IN THE MATTER OF
THE QUEENSLAND FLOODS COMMISSION OF INQUIRY

A COMMISSION OF INQUIRY UNDER THE COMMISSIONS OF INQUIRY ACT 1950

AND PURSUANT TO COMMISSIONS OF INQUIRY ORDER (No. 1) 2011

STATEMENT OF JOHN TIBALDI

I, **John Tibaldi**, of C/- 240 Margaret Street, Brisbane, say as follows:

1. I am currently employed by Queensland Bulk Water Supply Authority ("**Seqwater**") as Principal Engineer, Dam Safety.

Qualifications and Experience

2. I hold the following qualifications:

   (a) Bachelor of Engineering (Hons) (Civil), James Cook University.

   (b) Graduate Certificate in Electrical and Electronic Engineering, University of Southern Queensland.

   (c) Graduate Diploma of Maintenance Management, Central Queensland University.

   (d) Postgraduate Diploma in Environmental Impact Assessment, Murdoch University.

   (e) Bachelor of Business, University of Southern Queensland.

   (f) Graduate Diploma in Commercial Computing, Queensland University of Technology.

   (g) Certificate IV in Workplace Assessment and Training, OLI.

3. I have been registered as a Professional Engineer in Queensland since 1989.

4. My employment history may be summarised as follows:

[redacted] [redacted]

(a) Since 2008, I have held my present position at Seqwater as Principal Engineer, Dam Safety. That role has involved:

(i) The establishment and management of Seqwater's Dam Safety Management Program.

(ii) The management of Seqwater's Hydrologic and Hydrographic Units.

(iii) Management of the preparation of Resource Operations Plan Reports for Seqwater.

(iv) The management of Seqwater's Seismic Monitoring Unit.

(b) From 2007 to 2008, I was employed by SunWater Limited ("**SunWater**") as Manager, Project Development. That role involved:

(i) The establishment of SunWater's portion of the Queensland Regional Water Infrastructure program for dam upgrade and construction work.

(ii) Management of the preparation of preliminary designs (including flood and yield hydrology reports), Environment Impact Statements, Cultural Heritage Management Plans and preliminary business cases for dam upgrade and construction projects.

(c) From 2006 to 2007, I was Acting Technical Services Manager at SunWater. In that role, I was responsible for the ongoing management of SunWater's Dams and Water Supply Schemes throughout Queensland in relation to all aspects of asset management, dam safety, environmental management and land management.

(d) From 1995 to 2006, I was an Operations Manager at SunWater. That role involved:

(i) The management of the operation and maintenance of thirteen major water supply dams (seven of which had gated spillways), forty-eight weirs, and hundreds of kilometres of channels, pipelines and drains.

(ii) The management of ten SunWater Irrigation Projects across Southern Queensland, covering an area extending as far west as St George.

(iii) The management of facility management contracts, including the Seqwater contract for the management of Wivenhoe, Somerset and North Pine Dam, management of the Assets of the Border Rivers Commission including

[redacted] [redacted]

Glenlyon Dam and the management of Scrivener Dam which forms Lake Burley Griffin in Canberra.

(e) From 1993 to 1994, I was the Senior Policy Officer, Water Industry Strategy Unit at the Department of Primary Industries. That role involved:

(i) Assisting in the development of an irrigation water pricing policy.

(ii) Assisting in the development of a water for the environment policy.

(iii) Developing an annual program of projects for National Landcare Funding for projects related to bulk water supply.

(f) From 1990 to 1993, I was Manager (Stream Control), Brisbane District at the Water Resources Commission. That role involved:

(i) The approval and management of Waterworks Licenses for works affecting regulated and unregulated streams.

(ii) The approval and management of in-stream quarry material operations.

(iii) Being chairperson for the District's Rural Water Boards and responsible for the District's Water Advisory Committees.

(iv) The prosecution of breaches of the Water Resources Act in relation to unapproved works and water diversions impacting on streams.

(g) From 1983 to 1990, I was an Engineer with the Water Resources Commission at localities including Innisfail, Ayr, Mackay and Brisbane. That role involved:

(i) The investigation, design and construction of water distribution works (dams, weirs, water supply channels, pipelines, drains and pump stations) associated with bulk water supply and drainage projects.

(ii) Providing engineering support for the operation, maintenance, and management of water supply schemes and projects owned and operated by the Water Resources Commission.

5. I am one of the Flood Operations Engineers approved by the Chief Executive of the Department of Environment and Resource Management ("**DERM**") to direct the operations

[redacted] [redacted]

of the Wivenhoe, Somerset and North Pine dams during flood operations. I commenced work as a Flood Operations Engineer in 2008.

6. Between 2008 and the January 2011 Flood Event, I worked as a Flood Operations Engineer in 16 flood events. I found that experience valuable in managing the January 2011 Flood Event.

7. Prior to 2007, I gained considerable site experience in the operation of gated dams during flood events, including at Wivenhoe dam.

The January 2011 Flood Event

8. In this statement, references to the January 2011 Flood Event are to the events that impacted the Wivenhoe, Somerset and North Pine dams in the period Thursday, 6 January 2011 to Wednesday, 19 January 2011.

The Flood Operations Centre During the January 2011 Flood Event

9. During a flood event, flood operations are conducted from a Flood Operations Centre which is situated in SunWater's premises at 179 Turbot Street, Brisbane.

10. During the January 2011 Flood Event, the Flood Operations Centre was staffed 24 hours a day by at least one Flood Operations Engineer and at least one Flood Officer.

11. In general terms, the Flood Operations Engineers are responsible for directing flood operations and the Flood Officers are responsible for administrative tasks such as keeping the Event Log, answering the telephone, sending faxes and filing incoming and outgoing correspondence.

12. During the course of the event staffing levels were increased so that:

    (a) From 7pm on Sunday, 9 January 2011 until 7pm on Thursday, 13 January 2011, there were at least two Flood Operations Engineers on duty at a time.

    (b) From 7am on Tuesday, 11 January 2011 until 7pm on Wednesday, 12 January 2011, there were at least two Flood Officers on duty at a time.

13. On occasions during the event, Flood Operations Engineers and Flood Officers were present in the Flood Operations Centre providing assistance even though they were not rostered on duty.

14. The Flood Operations Engineers and Flood Officers were rostered on duty for 12 hour shifts. One shift was from 7am to 7pm. The other was from 7pm to 7am the next morning. The Flood Operations Engineers conducted handovers from one shift to the next. Those handovers involved the engineers who were coming off duty providing a briefing to those who were coming on duty.

15. Two of the engineers are designated Senior Flood Operations Engineers. The Senior Flood Operations Engineers are responsible for, amongst other things, setting the overall strategy for management of the flood event in accordance with the objectives set out in the approved Manual of Operational Procedures for Flood Mitigation. In order to preserve their privacy, I will refer to the Senior Flood Operations Engineers for the January 2011 Flood Event as Engineer 1 and Engineer 3. This is how they were referred to in the Flood Event Reports discussed below. For the purposes of the January 2011 Flood Event, I understood that Engineer 1 took responsibility as the primary Senior Flood Operations Engineer. Engineer 1 is an employee of SunWater and his services were provided to Seqwater pursuant to a contract between SunWater and Seqwater. Engineer 3 is employed by DERM.

16. To preserve his privacy, I will refer to the other Flood Operations Engineer who staffed the Flood Operations Centre during the event as Engineer 2. This is how he was referred to in the Flood Event Reports discussed below. Engineer 2 is employed by Seqwater.

17. I am referred to in the Flood Event Reports discussed below as Engineer 4.

Flood Event Reports

18. A Flood Event Report dated 2 March 2011 has been prepared in respect of the events impacting the Wivenhoe and Somerset dams.

19. A Flood Event Report dated 11 March 2011 has been prepared in respect of the events impacting the North Pine dam.

20. I was heavily involved in the preparation of each of those Flood Event Reports. Engineers 1, 2 and 3 were also involved in their preparation. They were prepared within a strict time limit in accordance with regulatory requirements.

21. Generally, the Flood Event Reports provide a fair and accurate account of the events in which I was involved during the January 2011 Flood Event.

22. An error appears in the Wivenhoe and Somerset Flood Event Report in the Event Summary at page 22. In the final dot point in the fifth column, reference is made to a conversation that

[redacted] [redacted]

occurred between Engineer 1 and the Dam Safety Regulator at 9pm on Monday, 10 January 2011 as follows:

> At 21:00, the Dam Safety Regulator was asked for permission to exceed a level of 74.0m in Wivenhoe Dam for a short period (maximum 12 hours) without invoking Strategy W4, provided the safety of the Dam could be guaranteed. The Regulator agreed with this approach and provided permission.

23. I wrote this part of the report. However, I was not a party to the conversation between Engineer 1 and the Dam Safety Regulator. Since the provision of the report to DERM on 2 March 2011, it has been pointed out to me that it was incorrect to say that the Regulator "provided permission" and I understand that the report should have said that the Regulator "agreed with this approach, but should the situation actually arise, he should be contacted again to obtain final agreement prior to proceeding".

24. There are also some inaccuracies in the account recorded in the Flood Event Log which appears as Appendix M to the Wivenhoe and Somerset Flood Event Report. Those inaccuracies are to be expected given the way in which the Flood Event Log is compiled.

25. I agree with the recommendations contained in Sections 16 and 20 of the Wivenhoe and Somerset Flood Event Report and Section 12 of the North Pine Flood Event Report.

Flood Event Log

26. The Flood Event Log is maintained electronically by the Flood Officer on a computer in the Flood Operations Centre. It provides a contemporaneous record of significant events that occur during a flood event. It is particularly useful as a record of the times at which communications occurred with particular agencies or people. However, because the Flood Officer is recording what he or she observes or hears, which may be only one side of a telephone conversation between the Flood Operations Engineer and someone else, it does not always provide a complete and accurate account of what occurred.

The Manual

27. The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7, November 2009) (the "**Manual**") was approved by the Chief Executive under the *Water Supply (Safety and Reliability) Act 2008* (Qld). It defines the procedures for the operation of Wivenhoe dam and Somerset dam during Flood Events.

28. The objectives set out in the Manual, in descending order of importance, are:

- Ensure the structural safety of the dams.

[redacted] [redacted]

- Provide optimum protection of urbanised areas from inundation.
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers.
- Retain the storage at Full Supply Level at the conclusion of the Flood Event.
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

29. The Manual sets out four strategies (W1 to W4) which are used when operating Wivenhoe dam during a Flood Event. Those strategies are based on the objectives set out above.

30. The Manual provides that the spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25.

31. From that point, the strategy to be adopted depends upon whether the particular conditions set out in the Manual for the adoption of a particular strategy are met.

32. Under Strategy W3, the primary consideration is protecting urban areas from inundation. The conditions for the adoption of that strategy are set out on page 28 of the Manual as follows:

- Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD.
- Maximum Release should not exceed 4,000m^3/s.
- The primary consideration is protecting urban areas from inundation.
- Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance.

The intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s, noting that 4,000m^3/s at Moggill is the upper limit of non-damaging floods downstream...

33. Under Strategy W4, the primary consideration is protecting the structural safety of the dam. The conditions for the adoption of that strategy are set out on page 29 of the Manual as follows:

- Wivenhoe Storage Level predicted to exceed 74.00m AHD.
- No limit on Maximum Release Rate.
- The primary consideration is protecting the structural safety of the dam.
- Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance.

[redacted]

> The intent of Strategy W4 is to ensure the safety of the dam while limiting downstream impacts as much as possible.
>
> This strategy normally comes into effect when the water level in Wivenhoe Dam reaches 74.00m AHD. However, the Senior Flood Operations Engineer may seek to invoke the discretionary powers of Section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.
>
> Under Strategy W4 the release rate is increased as the safety of the dam becomes a priority...
>
> There are no restrictions on gate opening increments or gate operating frequency once the storage level exceeds 74.0 AHD, as the safety of the dam is of primary concern at these storage levels. However, the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered when determining gate opening sequences.

Strategy W3

34. At about 8.00am on Saturday, 8 January 2011, Strategy W3 was adopted.

Strategy W4

35. Prior to the January 2011 Flood Event, Wivenhoe dam had never been operated under Strategy W4.

36. The adoption of Strategy W4 is a very serious step.

37. If you are going to ramp up releases from Wivenhoe dam as contemplated by Strategy W4, you are necessarily going to be putting water over the floor of habitable dwellings in urban areas. It is not a step you would take lightly. You would only take this step if no other option was available. Before taking such a serious step, you would want to know with a sufficient degree of certainty that it is actually necessary.

38. Engineer 2 and I made the decision to adopt Strategy W4 at about 8am on Tuesday, 11 January 2011. Before explaining the circumstances in which that decision was made, it is necessary to explain some things about flood models and rainfall forecasts.

39. Flood Operations Engineers produce computer generated flood models which assist in making operational decisions about dam releases. Although I am not a hydrologist, I am familiar with the characteristics of the models and their limitations. I routinely run and interpret the models during flood operations.

40. A model produces a prediction based on the available data. There are a number of variables or uncertainties in the input data and model parameters which mean that there is a degree of uncertainty as to the accuracy of the predicted result.

41. One such input is the rain which is recorded as having actually fallen in the catchment. This data is subject to a number of uncertainties.

42. Across a catchment as large as the Brisbane River basin (approximately 14,000 square kilometres) the rain gauges which record the rainfall cannot be guaranteed to always present a completely accurate picture of the intensity and distribution of rainfall.

43. Rain is often distributed unevenly across a catchment, which gives rise to uncertainty depending upon the location of particular gauges. It is possible that rain could be falling more intensely between gauges, such that the readings might understate actual rainfall. On the other hand, rain could be falling more intensely over gauges, such that the readings might overstate actual rainfall.

44. Further, the models have to predict how the rain that has fallen across the catchment is going to flow into the dam. This depends upon the terrain that the water has to flow through and the vegetation and land use arrangements associated with that terrain. The models predict this based on calibration to historical flows. However, vegetation and land use patterns can change over time, which can alter the way in which, and the speed with which, the water flows. Additionally, available stream height and rainfall inputs can vary between present and historical events. These issues provide another source of uncertainty.

45. The result is that the predictions of flood models based on recorded actual rainfall probably have an average margin for error in the order of plus or minus 5%-10%. In some instances larger errors may be experienced. The results of flood models have to be interpreted with this in mind, especially when making decisions as important as transitioning to Strategy W4. In most cases, a single model run predicting that the dam will just reach 74.00 m AHD at a particular point in the future would not be regarded as providing sufficient certainty to justify the adoption of Strategy W4. Faced with a single model run like this, you still have to ask whether the model is telling you that you really have no other option than to transition to Strategy W4. The very real risk is that you will ramp up releases and cause flooding that you did not need to.

46. Flood models are also run on a basis which incorporates rainfall forecasts received from the Bureau of Meteorology ("**BOM**"). These results are reported as "with forecast". However, operational decisions about dam releases are not made on the basis of these "with forecast" results. The "with forecast" results are too uncertain to provide a basis for making such decisions. This is in no way a criticism of BOM. It simply reflects the well understood limitations of rainfall forecasts. BOM itself recognises these limitations. In 2006, and again

in December 2010, BOM was asked to comment upon the possibility of making pre-releases based on forecasts. Annexed to this statement and marked "JT-1" is a true copy of an email from Peter Baddiley of BOM to Rob Drury of Seqwater dated 1 December 2010, together with the attached document entitled "Rainfall Forecasting for the Wivenhoe Dam Catchment".

47. The purpose of running models on the "with forecast" basis is to give us an idea of what is possible over coming days so that we can see whether we might have to get into the next strategy at some point in the next few days, and so that we can provide advance warning to Councils and other agencies as to how serious the situation might become in the next few days. That advance warning as to what might happen in the next few days assists in emergency planning which might, for example, involve the closure of roads or the mobilisation of emergency resources.

48. Against this background, the suggestion that releases from Wivenhoe dam should have been ramped up by, or from about, the night of Sunday, 9 January 2011 is in my view without foundation. The ramping up of releases at that time, based on the information available at that time, would have been contrary to the Manual, and contrary to what I would regard as sound practice.

49. At 7.00pm on Sunday, 9 January 2011, the predicted peak of Wivenhoe dam was 72.1 m AHD, and the predicted peak flow at Moggill was 3,300m^3/s. By 3.00pm on Monday, 10 January 2011, the first of the two distinct flood peaks experienced during the January 2011 Flood Event had entered the dam. At that time, the predicted peak of Wivenhoe dam was 73.6 m AHD, and the predicted peak flow at Moggill was 3,910m^3/s. If the second of the two distinct flood peaks (which had not been forecast) had not occurred on Tuesday, 11 January 2011, the flood event would have been contained without exceeding the threshold for urban damage of 4,000m^3/s at Moggill. If releases had been ramped up during this period, that would have involved making releases which would have exceeded the threshold for urban damage of 4,000m^3/s at Moggill. It would have involved making releases of the kind contemplated by Strategy W4 before the conditions for adopting Strategy W4 were met. If the second of the two distinct flood peaks had not occurred, the ramping up of releases during this period would have inundated urban areas when that was unnecessary.

50. The first time that any model run (excluding forecast) predicted that the level of Wivenhoe dam would exceed 74.0 m AHD was Run 35 conducted at around 4.00am on Tuesday, 11 January 2011. I was advised of the results of this model run at the commencement of my shift

[redacted] [redacted]

on Tuesday, 11 January 2011 and noted that there was a possibility that the level in Wivenhoe dam may reach or exceed 74.0 m AHD.

51. I was due to commence my shift, with Engineer 2, at 7.00am on the morning of Tuesday, 11 January 2011. Both Engineer 2 and I went into the Flood Operations Centre half an hour or so prior to 7am.

52. Following shift handover, we recognised that heavy rainfall had commenced in the Wivenhoe Dam catchment. We quickly completed a new model run. Annexed to this statement and marked "JT-2" is a true copy of Run 36 which bears the time 7.00am. It predicted that the dam would reach 74.35 m AHD.

53. Based on the rain that had fallen that morning, and these consecutive model runs, I was sufficiently certain that we had no option but to move to Strategy W4. Between 7am and 8am, we started preparing for that to occur and confirmed our streamflow and rainfall estimates by discussion between ourselves and with the BOM.

54. Another model run was conducted, which confirmed that the level in Wivenhoe dam would exceed 74.0 m AHD. Annexed to this statement and marked "JT-3" is a true copy of Run 37 which bears the time 8.00am. It was at about this time that we formally decided to adopt Strategy W4.

Statements about Forecasts in Flood Report

55. The Wivenhoe and Somerset Flood Event Report contains statements:

(a) (at, for example, p iii) that:

> Rainfall forecasts in the early stages of the Event did not support flood releases being made from Wivenhoe Dam greater than those that occurred.

(b) (at, for example, p 18) that:

> Although there was a full awareness of the rainfall forecasts and associated potential flood impacts, the strategy was not to release flows that would cause high level urban inundation until it was certain it could not be avoided.

56. I wrote these statements, which are true.

57. However, they were not intended to convey that operational decisions about dam releases were in fact made on the basis of forecasts. As I have explained, they were not. I also never intended any criticism of BOM by these statements. I have great respect for the BOM and its


officers and have only praise for the services they provide which I consider to be in accordance with best practice in all areas.

58. My purpose in writing these statements was to respond to suggestions which had been made in the press to the effect that Seqwater had failed to act despite the forecast of significant rainfall. In this regard, there are two points I would make. The first is that, as I have said, it is well recognised (including by the BOM) that forecasts do not provide a sound basis for making operational decisions about dam releases. The second is that, even if it were appropriate to use forecasts as a basis for making such decisions, the actual forecasts produced by the BOM at the time did not support making releases greater than those that were in fact made.

Suggestion that there was unused capacity within the dams

59. There have also been suggestions in the press that there were large volumes of flood storage capacity in Wivenhoe and Somerset dams, in the order of 690,000 ML, which should have been used, but were not.

60. In my view, these suggestions are without foundation. Before you get to the upper limit of the dams' nominal flood storage capacity, the Manual requires you to transition to a strategy to protect the structural safety of the dam. To allow Wivenhoe dam to fill to its upper limit without transitioning to Strategy W4 would both contravene the Manual and pose a very serious risk to the structural safety of the dam with potentially catastrophic consequences. This would be an inappropriate approach to the management of an extreme hazard dam having a population at risk in the event of failure of many thousands of people.

61. In fact, to guard against this risk of failure of Wivenhoe dam, fuse plugs have been constructed which would be triggered before the dam reached that upper limit, thus increasing the flow of water from the dam.

Strategy W2

62. It has been suggested that there may potentially have been non-compliance with the Manual because Strategy W2 was bypassed. In my view, that suggestion is incorrect because:

(a) In a practical sense, it is not possible to implement Strategy W2 unless the intent of this Strategy can be met.

(b) In this case, the intent of Strategy W2 that requires limiting the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill could not be


met and therefore it was simply not possible to invoke Strategy W2 in a practical sense.

(c) The Manual does not prevent the adoption of Strategy W3 as soon as its conditions are met.

4,000 m^3/s at Moggill

63. As I have noted above, the Manual provides that the upper limit for non-damaging floods downstream is 4,000 m^3/s at Moggill.

64. As recorded in the Flood Event Log, at about 12.45am on Monday, 10 January 2011, the Brisbane City Council (the "**BCC**") called Engineer 3 and asserted that the upper limit was in fact lower than that.

65. I heard about this when I went to the Flood Operations Centre for the 7.00am shift on Monday, 10 January 2011. This was the first time I had heard any suggestion that the BCC held this view.

66. I was surprised to hear this. The Manual has always provided for a threshold of 4,000 m^3/s at Moggill, and the BCC is one of the parties provided with a controlled copy of the Manual. I was involved in the last review of the Manual, and the BCC was briefed on this review. Annexed to this statement and marked "JT-4" is a true copy of the agenda and minutes of a meeting which I chaired on 22 December 2009 that was attended by, amongst others, the Principal Engineer, Water and Environment from the BCC. Annexed to this statement and marked "JT-5" is a true copy of a PowerPoint presentation I gave during the meeting.

67. At about 9.38am on Monday, 10 January 2011, I participated in a conference call with the BCC about this issue. I did not think we could ignore it. For five hours after this call, we attempted to accommodate the BCC's concerns by maintaining the flow at Moggill at or below 3500 m^3/s, in accordance with Strategy W3 that requires protecting urban areas from inundation. However, by 2.30pm we decided that it was no longer possible to limit the flows to this level and we proceeded on that basis.

68. I do not know what the true threshold at Moggill is. This obviously needs to be resolved.

Gate closure

69. It has been suggested that there may potentially have been non-compliance with the Manual because the gates at Wivenhoe dam were closed too fast. In my view that is incorrect because

[redacted] [redacted]

the Manual does not limit the speed with which the gates can be closed where that reduces downstream flooding as occurred in this case.

Signed by **John Tibaldi** in the presence of: 25 March 2014.

[redacted]
Witness Signature

[redacted]
Signature

[redacted]
Print Name

IN THE MATTER OF
THE QUEENSLAND FLOODS COMMISSION OF INQUIRY

A COMMISSION OF INQUIRY UNDER THE
COMMISSIONS OF INQUIRY ACT 1950

AND PURSUANT TO
COMMISSIONS OF INQUIRY ORDER (No. 1) 2011

STATEMENT OF JOHN TIBALDI

INDEX OF ANNEXURES

[redacted] [redacted]

"JT-1"

Hughes, James

From: Peter Baddiley [redacted]
Sent: Wednesday, 1 December 2010 9:44 AM
To: Rob Drury
Subject: FW: Forecasting rainfall in Wivenhoe Dam catchment [SEC=UNCLASSIFIED]
Follow Up Flag: Follow up
Flag Status: Red
Attachments: Response to Meeting with Chris Russell.doc

Rob
A small miracle - I found the Bureau's 2006 response/advice regarding forecasting rainfall for the Wivenhoe catchment.

As briefly discussed today, whilst weather prediction models are steadily improving, the forecast of rainfall amounts over catchment time/space scales is recognised as one of the most challenging/difficult tasks. Detailed rainfall forecasting is not deterministic - the uncertainties involved are often expressed in probablistic forecasts, an example of which is at our website at: http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp . Click on the "chance of rainfall' radio button.

regards, peter

Peter Baddiley
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From: Peter Baddiley
Sent: Monday, 24 July 2006 4:59 PM
To: [redacted]
Cc: Mike Bergin
Subject: Forecasting rainfall in Wivenhoe Dam catchment

Chris
As discussed with Mike on Friday, please find the attached. Apologies for the delay since our meeting of 6 July.

Please contact us if you require further information or clarification.

Regards, Peter

Peter Baddiley
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[redacted] [redacted]

Rainfall Forecasting for the Wivenhoe Dam Catchment

Background

1. On 6 July, Chris Russell, of Connell Wagner, met with Mike Bergin and Peter Baddiley seeking advice regarding the predictability of significant rain events over the Wivenhoe Dam catchment. Connell Wagner has been engaged by SEQWCo to provide advice on the feasibility of maintaining the water level in the Wivenhoe storage at one metre above Full Supply Level. As a part of the dam operations under that scenario, it would be required that the additional storage above FSL be released ahead of a major inflow into Wivenhoe Dam. This would require some 24 to 48 hour advance prediction of catchment average rainfalls in the order of 300mm in 24 hours; 375mm in 36 hours and/or 430mm in 48 hours.

2. Wivenhoe Dam catchment is located to the north-west of Brisbane and has an area of about 7,000 square kilometres. For meteorological forecasting, the catchment is broadly about 100 km in the north-south direction, and 70 kilometres wide (east-west); bounded in the west by the Dividing Range with its eastern boundary varying from about 40 to 80 kilometres inland from the coast. The distribution of rainfall over the catchment is significantly influenced by the topography in major events.

Discussion

3. As discussed at the meeting, the experience of Meteorologists and Hydrologists in the Brisbane office of the Bureau is that the short to medium term (0 to 48 hour) prediction of rainfall for the purpose of objective use in flood forecasting models is a difficult task. Quantitative Precipitation Forecasts (QPF) are available from the Australian and international Numerical Weather Prediction (NWP) models and have been used subjectively in the Brisbane office for many years. Whilst the NWP models have shown improvement in the accuracy of QPF over the past decade or so, there is still at times considerable error or uncertainty, in the prediction of the location, amount and timing of rainfall events at the catchment scale.

4. The improved skill of NWP models in recent years has particularly been in forecasting the development and movement of broad-scale synoptic features that would be likely to produce the threshold rainfall amounts in question. These large-scale features include decaying tropical cyclones, east coast low pressure systems and significant upper level troughs. However while these systems maybe well forecast on a time scale of 2 to 3 days the very heavy rainfall concentrations are dependent on finer scale (mesoscale) and convective features. Whilst there is often the ability to forecast the potential for a significant rain event to occur in the southeast Qld-northern NSW region, it is difficult (if not impossible) to predict the actual location of the heaviest rain, even with only a few hours notice.

5. Examples of high rainfall events that have occurred in the past 10 to 15 years in this region, some of which had little to no advance prediction of the "precise" location and/or magnitude of resulting rainfall, include Feb 1991, Dec 1991, Feb 1992, May 1996, Feb 1999, Mar 2001 and June 2005. Several of these events were not produced by large-scale features but by slow moving convergence zones which the current

modelling capability cannot adequately predict. The two most recent events in 2001 and 2005 were relatively short-lived events and occurred at different times of the day – 2001 in the afternoon and 2005 overnight. While one could reasonably expect that most really significant rainfall events are most likely through the warmer months, winter extreme events are by no means rare.

6. Considerable effort is being applied to derive improved deterministic and probabilistic QPFs from NWP models. In the near future, the Bureau will be providing a publicly available rainfall forecasting service via a website. The rainfall predictions will be generated automatically by combining the outlooks from a suite of Australian and international. Forecast rainfall amounts for 24 hour periods will be given for 4 days ahead, together with the chance of exceeding various amounts from 1mm to 50mm. The latter is a "pseudo" measure of probability based on the consistency in the forecast rain amounts given by up to eight NWP models used in deriving the rainfall forecast. Whilst it is not considered that this will provide a sufficiently accurate method for objective decision making for pre-releases from Wivenhoe Dam, the probabilistic rain forecasts may provide a basis for a risk management approach. There may need to be further studies on risk quantification for prediction of high to extreme rainfall events to support this approach. Given that there are large levels of uncertainty in rainfall forecasts, the forecasting of hydrological response may require an ensemble of future rain scenarios to be considered for the Wivenhoe Dam application.

7. As for a potential service provided by the Bureau an alert type product would seem to be the best alternative where the potential for an extreme rainfall event in the following 2 to 3 days across southeast Queensland was given a rating on say a 3 level scale. If that rating was high then a second phase could be activated which could provide more detailed forecast of expected rainfall amounts and location. However I emphasise that this type of service can be expected to not provide the required 2 days advice of an event on some occasions and may fail to provide anything more than a few hours notice, such is the nature of the predictability of the mesoscale components of these events.

8. Currently the Bureau provides a QPF service for the dams in Southeast Queensland. This twice-daily service predicts the average rainfall across the catchments in the following 24-hour period. We have not undertaken any verification of the service. However it is likely that verification would show reasonable skill in identifying rainfall events but quite poor skill in predicting extreme events. This service is to be reviewed in the next few months and we may commence charging for the product as it is essentially not a basic service and should not be publicly funded. We have yet to commence discussions with the client so these comments should be kept confidential. This issue is raised because any future customized product provided in support of dam operations will certainly be on a fee for service basis. There is also the issue of whether the Bureau would have the capacity to provide such a service at all and that would have to be part of any future discussions.

Summary

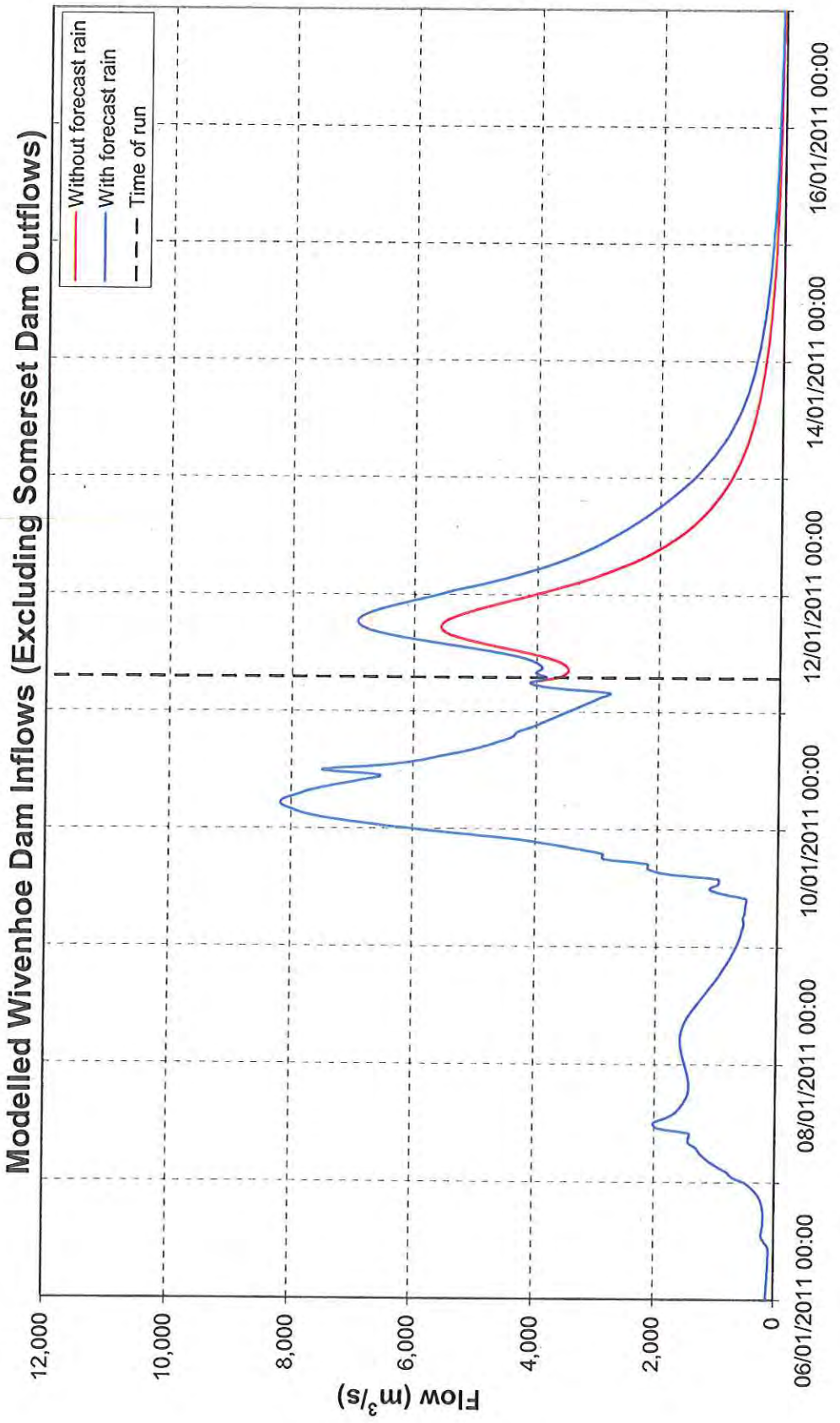
9. In light of the demand for water in southeast Queensland and the highly variable nature of rainfall in the area the project has many obvious attractions. However the capability of the science to provide sufficiently reliable 24 to 48 hour advance predictions of high catchment average rainfalls is limited. The Bureau would be willing to participate in future discussions on the subject and maybe able to assist with some service that would assist.

Mike Bergin
Manager Weather Services,
Bureau of Meteorology, Queensland.

Peter Baddiley
Supervising Engineer Hydrology
Bureau of Meteorology, Queensland

24 July 2006

"JT-2"



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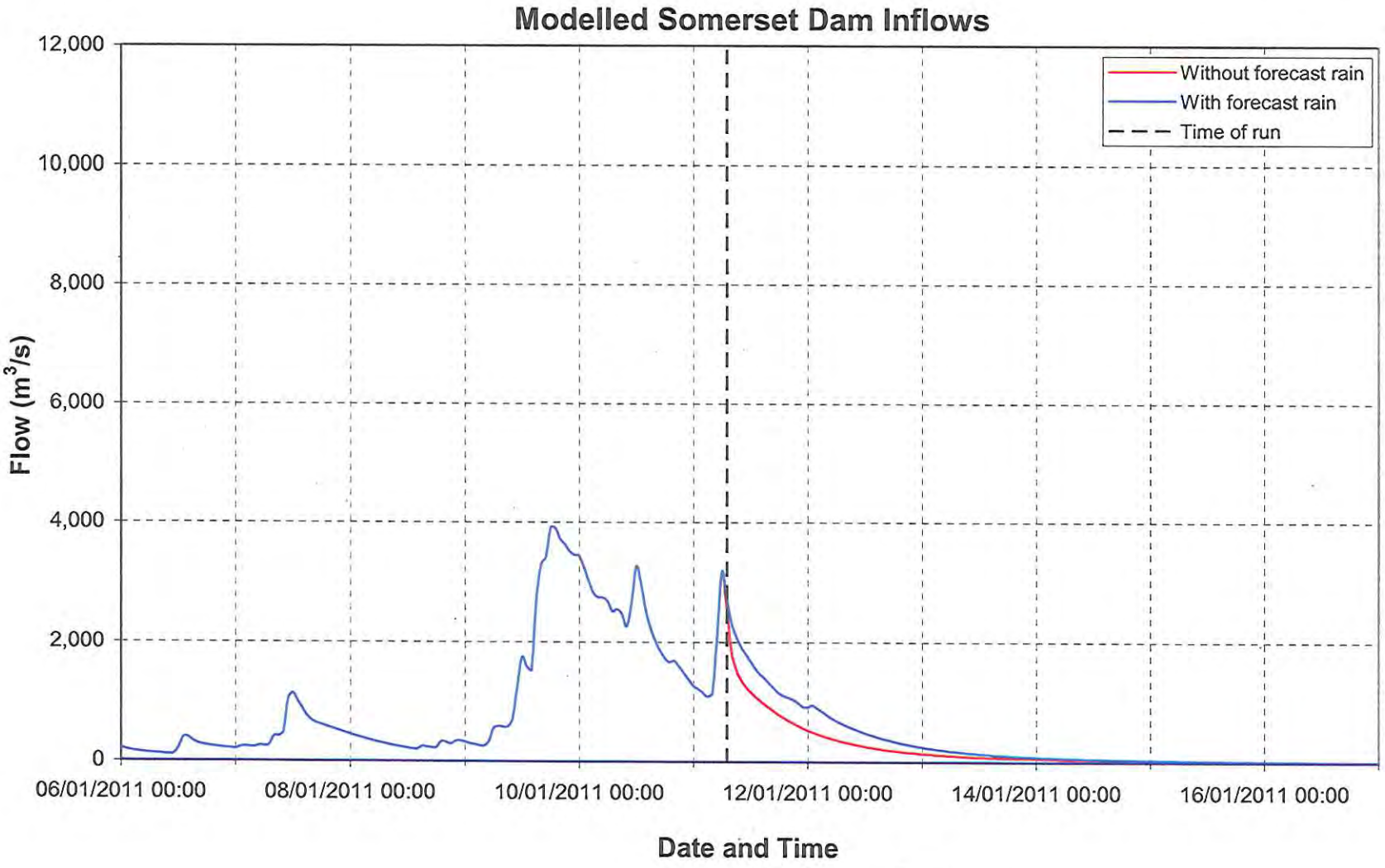
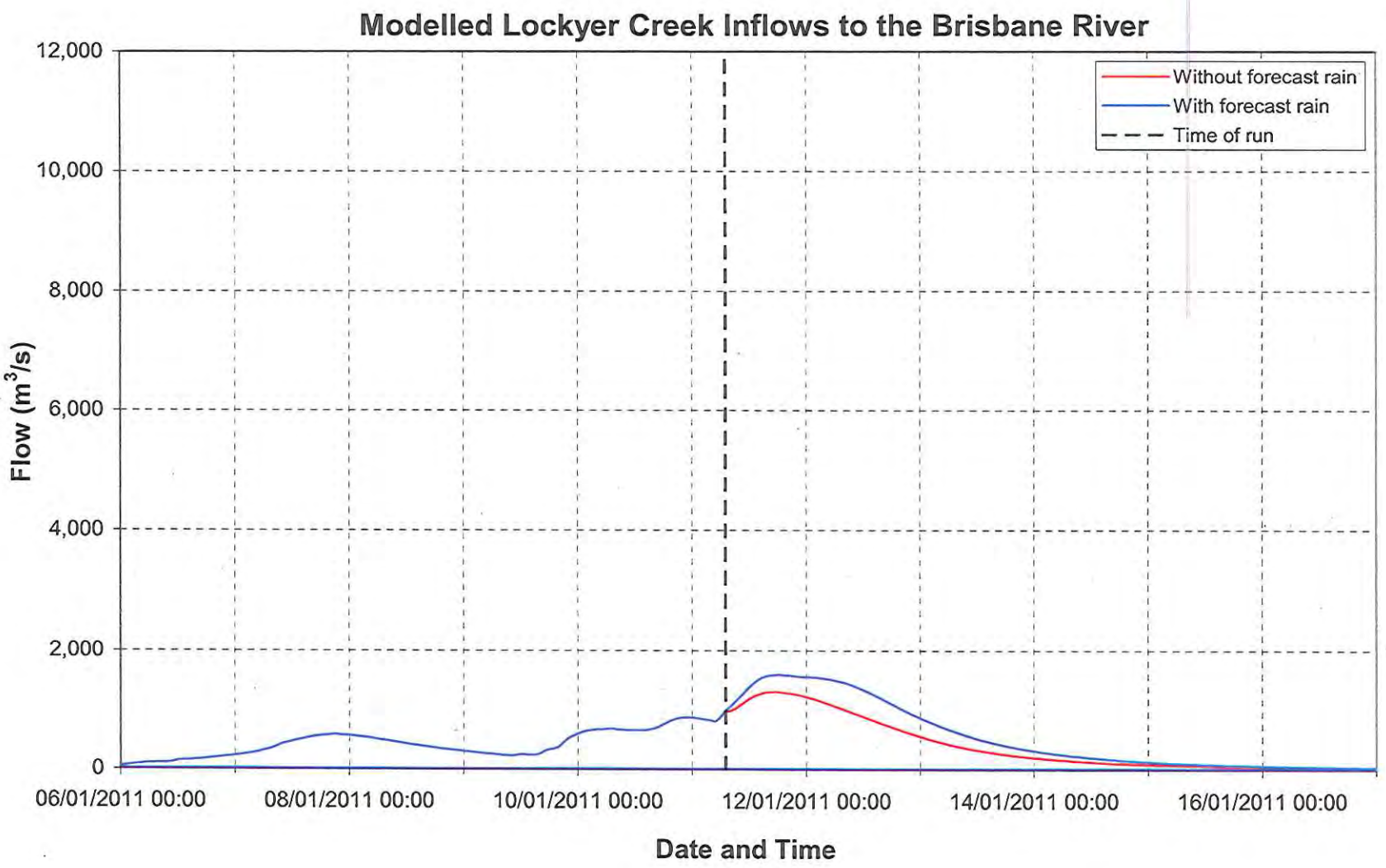
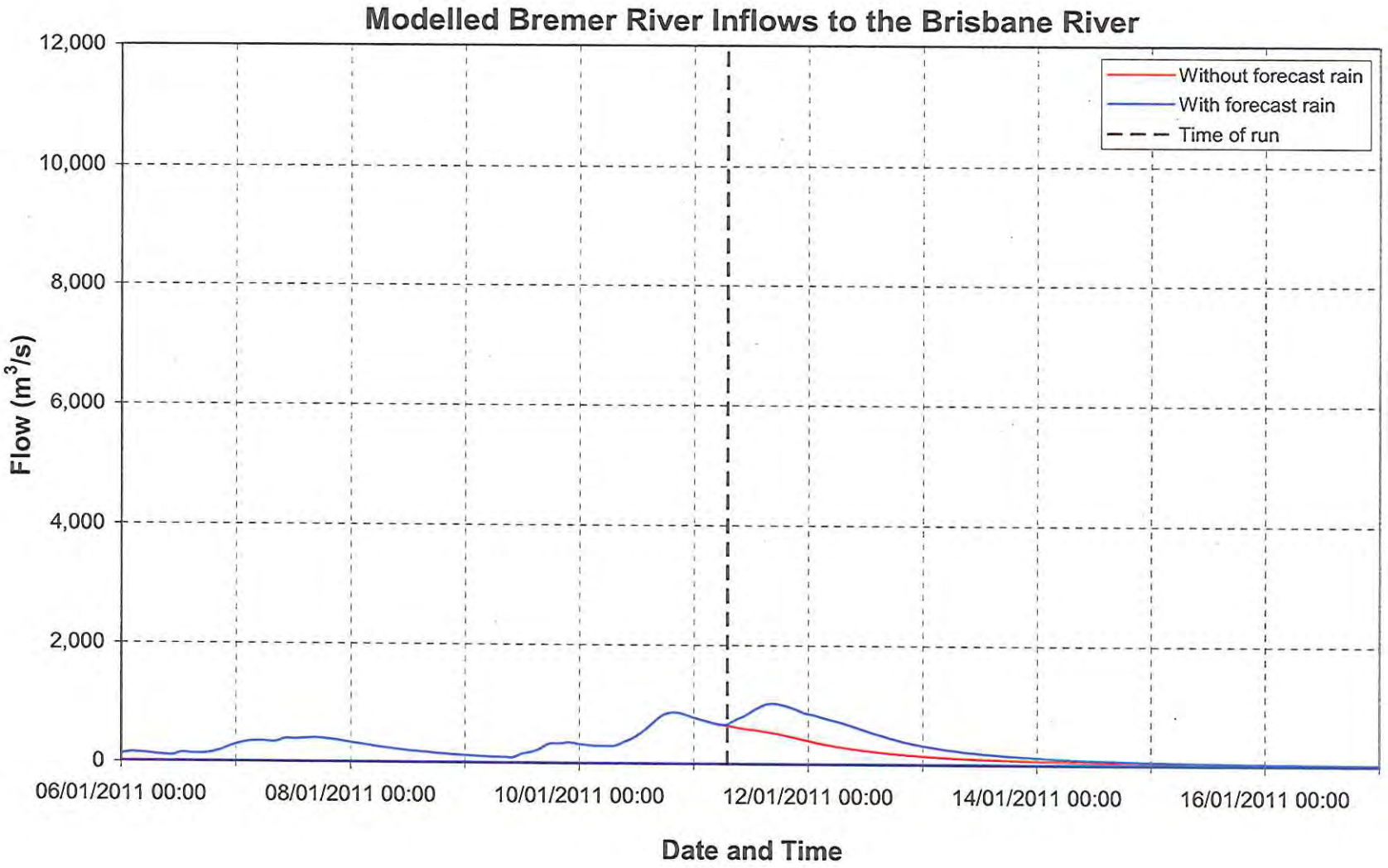
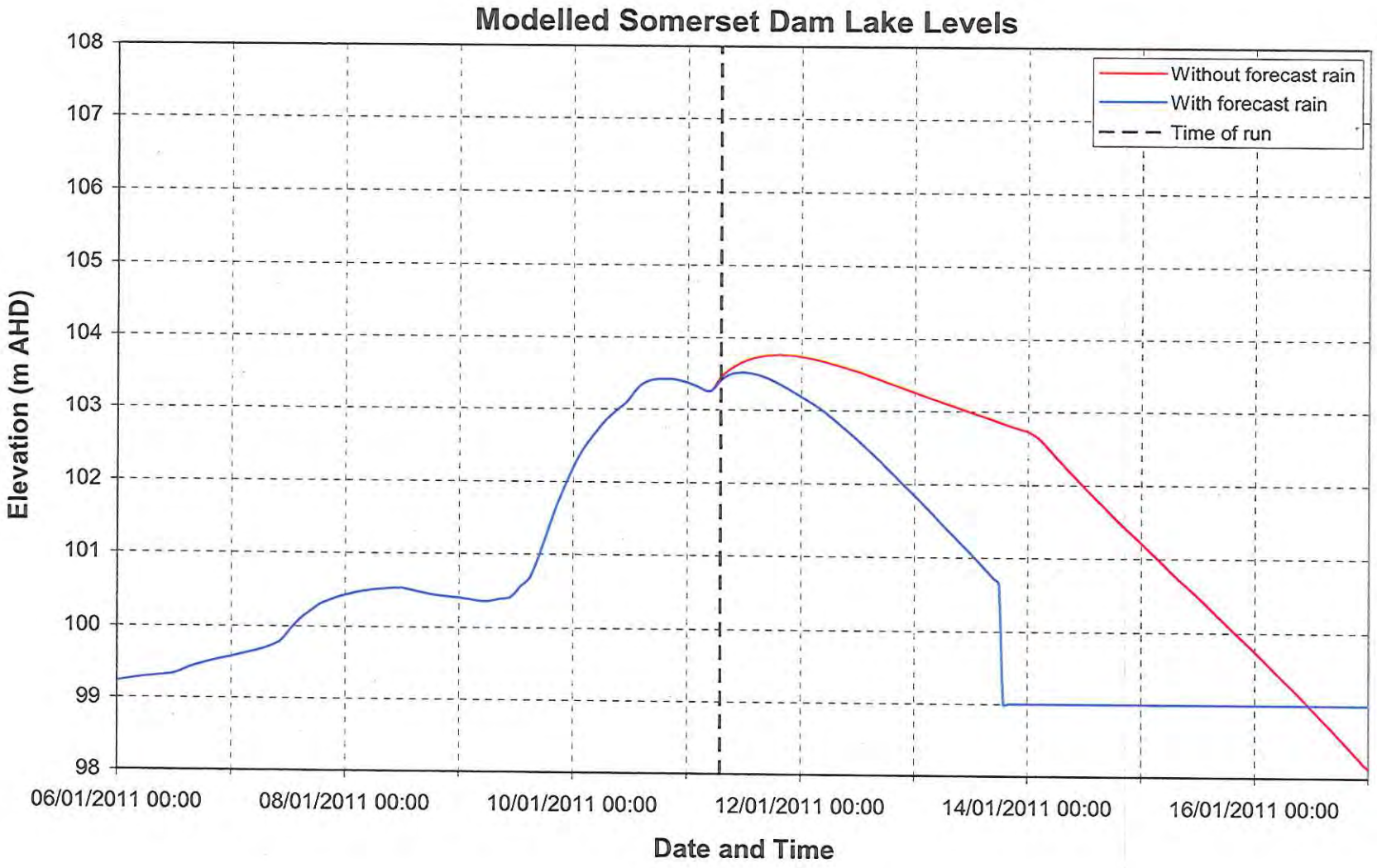
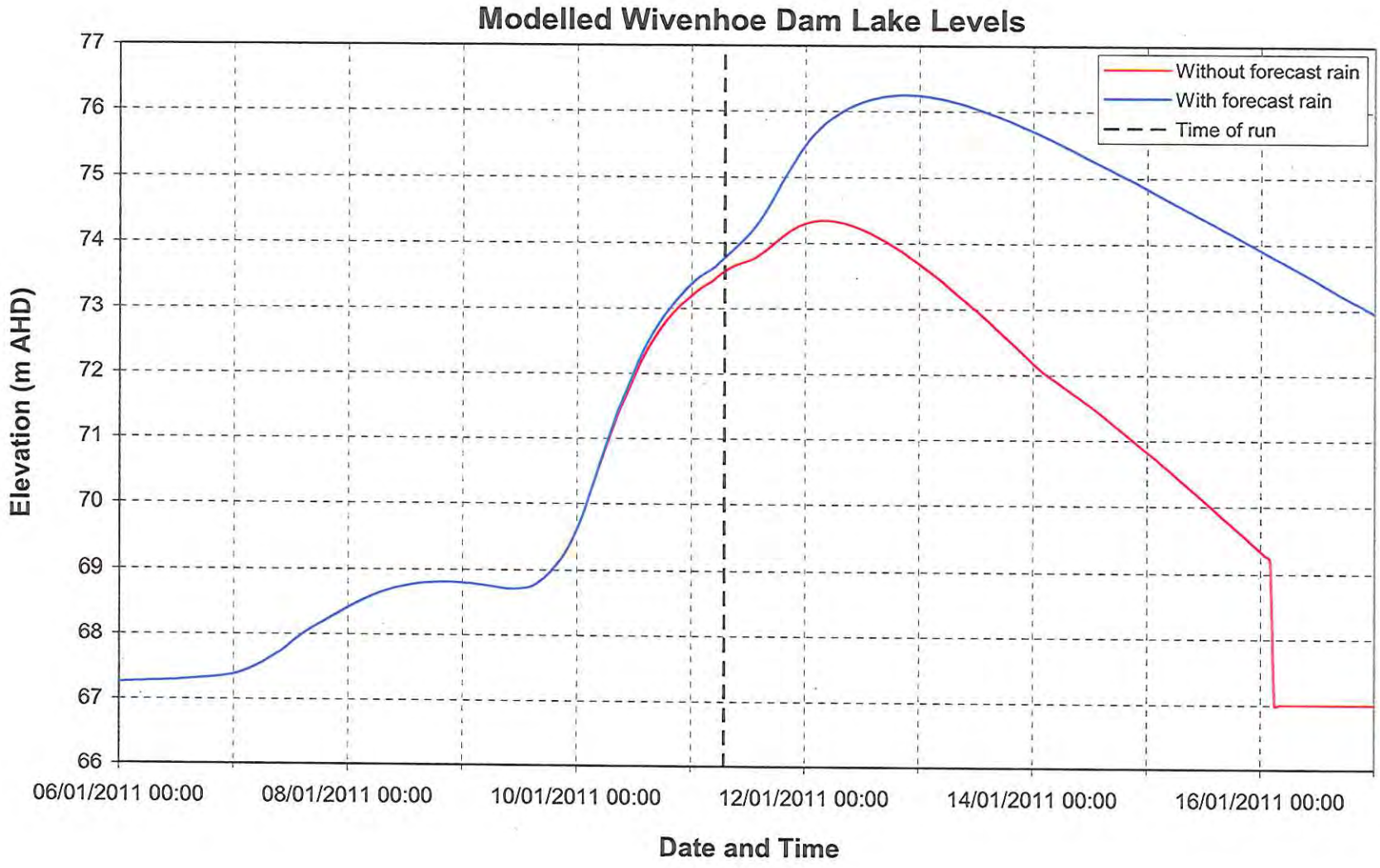
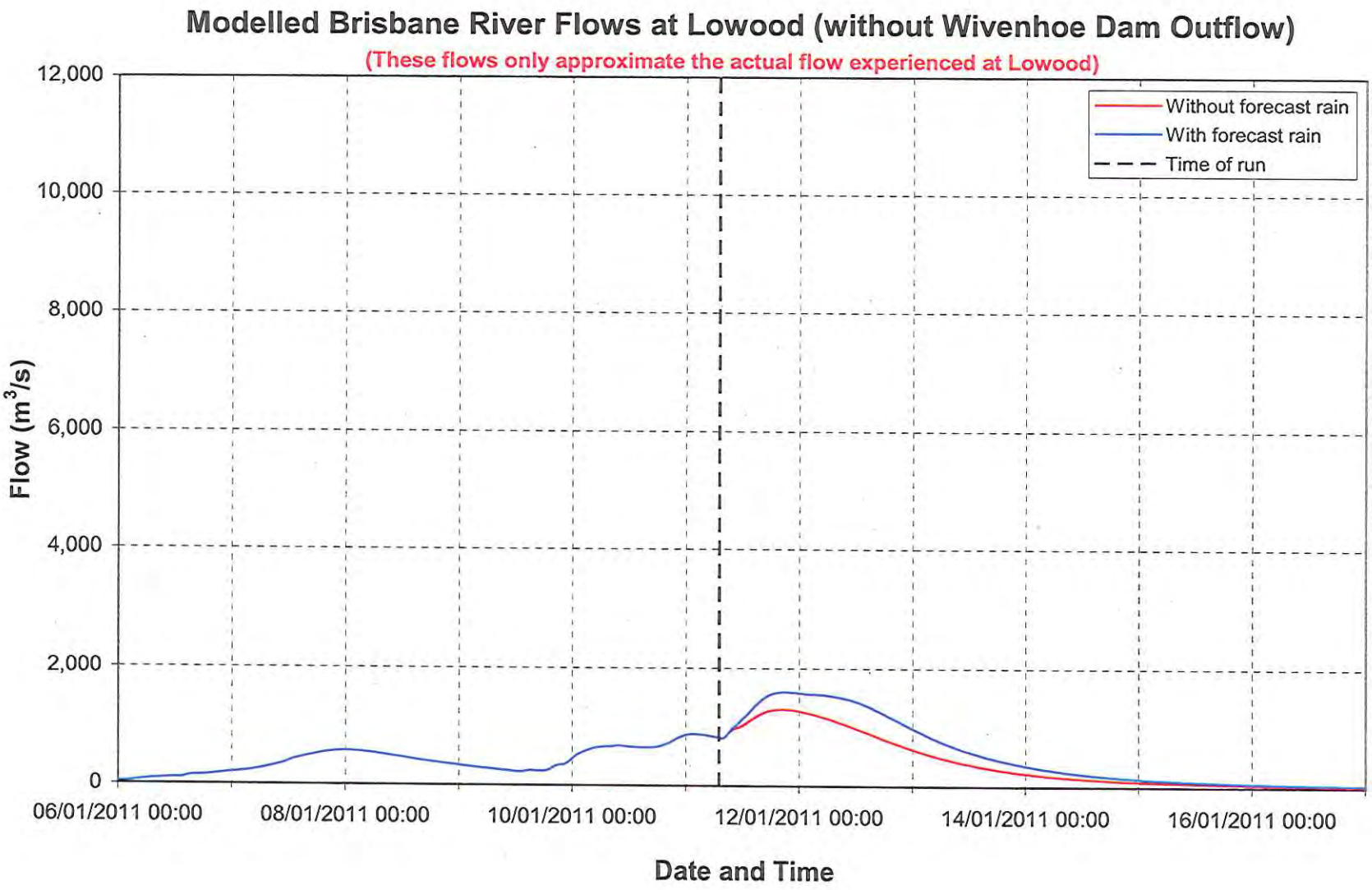

Modelled Somerset Dam Inflows
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

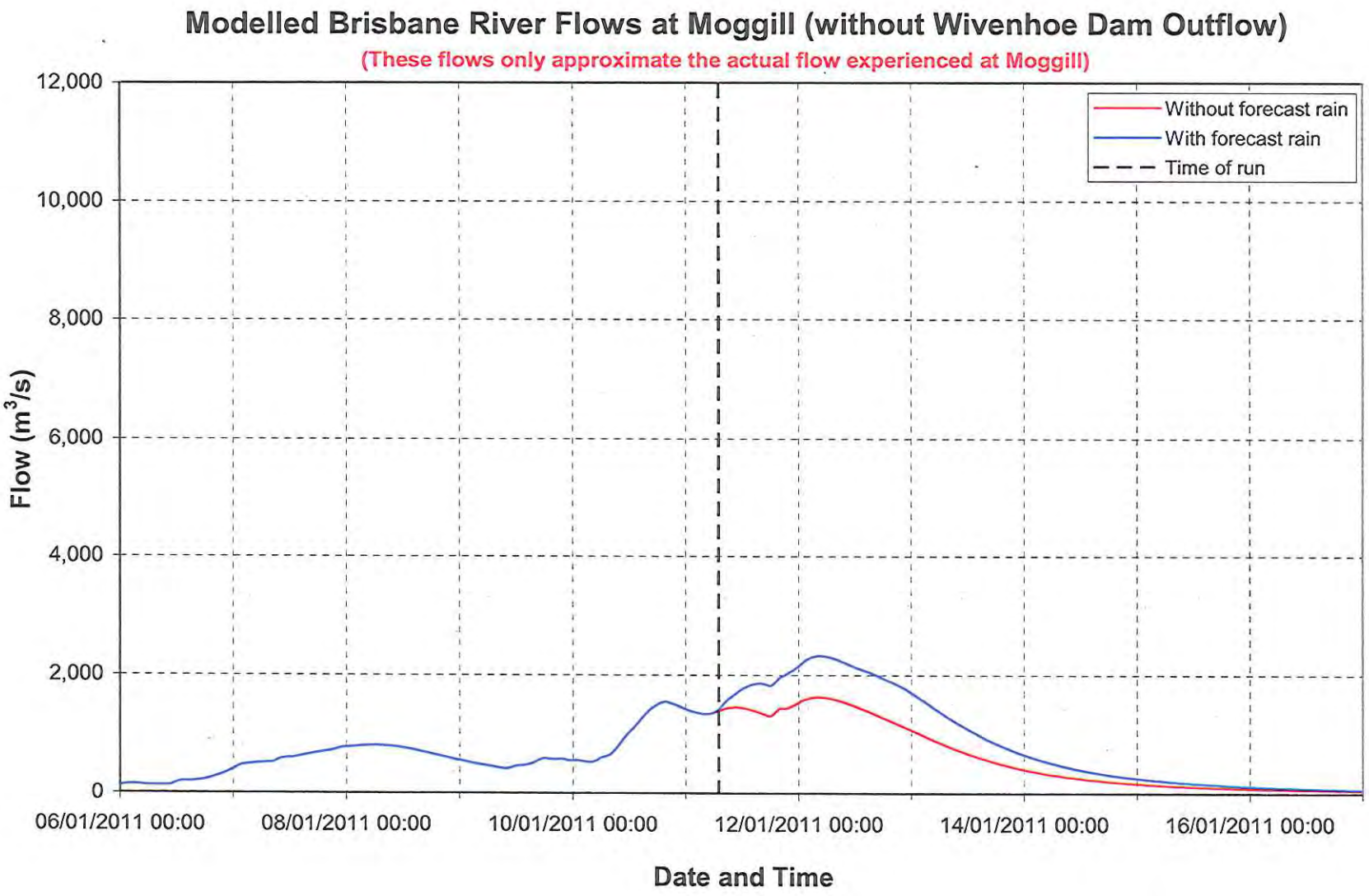

Modelled Lockyer Creek Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Without forecast rain
With forecast rain
Time of run


Modelled Bremer River Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

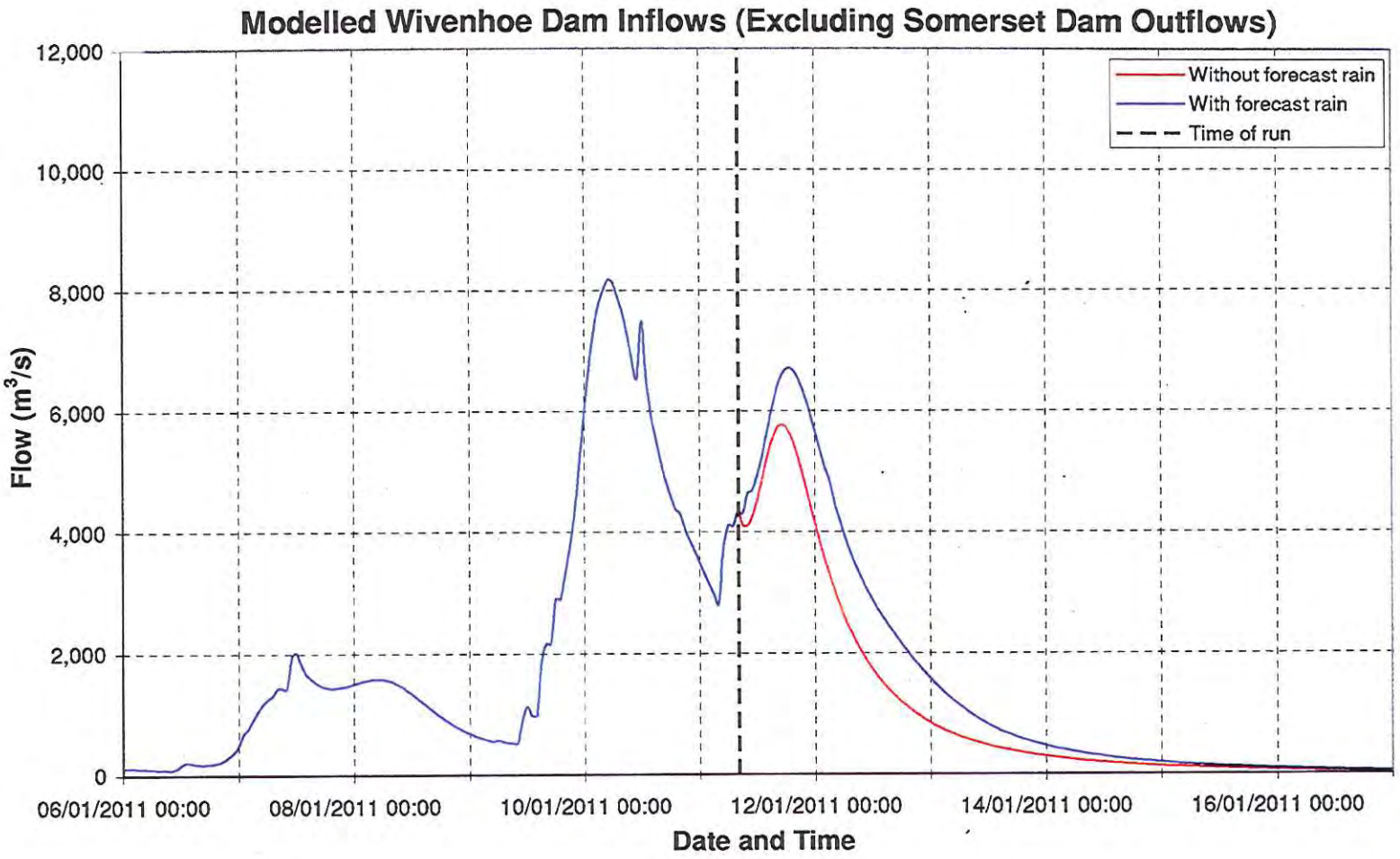

Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
77
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

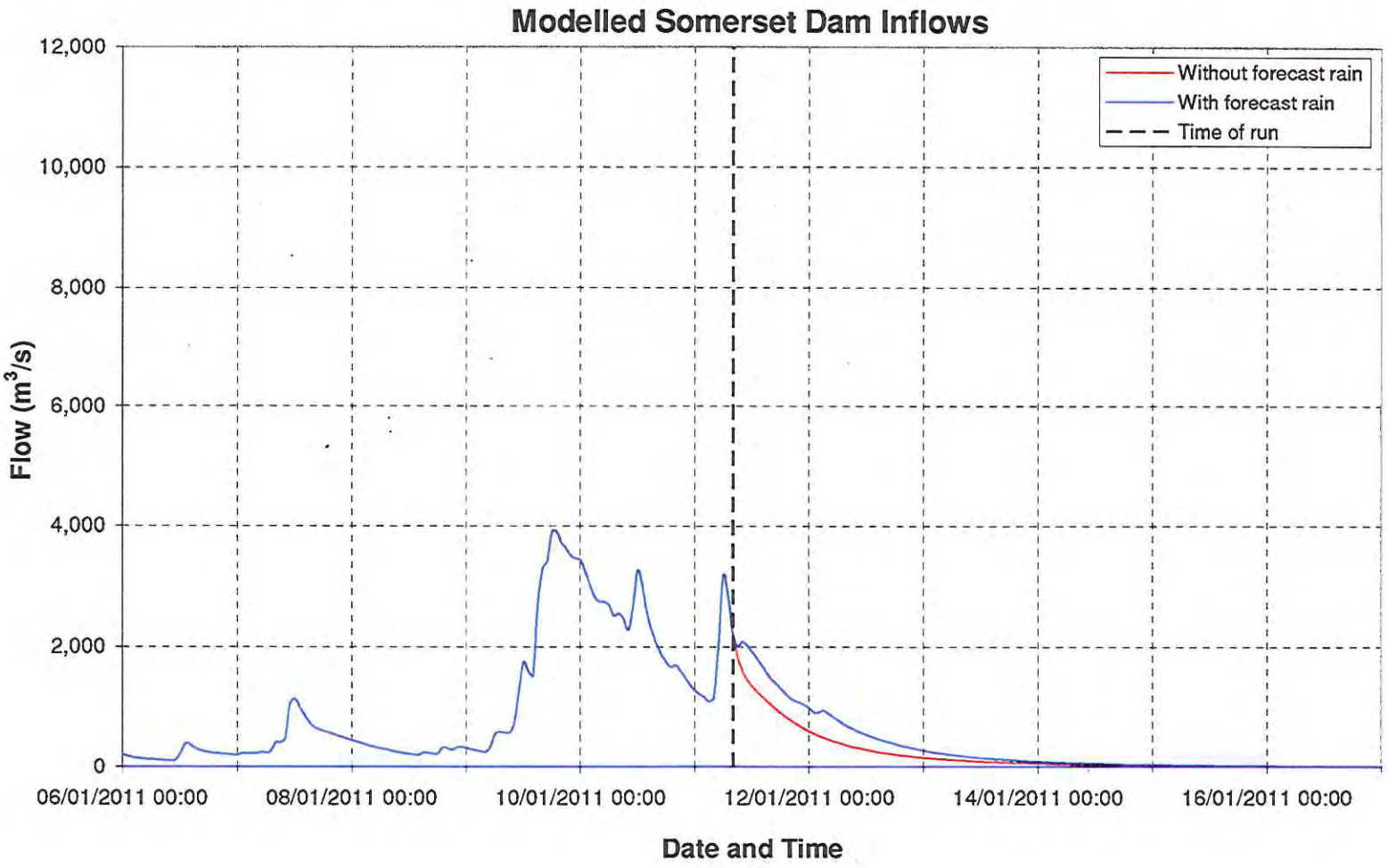
Run	36
Run Date	Tue 11/01/2011 07:00
Title1	Upper Brisbane R Modelled Flows
Title2	Stanley R Modelled Flows
Title3	Lockyer Ck Modelled Flows
Title4	Bremer R Modelled Flows
Title5	Somerset Dam
Title6	Wivenhoe Dam
Title7	Lowood
Title8	Moggill
Title9	Lowood (without WDO)
Title10	Moggill (without WDO)

	Min	Max
Run	11/01/2011 07:00	11/01/2011 07:00
Flow	0	100000
Somerset	98	108
Wivenhoe	66	77

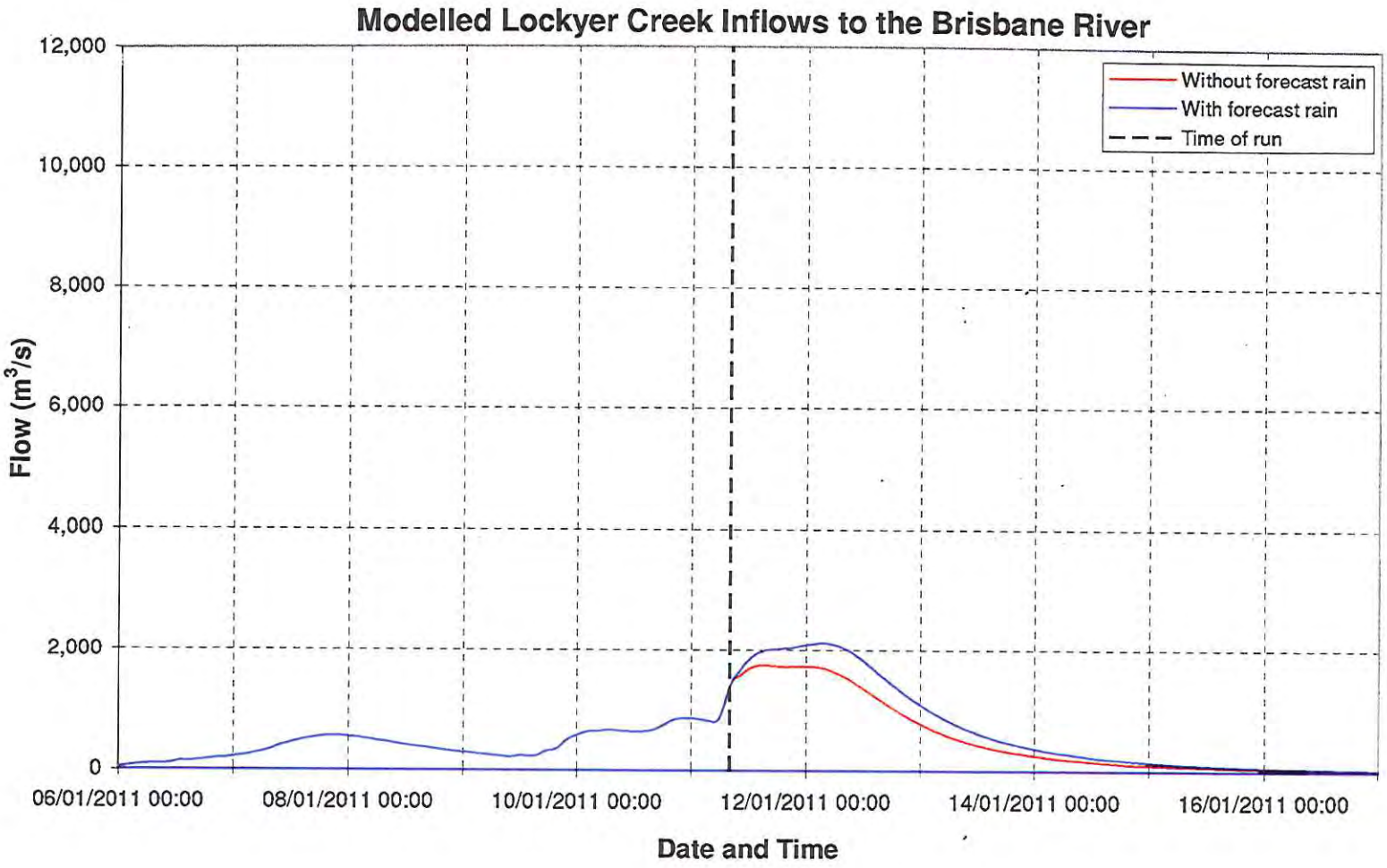


"JT-3"

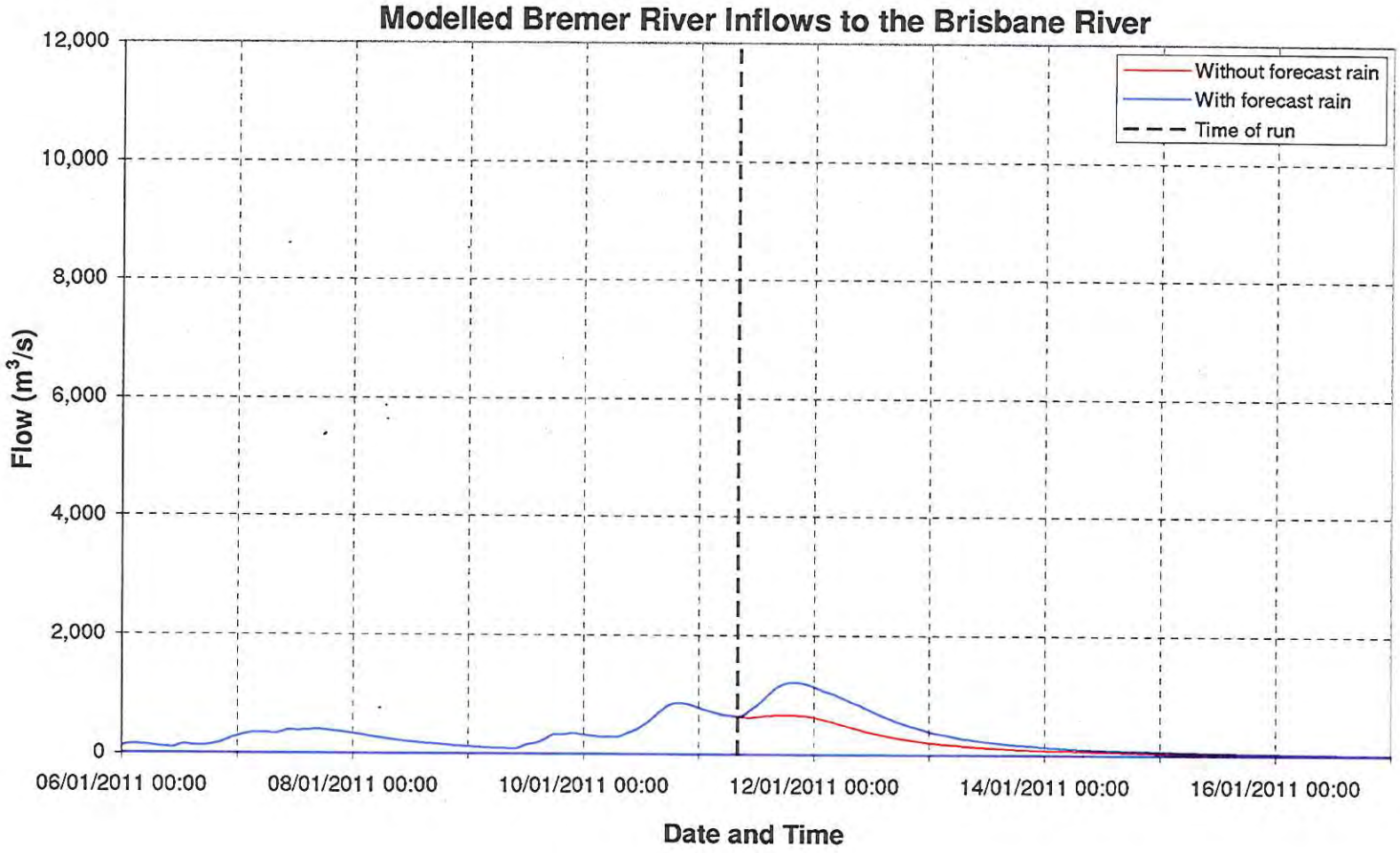
Run 37: Tuesday 11 January 2011, 08:00



Run 37: Tuesday 11 January 2011, 08:00


Modelled Lockyer Creek Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

17



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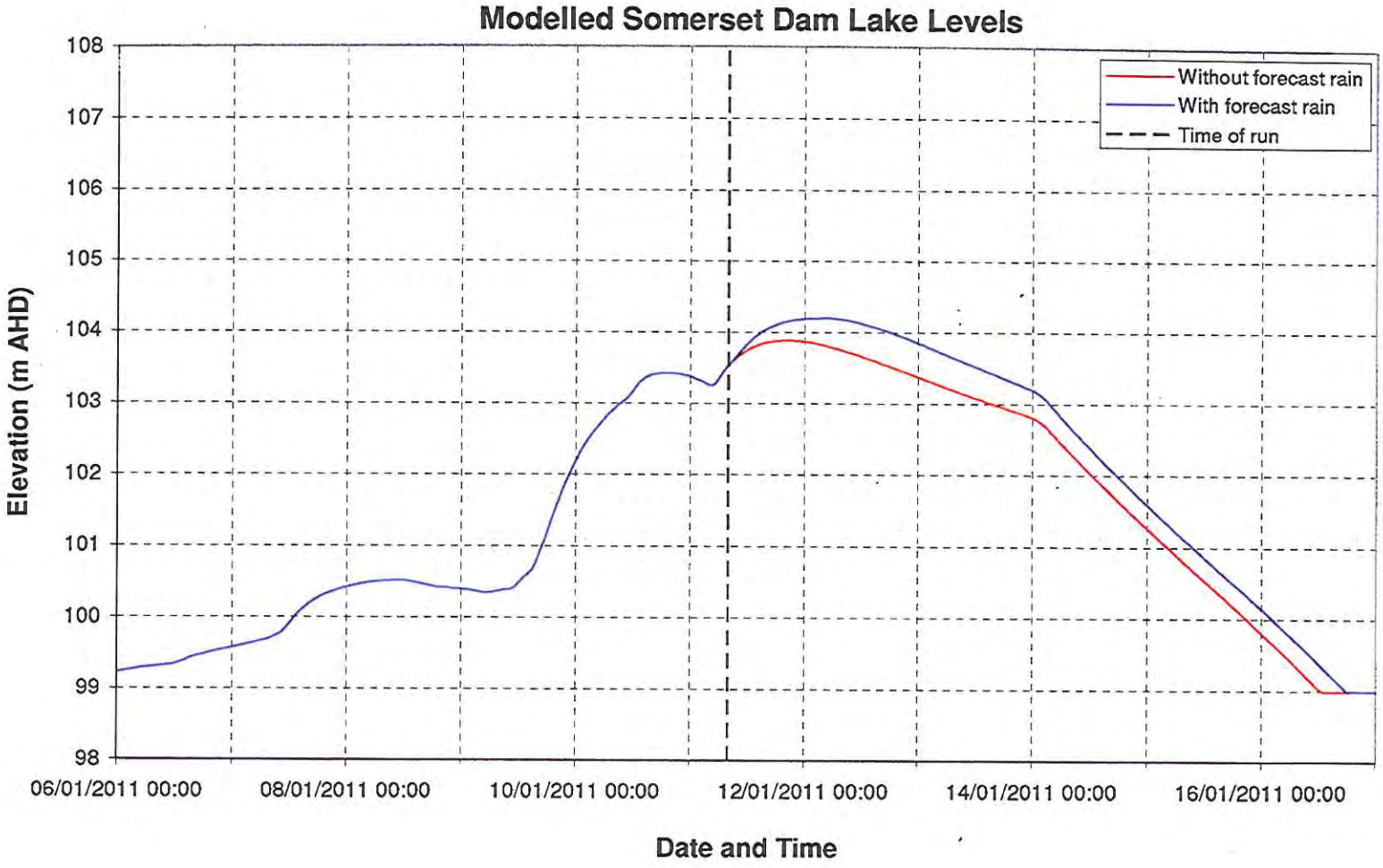

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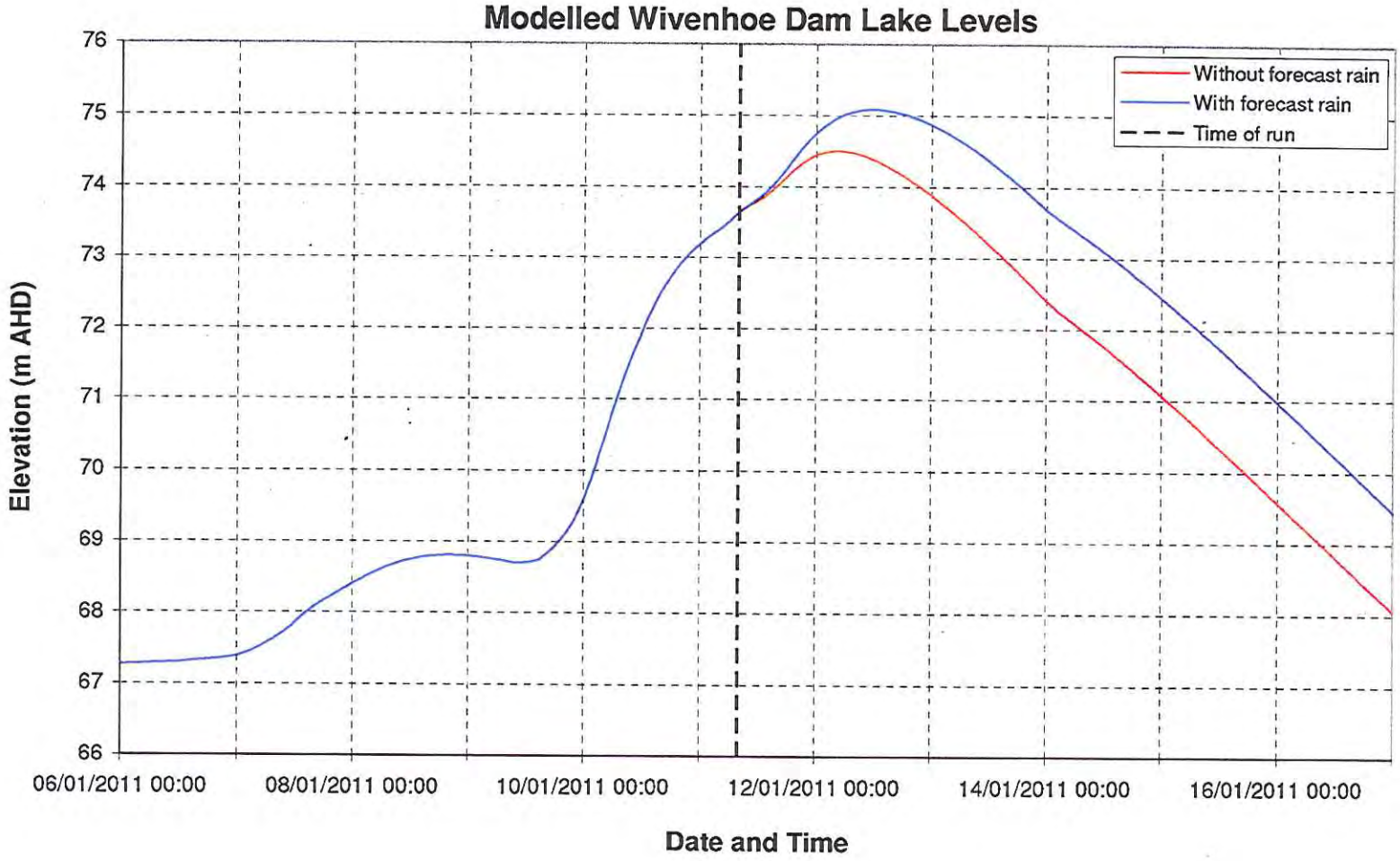

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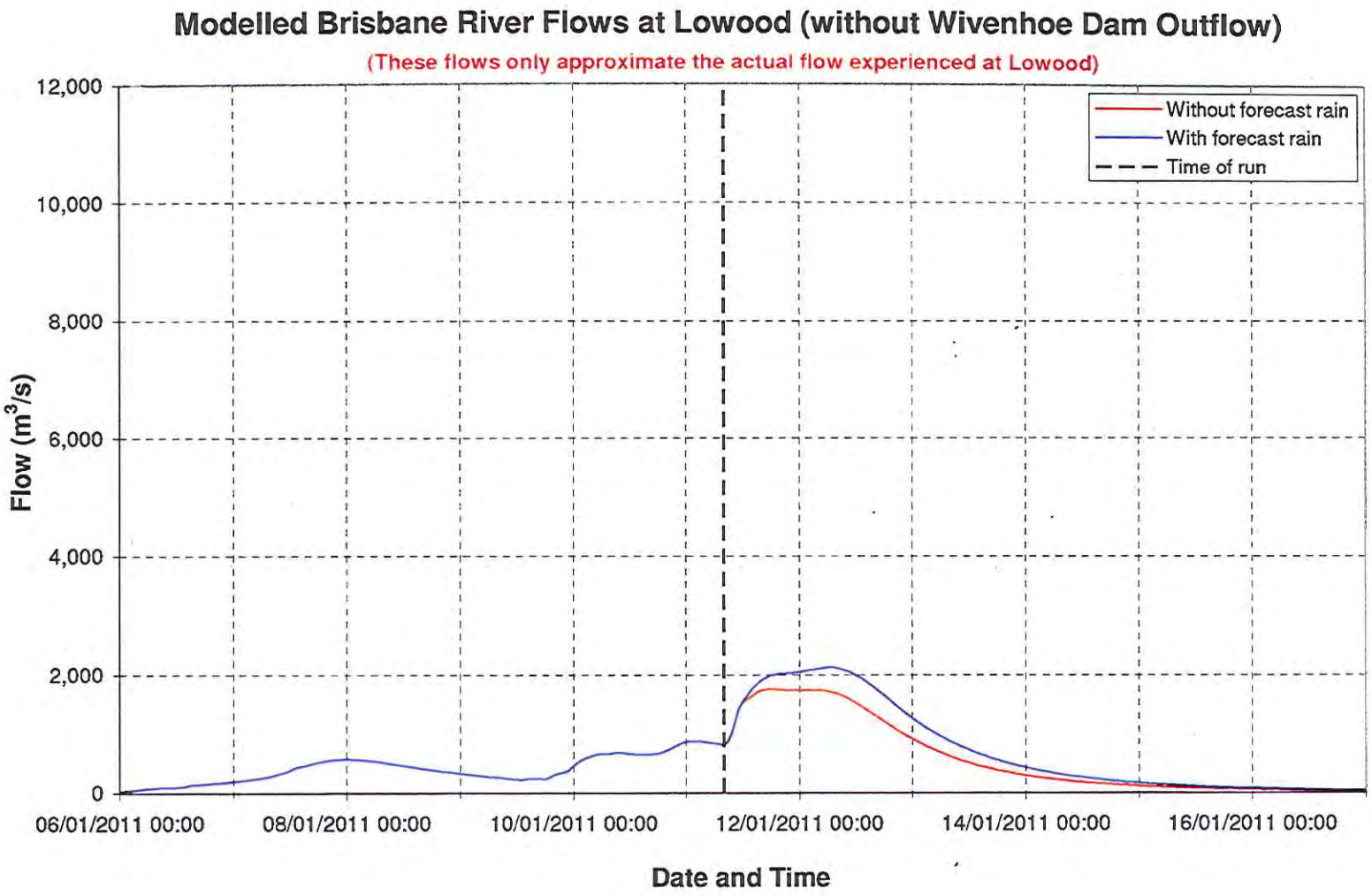
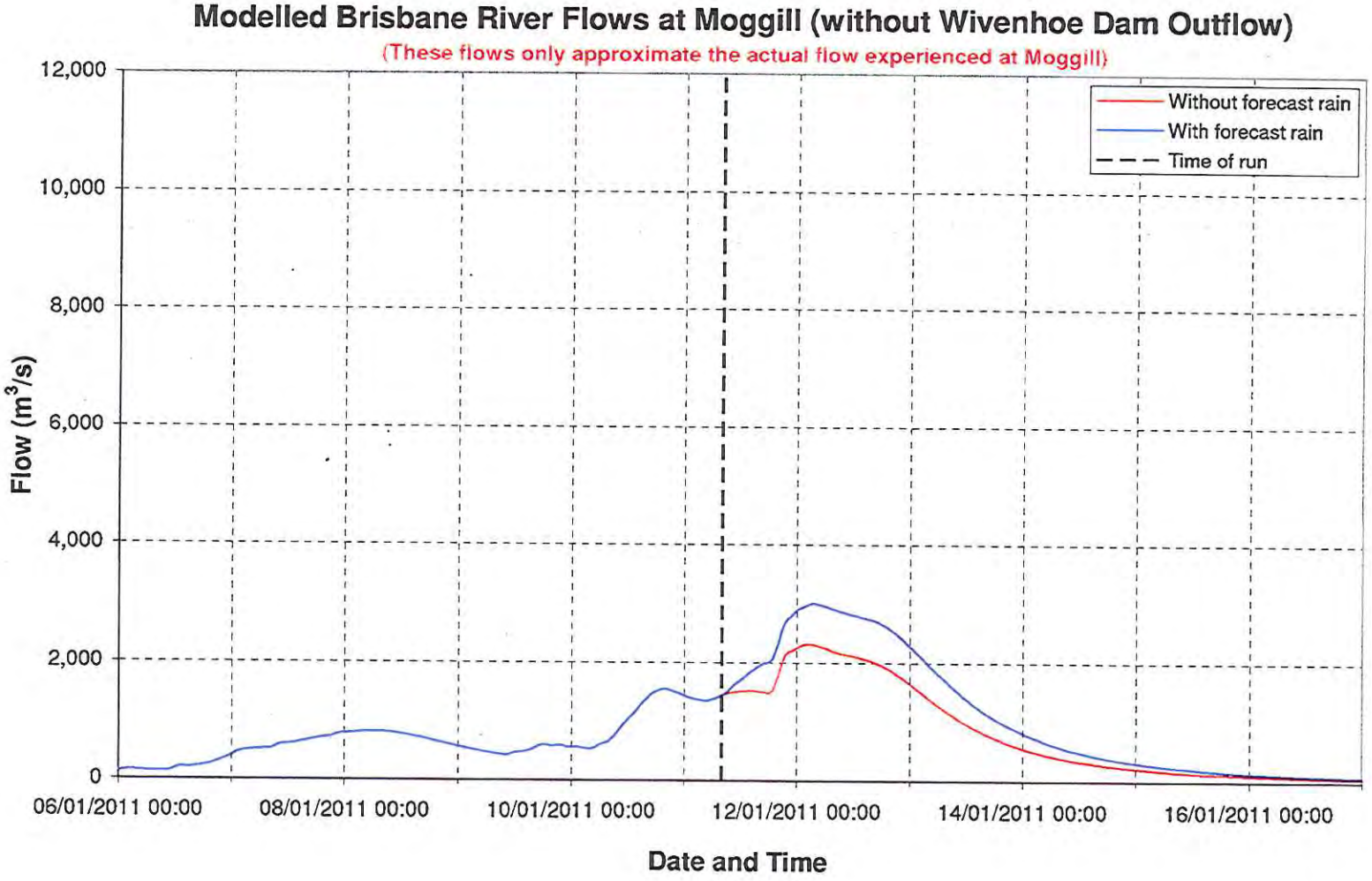

Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Run 37: Tuesday 11 January 2011, 08:00

22

"JT-4"

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FLOOD MODELING AND FLOOD OPERATIONS EXPERT PANEL
WIVENHOE, SOMERSET AND NORTH PINE DAMS
DATA COLLECTION AND FLOOD MODELLING PLATFORM INVESTIGATIONS

Agenda

Date:	**Tuesday, 22 December 2009**
Time:	**2.00pm – 4.00pm**
Place:	**Seqwater Board Room, Level 3 - 240 Margaret Street**
Invitees:	**John Tibaldi (Chair), Rob Drury, Terry Malone, Rob Ayre, Peter Allen, John Ruffini, Ken Morris, Peter Baddiley, Jimmy Stuart, Louw Van Blerk, Jim Pruss, Cynthia Crane,**
Apologies:	**John Ruffini**
Meeting No.	**4**

	Agenda Item		Discussion Format		Presenter	Suggested Time
1	**Introduction**		Discussion		All	5 mins
2	**Minutes of Last Meeting**		Paper		All	5 mins
3	**Flood Manual Revisions**		Presentation		John Tibaldi	15 mins
4	**FEWS Project Update**		Presentation		Terry Malone	15 mins
5	**ALERT Network Upgrades**		Presentation		Terry Malone	15 mins
6	**WIVOPS (Wivenhoe/Somerset Gate Operation Program)**		Presentation		John Tibaldi	15 mins
7	**Other Business**		General discussion		All	10 mins
	MEETING CLOSURE					

[redacted] [redacted]

FLOOD MODELING AND FLOOD OPERATIONS EXPERT PANEL
WIVENHOE, SOMERSET AND NORTH PINE DAMS
DATA COLLECTION AND FLOOD MODELLING PLATFORM INVESTIGATIONS

Minutes

Date:	**Tuesday, 22 December 2009**
Time:	**2.00pm – 4.00pm**
Place:	**Seqwater Board Room, Level 3 - 240 Margaret Street**
Attendees:	**John Tibaldi (Chair), Rob Drury, Terry Malone, Rob Ayre, Peter Allen, Ken Morris, Peter Baddiley, Jimmy Stuart, Louw Van Blerk, Cynthia Crane.**
Apologies:	**John Ruffini, Jim Pruss, Barton Maher.**
Meeting No.	**4**

	Agenda Item	Meeting Notes and Outcomes	Presenter
1	**Minutes of Last Meeting**	The minutes of the previous meeting were accepted.	
2	**Flood Manual Revisions**	John Tibaldi provided a presentation of the revisions to the Manual of Flood Mitigation for Wivenhoe and Somerset Dams. The Manual was gazetted by DERM in January 2010.	John Tibaldi
4	**FEWS Project Update**	Terry Malone provided an update on the FEWS project. It was agreed that the Draft Project Specification would be distributed for discussion at the next meeting.	Terry Malone
5	**ALERT Network Upgrades**	Terry Malone provided a presentation on Seqwater's recent upgrades to its ALERT Network. Ken Morris raised the point that some rationalisation of the overall network in SEQ would be useful. It was generally agreed that such a review should be lead by BOM in conjunction with owners of ALERT stations.	Terry Malone
6	**WIVOPS (Wivenhoe/Somerset Gate Operation Program)**	John Tibaldi provided a presentation on the current status of the WIVOPS program that is used to assist in developing gate operations strategies for Wivenhoe and Somerset Dams during flood events.	John Tibaldi
7	**Other Business**	Nil.	
	MEETING CLOSURE	3:20pm	

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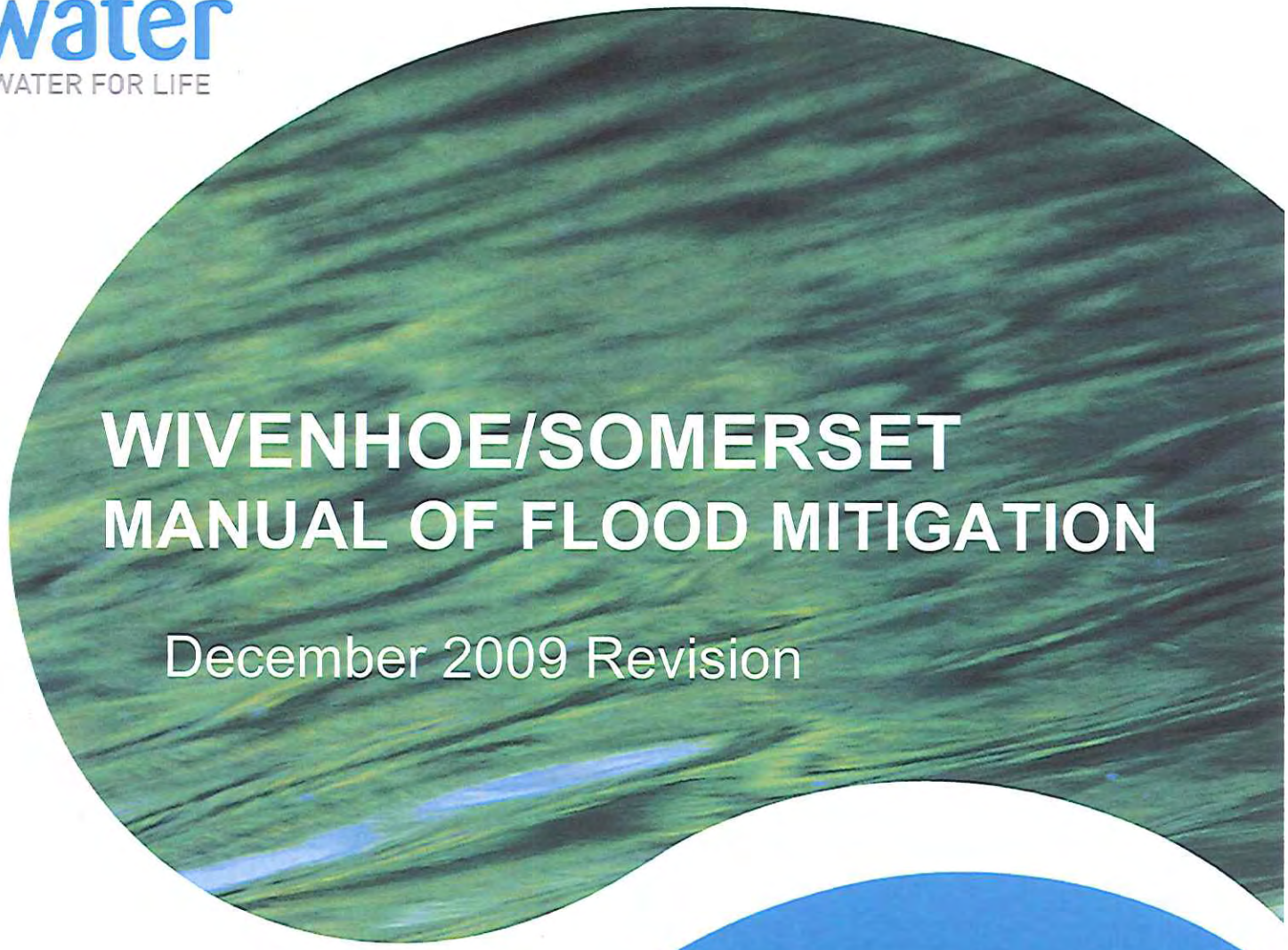

WIVENHOE/SOMERSET MANUAL OF FLOOD MITIGATION

December 2009 Revision

[redacted]

[redacted]

"JT-5"

SUMMARY OF REVISIONS

Revisions to the Manual can be grouped into four broad categories, which are:

- Administrative Issues.
- Review of Manual Objectives.
- Improved Operational Descriptions.
- Technical Amendments.

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ADMINISTRATIVE ISSUES

Reference changes to account for the new water management institutional arrangements were:

- Change to the Water Supply (Safety and Reliability) Act 2008.
- Change to the Department of Environment and Resource Management.
- Change to the Queensland Bulk Water Supply Authority (Seqwater).
- Changes in accordance with the Local Government Amalgamations of 2008.

None of these reference changes resulted in any change in operational procedure from the previous version of the Manual.

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REVIEW OF MANUAL OBJECTIVES

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

- ~~Minimise disruption and impact upon Wivenhoe Power Station;~~
- ~~Minimise disruption to navigation in the Brisbane River.~~

- Retain the storage at Full Supply Level at the conclusion of the Flood Event.
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

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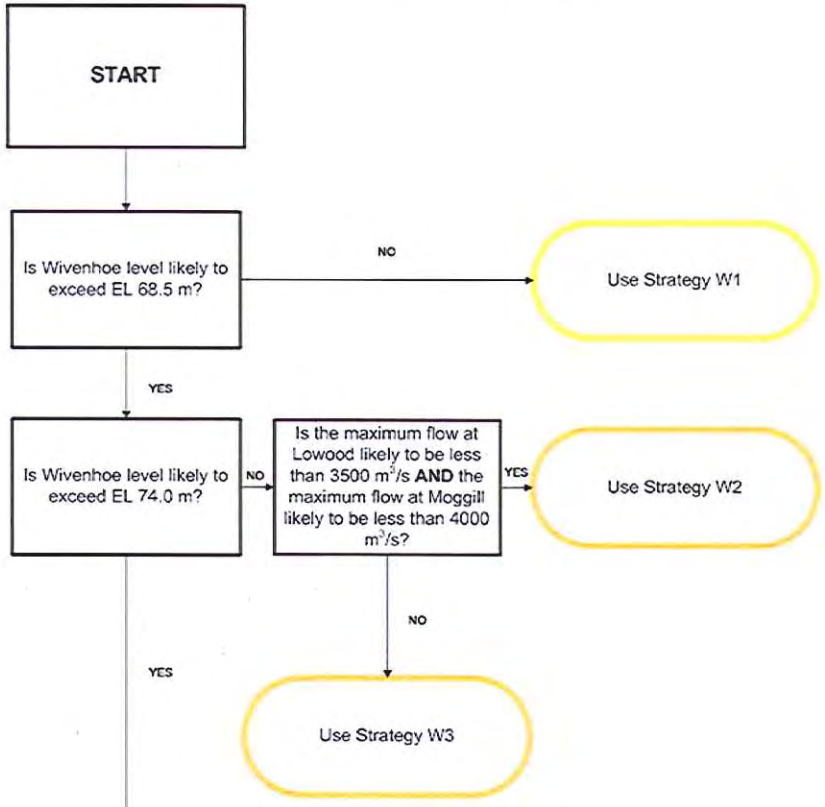
IMPROVED OPERATIONAL DESCRIPTIONS

WIVENHOE FLOOD STRATEGY FLOW CHART



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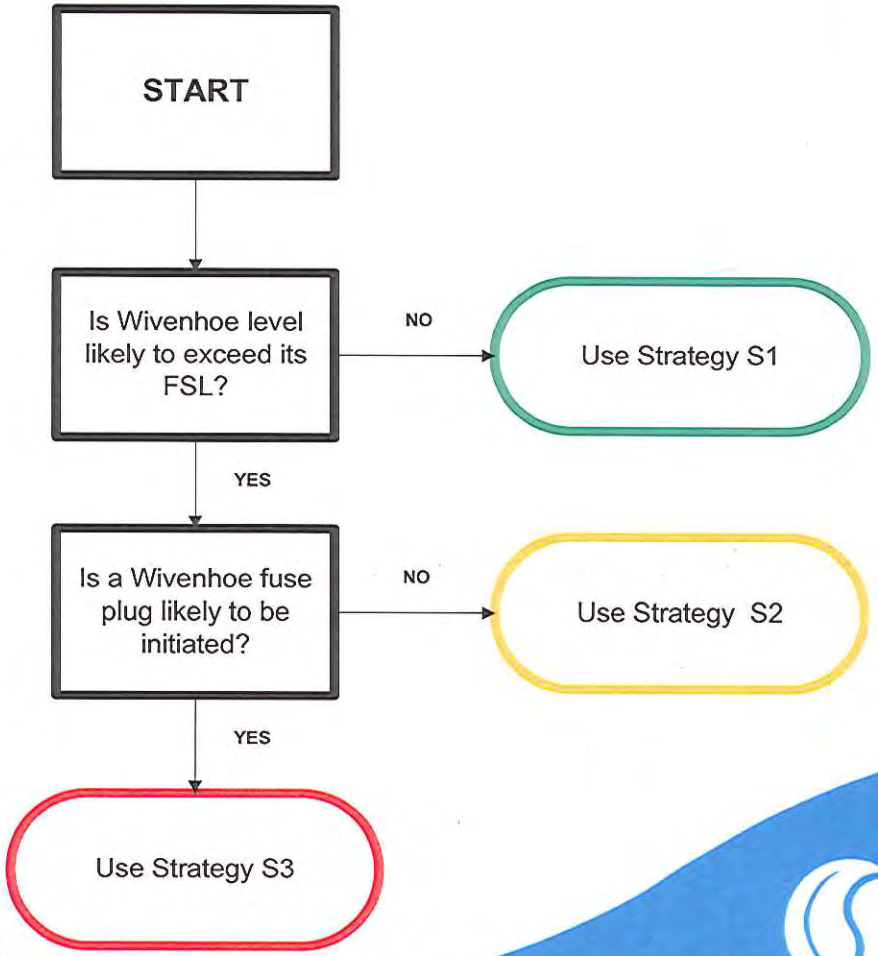
IMPROVED OPERATIONAL DESCRIPTIONS

SOMERSET FLOOD STRATEGY FLOW CHART



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TECHNICAL AMENDMENTS

Revisions to the Manual can be grouped into four broad categories, which are:

- Administrative Issues.
- Review of Manual Objectives.
- Improved Operational Descriptions.
- Technical Amendments.

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SUMMARY OF REVISIONS

Aim to maximise the combined flood mitigation benefits of the dams. Had to fully account for:

- The raising of Wivenhoe Dam and construction of an Auxiliary Spillway that occurred in 2005.
- The revised failure level of Somerset Dam.
- Floods centred on the Somerset Catchment.

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