February 2022 Flood Event

Hydrological Modelling

Report

March 2023

Executive Summary

This report has been prepared to describe selected hydrological modelling of the February 2022 Flood Event at Somerset and Wivenhoe Dams. The scope of this assessment consisted of the following tasks in order to provide additional context to the influence and operation of Somerset and Wivenhoe Dams during the February 2022 Flood Event:

- Undertaking hydrological modelling of a 'no dams' scenario to illustrate the flood mitigation effects of the presence and operation of the dams.
- Preparing a technical report summarising the inputs, methods and results of the modelling.

The 'no dams' scenario is a hypothetical simulation that provides an estimate of the possible flood hydrograph at Moggill assuming that Somerset and Wivenhoe Dams are not in place. When the modelled flood hydrograph at Moggill from this scenario is compared to an actual flood event, it is expected that the 'no dams' scenario would produce a hydrograph with a higher peak flow rate.

For the purposes of comparison, this study compares modelled hydrographs at Moggill from the 'no dams' hypothetical scenario with rated and modelled flows at Moggill from the February 2022 Flood Event. As noted in Section 4.3 of the Manual, Moggill is a key point of reference for flood mitigation operations of the Dams. The peak flood flow at Moggill is a key indicator of flood consequences along the reach of the Brisbane River downstream of Wivenhoe Dam.

Modelled flows at Moggill from the February 2022 Flood Event were derived from the whole of event calibration documented in February 2022 Flood Event: Report on the Operation of Somerset Dam and Wivenhoe Dam (HARC, 2022). That report contains details of the model calibration at selected points in the Brisbane River Basin.

The FEWS platform used by Seqwater and adopted for this study includes a 'no dams' module which is based on the URBS model configuration used to estimate flows at gauging stations and inflows to the dams during flood operations, with amendments to represent the removal of Somerset and Wivenhoe Dams. Further background information about FEWS and the Brisbane River Basin URBS model is provided in Section 17.4 of the Manual.

A comparison of rated flow at Moggill from the February 2022 Flood Event with the whole of event calibration and 'no dams' scenario is shown in Figure i. Figure ii illustrates a comparison of level at Moggill from the February 2022 Flood Event with the whole of event calibration and 'no dams' scenario.

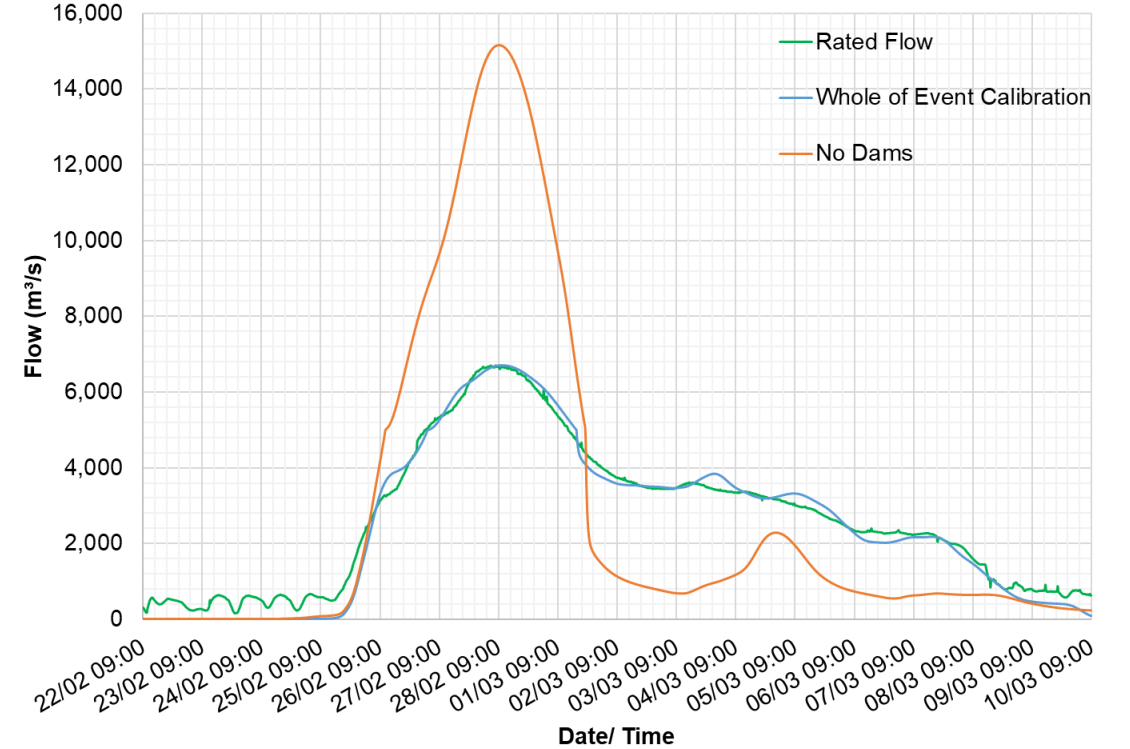

Figure i: Hydrograph at the Brisbane River at Moggill Gauge for the February 2022 Flood Event for the Whole of Event Calibration and No Dams Scenario

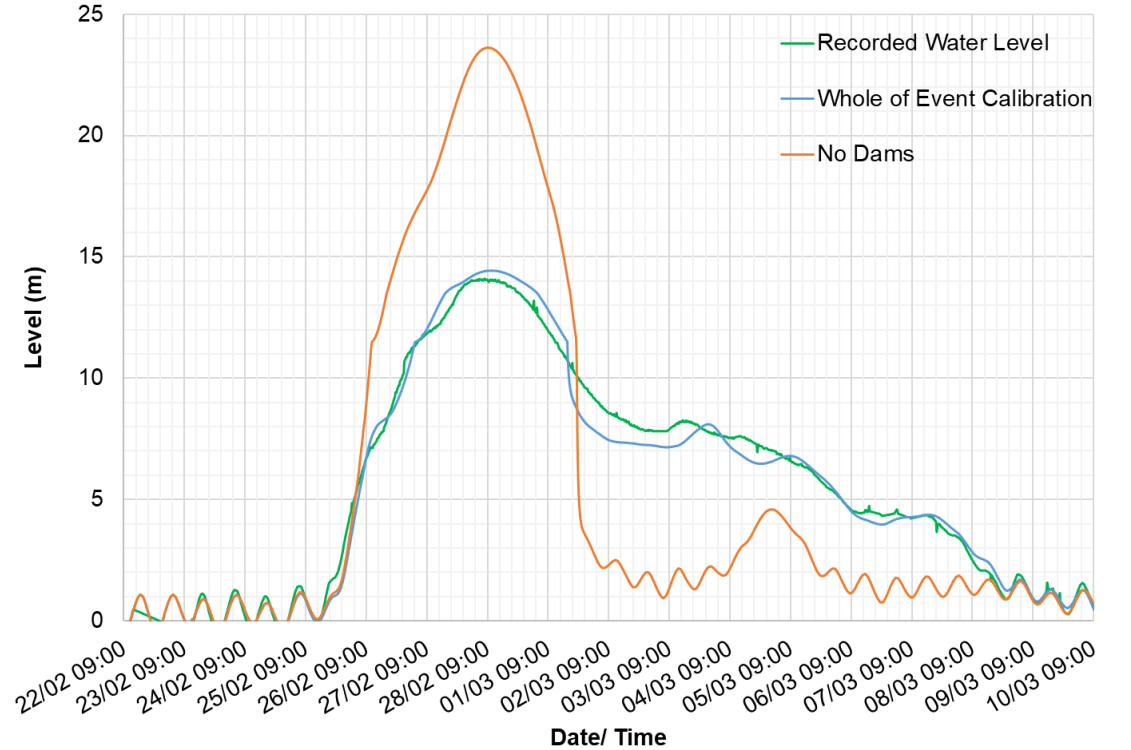

Figure ii: Water Level Hydrograph at the Brisbane River at Moggill Gauge for the February 2022 Flood Event for the Whole of Event Calibration and No Dams Scenario

The results of the hydrological modelling demonstrate that the 'no dams' scenario resulted in a significantly higher modelled peak flow rate at Moggill compared to the whole of event calibration. The hydrograph of the 'no dams' scenario has a much steeper rising and falling limb compared to the whole of event calibration. This result is consistent with expectations that the dams provide a significant flood mitigation effect at Moggill.

The 'no dam's scenario was compared to historical events that occurred prior to construction of the Somerset and Wivenhoe Dams, which are hydrologically comparable. The peak flow rates of these historical events were taken from Table I.3 of the Manual (Seqwater, 2021).

The peak flow at Moggill during the 1893 event is quoted to be 16,330 m^3/s (Seqwater, 2021). The peak flow rate at Moggill for the February 2022 Flood Event for the 'no dams' scenario was modelled to be approximately 15,000 m^3/s, which makes the February 2022 Flood Event comparable in peak flow at Moggill to the 'no dams' scenario (i.e. the estimated peak flow at Moggill for the 1893 event is within 10% of the estimated peak flow for the 'no dams' scenario).

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Glossary

AHD means Australian Height Datum.

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.

Dam means Wivenhoe Dam and Somerset Dam and "Dam" means either Wivenhoe Dam or Somerset Dam depending on the context used.

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.

Downstream Catchment Flow means the estimate of the flow from the catchments downstream of Wivenhoe Dam excluding the releases from Wivenhoe Dam, and is derived with the FFS.

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.

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 13.2 or Section 17.3(c) and Section 17.4(b) of the Manual 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.

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 Wivenhoe Dam and Somerset Dam** means the current version 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.

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).

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

HARC were engaged to undertake further hydrological modelling of the February 2022 Flood Event at Somerset and Wivenhoe Dams to assess a no dams scenario to understand the magnitude of the flood mitigation benefits provided by the dams. Details of Somerset and Wivenhoe Dams and the operational procedures can be found in the Manual. This report has been prepared to present the methodology and outcomes of this modelling.

The scope of this assessment consisted of the following tasks in order to provide additional context to the influence and operation of Somerset and Wivenhoe Dams during the February 2022 Flood Event:

- Undertaking hydrological modelling of a 'no dams' scenario to illustrate the flood mitigation effects of the presence and operation of the dams.
- Preparing a technical report summarising the inputs, methods and results of the modelling.

This report outlines the data received, hydrological modelling method and results of the hydrological modelling of the February 2022 Flood Event at Somerset and Wivenhoe Dams. This report references data and information contained in the February 2022 Flood Event Report on the Operation of Somerset Dam and Wivenhoe Dam (HARC, 2022), which should be read in conjunction with this report.

1.1 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 Post Flood Event Hydrological Modelling 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 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. Data Received

The following information was provided to HARC as an input to the hydrological modelling:

- FEWS package including data and hydrological modelling simulations pertaining to the operation of Somerset and Wivenhoe Dams during the February 2022 Flood Event. FEWS is a hydrological modelling platform that utilises data from Enviromon[1], WISKI[2] and the Bureau[3] 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. Further background information about the FFS, FEWS and the Brisbane River basin URBS model is provided in Section 7.4 of the Manual.
- The 'no dams' module included in the FEWS package.
- Rated flows at selected gauges for the February 2022 Flood Event.
- Whole of Event calibration parameters presented in the February 2022 Flood Event Report (HARC, 2022).

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. The calibration was based on selected archived model runs that already provided a reasonable match throughout the catchment, thus the whole of event calibration focused on minor adjustments to model parameter values at key locations to determine if the calibration could be enhanced with the benefit of hindsight.

Rated flow data for selected key gauges in the Brisbane River basin was used to support the whole of event calibration estimates of flow at key gauge sites. Whilst the focus of real time model calibration during the actual operations was to lake level at Somerset Dam and Wivenhoe Dam, and rated flow at Moggill, the whole of event calibration with the benefit of hindsight and more time available allows the overall fit to be improved by considering other gauges throughout the Brisbane River basin.

Rated flow data was calculated from the recorded water level data at each gauge using the relevant gauge rating tables from FEWS. It should be noted that there is a significant degree of uncertainty associated with some of these rating tables, particularly for flows that exceed the confinement of the channel of a watercourse and engage the surrounding floodplain.

[1] Enviromon collects real time ALERT gauge data.
[2] WISKI collects and stores other data such as telemetry, dam operator readings (gauge boards and gate settings).
[3] Bureau of Meteorology data feeds include modelling results and rainfall forecasts.

3. No Dams Scenario

The ‘no dams’ scenario is a hypothetical simulation that provides an estimate of the flood hydrograph at Moggill assuming that Somerset and Wivenhoe Dams are not in place. When the modelled flood hydrograph at Moggill from this scenario is compared to an actual flood event, it is expected that the ‘no dams’ scenario would produce a hydrograph with a higher peak flow rate. This is because the dams provide a significant flood mitigation effect.

The impact of the ‘no dams’ scenario on downstream flood impacts is that additional properties would likely be inundated and infrastructure impacted attributed to the higher peak flow rate when compared to an actual flood event. While the recession of flow rates at Moggill in the ‘no dams’ case would likely be faster than an actual flood event (due to a sharper falling limb of the hydrograph) this does not provide mitigation of flood impacts (by comparison) as the peak flow rate at Moggill is the key indicator for urban flood impacts rather than the duration of inundation.

4. Hydrological Modelling Method

This section describes the methodology that was utilised to undertake the hydrological modelling of of the February 2022 Flood Event at Somerset and Wivenhoe Dams. This section presents the model configuration and simulations completed using the FEWS hydrological modelling platform.

The FEWS platform includes a 'no dams' module which is based on the URBS model configuration used for flood forecasting (represented by the whole of event calibration) with the following exceptions to represent the removal of Somerset and Wivenhoe Dams:

- Removal of the storages used to represent Somerset and Wivenhoe Dams.
- Removal of the drowned reaches associated with Somerset and Wivenhoe Dams.
- Revision of the reach length factor (changed from 0.5 to 1) to represent natural routing of flows through the reaches associated with Somerset and Wivenhoe Dams.
- Removal of the fraction impervious applied for the lake of Somerset and Wivenhoe Dams.

5. Results

This section presents the results of the hydrological modelling described in Section 3 and 4. This section presents hydrograph comparisons of the 'no dams' scenario to the whole of event calibration at key gauges for February 2022 Flood Event at Somerset and Wivenhoe Dams.

5.1 Hydrographs at Key Gauges

From the model simulations described in Section 3 and 4, hydrographs were extracted at the Brisbane River at Lowood and Moggill gauges for the 'no dams' scenario and the whole of event calibration. These were compared to rated flows at these gauges.

Figure 5-1 presents the rated flow hydrograph at the Brisbane River at Lowood gauge for the February 2022 Flood Event, compared with modelled flows for the whole of event calibration and 'no dams' scenario.

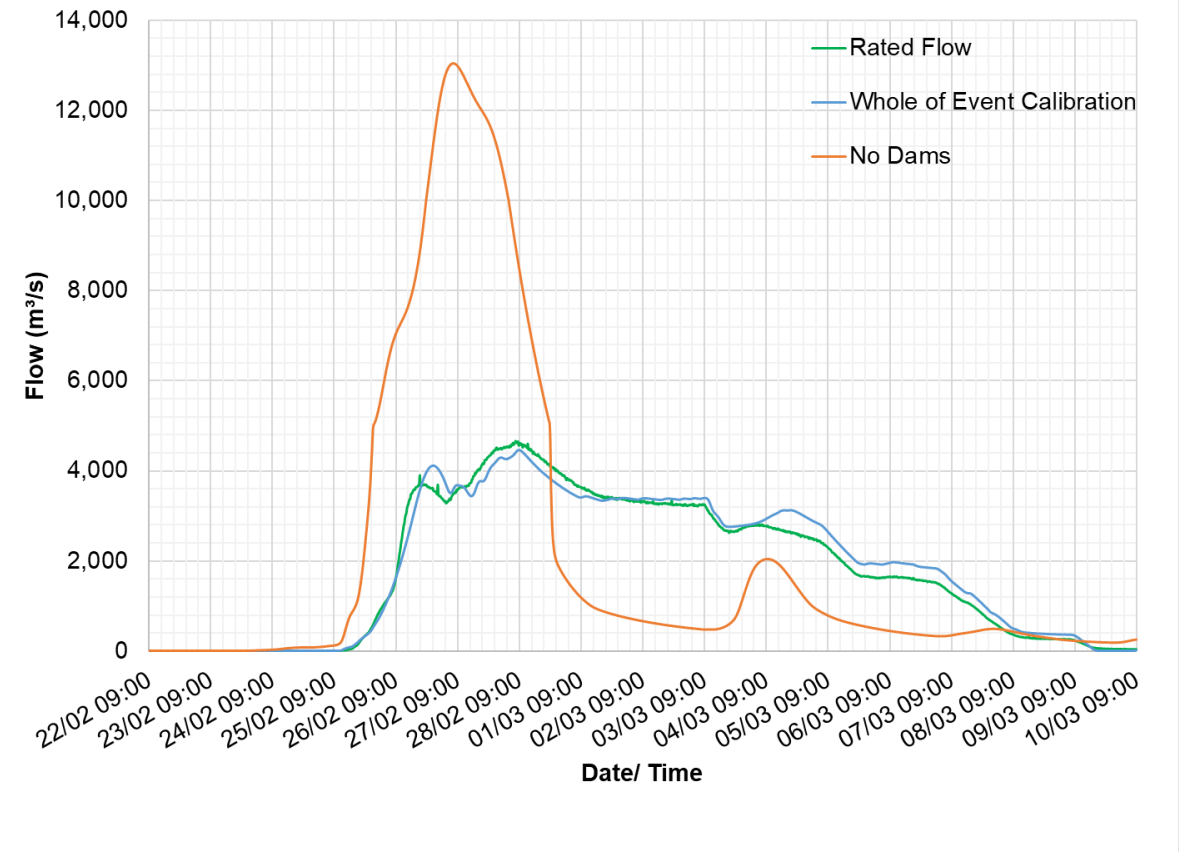

Figure 5-1: Hydrograph at the Brisbane River at Lowood Gauge for the February 2022 Flood Event for the Whole of Event Calibration and No Dams Scenario

Figure 5-2 presents the recorded water level hydrograph at the Brisbane River at Lowood gauge for the February 2022 Flood Event, compared with modelled flows for the whole of event calibration and 'no dams' scenario.

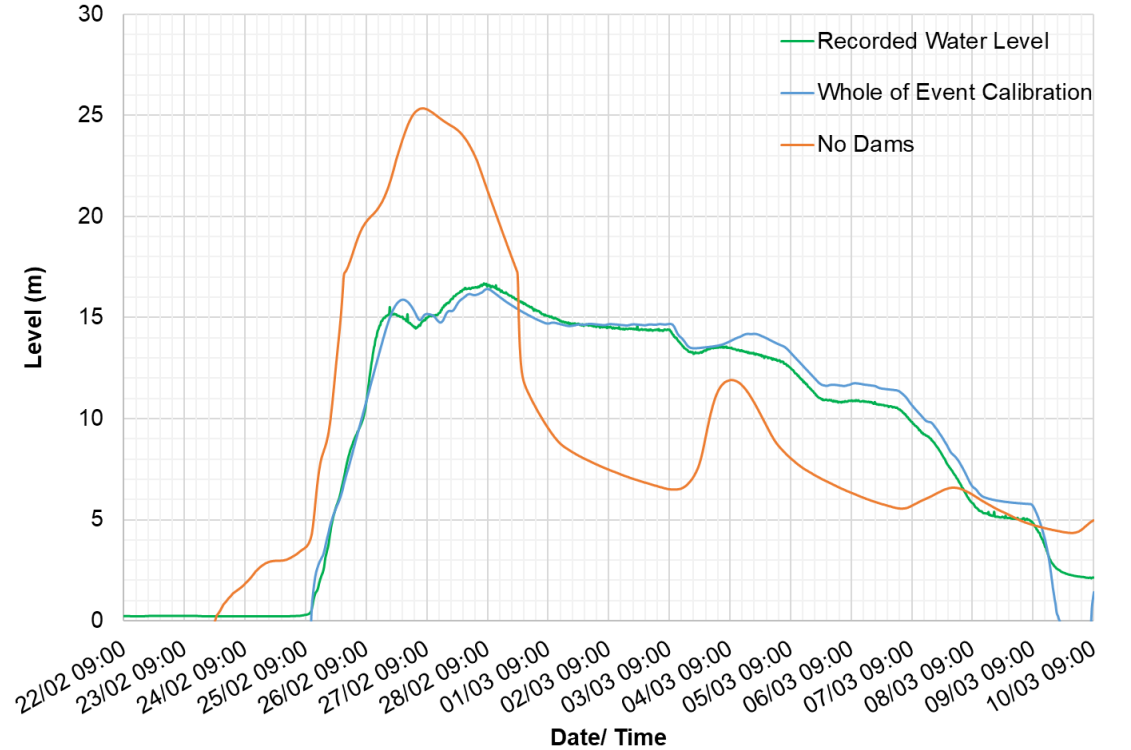

Figure 5-2: Water Level Hydrograph at the Brisbane River at Lowood Gauge for the February 2022 Flood Event for the Whole of Event Calibration and No Dams Scenario

For the purposes of comparison, the main focus of this study was the comparison of the modelled hydrographs at Moggill with rated and modelled flows at Moggill from the February 2022 Flood Event. As noted in Section 4.3 of the Manual, Moggill is a key point of reference for flood mitigation operations at the Dams. The peak flood flow at Moggill is a key indicator of flood consequences along the reach of the Brisbane River downstream of Wivenhoe Dam. Figure 5-3 presents the rated flow hydrograph at the Brisbane River at Moggill gauge for the February 2022 Flood Event, compared with modelled flows for the whole of event calibration and 'no dams' scenario.

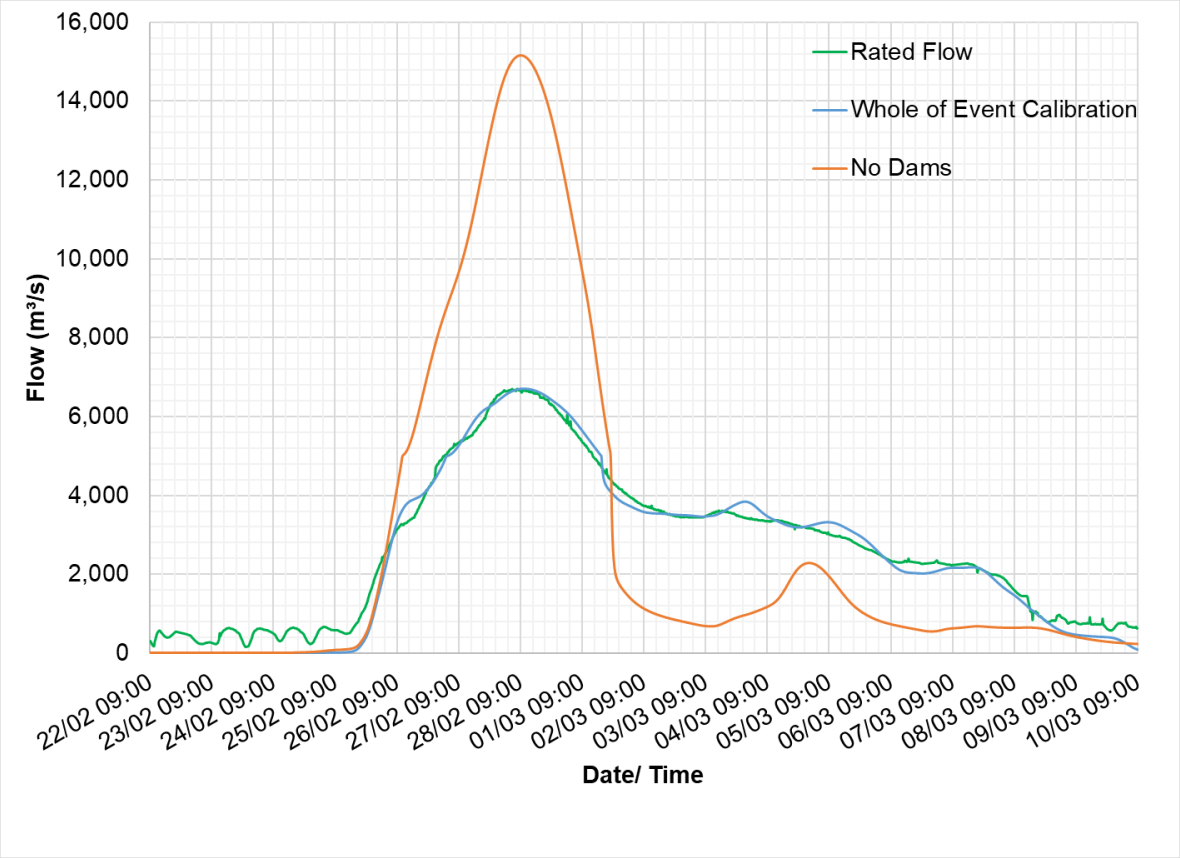

Figure 5-3: Hydrograph at the Brisbane River at Moggill Gauge for the February 2022 Flood Event for the Whole of Event Calibration and No Dams Scenario

Figure 5-4 presents the recorded water level hydrograph at the Brisbane River at Moggill gauge for the February 2022 Flood Event, compared with modelled flows for the whole of event calibration and ‘no dams’ scenario.

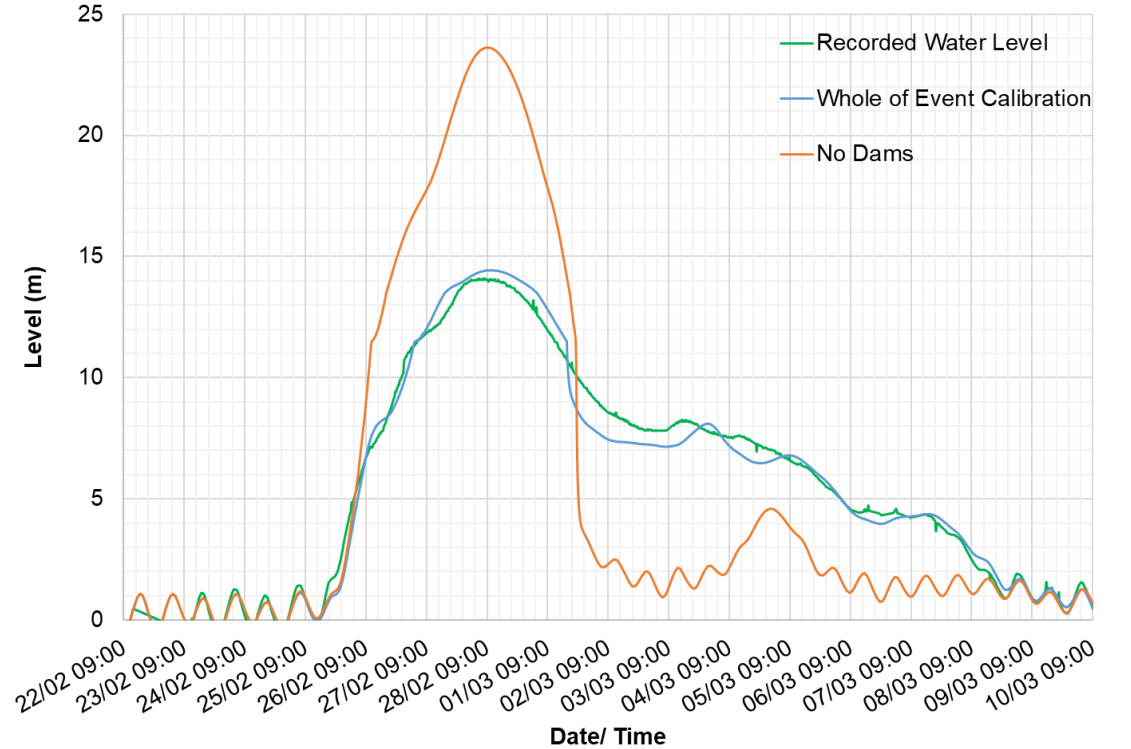

Figure 5-4: Water Level Hydrograph at the Brisbane River at Moggill Gauge for the February 2022 Flood Event for the Whole of Event Calibration and No Dams Scenario

The results presented in Figure 5-1 and Figure 5-3 demonstrate that the 'no dams' scenario resulted in a significantly higher modelled peak flow rate at Moggill compared to the whole of event calibration. The hydrograph of the 'no dams' scenario has a much steeper rising and falling limb compared to the whole of event calibration. This result is consistent with expectations that the dams provide a very significant flood mitigation effect at Moggill and Lowood.

5.2 Comparison to Significant Historical Events

The 'no dam's scenario was compared to historical events that occurred prior to construction of the Somerset and Wivenhoe Dams, which are hydrologically comparable. The peak flow rates of these historical events were taken from Table I.3 of the Manual (Seqwater, 2021).

The peak flow at Moggill during the 1893 event is quoted to be 16,330 m^3/s (Seqwater, 2021). The peak flow rate at Moggill for the February 2022 Flood Event for the 'no dams' scenario was modelled to be approximately 15,000 m^3/s, which makes the February 2022 Flood Event comparable in peak flow at Moggill to the 'no dams' scenario (i.e. the estimated peak flow at Moggill for the 1893 event is within 10% of the estimated peak flow for the 'no dams' scenario).

6. References

HARC. (2022). *February 2022 Flood Event: Report on the Operation of Somerset Dam and Wivenhoe Dam*.

Seqwater. (2021). *Wivenhoe Dam and Somerset Dam: Manual of Operational Procedures for Flood Mitigation Revision 16*.