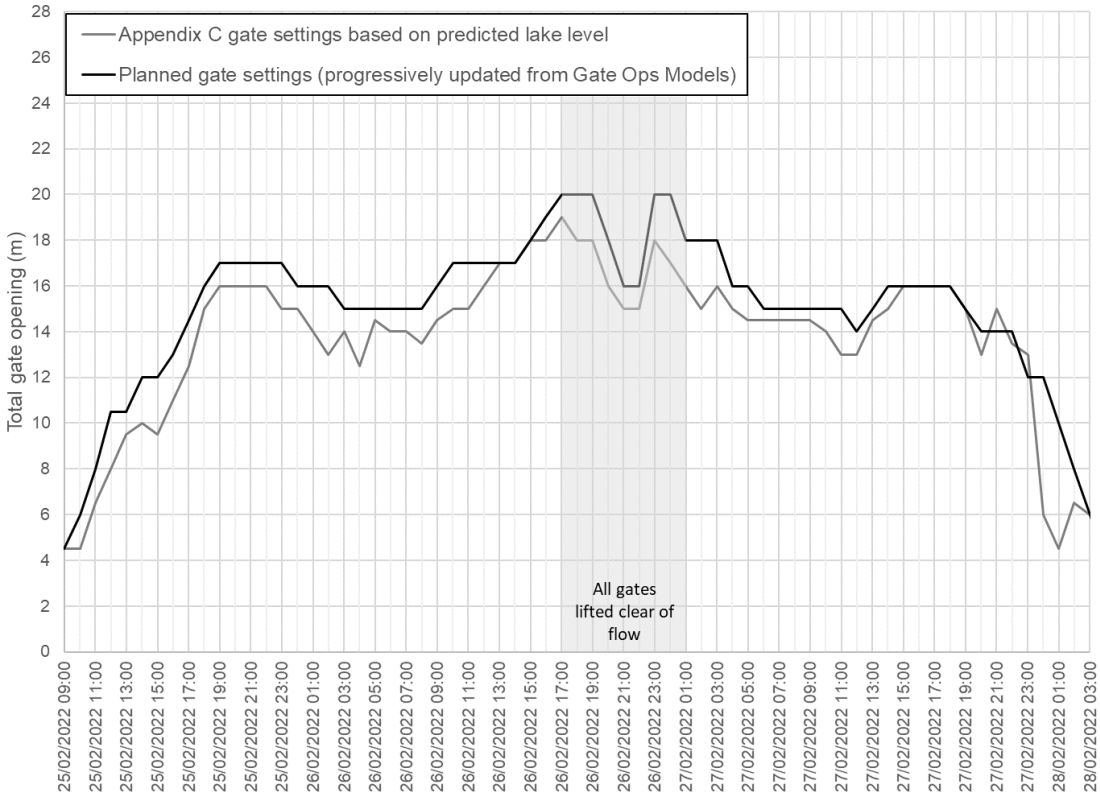


Figure 4-3: North Pine Dam Flood Operations Strategy Procedure 1b planned gate settings and gate settings based on application of Manual Appendix C to predicted lake level

Figure 4-3 demonstrates that the planned gate settings generally always exceeded those derived using predicted lake level and Appendix C of the Manual which is a requirement of Procedure 1b, criteria (v).

There was a short period on 27/02/2022 between 21:00 and 23:00 (after the actual peak lake level and peak release which had earlier occurred at 26/2/2022 19:00) where planned gate settings were slightly lower than those derived using predicted lake level recorded in the Gate

Operations Model and Appendix C of the Manual. At this time, there was a difference between the predicted (modelled) and recorded lake level in the Dam. The predicted (modelled) lake level was greater than the recorded lake level by approximately 300-400 mm during this period. The North Pine Dam Strategy Log notes that the Duty Engineer was aware of the discrepancy between the predicted (modelled) and recorded lake levels and this was taken into account in making decisions concerning the gate settings during this period. That is, in making operational decisions the Duty Engineer was giving due consideration to the over-estimation of the predicted (modelled) lake levels in determining reasonable gate settings in accordance with Appendix C of the Manual. This is an example of a situation during a Flood Event of the exercise of professional judgment in the interpretation of the reliability of quantitative information in the FFS in applying the procedures in the Manual. Section 3.4 of the Manual sets out considerations for professional judgment in applying the procedures in the Manual. These include the quality and availability (or absence) of information such as the reliability (level of certainty) of quantitative information in the FFS, including calibration and predictions of flows and levels.

Further recalibrations of the hydrologic model were completed between 27/02/2022 23:00 and 28/02/2022 01:00 which improved the fit to the recorded lake level in the FFS and restored a reasonable match between predicted and recorded lake level in the Gate Operations Model. As noted above, developing a good match to recorded lake level during this part of the flood event was difficult both during the event and in the post-event analysis.

It is of note that during the second (and largest) release peak, all gates at North Pine Dam were raised clear of the flow, as shown on Figure 4-3. Gates were progressively raised clear of the flow from 26/02/2022 10:00 to 26/02/2022 17:00. Between 26/02/2022 17:00 and 27/02/2022 01:00, all gates were lifted clear of the flow and releases from North Pine Dam were influenced solely by inflow and lake level. As can be seen from Figure 4-2, the frequency of updating the Release Plans slowed somewhat during this phase, because changes in gate settings would not change releases while the gate were lifted clear of the spillway flow. Release planning focused on predicting when inflows and lake level would begin to fall, and hence when the gates would need to be progressively lowered back into the spillway flow.

Consideration for exiting Flood Operations Strategy Procedure 1b using the exit criteria in Procedure 2a occurred on 28/02/2022 between approximately 00:00 and 01:45 on the basis that rainfall was judged as complete or nearly complete and it was judged likely, that when taking into account the current Release Plan, predicted inflows would not cause the lake level to rise above the actual peak level already observed since the Flood Event commenced.

The North Pine Dam lake level at the end of the Procedure 1b implementation period was 36.22 m AHD (0.22 m above OFSL) and releases had decreased by approximately 1,000 m^3/s from the peak release rate of 1,534 m^3/s down to 515 m^3/s.

Selection of Drain Down Strategy and implementation of Procedure 1a

The Drain Down Strategy Procedure 1a was selected at 28/02/2022 01:45. The strategy aimed to empty the flood storage compartment of the dam within 72 hours and finish the Flood Event with the lake level at OFSL.

Releases from the dam were steadily reduced from 515 m³/s to approximately 12 m³/s over the subsequent 72-hour period with the lake level being returned to 35.98 m AHD (0.12 m below OFSL) over the drain down period, as shown in Figure 4-1.

Selection of Flood Operations Strategy Procedure 1a

Flood Operations Strategy Procedure 1a was selected again on 03/03/2022 at approximately 10:30 following catchment average rainfall of 35 mm being recorded over the preceding six hours. FFS model runs indicated that sufficient runoff would be generated to increase the lake level to between 0.1 - 0.2 m above OFSL. The lake level peaked in response to the runoff generated at 36.04 m AHD (0.04 m above OFSL) at 03/03/2022 16:30. Releases from North Pine Dam during this period reached a maximum rate of approximately 90 m³/s.

Exit Criteria under Flood Operations Strategy Procedure 2a were met at approximately 03/03/2022 22:30. The North Pine Dam lake level at the end of this period was 36.03 m AHD (0.03 m above OFSL) and releases had decreased to 60 m³/s.

Selection of Drain Down Strategy Procedure 1a

Drain Down Strategy Procedure 1a was selected at 03/03/2022 22:30.

Releases from the dam were steadily reduced from 60 m³/s to 0 m³/s with the lake level being returned to 35.89 m AHD (0.11 m below OFSL) over the drain down period.

End of Flood Event

The Flood Event ended and releases ceased at North Pine Dam at 08/03/2022 09:00. At this stage, the lake level was within the range specified by Drain Down Strategy Procedure 2b(i)(a), and it was judged likely that the lake level would return to OFSL after consideration of the likely ongoing baseflow inflows under Procedure 2b(i)(b).

4.3 Review of gate opening and closing rates

A summary of total gate opening (the sum of the opening of all five gates) and the rate of change of gate settings is shown in Figure 4-4. The Manual provides specific criteria around the rate at which gates can be opened or closed, although it is noted that these rates can be exceeded in order to meet other criteria. A summary of the relevant criteria for each selected strategy are as follows:

- Flood Operations Procedure Strategy 1a (iii) - the maximum radial gate opening and closing rates are not more than two metres of opening or closing (total movement across one or more gates) in one hour.
- Flood Operations Procedure Strategy 1b (iii) - the maximum radial gate opening and closing rates are not more than three metres of opening or closing in one hour (total movement across one or more gates). This can be exceeded to ensure that the minimum release requirements in criteria (v) are met.
- Drain Down Strategy Procedure 1a (iii) - to protect the downstream environment, aim to reduce releases by closing the radial gates no faster than two metres per hour (total

movement across one or more gates). Faster closing rates may be used if considered necessary to ensure the Water Supply Compartment will be full at the conclusion of the Flood Event.

The rate of change of gate settings as shown in Figure 4-4 shows that the maximum rate of opening or closing was three metres per hour which occurred while Flood Operations Procedure Strategy 1b was selected. During the two periods when the Drain Down Strategy was selected, the maximum rate of gate closing was two metres per hour.

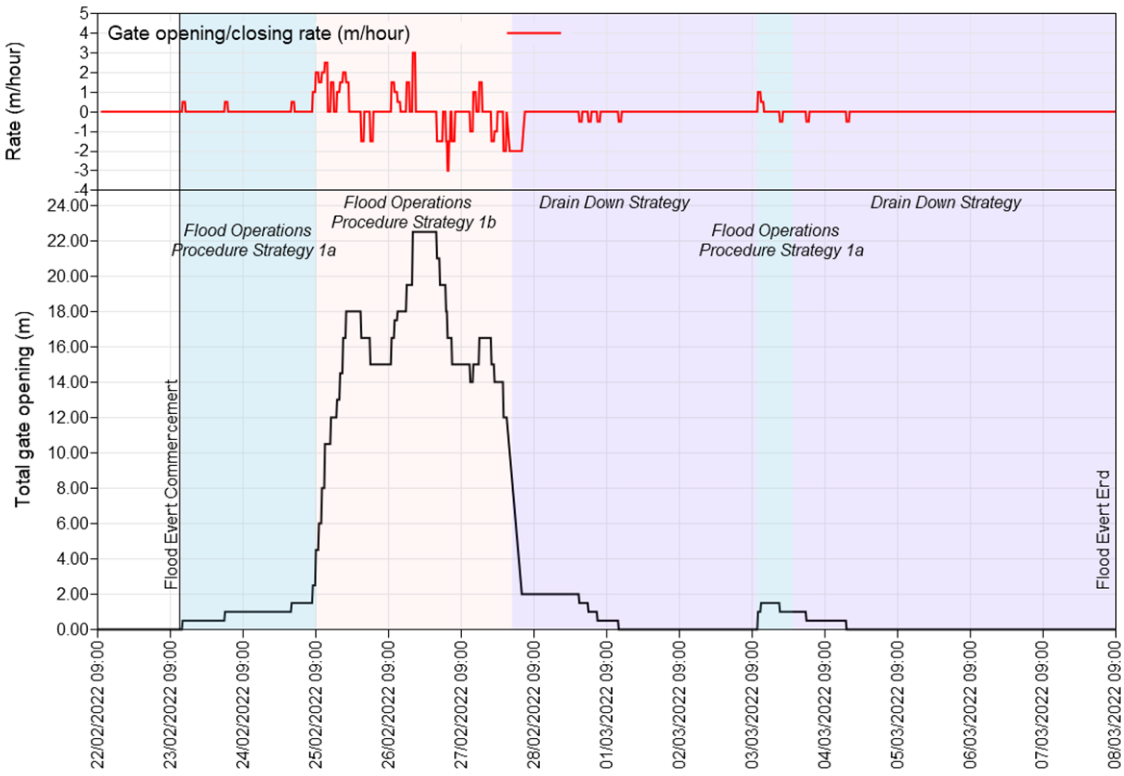


Figure 4-4: North Pine Dam total gate opening and rate of change of gate settings

5. External communications

This section describes the external communications activities undertaken by Seqwater during the Flood Event, including the issue of Situation Reports, advice to stakeholders and general communications. This section of the report provides an overview of these activities as required under section 385(1)(b)(i) of the Act. It is not a detailed review covering all aspects of communications activities undertaken by Seqwater during the Flood Event.

5.1 Overview

5.1.1 Summary of communication types

Key forms of communication with external stakeholders during the Flood Event included:

- Activation level status, summarising the Emergency Action Plan activation level of the Dam (refer Section 5.2)
- Flood Event Situation Reports (refer Section 5.3)
- Advice on the commencement of planned releases from the Dam (refer Section 5.4)
- Advice on releases that were likely to contribute to the inundation of roads and bridges (refer Section 5.5)
- North Pine Dam outflow hydrograph data (actual and planned releases) issued to Stakeholder Agencies (refer Section 5.5)

5.1.2 Sources of communications data and information

For the purpose of this report, the description of communications was prepared from documents that were sent by, or received in, the Flood Operations Centre email database or documented in the Flood Operations Centre Event Log. Additional information was also sourced from interviews with the Senior Flood Operations Engineers and recordings of relevant telephone calls and videoconferences made during the Flood Event.

5.1.3 Communications protocol

Communications about the Dam flood operations were guided by the Communications Protocol for Releases from Seqwater's Gated Dams (Wivenhoe Dam, Somerset Dam and North Pine Dam) April 2020 Version 2.1 (the Protocol). All relevant stakeholder agencies were supplied a copy of the Protocol prior to the Flood Event.

The Protocol defines the respective agency and stakeholder responsibilities. The Protocol also defines the communication of the Emergency Action Plan status of activation for the Flood Operations Centre (such as Alert, Lean forward, Stand up, Stand down), to align with established State Government terminology for disaster and emergency management response. The primary means of communications about the dam operations to stakeholder agencies are Situation Reports. The Protocol defines when Situation Reports will be issued, the recipients of Situation Reports, and suggested content of Situation Reports. The Protocol also defines the communication between the Flood Operations Centre and stakeholder agencies responsible for

bridge closures for situations where dam releases will contribute to inundation of downstream bridges.

The Protocol is directed towards respective stakeholder agency responsibilities to distribute information to:

- Support public safety;
- Keep agency stakeholders engaged and informed; and
- Support Queensland Government disaster management activities.

For Seqwater's role in dam flood operations, the Protocol is specifically relevant to issuing of Situation Reports. Further to this, during the Flood Event Seqwater provided North Pine Dam recorded and planned release hydrographs to the Moreton Bay Regional Council and Brisbane City Council, which operate flood modelling or flood warning systems.

5.2 Timeline of external communications

A table showing the dates and times when key external communications conducted under the protocol were released is included as Table 5-1.

Table 5-1: Chronological summary of key external communications conducted under the provisions of the Communications Protocol for Releases from Seqwater's Gated Dams

Event	Date	Time
Notification via email to stakeholder agencies that the Flood Operations Centre has moved to Alert activation level and flood releases are possible.	22/02/2022	19:48
Public notification on possibility of flood releases	22/02/2022	20:39
Notification via email to stakeholder agencies that the Flood Operations Centre has moved to Lean Forward activation level.	23/02/2022	01:07
Situation Report #1 issued to stakeholders	23/02/2022	07:00
Notification via email to stakeholder agencies that the Flood Operations Centre has moved to Stand Up activation level.	23/02/2022	12:36
Public notification on commencement of releases	23/03/2022	12:47
Situation Report #2 issued to stakeholders	23/02/2022	13:00
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	23/02/2022	13:53
Situation Report #3 issued to stakeholders	23/02/2022	19:00
Situation Report #4 issued to stakeholders	24/02/2022	07:00
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	24/02/2022	12:15
Situation Report #5 issued to stakeholders	24/02/2022	19:00
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	02:04
Situation Report #6 issued to stakeholders	25/02/2022	06:30

Event	Date	Time
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	08:46
Situation Report #7 issued to stakeholders	25/02/2022	09:30
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	10:19
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	11:13
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	12:12
Situation Report #8 issued to stakeholders	25/02/2022	13:00
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	17:38
Several phone calls with stakeholder agencies regarding the status of the AJ Wyllie Bridge,	25/02/2022	18:00 – 21:00
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	18:22
Situation Report #9 issued to stakeholders	25/02/2022	18:30
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	19:34
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	21:54M
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	25/02/2022	23:37
Situation Report #10 issued to stakeholders	26/02/2022	02:50
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	26/02/2022	06:13
Situation Report #11 issued to stakeholders	26/02/2022	06:15
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	26/02/2022	18:13
Situation Report #12 issued to stakeholders	26/02/2022	19:30
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	26/02/2022	21:00
Phone call to stakeholder agencies to advise that the AJ Wyllie Bridge was coming clear of the water and unlikely to be affected by further releases.	27/02/2022	04:00
Distribution of recorded and modelled release data (m³/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	27/02/2022	04:06

Event	Date	Time
Situation Report #13 issued to stakeholders	27/02/2022	06:30
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	27/02/2022	10:25
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	27/02/2022	16:05
Situation Report #14 issued to stakeholders	27/02/2022	18:30
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	28/02/2022	05:00
Situation Report #15 issued to stakeholders	28/02/2022	05:30
Situation Report #16 issued to stakeholders	28/02/2022	19:00
Situation Report #17 issued to stakeholders	01/03/2022	06:00
Situation Report #18 issued to stakeholders	01/03/2022	18:15
Situation Report #19 issued to stakeholders	02/03/2022	06:30
Situation Report #20 issued to stakeholders	02/03/2022	18:30
Situation Report #21 issued to stakeholders	03/03/2022	06:45
Situation Report #22 issued to stakeholders	03/03/2022	18:00
Situation Report #23 issued to stakeholders	04/03/2022	05:00
Distribution of recorded and modelled release data (m^3/s), and actual and modelled water level data for North Pine Dam (m AHD) to stakeholders.	04/03/2022	05:44
Situation Report #24 issued to stakeholders	04/03/2022	18:00
Situation Report #25 issued to stakeholders	05/03/2022	05:30
Situation Report #26 issued to stakeholders	05/03/2022	18:00
Situation Report #27 issued to stakeholders	06/03/2022	06:00
Situation Report #28 issued to stakeholders	06/03/2022	18:00
Situation Report #29 issued to stakeholders	07/03/2022	06:30
Situation Report #30 issued to stakeholders	07/03/2022	18:00
Situation Report #31 issued to stakeholders	08/03/2022	07:00
Public notification – completion of releases	08/03/2022	11:28
Situation Report #32 issued to stakeholders	08/03/2022	19:00
Notification via email to stakeholder agencies that the Flood Operations Centre has moved to Stand Down activation level and flood releases have ceased.	09/03/2022	15:47

5.3 Situation Reports

5.3.1 Content and preparation

The Situation Reports were prepared with the intent to communicate key information regarding the current status of the dams, strategies and associated dam operations to stakeholder agencies. The Situation Reports also describe a forward outlook, as best as can be provided based on information and trends known at the time of each report and time available to prepare

the report. A generic report structure and content guidance for Situation Reports is included as an Appendix in the Protocol.

Each Situation Report summarised the operations of the three gated dams[7] operated by Seqwater. The relevant aspects of the North Pine Dam operations described in the Situation Reports included:

- Situation Report number, date and time of preparation and time of next Situation Report being issued.
- Time of Flood Event Declaration and Time of Commencement of Dam Releases.
- Fixed Full Supply Level and Operational Full Supply Level.
- Current lake levels (in m AHD).
- Current applicable operation strategy selected in accordance with the Manual.
- Current estimate of dam inflow volume from FFS modelling start time (22/02/2022 09:00 as per Section 2.3) to current time.
- Estimate of catchment average rainfall in last 12 hours.
- Current release rate from the dam.
- Current and expected inundation status of downstream bridges.
- External URL links to Bureau weather and warnings.
- Seqwater Flood Operations Centre Operational Status Overview.
- Key messages relevant to the current situation at each dam including future outlook.

The Situation Reports were approved by the DSFOE for each shift and prepared using live operational data. It is important to note that in real-time operations, inflow rate and volume predictions evolve as the event unfolds, as more data is collected and as improved forecasting system model calibration is achieved. The Situation Reports were based on the then-current best estimate of inflow volume which was refined as the Flood Event progressed.

5.3.2 Distribution of Situation Reports

Situation Reports were distributed to the agencies or groups listed below in Table 5-2.

[7] Somerset Dam and Wivenhoe Dam flood operations are provided in the same Situation Reports

Table 5-2: Distribution of Situation Reports

State Government	Local Government	Other Agencies/ Stakeholders
Department of Regional Development, Manufacturing and Water	Brisbane City Council	Commonwealth Government Bureau of Meteorology (Flood Warning Centre, and Regional Forecasting Centre)
Department of Transport and Main Roads (including Maritime Safety)	Ipswich City Council	Queensland Urban Utilities and Unity Water
Department of Premier and Cabinet	Somerset Regional Council	Clean Co
Department of Community Services	Moreton Bay Regional Council	Internally within Seqwater including all Flood Operations Centre and Dam Operations personnel, executive management, media and communications personnel
Emergency Management Queensland including State Disaster Coordination Centre	Redland City Council	
Queensland Police Service	Scenic Rim Regional Council	
	Lockyer Valley Regional Council	
	Toowoomba Regional Council	

5.3.3 Situation Reports issued

For the Flood Event, 32 Situation Reports were issued that were relevant to North Pine Dam, equating to twice per day for the duration of the event. Table 5-3 presents a summary of the Situation Reports and key information relevant to North Pine Dam that was presented in each report.

Table 5-3: Summary of Situation Reports

Sit Rep No.	Preparation Time & Date	Key advice provided regarding North Pine Dam operations
1	23/02/2022 07:00	**Flood Operations Centre at STAND UP** • Heavy rainfall is forecast within the North Pine Dam catchment over the coming days.
2	23/02/2022 13:00	**FLOOD EVENT declared.** • Flood releases to commence from North Pine Dam shortly. • Releases are expected to continue overnight. • Youngs Crossing Road closed this morning and will remain closed for the duration of releases.
3	23/02/2022 19:00	**Applicable Strategy: FLOOD OPERATIONS** • Releases from North Pine Dam commenced at approximately 13:00. • Current release rate = 30 m³/s.
4	24/02/2022 07:00	• Releases expected to continue through Thursday and may increase if rainfall as forecast is received in the catchment. • Current release rate = 60 m³/s.
5	24/02/2022 19:00	• Current release rate = 60 m³/s.
6	25/02/2022 06:30	• Current release rate = 91 m³/s.

Sit Rep No.	Preparation Time & Date	Key advice provided regarding North Pine Dam operations
7	25/02/2022 09:30	**Applicable Strategy: FLOOD OPERATIONS** • Heavy rainfall recorded across North Pine Dam catchment over several hours. • Flood releases will increase this morning above 300 m³/s. • Another update will be issued if releases are expected to approach 1,000 m³/s. • Current release rate = 274 m³/s.
8	25/02/2022 13:00	• Current release rate = 660 m³/s.
9	25/02/2022 18:30	• Heavy rainfall is forecast to continue across North Pine Dam catchment today. • AJ Wyllie Bridge open, closure not expected but this may change subject to further rainfall. • Current release rate = 1,050 m³/s.
10	26/02/2022 02:50	• Current release rate = 1,050 m³/s.
11	26/02/2022 06:15	• Current release rate = 960 m³/s.
12	26/02/2022 19:30	• North Pine Dam reservoir level has peaked and is falling slowly. • AJ Wyllie Bridge has been closed. • Current release rate = 1,525 m³/s.
13	27/02/2022 06:30	• AJ Wylie Bridge no longer inundated (trafficability unknown) • Rainfall forecasts and Bureau of Meteorology advice indicated rain clearing today. • Current release rate = 970 m³/s.
14	27/02/2022 18:30	• Current release rate = 1,080 m³/s.
15	28/02/2022 05:30	**Applicable Strategy: DRAIN DOWN** • Current release rate = 240 m³/s, expected to decrease.
16	28/02/2022 19:00	• Current release rate = 120 m³/s.
17	01/03/2022 06:00	• Flood storage drained to OFSL. • AJ Wyllie Bridge now open. • Current release rate = 30 m³/s.
18	01/03/2022 18:15	• Current release rate = 28 m³/s, via regulating valves.
19	02/03/2022 06:30	• Current release rate = 28 m³/s, via regulating valves.
20	02/03/2022 18:30	• Current release rate = 11 m³/s, via regulating valves.
21	03/03/2022 06:45 (incorrect day entered into official SitRep - correction made here)	• Increased releases potentially required due to catchment rainfall. • Current release rate = 18 m³/s.
22	03/03/2022 18:00 (incorrect day entered into official SitRep - correction made here)	**Applicable Strategy: FLOOD OPERATIONS** • Small increase in releases to keep lake level near OFSL due to increase in inflows. • Current release rate = 61 m³/s.
23	04/03/2022 05:00	**Applicable Strategy: DRAIN DOWN** • Current release rate = 30 m³/s.

Sit Rep No.	Preparation Time & Date	Key advice provided regarding North Pine Dam operations
24	04/03/2022 18:00	• Current release rate = 28 m³/s.
25	05/03/2022 05:30	• Current release rate = 28 m³/s.
26	05/03/2022 18:00	• Youngs Crossing Road expected to be open late Sunday subject to further rain and road inspection. • Current release rate = 14 m³/s.
27	06/03/2022 06:00	• Current release rate = 14 m³/s.
28	06/03/2022 18:00	• Youngs Crossing Road expected to be open Monday subject to further rain and road inspection. • Current release rate = 28 m³/s.
29 - Revised	07/03/2022 06:30	• Youngs Crossing Road expected to be open late Monday/ early Tuesday subject to further rain and road inspection. • Current release rate = 28 m³/s.
30	07/03/2022 18:00	• Current release rate = 5 m³/s.
31	08/03/2022 07:00 (incorrect day and date entered into official SitRep - correction made here)	• North Pine Dam releases planned to cease mid-morning.
32	08/03/2022 19:00	**North Pine Dam Flood Event concluded at 09:00 8 March.**

5.4 Information to the public

Seqwater provided several communication pathways to inform the public of dam operations. These included email/SMS notification via the Dam Release Notification Service, access to a 1800 telephone recorded message, website updates, media releases and media interviews.

There were three messages released to subscribers of the Dam Release Notification Service during the Flood Event that were specifically for North Pine Dam:

- Notification that the Seqwater Flood Operations Centre was at Alert status and flood releases were possible sent to over 22,500 communication modes[8] on 22/02/2022 at 20:39.
- Notification on commencement of releases at North Pine Dam sent to over 7,000 communication modes on 23/2/2022 at 12:47.
- Notification on completion of releases at North Pine Dam sent to nearly 22,000 communication modes on 8/3/2022 at 11:28.

[8] The communication modes adopted by Seqwater include email notifications, text messages sent to mobile phones, calls by the public to a 1800 telephone number with a pre-recorded message and notifications via Apple and Android smart phone apps. An individual may receive a message via multiple modes, depending on how they choose to access notifications from Seqwater.

5.5 Other communications

Communications were undertaken between Seqwater and relevant external agencies to:

- Discuss with the Bureau the most up to date understanding of the weather situation.
- Provide advice to stakeholders to support their activities in response to flooding and actual or potential road closures.

The Bureau do not provide a formal flood warning service for the Pine River basin. This means Seqwater is not required to provide information on North Pine Dam releases to the Bureau. Dam release information was provided to Moreton Bay Regional Council and Brisbane City Council via email during Flood Event.

A combined Flood Operations Centre Event Log was used to record the operations for all Seqwater referable dams, including North Pine Dam. Telephone calls to and from the Flood Operations Centre telephone number were recorded. The types of matters and situations when communication was undertaken with external agencies included:

- Contact with Bureau for briefing of forecasts and obtaining updates on trends.
- Phone calls and emails on 25/02/2022 and 27/02/2022 with Moreton Bay Regional Council and the Department of Transport and Main Roads regarding potential inundation of bridges, actual bridge closures (including AJ Wyllie Bridge), and re-opening of bridges due to releases from North Pine Dam.
- Provision of release data and Release Plans for North Pine Dam to Stakeholder Agencies as listed in Table 5-1.

Other ad hoc communications occurred between Seqwater and the Bureau and were recorded in the Flood Operations Centre Event Log.

6. Flood Event Magnitude

This section of the report compares the magnitude of the rainfall and flood volumes generated by this Flood Event to other historical events.

6.1 Comparison with historic rainfalls

Table 6-1 shows a comparison between maximum 09:00 to 09:00 three-day catchment average rainfalls and maximum one hour rainfall intensities based on 15-minute catchment average data recorded in this Flood Event compared with the significant historical events of 1974, 2011 and 2013. This data has been sourced from the gridded historical rainfall database collated by Seqwater for the purpose of Seqwater's activities in calibrating the FFS hydrological models.

Table 6-1: Historical total catchment average rainfall and intensity comparison (replicated in Table iii)

	Event			
	1974	2011	2013	2022
Maximum 09:00 to 09:00 three-day rainfall total (mm)	693	479	435	727
Maximum one hour rainfall intensity (mm/hr) based on 15 minute catchment average data	51	56	27	37

The maximum 09:00 to 09:00 three-day catchment average rainfalls for this Flood Event were larger than those observed in the 1974, 2011 or 2013 events. The maximum one hourly rainfall intensity was higher than observed in 2013, but lower than for the 1974 and 2011 events.

6.2 Comparison with historical floods

Table 6-2 shows a comparison between the peak inflow, peak release, inflow volume and release volume for the Flood Event compared with historic floods.

Table 6-2: Comparison of historical Flood Event peak flows and volumes from Seqwater, 2013 (replicated in Table iv)

Event	Peak flows		Flood volumes	
	Inflow (m^3/s)	Release (m^3/s)	Inflow (ML)	Release (ML)
Jun-83	760†	N/A	36,900	N/A
Apr-88	790	630	178,000	75,900
Mar-89	1,430	1,440	124,000	124,000
Apr-89	1,150	980	94,700	96,000
Dec-91	1,740†	N/A	70,100	0
May-96	N/A	N/A	91,000	0
Feb-99	1,180	0	117,000	0
Feb-01	420	0	43,800	0
Mar-04	460†	0	27,500	0
Nov-08	220†	0	14,100	0

Event	Peak flows		Flood volumes	
	Inflow (m^3/s)	Release (m^3/s)	Inflow (ML)	Release (ML)
Apr-09	790	0	45,600	0
May-09	910	330	79,400	22,600
Feb-10	380	360	57,700	57,500
Oct-10	1,000	910	69,400	61,300
Jan-11	3,480	2,850	202,000	206,000
Jan-12	850	630	71,300	65,300
Jan-13	1,650	840	101,000	97,000
Dec-21‡	410	370	15,400	15,600
Feb-22*	1,700	1,560	281,300	281,400

†These values are estimates
‡Sourced from Seqwater (2021)
*Based on whole of event calibration described in Section 7.2

This Flood Event was not the flood of record from the perspective of peak inflow or peak outflow, as it is lower than the January 2011 event on both measures and comparable to the peak inflow for the December 1991 event. However, it is the flood of record for inflow and outflow volume by a considerable margin. This is consistent with the maximum 09:00 to 09:00 three-day catchment average rainfall data summarised in Table 6-1, which was higher than for the 1974, 2011 and 2013 events.

7. Post-Event Hydrology Analysis

7.1 Purpose

This section of the report documents flow data for the Flood Event as well as the methodology and results of a post-event hydrologic model calibration with the benefit of hindsight for the purpose of providing a more fulsome description of the Flood Event for section 385(1)(a) of the Act.

Post-event analysis is considered important for significant flood events and long duration events. Calibration of the catchment flows at each point in time during the event aims to obtain a reasonable match to recorded conditions relevant for making a Release Plan decision at that point in time. However, such real time calibrations may not provide the best overall definition of the Flood Event.

Comparison is made between the calibrated URBS parameter values adopted for the whole of event calibration (developed with the benefit of hindsight) and the URBS parameter values developed by the DSFOEs during the Flood Event (calibrated progressively during the event using the data that was available to that point in the event). Hydrological data from the event was also analysed to estimate a reverse routed inflow hydrograph to North Pine Dam (developed with the benefit of hindsight), which was compared with the inflow hydrograph estimated from URBS from the whole of event calibration. These assessments were undertaken with the benefit of hindsight and can be expected to differ from the data or information available to the Flood Engineers during the Flood Event.

It should be noted here that inflow to a dam cannot be measured directly and thus must be calculated from other data sets. There are three different types of inflow estimates documented in this report:

- Real time estimates of inflow derived with model runs in the FFS by the Flood Engineers and updated progressively through the course of the Flood Event. This is discussed in Section 3.2.
- Whole of event calibration inflow calculated from an FFS model calibration (with the benefit of hindsight) as part of post-event hydrologic analysis. To assist with this calibration, consideration has also been given to upstream gauges and the level data for upstream gauges presented in Section 2.5 has been converted to rated flow estimates which are presented in Section 7.2.1.
- Reverse routed inflow calculated as part of post-event hydrologic analysis on recorded lake level and release data.

7.2 Whole of event calibration

7.2.1 Rated flow hydrographs

Rated flow data for the gauges in the North Pine Dam catchment is shown in Figure 7-1 to Figure 7-4. Rated flow data was calculated from the recorded water level data at each gauge (shown in Section 2.5) using the relevant gauge rating tables from the FFS. It should be noted that there is a significant degree of uncertainty associated with these rating tables. The gauge sites in the North Pine Dam catchment are difficult to access, particularly during flood events, and some exhibit relatively mobile stream bed and banks. These characteristics mean that gaugings are difficult to obtain for these gauges, and stable, reliable rating tables are difficult to establish. There is evidence that during the Flood Event, rated flow at these gauges was primarily used to check inflow timing, with inflow magnitude primarily based on calibration to recorded lake level at North Pine Dam.

The rating tables for these gauges from the FFS used during the Flood Event are tabulated in Appendix E.

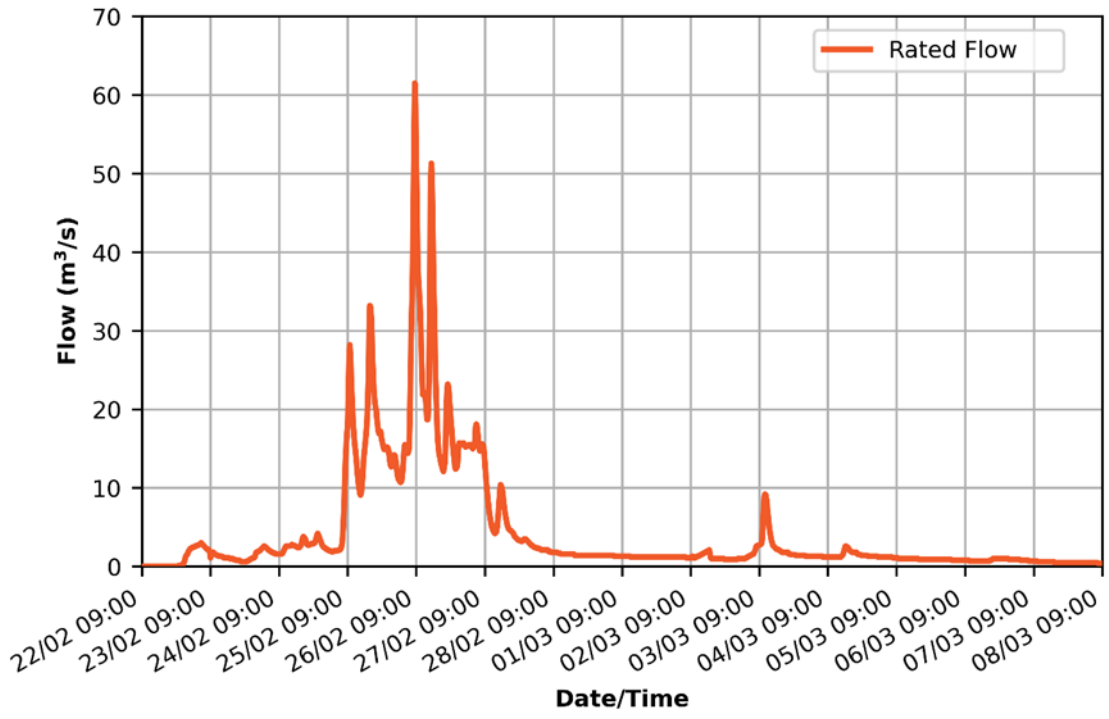


Figure 7-1: Rated flow at Terrors Creek for the period 22/02/2022 09:00 to 08/03/2022 09:00

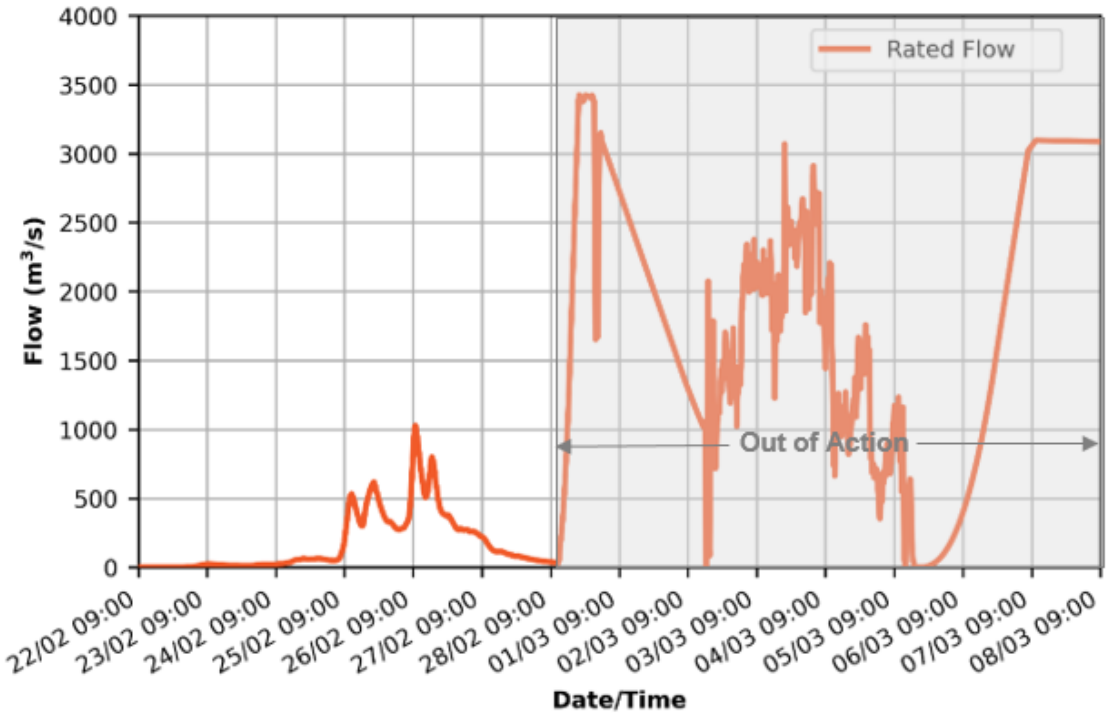


Figure 7-2: Rated flow at Baxters Creek for the period 22/02/2022 09:00 to 08/03/2022 09:00

The Baxters Creek gauge was marked as suspect prior to the Flood Event (refer to Table 2-1) and later during the Flood Event (28/02/2022) it was marked as Out of Action (refer to Table 2-2) when the water level readings appeared to be erroneous.

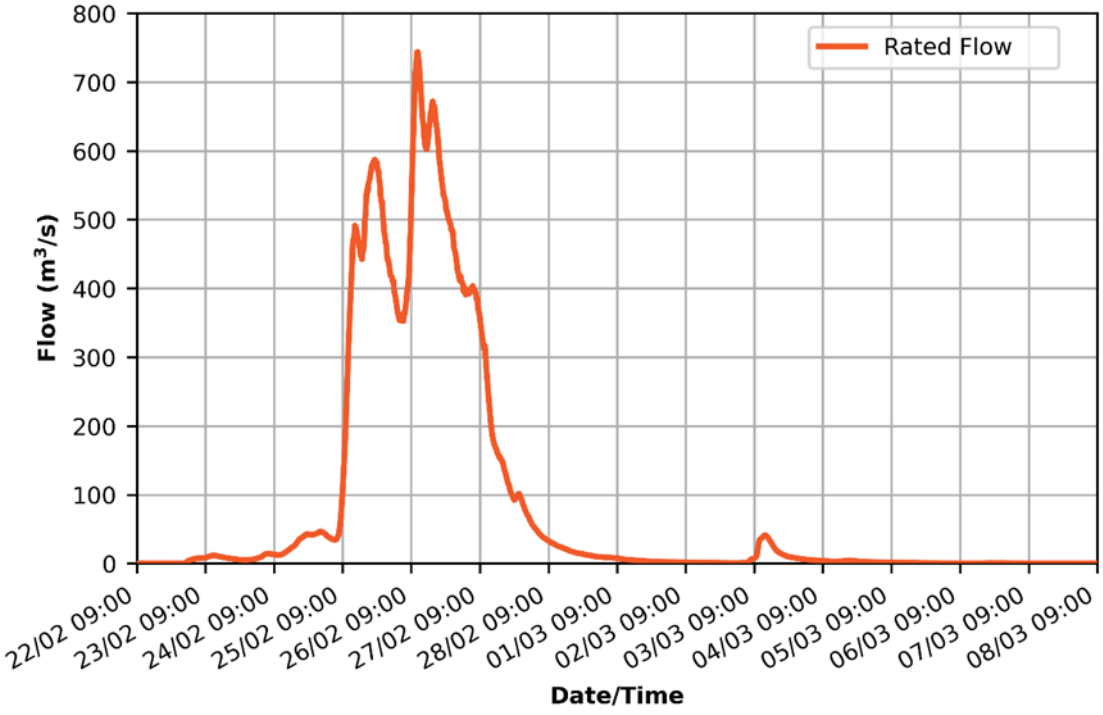


Figure 7-3: Rated flow at Dayboro WWTP for the period 22/02/2022 09:00 to 08/03/2022 09:00

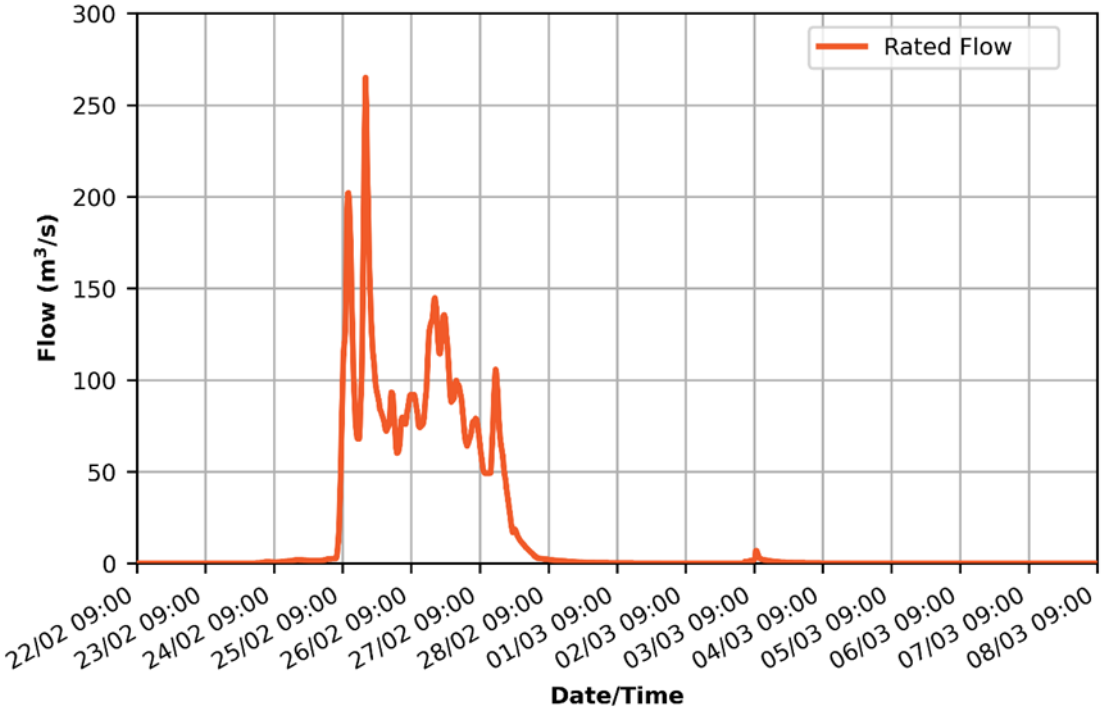


Figure 7-4: Rated flow at Kobble Creek for the period 22/02/2022 09:00 to 08/03/2022 09:00

7.2.2 URBS model calibration

The list of archived model runs in the FFS was used to select which model run was used as the initial starting point for the whole of event calibration. The archived model run that was selected was run on 03/03/2022 at 10:30, and included rainfall data up to that time. This run was selected as it occurred before rainfall re-intensified over the Dam catchment, causing additional inflows. Subsequent model runs in the FFS were focused primarily on matching to the small increase in recorded lake levels resulting from this re-intensified rainfall, as opposed to the peak of the Flood Event.

The aim of the whole of event calibration was to use the benefit of hindsight to achieve a generally good match to the overall Flood Event data, focussing on matching the simulated lake level to recorded lake level at North Pine Dam.

Three sets of parameter values were modified throughout the Flood Event by the Flood Engineers to achieve calibration of the model:

- The rainfall-run-off loss parameters: Initial Loss (IL), Initial Loss Recovery Rate (RIL) and Continuing Loss (CL)
- The URBS routing parameters: Alpha (α) and Beta (β)
- The baseflow parameters: baseflow constant (BC), baseflow recession constant (BR) and the baseflow exponent (BM) and the baseflow scaling factor

URBS has three additional routing parameters, which were kept at their default values for all model runs undertaken during the flood event. These were the exponent on non-linear routing within sub-catchments (m = 0.8), exponent on non-linear routing within stream reaches (n = 1.0) and the Muskingum routing translation parameter (x = 0.25). These default values were also retained for the whole of event calibration.

Minor adjustments were made to the URBS input parameter values to see if better fits could be achieved at the primary calibration points within the North Pine Dam catchment with the benefit of hindsight. The final parameter values that were adopted for the whole of event calibration are summarised in Table 7-1.

Table 7-1: Summary of whole of event calibration model parameter values adopted (changed values from selected archive run highlighted)

URBS model parameters	Archived model run parameter values on 03/03/2022 10:30	Whole of event parameter values produced with the benefit of hindsight
Initial loss (mm)	80	60
Continuing loss (mm/h)	1.68	2.5
Infiltration capacity [IF] (mm)	N/A	500
Recovering initial loss factor [RF]	0.12	0.12
Alpha [α]	0.13	0.11
Beta [β]	2.0	2.4
Baseflow scaling factor	0	0
Persistent baseflow [B0]	1	1

URBS model parameters	Archived model run parameter values on 03/03/2022 10:30	Whole of event parameter values produced with the benefit of hindsight
Baseflow recession [BR]	0.65	0.6
Baseflow constant [BC]	0.04	0.05
Baseflow exponent [BM]	1.0	1.0

Compared with the archived FFS model selected as the starting point for calibration, the parameter values that were modified were the initial loss, continuing loss, infiltration capacity, alpha, beta baseflow recession and the baseflow constant parameters. The significant changes applied to the model were:

- The initial loss was reduced from 80 mm to 60 mm
- The continuing loss was increased from 1.68 mm/h to 2.5mm/h
- Alpha was decreased from 0.13 to 0.11
- Beta was increased from 2.0 to 2.4

The aim of modifying the model parameter values was to improve the fit at North Pine Dam for all three peaks along with the long receding tail of the hydrograph.

7.2.3 Calibration results

The URBS model parameter values developed with the benefit of hindsight (summarised in Table 7-1) were modelled in the FFS to generate results at North Pine Dam. The modelled hydrographs are compared with the observed lake level data to demonstrate the fit and plotted in Figure 7-5. The resulting modelled inflow hydrograph is shown in Figure 7-6.

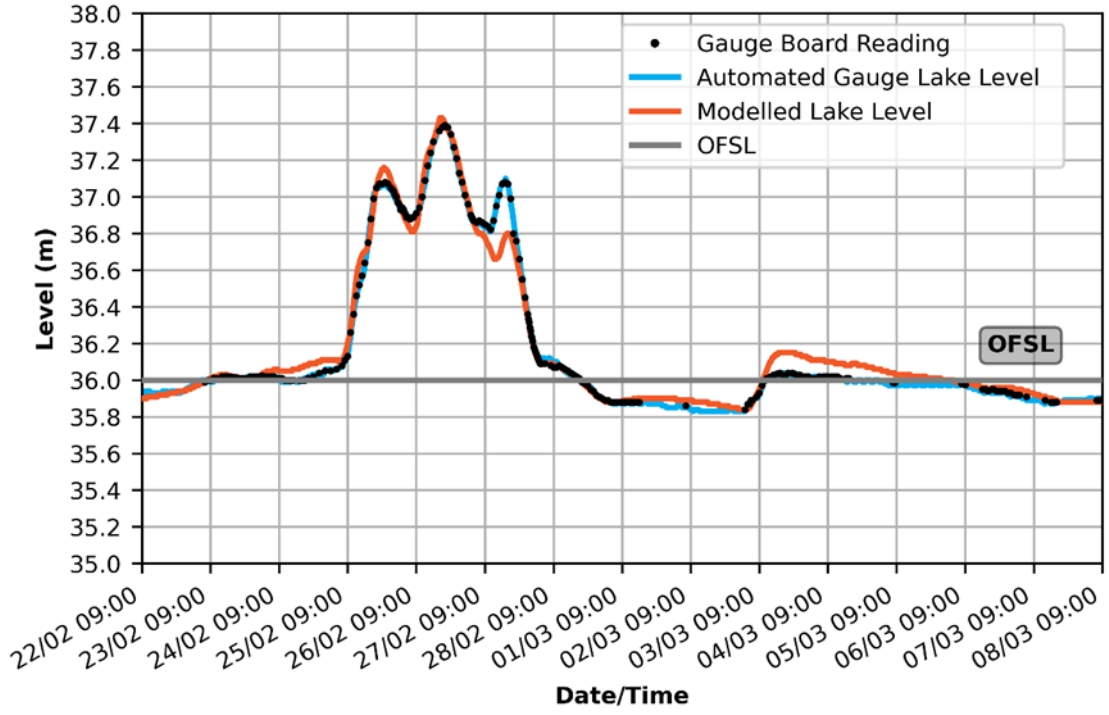


Figure 7-5: North Pine Dam post-event analysis whole of event calibration modelled lake level compared to automated data and gauge board readings (replicated in Figure iii)

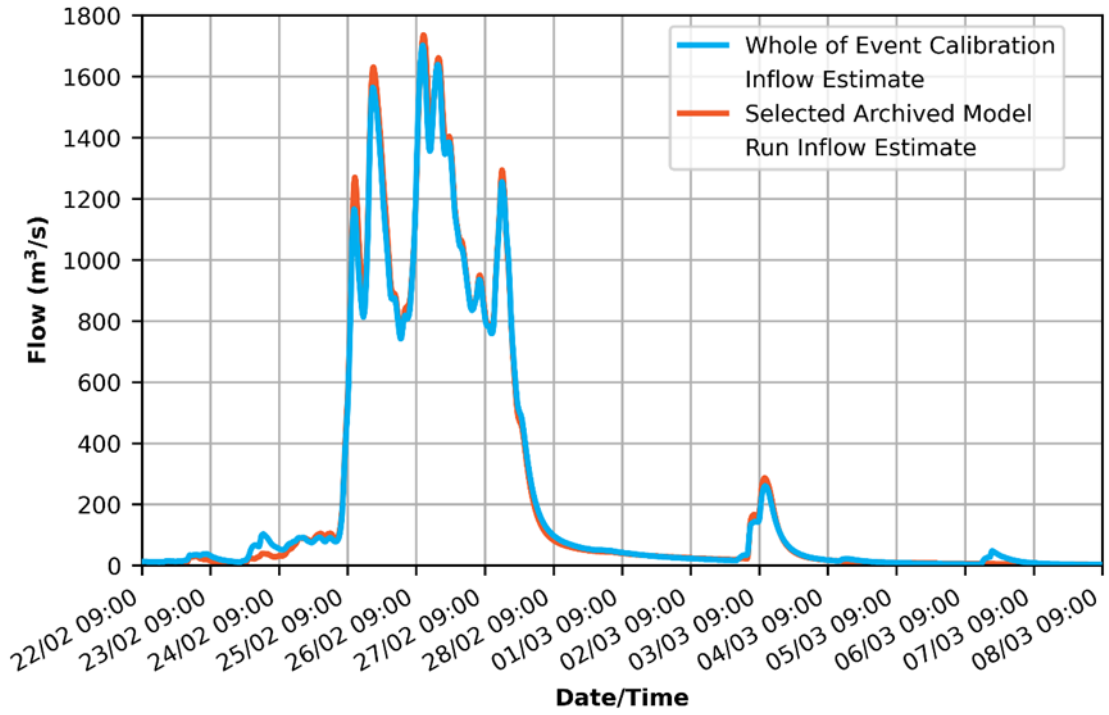


Figure 7-6: North Pine Dam post-event analysis whole of event calibration modelled inflow hydrograph compared to the inflow from the selected archive model run

The calibration to lake level at North Pine Dam (refer to Figure 7-5) improved for the first two peaks of the hydrograph because the FFS archived model run that was selected as the starting point for calibration tended to overestimate the lake level for this part of the event (refer to Figure 3-4). The match to the third lake level peak in the whole of event calibration was poorer than the archived run, however, the fit of the archived run was also relatively poor in comparison to the recorded data. The difference between the fit of the third peak between the two model runs is relatively small but the whole of event calibration has a better fit of the receding limb than the archived model run.

There were pragmatic difficulties in achieving a good calibration with all three peaks because the match to the first two peaks would be compromised if the URBS parameter values for recovering initial loss and infiltration capacity were modified regardless of the values adopted. As described in Section 3.2, calibration of the hydrologic model to recorded lake level data for the third peak on 27/02/2022 to 28/02/2022 may be hindered by the relatively steep rainfall gradient observed across the North Pine Dam catchment in the 24 hours to 28/02/2022 09:00 (refer Figure 2-11).

7.3 Reverse routed inflows

Reverse routing is a technique that can be used to derive an estimate of inflow for a dam, based on recorded lake levels (converted to storage volumes) and releases. For each time step, inflow is based on the change in storage volume and the releases over that time step.

The following information was extracted from the data provided by Seqwater for the reverse routing assessment:

- Recorded lake level hydrograph for North Pine Dam.
- Recorded release hydrograph from North Pine Dam, based on recorded lake level and gate settings.
- Elevation-storage relationship for North Pine Dam.

Lake level hydrograph

The recorded lake level data from North Pine Dam was extracted from the FFS. There were several different lake level data sources that were considered for use in the reverse routing assessment. These are summarised in Table 7-2.

Table 7-2: Lake level data sources used to inform the reverse routing assessment

Data source	Gauge ID
Bureau gauge	142801A
Seqwater automated gauge	540277
Gauge board reading	40999

The recorded lake level data from the Bureau and Seqwater automated gauges was compared to the manual gauge board reading data to validate the levels in North Pine Dam. The lake level data was generally consistent between all three datasets, therefore the Seqwater

automated gauge data was adopted for the reverse routing calculation. This data is shown in Figure 7-7.

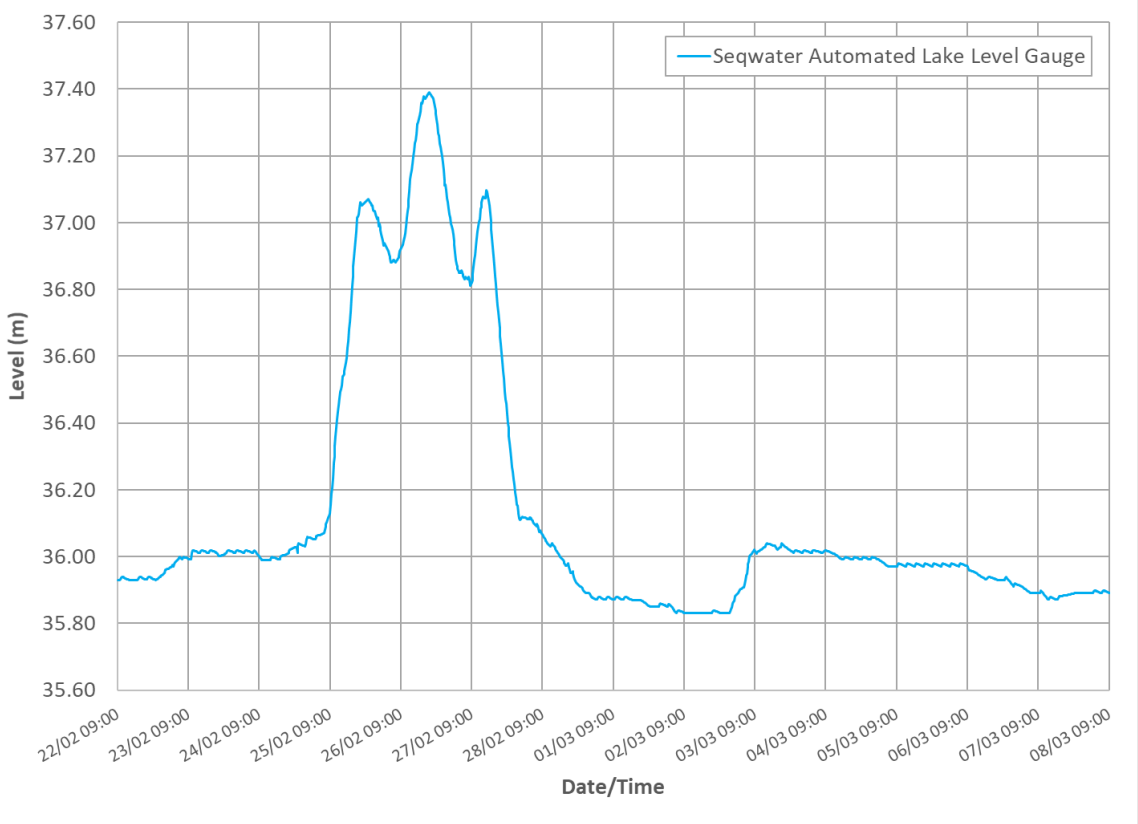


Figure 7-7: Adopted North Pine Dam lake level hydrograph for reverse routing

Recorded release hydrograph

The recorded release hydrograph for North Pine Dam, based on recorded lake level and gate settings was extracted from the FFS.

Elevation-storage relationship

The elevation-storage curve was obtained from the Gate Operations Model for North Pine Dam. The elevation storage-curve is shown in Figure 7-8.

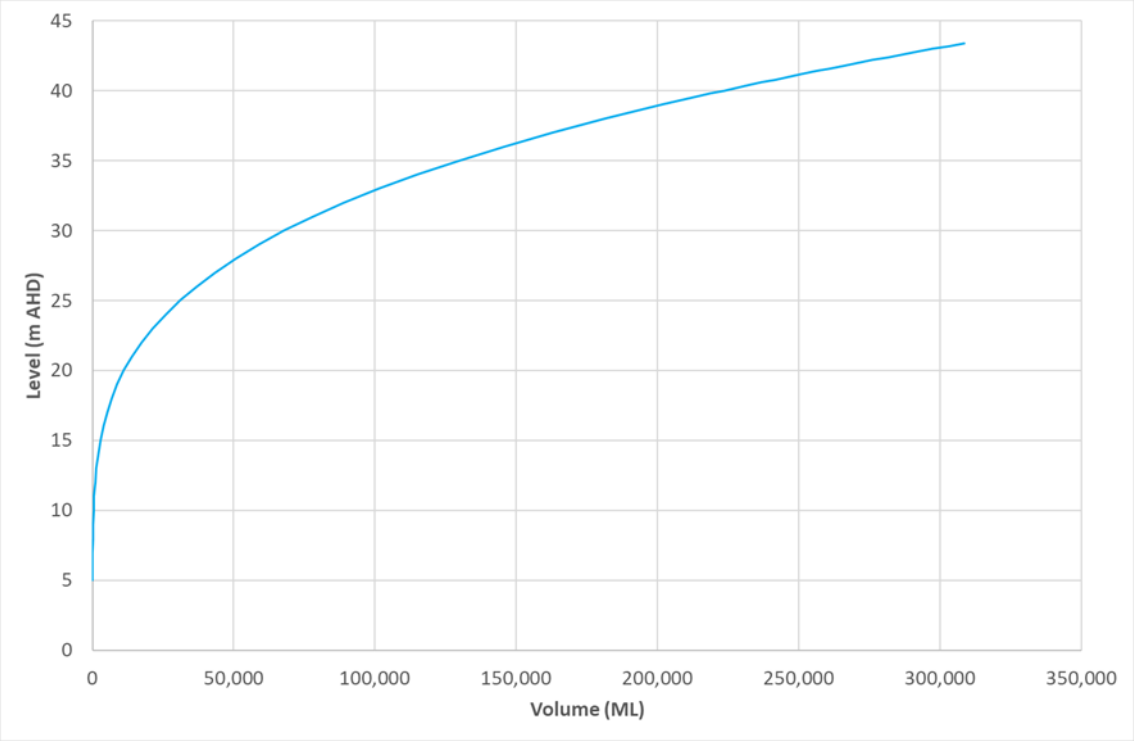


Figure 7-8: North Pine Dam storage-elevation relationship

The reverse routing process is dependent on the time step chosen for the lake volume calculations. There is a trade-off between temporal resolution and the noise (uncertainty in the estimated values for each time step) of the reverse routed inflow hydrograph. A smaller time step will typically improve the representation of the peak flows but it can result in a very "noisy" hydrograph, with the value for each time step subject to larger uncertainties. The time step that was chosen for the North Pine Dam reverse routed inflows was 60 minutes. This tended to produce a plausible inflow hydrograph that did not have a significant amount of noise when the inflows were above approximately 100 m^3/s.

The reverse routed inflow hydrograph for North Pine Dam is shown in Figure 7-9. The whole of event calibration inflow estimate has also been plotted to demonstrate differences between the two approaches.

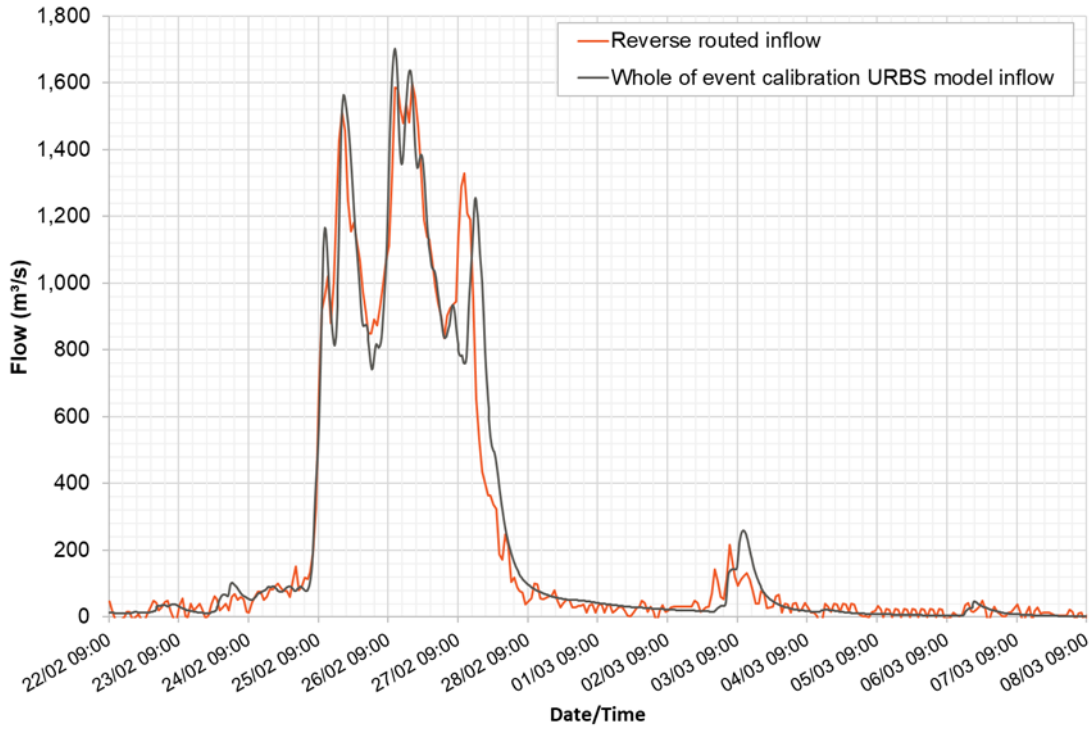


Figure 7-9: Post-event analysis reverse routed inflow calculation for North Pine Dam

The reverse routed inflow estimate (using a time step of 60 minutes) corresponded closely to the whole of event calibration inflow estimate. There was some noise in the rising and receding limbs of the reverse routed inflow hydrograph when inflows were less than approximately 100 m^3/s. Adoption of a longer time step would dampen this noise, however the shape of the peak would be compromised. The resolution of lake level readings is a key source of noise in reverse routing analyses.

8. Event Review

This section of the report summarises the operation of North Pine Dam during the Flood Event, and as required under the Act, provides an assessment of:

- The implementation of the Manual for North Pine Dam, including record keeping
- The effectiveness of the Manual
- The Flood Forecasting System
- The performance of and any damage to the Dam

8.1 Compliance with the Manual

The operating procedures relevant for this Flood Event are described in the North Pine Dam Manual of Operational Procedures for Flood Mitigation, Revision 11 (November 2021).

Based upon the evidence available from the Strategy Logs, Flood Forecasting System (FFS) simulations, Gate Operations Models, Gate Directives and recorded rainfall and river level data, the flood operations implemented at the Dam during this Flood Event complied with the procedures in the Manual.

A detailed description of the operating procedures applied at the Dam during the Flood Event is provided in Section 4.2. Throughout the Flood Event, there were a number of key decisions made by the DSFOEs which were critical for this Flood Event. These are described in more detail below:

- The decision that the criteria for commencement of the Flood Event described in Section 12.2 of the Manual were met at North Pine Dam on 23/02/2022 at 12:22. At this time it was judged likely based on FFS rain on ground model simulations that the lake level would exceed OFSL with no releases from the radial gates (see FFS run 23/02/2022 11:15 in Section 3.2). The Release Plan was required to be relatively flexible at this point in the Flood Event as inflows were minor and subject to significant uncertainty. It is to be noted at this time that Youngs Crossing was already closed due to outflows from Sideling Creek Dam and as such there was no requirement to delay releases at North Pine Dam to provide additional time for the road closure process to be implemented.
- The ongoing modelling assessments and Release Plans developed over 24/02/2022 and into the early hours of 25/02/2022 supporting the decision keep Flood Operations Strategy Procedure 1a selected. During this time, inflows and releases remained relatively small and lake level was close to OFSL. There was evidence that significant forecast rainfall was still expected over the South East Queensland region (see Table 2-4), but large uncertainty on whether this rainfall would impact the North Pine Dam catchment. During this time, the decision was made to remain in Procedure 1a as conditions were not suitable to select the Drain Down Strategy. The subsequent rainfall which developed over the catchment on the morning of 25/2/2022 (see Figure 2-8) demonstrated that this decision was justified.
- The decision to select Flood Operations Strategy Procedure 1b on 25/2/2022 at 09:00. At this point estimated inflows had begun to rise rapidly in response to heavy rainfall

over the catchment (see FFS run 25/02/2022 09:00 in Section 3.2), and it was clear that the lake level could not be maintained below 0.2 metres above OFSL with releases limited to 300 m^3/s as required under Procedure 1a.

- The trialling and selection of Release Plans throughout the period when Flood Operations Strategy Procedure 1b was selected at the Dam. As described in detail in Section 4.2, a total of 115 FFS model runs and 72 Gate Operations Model runs were simulated and archived over this period, resulting in 28 Gate Directives being issued. Care (including in the exercise of professional judgment) was taken to ensure that Release Plans were consistent with the criteria in the Manual. Planned releases were generally always larger than those derived using predicted lake level and Appendix C of the Manual, save for a short period on 28/02/2022 when rapidly falling inflows made model calibration difficult. The North Pine Dam Strategy Log notes that the Duty Engineer was aware of the discrepancy between the modelled and recorded lake levels and this was taken into account in making decisions concerning the gate settings during this period.
- The decision to lift all five gates clear of the spillway flow on 26/02/2022 at 17:00. At this point of the event, FFS modelling indicated that inflows and lake level were approaching the peak (see FFS run 26/02/2022 17:00 in Section 3.2). Once all gates were clear of the flow, release planning focused on predictions of when inflows and lake level would fall sufficiently to require lowering of the gates back into the spillway flow and resume management of releases with the gates.
- The decision to advise TMR and MBRC that releases were likely to contribute to closure of the AJ Wyllie Bridge on 26/2/2022 at 13:00 (see Section 4.1). This decision demonstrated the value and reliability of a well calibrated hydrologic model using rain on ground data to estimate forecast inflows to the Dam and prepare Release Plans (see FFS run 26/02/2022 10:00 in Section 3.2). At 17:00, releases exceeded the 1,500 m^3/s threshold which inundates the bridge.
- The decision to enter the Drain Down Strategy on 28/2/2022 at 01:45. At this point inflows had reduced significantly and the lake level had fallen well below the peak level reached during the Flood Event (see FFS run 28/02/2022 01:45 in Section 3.2). The decision was made once rainfall was judged to be likely complete, which provided sufficient time to plan a release strategy to meet the criteria in Drain Down Strategy Procedure 1a.

The available evidence suggests that the dam operations undertaken during this Flood Event achieved the Objectives stated in the Manual. Dam safety was prioritised, the dam ended the flood event at OFSL, peak outflow from the dam was less than estimated peak inflow indicating a degree of flood mitigation and protection of the riverine environment was considered.

8.2 Operational arrangements

Staffing at both the Flood Operations Centre and the dam site met the requirements of Section 3.1 of the Manual.

In the lead up to the Flood Event, Seqwater had access to a pool of four Senior Flood Operations Engineers (SFOEs). The training, qualifications and experience of the SFOEs

complied with Section 3.8 of the Manual. Over the course of the event, evidence from attendance records and rosters demonstrate that three of these SFOEs were available to fill the Duty Senior Flood Operations Engineer (DSFOE) role in the Flood Operations Centre on a rotating basis, with one SFOE confined to isolation for much of the Flood Event as a result of being identified as a close contact under COVID-19 regulations. This SFOE was available to provide support to the Flood Operations Centre team as a DFOE on a remote basis throughout the event with full access to the FFS and related operational systems. A pool of available Flood Operations Engineers and Flood Officers supported the DSFOE on a rostered basis inside the Flood Operations Centre. A pool of Dam Operators staffed the dam site on a rostered basis throughout the event to carry out operations at the Dam. All staff filling operational roles in the Flood Operations Centre and at the Dams during the Flood Event had appropriate experience, training and qualifications for their role. Staffing levels in the Flood Operations Centre and at the Dam were consistent with the Manual.

There is evidence from the Strategy Log and interviews conducted with the SFOEs that workload in the Flood Operations Centre, while intense at times, did not have an impact on the operation of the Dam using the procedures in the Manual.

8.3 Assessment of the Flood Forecasting System

8.3.1 Monitoring network

The rainfall and river level gauge network that Seqwater had access to during the Flood Event is described in Section 2.2. This network performed well during the Flood Event. Data from the network provided a crucial basis for understanding the temporal and spatial characteristics of the rainfall, as well as the response of the catchment.

Of the network of rainfall gauges available to Seqwater and relevant to the North Pine Dam catchment, only two were identified as not reporting or likely erroneous during the Flood Event (Mt Nebo and Raynbird Creek). This is not unexpected for an event of this magnitude, and similar in nature to the January 2011 event where 14 out of 75 rainfall stations were not operating correctly (Seqwater, 2011).

The river level monitoring network and lake level monitoring at the dam was useful to support understanding of catchment flow response. Given the relatively small size of the North Pine Dam catchment and the limited reliability of rating tables at the gauges upstream of the dam, the primary focus of hydrologic model calibration was the North Pine Dam lake level (see Section 3.2). The only river level gauge in the Pine River basin that was Out of Action during the Flood Event was the Baxters Creek station, which was reporting erroneous data from 28/02/2022. The impact of this was relatively minor for the reasons noted above.

It is recommended that Seqwater continue to explore improvements in river level gauging reliability upstream of North Pine Dam. Developing a better understanding of the high flow rating tables at Baxter Creek, Kobble Creek, Dayboro (Terrors Creek) and Dayboro WWTP would assist the DSFOEs to improve confidence in estimates of inflows. The significant challenges associated with high flow gaugings at difficult to access sites is noted and acknowledged in this context. It is also noted that gauge site redundancy is a particular issue

when considering the possibility of closely spaced flood events, where damage to gauges during one event may not be able to be easily rectified before the start of a following event.

8.3.2 Assessment of the data collection system

As described in Section 3.1, data collection systems are used to ingest data from a variety of sources into the FFS. The key data being ingested for this event included gauged rainfall and river level data (via Enviromon), gate settings and reservoir gauge board readings (via WISKI) and Bureau forecast rainfall and flood forecasts (via File Transfer Protocol).

The data collection systems used by Seqwater performed well during the event. There is evidence to suggest that there were a number of minor issues with the ALERT data receiver at North Pine Dam, however these appear to have been quickly identified and corrected. There is no evidence to suggest that decision making was adversely impacted by data latency or unavailability as a result of the collection systems.

8.3.3 Assessment of the modelling platform

Seqwater have invested significant effort in the development of the FFS over the last decade. As described in Section 3.2, 339 individual model simulations of the Pine River catchment were completed and archived in the FFS during the Flood Event. The system appeared to perform well, and feedback from the SFOEs and review of the archived model runs suggests that it was an efficient and useful tool for simulating and forecasting catchment flood flows and North Pine Dam lake level.

The FFS has a number of attributes that were critical to its performance during the Flood Event, namely:

- The URBS hydrologic models incorporated in the FFS are detailed and their performance has been extensively calibrated to historic flood events.
- The FFS ingests and provides a range of data for model input and analysis in a centralized location. This includes gauged rainfall, water level and streamflow data, dam gate settings, forecast rainfall data from the Bureau and contextual information such as flood classification levels at key gauge sites.
- The analysis and preparation of rainfall data is sufficiently sophisticated and flexible as to generate reasonable gridded estimates of rain on ground data from gauge information, as well as blending this data with forecast rainfall provided by the Bureau (although not used for quantitative Release Plan decision making).
- The process of real time Flood Event model calibration is enhanced by the ability to efficiently switch between flexible and scalable plots of gauged and modelled water level, streamflow and lake level at all gauges of interest.
- Model parameter values can be efficiently input and adjusted as the Flood Event unfolds, and appropriate guidance is provided within the FFS on typical ranges of parameter values based on physical limits and evidence from historic calibrations.
- The model runs on a 15 minute time step which is sufficient resolution to support the development of Release Plans.

- Key operational considerations (such as bridge deck levels) are clearly labelled in the FFS enhancing the user's ability to easily identify the critical points of interest.
- Data and model results can be readily imported and exported to support interoperability with other applications such as the Gate Operations Model and to support communications activities such as Situation Reports.
- Model simulations used as inputs to release planning decisions are archived in a database which can be readily extracted and viewed.

Given the critical importance of the FFS to operational decision-making during Flood Events, it is recommended that Seqwater continue to invest in the ongoing enhancement of the FFS. This is consistent with the requirements of Section 3.9 of the Manual.

8.3.4 Assessment of the Gate Operations Model

The Gate Operations Model performed satisfactorily during the Flood Event. The model has a number of key advantages which make it a useful tool for decision making during flood operations, including:

- The effect of changes to gate settings on reservoir water levels, outflows and estimated downstream flows can be assessed virtually instantaneously. This allows the Flood Engineers to quickly trial a range of possible Release Plans.
- The model contains a series of important visual cues which significantly increase situational awareness for Flood Operations Engineers. This allows timing of changes to gate settings, gate overtopping alerts and inconsistencies between gate settings in the FFS and the model to be readily identified and acted on.
- The model calculations occur on an hourly time step, which is preferable for trialling and confirming the development of Release Plans, particularly for this Flood Event, which had a relatively long duration.

The Gate Operations Model contains a plot labelled as the 'North Pine Dam Guide Curve'. There is evidence from the Strategy Log to indicate that the Flood Engineers refer to this plot as visual check of Release Plans while in the Flood Operations Strategy Procedure 1b. The plot is a visual representation of criteria iv and v in Procedure 1b of the Flood Operations Strategy, including Appendix C in the Manual. This guide curve is discussed further in Section 8.6.

It is noted that Seqwater have a forward program of works to incorporate gate operations modelling in the FFS. This is a reasonable and proactive area for development, given the critical nature of the model and its central role in decision making and development of Release Plans.

The databases and modelling tools established and used by Seqwater are sufficiently mature and robust to provide visual cues to the Flood Engineers that alert them of any major discrepancies. The 2022 Flood Event Report for Somerset and Wivenhoe Dams (HARC, 2022) identified a limited number of minor discrepancies between gate settings in the Gate Operations Model and the WISKI database for those dams. No issues in this regard were identified for North Pine Dam in this Flood Event, however at the time of writing it is understood that a limited

number of minor issues have been identified in the flood operations of Somerset Dam and Wivenhoe Dam which are equally applicable to North Pine Dam.

8.4 Record keeping

Extensive records were kept covering a range of Flood Operations Centre and dam site activities throughout the duration of the Flood Event. These included:

- The dam Strategy Log, which is a critical source for recording the Release Plan and operational decision making throughout the Flood Event.
- 339 archived hydrologic model runs in the FFS (Section 3.2).
- Gate Directives, of which 52 were issued for North Pine Dam.
- Flood Operations Centre attendance records.
- Sent and received emails from the Flood Operations Centre inbox.
- Recordings of telephone conversations from the Flood Operations Centre.

The extent and nature of record keeping during this Flood Event complied with the requirements of the Manual.

8.5 Dam infrastructure performance

There was no evidence of significant issues associated with performance of dam infrastructure as part of this Flood Event. All gates operated reliably throughout the Flood Event.

Some damage was sustained to North Pine Dam as a result of the Flood Event. A report prepared by Seqwater that describes the damage to North Pine Dam that was caused by the Flood Event is included in Appendix D of this report.

The North Pine Dam – Dam Safety Inspection Report (Appendix D) identified the following damage to North Pine Dam as a result of the Flood Event:

- North Pine Dam experienced a significant bank slump on the right bank (looking downstream) of the earth/rock shoulder embankment. It did not threaten the structural safety of the dam. Seqwater implemented early inspections and measures to stabilise the bank slump. Subsequent independent engineering assessment has recommended that no further stabilisation works are currently required. However, a more detailed independent engineering assessment of the bank slump will be undertaken over the next six months to determine if additional works to supplement the constructed filter buttress are needed to ensure the long term stability of the embankment.

The North Pine Dam – Dam Safety Inspection Report states that the damage was assessed to be caused by heavy rainfall that fell onto the downstream face of the embankment during the Flood Event and was unlikely to have been caused by lake level load on the upstream side of the embankment during the Flood Event.

8.6 Effectiveness of the Manual

There is evidence from the Strategy Logs as well as interviews with the SFOEs that the operational procedures in the Manual provided an effective guide to decision making during the Flood Event. At each change in strategy, the Strategy Logs document the relevant criteria from the Manual and record the assessment by the DSFOE against those criteria to justify the change. The SFOEs all remarked that the Manual procedures achieve a balance between providing sufficient guidance to achieve the Objectives and allowing for professional judgement to be applied when adapting to changing circumstances.

On 24/02/2022, during the early stages of the Flood Event, Flood Operations Strategy Procedure 1a was selected. Inflows were relatively minor during this period, and consideration was given to ceasing releases if necessary to maintain the lake level at OFSL. One consideration during this phase of the event was to cease releases during daylight hours to enable fish recovery. Conditions were such during this period that it would not have been possible to select the Drain Down Strategy or end the Flood Event. Seqwater should consider adding a criterion to Flood Operations Strategy Procedure 1a to clarify that, if gate closure is necessary in Procedure 1a the timing when releases are temporarily ceased should consider fish recovery requirements.

As discussed in Section 8.3.4, the Gate Operations Model contains a ‘North Pine Dam Guide Curve’ plot. The plot is understood to be a visual check of criteria iv and v in Procedure 1b in the Flood Operations Strategy, including the release rates in Appendix C. To avoid any potential misunderstanding of the nature of this plot, it is recommended that Seqwater consider whether it could be renamed in the Gate Operations Model. It may also be useful to include a static version of the plot below Table C.1 in Appendix C of the Manual as an example of how Appendix C is applied in Procedure 1b in the Flood Operations Strategy. This “Guide Curve” should also be checked to ensure it accurately reflects Appendix C in the Manual.

9. References

Seqwater. (2021). *Development of a Calibration Dataset for South East Queensland.*

Appendix A Dam Gate Operations Record

Table A-1: Dam gate operations record of North Pine Dam for the period from 22/02/2022 09:00 to 08/03/2022 09:00 (Source: FFS)

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m³/s)	(m³/s)	(m³/s)
22/02/2022 9:00	0	0	0	0	0	0	0	0
22/02/2022 10:00	0	0	0	0	0	0	0	0
22/02/2022 11:00	0	0	0	0	0	0	0	0
22/02/2022 12:00	0	0	0	0	0	0	0	0
22/02/2022 13:00	0	0	0	0	0	0	0	0
22/02/2022 14:00	0	0	0	0	0	0	0	0
22/02/2022 15:00	0	0	0	0	0	0	0	0
22/02/2022 16:00	0	0	0	0	0	0	0	0
22/02/2022 17:00	0	0	0	0	0	0	0	0
22/02/2022 18:00	0	0	0	0	0	0	0	0
22/02/2022 19:00	0	0	0	0	0	0	0	0
22/02/2022 20:00	0	0	0	0	0	0	0	0
22/02/2022 21:00	0	0	0	0	0	0	0	0
22/02/2022 22:00	0	0	0	0	0	0	0	0
22/02/2022 23:00	0	0	0	0	0	0	0	0
23/02/2022 0:00	0	0	0	0	0	0	0	0
23/02/2022 1:00	0	0	0	0	0	0	0	0
23/02/2022 2:00	0	0	0	0	0	0	0	0
23/02/2022 3:00	0	0	0	0	0	0	0	0
23/02/2022 4:00	0	0	0	0	0	0	0	0
23/02/2022 5:00	0	0	0	0	0	0	0	0
23/02/2022 6:00	0	0	0	0	0	0	0	0
23/02/2022 7:00	0	0	0	0	0	0	0	0
23/02/2022 8:00	0	0	0	0	0	0	0	0
23/02/2022 9:00	0	0	0	0	0	0	0	0
23/02/2022 10:00	0	0	0	0	0	0	0	0
23/02/2022 11:00	0	0	0	0	0	0	0	0
23/02/2022 12:00	0	0	0	0	0	0	0	0
23/02/2022 13:00	0	0	0.5	0	0	0	30	30
23/02/2022 14:00	0	0	0.5	0	0	0	30	30
23/02/2022 15:00	0	0	0.5	0	0	0	30	30
23/02/2022 16:00	0	0	0.5	0	0	0	30	30
23/02/2022 17:00	0	0	0.5	0	0	0	30	30
23/02/2022 18:00	0	0	0.5	0	0	0	30	30
23/02/2022 19:00	0	0	0.5	0	0	0	30	30
23/02/2022 20:00	0	0	0.5	0	0	0	30	30
23/02/2022 21:00	0	0	0.5	0	0	0	30	30

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m^3/s)	(m^3/s)	(m^3/s)
23/02/2022 22:00	0	0	0.5	0	0	0	30	30
23/02/2022 23:00	0	0	0.5	0	0	0	30	30
24/02/2022 0:00	0	0	0.5	0	0	0	30	30
24/02/2022 1:00	0	0	0.5	0	0	0	30	30
24/02/2022 2:00	0	0	0.5	0	0	0	30	30
24/02/2022 3:00	0	0	1	0	0	0	60	60
24/02/2022 4:00	0	0	1	0	0	0	60	60
24/02/2022 5:00	0	0	1	0	0	0	60	60
24/02/2022 6:00	0	0	1	0	0	0	60	60
24/02/2022 7:00	0	0	1	0	0	0	60	60
24/02/2022 8:00	0	0	1	0	0	0	60	60
24/02/2022 9:00	0	0	1	0	0	0	60	60
24/02/2022 10:00	0	0	1	0	0	0	60	60
24/02/2022 11:00	0	0	1	0	0	0	60	60
24/02/2022 12:00	0	0	1	0	0	0	60	60
24/02/2022 13:00	0	0	1	0	0	0	60	60
24/02/2022 14:00	0	0	1	0	0	0	60	60
24/02/2022 15:00	0	0	1	0	0	0	60	60
24/02/2022 16:00	0	0	1	0	0	0	60	60
24/02/2022 17:00	0	0	1	0	0	0	60	60
24/02/2022 18:00	0	0	1	0	0	0	60	60
24/02/2022 19:00	0	0	1	0	0	0	60	60
24/02/2022 20:00	0	0	1	0	0	0	60	60
24/02/2022 21:00	0	0	1	0	0	0	60	60
24/02/2022 22:00	0	0	1	0	0	0	60	60
24/02/2022 23:00	0	0	1	0	0	0	60	60
25/02/2022 0:00	0	0	1	0	0	0	60	60
25/02/2022 1:00	0	0	1	0	0.5	0	91	91
25/02/2022 2:00	0	0	1	0	0.5	0	91	91
25/02/2022 3:00	0	0	1	0	0.5	0	91	91
25/02/2022 4:00	0	0	1	0	0.5	0	91	91
25/02/2022 5:00	0	0	1	0	0.5	0	91	91
25/02/2022 6:00	0	0	1	0	0.5	0	91	91
25/02/2022 7:00	0	0	1	0	0.5	0	91	91
25/02/2022 8:00	0.5	0	1	0	1	0	152	152
25/02/2022 9:00	1	0.5	1	1	1	0	274	274
25/02/2022 10:00	1	1	2	1	1	0	368	368
25/02/2022 11:00	2	1	2	1	2	0	495	495
25/02/2022 12:00	2	2	2.5	2	2	0	653	653
25/02/2022 13:00	2	2	2.5	2	2	0	658	658
25/02/2022 14:00	2	2	3	2	3	0	751	751

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m^3/s)	(m^3/s)	(m^3/s)
25/02/2022 15:00	2	2	3	2	3	0	757	757
25/02/2022 16:00	3	2	3	2	3	0	828	828
25/02/2022 17:00	3	2.5	3	3	3	0	934	935
25/02/2022 18:00	3	3	4.5	3	3	0	1053	1053
25/02/2022 19:00	3	3	4.5	3	4.5	0	1146	1146
25/02/2022 20:00	3	3	4.5	3	4.5	0	1147	1147
25/02/2022 21:00	3	3	4.5	3	4.5	0	1149	1150
25/02/2022 22:00	3	3	4.5	3	4.5	0	1152	1152
25/02/2022 23:00	3	3	4.5	3	4.5	0	1148	1148
26/02/2022 0:00	3	3	4.5	3	3	0	1064	1064
26/02/2022 1:00	3	3	4.5	3	3	0	1059	1059
26/02/2022 2:00	3	3	4.5	3	3	0	1054	1055
26/02/2022 3:00	3	3	3	3	3	0	974	974
26/02/2022 4:00	3	3	3	3	3	0	972	972
26/02/2022 5:00	3	3	3	3	3	0	969	969
26/02/2022 6:00	3	3	3	3	3	0	967	967
26/02/2022 7:00	3	3	3	3	3	0	967	967
26/02/2022 8:00	3	3	3	3	3	0	967	967
26/02/2022 9:00	3	3	3	3	3	0	970	970
26/02/2022 10:00	3	3	4.5	3	3	0	1046	1046
26/02/2022 11:00	3	3	4.5	3	4	0	1132	1132
26/02/2022 12:00	3	3	4.5	3	4.5	0	1151	1151
26/02/2022 13:00	3	3	4.5	3	4.5	0	1172	1172
26/02/2022 14:00	3	3	4.5	3	4.5	0	1192	1192
26/02/2022 15:00	4.5	3	4.5	3	4.5	0	1301	1301
26/02/2022 16:00	4.5	3	4.5	3	4.5	0	1312	1312
26/02/2022 17:00	4.5	4.5	4.5	4.5	4.5	0	1529	1529
26/02/2022 18:00	4.5	4.5	4.5	4.5	4.5	0	1530	1530
26/02/2022 19:00	4.5	4.5	4.5	4.5	4.5	0	1535	1535
26/02/2022 20:00	4.5	4.5	4.5	4.5	4.5	0	1528	1528
26/02/2022 21:00	4.5	4.5	4.5	4.5	4.5	0	1511	1511
26/02/2022 22:00	4.5	4.5	4.5	4.5	4.5	0	1482	1482
26/02/2022 23:00	4.5	4.5	4.5	4.5	4.5	0	1458	1458
27/02/2022 0:00	4.5	4.5	4.5	4.5	4.5	0	1421	1421
27/02/2022 1:00	4.5	3	4.5	4.5	4.5	0	1316	1316
27/02/2022 2:00	4.5	3	4.5	3	4.5	0	1217	1217
27/02/2022 3:00	4.5	3	4.5	3	4.5	0	1202	1202
27/02/2022 4:00	4.5	3	4.5	3	3	0	1109	1109
27/02/2022 5:00	3	3	4.5	3	3	0	1034	1034
27/02/2022 6:00	3	3	3	3	3	0	963	963
27/02/2022 7:00	3	3	3	3	3	0	963	963

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m³/s)	(m³/s)	(m³/s)
27/02/2022 8:00	3	3	3	3	3	0	963	963
27/02/2022 9:00	3	3	3	3	3	0	961	961
27/02/2022 10:00	3	3	3	3	3	0	961	961
27/02/2022 11:00	3	3	3	3	3	0	959	959
27/02/2022 12:00	3	2	3	3	3	0	903	903
27/02/2022 13:00	3	3	3	3	3	0	974	974
27/02/2022 14:00	3	3	3	3	3	0	981	981
27/02/2022 15:00	3	3	4.5	3	3	0	1070	1070
27/02/2022 16:00	3	3	4.5	3	3	0	1070	1070
27/02/2022 17:00	3	3	4.5	3	3	0	1069	1069
27/02/2022 18:00	3	3	4.5	3	3	0	1054	1054
27/02/2022 19:00	3	3	3	3	3	0	965	966
27/02/2022 20:00	3	2	3	3	3	0	891	891
27/02/2022 21:00	3	2	3	3	3	0	881	881
27/02/2022 22:00	3	2	3	3	3	0	870	870
27/02/2022 23:00	2	2	3	2	3	0	752	753
28/02/2022 0:00	2	2	3	2	3	0	768	769
28/02/2022 1:00	2	2	2	2	2	0	608	609
28/02/2022 2:00	2	1	2	1	2	0	484	484
28/02/2022 3:00	1	1	2	1	1	0	363	363
28/02/2022 4:00	1	0	1	1	1	0	243	243
28/02/2022 5:00	0	0	1	0	1	0	121	122
28/02/2022 6:00	0	0	1	0	1	0	121	122
28/02/2022 7:00	0	0	1	0	1	0	121	121
28/02/2022 8:00	0	0	1	0	1	0	121	121
28/02/2022 9:00	0	0	1	0	1	0	121	121
28/02/2022 10:00	0	0	1	0	1	0	121	121
28/02/2022 11:00	0	0	1	0	1	0	121	121
28/02/2022 12:00	0	0	1	0	1	0	121	121
28/02/2022 13:00	0	0	1	0	1	0	121	121
28/02/2022 14:00	0	0	1	0	1	0	120	120
28/02/2022 15:00	0	0	1	0	1	0	120	120
28/02/2022 16:00	0	0	1	0	1	0	120	120
28/02/2022 17:00	0	0	1	0	1	0	120	120
28/02/2022 18:00	0	0	1	0	1	0	120	120
28/02/2022 19:00	0	0	1	0	1	0	120	120
28/02/2022 20:00	0	0	1	0	1	0	119	119
28/02/2022 21:00	0	0	1	0	1	0	119	119
28/02/2022 22:00	0	0	1	0	1	0	119	119
28/02/2022 23:00	0	0	1	0	1	0	119	119
1/03/2022 0:00	0	0	1	0	0.5	0	89	89

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m^3/s)	(m^3/s)	(m^3/s)
1/03/2022 1:00	0	0	1	0	0.5	0	89	89
1/03/2022 2:00	0	0	1	0	0.5	0	89	89
1/03/2022 3:00	0	0	1	0	0	0	59	59
1/03/2022 4:00	0	0	1	0	0	0	59	59
1/03/2022 5:00	0	0	1	0	0	0	59	59
1/03/2022 6:00	0	0	0.5	0	0	0	30	30
1/03/2022 7:00	0	0	0.5	0	0	0	30	30
1/03/2022 8:00	0	0	0.5	0	0	0	30	30
1/03/2022 9:00	0	0	0.5	0	0	0	30	30
1/03/2022 10:00	0	0	0.5	0	0	0	30	30
1/03/2022 11:00	0	0	0.5	0	0	0	30	30
1/03/2022 12:00	0	0	0.5	0	0	0	30	30
1/03/2022 13:00	0	0	0	0	0	31	0	31
1/03/2022 14:00	0	0	0	0	0	31	0	31
1/03/2022 15:00	0	0	0	0	0	30	0	30
1/03/2022 16:00	0	0	0	0	0	30	0	30
1/03/2022 17:00	0	0	0	0	0	30	0	30
1/03/2022 18:00	0	0	0	0	0	30	0	30
1/03/2022 19:00	0	0	0	0	0	31	0	31
1/03/2022 20:00	0	0	0	0	0	31	0	31
1/03/2022 21:00	0	0	0	0	0	31	0	31
1/03/2022 22:00	0	0	0	0	0	31	0	31
1/03/2022 23:00	0	0	0	0	0	31	0	31
2/03/2022 0:00	0	0	0	0	0	31	0	31
2/03/2022 1:00	0	0	0	0	0	31	0	31
2/03/2022 2:00	0	0	0	0	0	31	0	31
2/03/2022 3:00	0	0	0	0	0	31	0	31
2/03/2022 4:00	0	0	0	0	0	31	0	31
2/03/2022 5:00	0	0	0	0	0	31	0	31
2/03/2022 6:00	0	0	0	0	0	31	0	31
2/03/2022 7:00	0	0	0	0	0	31	0	31
2/03/2022 8:00	0	0	0	0	0	31	0	31
2/03/2022 9:00	0	0	0	0	0	31	0	31
2/03/2022 10:00	0	0	0	0	0	31	0	31
2/03/2022 11:00	0	0	0	0	0	31	0	31
2/03/2022 12:00	0	0	0	0	0	31	0	31
2/03/2022 13:00	0	0	0	0	0	31	0	31
2/03/2022 14:00	0	0	0	0	0	31	0	31
2/03/2022 15:00	0	0	0	0	0	31	0	31
2/03/2022 16:00	0	0	0	0	0	31	0	31
2/03/2022 17:00	0	0	0	0	0	31	0	31

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m³/s)	(m³/s)	(m³/s)
2/03/2022 18:00	0	0	0	0	0	31	0	31
2/03/2022 19:00	0	0	0	0	0	31	0	31
2/03/2022 20:00	0	0	0	0	0	31	0	31
2/03/2022 21:00	0	0	0	0	0	31	0	31
2/03/2022 22:00	0	0	0	0	0	31	0	31
2/03/2022 23:00	0	0	0	0	0	31	0	31
3/03/2022 0:00	0	0	0	0	0	31	0	31
3/03/2022 1:00	0	0	0	0	0	31	0	31
3/03/2022 2:00	0	0	0	0	0	31	0	31
3/03/2022 3:00	0	0	0	0	0	31	0	31
3/03/2022 4:00	0	0	0	0	0	31	0	31
3/03/2022 5:00	0	0	0	0	0	12	0	12
3/03/2022 6:00	0	0	0	0	0	12	0	12
3/03/2022 7:00	0	0	0	0	0	12	0	12
3/03/2022 8:00	0	0	0	0	0	12	0	12
3/03/2022 9:00	0	0	0	0	0	12	0	12
3/03/2022 10:00	0	0	0	0	0	31	0	31
3/03/2022 11:00	0	0	1	0	0	31	60	91
3/03/2022 12:00	0	0	1	0	0.5	0	90	90
3/03/2022 13:00	0	0	1	0	0.5	0	90	90
3/03/2022 14:00	0	0	1	0	0.5	0	90	90
3/03/2022 15:00	0	0	1	0	0.5	0	90	91
3/03/2022 16:00	0	0	1	0	0.5	0	91	91
3/03/2022 17:00	0	0	1	0	0.5	0	91	91
3/03/2022 18:00	0	0	1	0	0.5	0	91	91
3/03/2022 19:00	0	0	1	0	0	0	60	60
3/03/2022 20:00	0	0	1	0	0	0	60	60
3/03/2022 21:00	0	0	1	0	0	0	60	60
3/03/2022 22:00	0	0	1	0	0	0	60	60
3/03/2022 23:00	0	0	1	0	0	0	60	60
4/03/2022 0:00	0	0	1	0	0	0	60	60
4/03/2022 1:00	0	0	1	0	0	0	60	60
4/03/2022 2:00	0	0	1	0	0	0	60	60
4/03/2022 3:00	0	0	0.5	0	0	0	30	30
4/03/2022 4:00	0	0	0.5	0	0	0	30	30
4/03/2022 5:00	0	0	0.5	0	0	0	30	30
4/03/2022 6:00	0	0	0.5	0	0	0	30	30
4/03/2022 7:00	0	0	0.5	0	0	0	30	30
4/03/2022 8:00	0	0	0.5	0	0	0	30	30
4/03/2022 9:00	0	0	0.5	0	0	0	30	30
4/03/2022 10:00	0	0	0.5	0	0	0	30	30

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m³/s)	(m³/s)	(m³/s)
4/03/2022 11:00	0	0	0.5	0	0	0	30	30
4/03/2022 12:00	0	0	0.5	0	0	0	30	30
4/03/2022 13:00	0	0	0.5	0	0	0	30	30
4/03/2022 14:00	0	0	0.5	0	0	0	30	30
4/03/2022 15:00	0	0	0.5	0	0	0	30	30
4/03/2022 16:00	0	0	0.5	0	0	0	30	30
4/03/2022 17:00	0	0	0	0	0	0	0	0
4/03/2022 18:00	0	0	0	0	0	31	0	31
4/03/2022 19:00	0	0	0	0	0	31	0	31
4/03/2022 20:00	0	0	0	0	0	31	0	31
4/03/2022 21:00	0	0	0	0	0	31	0	31
4/03/2022 22:00	0	0	0	0	0	31	0	31
4/03/2022 23:00	0	0	0	0	0	31	0	31
5/03/2022 0:00	0	0	0	0	0	31	0	31
5/03/2022 1:00	0	0	0	0	0	31	0	31
5/03/2022 2:00	0	0	0	0	0	31	0	31
5/03/2022 3:00	0	0	0	0	0	31	0	31
5/03/2022 4:00	0	0	0	0	0	31	0	31
5/03/2022 5:00	0	0	0	0	0	31	0	31
5/03/2022 6:00	0	0	0	0	0	31	0	31
5/03/2022 7:00	0	0	0	0	0	31	0	31
5/03/2022 8:00	0	0	0	0	0	31	0	31
5/03/2022 9:00	0	0	0	0	0	15	0	15
5/03/2022 10:00	0	0	0	0	0	15	0	15
5/03/2022 11:00	0	0	0	0	0	15	0	15
5/03/2022 12:00	0	0	0	0	0	15	0	15
5/03/2022 13:00	0	0	0	0	0	15	0	15
5/03/2022 14:00	0	0	0	0	0	15	0	15
5/03/2022 15:00	0	0	0	0	0	15	0	15
5/03/2022 16:00	0	0	0	0	0	15	0	15
5/03/2022 17:00	0	0	0	0	0	15	0	15
5/03/2022 18:00	0	0	0	0	0	15	0	15
5/03/2022 19:00	0	0	0	0	0	15	0	15
5/03/2022 20:00	0	0	0	0	0	15	0	15
5/03/2022 21:00	0	0	0	0	0	15	0	15
5/03/2022 22:00	0	0	0	0	0	15	0	15
5/03/2022 23:00	0	0	0	0	0	15	0	15
6/03/2022 0:00	0	0	0	0	0	15	0	15
6/03/2022 1:00	0	0	0	0	0	15	0	15
6/03/2022 2:00	0	0	0	0	0	15	0	15
6/03/2022 3:00	0	0	0	0	0	15	0	15

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m³/s)	(m³/s)	(m³/s)
6/03/2022 4:00	0	0	0	0	0	15	0	15
6/03/2022 5:00	0	0	0	0	0	15	0	15
6/03/2022 6:00	0	0	0	0	0	15	0	15
6/03/2022 7:00	0	0	0	0	0	15	0	15
6/03/2022 8:00	0	0	0	0	0	15	0	15
6/03/2022 9:00	0	0	0	0	0	15	0	15
6/03/2022 10:00	0	0	0	0	0	15	0	15
6/03/2022 11:00	0	0	0	0	0	15	0	15
6/03/2022 12:00	0	0	0	0	0	31	0	31
6/03/2022 13:00	0	0	0	0	0	31	0	31
6/03/2022 14:00	0	0	0	0	0	31	0	31
6/03/2022 15:00	0	0	0	0	0	31	0	31
6/03/2022 16:00	0	0	0	0	0	31	0	31
6/03/2022 17:00	0	0	0	0	0	31	0	31
6/03/2022 18:00	0	0	0	0	0	31	0	31
6/03/2022 19:00	0	0	0	0	0	31	0	31
6/03/2022 20:00	0	0	0	0	0	31	0	31
6/03/2022 21:00	0	0	0	0	0	31	0	31
6/03/2022 22:00	0	0	0	0	0	31	0	31
6/03/2022 23:00	0	0	0	0	0	31	0	31
7/03/2022 0:00	0	0	0	0	0	31	0	31
7/03/2022 1:00	0	0	0	0	0	31	0	31
7/03/2022 2:00	0	0	0	0	0	31	0	31
7/03/2022 3:00	0	0	0	0	0	31	0	31
7/03/2022 4:00	0	0	0	0	0	31	0	31
7/03/2022 5:00	0	0	0	0	0	31	0	31
7/03/2022 6:00	0	0	0	0	0	31	0	31
7/03/2022 7:00	0	0	0	0	0	31	0	31
7/03/2022 8:00	0	0	0	0	0	31	0	31
7/03/2022 9:00	0	0	0	0	0	31	0	31
7/03/2022 10:00	0	0	0	0	0	31	0	31
7/03/2022 11:00	0	0	0	0	0	31	0	31
7/03/2022 12:00	0	0	0	0	0	26	0	26
7/03/2022 13:00	0	0	0	0	0	26	0	26
7/03/2022 14:00	0	0	0	0	0	26	0	26
7/03/2022 15:00	0	0	0	0	0	26	0	26
7/03/2022 16:00	0	0	0	0	0	26	0	26
7/03/2022 17:00	0	0	0	0	0	26	0	26
7/03/2022 18:00	0	0	0	0	0	5	0	5
7/03/2022 19:00	0	0	0	0	0	5	0	5
7/03/2022 20:00	0	0	0	0	0	5	0	5

Date time	Opened (settings)					Outflow (release)		
	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Regulator	Gate	Total
	(m)	(m)	(m)	(m)	(m)	(m^3/s)	(m^3/s)	(m^3/s)
7/03/2022 21:00	0	0	0	0	0	5	0	5
7/03/2022 22:00	0	0	0	0	0	5	0	5
7/03/2022 23:00	0	0	0	0	0	5	0	5
8/03/2022 0:00	0	0	0	0	0	5	0	5
8/03/2022 1:00	0	0	0	0	0	5	0	5
8/03/2022 2:00	0	0	0	0	0	5	0	5
8/03/2022 3:00	0	0	0	0	0	5	0	5
8/03/2022 4:00	0	0	0	0	0	5	0	5
8/03/2022 5:00	0	0	0	0	0	5	0	5
8/03/2022 6:00	0	0	0	0	0	5	0	5
8/03/2022 7:00	0	0	0	0	0	5	0	5
8/03/2022 8:00	0	0	0	0	0	5	0	5
8/03/2022 9:00	0	0	0	0	0	5	0	5

Appendix B Model Run Summary

Table B-2: FFS Model Simulation Summary for North Pine Dam for the period from 12:30 22/02/2022 to 07:30 09/03/2022

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
22/02/2022 12:30	339	35.94	0	0	1
22/02/2022 13:00	338	35.94	0	204	206
23/02/2022 05:15	337	36.19	115	212	221
23/02/2022 05:30	336	36.10	115	272	290
23/02/2022 06:30	335	36.05	77	270	278
23/02/2022 06:45	333	36.05	77	241	251
23/02/2022 07:45	332	36.13	66	0	10
23/02/2022 08:15	331	36.13	66	0	8
23/02/2022 09:45	330	36.09	49	0	8
23/02/2022 10:30	329	36.09	49	0	8
23/02/2022 11:15	328	36.09	51	0	8
23/02/2022 12:30	326	36.04	52	30	39
23/02/2022 13:00	325	36.04	52	30	39
23/02/2022 17:00	322	36.04	50	31	40
23/02/2022 18:30	321	36.04	50	31	40
24/02/2022 00:45	320	36.15	66	31	58
24/02/2022 01:45	319	36.10	68	31	58
24/02/2022 02:15	318	36.15	92	31	58
24/02/2022 02:45	317	36.18	96	31	58
24/02/2022 05:30	315	36.08	97	60	78
24/02/2022 07:15	314	36.02	84	60	77
24/02/2022 08:45	313	36.02	85	60	77
24/02/2022 10:00	312	36.02	85	60	77
24/02/2022 15:45	311	36.02	85	60	77
24/02/2022 16:15	310	36.02	85	60	77
24/02/2022 16:30	308	36.02	82	60	79
24/02/2022 18:00	307	36.05	86	60	79
24/02/2022 19:30	306	36.05	86	60	79
24/02/2022 20:00	305	36.06	86	60	79
24/02/2022 20:30	304	36.07	86	60	79
24/02/2022 21:30	303	36.07	86	60	79
24/02/2022 22:00	302	36.07	86	60	79
25/02/2022 00:00	301	36.23	73	60	79
25/02/2022 00:15	300	36.23	74	60	79
25/02/2022 00:45	299	36.11	74	91	101
25/02/2022 02:00	298	36.17	75	91	101
25/02/2022 02:15	297	36.17	75	91	101
25/02/2022 02:30	295	36.17	75	91	101

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
25/02/2022 03:00	294	36.17	75	91	101
25/02/2022 04:15	293	36.17	75	91	101
25/02/2022 04:30	292	36.17	75	91	101
25/02/2022 05:00	291	36.16	75	91	101
25/02/2022 05:15	290	36.17	79	91	101
25/02/2022 07:00	289	36.66	227	93	114
25/02/2022 07:30	288	36.15	269	272	299
25/02/2022 08:15	287	36.32	370	277	308
25/02/2022 09:00	286	36.53	556	285	318
25/02/2022 09:15	285	36.37	604	374	411
25/02/2022 09:45	284	36.56	827	383	442
25/02/2022 10:00	283	36.56	960	507	579
25/02/2022 10:30	282	36.63	1035	511	584
25/02/2022 11:00	281	36.57	1061	663	748
25/02/2022 11:15	280	36.58	1068	663	752
25/02/2022 11:30	279	36.58	1068	663	752
25/02/2022 12:30	278	36.59	1068	664	755
25/02/2022 12:45	277	36.59	1068	664	757
25/02/2022 13:00	276	36.60	1068	665	759
25/02/2022 13:15	275	36.59	1068	754	842
25/02/2022 14:00	274	36.59	1068	754	858
25/02/2022 14:30	273	36.60	1068	754	869
25/02/2022 14:45	272	36.60	1068	754	869
25/02/2022 15:00	271	36.60	1068	755	891
25/02/2022 15:15	268	36.66	1068	760	913
25/02/2022 15:30	267	36.64	1068	818	972
25/02/2022 15:45	265	36.81	1092	835	1002
25/02/2022 16:00	264	36.85	1238	932	1103
25/02/2022 16:15	263	36.90	1320	937	1110
25/02/2022 16:30	262	36.89	1320	1038	1188
25/02/2022 16:45	259	36.94	1396	1041	1203
25/02/2022 17:00	258	37.01	1440	1041	1240
25/02/2022 17:15	257	37.03	1458	1062	1258
25/02/2022 17:30	256	37.04	1465	1064	1265
25/02/2022 18:00	255	37.06	1477	1148	1355
25/02/2022 18:15	254	37.07	1477	1151	1363
25/02/2022 18:30	253	37.07	1477	1152	1369
25/02/2022 18:45	252	37.08	1477	1154	1374
25/02/2022 19:00	251	37.09	1477	1155	1379
25/02/2022 20:15	250	37.10	1477	1159	1385
25/02/2022 20:45	249	37.10	1477	1159	1385

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
25/02/2022 22:00	247	37.08	1580	1155	1386
25/02/2022 22:15	246	37.08	1580	1155	1386
25/02/2022 23:45	245	37.08	1580	1155	1386
26/02/2022 00:45	244	37.02	1502	1139	1366
26/02/2022 01:15	242	37.11	1530	1161	1388
26/02/2022 02:30	241	37.11	1530	1161	1393
26/02/2022 04:15	238	37.11	1530	1161	1393
26/02/2022 04:30	237	38.50	1460	1156	1386
26/02/2022 04:45	236	38.53	1460	1156	1386
26/02/2022 05:00	235	37.09	1460	1156	1386
26/02/2022 05:15	233	37.09	1460	1156	1386
26/02/2022 06:15	231	37.16	1460	1156	1386
26/02/2022 07:45	228	37.51	1460	1156	1386
26/02/2022 08:15	227	37.85	1460	1156	1386
26/02/2022 08:45	226	37.95	1460	1156	1386
26/02/2022 09:00	225	37.56	1503	1156	1386
26/02/2022 09:30	224	37.66	1551	1156	1386
26/02/2022 09:45	221	37.71	1564	1156	1386
26/02/2022 10:00	219	37.65	1571	1165	1405
26/02/2022 10:30	218	37.74	1579	1172	1415
26/02/2022 11:15	217	37.87	1579	1179	1422
26/02/2022 11:30	216	37.75	1550	1152	1395
26/02/2022 12:00	215	38.01	1579	1182	1425
26/02/2022 12:15	214	38.04	1579	1183	1425
26/02/2022 13:00	213	37.21	1579	1185	1425
26/02/2022 13:30	212	37.27	1579	1198	1438
26/02/2022 14:30	211	37.37	1579	1221	1458
26/02/2022 14:45	210	37.33	1579	1312	1547
26/02/2022 16:00	209	37.35	1595	1418	1666
26/02/2022 17:00	207	37.36	1602	1523	1754
26/02/2022 17:45	206	37.38	1602	1532	1772
26/02/2022 18:30	204	37.38	1602	1532	1774
26/02/2022 19:45	203	37.38	1602	1532	1774
26/02/2022 22:00	200	37.43	1652	1553	1796
26/02/2022 22:15	199	37.43	1652	1553	1796
26/02/2022 22:30	196	37.43	1652	1553	1796
26/02/2022 22:45	194	37.38	1639	1532	1774
27/02/2022 02:00	193	37.42	1665	1547	1789
27/02/2022 02:15	192	37.42	1665	1547	1789
27/02/2022 03:30	191	37.42	1687	1546	1788
27/02/2022 05:00	189	37.42	1687	1546	1788

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
27/02/2022 05:15	188	37.42	1687	1546	1788
27/02/2022 05:30	186	37.42	1687	1546	1788
27/02/2022 05:45	185	37.42	1687	1546	1788
27/02/2022 07:30	184	37.41	1684	1544	1785
27/02/2022 07:45	183	37.41	1684	1544	1785
27/02/2022 08:00	182	37.41	1684	1544	1785
27/02/2022 09:00	181	37.41	1684	1544	1785
27/02/2022 10:00	180	37.38	1675	1531	1773
27/02/2022 11:00	178	35.93	879	946	1122
27/02/2022 11:15	177	37.40	1692	1540	1781
27/02/2022 11:45	176	37.42	1697	1546	1795
27/02/2022 12:00	175	37.45	1705	1560	1808
27/02/2022 12:15	174	37.46	1710	1567	1815
27/02/2022 12:30	173	37.46	1716	1564	1813
27/02/2022 13:00	172	37.49	1724	1578	1824
27/02/2022 13:15	171	37.84	1729	1584	1829
27/02/2022 13:45	170	37.50	1729	1584	1829
27/02/2022 14:30	169	37.51	1734	1588	1834
27/02/2022 15:00	168	37.51	1734	1588	1890
27/02/2022 15:15	167	37.51	1734	1588	1903
27/02/2022 15:30	166	37.51	1734	1588	1949
27/02/2022 16:00	164	37.51	1734	1588	1996
27/02/2022 16:15	163	37.51	1734	1588	1999
27/02/2022 16:45	162	37.51	1734	1588	1999
27/02/2022 17:00	161	37.51	1734	1588	1999
27/02/2022 17:15	160	37.43	1679	1550	1994
27/02/2022 17:45	159	37.54	1768	1603	1994
27/02/2022 18:15	157	37.53	1764	1597	1987
27/02/2022 18:30	156	37.53	1764	1597	1987
27/02/2022 18:45	155	37.53	1764	1597	1987
27/02/2022 19:30	154	37.44	1740	1556	1969
Note model simulations from 27/2/2022 20:00 to 28/2/2022 01:45 shifted focus to aiming to achieve a better calibration of current lake level and falling trend at the time and consequently adversely impacted the predicted peak flow and predicted peak level that had already occurred. *This was rectified after the 28/2/2022 01:45 model run.*					
27/02/2022 20:00	149	38.24	2827	1900	2125
27/02/2022 20:30	148	38.24	2827	1900	2125
27/02/2022 22:15	147	38.17	2638	1876	2103
27/02/2022 23:00	146	38.17	2638	1876	2103
27/02/2022 23:15	144	38.17	2638	1876	2103
27/02/2022 23:30	143	38.17	2638	1876	2103
28/02/2022 00:00	142	38.17	2638	1876	2103

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
28/02/2022 00:15	141	38.17	2638	1876	2115
28/02/2022 00:30	140	38.17	2638	1876	2115
28/02/2022 00:45	139	38.17	2638	1876	2115
28/02/2022 01:45	137	38.17	2638	1876	2115
28/02/2022 02:00	135	37.47	1725	1571	1893
28/02/2022 03:00	133	37.51	1735	1587	1898
28/02/2022 05:15	132	37.51	1735	1587	1898
28/02/2022 07:30	131	37.54	1735	1599	1925
28/02/2022 08:00	130	37.54	1735	1599	1925
28/02/2022 11:15	129	37.54	1735	1599	1925
28/02/2022 11:30	128	37.54	1736	1600	1926
28/02/2022 19:15	126	37.54	1736	1600	1926
28/02/2022 20:15	125	37.54	1736	1600	1926
28/02/2022 20:30	124	37.54	1736	1600	1926
28/02/2022 21:15	122	37.54	1736	1600	1926
28/02/2022 21:30	120	37.54	1736	1600	1926
28/02/2022 22:30	119	37.54	1736	1601	1927
28/02/2022 22:45	118	37.54	1736	1601	1927
01/03/2022 00:00	115	37.54	1737	1601	1927
01/03/2022 01:00	114	37.54	1737	1601	1927
01/03/2022 02:15	113	37.54	1737	1601	1927
01/03/2022 03:45	112	37.54	1737	1601	1927
01/03/2022 04:45	111	37.54	1737	1601	1927
01/03/2022 05:15	110	37.54	1737	1601	1927
01/03/2022 11:15	109	37.54	1737	1601	1927
01/03/2022 11:30	108	37.54	1737	1601	1927
01/03/2022 18:15	107	37.54	1737	1601	1927
01/03/2022 20:45	106	37.54	1737	1601	1927
01/03/2022 21:00	105	37.54	1737	1601	1927
02/03/2022 03:30	104	37.54	1737	1601	1845
02/03/2022 03:45	103	37.54	1737	1601	1929
02/03/2022 04:15	102	37.54	1737	1601	1929
02/03/2022 04:30	100	37.54	1736	1601	1928
02/03/2022 06:00	96	37.54	1736	1601	1928
02/03/2022 06:15	95	37.54	1736	1601	1928
02/03/2022 07:15	93	37.54	1736	1601	1928
02/03/2022 10:45	92	37.54	1744	1599	1928
02/03/2022 15:00	91	37.56	1744	1607	1930
03/03/2022 04:30	89	37.56	1744	1607	1928
03/03/2022 04:45	88	37.56	1744	1607	1928
03/03/2022 06:00	87	37.56	1744	1607	1928

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
03/03/2022 07:30	86	37.55	1739	1605	1870
03/03/2022 08:30	85	37.54	1739	1601	1853
03/03/2022 10:00	84	37.53	1736	1596	1848
03/03/2022 10:30	83	37.53	1736	1596	1848
03/03/2022 11:45	82	37.43	1647	1551	1819
03/03/2022 12:30	80	37.46	1686	1567	1818
03/03/2022 12:45	79	37.46	1708	1565	1816
03/03/2022 14:00	78	37.46	1708	1565	1816
03/03/2022 17:30	77	37.42	1676	1548	1799
03/03/2022 18:00	76	37.43	1676	1554	1805
03/03/2022 19:00	75	37.43	1676	1554	1805
03/03/2022 19:30	74	37.43	1676	1554	1805
03/03/2022 22:00	73	37.44	1676	1558	1809
03/03/2022 22:45	70	37.44	1676	1558	1809
03/03/2022 23:00	65	37.44	1676	1558	1809
04/03/2022 02:15	64	37.44	1676	1558	1809
04/03/2022 03:45	63	37.44	1676	1558	1809
04/03/2022 04:45	62	37.44	1676	1558	1809
04/03/2022 05:15	61	37.44	1676	1558	1809
04/03/2022 05:45	59	37.44	1673	1557	1807
04/03/2022 08:30	58	37.45	1676	1559	1810
04/03/2022 09:45	57	37.45	1676	1560	1811
04/03/2022 10:00	56	37.45	1676	1559	1810
04/03/2022 12:00	55	37.45	1676	1559	1810
04/03/2022 12:30	54	37.45	1676	1559	1810
04/03/2022 13:00	53	37.45	1676	1559	1810
04/03/2022 13:30	52	37.45	1676	1560	1811
04/03/2022 15:00	51	37.45	1676	1560	1811
04/03/2022 17:45	50	37.45	1676	1560	1811
04/03/2022 18:45	49	37.45	1676	1560	1811
04/03/2022 22:30	48	37.45	1676	1560	1811
05/03/2022 00:00	47	37.45	1676	1560	1811
05/03/2022 01:45	46	37.45	1676	1560	1811
05/03/2022 04:30	44	37.45	1676	1560	1811
05/03/2022 05:45	42	37.45	1676	1560	1811
05/03/2022 07:30	41	37.45	1676	1560	1811
05/03/2022 14:45	40	37.45	1676	1560	1811
05/03/2022 18:45	39	37.45	1676	1560	1811
05/03/2022 19:00	38	37.45	1676	1560	1811
06/03/2022 00:30	37	37.45	1676	1560	1811
06/03/2022 03:45	36	37.45	1676	1560	1811

Date time	FFS run number	Predicted Peak Lake Level (m AHD)	Predicted Peak Inflow (m^3/s)	Predicted Peak Outflow (m^3/s)	Predicted peak flow at AJ Wyllie Bridge (m^3/s)
06/03/2022 05:00	35	37.45	1676	1560	1811
06/03/2022 08:30	34	37.45	1676	1560	1811
06/03/2022 10:30	33	37.45	1676	1560	1811
06/03/2022 11:00	32	37.45	1676	1560	1811
06/03/2022 12:45	31	37.75	1894	1693	1943
06/03/2022 13:00	29	37.75	1894	1693	1943
06/03/2022 14:45	27	37.75	1894	1693	1943
06/03/2022 15:00	26	37.75	1894	1693	1943
06/03/2022 15:15	25	37.75	1894	1693	1943
06/03/2022 16:30	24	37.75	1894	1693	1943
06/03/2022 17:15	23	37.75	1894	1693	1943
06/03/2022 17:45	22	37.75	1894	1693	1943
06/03/2022 20:30	21	37.47	1706	1569	1825
06/03/2022 22:15	20	37.44	1699	1556	1812
06/03/2022 22:45	18	37.44	1699	1556	1812
07/03/2022 00:15	17	37.44	1699	1556	1812
07/03/2022 02:15	16	37.44	1699	1557	1812
07/03/2022 06:00	15	37.44	1699	1557	1812
07/03/2022 07:30	14	37.44	1699	1557	1812
07/03/2022 09:15	13	37.44	1699	1557	1812
07/03/2022 09:45	11	37.44	1699	1557	1812
07/03/2022 11:30	10	37.44	1699	1557	1812
07/03/2022 13:00	9	37.44	1699	1557	1812
07/03/2022 13:15	8	37.44	1699	1557	1812
07/03/2022 18:00	7	37.44	1699	1557	1812
07/03/2022 18:45	6	37.44	1699	1557	1812
07/03/2022 20:30	5	37.44	1699	1557	1812
08/03/2022 00:00	4	37.44	1699	1557	1812
08/03/2022 07:00	3	37.44	1699	1557	1812
09/03/2022 06:00	2	37.44	1699	1557	1812
09/03/2022 07:30	1	35.99	13	31	37

Appendix C North Pine Dam Lake Level Data

Table C-1: North Pine Dam Recorded Lake Level Data

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
22/02/2022 9:58		35.93	
22/02/2022 10:20		35.94	
22/02/2022 10:20			35.92
22/02/2022 12:58		35.93	
22/02/2022 13:20			35.94
22/02/2022 15:58		35.93	
22/02/2022 16:20		35.94	
22/02/2022 16:20			35.94
22/02/2022 18:58		35.93	
22/02/2022 19:20		35.94	
22/02/2022 19:20			35.94
22/02/2022 21:58		35.93	
22/02/2022 22:20			35.94
23/02/2022 0:58		35.95	
23/02/2022 1:11			35.96
23/02/2022 1:11		35.96	
23/02/2022 1:20		35.96	
23/02/2022 1:20			35.96
23/02/2022 3:32		35.97	
23/02/2022 3:34		35.98	
23/02/2022 3:58		35.97	
23/02/2022 4:20		35.98	
23/02/2022 6:20		36.00	
23/02/2022 6:20			36.00
23/02/2022 6:58		35.99	
23/02/2022 7:00	35.99		
23/02/2022 7:20		36.00	
23/02/2022 7:20			36.00
23/02/2022 8:00	36.00		
23/02/2022 9:00	36.00		
23/02/2022 9:58		35.99	
23/02/2022 10:00	36.01		
23/02/2022 10:20		36.02	
23/02/2022 10:20			36.02
23/02/2022 11:00	36.01		
23/02/2022 12:58		36.01	
23/02/2022 13:00	36.02		
23/02/2022 13:20		36.02	
23/02/2022 13:20			36.02
23/02/2022 14:00	36.02		

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
23/02/2022 15:00	36.02		
23/02/2022 15:58		36.01	
23/02/2022 16:00	36.02		
23/02/2022 16:20		36.02	
23/02/2022 16:20			36.02
23/02/2022 17:00	36.02		
23/02/2022 18:00	36.02		
23/02/2022 18:58		36.01	
23/02/2022 19:00	36.01		
23/02/2022 19:20		36	
23/02/2022 19:20			36.02
23/02/2022 20:00	36.01		
23/02/2022 21:00	36.01		
23/02/2022 21:58		36.01	
23/02/2022 22:00	36.01		
23/02/2022 22:20		36.02	
23/02/2022 22:20			36.02
23/02/2022 23:00	36.02		
24/02/2022 0:00	36.02		
24/02/2022 0:58		36.01	
24/02/2022 1:00	36.02		
24/02/2022 1:20		36.02	
24/02/2022 1:20			36.02
24/02/2022 2:00	36.02		
24/02/2022 3:00	36.03		
24/02/2022 3:58		36.01	
24/02/2022 4:00	36.02		
24/02/2022 4:20		36.02	
24/02/2022 4:20			36.02
24/02/2022 5:00	36.02		
24/02/2022 6:00	36.02		
24/02/2022 6:58		36.01	
24/02/2022 7:00	36.02		
24/02/2022 7:20		36.02	
24/02/2022 7:20			36.02
24/02/2022 8:00	36.01		
24/02/2022 9:00	36.01		
24/02/2022 9:58		35.99	
24/02/2022 10:00	36.01		
24/02/2022 10:20			36.00
24/02/2022 11:00	36.00		
24/02/2022 12:00	36.00		
24/02/2022 12:58		35.99	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
24/02/2022 13:00	36.00		
24/02/2022 13:20		36.00	
24/02/2022 13:20			36.00
24/02/2022 14:00	36.00		
24/02/2022 15:58		35.99	
24/02/2022 16:00	36.00		
24/02/2022 16:20		36.00	
24/02/2022 16:20			36.00
24/02/2022 17:00	36.00		
24/02/2022 18:00	36.00		
24/02/2022 18:58		36.01	
24/02/2022 19:00	36.01		
24/02/2022 19:20		36.02	
24/02/2022 19:20			36.00
24/02/2022 20:41			36.02
24/02/2022 21:00	36.02		
24/02/2022 21:37		36.03	
24/02/2022 21:58		36.01	
24/02/2022 22:20		36.04	
24/02/2022 22:20			36.04
24/02/2022 23:00	36.04		
25/02/2022 0:36		36.03	
25/02/2022 0:50			36.06
25/02/2022 0:58		36.05	
25/02/2022 1:00	36.05		
25/02/2022 1:20		36.06	
25/02/2022 1:20			36.06
25/02/2022 3:00	36.05		
25/02/2022 3:58		36.05	
25/02/2022 4:20		36.06	
25/02/2022 4:20			36.06
25/02/2022 5:00	36.06		
25/02/2022 6:55		36.07	
25/02/2022 6:57			36.08
25/02/2022 6:58		36.07	
25/02/2022 7:00	36.08		
25/02/2022 7:20			36.10
25/02/2022 7:25		36.09	
25/02/2022 7:55		36.10	
25/02/2022 8:00	36.11		
25/02/2022 8:05			36.12
25/02/2022 8:39		36.12	
25/02/2022 8:56			36.14

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
25/02/2022 9:00	36.13		
25/02/2022 9:03		36.13	
25/02/2022 9:09			36.16
25/02/2022 9:12		36.15	
25/02/2022 9:20			36.18
25/02/2022 9:23		36.17	
25/02/2022 9:29			36.20
25/02/2022 9:30		36.19	
25/02/2022 9:47		36.21	
25/02/2022 9:56			36.24
25/02/2022 9:58		36.23	
25/02/2022 10:00	36.26		
25/02/2022 10:04		36.25	36.26
25/02/2022 10:04		36.26	
25/02/2022 10:20		36.29	
25/02/2022 10:20		36.28	
25/02/2022 10:20			36.28
25/02/2022 10:32			36.30
25/02/2022 10:34		36.31	
25/02/2022 10:43			36.32
25/02/2022 10:44		36.33	
25/02/2022 10:51			36.34
25/02/2022 10:53		36.35	
25/02/2022 11:00	36.36		
25/02/2022 11:02			36.36
25/02/2022 11:04		36.37	
25/02/2022 11:18		36.39	
25/02/2022 11:27			36.40
25/02/2022 11:28		36.41	
25/02/2022 11:42		36.43	
25/02/2022 11:52			36.44
25/02/2022 11:57		36.45	
25/02/2022 12:00	36.46		
25/02/2022 12:09			36.48
25/02/2022 12:12		36.47	
25/02/2022 12:26		36.50	36.50
25/02/2022 12:32		36.49	
25/02/2022 12:51			36.52
25/02/2022 12:55		36.51	
25/02/2022 12:58		36.51	
25/02/2022 13:00	36.52		
25/02/2022 13:10		36.54	
25/02/2022 13:20		36.54	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
25/02/2022 13:20			36.54
25/02/2022 13:51		36.55	
25/02/2022 13:54			36.56
25/02/2022 14:00	36.57		
25/02/2022 14:18		36.57	
25/02/2022 14:42		36.59	
25/02/2022 14:52		36.61	
25/02/2022 14:53		36.62	
25/02/2022 14:57			36.62
25/02/2022 15:00	36.64		
25/02/2022 15:05		36.63	
25/02/2022 15:17		36.65	
25/02/2022 15:23			36.66
25/02/2022 15:27		36.67	
25/02/2022 15:28		36.68	
25/02/2022 15:34			36.70
25/02/2022 15:41		36.69	
25/02/2022 15:42		36.70	
25/02/2022 15:48			36.72
25/02/2022 15:51		36.71	
25/02/2022 15:55			36.74
25/02/2022 15:58		36.73	
25/02/2022 16:00	36.75		
25/02/2022 16:05			36.76
25/02/2022 16:07		36.75	
25/02/2022 16:08		36.76	
25/02/2022 16:20			36.78
25/02/2022 16:21		36.79	
25/02/2022 16:29		36.81	
25/02/2022 16:38			36.82
25/02/2022 16:49			36.84
25/02/2022 16:50		36.85	
25/02/2022 16:59			36.86
25/02/2022 17:00	36.88		
25/02/2022 17:00		36.87	
25/02/2022 17:11			36.88
25/02/2022 17:12		36.89	
25/02/2022 17:21		36.91	36.90
25/02/2022 17:29		36.92	
25/02/2022 17:33			36.92
25/02/2022 17:33		36.93	
25/02/2022 17:45		36.95	
25/02/2022 17:46			36.94

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
25/02/2022 17:58		36.97	
25/02/2022 18:00	36.99		
25/02/2022 18:07		36.99	
25/02/2022 18:09			37.00
25/02/2022 18:16		37.02	
25/02/2022 18:18		37.01	
25/02/2022 18:50		37.03	
25/02/2022 19:00	37.05		
25/02/2022 19:09		37.06	
25/02/2022 19:20		37.06	
25/02/2022 19:49		37.05	
25/02/2022 19:49		37.05	
25/02/2022 20:00	37.07		
25/02/2022 21:00	37.07		
25/02/2022 21:58		37.07	
25/02/2022 22:00	37.08		
25/02/2022 23:00	37.07		
25/02/2022 23:14		37.05	
25/02/2022 23:14			37.06
25/02/2022 23:19		37.06	
25/02/2022 23:52		37.03	
26/02/2022 0:00	37.05		
26/02/2022 0:06		37.04	
26/02/2022 0:30	37.04		
26/02/2022 0:58		37.01	
26/02/2022 1:00	37.03		
26/02/2022 1:11			37.00
26/02/2022 1:13		37.02	
26/02/2022 1:30	37.01		
26/02/2022 1:30		36.99	
26/02/2022 1:52		37.00	
26/02/2022 1:55			36.98
26/02/2022 2:00	37.00		
26/02/2022 2:06		36.97	
26/02/2022 2:20		36.98	
26/02/2022 2:27			36.96
26/02/2022 2:30	36.97		
26/02/2022 2:40		36.95	
26/02/2022 2:49		36.96	
26/02/2022 2:51			36.94
26/02/2022 3:00	36.96		
26/02/2022 3:12		36.93	
26/02/2022 3:25			36.92

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
26/02/2022 3:26		36.94	
26/02/2022 3:30	36.93		
26/02/2022 3:58		36.93	
26/02/2022 4:00	36.94		
26/02/2022 4:20			36.92
26/02/2022 4:30	36.93		
26/02/2022 4:55		36.91	
26/02/2022 5:00	36.91		
26/02/2022 5:05			36.90
26/02/2022 5:06		36.90	
26/02/2022 5:30	36.89		
26/02/2022 5:40		36.89	
26/02/2022 5:41			36.88
26/02/2022 5:43		36.88	
26/02/2022 6:00	36.89		
26/02/2022 6:30	36.88		
26/02/2022 6:58		36.89	
26/02/2022 7:00	36.88		
26/02/2022 7:20		36.88	
26/02/2022 7:20			36.88
26/02/2022 8:00	36.89		
26/02/2022 8:46		36.90	
26/02/2022 8:49		36.91	36.90
26/02/2022 9:00	36.91		
26/02/2022 9:47		36.93	
26/02/2022 9:47			36.92
26/02/2022 9:58		36.93	
26/02/2022 10:00	36.94		
26/02/2022 10:03		36.94	
26/02/2022 10:13			36.94
26/02/2022 10:20			36.94
26/02/2022 10:24		36.95	
26/02/2022 10:43			36.98
26/02/2022 10:48		36.97	
26/02/2022 10:57			37.00
26/02/2022 11:00	37.00		
26/02/2022 11:00		36.99	
26/02/2022 11:11		37.02	
26/02/2022 11:13			37.02
26/02/2022 11:20		37.01	
26/02/2022 11:31		37.04	
26/02/2022 11:32			37.04
26/02/2022 11:34		37.03	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
26/02/2022 11:44		37.05	
26/02/2022 11:57			37.08
26/02/2022 12:00	37.09		
26/02/2022 12:00		37.07	
26/02/2022 12:10			37.10
26/02/2022 12:13		37.09	
26/02/2022 12:28			37.12
26/02/2022 12:29		37.13	
26/02/2022 12:40		37.14	37.14
26/02/2022 12:50		37.15	
26/02/2022 12:58		37.15	
26/02/2022 13:00	37.17		
26/02/2022 13:00		37.16	
26/02/2022 13:01			37.16
26/02/2022 13:12		37.17	
26/02/2022 13:16		37.18	
26/02/2022 13:20			37.18
26/02/2022 13:23		37.19	
26/02/2022 13:30		37.20	
26/02/2022 13:33			37.20
26/02/2022 13:41		37.21	
26/02/2022 13:53			37.22
26/02/2022 13:54		37.23	
26/02/2022 13:54		37.25	
26/02/2022 13:59		37.24	
26/02/2022 14:00	37.24		
26/02/2022 14:13			37.24
26/02/2022 14:22		37.25	
26/02/2022 14:25		37.26	
26/02/2022 14:35		37.27	
26/02/2022 14:41		37.30	
26/02/2022 14:49			37.30
26/02/2022 14:52		37.29	
26/02/2022 15:00	37.30		
26/02/2022 15:30		37.31	37.32
26/02/2022 15:58		37.33	
26/02/2022 16:02			37.34
26/02/2022 16:16		37.36	
26/02/2022 16:20			37.36
26/02/2022 16:21		37.35	
26/02/2022 17:00	37.36		
26/02/2022 17:04		37.38	
26/02/2022 17:06			37.38

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
26/02/2022 17:20		37.37	
26/02/2022 18:00	37.38		
26/02/2022 18:58		37.39	
26/02/2022 18:59			37.40
26/02/2022 19:00	37.39		
26/02/2022 19:20			37.38
26/02/2022 20:00	37.38		
26/02/2022 20:22		37.37	
26/02/2022 20:30		37.36	
26/02/2022 20:42		37.35	
26/02/2022 20:47			37.34
26/02/2022 20:50		37.34	
26/02/2022 21:00	37.34		
26/02/2022 21:11		37.33	
26/02/2022 21:17			37.32
26/02/2022 21:29		37.31	
26/02/2022 21:34			37.30
26/02/2022 21:50		37.29	
26/02/2022 21:55			37.28
26/02/2022 21:58		37.27	
26/02/2022 22:00	37.27		
26/02/2022 22:11			37.26
26/02/2022 22:13		37.25	
26/02/2022 22:13		37.26	
26/02/2022 22:20		37.26	
26/02/2022 22:33		37.23	
26/02/2022 22:40		37.24	
26/02/2022 22:42			37.24
26/02/2022 22:50		37.21	
26/02/2022 22:56		37.22	
26/02/2022 22:59			37.22
26/02/2022 23:00	37.21		
26/02/2022 23:09		37.19	
26/02/2022 23:16		37.20	
26/02/2022 23:18			37.18
26/02/2022 23:24		37.17	
26/02/2022 23:29		37.18	
26/02/2022 23:39		37.15	
26/02/2022 23:44		37.16	
26/02/2022 23:46			37.14
26/02/2022 23:54		37.13	
27/02/2022 0:00	37.13		
27/02/2022 0:08			37.12

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
27/02/2022 0:15		37.11	
27/02/2022 0:27		37.12	
27/02/2022 0:29			37.10
27/02/2022 0:39		37.09	
27/02/2022 0:47		37.10	
27/02/2022 0:58		37.07	
27/02/2022 1:00	37.08		
27/02/2022 1:04		37.08	
27/02/2022 1:14			37.06
27/02/2022 1:20			37.06
27/02/2022 1:21		37.05	
27/02/2022 1:33			37.04
27/02/2022 1:34		37.04	
27/02/2022 1:56			37.02
27/02/2022 1:56		37.01	
27/02/2022 1:56		37.02	
27/02/2022 2:00	37.01		
27/02/2022 2:19			37.00
27/02/2022 2:20		36.99	
27/02/2022 2:20		37.00	
27/02/2022 2:42			36.98
27/02/2022 2:43		36.97	
27/02/2022 2:44		36.98	
27/02/2022 3:00	36.96		
27/02/2022 3:04		36.96	
27/02/2022 3:04			36.96
27/02/2022 3:24		36.93	
27/02/2022 3:25		36.94	
27/02/2022 3:27			36.94
27/02/2022 3:47			36.92
27/02/2022 3:58		36.89	
27/02/2022 4:00	36.90		
27/02/2022 4:10			36.90
27/02/2022 4:20			36.90
27/02/2022 4:22		36.87	
27/02/2022 4:30	36.89		
27/02/2022 5:00	36.87		
27/02/2022 5:09		36.86	
27/02/2022 5:41		36.85	
27/02/2022 6:00	36.86		
27/02/2022 6:58		36.85	
27/02/2022 7:00	36.87		
27/02/2022 7:20		36.86	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
27/02/2022 7:20			36.88
27/02/2022 8:00	36.86		
27/02/2022 9:00	36.85		
27/02/2022 9:04		36.83	
27/02/2022 9:05		36.84	
27/02/2022 9:06			36.84
27/02/2022 9:58		36.83	
27/02/2022 10:00	36.84		
27/02/2022 10:20		36.84	
27/02/2022 10:20			36.84
27/02/2022 10:40			36.82
27/02/2022 10:45		36.81	
27/02/2022 11:00	36.82		
27/02/2022 11:35			36.84
27/02/2022 11:35		36.83	
27/02/2022 11:46		36.85	
27/02/2022 11:46			36.86
27/02/2022 11:47		36.86	
27/02/2022 12:00	36.87		
27/02/2022 12:02		36.87	
27/02/2022 12:11			36.90
27/02/2022 12:17		36.89	
27/02/2022 12:29			36.92
27/02/2022 12:37		36.91	
27/02/2022 12:39			36.94
27/02/2022 12:44		36.93	
27/02/2022 12:55			36.96
27/02/2022 12:58		36.95	
27/02/2022 13:00	36.95		
27/02/2022 13:09			36.98
27/02/2022 13:10		36.97	
27/02/2022 13:20		36.98	
27/02/2022 13:32		36.99	
27/02/2022 13:33		37.00	
27/02/2022 13:33			37.00
27/02/2022 14:00	37.01		
27/02/2022 14:01		37.01	
27/02/2022 14:01		37.02	
27/02/2022 14:02			37.02
27/02/2022 14:12		37.03	
27/02/2022 14:13		37.04	
27/02/2022 14:40		37.05	
27/02/2022 14:40		37.06	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
27/02/2022 14:42			37.06
27/02/2022 15:00	37.07		
27/02/2022 15:00		37.07	
27/02/2022 15:00		37.08	
27/02/2022 15:58		37.07	
27/02/2022 16:00	37.08		
27/02/2022 16:16		37.10	
27/02/2022 16:20		37.10	
27/02/2022 16:20			37.10
27/02/2022 17:00	37.07		
27/02/2022 17:11			37.08
27/02/2022 17:11			37.10
27/02/2022 17:16		37.05	
27/02/2022 17:25			37.06
27/02/2022 17:27		37.03	
27/02/2022 17:38			37.04
27/02/2022 17:41		37.01	
27/02/2022 17:55		36.99	
27/02/2022 18:00	36.99		
27/02/2022 18:04			36.98
27/02/2022 18:05		36.97	
27/02/2022 18:14			36.96
27/02/2022 18:17		36.95	
27/02/2022 18:28		36.93	
27/02/2022 18:38			36.92
27/02/2022 18:39		36.91	
27/02/2022 18:50			36.90
27/02/2022 18:52		36.89	
27/02/2022 18:57		36.88	
27/02/2022 19:00	36.80		
27/02/2022 19:07		36.85	
27/02/2022 19:20			36.84
27/02/2022 19:20		36.83	
27/02/2022 19:30			36.82
27/02/2022 19:31		36.81	
27/02/2022 19:39		36.79	
27/02/2022 19:40			36.80
27/02/2022 19:51		36.77	
27/02/2022 19:51		36.75	
27/02/2022 19:51			36.78
27/02/2022 20:00	36.76		
27/02/2022 20:03			36.76
27/02/2022 20:04		36.75	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
27/02/2022 20:16		36.73	
27/02/2022 20:16			36.74
27/02/2022 20:26			36.72
27/02/2022 20:28		36.71	
27/02/2022 20:39			36.70
27/02/2022 20:41		36.69	
27/02/2022 20:51			36.68
27/02/2022 20:55		36.67	
27/02/2022 21:00	36.66		
27/02/2022 21:06		36.65	
27/02/2022 21:06			36.66
27/02/2022 21:13		36.64	
27/02/2022 21:18		36.63	
27/02/2022 21:20			36.64
27/02/2022 21:28		36.61	
27/02/2022 21:31			36.62
27/02/2022 21:37		36.60	
27/02/2022 21:51		36.57	
27/02/2022 21:54			36.58
27/02/2022 21:58		36.55	
27/02/2022 22:00	36.55		
27/02/2022 22:01		36.56	
27/02/2022 22:04			36.56
27/02/2022 22:06		36.53	
27/02/2022 22:13		36.54	
27/02/2022 22:17			36.54
27/02/2022 22:20		36.51	
27/02/2022 22:31		36.49	
27/02/2022 22:34			36.50
27/02/2022 22:44		36.47	
27/02/2022 22:47			36.48
27/02/2022 22:58		36.45	
27/02/2022 22:58			36.46
27/02/2022 22:59		36.46	
27/02/2022 23:00	36.45		
27/02/2022 23:09		36.43	
27/02/2022 23:10		36.44	
27/02/2022 23:11			36.44
27/02/2022 23:21		36.41	
27/02/2022 23:24			36.42
27/02/2022 23:36		36.39	
27/02/2022 23:37		36.40	
27/02/2022 23:39			36.40

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
27/02/2022 23:49		36.38	
27/02/2022 23:51			36.38
28/02/2022 0:00	36.36		
28/02/2022 0:04		36.35	
28/02/2022 0:05			36.36
28/02/2022 0:14		36.33	
28/02/2022 0:14		36.34	
28/02/2022 0:15	36.33		
28/02/2022 0:17			36.34
28/02/2022 0:29		36.31	
28/02/2022 0:29		36.32	
28/02/2022 0:30	36.32		
28/02/2022 0:30			36.32
28/02/2022 0:42		36.29	
28/02/2022 0:42		36.30	
28/02/2022 0:44			36.30
28/02/2022 0:45	36.29		
28/02/2022 0:57		36.27	
28/02/2022 0:58		36.27	
28/02/2022 0:59			36.28
28/02/2022 1:00	36.27		
28/02/2022 1:11		36.25	
28/02/2022 1:11		36.26	
28/02/2022 1:15	36.24		
28/02/2022 1:20			36.26
28/02/2022 1:30	36.23		
28/02/2022 1:32		36.23	
28/02/2022 1:36			36.24
28/02/2022 1:40		36.22	
28/02/2022 1:45	36.21		
28/02/2022 1:50		36.21	
28/02/2022 1:56			36.22
28/02/2022 1:56		36.20	
28/02/2022 2:00	36.18		
28/02/2022 2:08		36.17	
28/02/2022 2:15	36.17		
28/02/2022 2:16			36.20
28/02/2022 2:17		36.18	
28/02/2022 2:30	36.16		
28/02/2022 2:32		36.15	
28/02/2022 2:40		36.16	
28/02/2022 2:45	36.15		
28/02/2022 2:58		36.13	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
28/02/2022 3:00	36.14		
28/02/2022 3:05		36.14	
28/02/2022 3:06			36.16
28/02/2022 3:15	36.13		
28/02/2022 3:30	36.12		
28/02/2022 3:35		36.11	
28/02/2022 3:45	36.11		
28/02/2022 3:47			36.14
28/02/2022 3:58		36.11	
28/02/2022 4:00	36.10		
28/02/2022 4:15	36.09		
28/02/2022 4:20		36.12	
28/02/2022 4:20			36.12
28/02/2022 4:30	36.09		
28/02/2022 4:45	36.09		
28/02/2022 5:00	36.09		
28/02/2022 5:06			36.10
28/02/2022 6:00	36.09		
28/02/2022 6:58		36.11	
28/02/2022 7:20		36.12	
28/02/2022 7:20			36.10
28/02/2022 8:00	36.08		
28/02/2022 9:00	36.07		
28/02/2022 9:58		36.09	
28/02/2022 10:00	36.07		
28/02/2022 10:20		36.10	
28/02/2022 11:00	36.08		
28/02/2022 11:06		36.07	
28/02/2022 11:07		36.08	
28/02/2022 12:00	36.07		
28/02/2022 12:58		36.05	
28/02/2022 13:00	36.06		
28/02/2022 14:00	36.05		
28/02/2022 14:41		36.03	
28/02/2022 14:56			36.04
28/02/2022 15:00	36.04		
28/02/2022 15:11		36.04	
28/02/2022 15:58		36.03	
28/02/2022 16:00	36.03		
28/02/2022 16:20			36.02
28/02/2022 17:00	36.02		
28/02/2022 17:23		36.01	
28/02/2022 18:00	36.01		

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
28/02/2022 18:01		36.00	
28/02/2022 18:06			36.00
28/02/2022 18:58		35.99	
28/02/2022 19:00	35.99		
28/02/2022 19:20			36.00
28/02/2022 20:00	35.98		
28/02/2022 20:08		35.97	
28/02/2022 20:42		35.98	
28/02/2022 21:00	35.97		
28/02/2022 21:31		35.95	
28/02/2022 21:51			35.96
28/02/2022 21:58		35.95	
28/02/2022 22:00	35.95		
28/02/2022 22:04		35.96	
28/02/2022 22:20			35.96
28/02/2022 23:00	35.94		
28/02/2022 23:05		35.93	
28/02/2022 23:28			35.94
28/02/2022 23:43		35.92	
1/03/2022 0:00	35.92		
1/03/2022 0:39		35.91	
1/03/2022 0:58		35.91	
1/03/2022 1:00	35.91		
1/03/2022 2:00	35.90		
1/03/2022 2:52		35.89	
1/03/2022 3:00	35.89		
1/03/2022 3:20			35.90
1/03/2022 3:58		35.89	
1/03/2022 4:00	35.89		
1/03/2022 4:20		35.88	
1/03/2022 4:20			35.90
1/03/2022 5:00	35.88		
1/03/2022 6:00	35.88		
1/03/2022 6:58		35.87	
1/03/2022 7:00	35.88		
1/03/2022 7:20		35.88	
1/03/2022 7:20			35.88
1/03/2022 8:00	35.88		
1/03/2022 9:00	35.88		
1/03/2022 9:58		35.87	
1/03/2022 10:00	35.88		
1/03/2022 10:20		35.88	
1/03/2022 10:20			35.88

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
1/03/2022 11:00	35.88		
1/03/2022 12:00	35.88		
1/03/2022 12:58		35.87	
1/03/2022 13:00	35.88		
1/03/2022 13:20		35.88	
1/03/2022 14:00	35.88		
1/03/2022 15:00	35.88		
1/03/2022 15:58		35.87	
1/03/2022 16:20		35.88	
1/03/2022 16:20			35.88
1/03/2022 18:58		35.87	
1/03/2022 21:58		35.87	
1/03/2022 22:20			35.88
2/03/2022 0:58		35.85	
2/03/2022 1:20			35.86
2/03/2022 3:58		35.85	
2/03/2022 4:20		35.86	
2/03/2022 4:20			35.86
2/03/2022 6:58		35.85	
2/03/2022 7:15	35.86		
2/03/2022 7:20		35.86	
2/03/2022 7:20			35.86
2/03/2022 9:58		35.83	
2/03/2022 10:20		35.84	
2/03/2022 12:58		35.83	
2/03/2022 13:20			35.84
2/03/2022 15:58		35.83	
2/03/2022 18:58		35.83	
2/03/2022 19:20			35.84
2/03/2022 21:58		35.83	
2/03/2022 22:20		35.84	
2/03/2022 22:20			35.84
3/03/2022 0:58		35.83	
3/03/2022 1:20			35.84
3/03/2022 3:58		35.83	
3/03/2022 4:00	35.84		
3/03/2022 4:20			35.86
3/03/2022 4:52		35.85	
3/03/2022 4:55			35.88
3/03/2022 5:00	35.87		
3/03/2022 5:00		35.86	
3/03/2022 5:30	35.87		
3/03/2022 5:38		35.87	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
3/03/2022 5:40			35.90
3/03/2022 5:41		35.88	
3/03/2022 6:00	35.89		
3/03/2022 6:30	35.89		
3/03/2022 6:36		35.89	
3/03/2022 6:40			35.92
3/03/2022 6:58		35.89	
3/03/2022 7:20		35.90	
3/03/2022 7:20			35.90
3/03/2022 8:00	35.91		
3/03/2022 8:49			35.92
3/03/2022 8:51		35.91	
3/03/2022 9:00	35.93		
3/03/2022 9:15			35.94
3/03/2022 9:15		35.93	
3/03/2022 9:16		35.94	
3/03/2022 9:46			35.96
3/03/2022 9:47		35.95	
3/03/2022 9:58		35.97	
3/03/2022 10:00	35.97		
3/03/2022 10:20		35.98	
3/03/2022 10:20			35.98
3/03/2022 10:38		35.99	
3/03/2022 10:40		36.00	
3/03/2022 11:00	36.00		
3/03/2022 11:30	36.01		
3/03/2022 11:33			36.02
3/03/2022 11:34		36.01	
3/03/2022 12:00	36.01		
3/03/2022 12:14		36.02	
3/03/2022 12:58		36.01	
3/03/2022 13:00	36.02		
3/03/2022 13:20			36.02
3/03/2022 14:00	36.03		
3/03/2022 15:15	36.04		
3/03/2022 15:58		36.03	
3/03/2022 16:10	36.04		
3/03/2022 16:20		36.04	
3/03/2022 16:20			36.04
3/03/2022 17:07	36.03		
3/03/2022 18:12	36.03		
3/03/2022 18:58		36.03	
3/03/2022 19:00	36.04		

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
3/03/2022 19:20		36.02	
3/03/2022 19:20			36.04
3/03/2022 20:30	36.04		
3/03/2022 20:35		36.03	
3/03/2022 20:36		36.04	
3/03/2022 21:00	36.04		
3/03/2022 21:58		36.03	
3/03/2022 22:00	36.03		
3/03/2022 22:20			36.04
3/03/2022 23:00	36.03		
4/03/2022 0:00	36.02		
4/03/2022 0:58		36.01	
4/03/2022 1:00	36.02		
4/03/2022 1:20		36.02	
4/03/2022 1:20			36.02
4/03/2022 2:00	36.02		
4/03/2022 3:00	36.01		
4/03/2022 3:58		36.01	
4/03/2022 4:00	36.01		
4/03/2022 4:20		36.02	
4/03/2022 5:00	36.01		
4/03/2022 6:00	36.02		
4/03/2022 6:58		36.01	
4/03/2022 7:20		36.02	
4/03/2022 7:20			36.02
4/03/2022 7:22	36.02		
4/03/2022 8:17	36.02		
4/03/2022 9:01	36.02		
4/03/2022 9:58		36.01	
4/03/2022 10:08	36.02		
4/03/2022 10:20		36.02	
4/03/2022 10:20			36.02
4/03/2022 11:15	36.02		
4/03/2022 12:12	36.02		
4/03/2022 12:58		36.01	
4/03/2022 13:13	36.01		
4/03/2022 15:23	36.01		
4/03/2022 15:58		35.99	
4/03/2022 16:12	36.01		
4/03/2022 16:20		36.00	
4/03/2022 16:20			36.00
4/03/2022 18:58		35.99	
4/03/2022 19:20		36.00	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
4/03/2022 21:58		35.99	
4/03/2022 22:20		36.00	
4/03/2022 22:20			36.00
5/03/2022 0:58		35.99	
5/03/2022 1:20		36.00	
5/03/2022 1:20			36.00
5/03/2022 3:58		35.99	
5/03/2022 6:58		35.97	
5/03/2022 7:20			35.98
5/03/2022 7:45	35.99		
5/03/2022 8:30	35.99		
5/03/2022 9:58		35.97	
5/03/2022 10:20		35.98	
5/03/2022 10:20			35.98
5/03/2022 12:58		35.97	
5/03/2022 13:20		35.98	
5/03/2022 15:58		35.97	
5/03/2022 16:20		35.98	
5/03/2022 16:20			35.98
5/03/2022 18:58		35.97	
5/03/2022 19:20		35.98	
5/03/2022 19:20			35.98
5/03/2022 21:58		35.97	
5/03/2022 22:20		35.98	
5/03/2022 22:20			35.98
6/03/2022 0:58		35.97	
6/03/2022 1:20		35.98	
6/03/2022 1:20			35.98
6/03/2022 3:58		35.97	
6/03/2022 4:20		35.98	
6/03/2022 4:20			35.98
6/03/2022 6:58		35.97	
6/03/2022 7:20		35.98	
6/03/2022 7:45	35.98		
6/03/2022 8:00	35.98		
6/03/2022 9:00	35.98		
6/03/2022 9:58		35.97	
6/03/2022 10:20		35.96	
6/03/2022 10:20			35.96
6/03/2022 12:58		35.95	
6/03/2022 13:20			35.96
6/03/2022 15:07	35.95		
6/03/2022 15:58		35.93	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
6/03/2022 16:06	35.95		
6/03/2022 16:20		35.94	
6/03/2022 16:20			35.94
6/03/2022 17:05	35.94		
6/03/2022 18:08	35.95		
6/03/2022 18:58		35.93	
6/03/2022 19:00	35.95		
6/03/2022 19:20			35.94
6/03/2022 20:00	35.94		
6/03/2022 21:00	35.94		
6/03/2022 21:58		35.93	
6/03/2022 22:00	35.94		
6/03/2022 22:20		35.94	
6/03/2022 22:20			35.94
6/03/2022 23:00	35.94		
7/03/2022 0:00	35.93		
7/03/2022 0:58		35.91	
7/03/2022 1:00	35.93		
7/03/2022 1:20		35.92	
7/03/2022 1:20			35.92
7/03/2022 2:00	35.92		
7/03/2022 3:00	35.92		
7/03/2022 3:58		35.91	
7/03/2022 4:00	35.92		
7/03/2022 4:20			35.92
7/03/2022 6:30	35.91		
7/03/2022 6:58		35.89	
7/03/2022 7:20			35.90
7/03/2022 9:58		35.89	
7/03/2022 10:20		35.90	
7/03/2022 12:58		35.87	
7/03/2022 13:00	35.89		
7/03/2022 13:20		35.88	
7/03/2022 13:20			35.88
7/03/2022 15:00	35.88		
7/03/2022 15:58		35.87	
7/03/2022 16:00	35.88		
7/03/2022 16:20		35.88	
7/03/2022 17:00	35.88		
7/03/2022 21:58		35.89	
8/03/2022 0:58		35.89	
8/03/2022 3:58		35.89	
8/03/2022 4:20		35.90	

Date time	North Pine Dam Gauge Board Reading	North Pine Dam AL-P2 (540202) m AHD	North Pine Dam AL-B (540277) m AHD
8/03/2022 4:20			35.88
8/03/2022 6:58		35.89	
8/03/2022 7:00	35.89		
8/03/2022 7:20		35.90	
8/03/2022 8:00	35.89		
8/03/2022 9:00	35.89		

Appendix D Dam Safety Inspection Report

NORTH PINE DAM – DAM SAFETY INSPECTION
FEBRUARY 2022 FLOOD EVENT

INTRODUCTION

A significant flood event impacted North Pine Dam in late February and early March 2022. Following this flood event, I inspected North Pine Dam for damage that had been contributed to or caused by the February 2022 flood event. I also examined surveillance and dam safety instrumentation records for the period of, and immediately following, the February 2022 flood event.

Based on these investigations, this report contains the following information which is required to be included in the Flood Event Report under section 385(1)(g) and (h) and the Emergency Event Report under sections 352V(1)(c) and (d) of the *Water Supply (Safety and Reliability) Act 2008* (Qld) (**the Act**):

- A description of any damage to the dam caused by the flood event, including photographs of the damage.

- An assessment as to whether and to what extent the damage identified has been caused or contributed to by the flood event.

North Pine Dam experienced a significant bank slump on the right bank (looking downstream) of the earth/rock shoulder embankment during the February 2022 flood event. The bank slump required relatively urgent repairs, and these repairs that involved the construction of a filter buttress, were completed on 7 April 2022.

Subsequent engineering assessment by GHD has recommended that no further stabilization works are currently required. However, a more detailed engineering assessment of the bank slump will be undertaken over the next 6 months to determine if additional works to supplement the constructed filter buttress are needed to ensure the long term stability of the embankment.

In my assessment, this damage was likely to have been caused by the heavy rainfall that occurred directly onto the embankment downstream face during the February 2022 flood event and was unlikely to have been caused by the lake level load on the upstream side of the embankment. Further information on this is presented in this report.

ASSESSMENT OF ANY DAMAGE TO THE DAM

To assess whether North Pine Dam had sustained any damage caused by the February 2022 flood event, I:

- inspected the North Pine Dam site on 18 March 2022 and again on 14 April 2022. The following components of the dam were inspected:

    - The main dam concrete embankment (including spillway and Radial Gates).

- The earth/rock shoulder embankments.
- The saddle dams.

- reviewed the dam safety surveillance inspection reports that were completed by the dam operators during the February 2022 flood event.

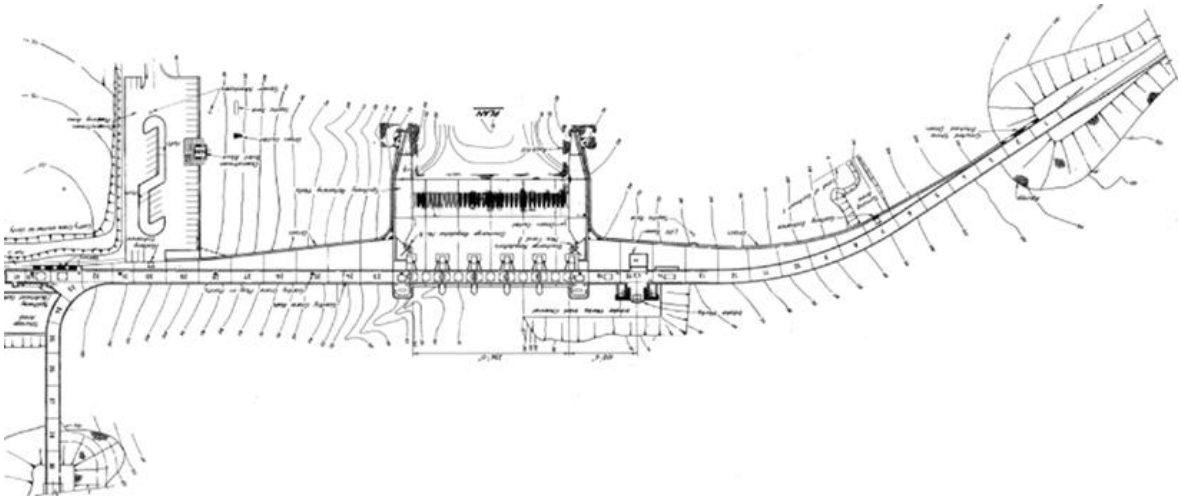
- consulted with the dam operators during my site inspection to confirm that no further dam safety issues had been identified during the February 2022 flood event which had not previously been documented or otherwise brought to my attention during the February 2022 flood event.

- reviewed the dam safety instrumentation records to identify whether visual or other tangible evidence of structural issues that could potentially threaten the safety of the dam have arisen as a result of the February 2022 flood event.

My assessment of each of the components of the dam inspected, and the outcomes of the review of the dam safety surveillance inspection reports and instrumentation records, is set out below.

The Main Dam Concrete Embankment

North Pine Dam is located on the North Pine River, approximately 5 kilometres upstream of Petrie. The dam was constructed between 1971 to 1976 to form Lake Samsonvale. As shown in the following plan, the main dam wall is a central mass concrete gravity dam with earth/rock shoulder embankments on either side. The main dam concrete embankment has a maximum height of 46 metres and a central gated overflow spillway within the mass concrete section. Forty (40) monoliths make up the mass concrete section, with the spillway structure comprising of blocks 17 to 22.

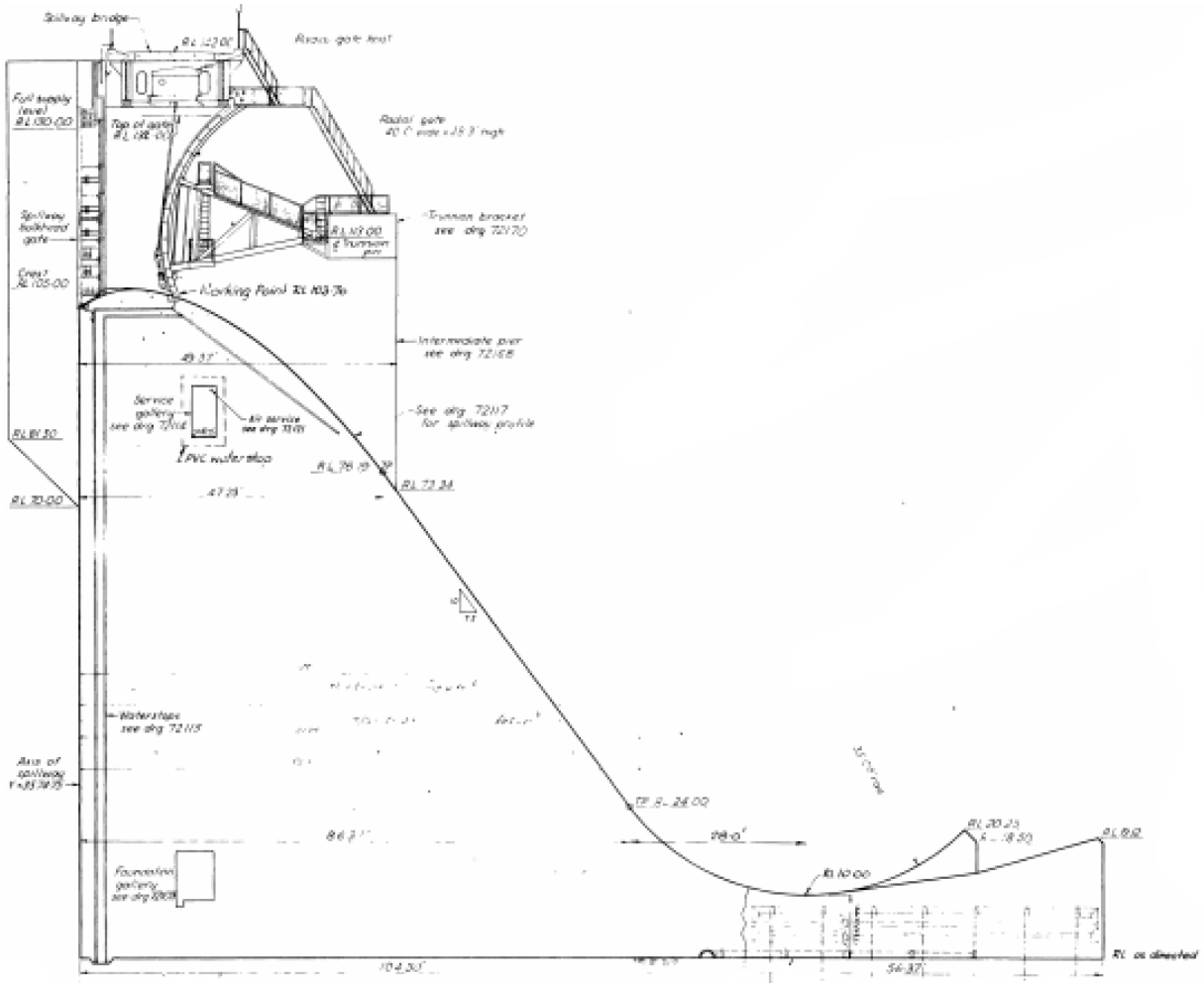


NORTH PINE DAM – MARCH 2022

NORTH PINE DAM MAIN DAM CONCRETE EMBANKMENT – MARCH 2022

The North Pine Dam spillway is 61 metres wide with a crest elevation of EL 32 metres AHD. There are five 12.2 metre wide by 8.2 metre high radial gates that control the spillway. Water is discharged from the spillway into a flip bucket with splitter piers for energy dissipation. The spillway is flanked by mass concrete retaining walls.

A cross section through the spillway is shown on the following diagram. The spillway is mass concrete construction of significant thickness.



No damage to the Main Dam Concrete Embankment or spillway was found during the inspections. Additionally, the surveillance inspection sheets completed over the course of the February 2022 flood event do not record any significant damage to the Main Dam Concrete Embankment or Spillway.

The 2011 flood event is the flood of record for North Pine Dam in terms of the peak inflow, outflow and lake level. Very little damage was observed to the Main Dam Concrete Embankment and Spillway following the 2011 flood event. The maximum dam outflow for the February 2022 flood event was approximately 1530 cubic metres per second, as compared to the maximum dam outflow in the 2011 flood event of 2850[1] cubic metres per second. The absence of damage to the Main Concrete Embankment and Spillway is therefore not unexpected.

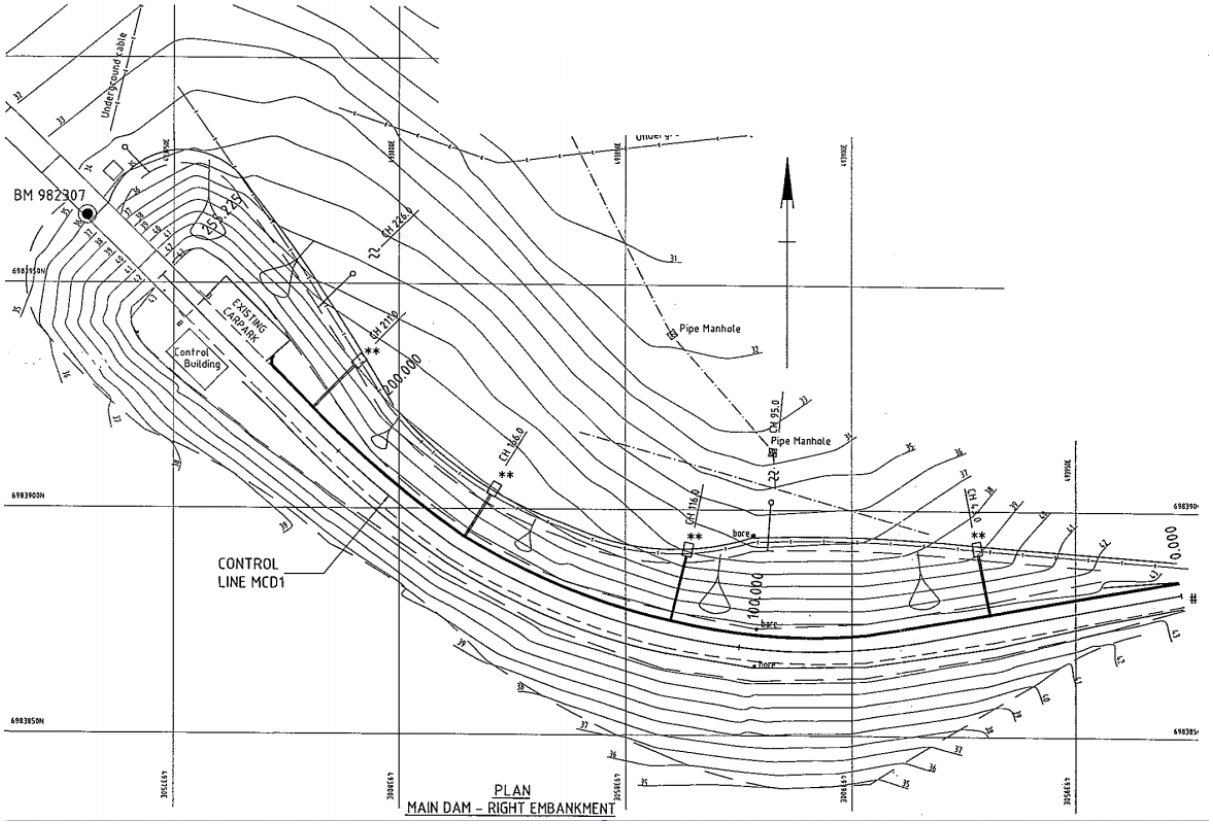
[1] Source: Appendix F in North Pine Dam Manual of Operational Procedures for Flood Mitigation at North Pine Dam, Revision 11 (2021).

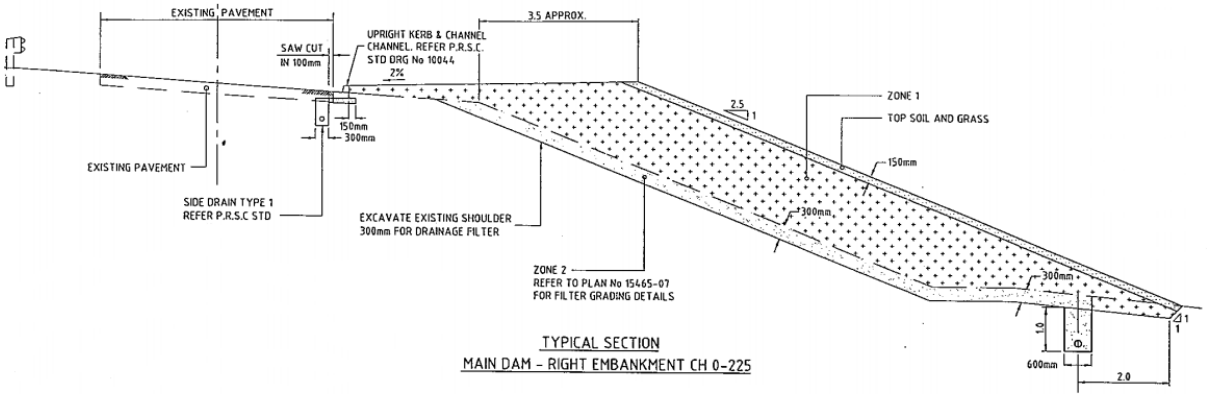
The Earth/Rock Shoulder Embankments

The earth/rock shoulder embankments are located on either side of the Main Concrete Dam Embankment. As shown in the photograph below, the embankment on the left bank side (looking downstream) is relatively minor in nature, being around 50 metres in length and substantially constructed around the end of the main dam concrete embankment. This left bank embankment was not damaged by the February 2022 flood event and the associated rainfall.

LEFT BANK EARTH/ROCK SHOULDER EMBANKMENT

The embankment on the right bank side is much more substantial, being approximately 300 metres long and up to six metres high as shown in the plans below. There was damage to this right bank embankment observed during the February 2022 flood event.





The right bank earth/rock shoulder embankment was originally a homogeneous embankment without filters or drainage provisions. In 1999 the embankment was upgraded, primarily by installing a blanket filter as shown in the above cross section.

A slump on the downstream batter of the right bank earth/rock shoulder embankment was identified by the dam operator at sunrise on Monday 28 February 2022, following several days of intense rainfall. The Flood Forecasting System operated in the Seqwater Flood Operations Centre recorded the following data for conditions around that time:

- Lake Level (operator gauge board reading) at 0600 28 February was 36.09 metres AHD (0.09 metres above OFSL, and 1.3 metres below the peak lake level that occurred around 1900 26 February).

- Peak rainfall intensity at the North Pine Dam ALERT rainfall gauge (station 0540202) occurred between 1330 and 1600 on 27 February with 134 millimetres of rain recorded in this period.

The approximate slump dimensions were 35 metres along the embankment, and 12 to 20 metres down the batter. This is shown in the following photograph.

Exposed embankment material in back scarp and other cracks was observed to be clay fill / earth fill, and underlying superficial topsoil. No fine filter material was observed in these areas. The slump area was wet, with ponded water in some cracks, but no obvious discharge of seepage.

Elevated lake levels increase the force behind the earth/rock embankment. As the lake level rises, the force behind the earth/rock embankment increases. An increase in the force behind the earth/rock embankment may cause a slump on the embankment. However, I believe it unlikely that the slump that occurred in the February 2022 flood event was caused by a rise in the water level in the dam as opposed to the infiltration of rainfall on the embankment itself. This is because:

- The data recorded in the flood forecasting system (described above) showed the lake level at the time was below the maximum lake level over the period of the February Flood Event which was EL 37.4 metres AHD;

- the slump occurred on part of the embankment which is above EL 37.4 metres AHD;

- North Pine Dam has previously stored water for many years at or around its design full supply level of EL 39.6 metres AHD without any slumps occurring in the same location;

- the maximum water level in the January 2011 flood event exceeded EL 41 metres AHD without any slumps occurring in the same location.

A key contributing factor to the cause of the slump appears to have been surface water infiltration of the batter due to the rain event in the preceding days. Approximately 750 millimetres of rainfall had been recorded at the dam in the 3 days leading up to when the slump was first observed. This is an unusually high total for the area. The highest intensity rainfall occurred on the afternoon before the slump was identified.

The embankment seepage points and piezometers in the area of the slump support this observation. Of particular relevance, borehole piezometer B12 (situated near the toe of the slump area) had a measured depth to water prior to the February 2022 flood event of 4.97 metres. This reduced to 2.27 metres to water (a water level rise of 2.7 metres) on Monday 28 February 2022 after the slump was observed. The piezometer then returned to normal water levels of around 4.6 metres to water following the conclusion of the rainfall and the February 2022 flood event.

The combined evidence of the data for lake levels, rainfall intensities, and piezometer levels indicate that it is likely that the slump was caused by rainfall infiltration directly on the downstream face of the embankment and that is was unlikely that the slump was caused by a high lake level load on the upstream side of the embankment.

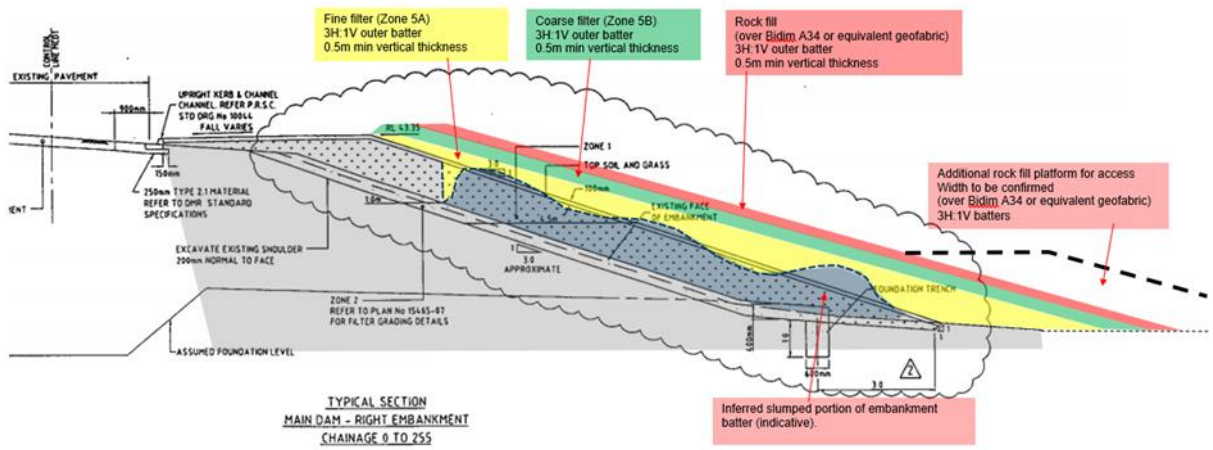
A registered professional civil engineer with geotechnical engineering expertise inspected the slump immediately after it occurred as first response on 28 February 2022. The geotechnical engineer did not undertake an inspection of the entire dam, with the inspection focusing on the slump. The findings from that engineer's inspection align to my findings outlined above.

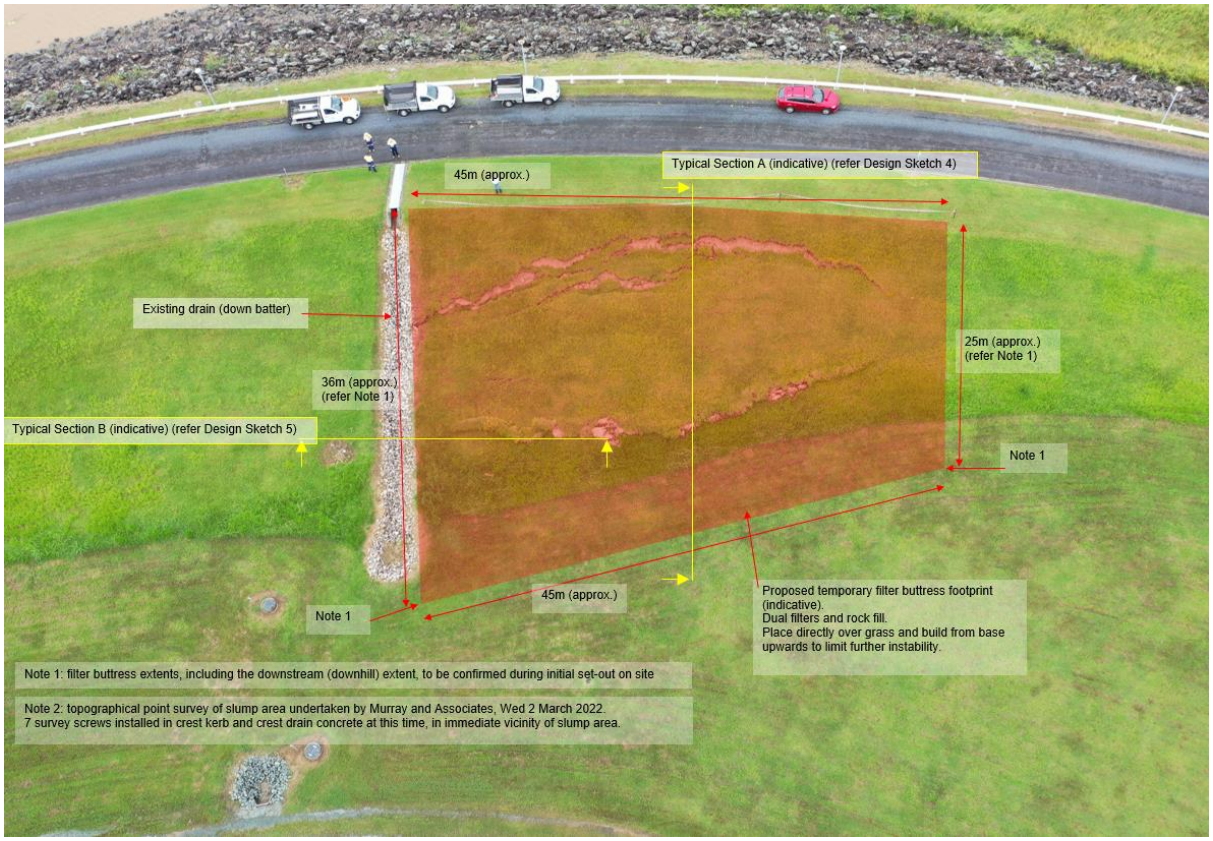
On Tuesday 1 March 2022, Seqwater pumped the water from the slumped area and covered the area in 200um Low-Density Polyethylene, as an interim measure to assist in reducing further rainwater infiltration into the slump. This is shown on the following photograph. The area was surveyed by a surveying consultant on Wednesday 2 March 2022.

Interim filter buttress works were then initiated to provide an interim improvement in stability of the slumped area. This was achieved by the careful placement of a filter buttress with materials consisting of:

- Suitable fine filter layer (overlain by geotextile).
- Suitable coarse filter layer (overlain by geotextile).
- Well graded rock fill.

Concept plans of the interim filter buttress works are shown below. The works were completed on 7 April 2022.





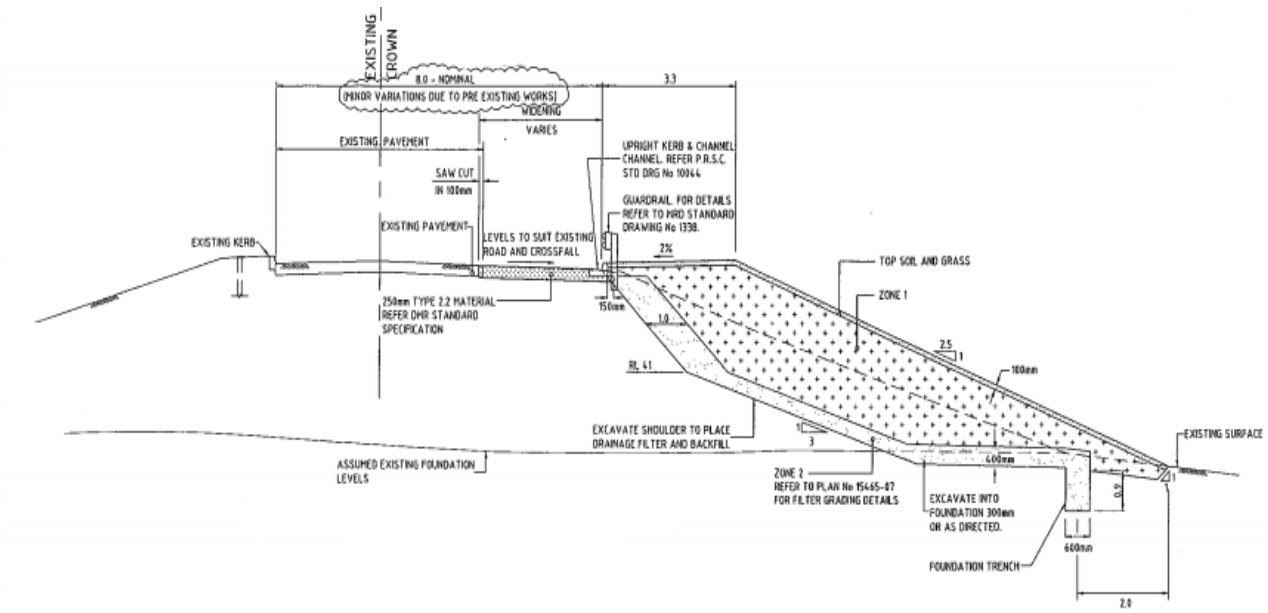
There is a risk that the slump may have caused a discontinuity to the existing filter zone. The interim filter buttress did not address this risk, but it was not considered appropriate to delay the construction of the filter buttress which were undertaken to stabilise the embankment and prevent any further damage.

Subsequent engineering assessment by GHD has recommended that no further stabilization works are currently required. However, a more detailed engineering assessment of the bank slump will be undertaken over the next 6 months to determine if additional works to supplement the constructed filter buttress are needed to ensure the long term stability of the embankment.

COMPLETED FILTER BUTTRESS

The Saddle Dams

There are three homogeneous earth embankment saddle dams at North Pine Dam. These are named Saddle Dam Nos. 1, 2 and 3, with Saddle Dam No. 3 being the closest to the main dam. The largest of the Saddle Dams is 9 metres high. Following observed erosion of the downstream face of the embankments and subsequent geotechnical investigations in 1999, a downstream filter buttress was installed on Saddle Dams 2 and 3 in accordance with the cross section below.



The Saddle Dams only pond water if the lake level of North Pine Dam exceeds the Design Full Supply Level of EL 39.6 metres AHD. As the maximum lake level over the period of the February 2022 flood event was EL 37.4 metres AHD, there was no water was ponded against the Saddle Dams during the February 2022 flood event.

No damage to the Saddle Dams was observed following the February 2022 flood event. Additionally, no damage to the Saddle Dams has been noted on the Surveillance Inspection sheets completed over the course of the February 2022 flood event. The saddle dams are well maintained an in a satisfactory condition.

INSTRUMENTATION REVIEW

I reviewed the dam safety instrumentation data for North Pine Dam following the conclusion of the February 2022 flood event. There is nothing apparent in the data to suggest that any new structural issues that could potentially threaten the safety of the dam have arisen as a result of the February 2022 flood event.

RPEQ CERTIFICATION

I inspected North Pine Dam on 11 March 2022 and again on 14 April 2022 and also reviewed the surveillance and instrumentation records for this period. This report has been prepared as a result of those inspections and investigations.

Appendix E Gauge Rating Tables

Table E-1: Terrors Creek rating table

Stage (m)	Discharge (m³/s)
0.40	0.0
0.55	0.1
0.70	0.4
0.86	0.7
1.01	1.1
1.16	1.5
1.31	2.0
1.46	2.5
1.62	3.1
1.77	3.7
1.92	4.3
2.07	4.9
2.22	5.6
2.38	6.4
2.53	7.1
2.68	7.9
2.83	8.7
2.98	10
3.14	10
3.29	11
3.44	12
3.59	13
3.74	14
3.90	15
4.05	16
4.20	17
4.35	19
4.50	21
4.66	22
4.81	24
4.96	26
5.11	28
5.26	30
5.42	33
5.57	35
5.72	37
5.87	39
6.02	42
6.18	45
6.33	47
6.48	50

Stage (m)	Discharge (m³/s)
6.63	53
6.78	56
6.94	59
7.09	62
7.24	65
7.39	69
7.54	72
7.70	76
7.85	79
8.00	83

Table E-2: Baxters Creek rating table

Stage (m)	Discharge (m³/s)
0.20	0
0.55	2
0.93	6
1.24	11
1.54	19
1.81	28
2.06	38
2.31	50
2.56	64
2.78	78
3.00	94
3.23	112
3.43	130
3.63	149
3.85	171
4.05	193
4.23	215
4.44	241
4.62	266
4.81	292
4.99	319
5.18	349
5.35	378
5.52	408
5.70	441
5.88	474
6.05	507
6.22	543
6.39	579

Stage (m)	Discharge (m³/s)
6.55	615
6.72	655
6.88	693
7.04	732
7.21	774
7.37	816
7.52	858
7.69	903
7.84	947
7.99	992
8.15	1040
8.30	1087
8.45	1134
8.60	1183
8.75	1235
8.90	1285
9.05	1336
9.20	1391
9.34	1444
9.49	1498
9.63	1555
9.78	1611

Table E-3: Dayboro WWTP rating table

Stage (m)	Discharge (m³/s)
0.40	0.0
0.51	0.0
0.62	0.1
0.74	0.4
0.85	0.8
0.96	1.5
1.07	2.3
1.18	3.3
1.30	4.8
1.41	6.4
1.52	8.3
1.63	10
1.74	13
1.86	16
1.97	19
2.08	23
2.19	27

Stage (m)	Discharge (m³/s)
2.30	31
2.42	36
2.53	41
2.64	47
2.75	53
2.86	59
2.98	67
3.09	74
3.20	82
3.31	90
3.42	99
3.54	109
3.65	119
3.76	129
3.87	140
3.98	151
4.10	164
4.21	177
4.32	190
4.43	203
4.54	218
4.66	234
4.77	249
4.88	265
4.99	282
5.10	299
5.22	318
5.33	337
5.44	356
5.55	376
5.66	396
5.78	419
5.89	441
6.00	463

Table E-4: Kobble Creek rating table

Stage (m)	Discharge (m³/s)
1.58	0
2.00	0.5
2.50	3.0
3.00	15
3.50	60
4.00	110
5.00	220
5.50	350
6.00	600