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Department of Emergency Services

Emergency Management EMQ Queensland

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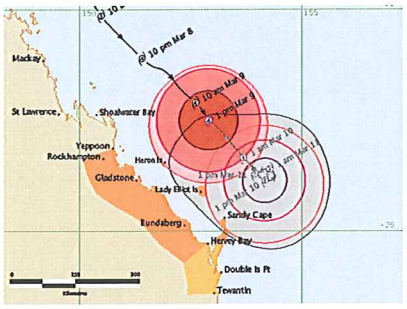
DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

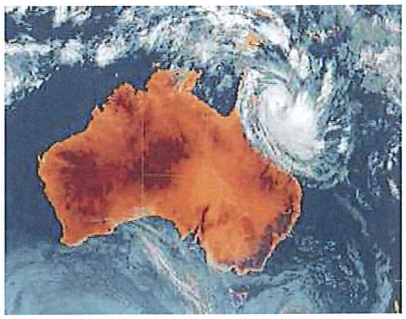
Brisbane River Hydraulic Model to Probable Maximum Flood (PMF) Final Report

24 June 2009

Prepared for
Families and Community Services Division
Brisbane City Council

Prepared by
Flood Management
City Design





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Executive Summary

The Brisbane River Hydraulic Model to Probable Maximum Flood (PMF) Project has delivered a two dimensional (2D) TUFLOW hydraulic model for the Brisbane River floodplain from Wivenhoe Dam to Moreton Bay. The 2D model encompasses a study area of 4,500 square kilometres or about one third of the Brisbane River catchment, which in total covers 13,500 square kilometres. The development of this 2D 'mega model' is considered a significant technical achievement.

The following project success factors established for the project have been achieved:

- A 2D calibrated Brisbane River PMF hydraulic model has been produced and deemed acceptable following peer review by key stakeholders

- Model outputs have been translated into flood emergency response tools to be utilised during a river flooding event for emergency preparation and response planning. Specifically, these deliverables include:

    - Inundation mapping
    - Critical infrastructure mapping and reporting
    - Isolated area mapping
    - Evacuation zone mapping

- The community of Brisbane are better informed and are able to respond more effectively in the event of a Brisbane River flood as a result of the above works

- Relevant actions and outcomes of the Council's ***Corporate Plan (2008-2012)*** and ***Lord Mayor's Taskforce on Suburban Flooding (2005)*** have been addressed

Overall this project represents a significant improvement in the flood response capability of the Council. However, in the context of educating and preparing the Brisbane community for a major flooding event there is more work to be undertaken.

Following on from this achievement, it is recommended that further work should be undertaken and include:

1. Incorporate into the 2D model the Council's new survey data (available in late 2009) and produce an addendum report

2. Incorporate the results of this Project into the Council's Disaster Management Planning; ***Threat Specific Plan for River Flood and Storm Surge Event (2008)***.

3. Develop a community safety education campaign that integrates the outcomes of this project and other related projects (for example 'Be FloodWise Campaign'), the focus of which should relate to the publishing and use of the project deliverables in the public domain and on the Council's website. This will improve awareness to river flooding and empower the

community to self-assess individual flood risk and make appropriate and safe decisions for a range of river flooding events from minor to extreme.

4. Deliver training to the State Emergency Service (SES), Emergency Coordination Centre (ECC), the Flood Information Centre (FIC), senior management, and other relevant personnel within the Council in the use and application of the flood emergency response tools.

5. Investigate 'innovative ways' that the results of this project can be applied to improve the interpretation across the various disciplines within the Council.

6. Annually review the outcomes of this study to integrate new initiatives and developments.

7. Investigate possible external revenue options through State and Commonwealth Government grants to fund eligible and related future works.

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1.0 Introduction

Brisbane is a sub-tropical city that has developed around its river and major creeks. Historically, the city experiences high annual rainfall with a climate and topography that make some areas susceptible to flooding. Much of the flooding that occurs in Brisbane's suburbs relates to the many creeks, watercourses and stormwater systems that make up the landscape of our river city. Minimising flood damage is a community-wide responsibility. Although Brisbane City Council has an important part to play, residents and businesses can lessen the effect that flooding has on their properties and families, while also assisting the wider community to respond to, and recover from a flood.

To support our community to be 'flood prepared', the Council has developed the 'Be FloodWise Campaign'. Though this campaign the Council has developed a range of materials that provide information to assist in personal flood management. Many of the actions suggested in the 'Be FloodWise' guides are low-cost and easy to implement.

The Council has a responsibility under State legislation to manage the impacts of, and where possible mitigate against the adverse impact of disaster events, such as floods. The ***Disaster Management Act (2003)*** forms the legislative basis for disaster management activities within all levels of government in Queensland. For local government this includes the preparation of disaster management plans and guidelines, helping communities mitigate and prepare for the potential adverse impacts of disaster events and promote best practice disaster management including a comprehensive "all hazards" approach.

In February 2005, The Lord Mayor of Brisbane commissioned a Taskforce on Suburban Flooding which proposed several key priority actions. These included a voluntary home purchase scheme for identified 'at-risk' residential properties and the reviewing and strengthening of land use planning, development and building controls to ensure future activities have no adverse effect on flooding. The report also recommended a community education and awareness program and the development of early warning systems aimed at enhancing community capacity to prepare for and manage the impacts of flooding.

In addition to the above, the Council's ***Corporate Plan (2008-2012)*** outlines the medium to long term outcomes for the City that each program is working to achieve. Within the Council, two program areas, Program 2 and Program 7 deliver disaster management strategies.

Program 2 is the Council's ***Integrated Water Management Program***. Its objective is for the Brisbane River and Moreton Bay catchments to be managed to reduce the impacts of flooding. This is to be achieved through:

- providing easy and free access to flood information on www.brisbane.qld.gov.au,
- establishing best practice disaster response and flood management procedures, and
- progressing the ***Lord Mayor's Taskforce on Suburban Flooding (2005)*** recommendations.

Program 7 is the Council's ***Public Health and Safety Program***. Its objective is to establish by 2010 a system of regionally consistent flood warnings in collaboration with the Bureau of Meteorology and

other regional Councils and to establish natural disaster management plans to support best practice disaster response and flood management procedures. This will be achieved through taking an "all hazards" approach to safeguarding Brisbane against natural disasters, including flooding.

The Council's existing hydraulic model of the Brisbane River has simulated to the 1974 flood profile, as it occurred. However, even with the construction of Wivenhoe Dam larger floods than occurred in 1974 are possible. Therefore, the basis of this project is to provide a flood emergency response capability up to and including the Probable Maximum Flood (PMF). The flood emergency response tools or key deliverables from this project include:

- Inundation mapping
- Critical infrastructure mapping and reporting
- Isolated area mapping
- Evacuation zone mapping

It is important to note that the results of this project inform the Council's emergency response capabilities and mitigation planning and do not in any way impact or influence the Council's land use planning policies and decisions.

2.0 Background

In order to provide a flood emergency response capability up to and including the PMF it was necessary to improve upon the Council's existing one dimensional (1D) hydraulic model and develop a two dimensional (2D) calibrated model of the Brisbane River. The reasoning for this is because the possible schematisation of a 1D flood model does not easily represent 'channel breakouts' or the 'short-circuiting' of flood flow across river bends experienced during major flooding events. Furthermore, the Council's existing disaster response capacity (inundation maps and reporting) is limited to a flood event comparable in size to 1974. Refer to Appendix D for more on the history of the Brisbane River 1D models.

This project was also based on legislation and a number of related projects including:

- Legislative requirements contained in the ***Disaster Management Act (2003)***
- The Council of Australian Governments (COAG) review of Natural Disasters in Australia resulting in the report ***Natural Disasters in Australia: Reforming mitigation, relief and recovery arrangements (2004)***
- ***Report No. 2 for 2004-05: Audit of the Queensland Disaster Management System (2004).***
- ***The Brisbane City Natural Disaster Risk Management Study (2005)***
- The establishment of the ***Lord Mayor's Taskforce on Suburban Flooding (2005)*** and subsequent recommendations report
- ***The Brisbane Valley Flood Damage Minimisation Study (2007)***

In February 2007, the Council submitted an application for funding under the Natural Disaster Mitigation Program (NDMP) 2007 – 2008 to the State Department of Emergency Services (DES) and the Commonwealth Department of Transport and Regional Services (DoTaRs) for the Brisbane River Hydraulic Model Review to Probable Maximum Flood (PMF) Project.

The application was successful with the various approval processes taking place during the remainder of 2007. Refer to Appendix B for further information on the NDMP funding process. The project commenced in February 2008 and was delivered within the 2008-2009 financial year.

3.0 Project Objectives

The original objectives of this project were:

- To develop a calibrated and peer reviewed two-dimensional (2D) Brisbane River Hydraulic Model to PMF (hereafter referred to as the '2D model') for five (5) key flood profiles up to and including the Probable Maximum Flood (PMF).

- To develop a number of flood emergency response tools from the 2D model. These deliverables include:

    - Inundation mapping
    - Critical infrastructure mapping and reporting
    - Isolated area mapping
    - Evacuation zone mapping

3.1 Variation to Project Objectives

During the course of the project variations to the original scope were made as follows:

1. The number of flood profiles analysed was increased from five (5) to ten (10).
2. Additional work was undertaken on the hydrology used in this study.

Refer to Section 5.0 for the project definition and scope of works.

4.0 Project Success Factors

The criteria against which the success of this project are to be measured include:

- A 2D calibrated Brisbane River PMF hydraulic model is developed and deemed acceptable following peer review by stakeholders
- Outputs from the model are able to be translated into flood response tools utilised for flood disaster and emergency response planning
- As a result of the above works the community of Brisbane are better informed and are able to respond more effectively in the event of a Brisbane River flood
- The related actions and outcomes of the Council's ***Corporate Plan (2008-2012)*** and ***Lord Mayor's Taskforce on Suburban Flooding (2005)*** are addressed

5.0 Project Definition

5.1 In Scope

The following tasks were included in the project's original scope of works:

- Hydraulic model scoping
- Hydraulic model development
- Hydraulic model calibration
    - Coarse
    - Detailed
- Flood profile modelling (5 events only)
- Development of flood response tools
    - Inundation mapping
    - Critical infrastructure mapping and reporting
    - Isolated area mapping
    - Evacuation zone mapping
- Project documentation
- Project management reporting
    - Monthly project status
    - Monthly financial status
- Peer Review

5.2 Out of Scope

The following tasks were excluded from the project's scope of works:

- Survey and site specific photogrammetry
- Tidal calibration and flood frequency analysis
- Response tool implementation and public education

5.3 Variations

5.3.1 Flood Profiles

During the project five (5) additional flood profiles were added to the scope of works to provide a greater range of events. Therefore ten (10) flood profiles and associated flood response tools were analysed and developed respectively. Refer to Section 12.6 for details on the Flood Profile Series.

5.3.2 Hydrology

Following a review of available information further hydrology works were deemed necessary to achieve the project's outcomes and these are detailed in Section 12.0 and Appendices H, I, J & K.

6.0 Project Governance

Paramount to the success of this project is the development of the governance structure and associated responsibilities as outlined in Table 1.

Table 1: Project Governance

Name	Role	Responsibilities
Client and Service Provider Arrangements		
Cathy Wilson	Project Client	Monitor project on behalf of Project Sponsor Sign off of Project Management Plan
Ken Morris	Project Director	Overall project delivery accountability Oversee technical working and project control groups
James Charalambous	Project Manager	Operational project management Project reporting and financial reporting
Katrina Donaghy	Grants Coordinator	Contractual/grant management and project context
Technical Team		
James Charalambous	Technical Project Manager and Senior Project Engineer	Project management and oversee all technical activities Undertake 2D modelling/hydrology works
Peter Murray	Senior Engineering Surveyor	Review survey data, digital terrain model (DTM) & assist with processing of mapping deliverables
Jeffrey Secker Paul Weston	Spatial Data Officer Spatial Data Specialist	Oversee production of mapping deliverables Oversee 'Corporate' mapping requirements
Ellen Davidge	Project Manager	Representing the interests of the Fernvale Lowood Flood Study
Josh Luck	Project Engineer	Project delivery and quality
Peer Review Team		
Bill Syme	Peer Reviewer – Hydraulics (BMT WBM P/L)	Provide input and expert peer review of TUFLOW modelling
Greg Roads	Peer Reviewer – Hydrology (WRM Water and Env. P/L)	Provide input and expert peer review of hydrology works
Evan Caswell	Peer Reviewer – Deliverables and Final Report	Provide input and expert peer review of the flood emergency response tools and final report

7.0 Stakeholders

Table 2 identifies key stakeholders, their role and organisation, including the interest they have in the initiation, execution and delivery of the project. Membership of stakeholders is categorised into the Project Control Group (PCG) and the Technical Working Group (TWG). Refer also Appendix K for a list of stakeholder meetings.

Table 2: Stakeholder Information

Stakeholder Role	Stakeholder Name	Stakeholder Organisation	Interest
Primary Client/PCG Member	Cathy Wilson	Community Safety & Disaster Management	Client - Families and Community Services
Project Sponsor	Greg Scroope	Community Safety & Disaster Management	Client - Families and Community Services
State Client/PCG Member	Jason Cameron	Department of Emergency Services Queensland	Client - Emergency Management Queensland
SES Operations and Logistics	Wade Harrison	SES Local Controllor	Stakeholder - Families and Community Services/SES
PCG/TWG Member	John Ruffini	Department of Natural Resources and Water*	Representing the interests of the DNRW
PCG/TWG Member	Rob Drury, Barton Maher, Terry Malone	Seqwater	Representing the interests of Seqwater
PCG/TWG Member	Rob Ayre	Sunwater	Representing the interests of Sunwater
PCG/TWG Member	Peter Baddiley & Jeff Perkins	Bureau of Meteorology	Representing the interests of the Bureau of Meteorology
PCG/TWG Member	Quentin Underwood & Ashley Dobbie	Ipswich City Council	Representing the interests of Ipswich City Council
PCG Member	Hamid Mirfenderesk	Gold Coast City Council	Representing the interests of Gold Coast City Council
PCG Member	Tony Jacobs	Somerset Regional Council	Representing the interests of Somerset Regional Council
PCG Member	Bill Weeks	Department of Main Roads	Representing the interests of DMR
Peer Review/TWG Member	Bill Syme	BMT WBM P/L	Technical Reviewer
Peer Review/TWG Member	Greg Roads	WRM Water and Env. P/L	Technical Reviewer
Project Team			
Project Director	Ken Morris	City Design	Project delivery and quality
Peer Review	Evan Caswell	City Design	Project delivery and quality
Project Manager	James Charalambous	City Design	Project delivery and quality
Project Manager	Ellen Davidge	City Design	Fernvale Lowood Flood Study
Grants Management	Katrina Donaghy	City Design	Grants Coordinator
Project Engineer	Josh Luck	City Design	Project delivery and quality
Spatial Data Officer	Jeffrey Secker	City Design	Mapping Deliverables
Senior Engineering Surveyor	Peter Murray	City Design	Survey & Mapping Deliverables
Spatial Data Specialist	Paul Weston	I- Division	Mapping Deliverables

*DNRW is now the Department of Environment and Resource Management

8.0 Related Projects

8.1.1 Lord Mayor's Taskforce on Suburban Flooding 2005

The primary objective of the Taskforce was to develop strategies to reduce the impact of flooding on residents in areas subject to frequent and sometimes severe inundation. The taskforce identified that all flood risk information relating to a Brisbane River event was to be extended beyond the Defined Flood Event (DFE) to a PMF event.

8.1.2 Brisbane City Natural Disaster Risk Management Study 2005

The flood emergency response tools component of Brisbane River to PMF project has been identified and scoped as a direct result of the Brisbane City Natural Disaster Risk Management Study. Representatives from approximately 18 agencies - local, state, federal, private and community were heavily consulted throughout the delivery of the risk management study.

The study recommended a range of flood preparedness measures to enable the community and the authorities to better respond to a river flood event. One recommendation was for the Council to conduct further flood studies over a range of flood events up to and including the PMF.

8.1.3 Brisbane Valley Flood Damage Minimisation Study 2007

The primary aim of the study was to gain a greater understanding of the potential flood damage caused by a range of river flood events in the Brisbane River catchment and determine if the operating rules for Brisbane Valley dams could be modified to minimise this damage.

8.1.4 Threat Specific Plan for River Flood and Storm Surge Event 2008

The project is to complete the Council's Disaster Management Planning Framework as outlined in the *Disaster Management Act 2003*. The 'threat specific plan' for a flood emergency event includes the Council's response, initial recovery actions and key tasks associated with a Brisbane River flood corresponding to the DFE and a 'storm surge or tide event' to 2.5m AHD. The 'threat specific plan' will incorporate the flood emergency response tools from this project.

8.1.5 Flood Study of Fernvale and Lowood 2009

Flood profiles and inundation extents for a suite of events including PMF will be produced as part of the study. The project will deliver a design report and produce associated flood maps. It is also funded under NDMP and is to be delivered by June 2009.

9.0 Study Area

The Brisbane River catchment has an area of 13,570 square kilometres. This catchment is illustrated in Figure 1 and has been classified into various 'subregions' for the purposes of hydrologic modelling.

The digital terrain model (DTM) - essentially the land surface topography used for the 2D model - encompasses an area approximately 83.4 km (Easting length) by 53.8 km (Northing length) from Wivenhoe Dam to Moreton Bay. This represents an area of approximately 4500 square kilometres or about one third of the total Brisbane River catchment. The DTM includes the three key floodplain areas:

- Lockyer Valley (Lockyer Creek)
- Ipswich Valley (Bremer River) and
- Lower Brisbane River floodplains (Wivenhoe Dam to Moreton Bay),

The DTM (illustrated in Figure 2) essentially forms the study area and the basis for the 2D model development undertaken as part of this project. Due to the vastness of the study area encompassed by the DTM, the 2D model has been labelled a 'mega model'.

10.0 Data

The data collection phase for this project was comprehensive and can be summarised as follows:

1. DTM development
2. Hydrology data
3. Stream data

The data collection involved contacting representatives from all levels of government and the private sector over a twelve (12) month period and is detailed in Appendix C.

11.0 Modelling Platform

11.1 History of Brisbane River 1D Model

The historical development of the one dimensional (1D) Brisbane River model is described in Appendix D. This information provides the background and highlights the need for a new 2D modelling platform to achieve the project outcomes.

11.2 Project Approach - 2D Model

Originally it was planned to develop an expanded 1D model for this project. However City Design's recent 2D modelling experiences indicated the 'channel breakouts' would be complex and difficult to explicitly define in a 1D modelling format (refer to Figure 4 which provides an example of a 'channel breakout' or 'short-circuiting' of flood flow across river bends). Therefore, it was concluded that to develop a PMF model in a 1D format would not be feasible, nor would it deliver the anticipated outcomes and benefits to the client.

Accordingly the project was re-scoped to replace the original 1D modelling approach using MIKE 11 with a 2D modelling approach. Following evaluation of the 2D modelling platforms available on the market, TUFLOW was selected. Appendix E outlines the scoping exercise and appraisal. The appropriate change management processes were undertaken and variations to contract were submitted to the Department of Emergency Services (DES) for review and subsequently approved.

11.3 Hydraulic Model Development

The hydraulic model development is detailed in Appendix F.

12.0 Hydrology and Calibration

12.1 Introduction

The hydrology used in this study can be categorised as follows:

- Calibration hydrology
  - 1974 - Primary Calibration Event
  - 1996 - Verification Event
- Flood Profiles Series
  - 10 events

The calibration hydrology was based on the Brisbane and Pine Rivers Flood Study (1994) undertaken by the State Government. The flood profiles series was based on hydrology from the ***Brisbane River Extreme Flood Estimation Study*** undertaken by WRM Water and Environment P/L (2007).

12.2 WT42D Hydrology Model

The Brisbane and Pine Rivers Flood Study (1994) used the WT42D hydrology model. This model was adopted for this study. The WT42D model is a rainfall routing model. Refer to Appendix G for further information on WT42D.

12.3 1974 - Primary Calibration Event

The January 1974 event was adopted as the 'primary' calibration event for this study. The 1974 event was a significant historical flooding event for the Brisbane River. It was classified as the major flooding event of the twentieth century and is also the most recent, occurring 35 years ago. Refer to Appendices C, H and I for details of the 1974 calibration methodology and results.

12.4 1996 - Verification Event

The May 1996 event was used as a 'verification' event only for this study. This flooding produced only minor flooding in Brisbane and there was less historical data available compared with the 1974 event. Accordingly a lesser weighting was placed on the calibration process and results from the 1996 event. Refer to Appendices C and J which contain the 1996 calibration methodology and results.

12.5 Outcomes of Hydrology and Calibration Process

The calibration process for this study was undertaken from August 2008 to March 2009 (refer to Appendix K for meeting dates) with results presented to stakeholders at the 5 March PCG meeting.

There was agreement at this meeting that a 2D calibrated Brisbane River PMF hydraulic model had been developed and is 'acceptable' for the purposes of this study.

12.6 Flood Profile Series

The Flood Profile Series was based on hydrology from the ***Brisbane River Extreme Flood Estimation Study (2007)*** conducted by WRM P/L and is listed in Table 3.

Table 3: Flood Profile Series

Flood Profile	Peak Discharge at the Port Office Gauge (m^3/s)	Approximate Event
Minor Event		
1.	**3,000**	
Moderate Event		
2.	**4,000**	
3.	**5,000**	
Major Event		
4.	**7,000**	**DFE**
5.	**9,000**	
6.	**10,000**	**1974 historical event**
Extreme Event		
7.	**12,000**	**1893 historical event**
8.	**15,000**	
9.	**21,000**	
10.	**38,000**	**PMF**

The Flood Profile Series hydrology is based on only one type of storm; namely, one being centred over the Brisbane River catchment. Naturally any number of different storms can occur within the Brisbane River during a river flood event with 'catchment variability' related to:

- rainfall spatial patterns
- rainfall temporal patterns
- rainfall intensity and peak storm bursts
- antecedent conditions

Therefore it is recommended that the future revision of the flood emergency response tools takes into account 'catchment variability'. In the future it is envisaged that the 'interactive' flood emergency response tools would take BOM predictions of rainfall and flood levels during the flooding event and translate these into mapping products (similar to those pre-prepared as part of this project). Such works are beyond the scope of this study.

13.0 Deliverables

13.1 Introduction

The flood response tools developed as part of this study were subjected to a detailed scoping and review process which was conducted from October 2008 to June 2009 and involved (ten) 10 separate meetings as detailed in Appendix L. The purpose of these meetings was to scope and produce mapping deliverables suitable for the end user now and in the future. The meetings addressed the following issues:

- Update on modelling process and progress
  - Calibration
  - Flood profiles
- For each response tool produced the following criteria were considered
  - Ease of interpretation
  - End user and operational suitability
  - SES, ECC and FIC suitability
  - Possible future applications of response tools (i.e. internet and community)
  - Community use and education
  - Electronic and hardcopy use of the data
  - Contingency requirements
  - Maintenance requirements

13.2 Final Products

Flood emergency response tools from the project include 85 maps. These are listed in Table 4 and are attached in Appendix A.

Table 4: Deliverables

Deliverable	Product	Figure Numbers
Inundation mapping	One key map and three sub-area maps (west, south, east) Total: 10 key maps and 30 sub-areas maps	101-140
Critical infrastructure mapping & reporting	Three example maps 10 digital GIS layers corresponding to each flood profile	141-143
Isolated areas	One key map	144
Evacuation zone mapping	One key map and three sub-area maps (west, south, east) Total: 10 key maps and 30 sub-areas maps 1 combined key map	145-184 185

Note: For reporting purposes, the majority of mapping deliverables are printed as 'ISO A3' (210mm x 297mm) attachments in Appendix A. However the majority of mapping deliverables are intended to be viewed as 'ISO A0' (841mm x 1189mm) and so explains the small font size in Appendix A

14.0 Conclusions

A 2D hydraulic TUFLOW model has been developed for the Brisbane River. The model extents encompass the Brisbane River floodplain from Wivenhoe Dam to Moreton Bay, and this area is approximately 4,500 square kilometres or approximately one third of the total Brisbane River catchment which is 13,500 square kilometres. The development of this 2D 'mega model' is considered a significant technical achievement.

Overall this project represents a significant improvement in the flood response capability of the Council. However in the context of educating and preparing the Brisbane community for a major flooding event there is certainly much more work to be undertaken. These works have been identified in Section 15.0.

The project success factors established for this project have been achieved and include:

- A 2D calibrated Brisbane River PMF hydraulic model has been produced and deemed acceptable when peer reviewed by stakeholders

- Model outputs have been translated into flood response tools and mapping deliverables which can be utilised for flood disaster and emergency response planning specifically these deliverables include:

    - Inundation mapping
    - Critical infrastructure mapping and reporting
    - Isolated areas mapping
    - Evacuation zone mapping

- The community of Brisbane are better informed and are able to respond more effectively in the event of a Brisbane River flood as a result of the above works

- Relevant actions and outcomes of the Council's ***Corporate Plan (2008-2012)*** and ***Lord Mayor's Taskforce on Suburban Flooding (2005)*** are addressed

15.0 Recommendations

Recommendations from this project relate to future works and include:

1. Incorporate the Council's new survey data (available in late 2009) with subtasks as follows:
    - Revise the digital terrain model (DTM) used in this study with the latest information
    - Rerun the calibration events
    - Check and modify model parameters as necessary to achieve calibration
    - Rerun the flood profiles
    - Reproduce the deliverable and digital mapping layers
    - Produce a succinct addendum report

2. Incorporate the results of the project as part of the Council's Disaster Management Planning; ***Threat Specific Plan for River Flood and Storm Surge Event (2008)***.

3. Develop a community safety education campaign that integrates the outcomes of this project and other related projects (for example, 'Be FloodWise Campaign'), the focus of which should relate to the publishing and use of the project deliverables in the public domain and on the Council's website. This will improve awareness to river flooding and empower the community to self-assess individual flood risk and make appropriate and safe decisions during a river flooding event.

4. Deliver training for SES, ECC, FIC, senior management and other identified personnel within the Council in the use and application of the flood emergency response tools.

5. Investigate 'innovative ways' that the results of this project can be applied to improve the interpretation across the various disciplines within the Council. For example, overlaying the flood profiles and associated flood surfaces on 3D models of the city or utilising available technologies that modify flood surfaces according to predictions from the BOM. Both these examples would provide a greater understanding of a major river flood and provide an advanced flood response tool to allow interpretation of forecasts.

6. Annually review the outcomes of this study to integrate new initiatives and developments. These include:
    - the Draft SEQ regional plan 2009-2031
    - climate change
    - advancements in technology
    - changes in the operational requirements of the 'end user'
    - improvements to the format, style and required output of the mapping deliverables
    - changes in the input data (such as improved survey data or hydrology inputs)
    - the availability of additional calibration events

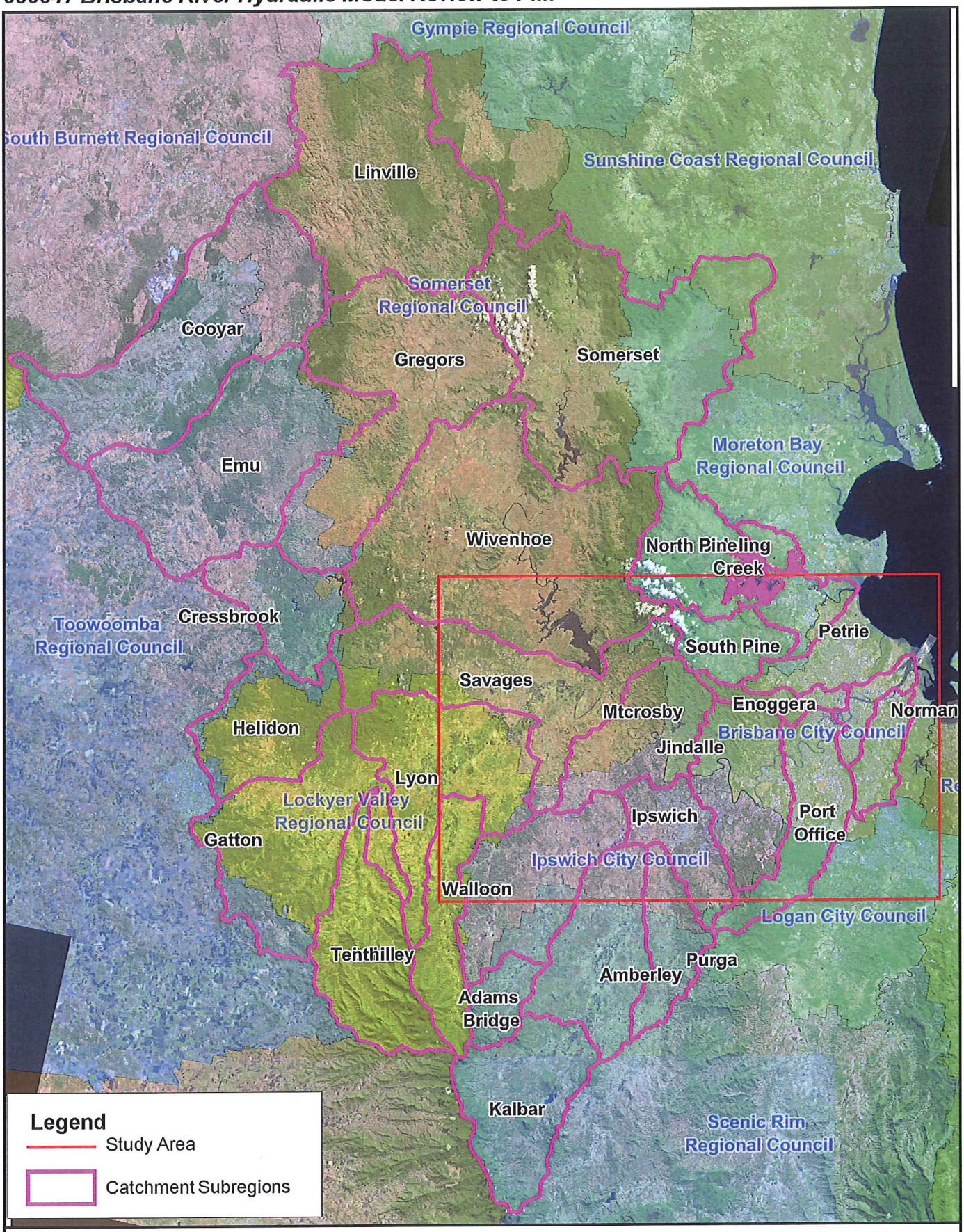
7. Investigate possible external revenue options through State and Commonwealth Government grants to fund eligible and related future works.

Appendix A Figures

REPORT FIGURES

DELIVERABLES

080547 Brisbane River Hydraulic Model Review to PMF



Brisbane River Catchment with Study Area

Figure 1

Dedicated to a better Brisbane

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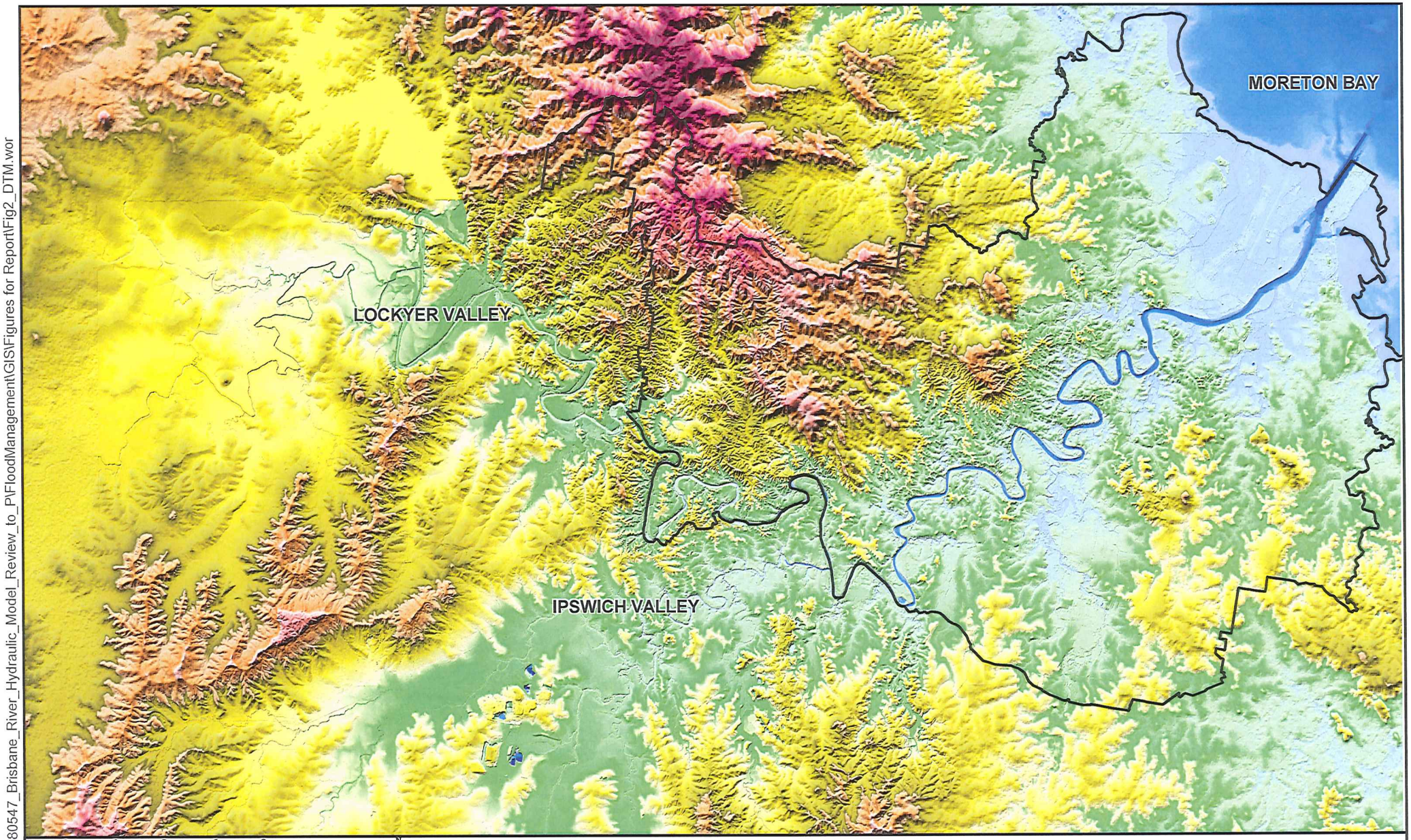

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Digital Terrain Model (DTM) for Study Area

Figure 2

Dedicated to a better Brisbane

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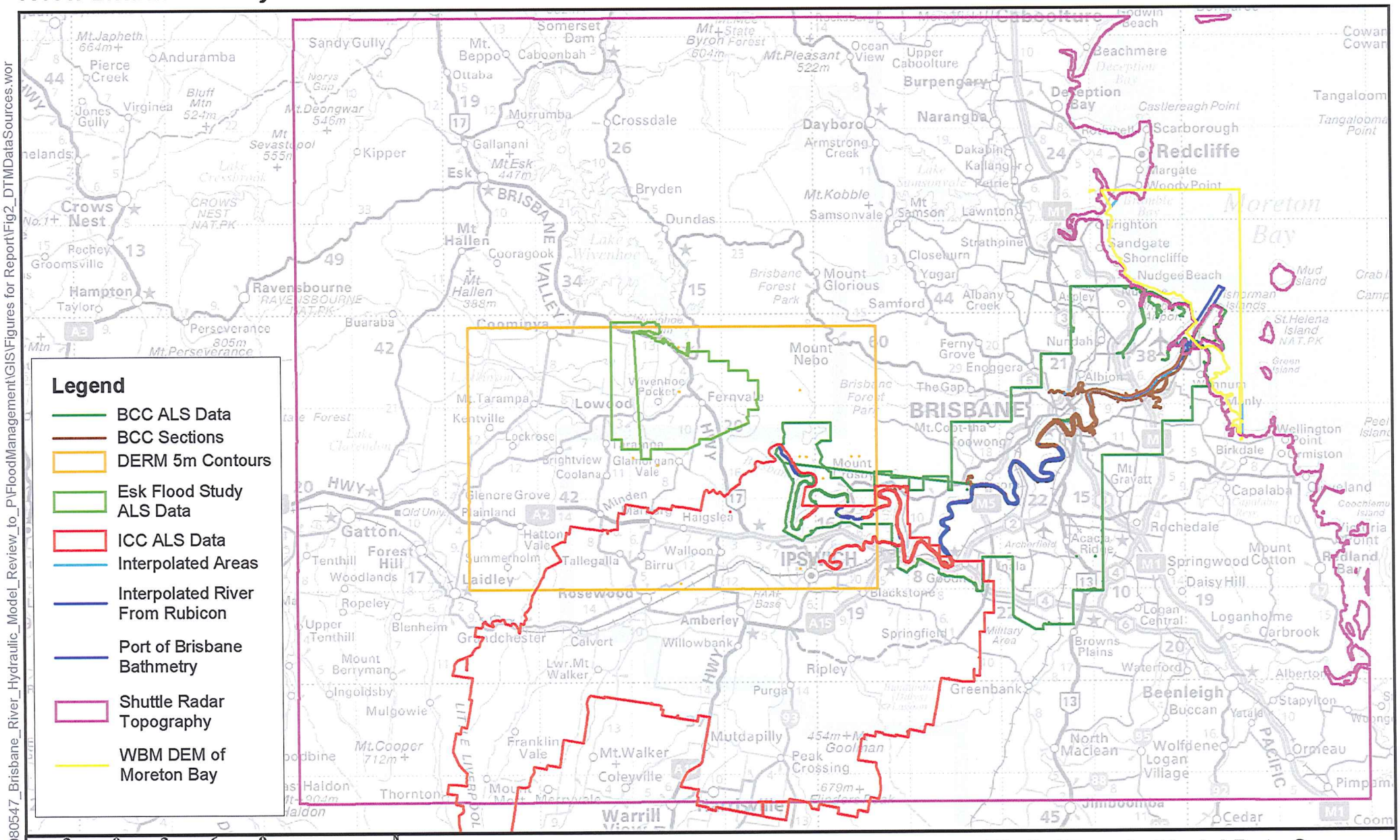
080547 Brisbane River Hydraulic Model Review to PMF



Digital Terrain Model Data Sources

Figure 3

Dedicated to a better Brisbane

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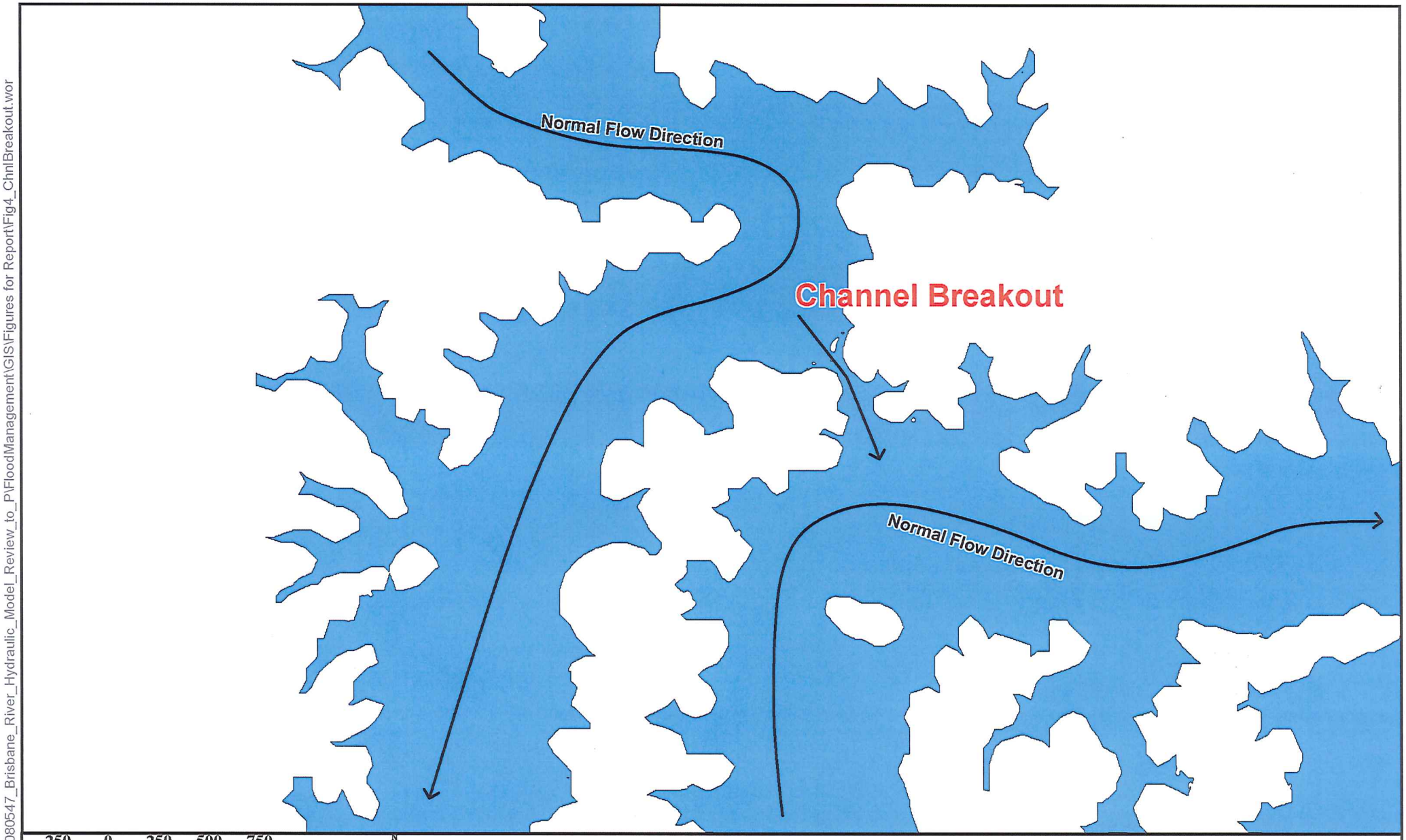

Example of a River "Channel Breakout"

Figure 4

Dedicated to a better Brisbane

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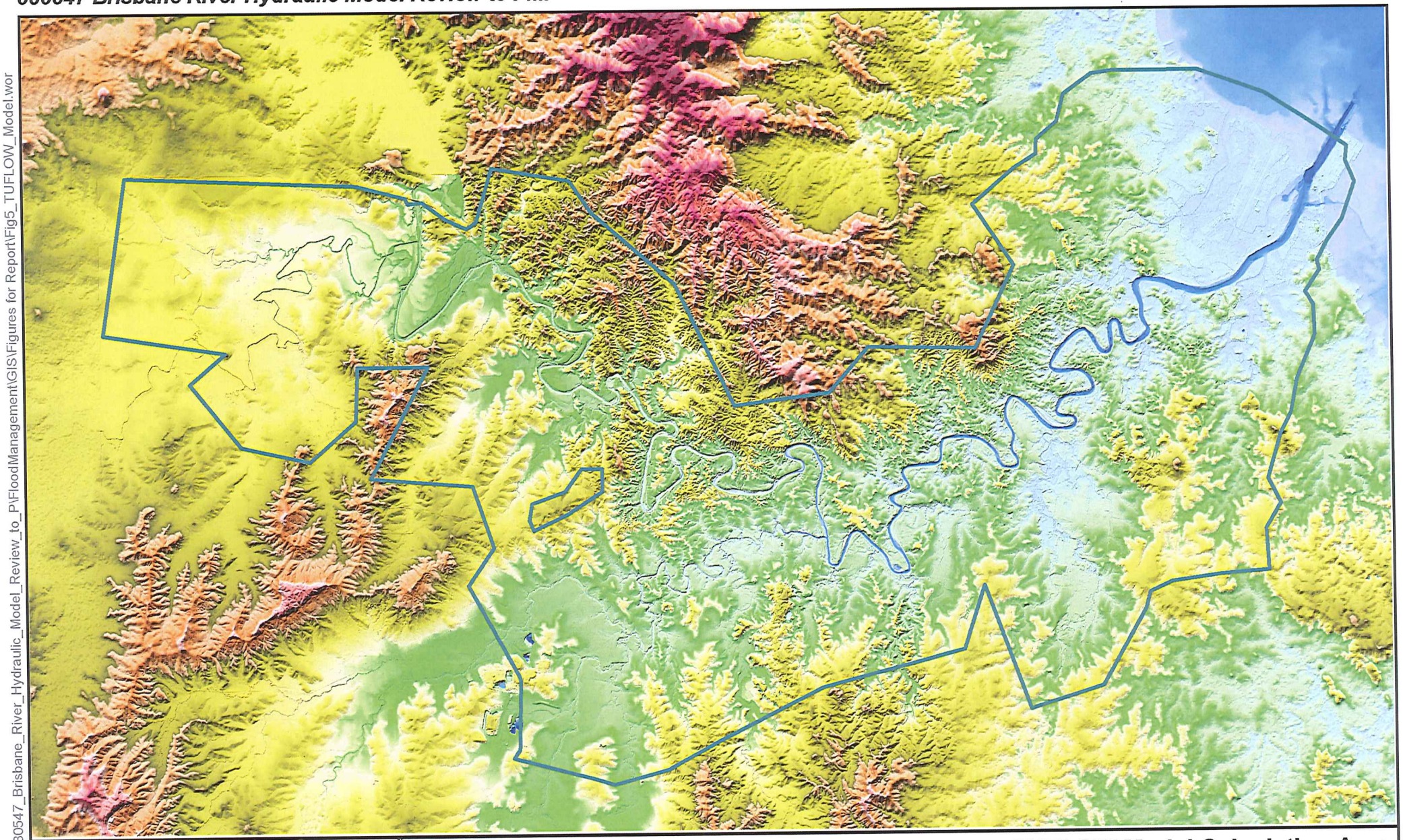

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TUFLOW Model Calculation Area

Figure 5

BCC.009.6403

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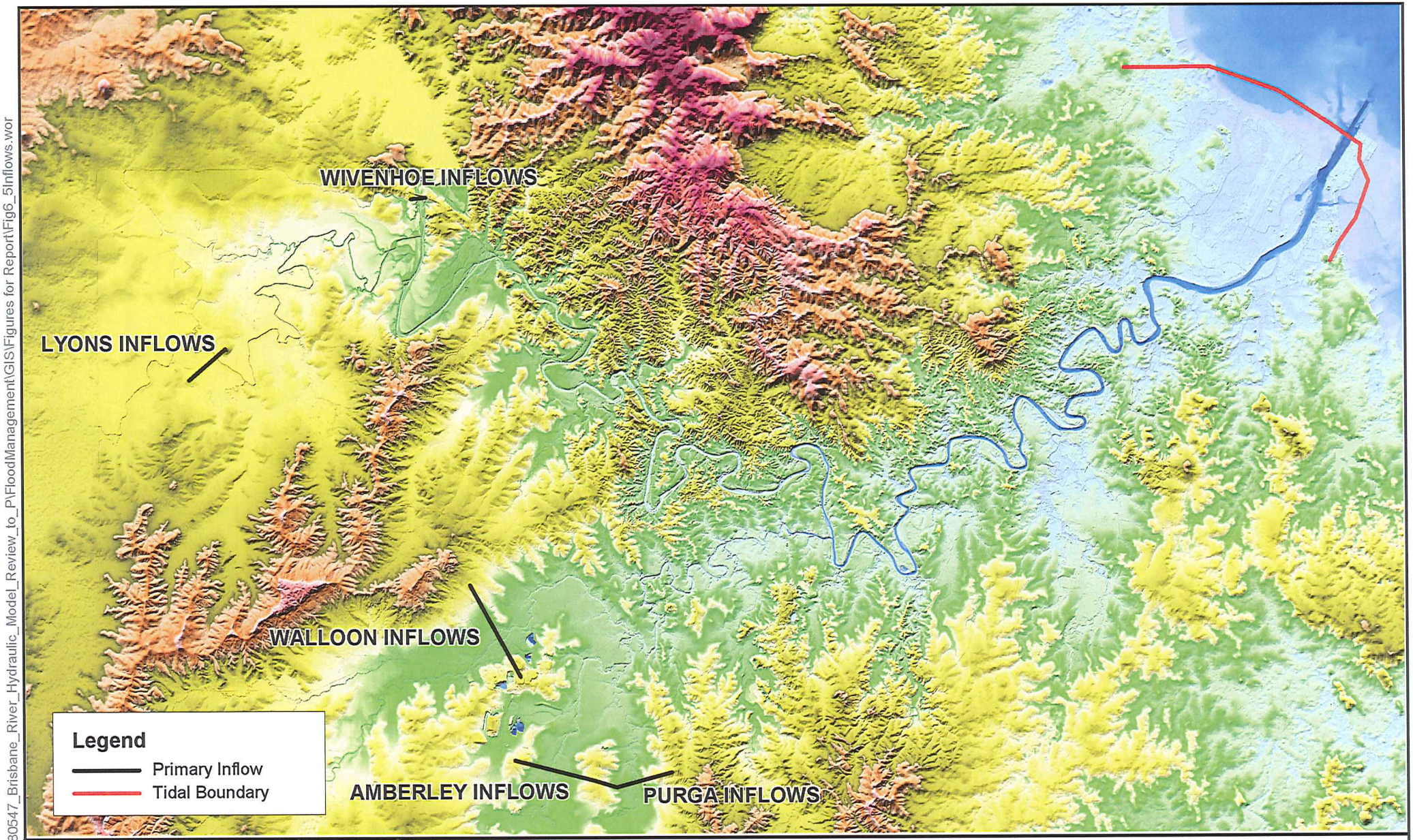

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Five Primary Inflows

Figure 6

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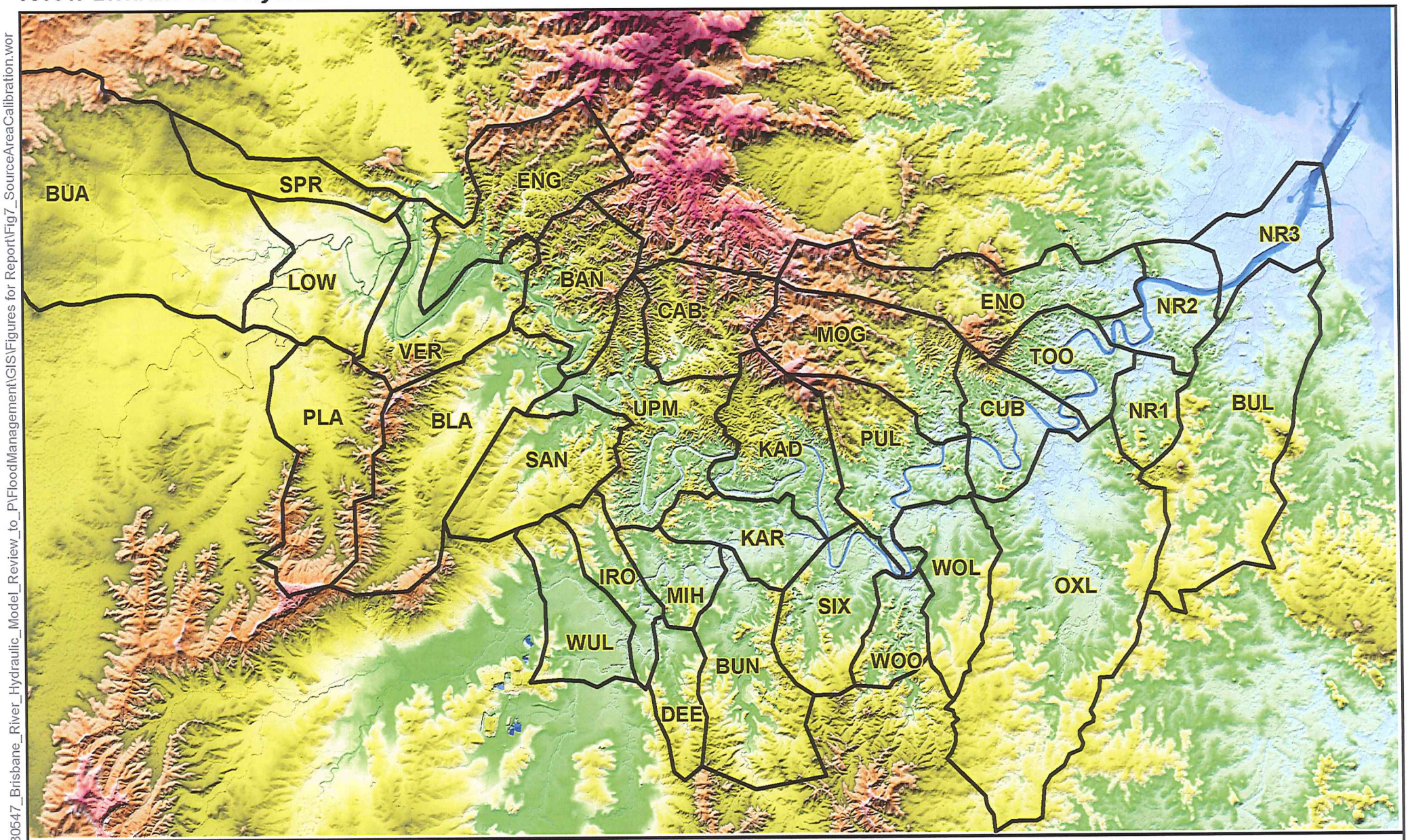

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2D Source of Areas - Calibration Model

Figure 7

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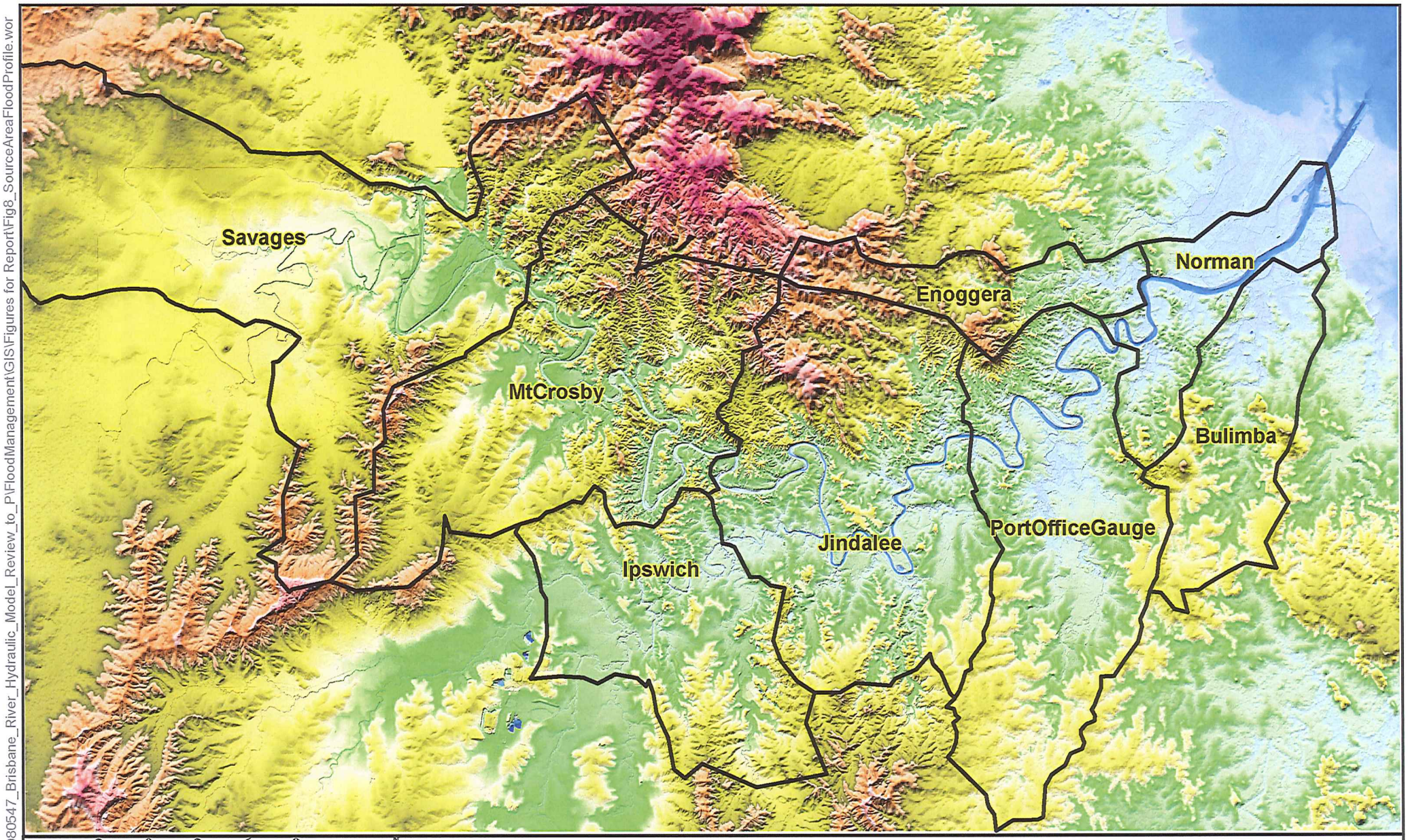

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2D Source of Areas - Flood Profile Model

Figure 8

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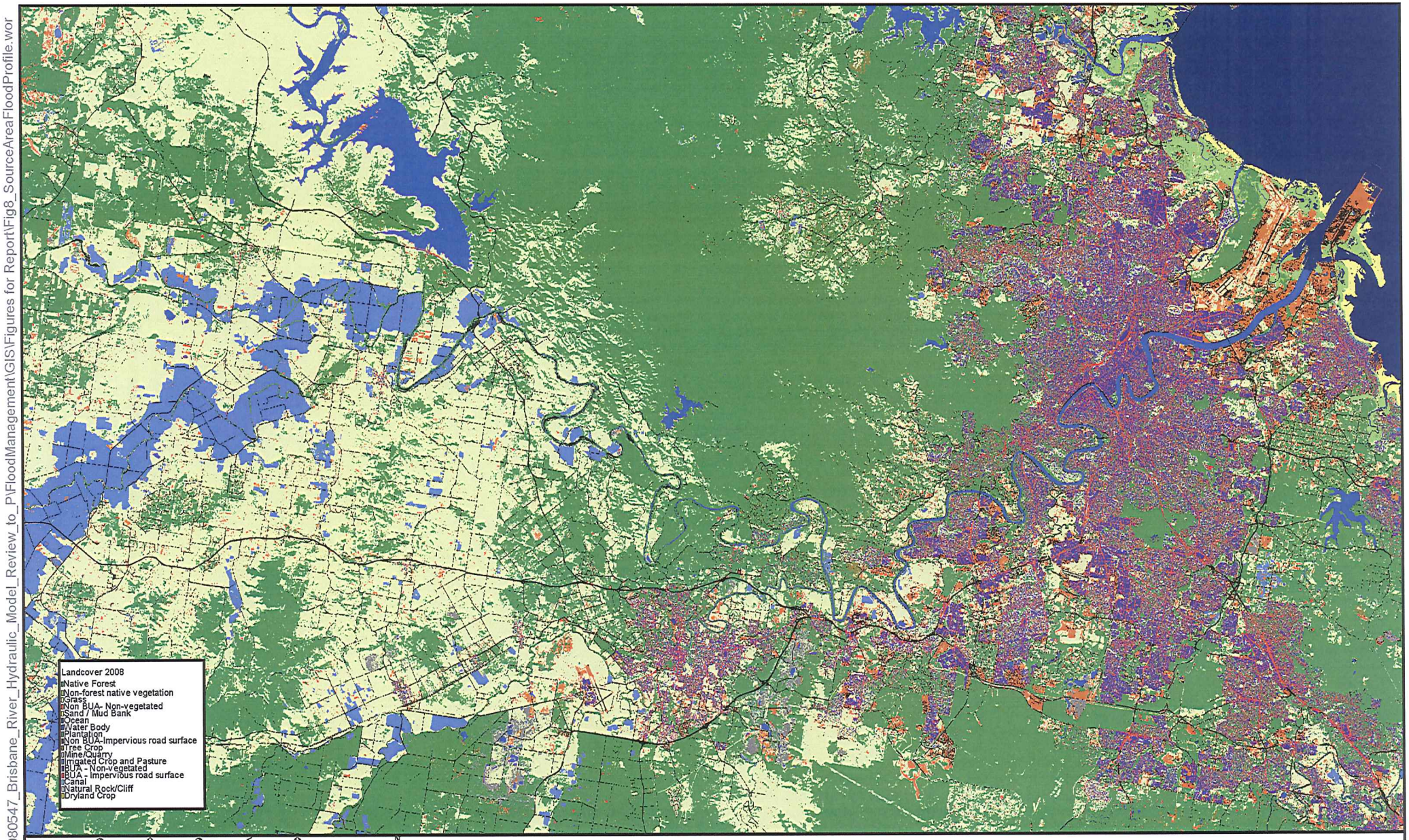

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Example of Land Cover Data

Figure 9

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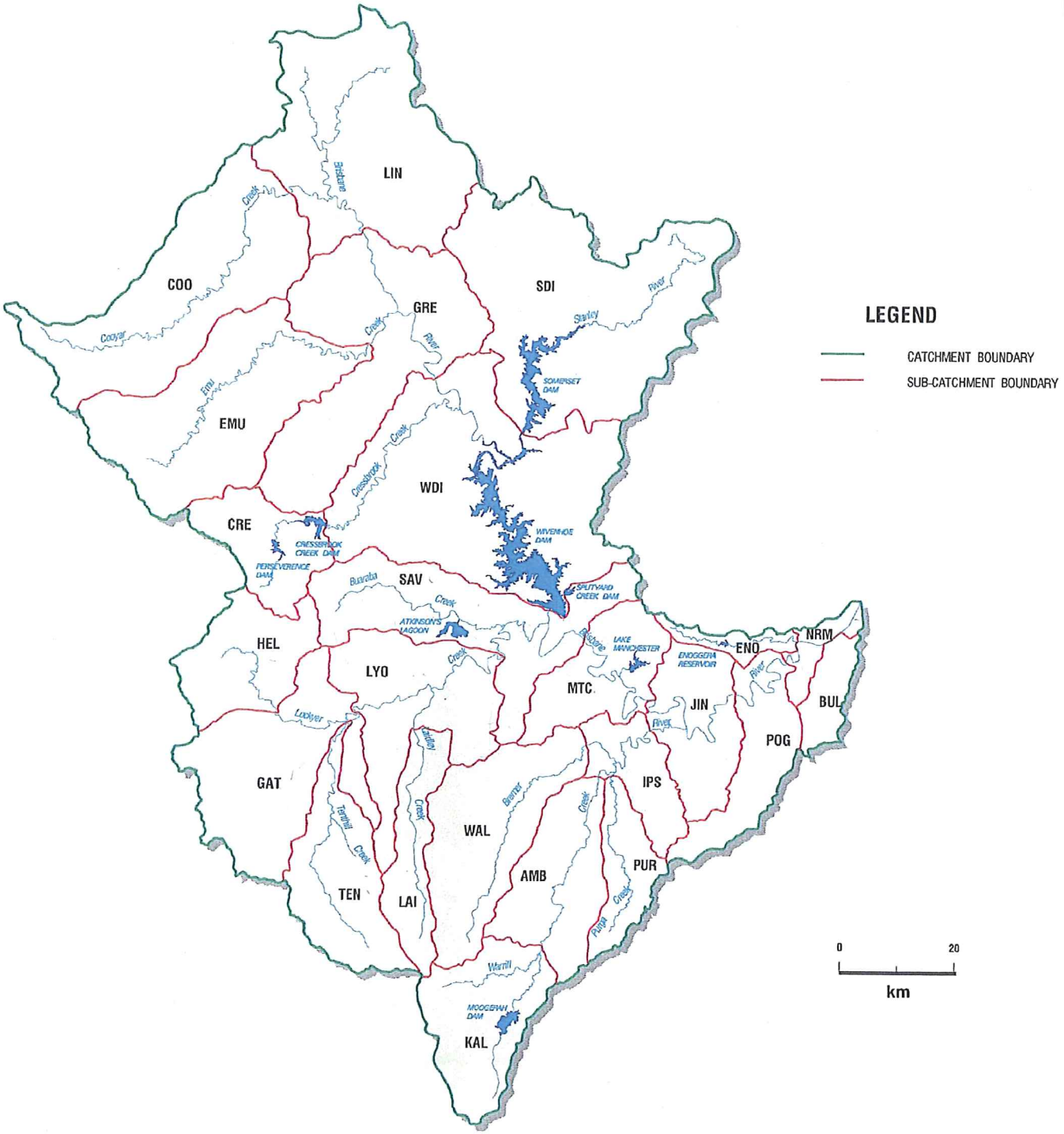

Image from "Brisbane River and Pine Rivers Flood Study" (1994), SEQWB

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WT42D Model Region Subdivision

Figure 10

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080547 Brisbane River Hydraulic Model Review to PMF

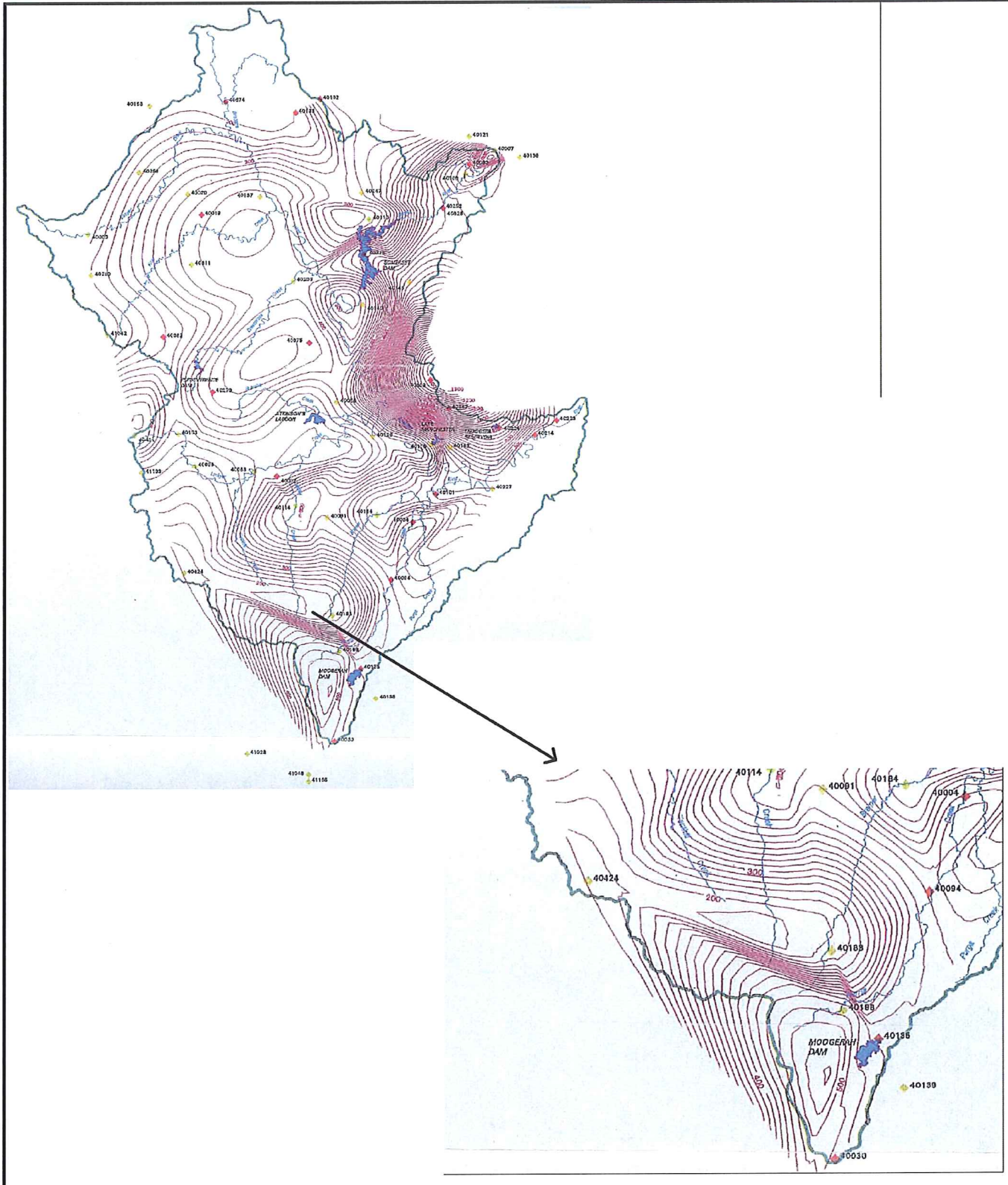

Image from "Brisbane River and Pine Rivers Flood Study" (1994), SEQWB

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1974 Rainfall Isohyets

Figure 12

Dedicated to a better Brisbane

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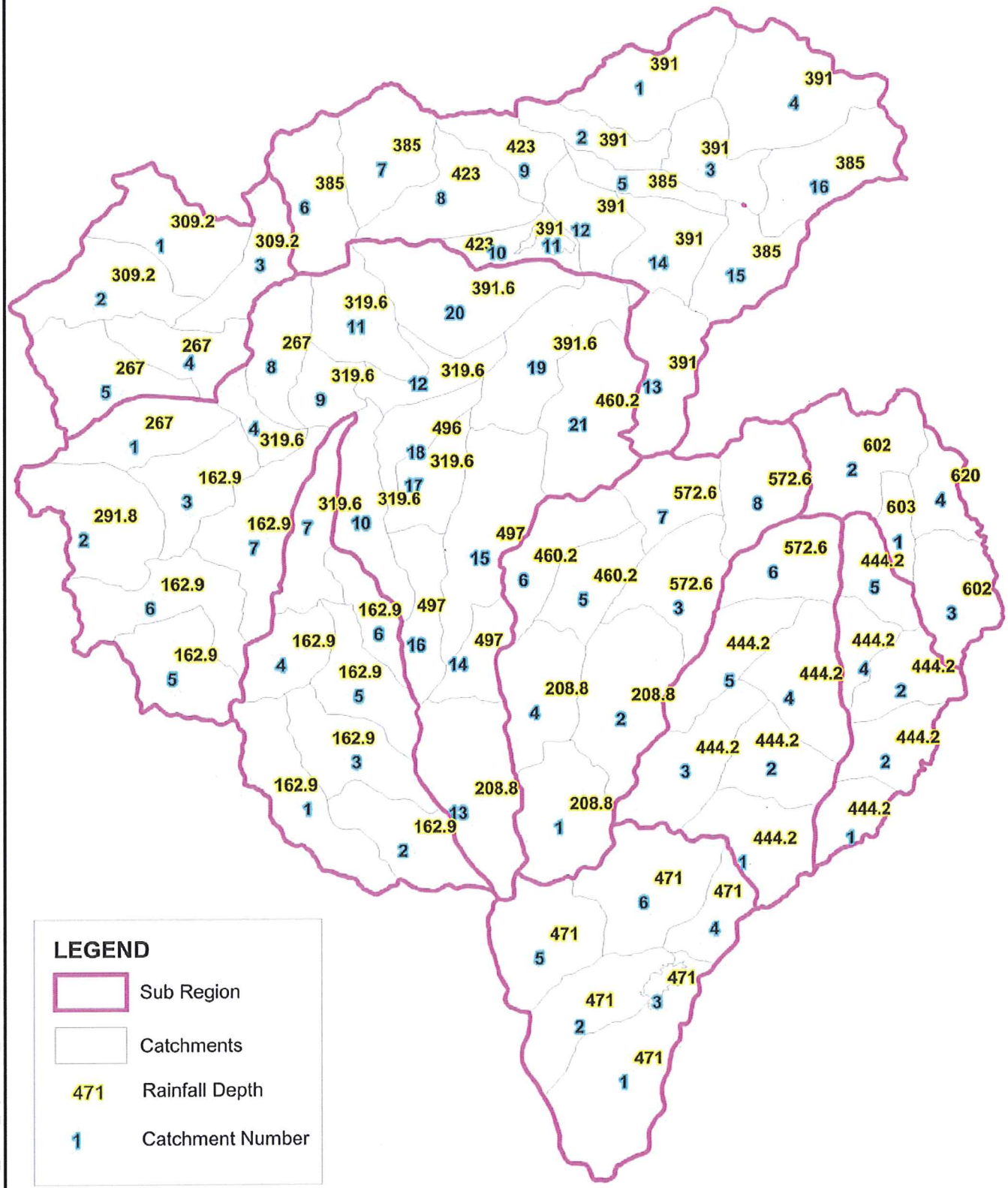

LEGEND

- Sub Region
- Catchments
- 471 Rainfall Depth
- 1 Catchment Number

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Kilometres

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WT42D 1974 Rainfall Depths for Lockyer Creek and Bremer River - Original

Figure 13

Dedicated to a better Brisbane

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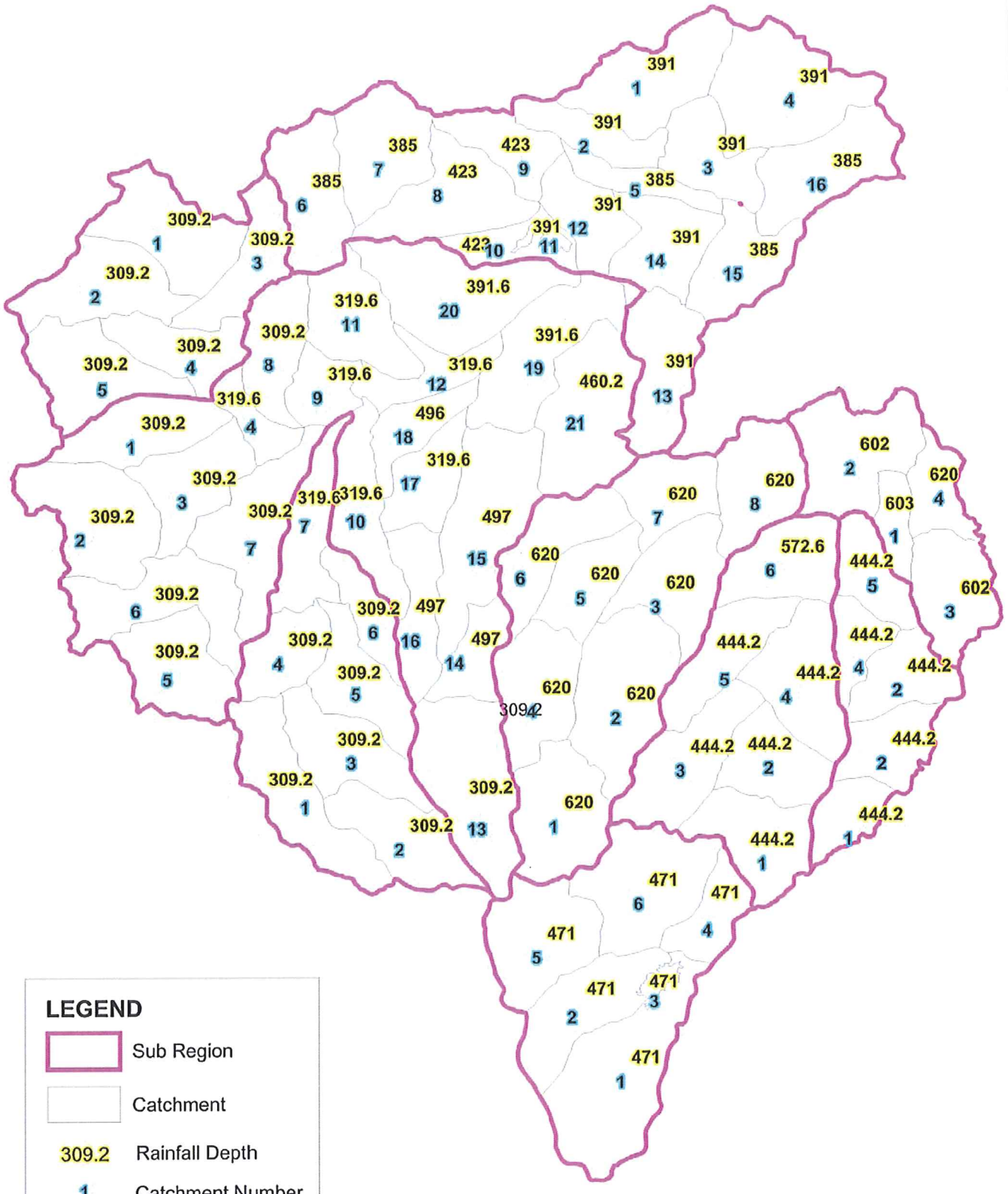

WT42D 1974 Rainfall Depths for Lockyer Creek and Bremer River - Modified

Figure 14

Dedicated to a better Brisbane

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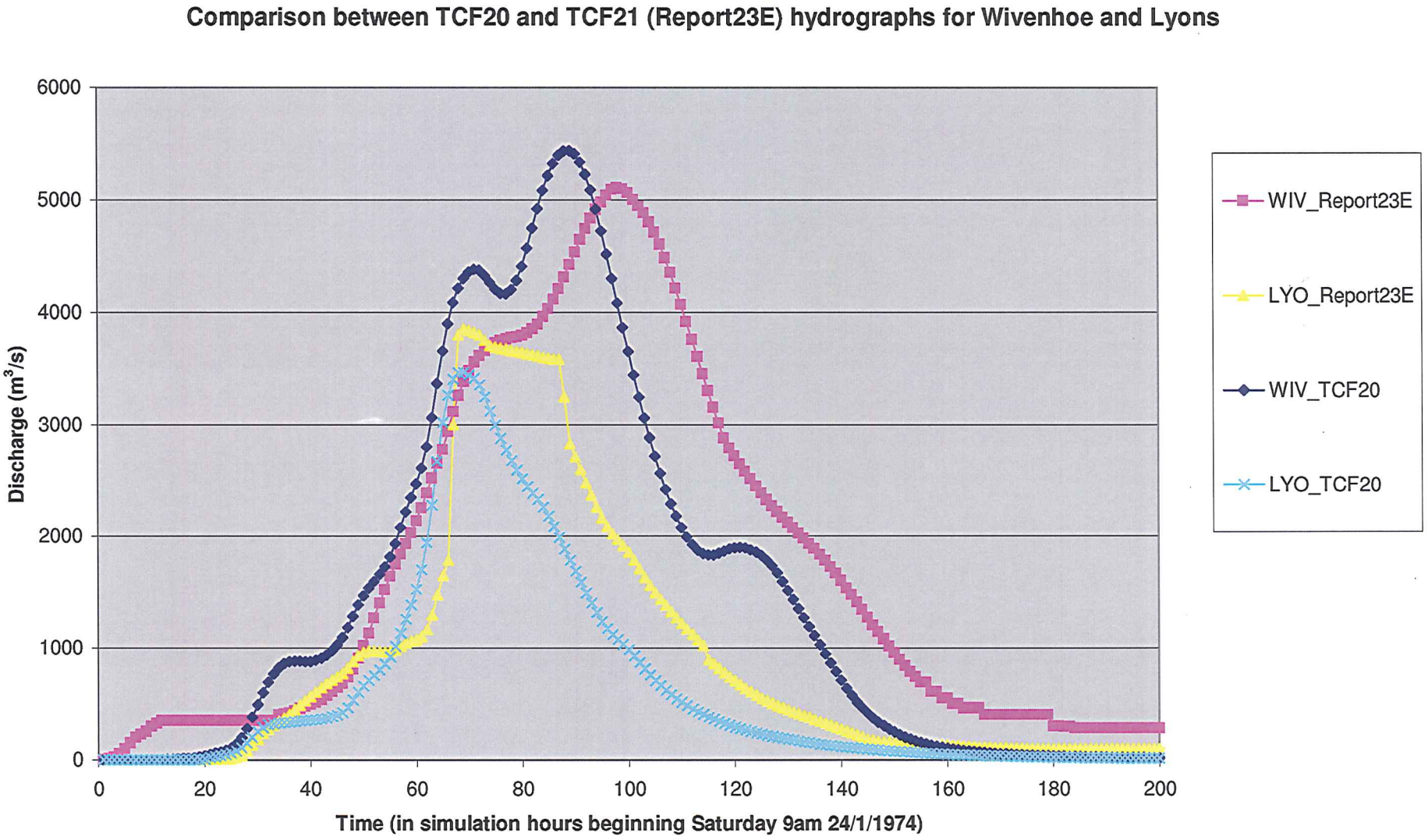


Figure 15: Comparison of Primary Inflow Hydrographs (Wivenhoe and Lyons)

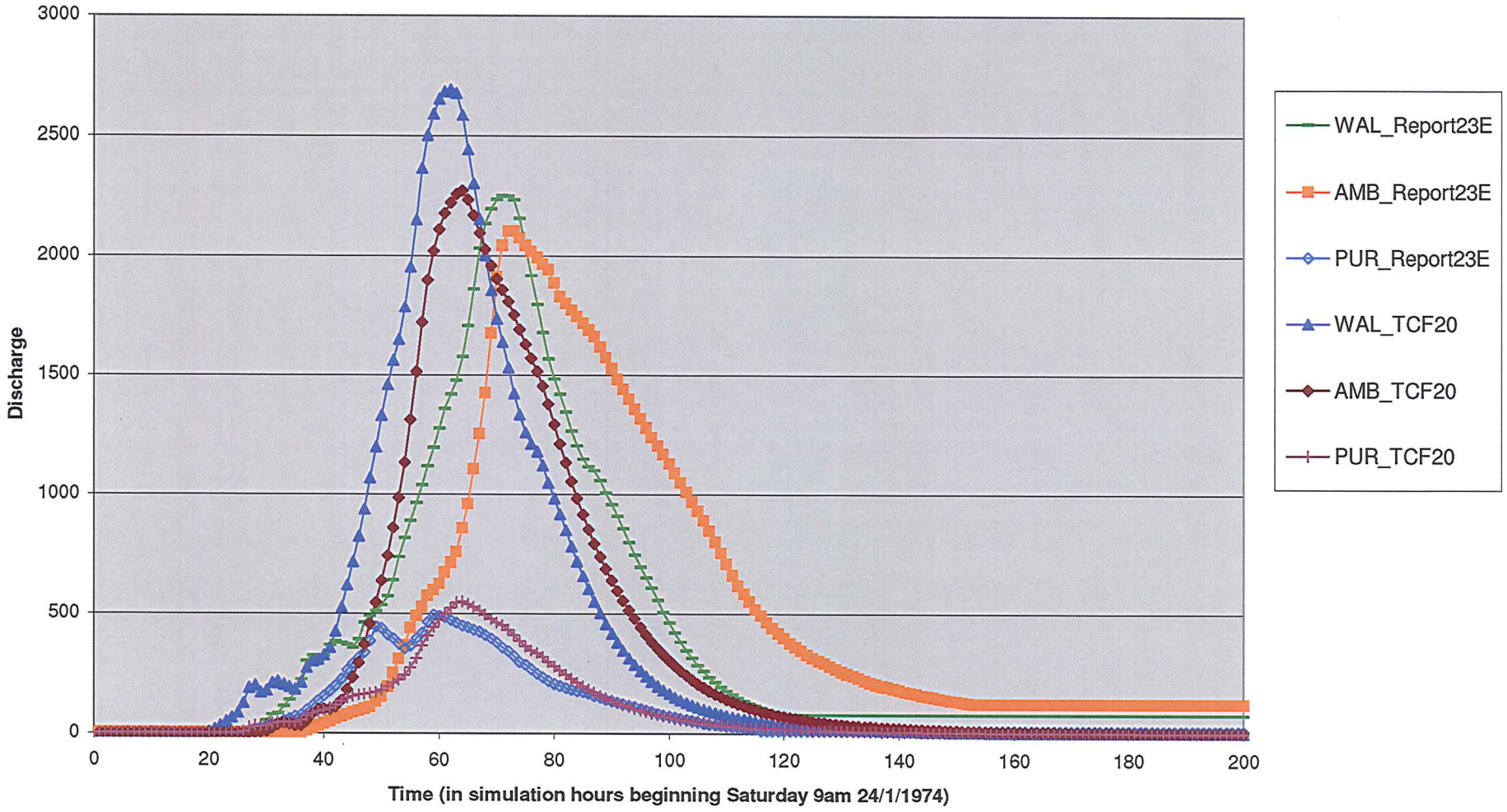
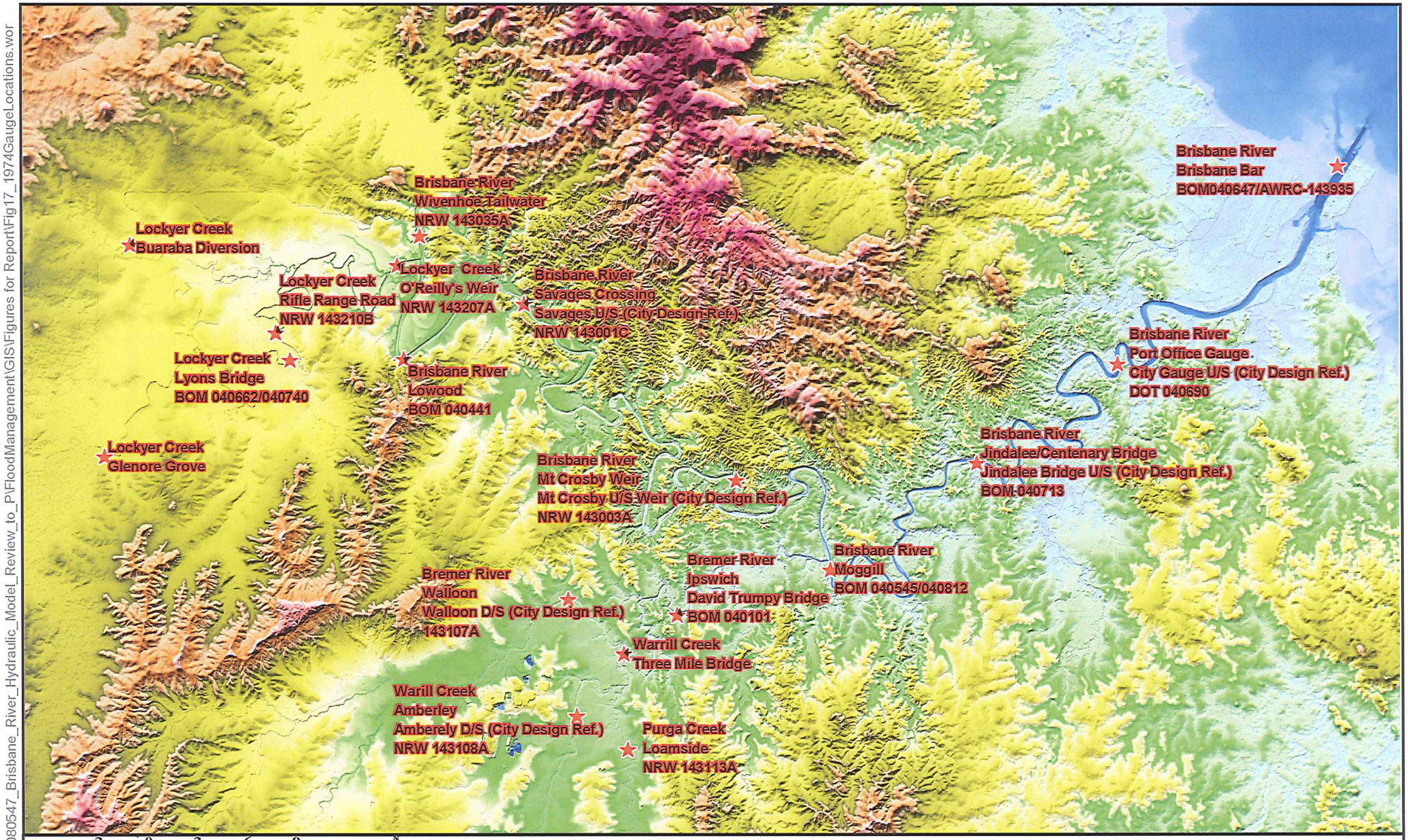


Figure 16: Comparison of Primary Inflow Hydrographs (Walloon, Amberley and Purga Inflows)



1974 Calibration - Gauge Locations

Figure 17

Dedicated to a better Brisbane

G:\BI\CD\Proj08\080547_Brisbane_River_Hydraulic_Model_Review_to_P\FloodManagement\GIS\Figures for Report\Fig17_1974GaugeLocations.wor

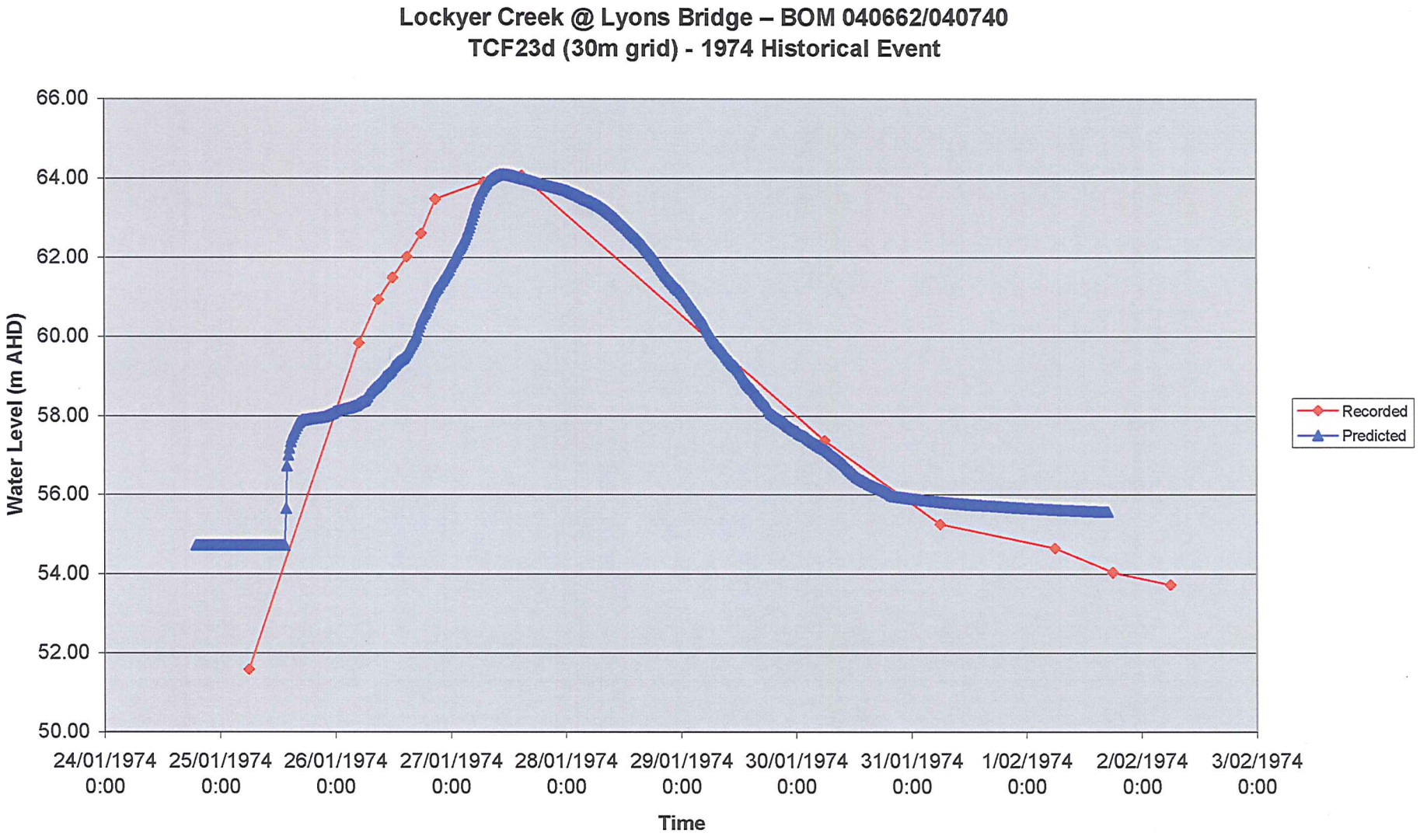


Figure 18: Lockyer Creek @ Lyons Bridge - Water Level Comparison

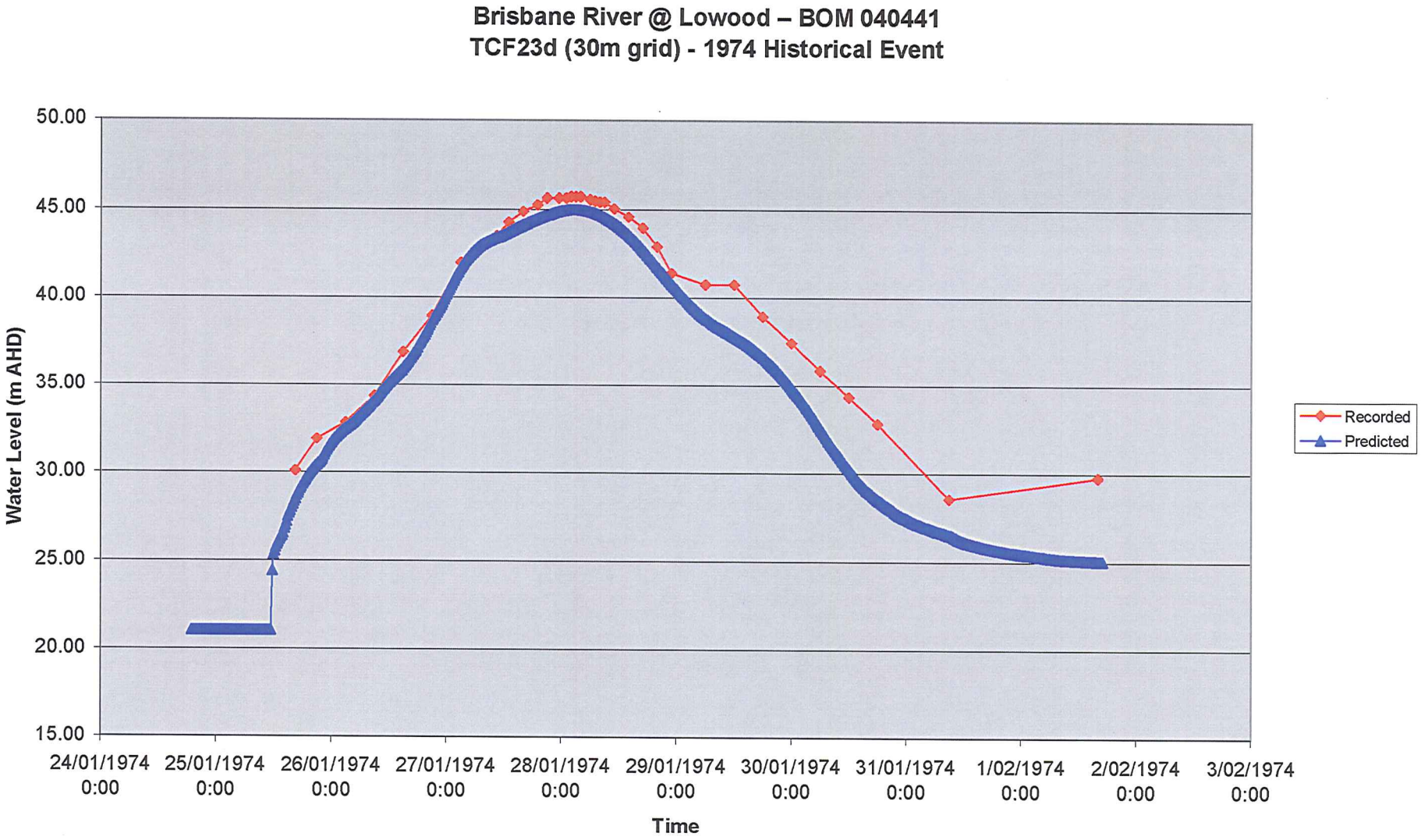


Figure 19: Brisbane River @ Lowood - Water Level Comparison

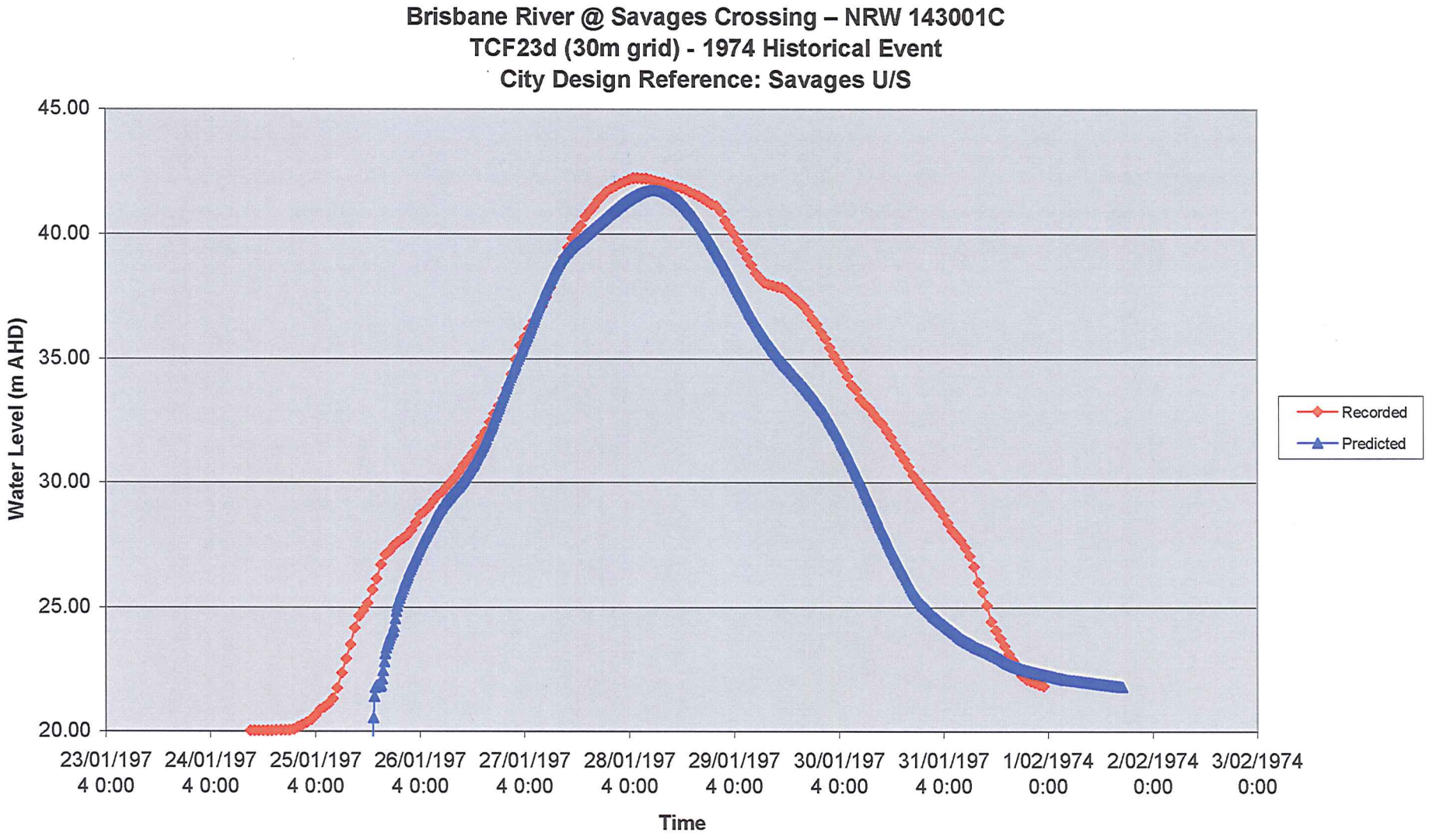


Figure 20: Brisbane River @ Savages Crossing - Water Level Comparison

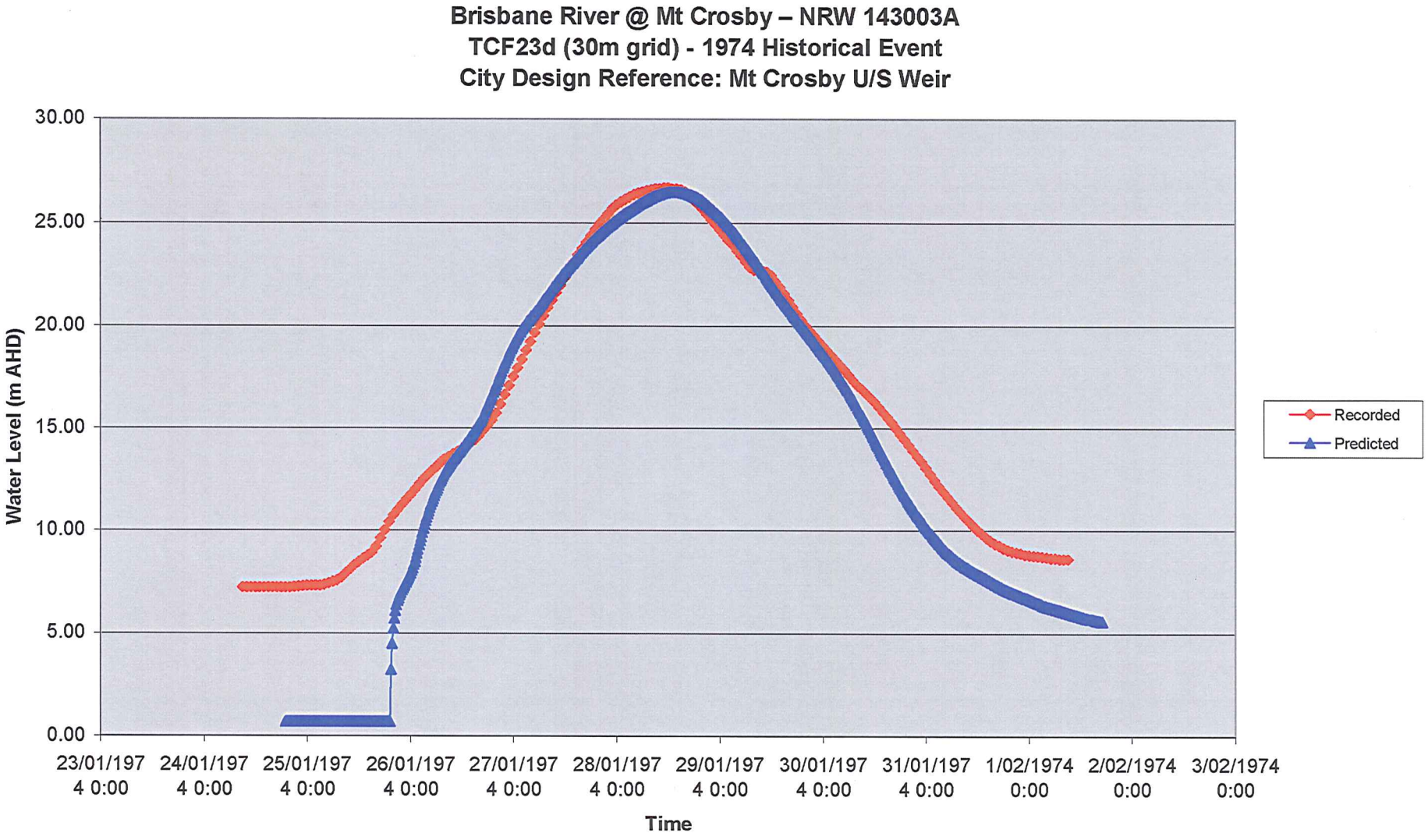


Figure 21: Brisbane River @ Mt Crosby - Water Level Comparison

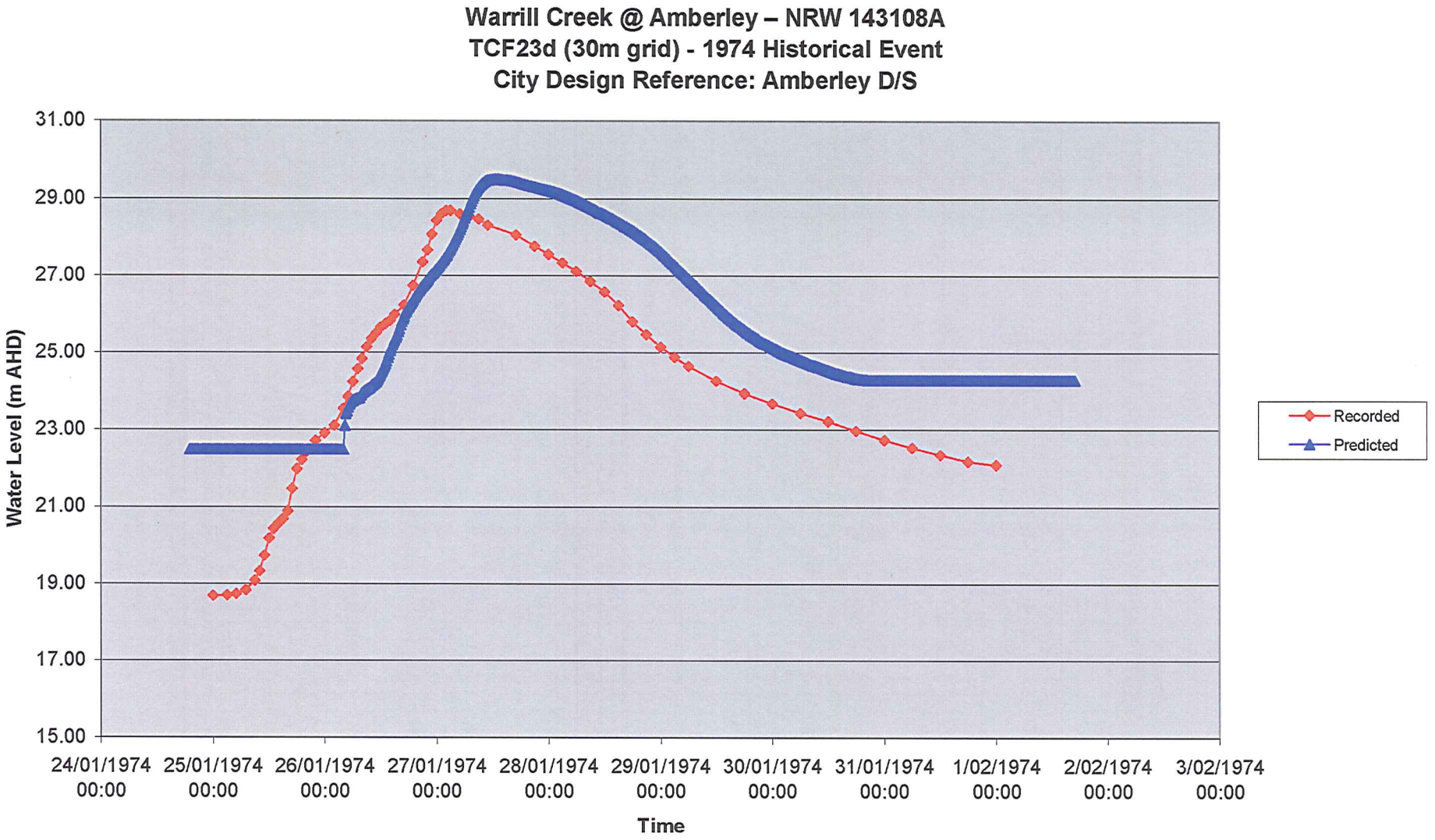


Figure 22: Warrill Creek @ Amberley - Water Level Comparison

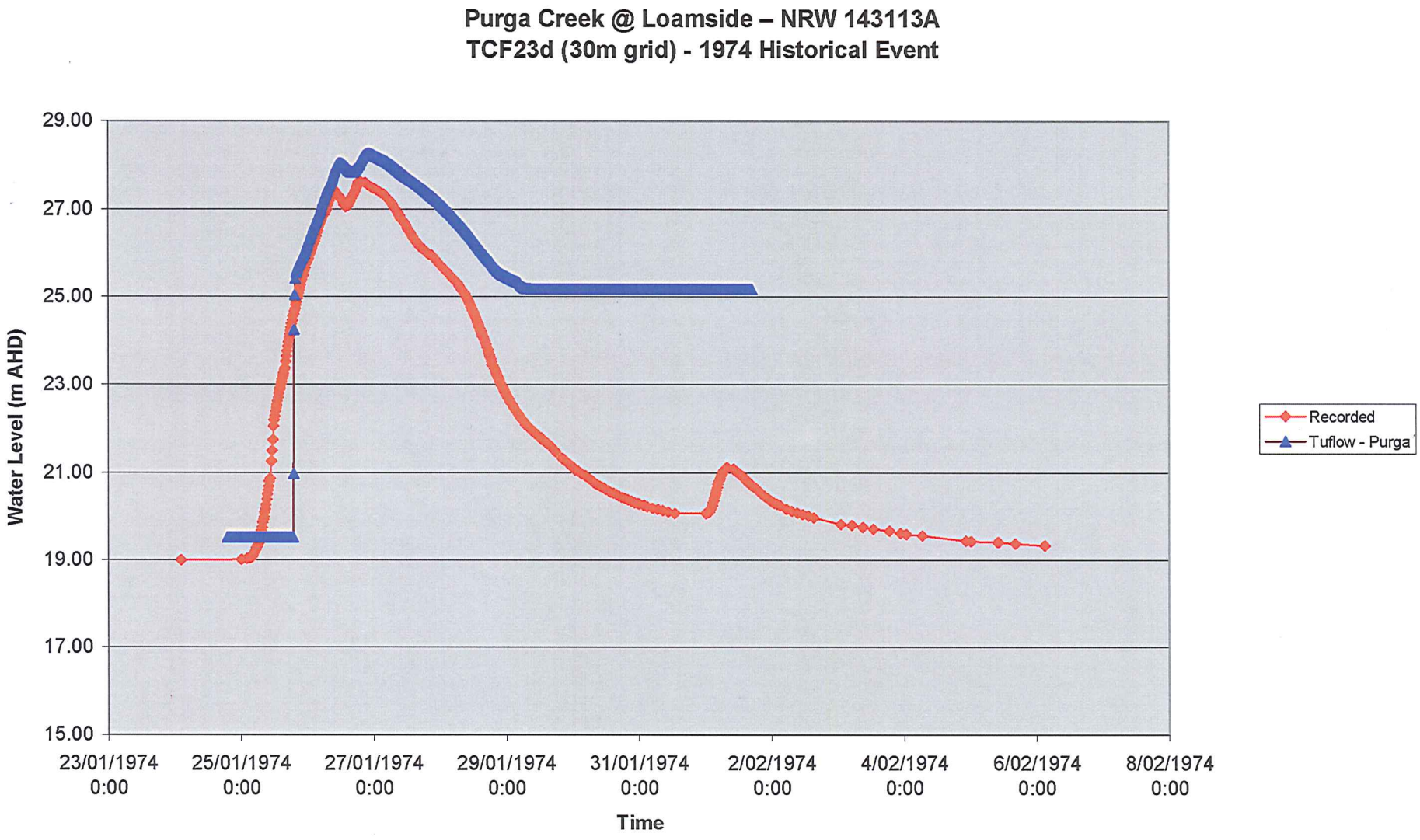


Figure 23: Purga Creek @ Loamside - Water Level Comparison

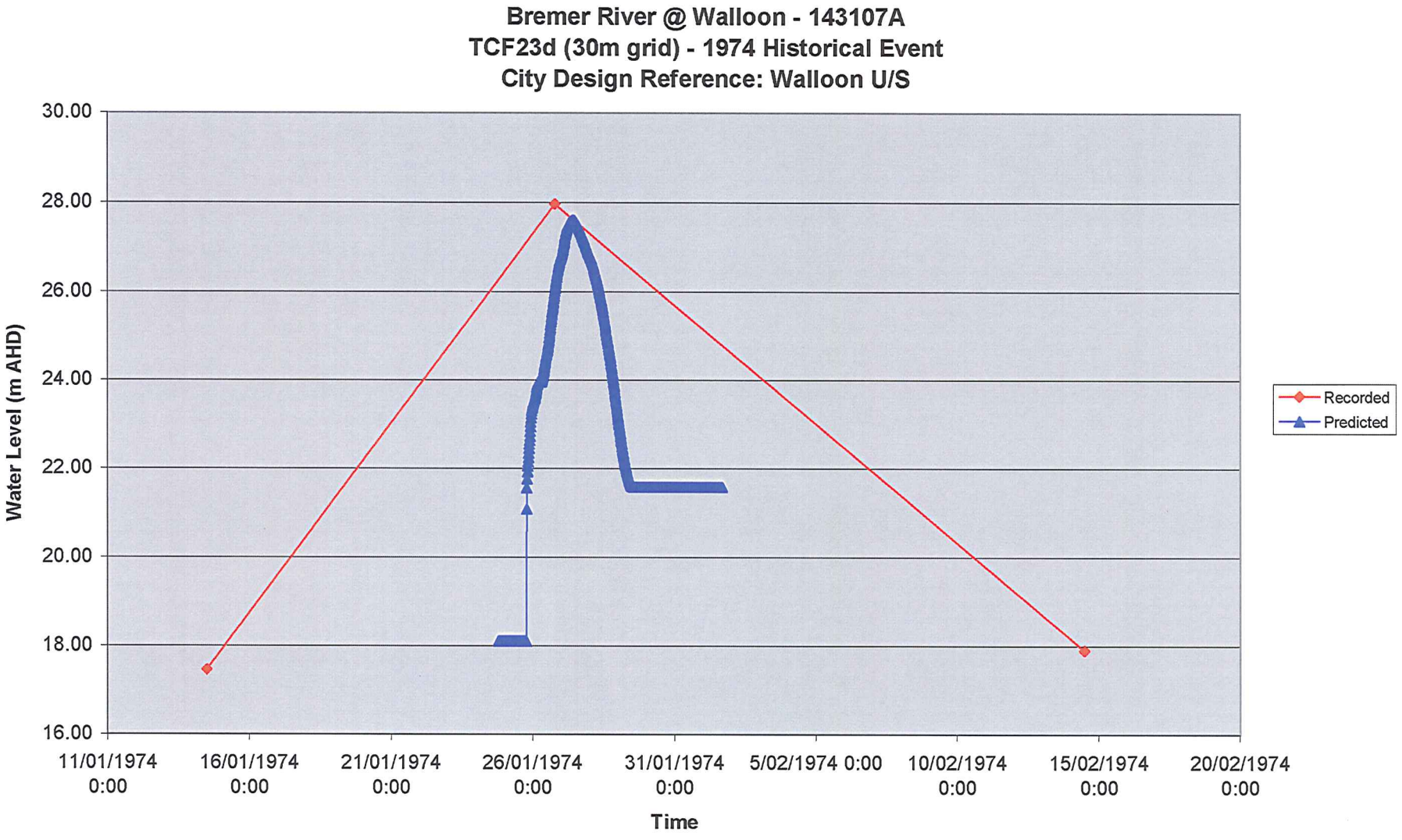


Figure 24: Bremer River @ Walloon - Water Level Comparison

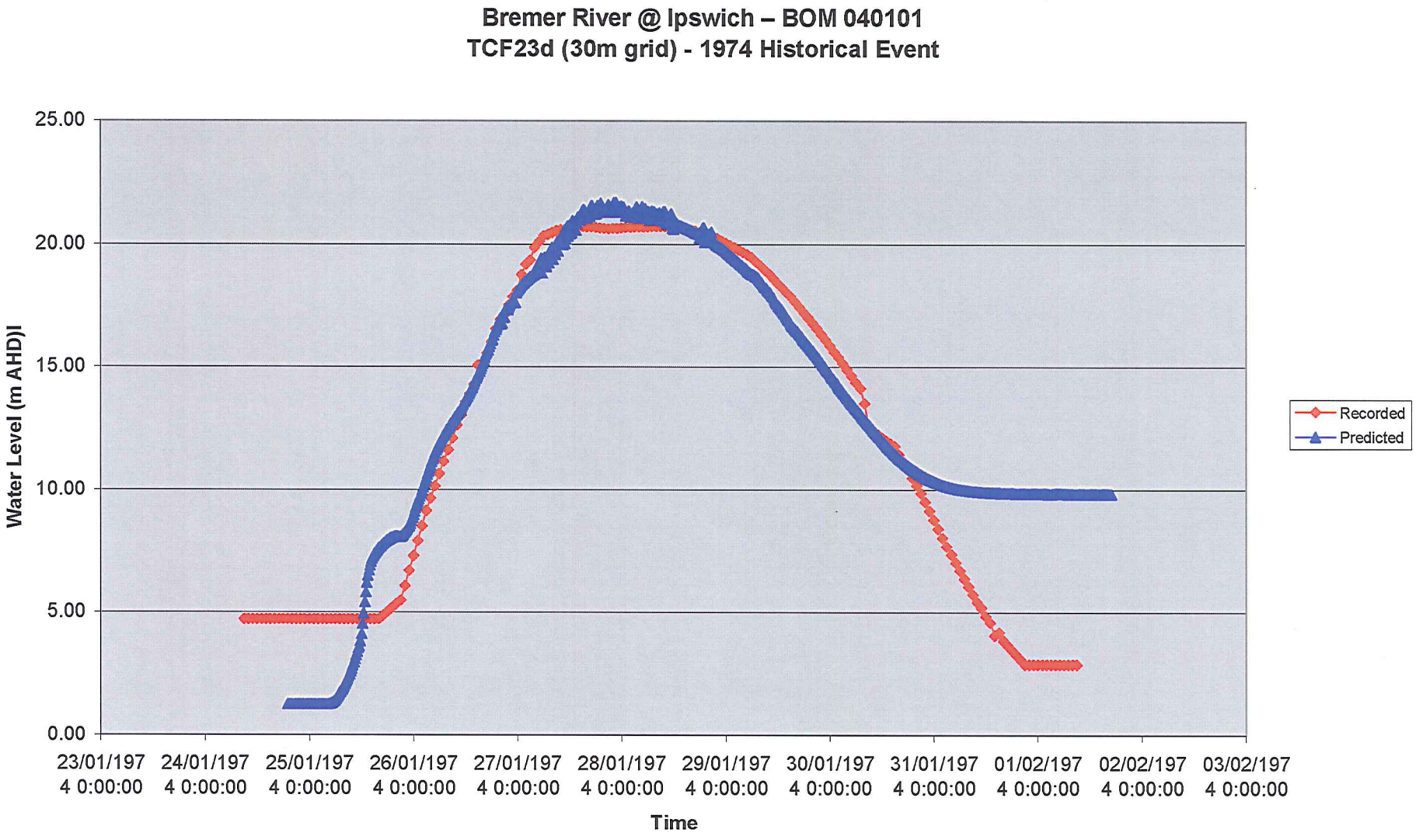


Figure 25: Bremer River @ Ipswich - Water Level Comparison

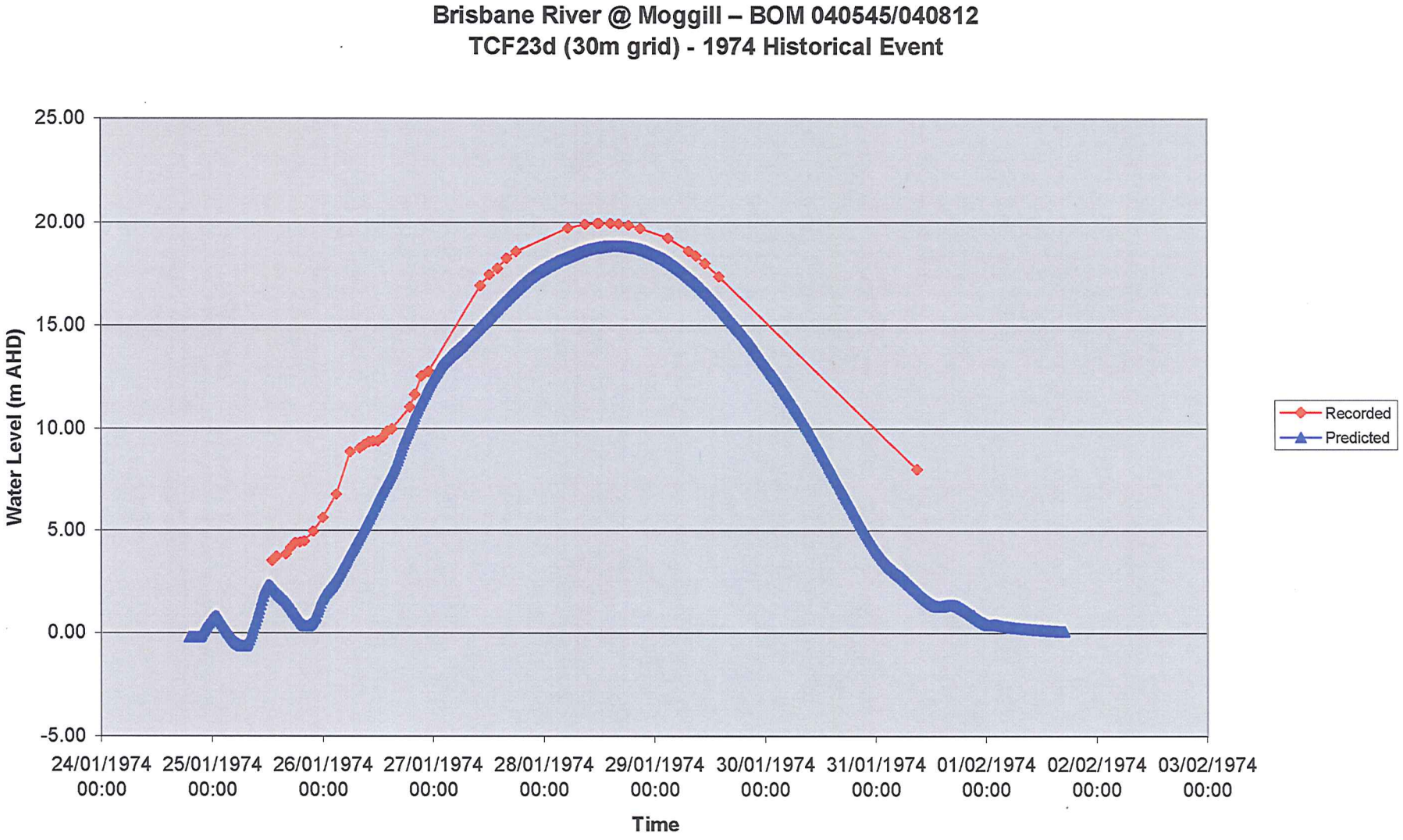


Figure 26: Brisbane River @ Moggill - Water Level Comparison

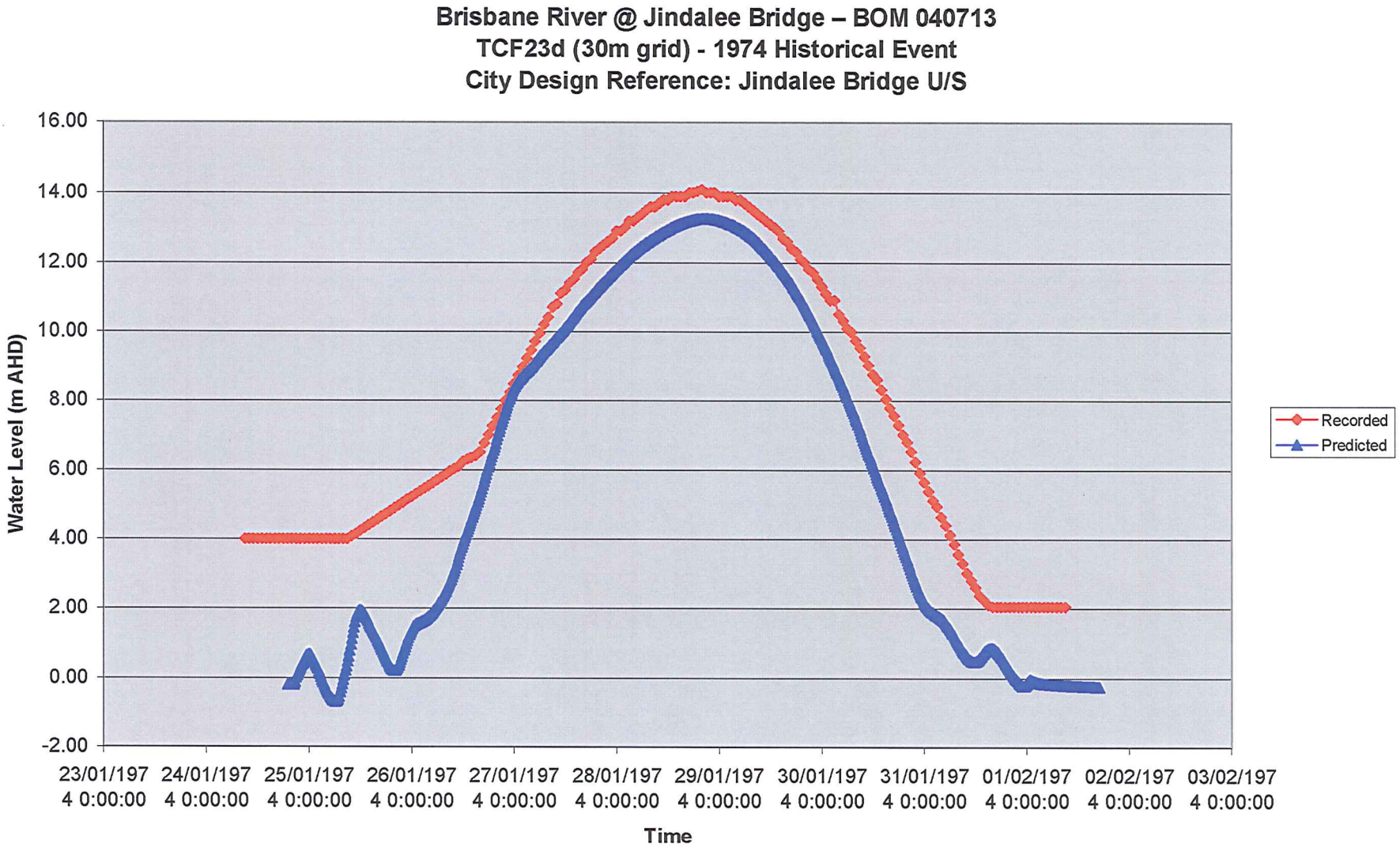


Figure 27: Brisbane River @ Jindalee - Water Level Comparison

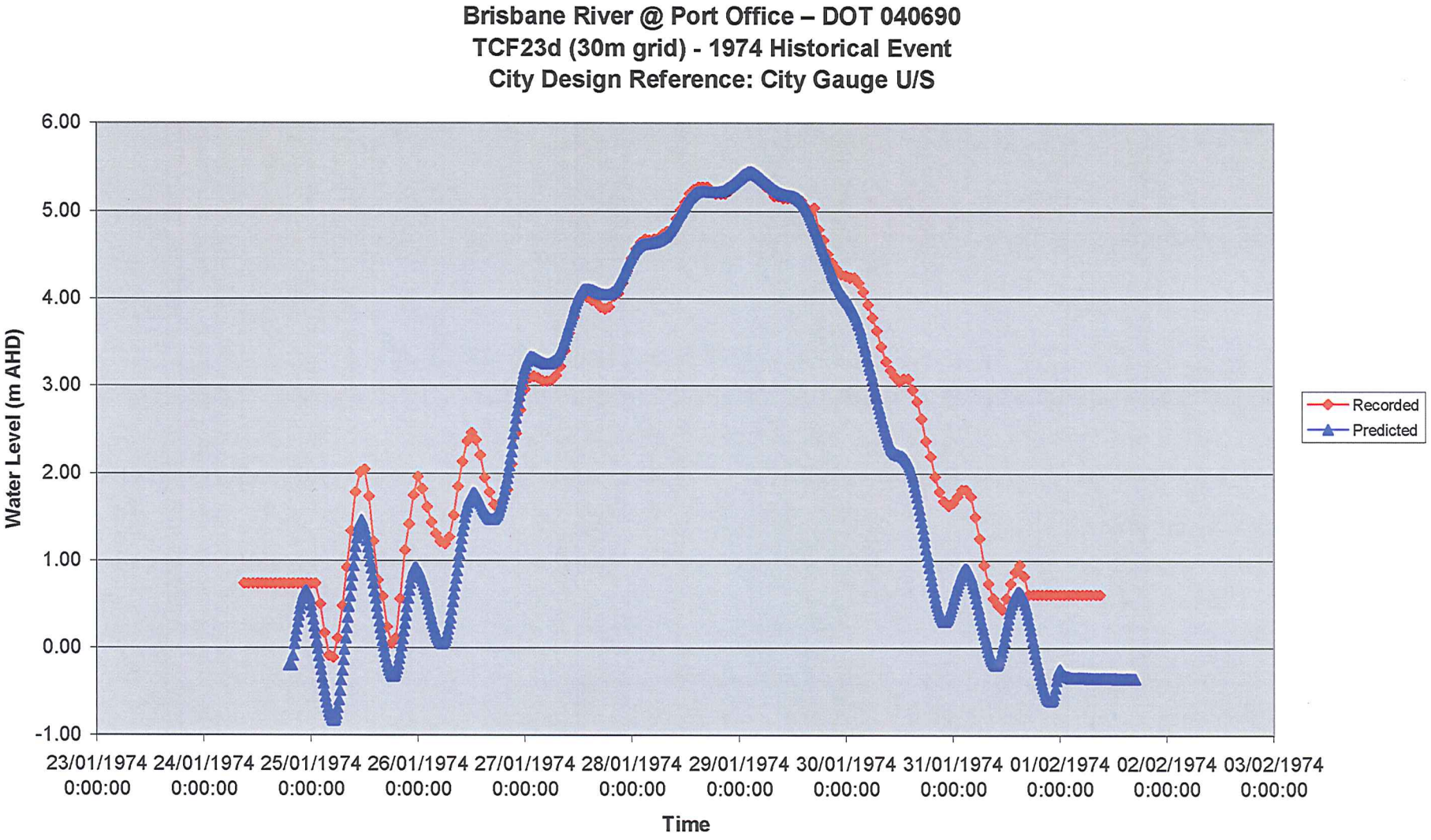


Figure 28: Brisbane River @ Port Office - Water Level Comparison

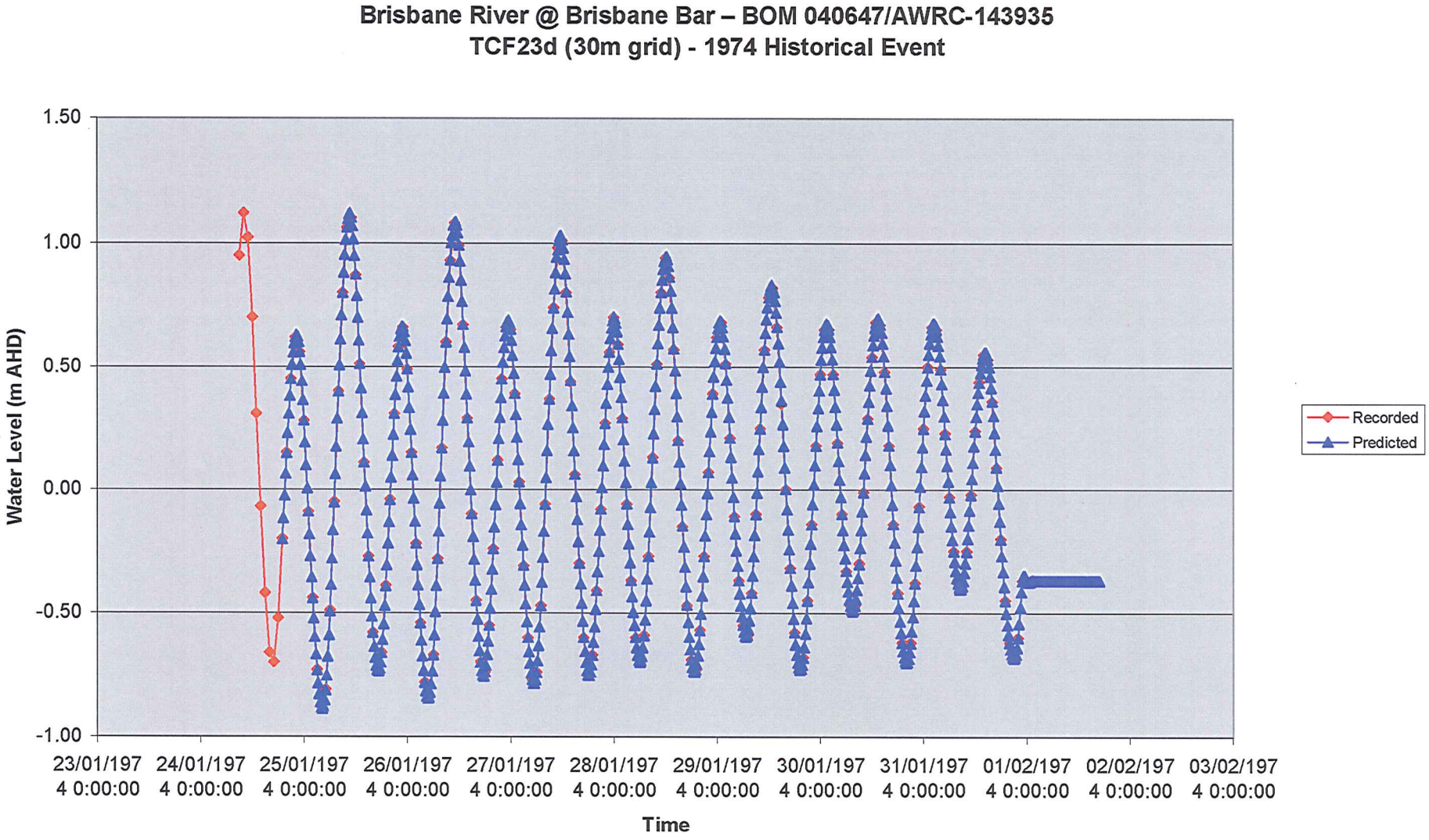


Figure 29: Brisbane River @ Brisbane Bar - Water Level Comparison

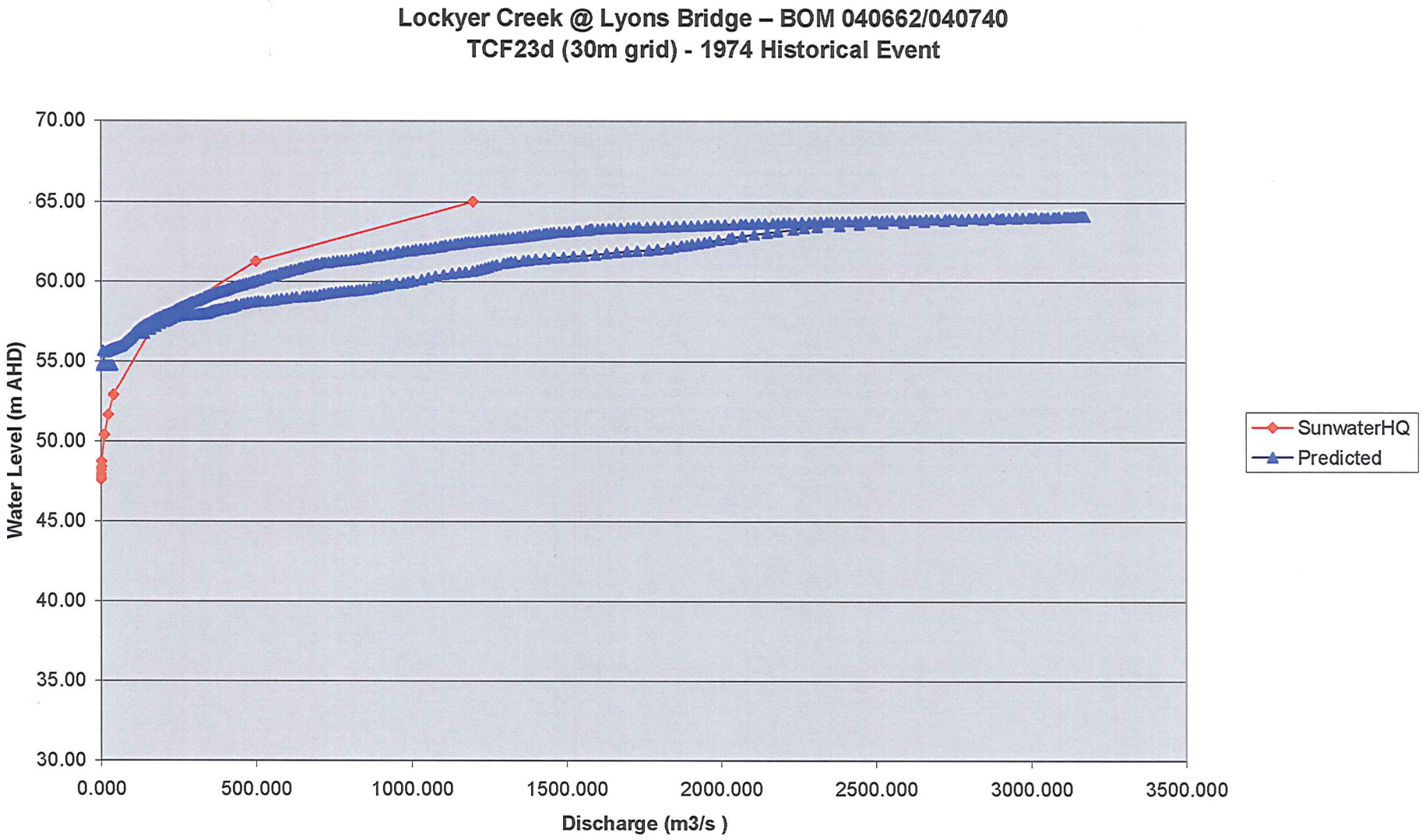


Figure 30: Lockyer Creek @ Lyons Bridge - Rating Curve Comparison

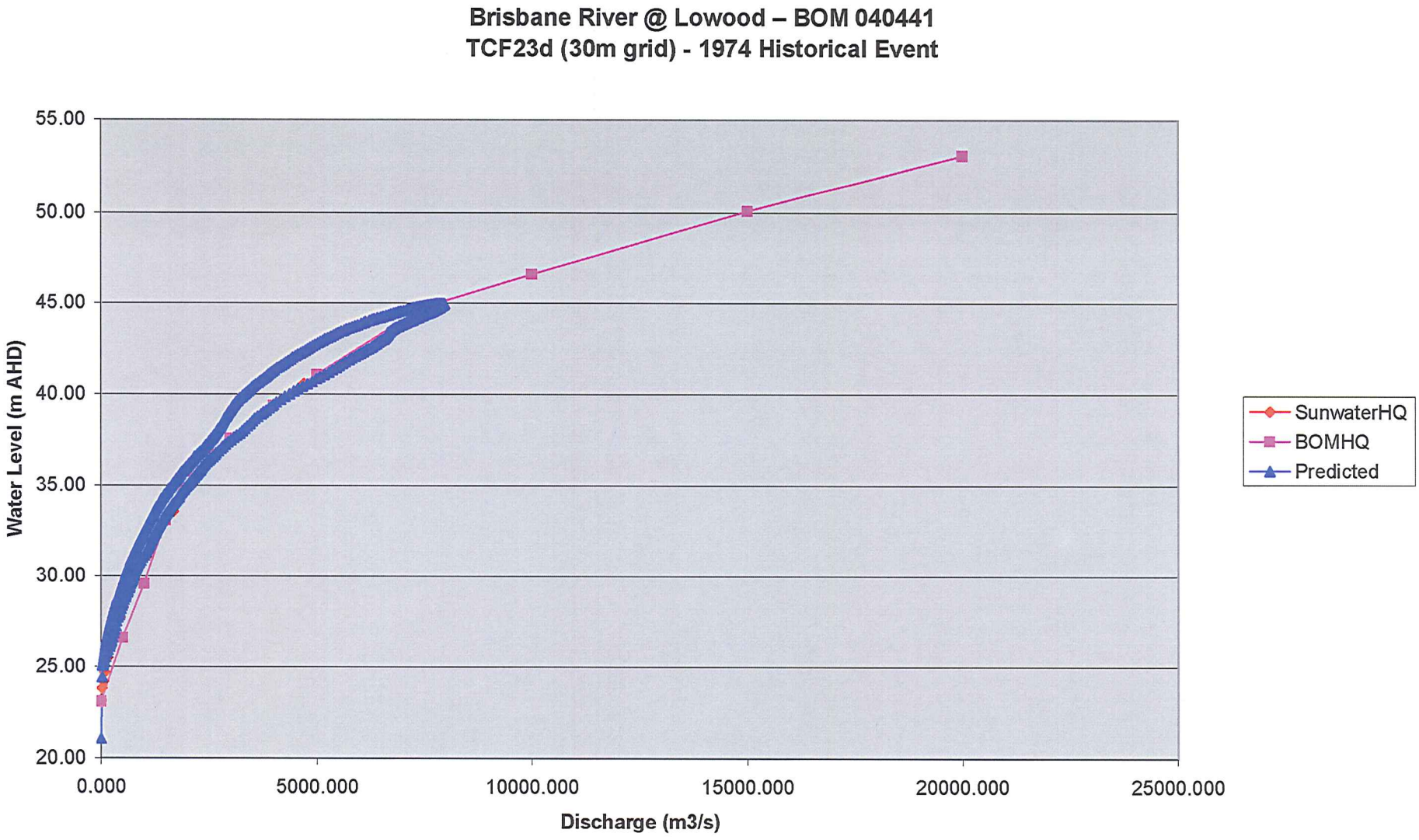


Figure 31: Brisbane River @ Lowood - Rating Curve Comparison

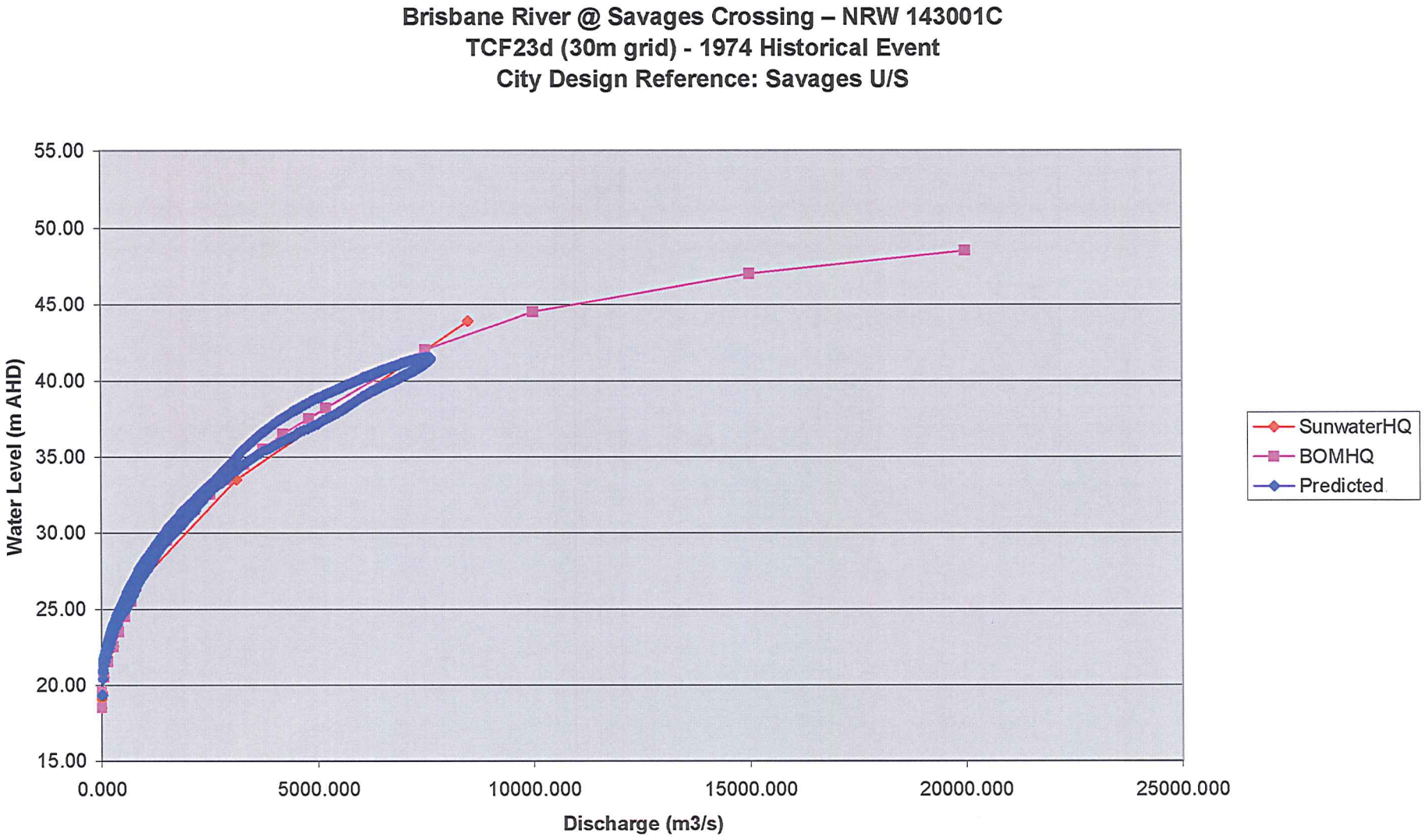


Figure 32: Brisbane River @ Savages Crossing - Rating Curve Comparison

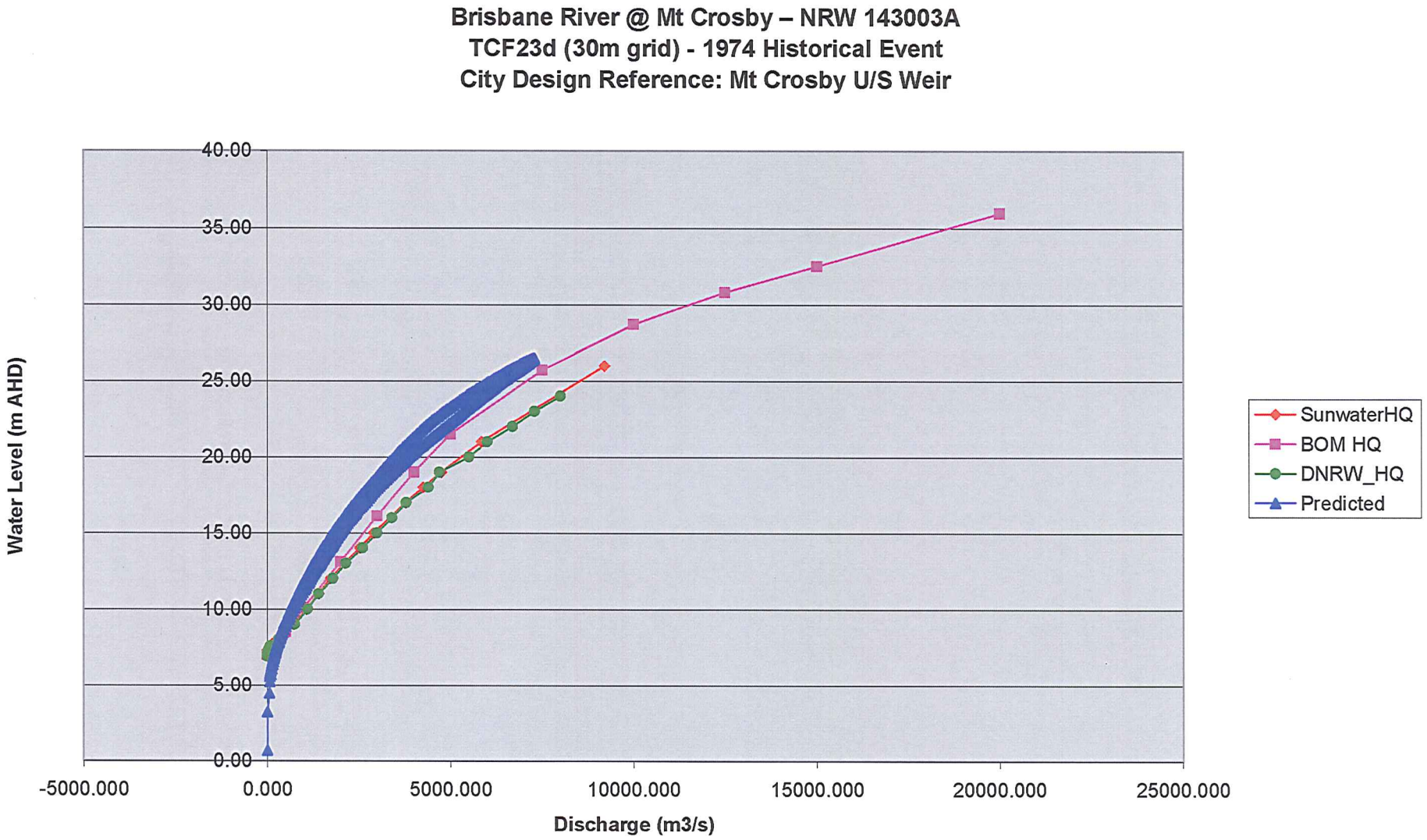


Figure 33: Brisbane River @ Mt Crosby - Rating Curve Comparison

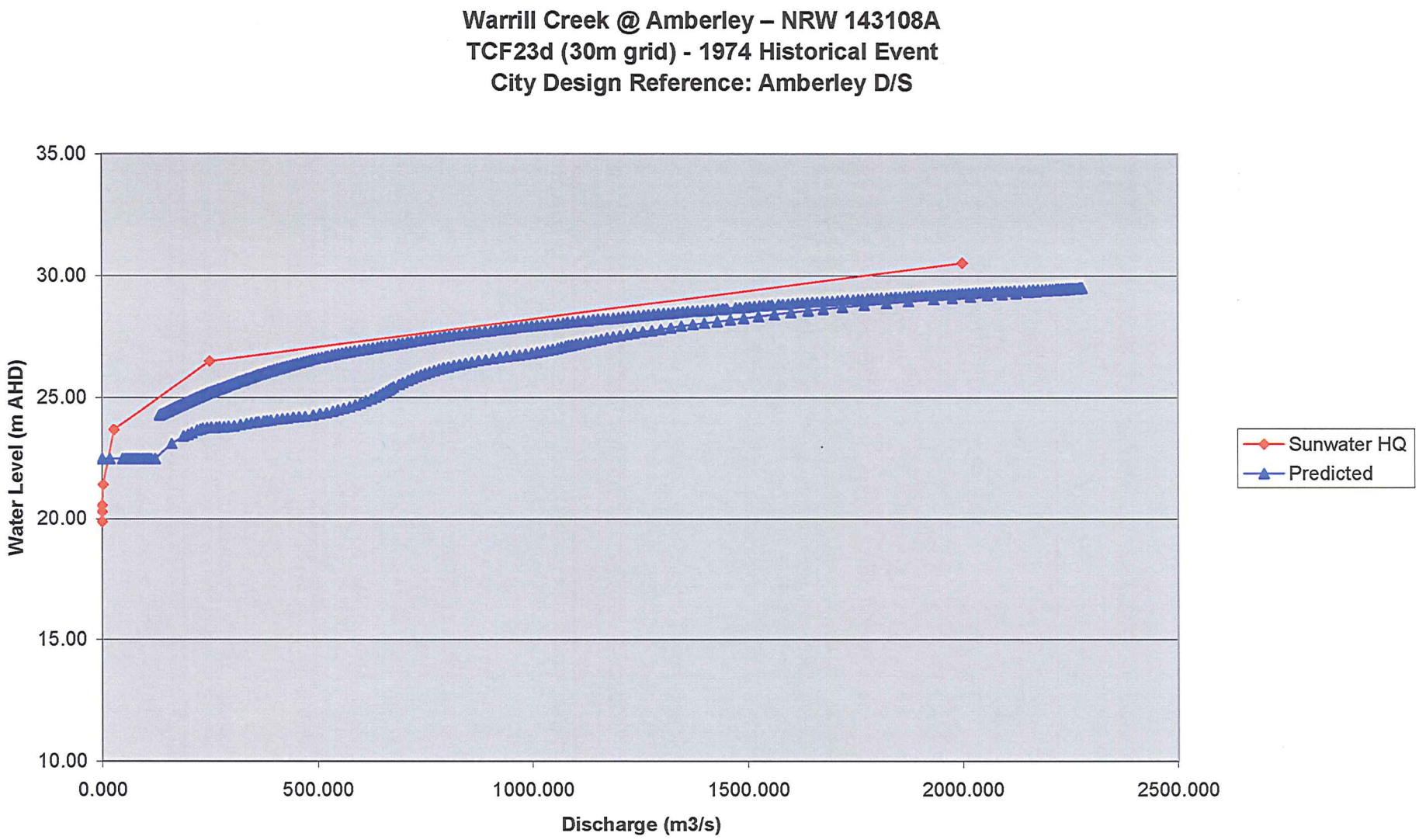


Figure 34: Warrill Creek @ Amberley - Rating Curve Comparison

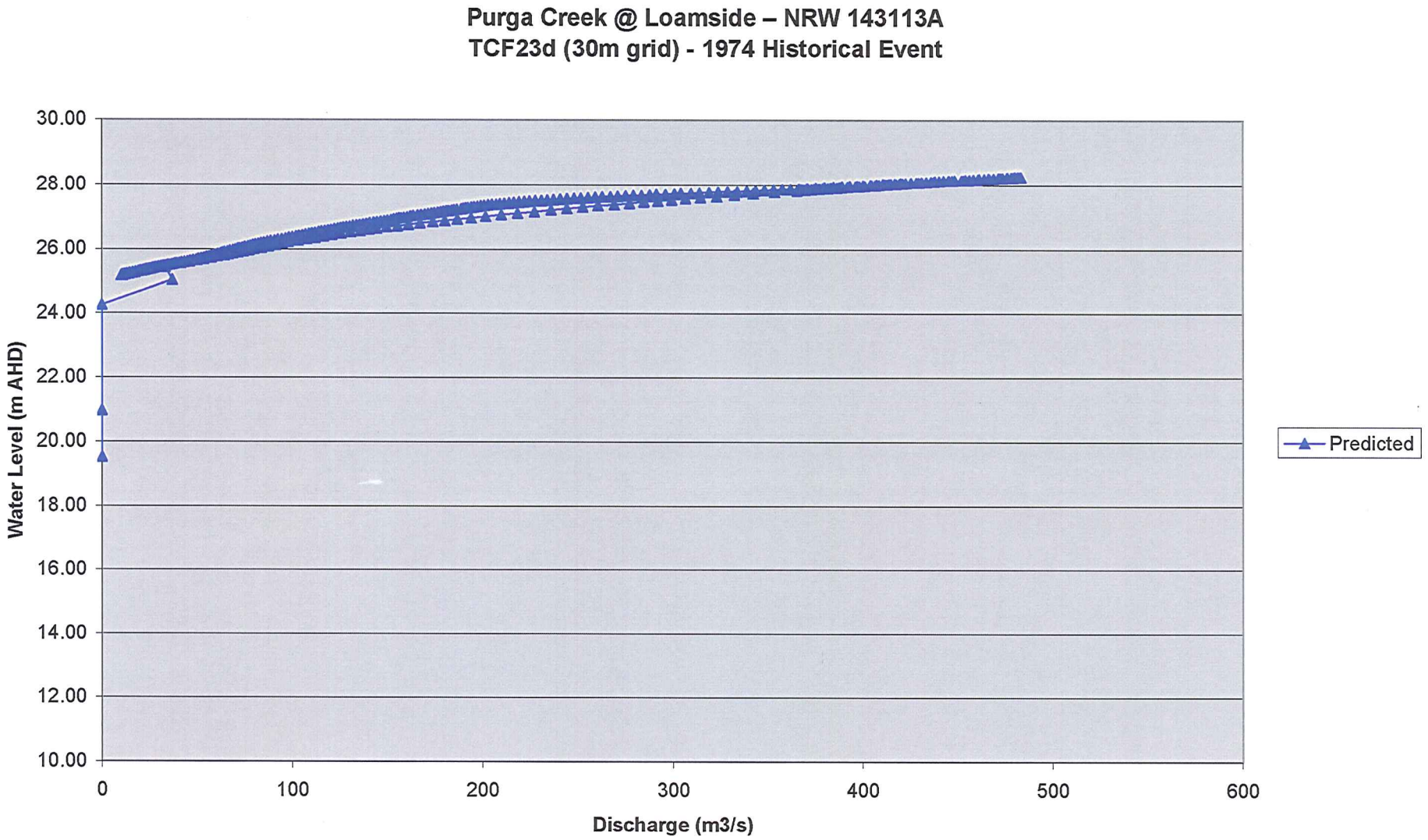


Figure 35: Purga Creek @ Loamside - Rating Curve Comparison

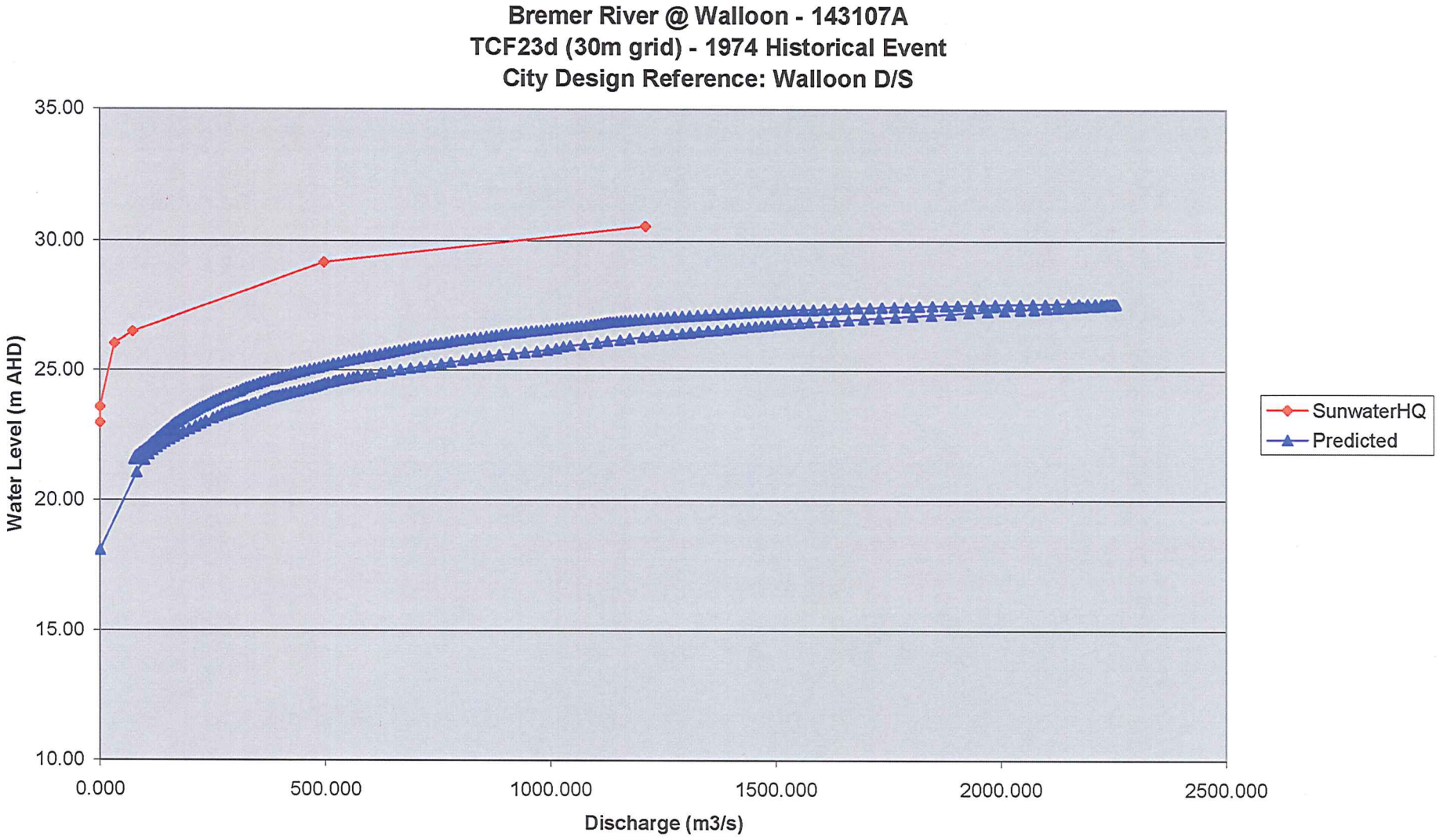


Figure 36: Bremer River @ Walloon - Rating Curve Comparison

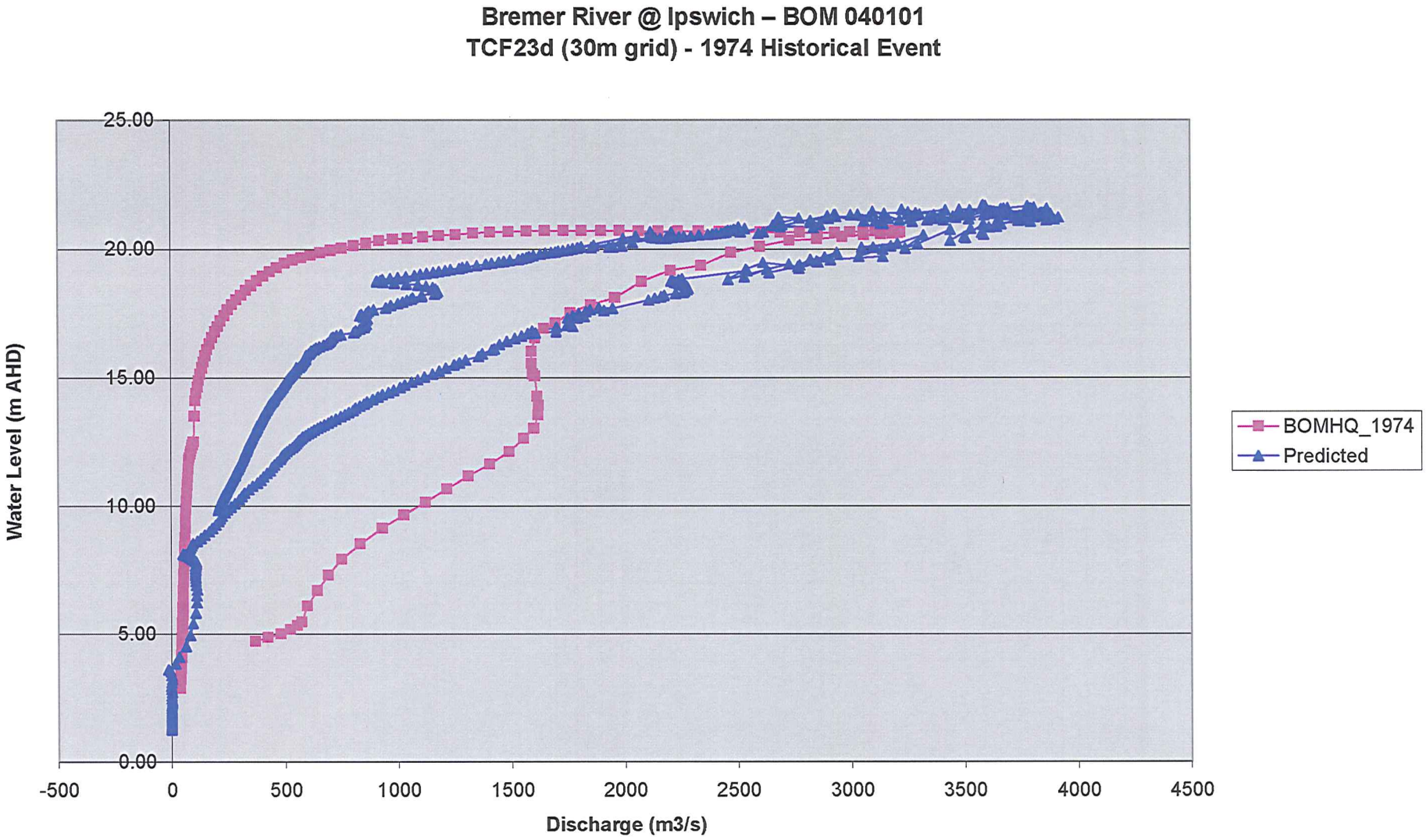


Figure 37: Bremer River @ Ipswich - Rating Curve Comparison

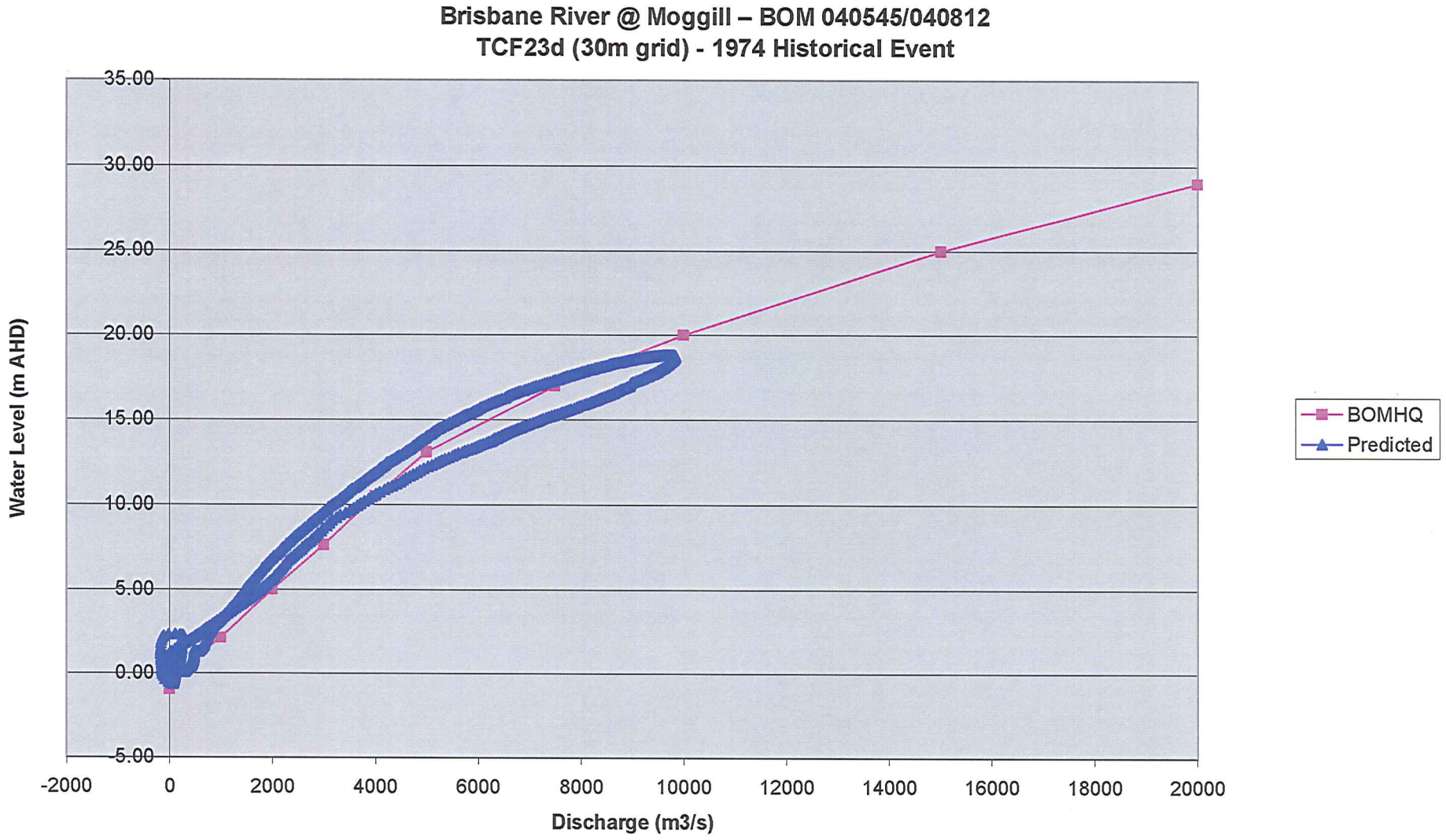


Figure 38: Brisbane River @ Moggill - Rating Curve Comparison

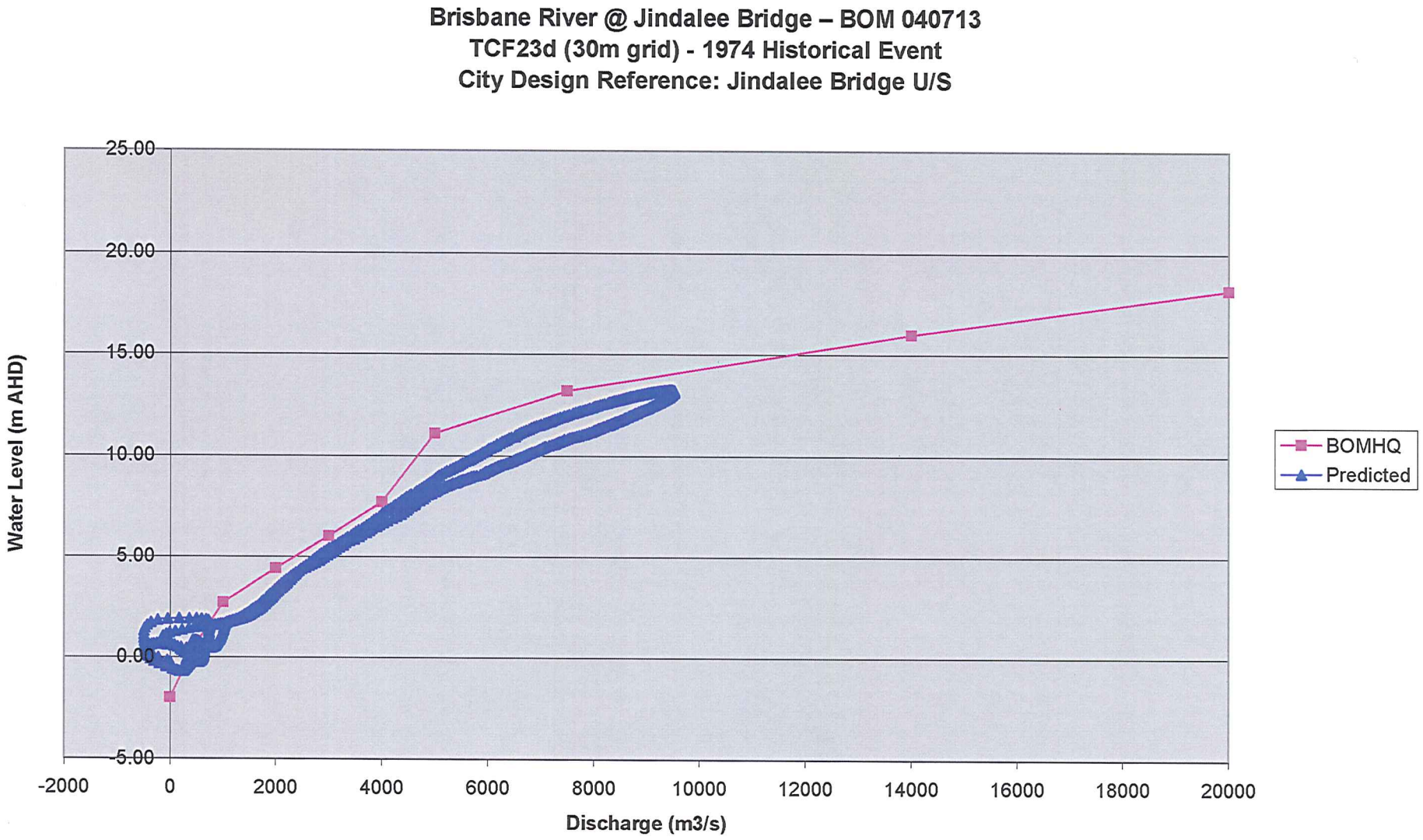


Figure 39: Brisbane River @ Jindalee - Rating Curvel Comparison

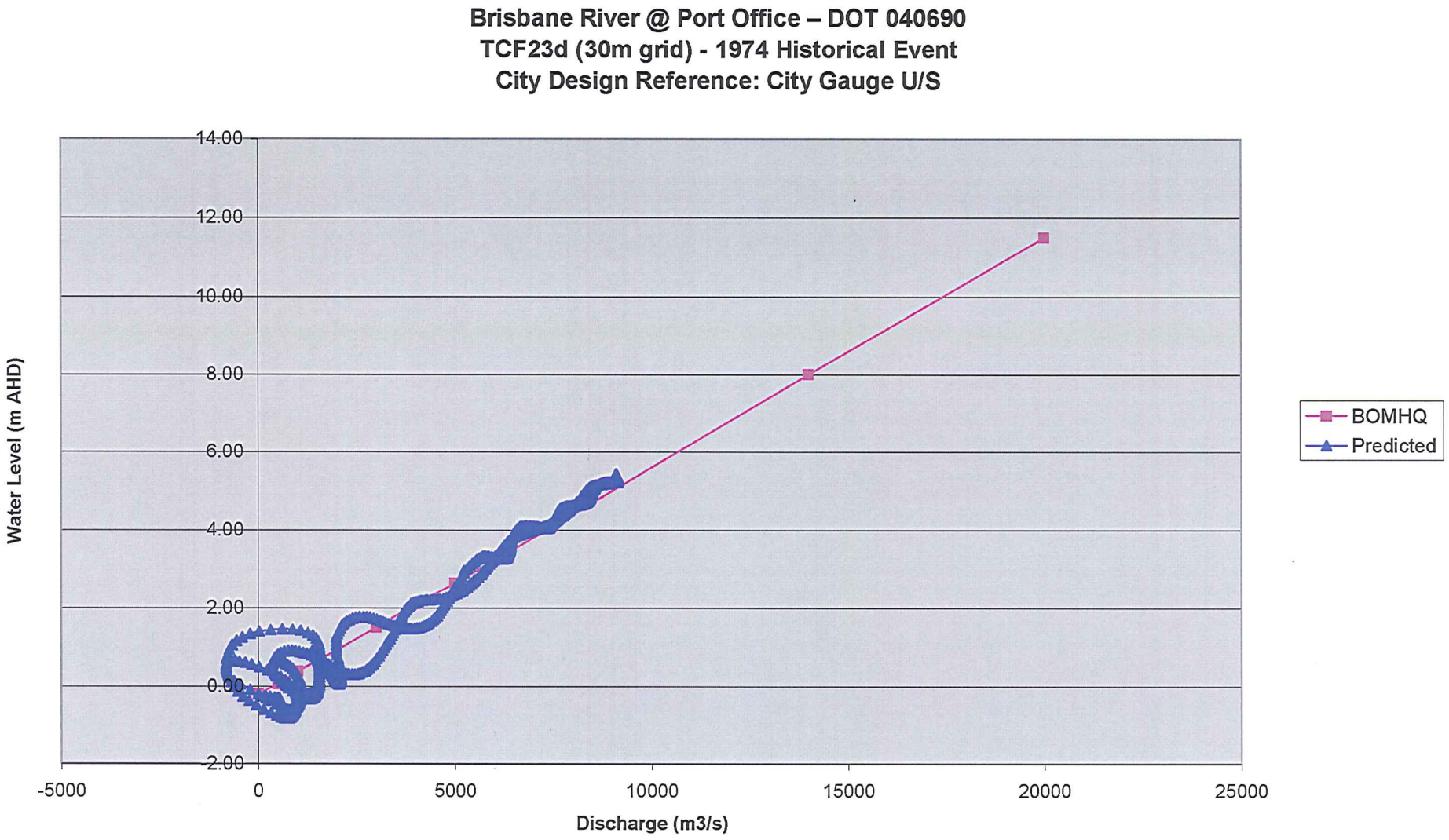


Figure 40: Brisbane River @ Port Office - Rating Curve Comparison

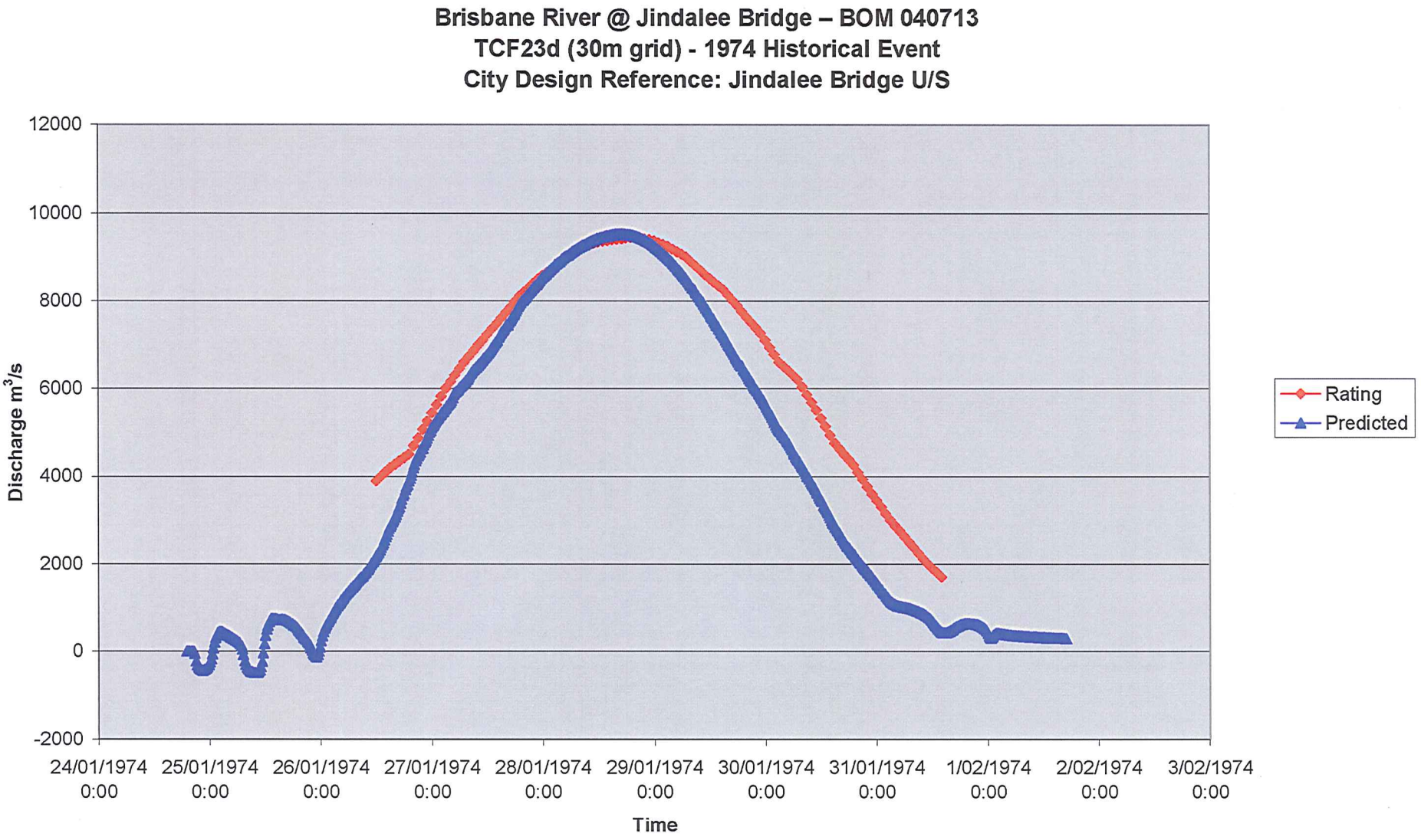
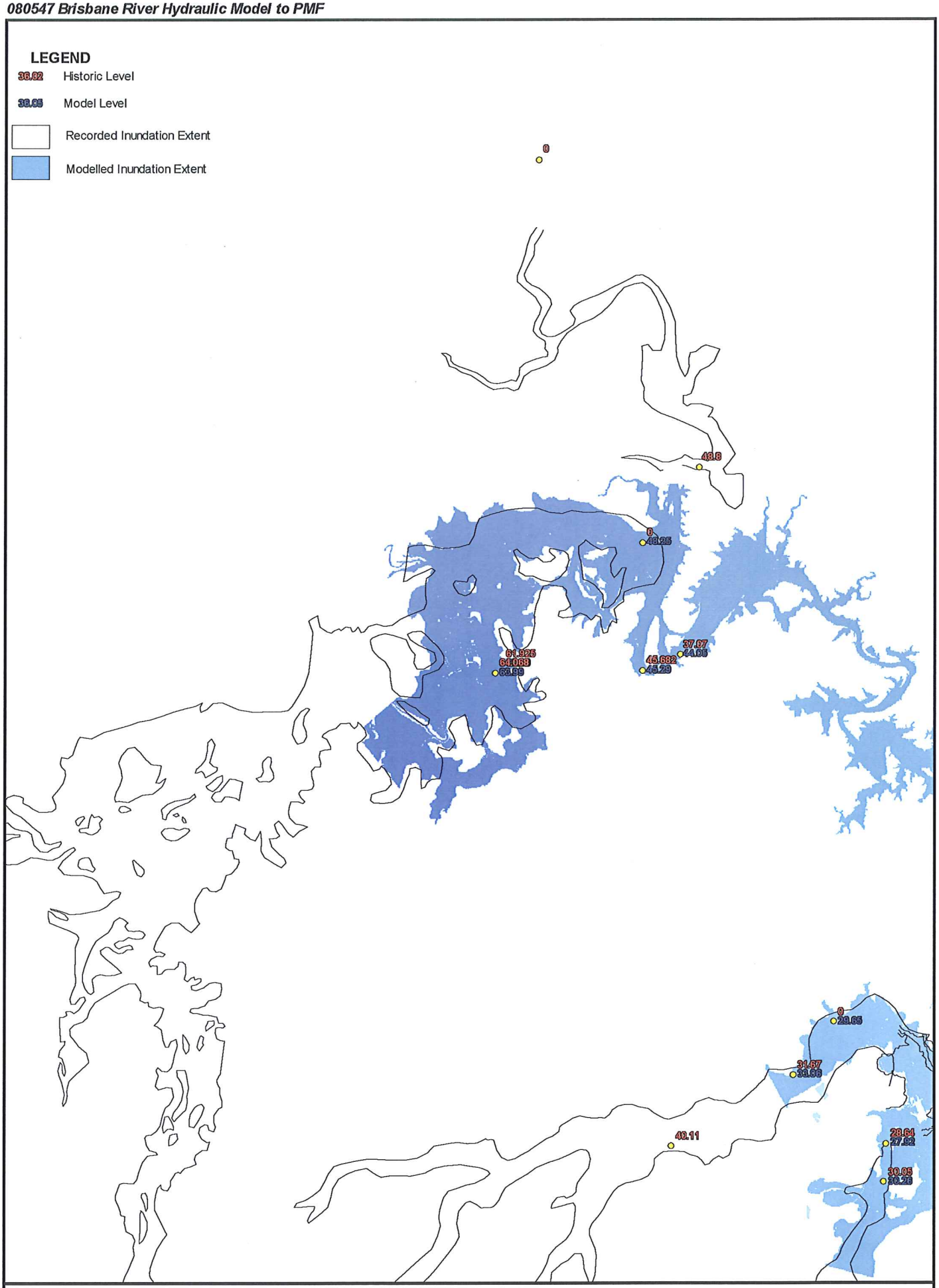
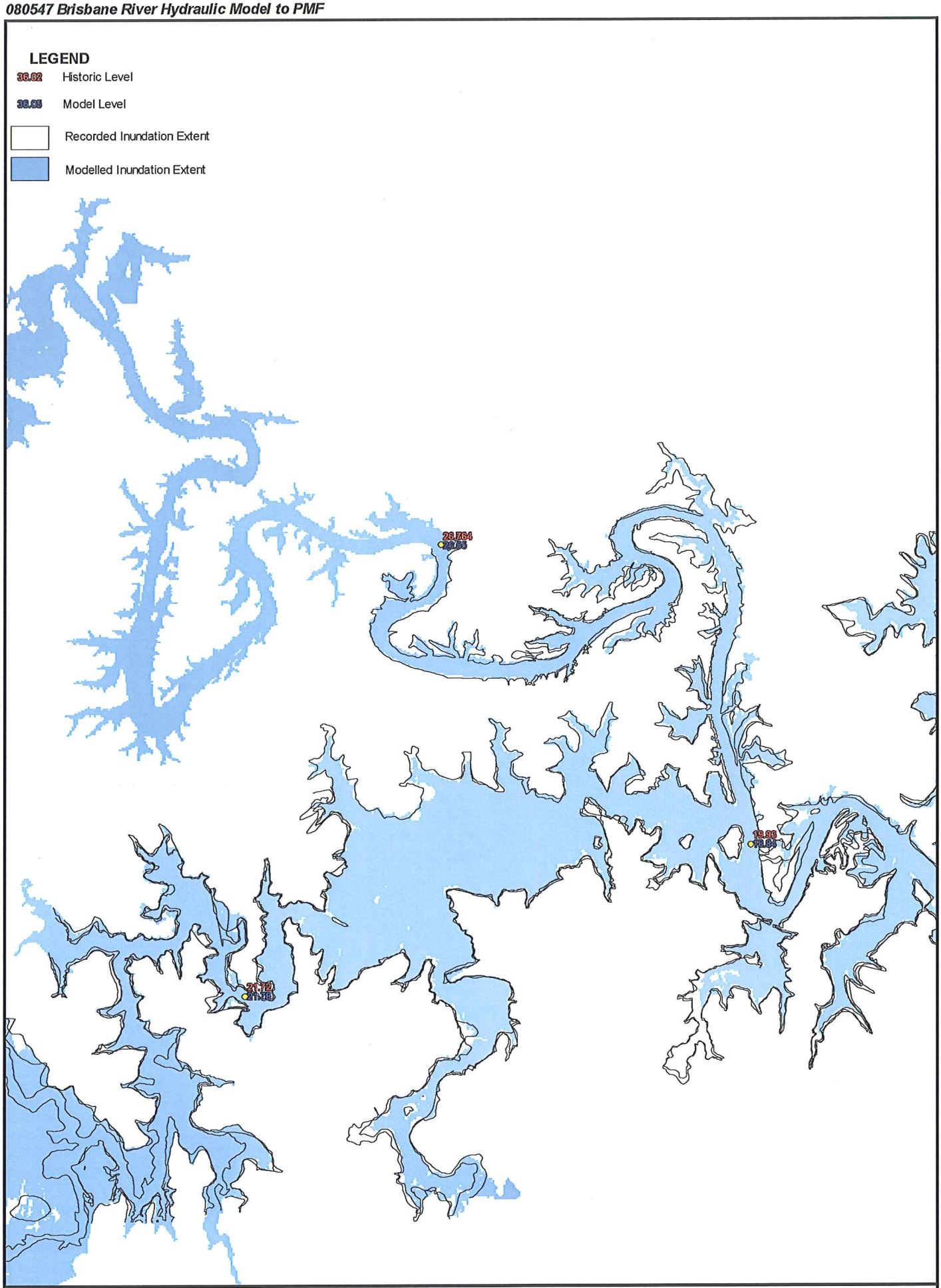


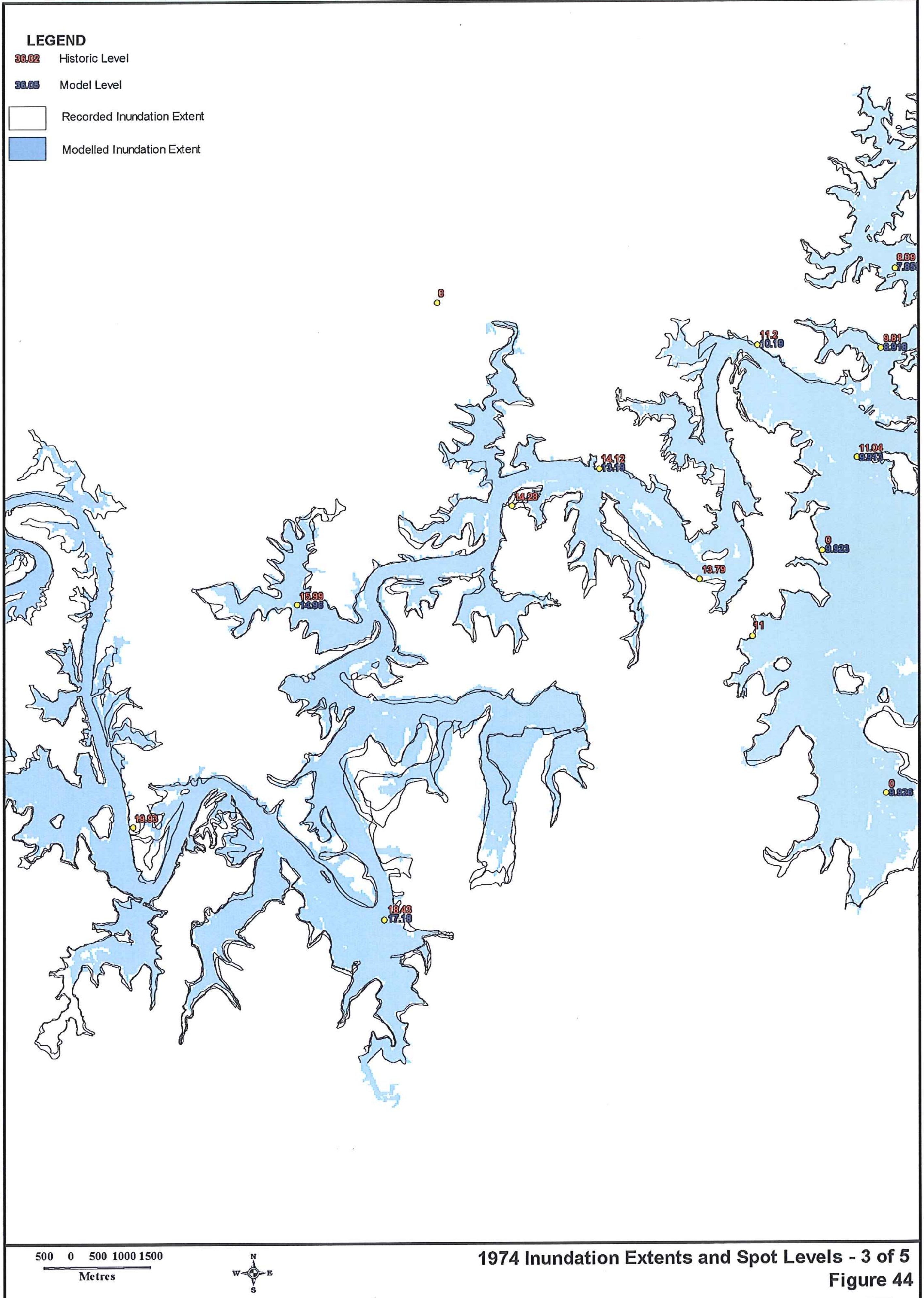
Figure 41: Discharge Rating Comparisonr @ Jindalee



1974 Inundation Extents and Spot Levels - 1 of 5
Figure 42



1974 Inundation Extents and Spot Levels - 2 of 5
Figure 43



1974 Inundation Extents and Spot Levels - 3 of 5

Figure 44

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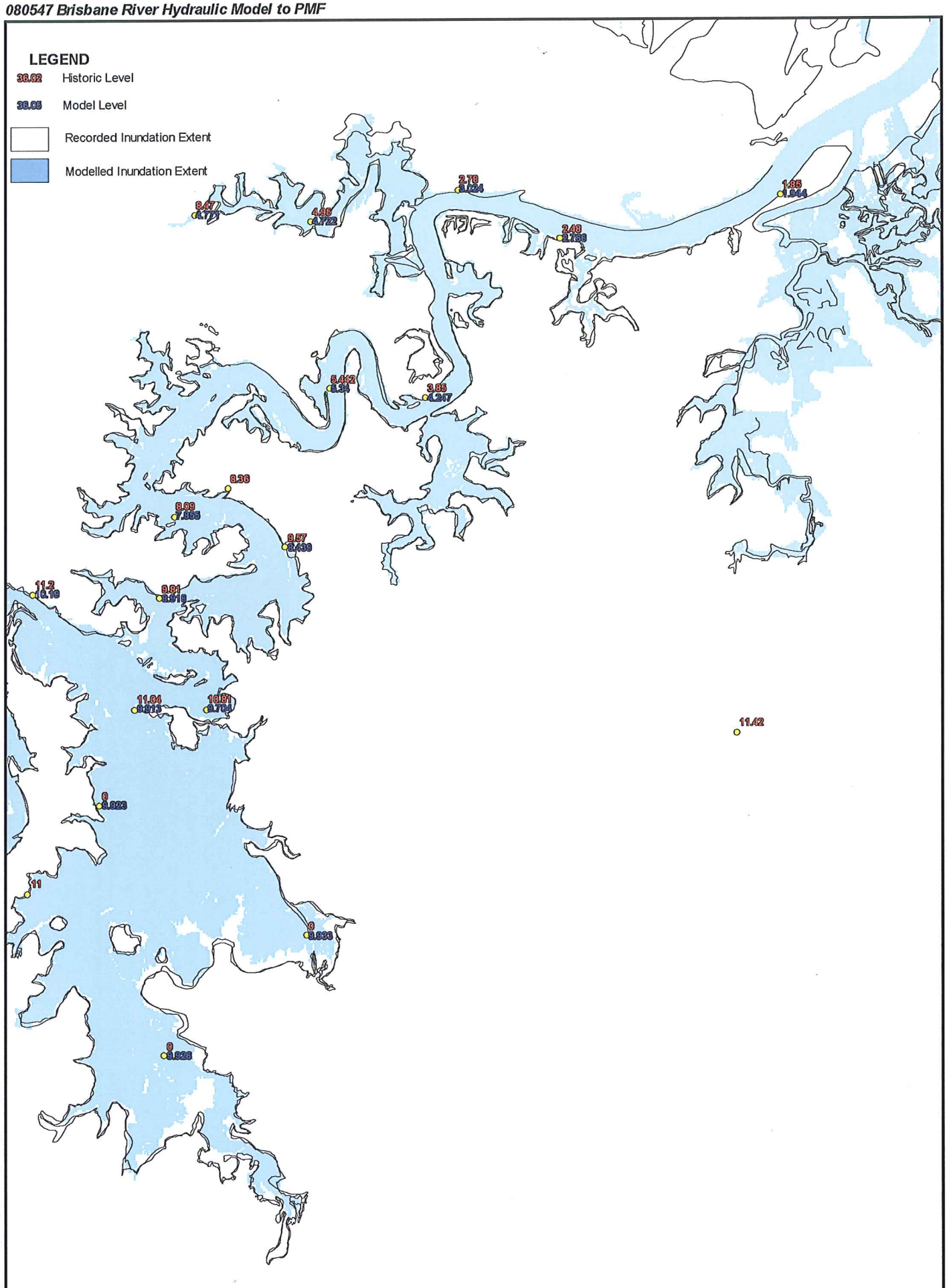
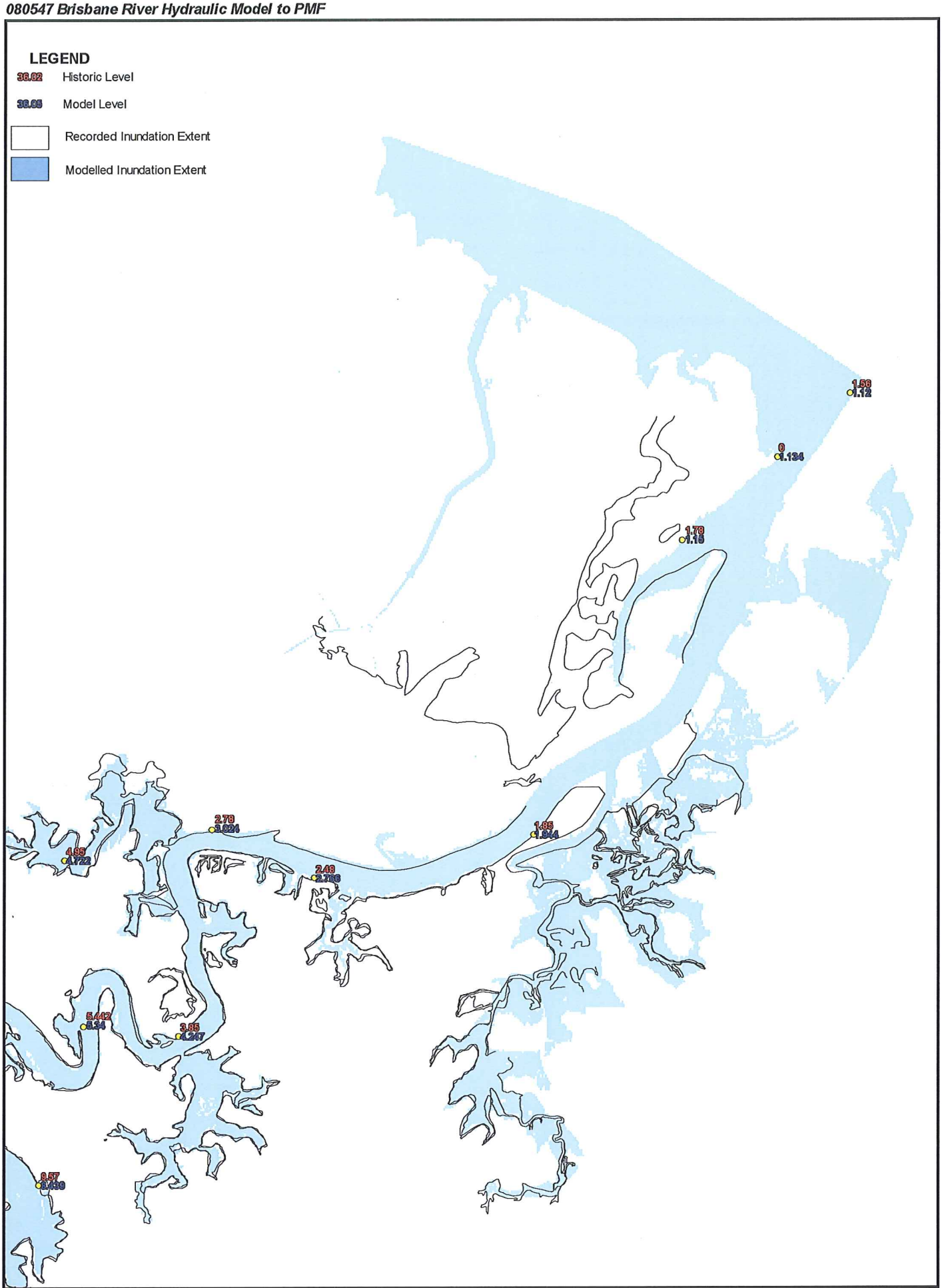


1974 Inundation Extents and Spot Levels - 4 of 5
Figure 45



1974 Inundation Extents and Spot Levels - 5 of 5
Figure 46

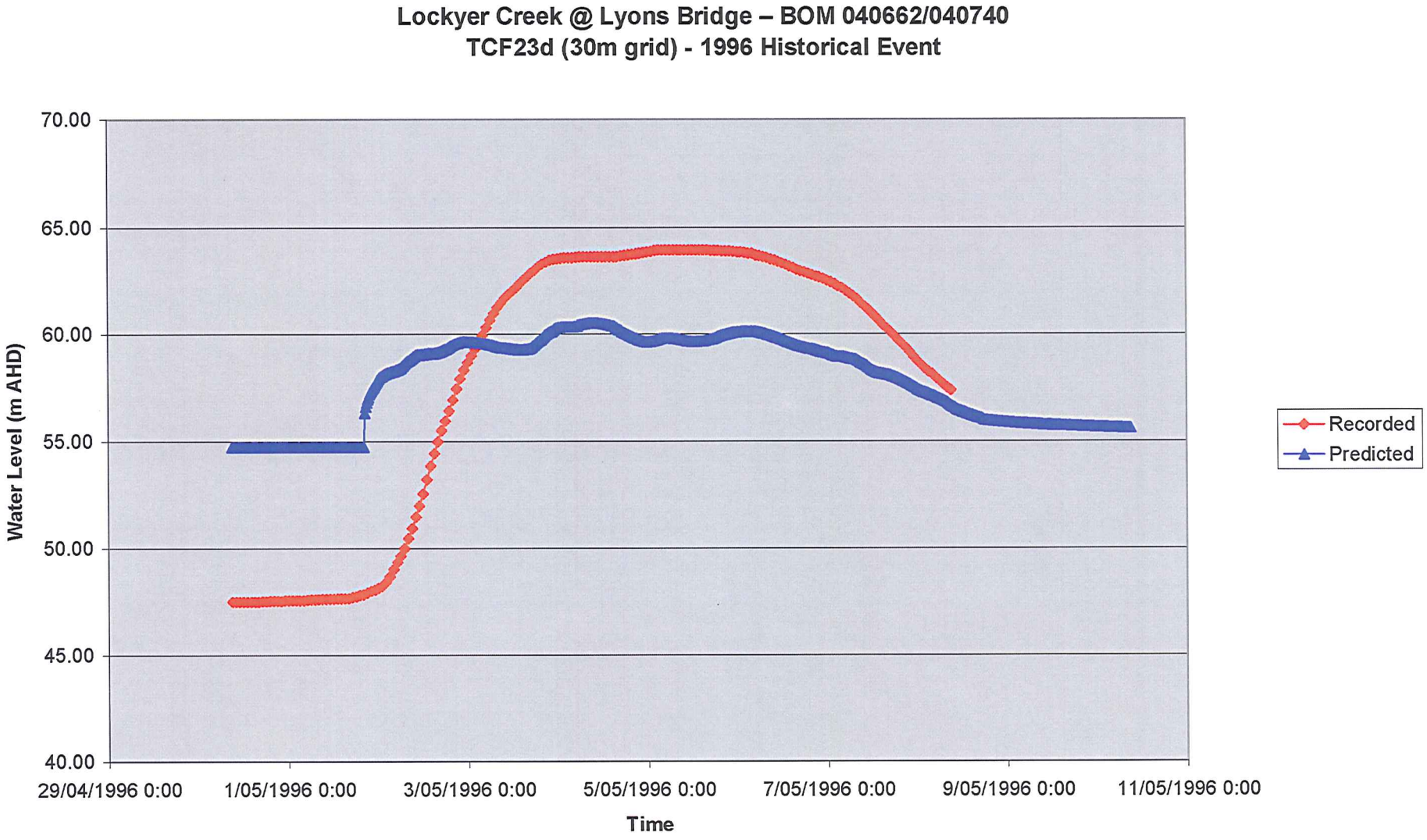


Figure 47: Lockyer Creek @ Lyons Bridge - Water Level Comparison

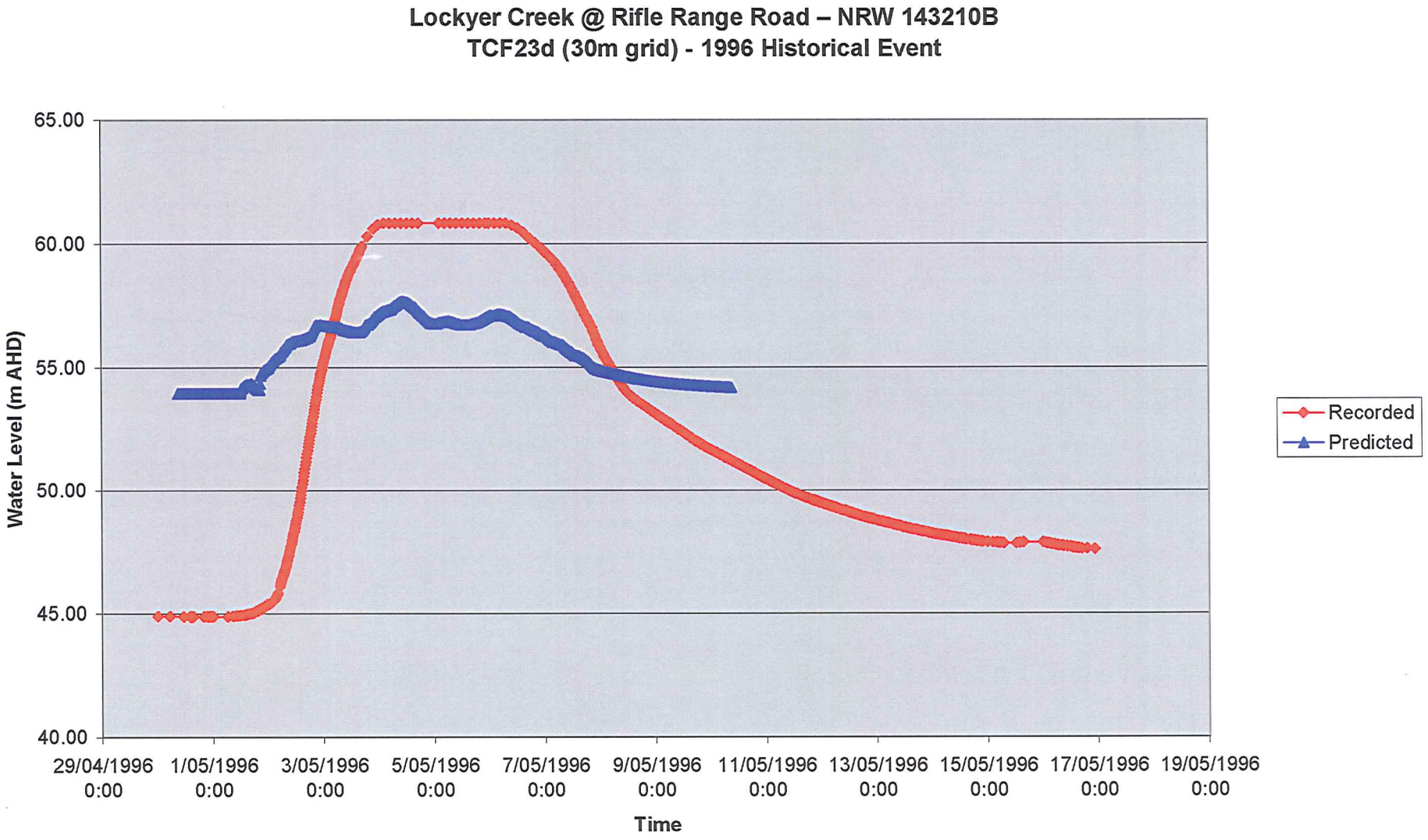


Figure 48: Lockyer Creek @ Rifle Rannge Road - Water Level Comparison

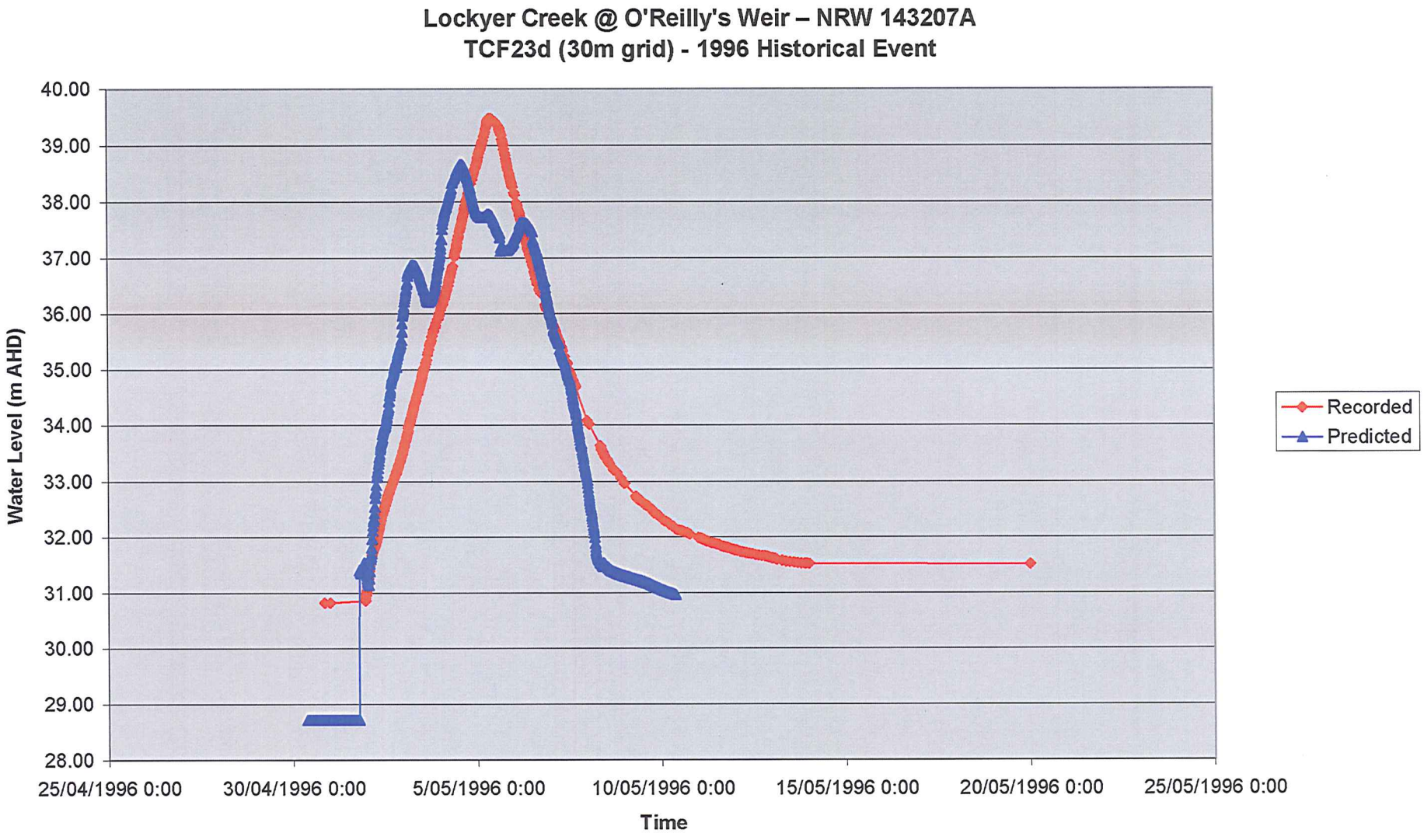


Figure 49: Lockyer Creek @ O'Reilly's Weir - Water Level Comparison

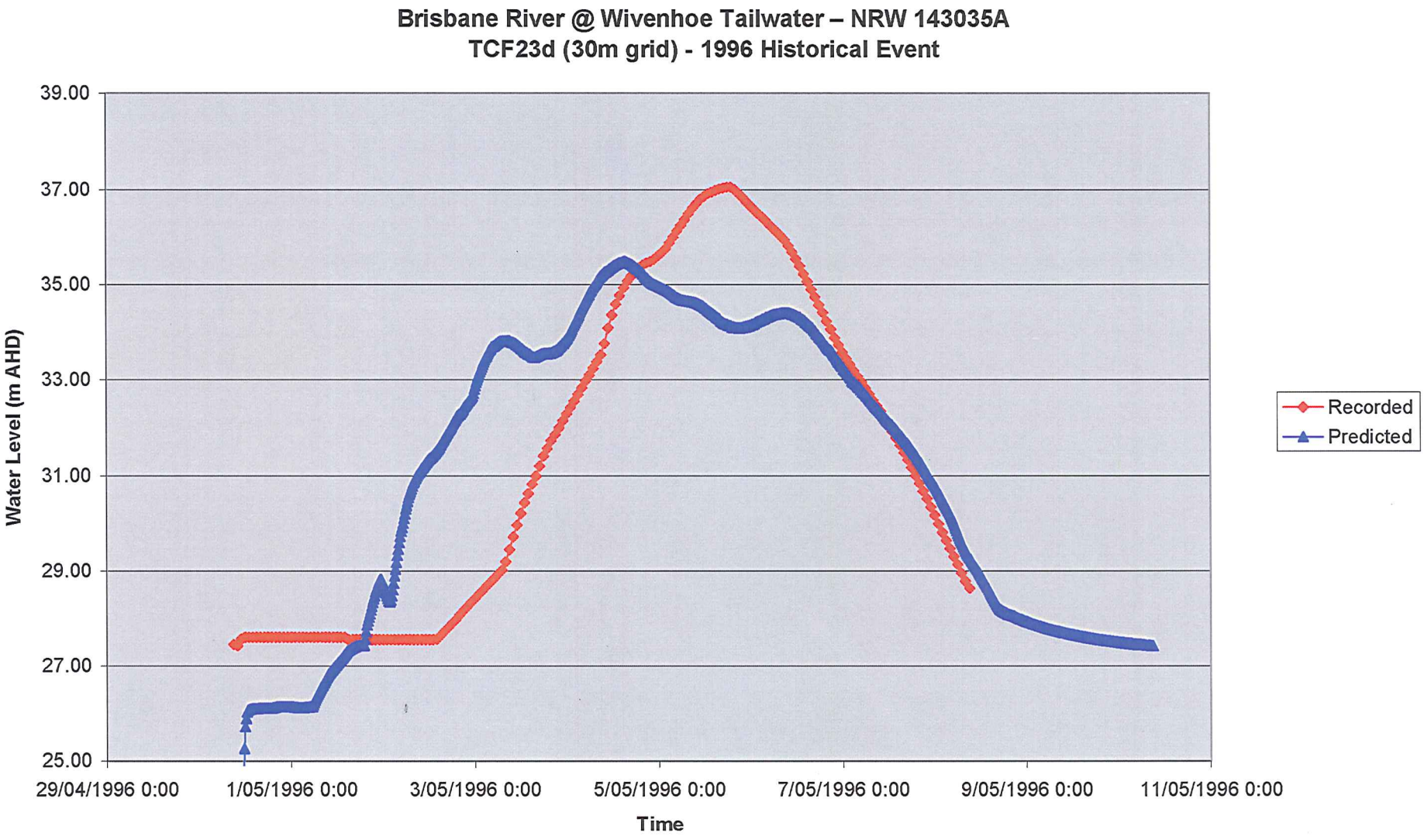


Figure 50: Brisbane River @ Wivenhoe Tailwater - Water Level Comparison

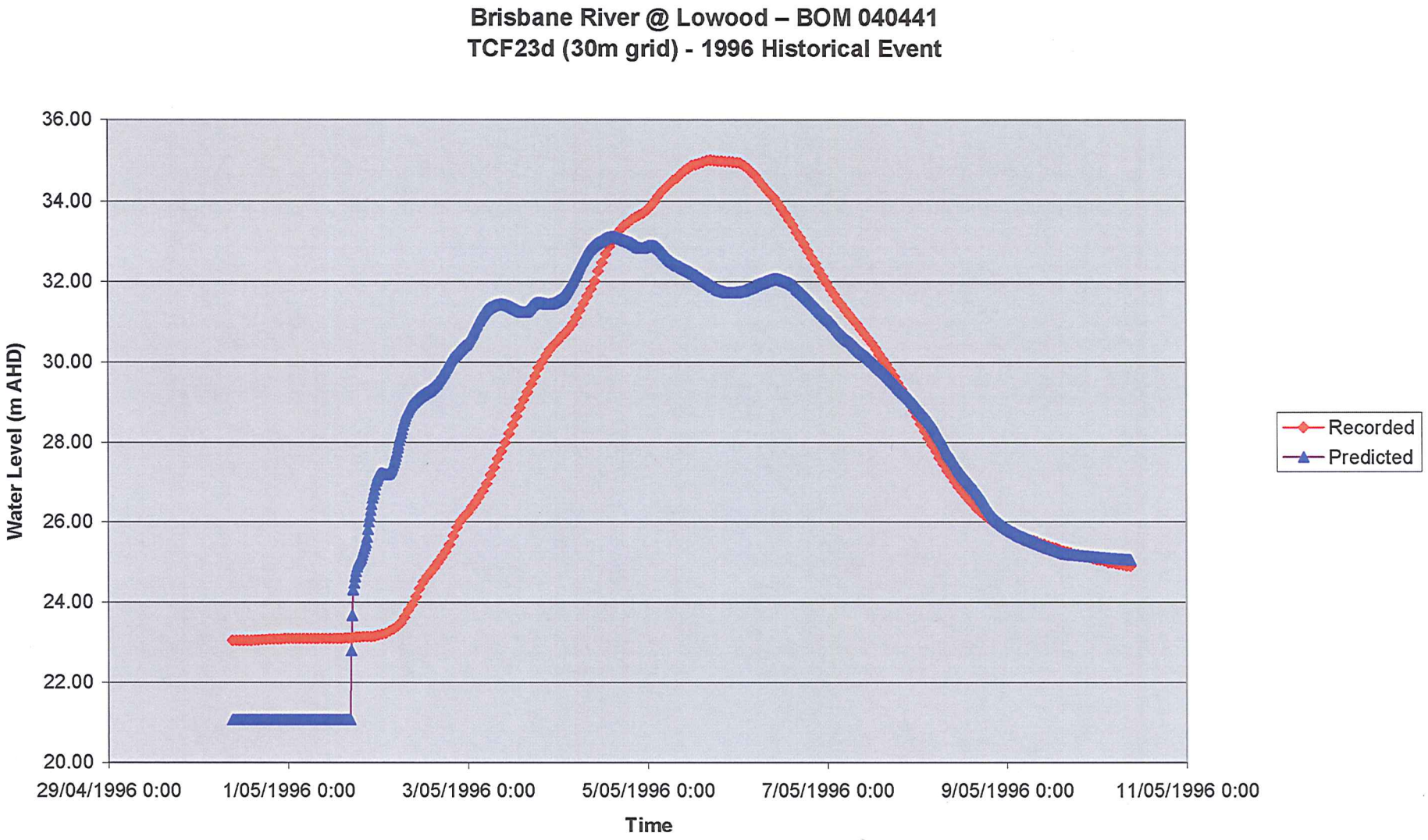


Figure 51: Brisbane River @ Lowood - Water Level Comparison

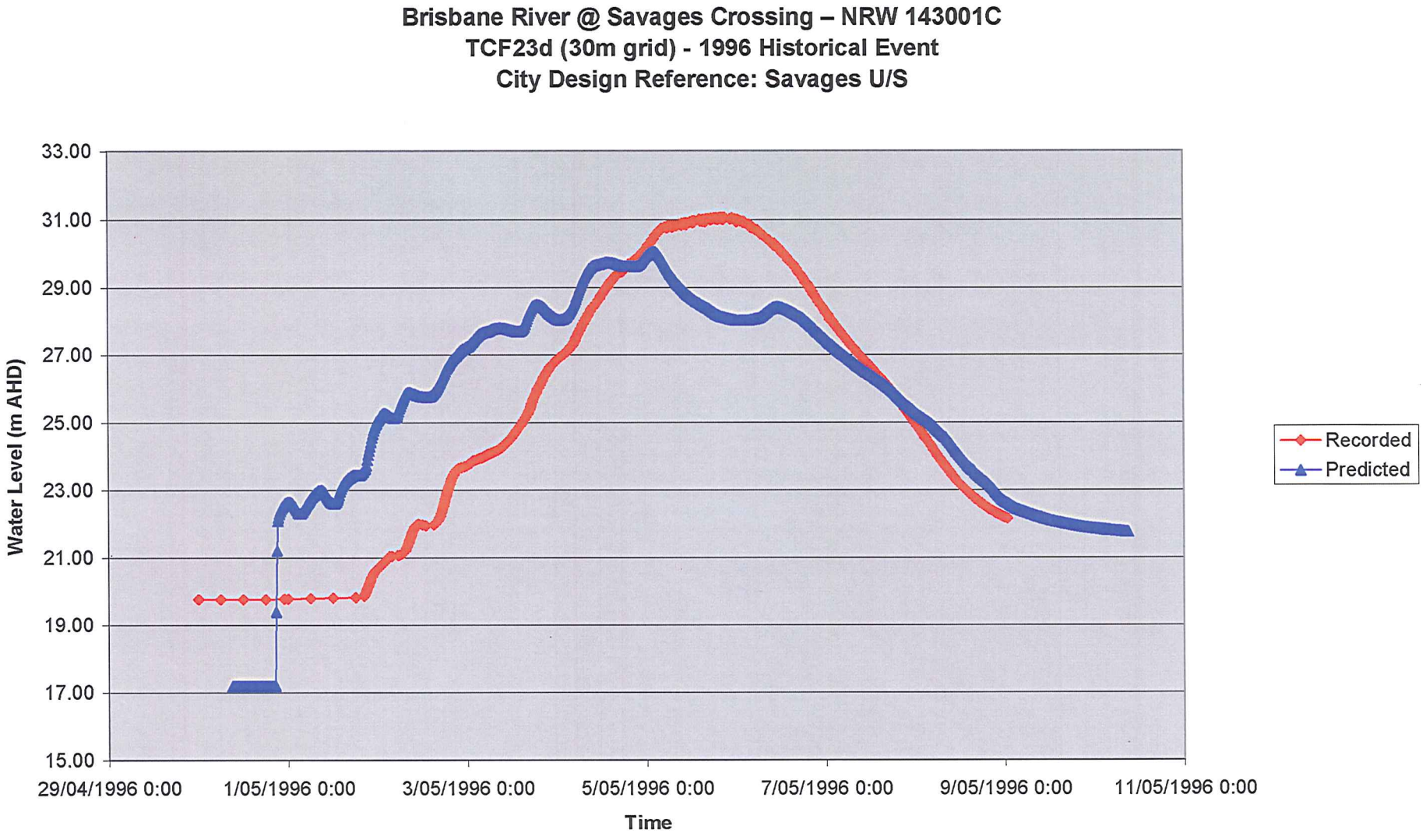


Figure 52: Brisbane River @ Savages Crossing - Water Level Comparison

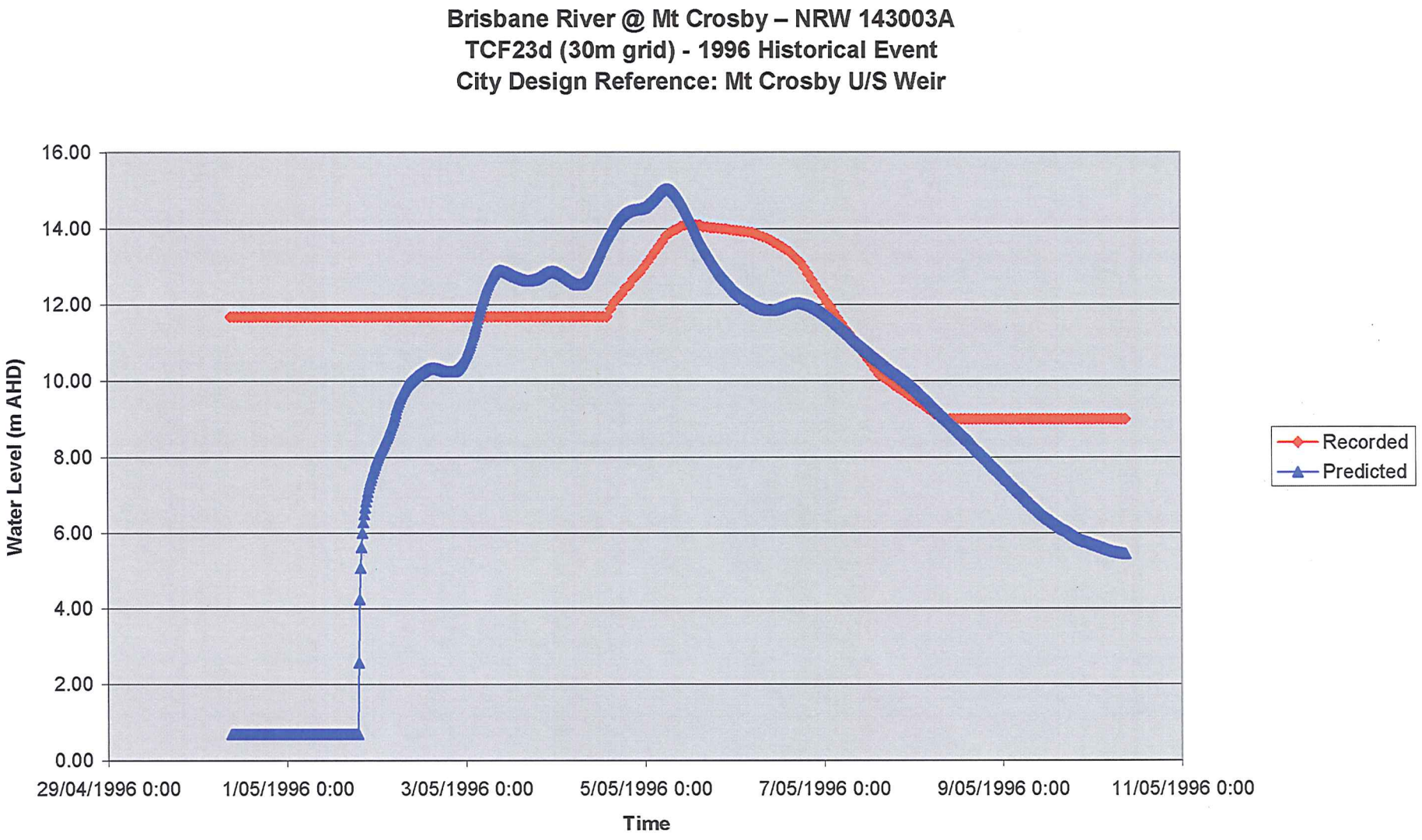


Figure 53: Brisbane River @ Mt Crosby - Water Level Comparison

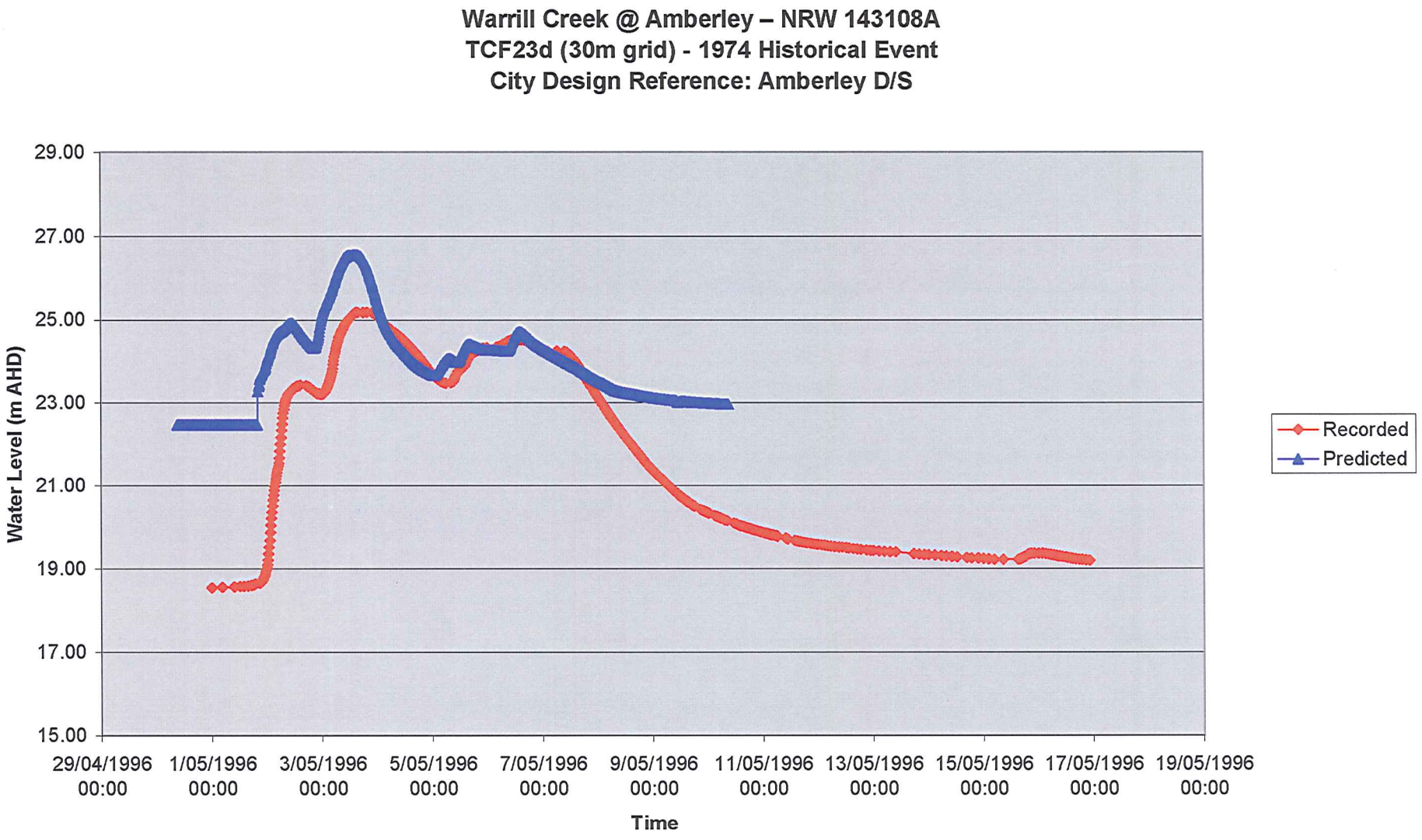


Figure 54: Warrill Creek @ Amberley - Water Level Comparison

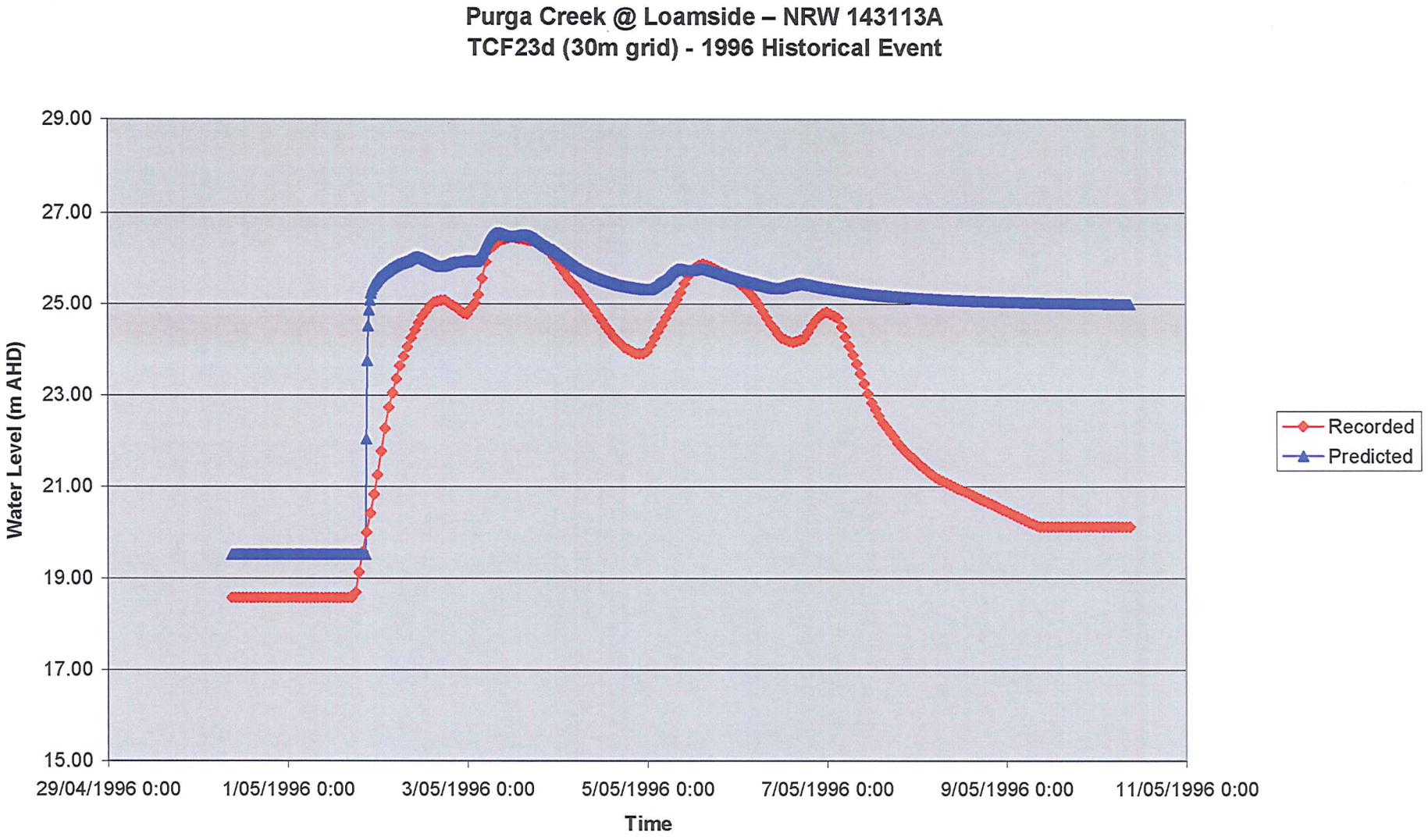


Figure 55: Purga Creek @ Loamside - Water Level Comparison

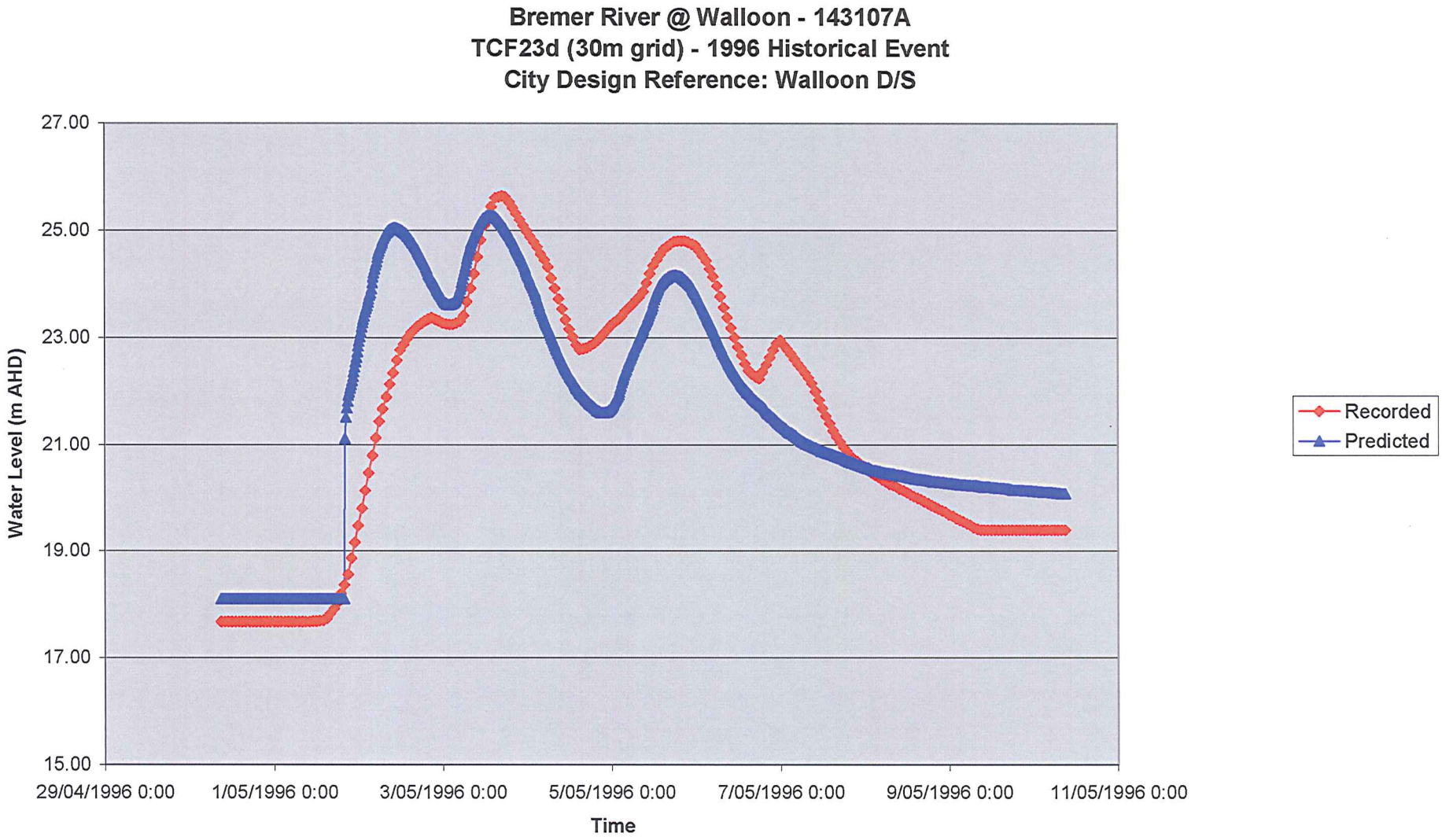


Figure 56: Bremer River @ Walloon - Water Level Comparison

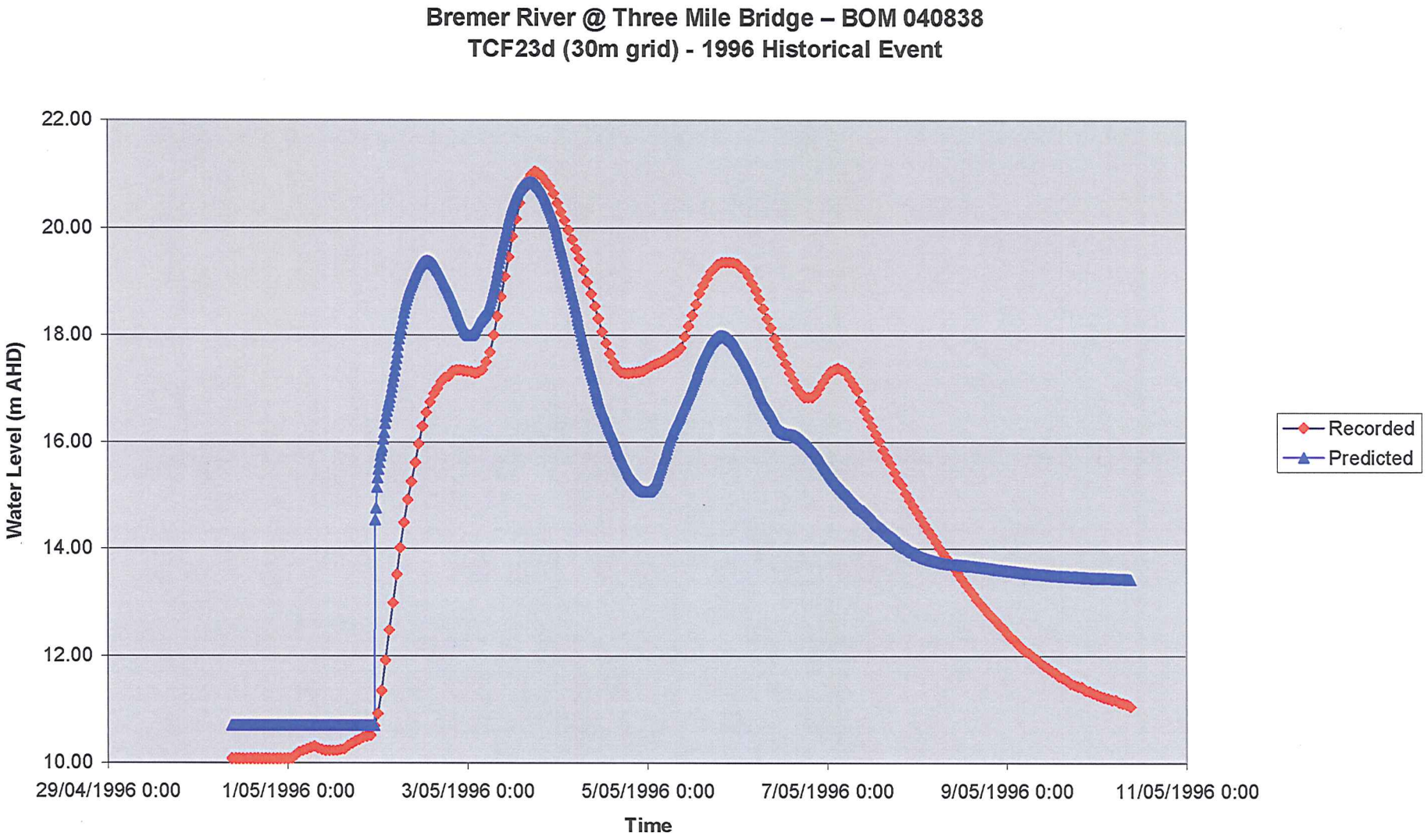


Figure 57: Bremer River @ Three Mile Bridge - Water Level Comparison

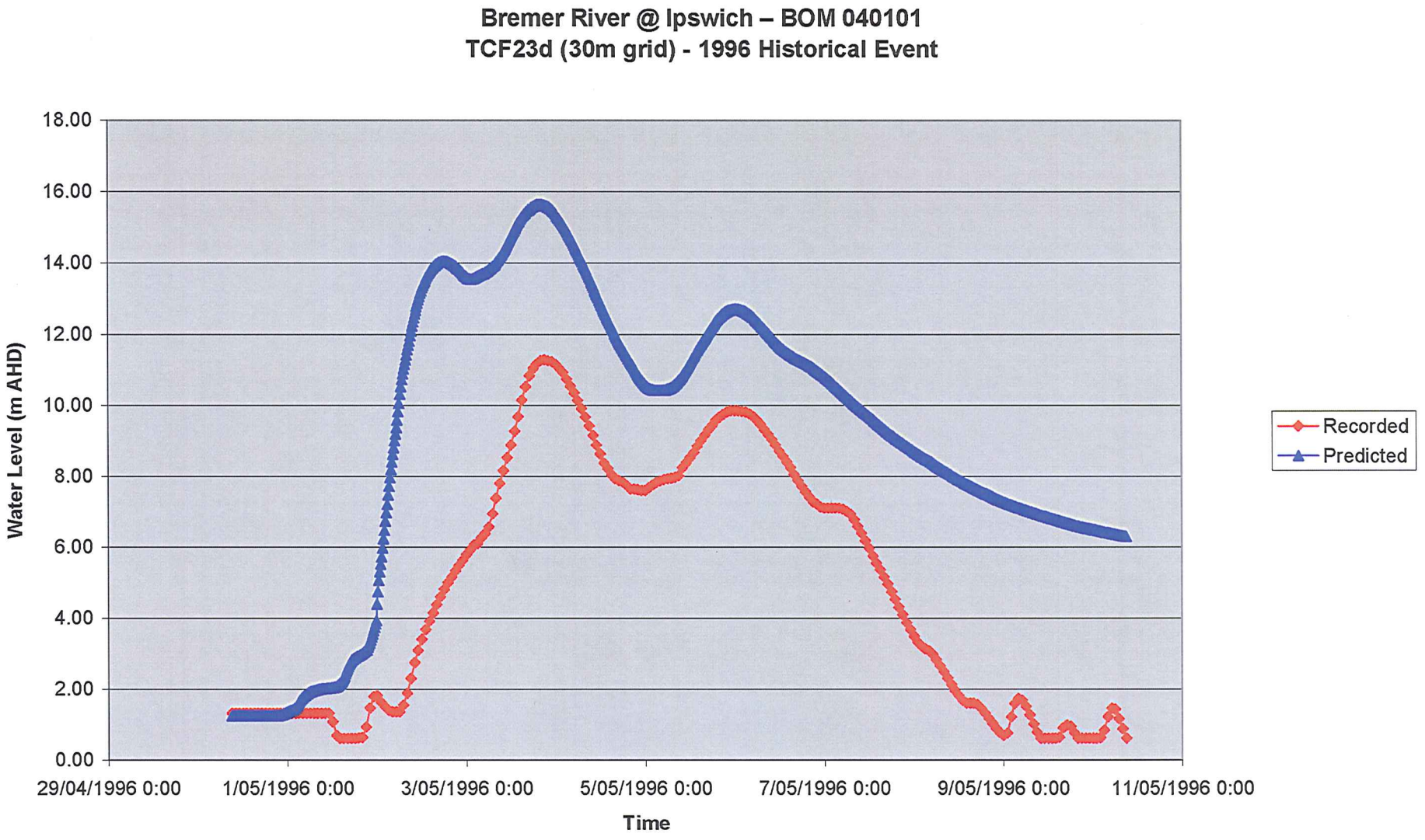


Figure 58: Bremer River @ Ipswich - Water Level Comparison

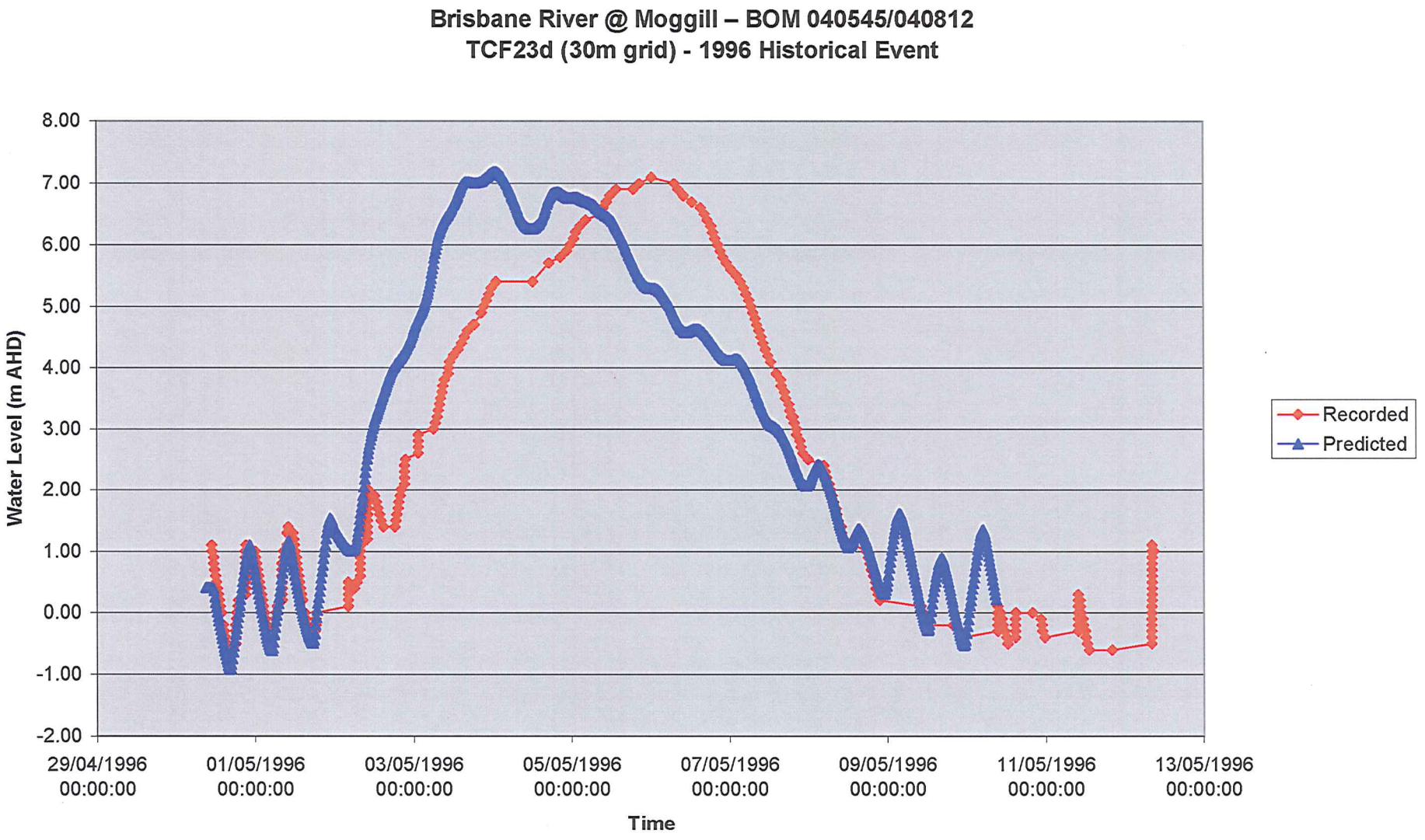


Figure 59: Brisbane River @ Moggill - Water Level Comparison

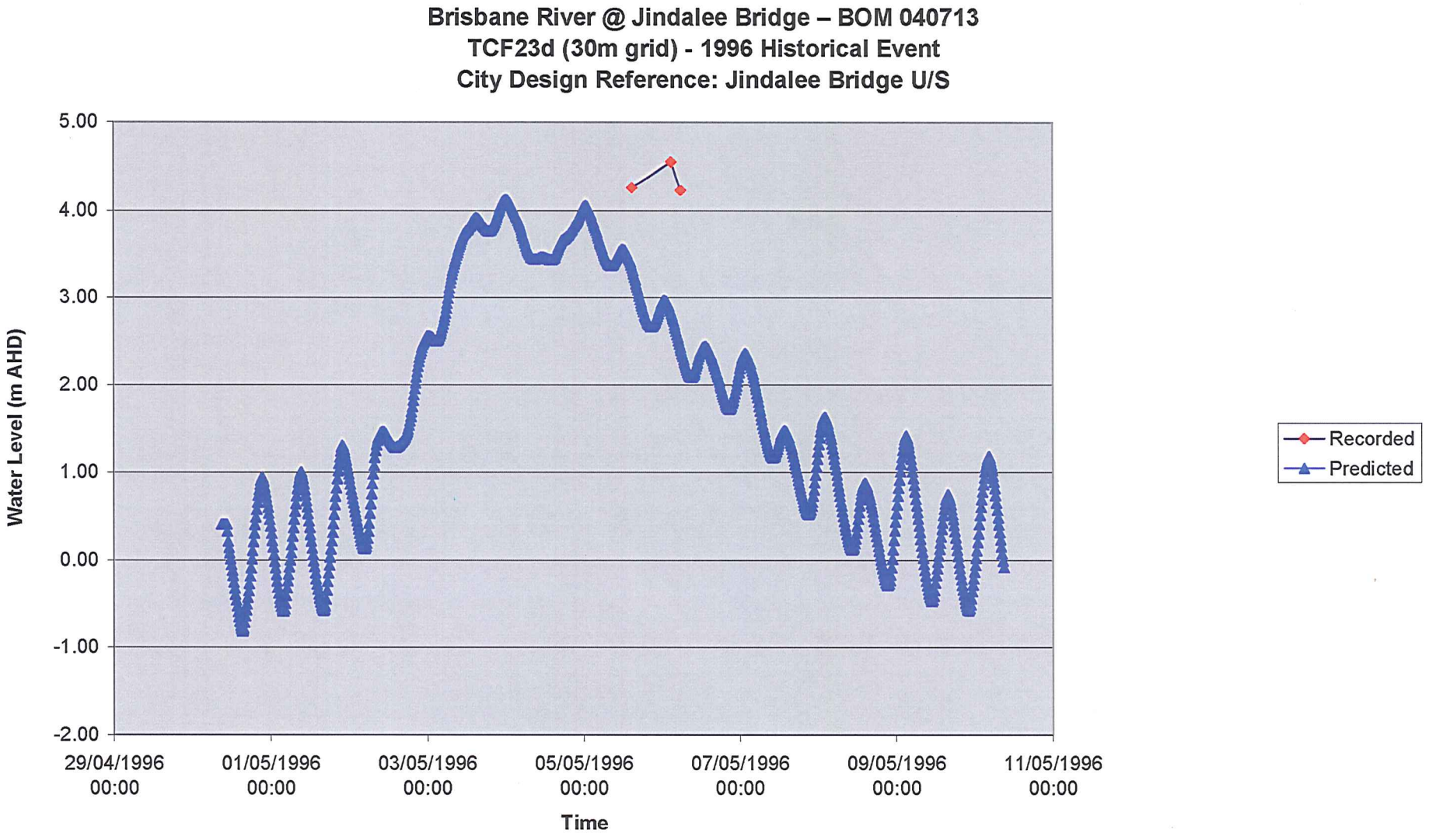


Figure 60: Brisbane River @ Moggill - Water Level Comparison

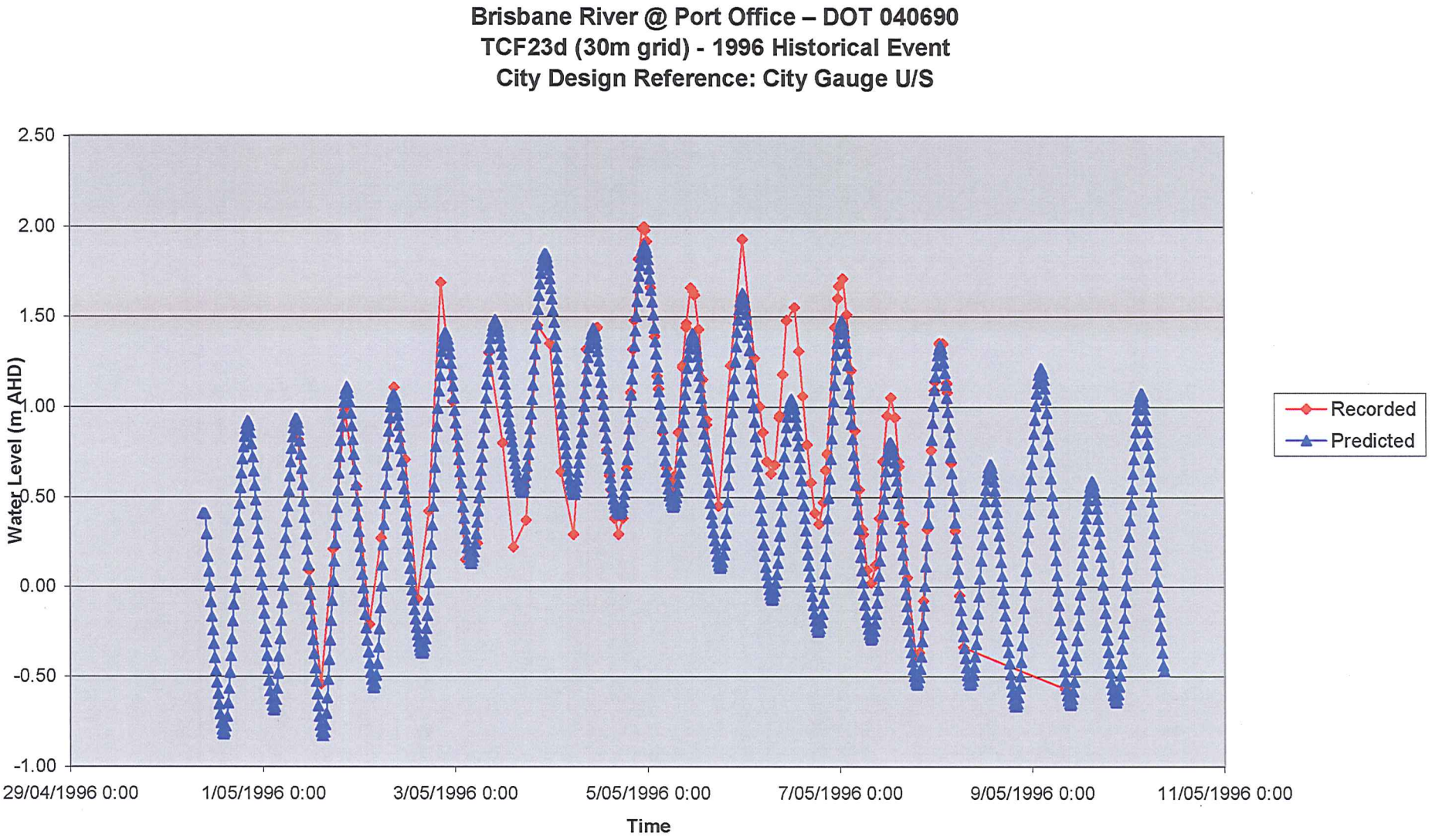


Figure 61: Brisbane River @ Port Office - Water Level Comparison

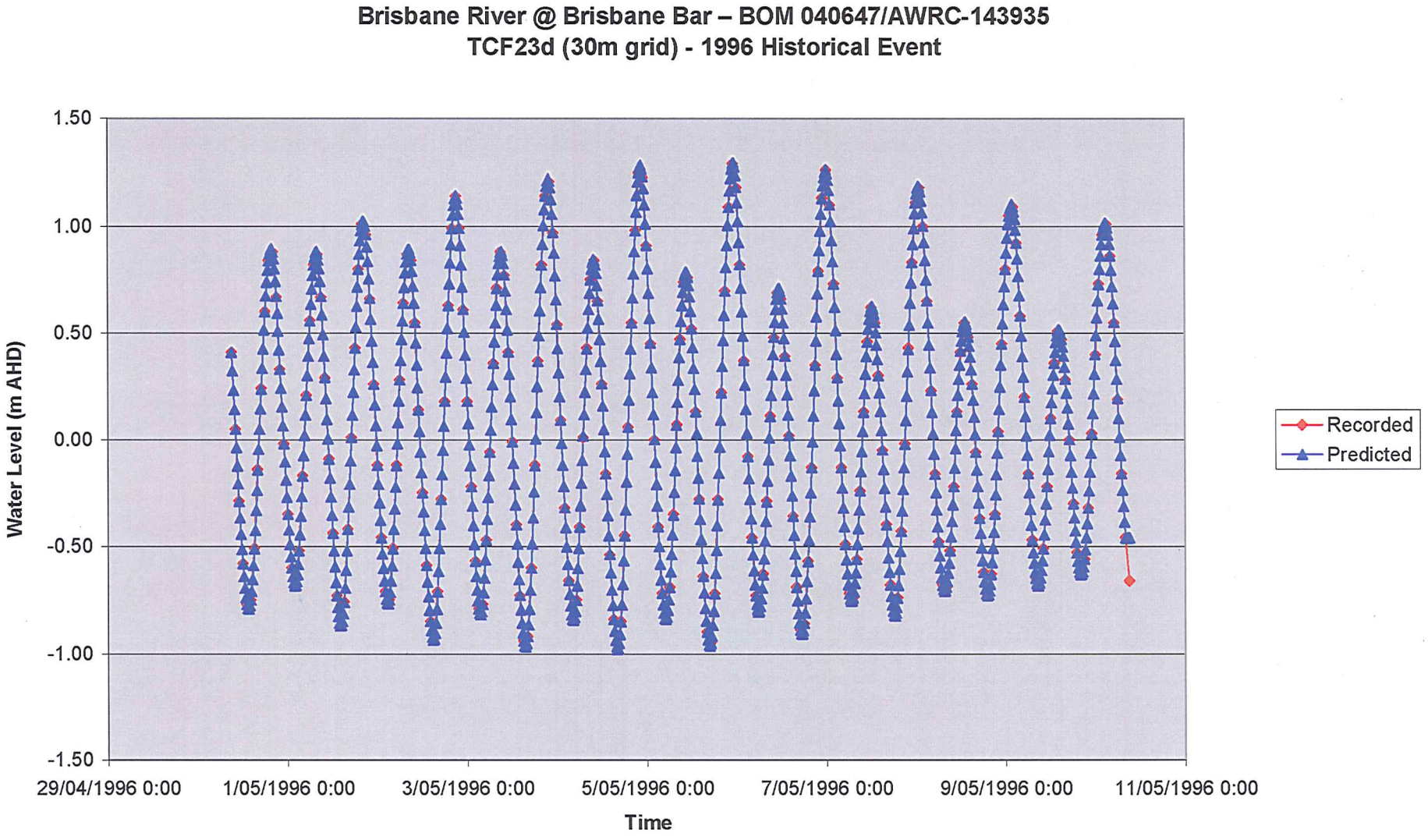


Figure 62: Brisbane River @ Brisbane Bar - Water Level Comparison

1 0 1 2 3 4 5
Kilometres

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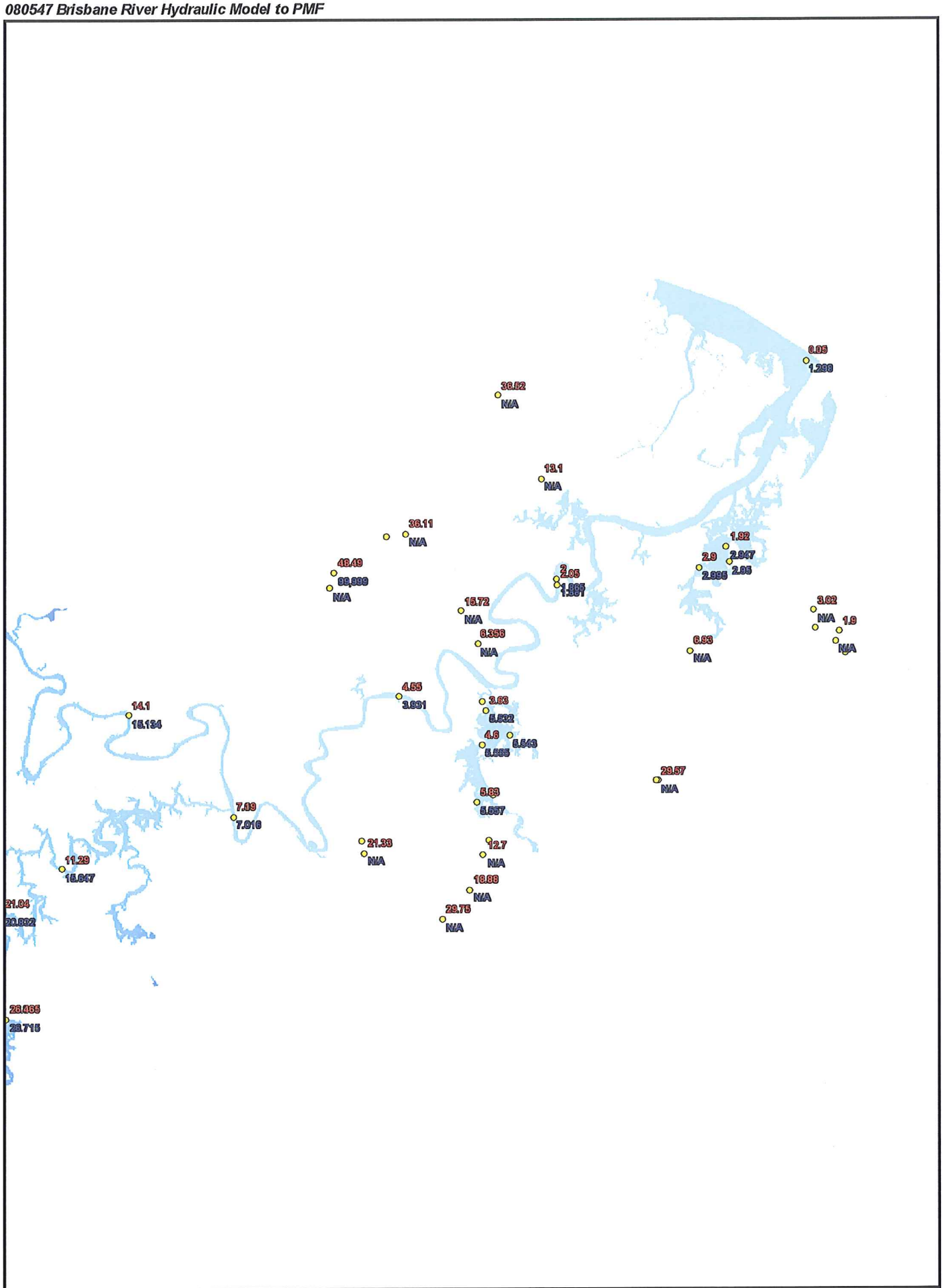
1996 Inundation Extents and Spot Levels - 1 of 2
Figure 63



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1996 Inundation Extents and Spot Levels - 2 of 2
Figure 64

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Appendix B Project Context

B1 State and Federal Legislative Requirements

In June 2001, the Council of Australian Governments (COAG) commissioned a review of Australia's approach and arrangements for dealing with natural disasters. The review objective was to determine whether current arrangements for assessing disaster risks, taking mitigation action and dealing with natural disasters when and as they occur, provide an effective framework to meet the needs of those affected by natural disasters.

The resulting report ***Natural Disasters in Australia: Reforming mitigation, relief and recovery arrangements*** (February 2004), concluded that current arrangements could be improved by broadening the focus of disaster management beyond historic disaster response and reaction, towards anticipation and mitigation of disasters. This report recommended a unified national approach to natural disasters and the adoption of a national framework to:

- create safer, more sustainable communities in social, economic and environmental terms
- reduce risks, damage and losses from natural disasters
- find the right balance between mitigation, preparedness, response, relief & recovery activities
- recognise the investment and savings opportunities provided by mitigation

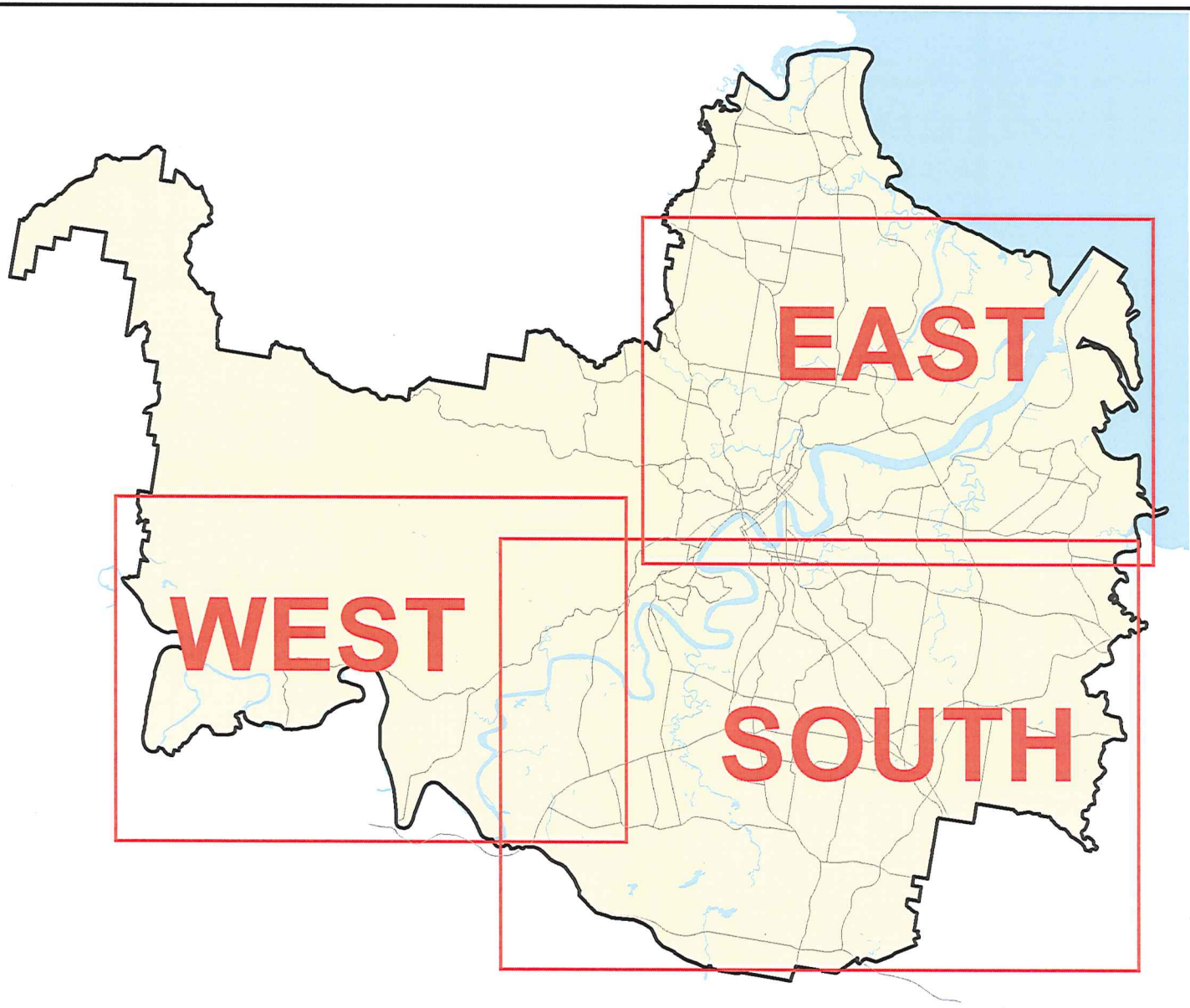
The report also described desirable attributes of a national framework for natural disaster management as well as twelve commitments by all levels of government to reform Australia's natural disaster management over the next five years. The general themes of these commitments were the development of:

- systematic and rigorous disaster risk assessments and mitigation measures and strategies
- a nationally consistent system of data collection, research and analysis and cost-sharing principles for natural disaster management with a stronger focus on anticipation, mitigation, and recovery and resilience
- effective land use planning, development and building controls
- national practices in community awareness, education and warnings
- enhanced Commonwealth Natural Disaster Relief Arrangements and support for emergency management volunteers

In August 2004, the Queensland Audit Office (QAO) tabled its ***Report No. 2 for 2004-05: Audit of the Queensland Disaster Management System.*** QAO considered that the report was of strategic importance in the development of a more holistic, integrated and balanced approach to disaster management in Queensland under the Disaster Management Act 2003.

B2 NDMP Funding Arrangements

The NDMP is a national program aimed at identifying and addressing natural disaster risk priorities across the nation. Funds are available for natural disaster mitigation works, measures and related



3 0 3 6 9

Kilometres

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Dedicated to a better Brisbane

Key Map for Inundation and Evacuation Maps

Figure 100

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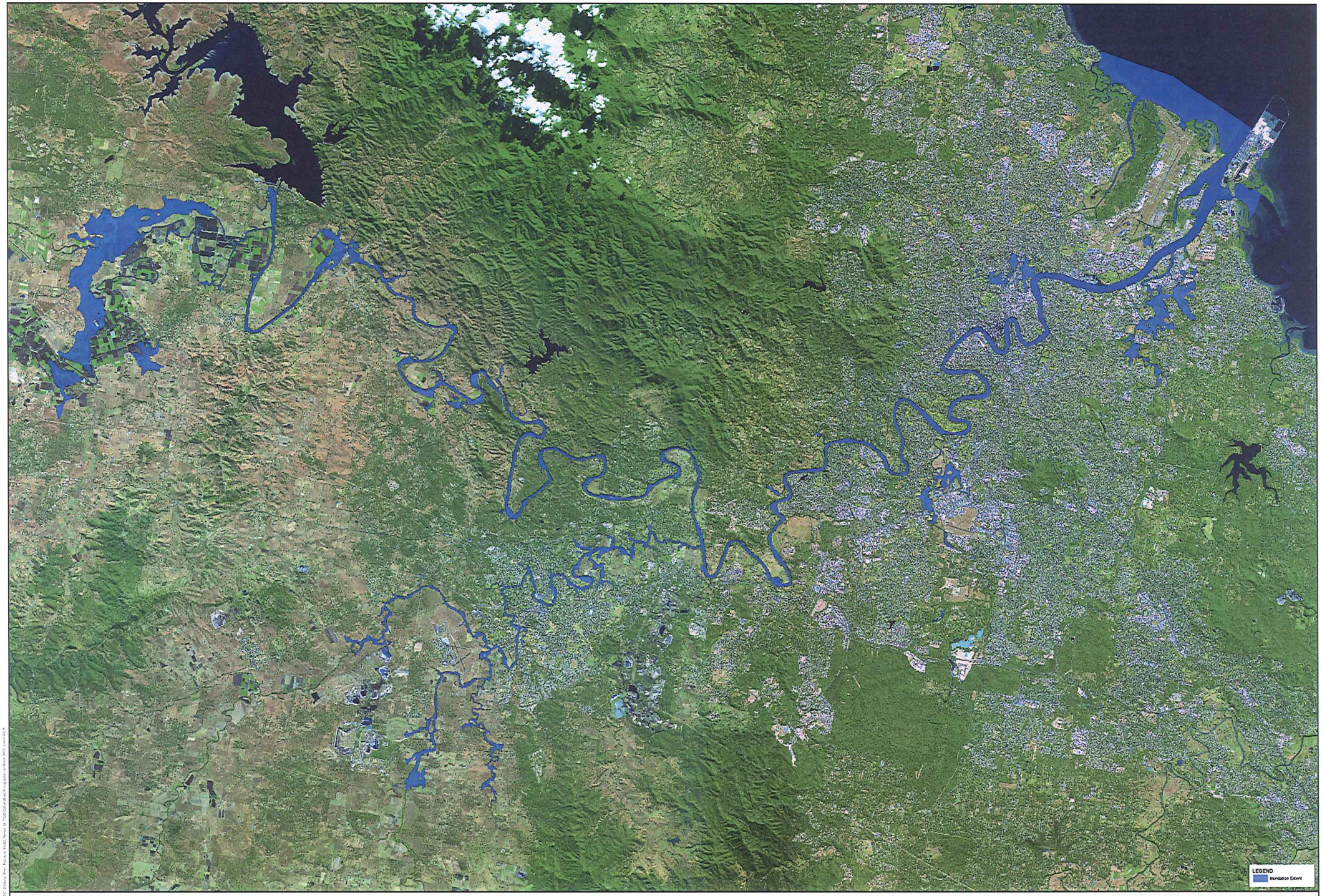
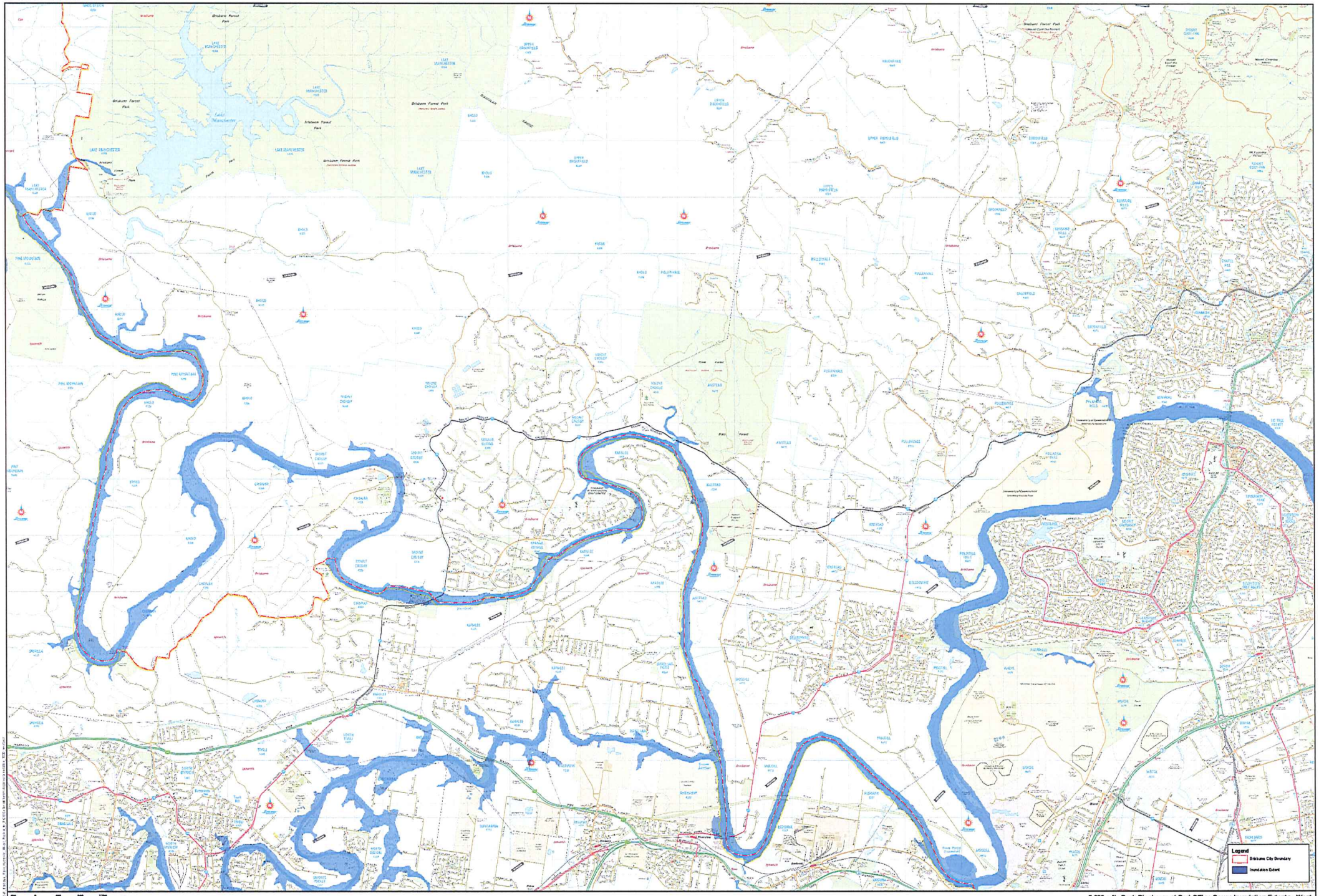


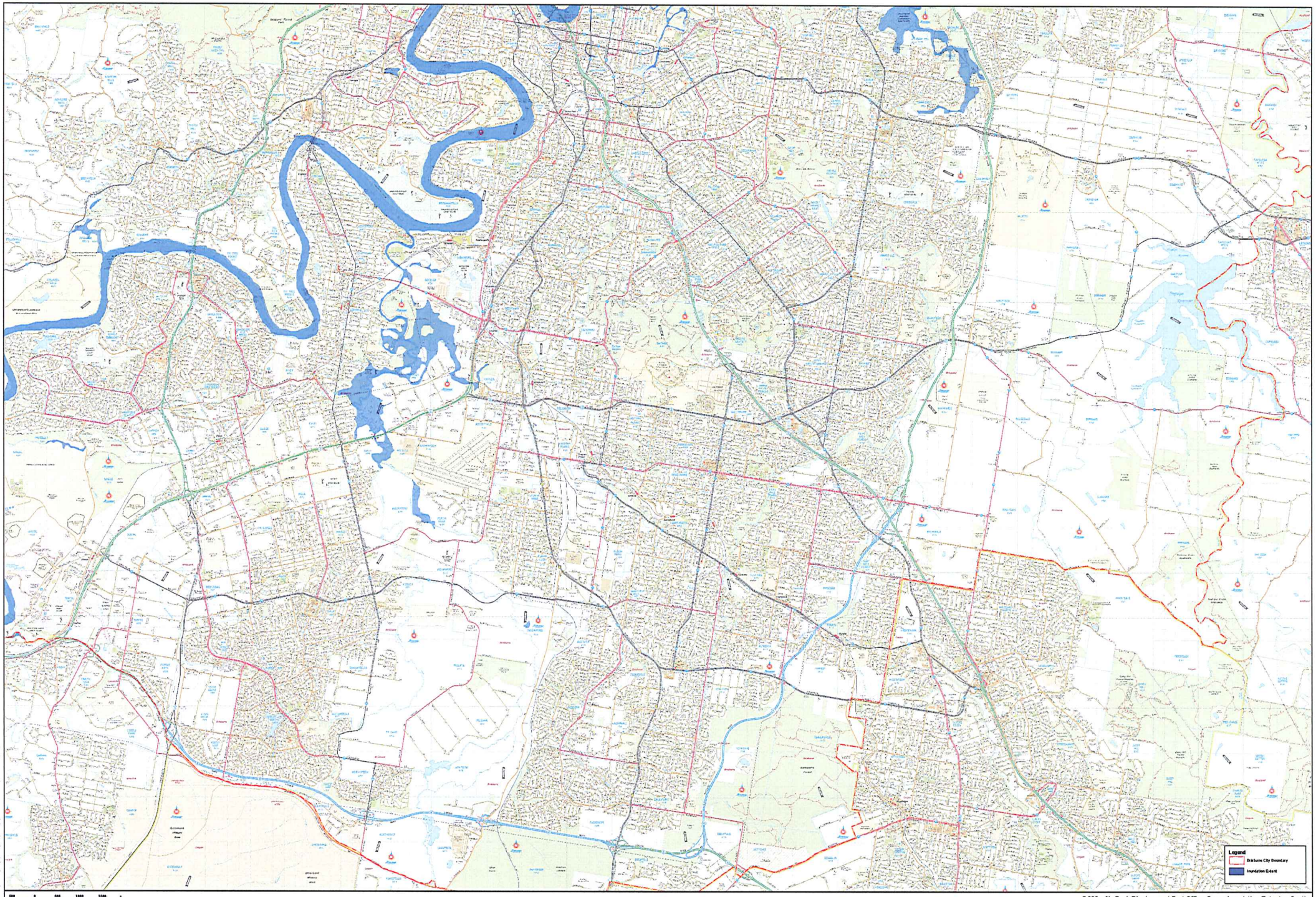
3,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents

Figure 101



3,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - West

Figure 102

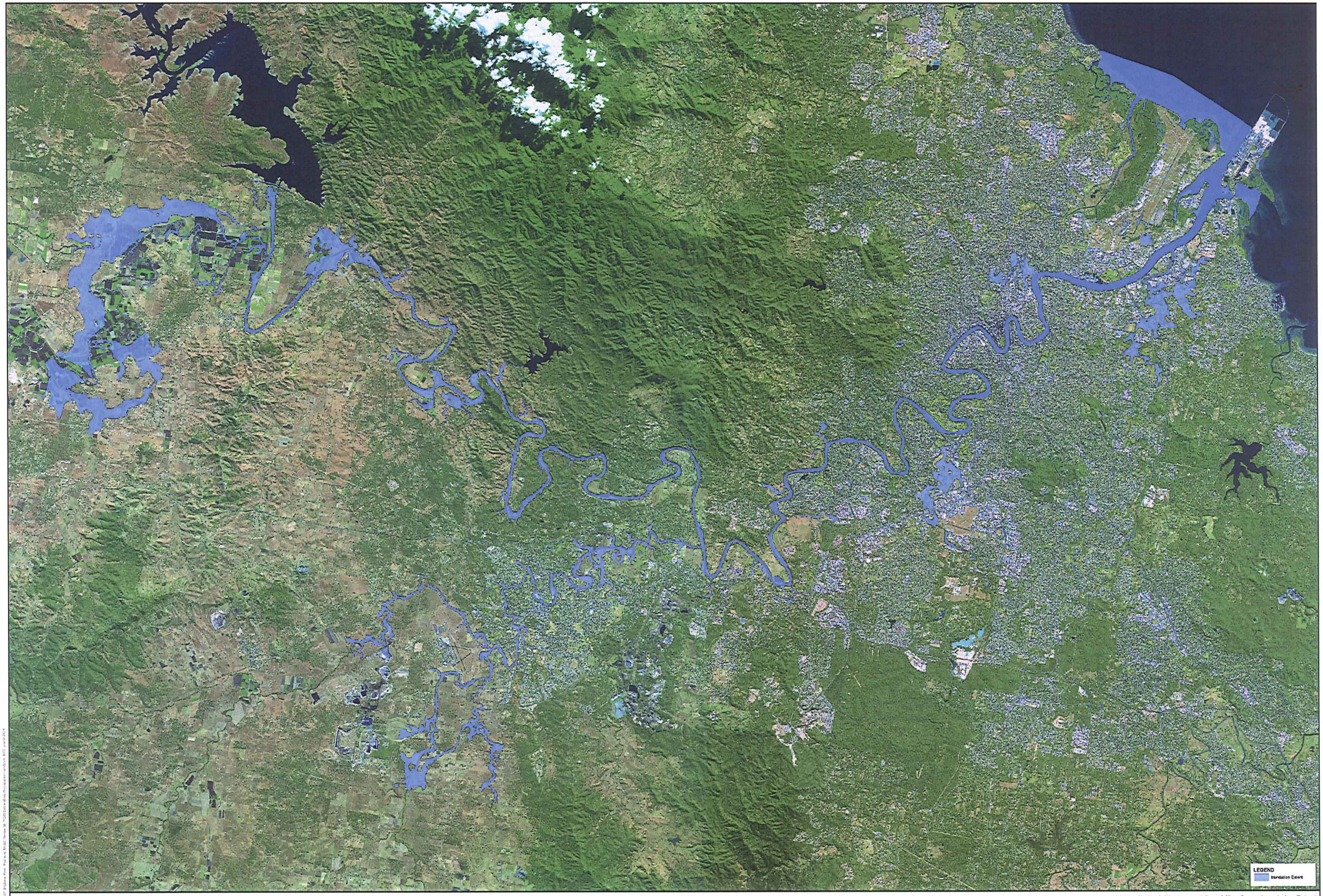


3,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - South

Figure 103

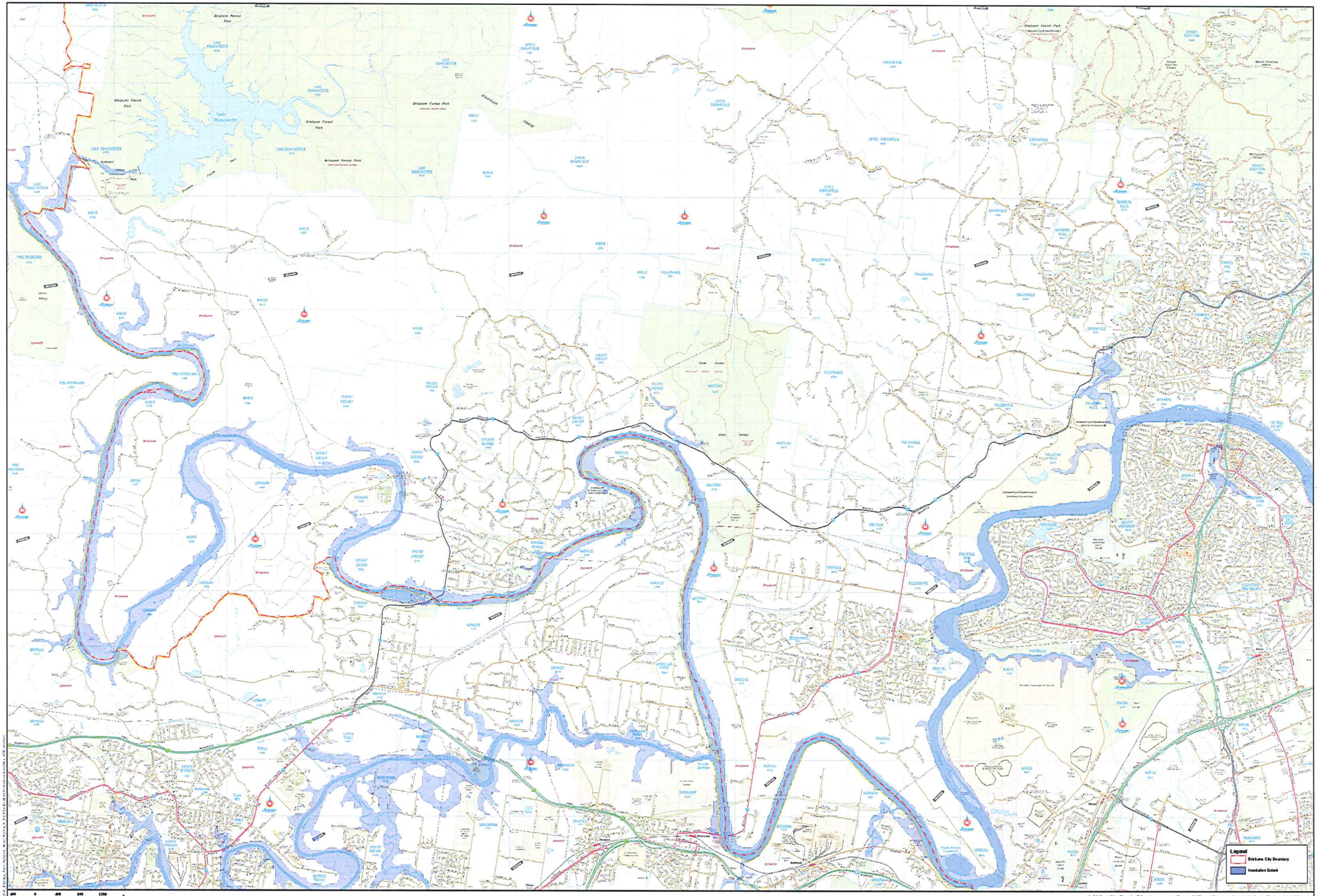
3,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - East

Figure 104



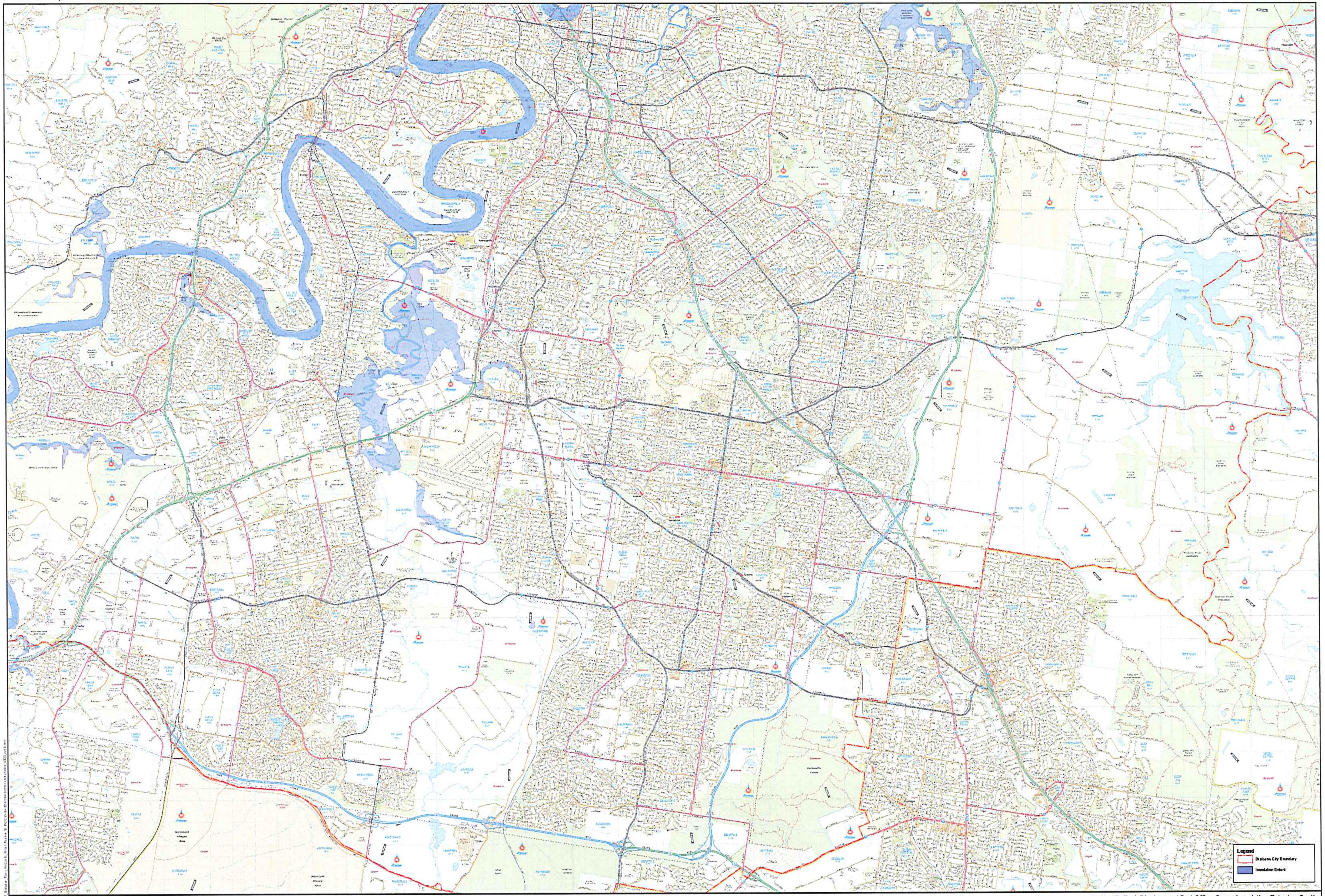
4,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents

Figure 105



4,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - West

Figure 106

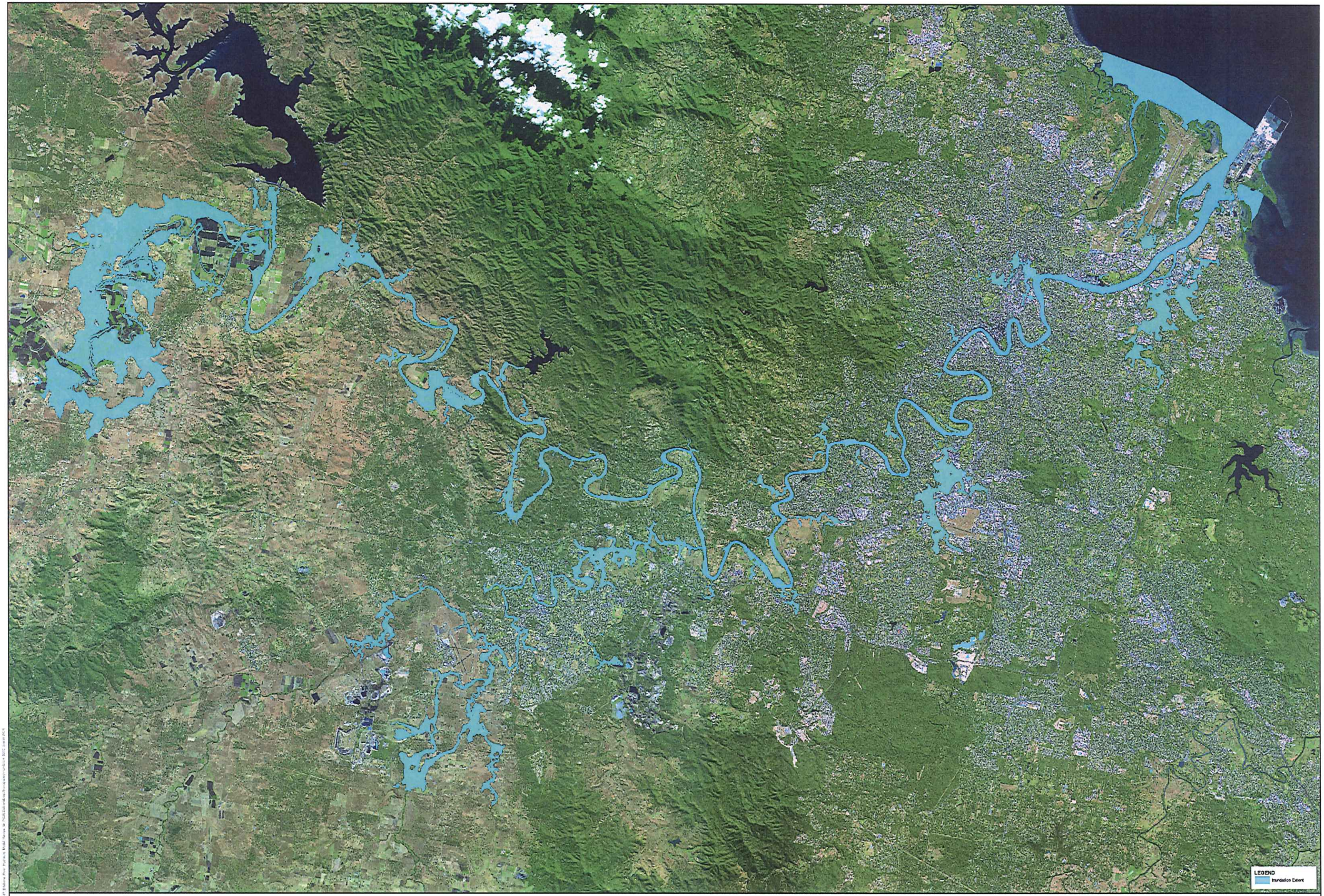


4,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - South

Figure 107

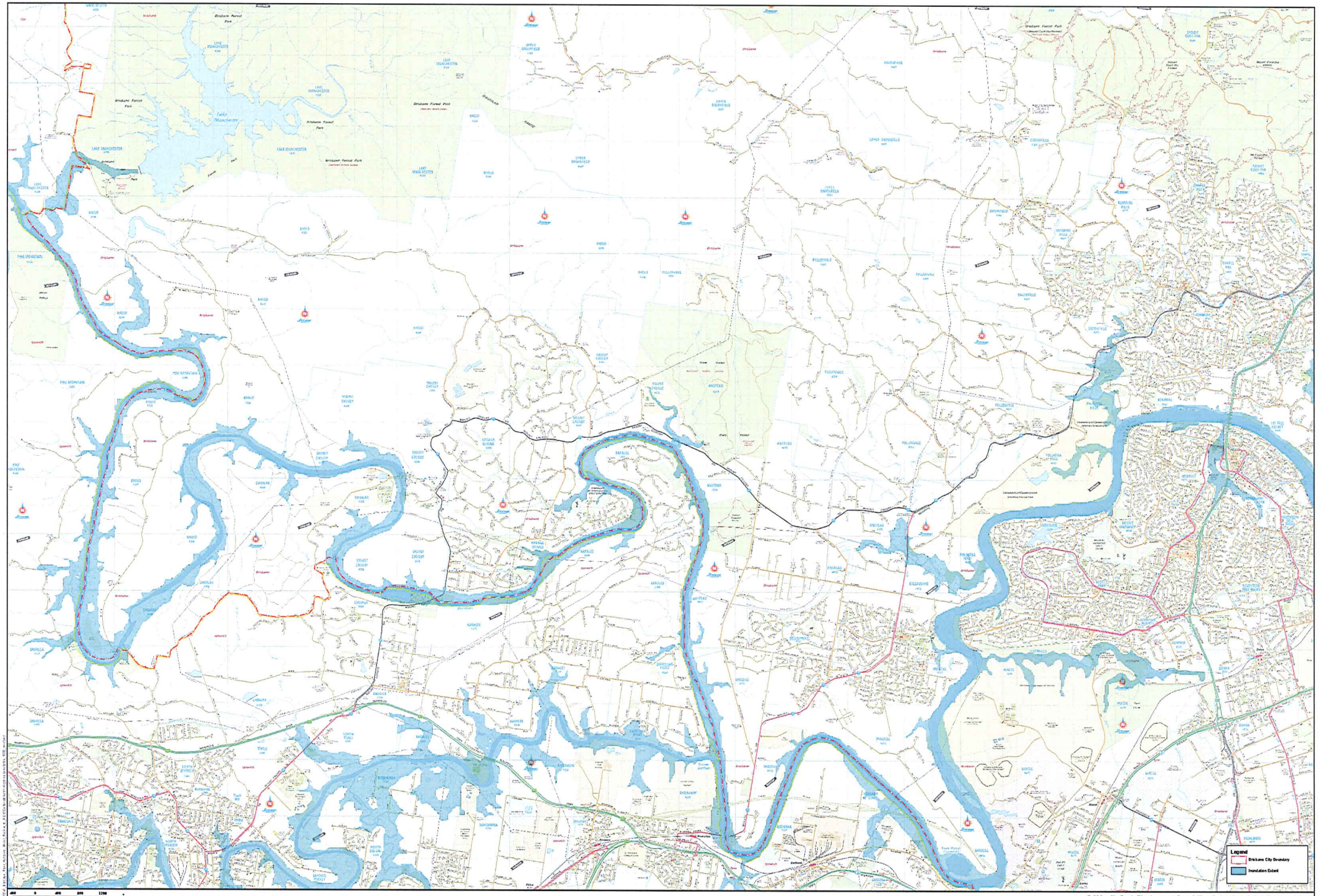
4,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - East

Figure 108



5,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents

Figure 109



5,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - West

Figure 110

5,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - South

Figure 111

5,000 m³/s Peak Discharge at Port Office Gauge Inundation Extents - East

Figure 112