BASSLINK INTEGRATED IMPACT ASSESSMENT STATEMENT

POTENTIAL EFFECTS OF CHANGES TO HYDRO POWER GENERATION

APPENDIX 1:

SCOPING REPORT

BASSLINK AQUATIC ENVIRONMENTAL PROJECT

Environmental Services Department, Hydro Consulting

February 2000

Prepared for

Hydro Tasmania
the renewable energy business

EXECUTIVE SUMMARY

The aims of this scoping report are to identify the type and extent of likely changes to the Tasmanian non-marine aquatic environment arising from the changed operation of hydro power stations after the installation of Basslink, and to identify further work required to clarify potential environmental and social issues resulting from these changes.

The methodology pursued for this scoping exercise involved:

1. Review of the Hydro's simulation model of the Tasmanian generating system under the National Electricity Market, TEMSIM (based on the Hydro's systems operation model, SYSOP), and assessment of the effect of Basslink scenarios on power station (PS) and storage behaviour.
2. Running the TEMSIM model under a range of scenarios including no cable (the 'base case'), and a range of cable sizes (300, 450 and 600 MW);
3. Analysis of the hydrological (water-related) outputs of TEMSIM to allow identification of those waters affected by Basslink. This involved comparing the outputs of the Basslink cable scenarios with those for the 'base case', and where appropriate, comparison to historical data.
4. Identification, as far as possible, of the environmental and social issues associated with those waters.
5. Recommendations on studies / assessments and potential mitigation strategies required to further evaluate and address these environmental and social issues.

Results from the modelling show that the most significant changes to Hydro waterways will be downstream of the major storages in the system. Discharges out of both the Gordon and Poatina Power Stations are likely to show the same trends under Basslink. Notably, these are increased short-term variability in flow discharges, increased frequency of short duration (and weekend) shutdowns, and changes in the seasonality of flows. Changes in the seasonal nature of discharges out of the John Butters Power Station are indicated, and possibly some alterations in the already highly variable pulses of discharge.

No significant changes are indicated by the modelled results for any of the lakes within the Hydro's generating system. Modelling has shown that these lakes are managed similarly to historical patterns. In addition, many lakes are currently constrained by lake level agreements. These constraints will continue in operation after the commissioning of Basslink. The present lake level agreements will be reviewed and assessed in relation to environmental and social issues as part of the Water Management Review process that the Hydro is engaging in with Department of Primary Industries, Water and Environment over the next 5 years.

Planned environmental investigations into the effects of the Basslink cable on the Gordon River will address geomorphology, instream ecological health, meromictic lakes, water quality and cultural heritage issues. Environmental investigations on the waterways downstream of Poatina Power Station will address geomorphology, instream ecological health, water quality, cultural heritage, and public use issues. Investigations downstream of the John Butters Power Station will address geomorphology, water quality, instream ecological health and tourism issues in the King River, and water quality in Macquarie Harbour.

PREFACE AND ACKNOWLEDGEMENTS

This report has been prepared as part of the Hydro's Basslink Project. The environmental component of this Project is headed by Andrew Scanlon. This report describes preliminary investigations into the environmental and social impacts of a proposed Basslink cable across the Bass Strait on the Tasmanian aquatic environment.

This report, and the material therein in no way represents any final or fully evaluated Environmental Impact Assessment for the Basslink cable.

This report is a product of numerous contributions from different areas within the Hydro:

- TEMSIM modelling was provided by the Hydro's Systems Studies section, including Roger Allen, Roger Parkyn, Dr. Michael Connarty, and Gregg Barker.

- Hydrological analyses were provided by the Hydro's Hydrology section, including Lennie Palmer, Kirsten Adams and Holly Taylor.

- Interpretation of data, identification of environmental issues and other aspects of report production have been conducted by the Hydro's Environmental Services section, including Andrew Scanlon, Mick Howland, Jackie Griggs, Helen Locher and Vanessa McNeair.

The contributions of Dr. Peter Davies, the Hydro's SGIS section, and Stephen Stolp are gratefully acknowledged.

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GLOSSARY AND LIST OF ACRONYMS

The following is a list of terms and acronyms used in this report.

Term	Definition
Active Storage	Storage volume situated above the normal minimum operating level of a lake, drawn from to generate power.
ASL	Altitude above Sea Level
BDB	Basslink Development Board
EOL	Economic Operating Level - The monthly or seasonal level above which the reservoir should be maintained to maximise energy potential.
Efficient Load	Power station energy generation at maximum efficiency
Following Stations	Generally run-of-river stations, downstream stations which operate at same time as immediately upstream stations, utilising water discharged from the immediately upstream station.
Full Gate	Maximum power generation from a given power station
FSL	Full Supply Level - The maximum level at which water can be stored indefinitely, equal to the crest level of the spillway.
Head Storage	Usually a medium-sized storage, situated at the top of ‘run-of-river’ systems defined below.
JAP	Joint Advisory Panel
LLA	Lake level agreement
LTMC	Long-Term Marginal Cost
Major Storage	Largest storages with inter-annual variation in major storage capacity; ie Lake Gordon, Great Lake
Medium-Sized Storage	Large storages with inter-seasonal variation in major storage capacity; e.g. Lakes Burbury and Rowallan.
MOL	Minimum Operating Level - Minimum level at which power can be generated.
NEM	National Electricity Market
NMOL	Normal Minimum Operating Level - The lowest level of storage at which all the machines in the power station can be simultaneously and continuously operated at full gate opening.
PEV	Protected Environmental Value
PS	Power Station
RPDC	Resource Planning and Development Commission
Run-of-River Storage	Small storages with limited variation in level, usually in a sequence, and responding largely to inflows (river flows and rainfall); e.g. in Derwent, Pieman and Forth systems

SMP	System Marginal Price
SYSOP	The current Hydro operating system simulation model
TEIS	Total Energy in Storage
TEMSIM	Tasmanian Electricity Market Simulation model
VoLL	Value of Lost Load
WMP	Water Management Plan
WQG	Water Quality Guideline
WQO	Water Quality Objective

1 INTRODUCTION

1.1 This Document

1.1.1 Objectives and Content

The objectives of this report are:

- to give an approximation of likely operational changes from the existing generating regime of the Tasmanian Hydro System under a number of Basslink scenarios;
- to identify any significant potential environmental or social issues resulting from these changes; and
- to outline scopes of work to further examine these identified issues.

This report details how the current Hydro system is operated in Tasmania, describes the model used to predict possible changes under Basslink, presents the modelling results, highlights possible environmental and social issues arising from changes in operations, and gives general scopes for the Hydro's works program to address these issues.

A fundamental approach of this study was the utilisation of a Tasmanian Hydro Energy System simulation model (TEMSIM). Outputs from this model allowed a comparative evaluation of a variety of scenarios with different Basslink cable sizes (300, 450 and 600 MW), and a Tasmanian competitive electricity market without the Basslink cable (0 MW). The TEMSIM model was used to identify hydrological (lake level and river flow) changes associated with Basslink and allowed comparison with historical system operations.

1.1.2 Structure

The document is structured as follows:

Section 1	Gives relevant background information including the legislative framework for the Basslink project as it relates to the Hydro-Electric Corporation, and the way in which the Hydro system is used to meet current electricity demand. Provides background information on the Hydro's current environmental programs.
Section 2	Describes the TEMSIM model and how it works. The model inputs, outputs and the scenarios modelled are described, and limitations and constraints to the study arising from the methodology followed are outlined.
Section 3	Presents the results of the model runs for the differing Basslink scenarios and data analyses. Data is presented by Hydro catchment, detailing effects on lakes and then downstream discharge. Explanation of the results and their limitations is provided in this section.
Section 4	Discusses the environmental and social issues, which arise from the results as presented in Section 3.
Section 5	Defines in detail environmental studies to investigate the environmental and social issues associated with the Basslink cable, which were identified in Chapter 4.

1.2 Background

1.2.1 Context

Basslink is the planned undersea power cable across Bass Strait that will link Tasmania's electricity grid with Australia's national electricity grid. Basslink will allow Tasmania to export its hydro-electricity into the National Electricity Market (NEM) to obtain high returns at peak times, and balance its electricity needs by importing lower cost electricity produced by Victoria, NSW and other states in the NEM during offpeak times.

The Basslink development includes:

- a high voltage direct current undersea cable across Bass Strait (approximately 250 kilometres);
- AC/DC converter stations in Tasmania and Victoria;
- DC connecting lines from the converter stations; and
- AC transmission connections to the Tasmanian and Victorian transmission networks.

To facilitate the development of Basslink, the Tasmanian government has appointed a Basslink Development Board (BDB). The BDB has received expressions of interest in the construction of Basslink from three private consortia. The successful consortium will be announced in early February 2000.

The Tasmanian government has also announced that the Basslink project is a Project of State Significance. It will be subject to a combined environmental assessment and development approvals process to satisfy statutory requirements under current Tasmanian, Victorian, and Commonwealth law. A Joint Advisory Panel (JAP), consisting of Tasmania's Resource Planning and Development Commission and Victorian and Commonwealth representatives, will be appointed to carry out this process. The JAP will prepare a draft integrated assessment report, hold hearings into submissions on the report, and finalise the report. This assessment process is scheduled for April to September 2000.

The integrated assessment is to address the environmental, social, economic, and community impacts of Basslink. Preliminary studies on baseline conditions associated with the potential route corridors for Basslink have been commissioned by the BDB. When the successful proponent is announced in February 2000, they will be responsible for the continuation of those studies.

1.2.2 Assessment Requirements for Tasmanian Rivers

The management of Tasmanian waterways for electricity generation is the responsibility of the Hydro-Electric Corporation. Basslink will create a changed market for electricity and, as a consequence, changes will occur to the lake levels and downstream flows in the Hydro-Electric Corporation's system as managed by the Hydro.

The Ministerial direction to the Resource Planning and Development Commission (RPDC) on the Basslink assessment process includes a requirement to consider:

a) the likely environmental impacts upon rivers, hydro-electric storages and other inland waters of any changes to the operation of Tasmania's hydro-electric electricity generation system that may arise from connection to the National Electricity Market, in particular from managing that system to meet power demand variations on the Australian mainland;

b) any likely environmental impacts upon the natural heritage or cultural heritage values of the Tasmanian Wilderness World Heritage Area, as identified in the nomination of that area for inclusion on the World Heritage List under the Convention for the Protection of the World Cultural and Natural Heritage;

c) any social, economic and community impacts flowing from the environmental impacts to which clauses (a) and (b) refer; and

d) means proposed for managing any impacts identified under clauses (a), (b), and (c).

Further, in considering the issues to which the above refers, the RPDC is to liaise with the Department of Primary Industries, Water and the Environment in relation to requirements under the State's water management and environment protection legislation.

The above directive recognises that current water and environmental legislation is designed to protect the important environmental, social and economic values of Tasmania's waterways. This legislative framework includes:

- The *Water Management Act 1999*;
- The *State Policy on Water Quality Management 1997*; and
- The *Environmental Management and Pollution Control Act 1994.*

This regulatory framework should ensure that the Hydro-Electric Corporation operates its waterways in a manner that does not have unacceptable environmental, economic or social impacts.

To assist in meeting these obligations the Hydro-Electric Corporation is conducting its own assessment of potential impacts on its lakes and waterways as a result of the Basslink project. This document is part of that assessment.

The remainder of this chapter provides background information useful for understanding the current status of environmental issues in Hydro waterways. Subsequent sections include the relevant legislative framework (Section 1.3), the Hydro's Aquatic Environment Program (Section 1.4), and the current operating system for hydro-electric power generation (Section 1.5).

1.3 Legislative Framework

1.3.1 Water Management Act 1999

The Tasmanian Parliament recently passed the *Water Management Act 1999*. This Act is expected to be proclaimed in January / February 2000. It will bring the Hydro-Electric Corporation under a new regulatory framework. The objectives of the Act are to further the objectives of the Resource Management and Planning System of Tasmania. They specify the need to:

- promote sustainable use and facilitate economic development of water resources;
- recognise and foster the significant social and economic benefits resulting from the sustainable use and development of water resources for the generation of hydro-electricity and for the supply of water for human consumption and commercial activities dependant on water;
- maintain ecological processes and genetic diversity for aquatic ecosystems;
- provide for the fair, orderly and efficient allocation of water resources to meet the communities needs;
- increase the communities understanding of aquatic ecosystems and the need to use and manage water in a sustainable and cost efficient manner; and
- encourage community involvement in water resource management.

The Act gives high priority to the needs of ecosystems (Section 94).

1.3.1.1 Hydro Special Licence

The Hydro-Electric Corporation is granted a Special Licence under "Schedule 4 Savings and Transitional Provisions" of the *Water Management Act* 1999.

The draft terms and conditions of the Hydro's Special Licence spell out its requirements to implement environmental provisions of a Water Management Plan.

1.3.1.2 Water Management Plans

The Water Management Act 1999 allows for the development of Water Management Plans for:

(a) a watercourse or several joined watercourses or part of a watercourse; or

(b) a lake; or

(c) a groundwater area; or

(d) any combination of paragraphs (a), (b) and (c), whether the water resources are joined naturally or artificially –

and may include surface water that normally flows into or replenishes the water resource or water resources in the plan (Clause 14(1), Division 1, Part 4, Water Management Act 1999).

Clause 14(2) of the Act prescribes that the scope of a WMP is to include:

a) an assessment of the quantity of water needed by the ecosystems that depend on a water resource and the times at which, or the periods during which, those ecosystems will need that water; and

b) an assessment of likely detrimental effects, arising from the taking or use of water from the resource, on the quantity of water that is available to meet the needs of the ecosystems that depend on the resource; and

c) an assessment of likely detrimental effects of the plan on the quality of the water.

The Hydro is committed to working with the Department of Primary Industries, Water and Environment in the development and implementation of Water Management Plans for the catchments in which it operates. This process is already underway in the Great Lake / South Esk Catchment.

1.3.2 State Policy on Water Quality Management 1997

The principal purpose of this Policy is to maintain or enhance Tasmania's groundwater resources and surface waters while allowing for sustainable development, as set out in the objectives of the Tasmanian Resource Management and Planning System (Clause 5.1, *State Policy on Water Quality Management 1997*).

1.3.2.1 Protected Environmental Values

The first step in implementing the Policy is to set Protected Environmental Values (PEVs) for water quality. The PEVs will be used by Department of Primary Industries, Water and Environment (DPIWE) to set Water Quality Guidelines (WQGs) and Water Quality Objectives (WQOs).

Protected Environmental Values (PEVs) are values or uses of the environment for which it has been determined that a given area of the environment should be protected. Water quality objectives that underpin these values may be set for surface waters and ground waters in Tasmania by determining which of the following protected environmental values should apply to each body of water:

- Protection of Aquatic Ecosystems (eg. pristine or modified);
- Recreational Water Quality and Aesthetics;
- Raw Water for Drinking Water Supply;
- Agricultural Water Uses; and
- Industrial Water Supply.

PEVs will be set by DPIWE in consultation with the community.

1.3.2.2 Water Quality Guidelines and Water Quality Objectives

Once PEVs are set, Water Quality Guidelines (WQGs) will be determined for each value. WQGs are estimates of indicator levels that need to be met in order to protect an environmental value. Guidelines will be determined by DPIWE on a case by case basis using site specific information where appropriate. Alternatively, the Australian Water Quality Guidelines and any other appropriate information can be used.

The most stringent water quality guidelines for a specific body of water are known as Water Quality Objectives. These objectives offer a range of pollutant limits and are designed to ensure that the water quality of a nominated body of water is maintained at a level to achieve all of the PEVs developed for that body of water. Implementation of WQOs is through planning authorities with jurisdiction over these water bodies, and where relevant, the water management authorities with jurisdiction over water bodies.

1.4 The Hydro's Aquatic Environment Program

In recent years, the Hydro has put significant efforts into developing and implementing its Aquatic Environment Program. The aims of the Hydro's aquatic environmental management program are to manage its resources in an environmentally sustainable manner, be more aware of community views and values and be more responsive to community concerns. The Hydro recognises that it is a major water manager in Tasmania as well as a generator of electricity, and needs to manage resources in an ecologically sound way. This will ensure future generations can enjoy the benefits of both a healthy environment and a clean, renewable source of energy.

1.4.1 Environmental and Aquatic Policies

To meet the objectives of this program, the Hydro developed an Environmental Policy in 1992, and an Aquatic Environmental Policy in 1998 (see Attachment 1). The Aquatic Environmental Policy describes the Hydro's position regarding environmental management of its waterways in six key areas. These areas are: sustainable development, responsible environmental management, compliance with environmental policy and legislation, water management decisions, reviews of performance, and environmental expertise and availability. The Aquatic Environment Program is aimed at ensuring compliance with Hydro environmental policies, and is also responding to the recent regulatory water reforms as mentioned in previous sections.

1.4.2 Water Management Reviews

The Hydro has commenced a process of review of its water management practices across the State, on a catchment-by-catchment basis. The aim of this review is ensure that the Hydro is managing its resources in an environmentally and economically sustainable manner. The review process involves gathering background information, consulting the community and stakeholders, researching options to address any outstanding water management issues, analysing the results and then proposing options to address the issues.

The Hydro's water management reviews are being conducted alongside and with the full endorsement of the Department of Primary Industries, Water and Environment. DPIWE will take the outcomes of the Hydro's water management reviews one step further, and develop Water Management Plans for these catchments under the Water Management Act 1999. The first of the Hydro water management reviews is presently underway in the Great Lake / South Esk catchment.

In support of this process, the Hydro is producing review documents on Hydro aquatic environmental issues for each of its six major catchment areas. The first of these, for the Great Lake and South Esk catchment area, has just been finalised.

1.4.3 Waterway Health Monitoring

The waterway health component of the Aquatic Environment Program aims to assess the health of lakes and rivers influenced by Hydro activities. The Hydro, in conjunction with the Inland Fisheries Commission, conducts regular monitoring of water quality, biological and physical condition assessments in its lakes and rivers, along with more detailed monitoring of some problem waterbodies. This ensures the Hydro can respond appropriately to aquatic issues. In addition, for the past 10 years the Hydro has been part of a program to monitor the water quality of the Pieman catchment, particularly in regard to heavy metals. This program has support from the Hydro, members of the Mining Industry, and the Tasmanian Government.

An example of more detailed monitoring is a project to improve water quality in the Lagoon of Islands, an ecologically significant water body. Problems with increased turbidity and nutrient levels in Lagoon of Islands have resulted in poor water quality and increased algal blooms. The Hydro has a program of research, monitoring, consultation and action to address these problems. Through this program, an improvement in the environmental conditions within the lagoon has been achieved.

1.4.4 Biological Studies

The Aquatic Environment Program contains a detailed fish migration project which is documenting the dispersal and migratory needs of native species. This project involves an in-depth analysis of existing Hydro structures and natural barriers to fish migration, as well as the biology and ecology of Tasmania's native fish fauna. The Hydro is investigating fish passage structures suitable for native species that are likely to be effective in Tasmanian dams. The design and installation of Australia's first elver ladder at Trevallyn late in 1996 was an early initiative of this program. By allowing elvers to migrate upstream, the sustainability of the commercial Tasmanian eel fishery is enhanced and the ecological balance of upstream areas is maintained. The Hydro is currently implementing a monitoring program to assess the effectiveness of the ladder.

Similarly, threatened species are given a high priority in Hydro studies. Distributions of these species are analysed in conjunction with risk analyses and evaluation of threat sources using GIS software. The Hydro has made a strategic review of threatened species found within its catchments as a first step towards sustainable management of this issue.

The Hydro has been a major contributor to a recovery plan for several Tasmanian native fish species: the Pedder galaxias, swamp galaxias and saddled galaxias. For example, the Hydro has modified its operation of Woods Lake to improve the environment for the saddled galaxias. It has also modified the Strathgordon water supply dam to create a secure predator-free environment for Pedder galaxias. In conjunction with a translocation program to nearby Lake Oberon, this habitat will form an important component of the recovery plan for this species.

The primary threat to the continued survival of many native species is predation by introduced exotic fish. The Hydro is actively involved in reducing opportunities for these fish to colonise new areas through active water level management, installing barriers and being involved in public education campaigns. Lake Pedder is now kept at least one metre higher than Lake Gordon to ensure a water velocity barrier prevents Redfin perch colonising Lake Pedder and threatening swamp galaxias and any Pedder galaxias which may remain. Fish barriers have been installed at Penstock Lagoon and Liaweenee Canal to control movement of exotic fish. Ongoing monitoring of exotic fish distributions is conducted in key areas of the Hydro's waterway network.

1.4.5 Water for the Environment

Managing water for environmental objectives is an important priority for the Hydro. For example, it has recently completed the following projects:

- the Mersey River Flow and Catchment Assessment, which culminated in the Hydro releasing a minimum flow down the Mersey River out of Parangana Dam;
- a study of the Ouse River and its tributaries following excessive algal and macrophyte growth in the river; and
- major studies into impacts on the instream biota downstream of hydro-electric power stations.

The Mersey River project commenced in 1996, following concerns about flows in the Mersey River below the Parangana Dam. The Hydro, a number of government agencies and the local community investigated the environmental health of the river and its tributaries. This study utilised a habitat-based technique to determine an appropriate environmental flow. A key step in the process was to require environmental monitoring to be carried out prior to and following flow trials. This was to allow the environmental benefits of any release from Parangana Dam to be scientifically evaluated and ensure that any flow releases remain economically, socially and environmentally justifiable in the long term. The Hydro has now implemented the recommendations of the study at an approximate cost of $700,000 per annum. Furthermore, a release valve at Parangana Dam has been automated at a cost of $100,000 to ensure a minimum flow of two cumecs in the middle Mersey River at Liena. The Hydro is also funding the ongoing biological monitoring of the flow release.

1.4.6 Lake Level Agreements

The Hydro has voluntarily made agreements to manage water levels in several Tasmanian lakes to achieve environmental objectives. This has been done in consultation with various government agencies, particularly the Inland Fisheries Commission, and members of the community. The lakes where agreements are in place include Little Pine Lagoon, Shannon Lagoon, Bronte Lagoon, Penstock Lagoon, Lagoon of Islands, Arthurs Lake and Woods Lake. The aim of these agreements is to improve water quality, increase habitat for aquatic biota including vulnerable native fish species, and improve fishing conditions and other recreational activities. Lake St. Clair has a lake level agreement to minimise the extent of erosion around its shoreline. This has been negotiated with the Parks and Wildlife Service and is included in the Tasmanian Wilderness World Heritage Area Management Plan.

1.5 Current Operating System

The Hydro generating system consists of a network of 51 dams and 27 hydro-electric power stations. In addition, a thermal power station is located at Bell Bay and can be utilised to supplement generation if there is a projected short-fall in system security. An overview of the Hydro's storages and infrastructure is shown in Figure 1.1. The objectives of the current operating system are twofold:

1. to operate a secure power system in order to meet customer requirements in terms of energy and quality of supply; and
2. to operate the integrated hydro power system efficiently while satisfying hydrological, electrical, social and environmental constraints.

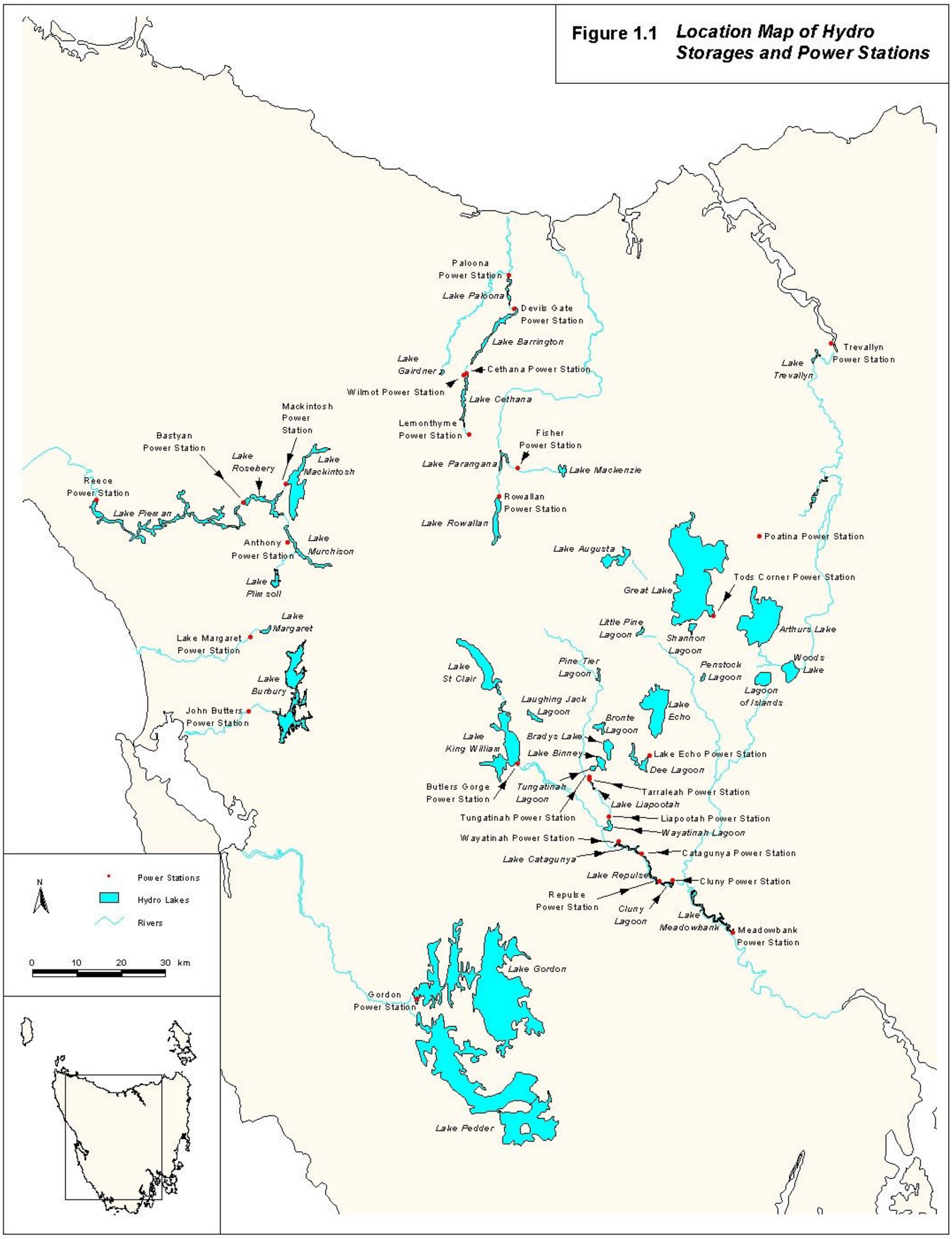

Figure 1.1 – Location map of Hydro Storages and Power Stations

To meet these objectives, the Hydro has developed and uses a system planning regime. The operating system is planned for:

- the long term (2 – 10 years);
- the medium term (1 week – 2 years);
- the short term and scheduling (1/2 hour to 1 week); and
- real–time operation and modifications to plans (immediate to next ½ hour).

In planning the operation of the system, various constraints apply, including safety, electrical and hydraulic, maintenance, irrigation, environmental, commercial and recreational considerations. The following sections outline how the system is currently operated in relation to storages and power stations.

1.5.1 Storages

The Hydro's storages can be categorised into three sizes: major; medium; and minor. These categories are based on the life cycle of the storage, that is, typical time taken to fill or empty the storage under normal weather conditions. Table 1.1 gives the categories for the Hydro's storages.

Table 1.1 – Categories of Hydro Storages

MAJOR (long period cycling)	MEDIUM (annual cycling)	MINOR (run-of-river)
Great Lake	Lake Echo	Lake Liapootah
Lakes Pedder + Gordon	Bronte Lagoon+ Bradys Lake + Lake Binney + Tungatinah Lagoon	Wayatinah Lagoon
	Lakes St. Clair + King William	Lake Catagunya
	Lake Rowallan	Lake Repulse
	Lake Mackenzie	Cluny Lagoon
	Lakes Murchison + Mackintosh	Lake Meadowbank
	Lake Burbury	Lake Trevallyn
	Lake Gairdner	Lake Parangana
	Lake Plimsoll	Lake Cethana
		Lake Barrington
		Lake Paloona
		Lake Rosebery
		Lake Pieman

Where Table 1.1 has joint listings (e.g. Lakes Murchison + Mackintosh), these storages can conveniently be regarded as one for this classification purpose as one is the hydrological extension of the other via river, tunnel or canal. Despite this, the TEMSIM modelling used for this report assesses these aggregated storages separately in order to quantify individual potential environmental impacts.

Most of the minor storages supply run-of-river power stations and have only limited storage. Consequently, these lakes can theoretically cycle (fill and empty) over a period of hours to days. Medium storages are usually the top lakes of a run-of-river chain and can cycle over a monthly or seasonal basis, and the two major storages cycle over a period of decades. The long-term system supply security (security of generation supply during times of drought) at present depends on the two major storages.

The Bell Bay thermal Power Station is only prepared for service if there is a real risk of not meeting power demand through the hydro-electric system. This is currently controlled by the thermal control rule (Section 1.5.5), but the need for this will be replaced by the system security offered by a Basslink cable.

1.5.2 Spills

Dams will fill during periods when inflows (ie. rainfall) exceed the associated power station's discharge. Spill of water from storages will occur when the water level exceeds the full supply level (FSL) and cannot be controlled by power station discharge. Spills are usually made via a spillway near the dam wall, but may occur via tunnels, canals or the opening of gates. Spills will bypass the turbines of a power station and therefore represent a loss of generation revenue. Consequently, the Hydro system is managed to reduce the incidence of spills, and priority of power stations within a schedule is determined largely by the proximity of its storage to spilling.

1.5.3 Power Station Operation

Power stations are not utilised continuously. The Hydro has an installed capacity of 2262 MW (hydro-electric stations only), but currently only generates an average of 1104 MW, with a system peak of around 1562 MW. The operational schedule for the network of Hydro power stations is determined by the following (in priority order):

1. Use any storage spill. This is water that would otherwise spill and therefore bypass the turbines.
2. Use pickup to run-of-river stations. These dams have limited storage and are therefore likely to spill if not utilised; and
3. Storage release. Release of water from dams is prioritised by the size of storage. Small storages are utilised first to maximise their storage potential. Medium storages are scheduled next and are prioritised according to their immediate probability of spill. The major storages are last on the priority list because they are unlikely to spill, and can provide the reserve energy when water is not available within the rest of the Hydro system (for example, during summer months).

1.5.4 Load on the System

The energy demand on the Hydro system fluctuates on annual, seasonal, weekly and hourly timeframes. To efficiently operate the system with the required level of security of supply, the load on the system needs to be estimated (at different levels of resolution) hours, days, weeks, months and years in advance. Forward planning is essential, as water needs to be stored and available in advance of power demand, and needs to take into account all the constraints on the system.

The Hydro system simulation program SYSOP is currently utilised to predict and run the Hydro system as it currently is without a freely competitive electricity market. An alternate model called the Tasmanian Electricity Market simulation model (TEMSIM) has been developed to enable better predictions of system usage under a competitive electricity market (see Section 2).

Figure 1.2 is provided to clarify some further terms related to load - base load, step load, deficit load, frequency, and peak power. Figure 1.2 shows a representative load curve, and how power stations are operated to meet this load. Time (24 hours) is shown on the x-axis, and load (in MW) is shown on the y-axis. 'Peak load' occurs in the morning and early evening, and is shown by the two peaks.

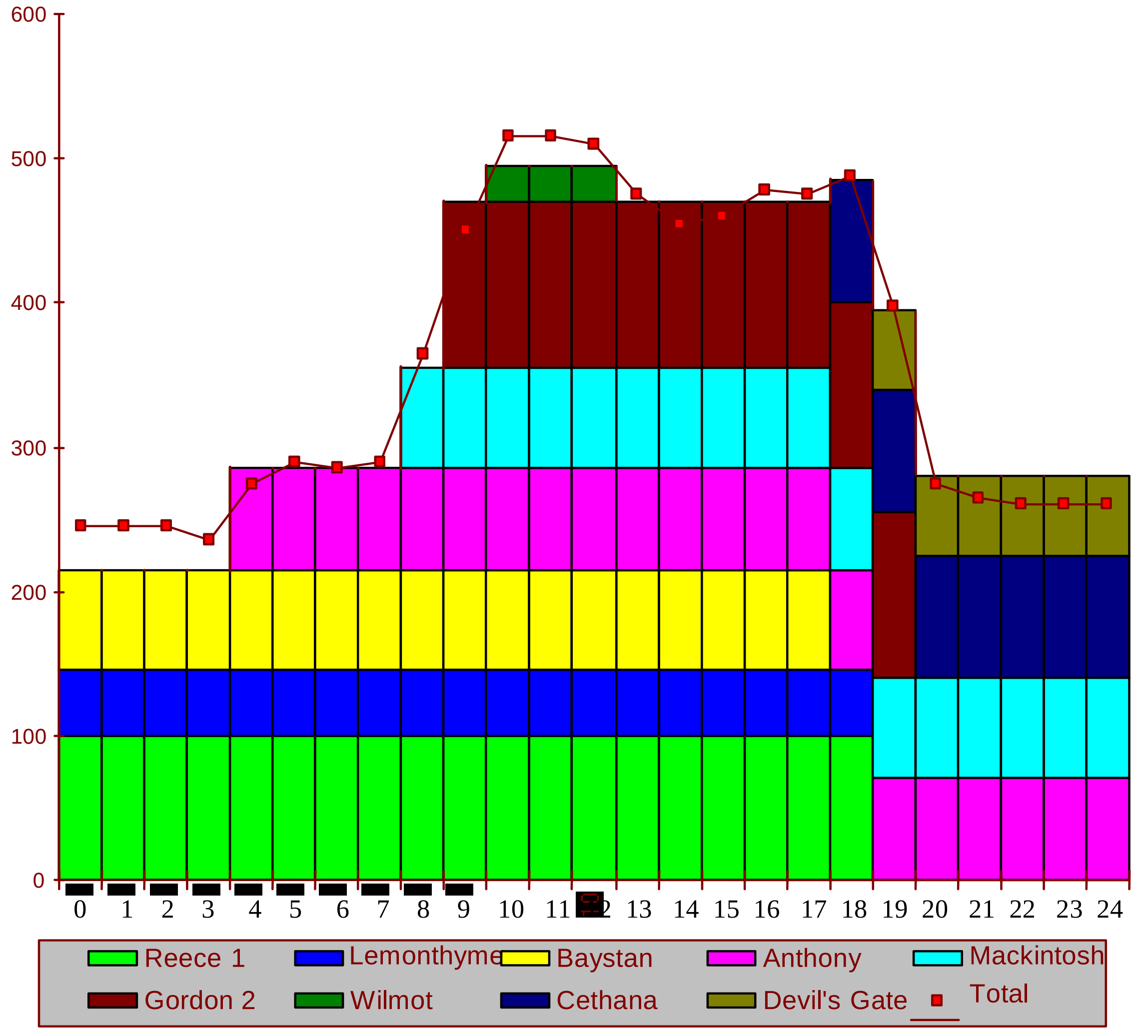

Figure 1.2 – Representative Load Curve

Certain power stations are scheduled to supply ‘base load’, the load that is constantly required during the day, shown at the bottom of the daily load curve. If there is sufficient rainfall to utilise the run-of-river storages, water will be drawn from them to generate base load. Power stations operating in base mode generate a constant load all day, and if sufficient water, keep generating that constant load the next day as well.

Load above the base load in Figure 1.2 is divided into steps of differing magnitude at different parts of the day. This is known as ‘step load’. Specific power stations are turned on for set periods of the day, running at their efficient load (or full gate if the storage is close to spill). Power stations operating in step mode are generally turned on at some point in the day, generate power at a constant load for a certain number of hours (e.g. 6-18), and then turn off.

‘Deficit load’ is the additional load above step load that constitutes the remainder of the daily load curve. It is supplied by power stations operating in deficit or frequency mode. These power stations vary their generation within a particular range (somewhere around their efficient load if possible) to meet the fluctuations of the daily load curve. Discharge from these power stations is variable over very short time periods.

1.5.5 Thermal Control Rule

Bell Bay is the Hydro's only thermal generator in Tasmania and is only brought into operation when the total system energy in storage falls below the Thermal Control Level. This level is derived to ensure a desired system security with minimum expenditure on thermal generation, whilst allowing the total hydro energy in storage to increase sufficiently. The thermal control rule does not just describe a static emergency level. The threshold changes continually in response to forecasted load and storage levels.

2 MODELLING OF THE HYDRO BASSLINK OPERATING SYSTEM

2.1 Introduction

This chapter describes the five stepped methodology used for modelling changes to Hydro's operating regime resulting from the introduction of the Basslink cable. The methodology used in this report is summarised in Figure 2.1. This figure shows five numbered steps that are explained as follows:

1. The basic tool for this study is the Tasmanian Electricity Market Simulation model, known as TEMSIM. TEMSIM is described in detail in Section 2.2.

2. To provide the desired outputs for this study, the TEMSIM model has a number of inputs and outputs.

   a) Inputs to TEMSIM include a finance model (PROPHET), efficiency curves and an inflow database. These are described in Section 2.3.

   b) Outputs from TEMSIM include lake level fluctuations and power station (PS) discharges. These are described in Section 2.4.

3. Model runs include three different Basslink cable sizes (with assumptions). These are compared to the projected way the current system would be operated in 2003 without the Basslink cable but includes competition within the system, and to the historical pattern of operation. These model runs are outlined in Section 2.5, along with assumptions and limitations of the TEMSIM model.

4. Hydrological data analyses conducted on the model output data are identified in Section 2.6.

5. Environmental and social issues are identified according to the methodology described in Section 2.7.

Section 2.8 details the limitations and constraints in the study methodology as a whole.

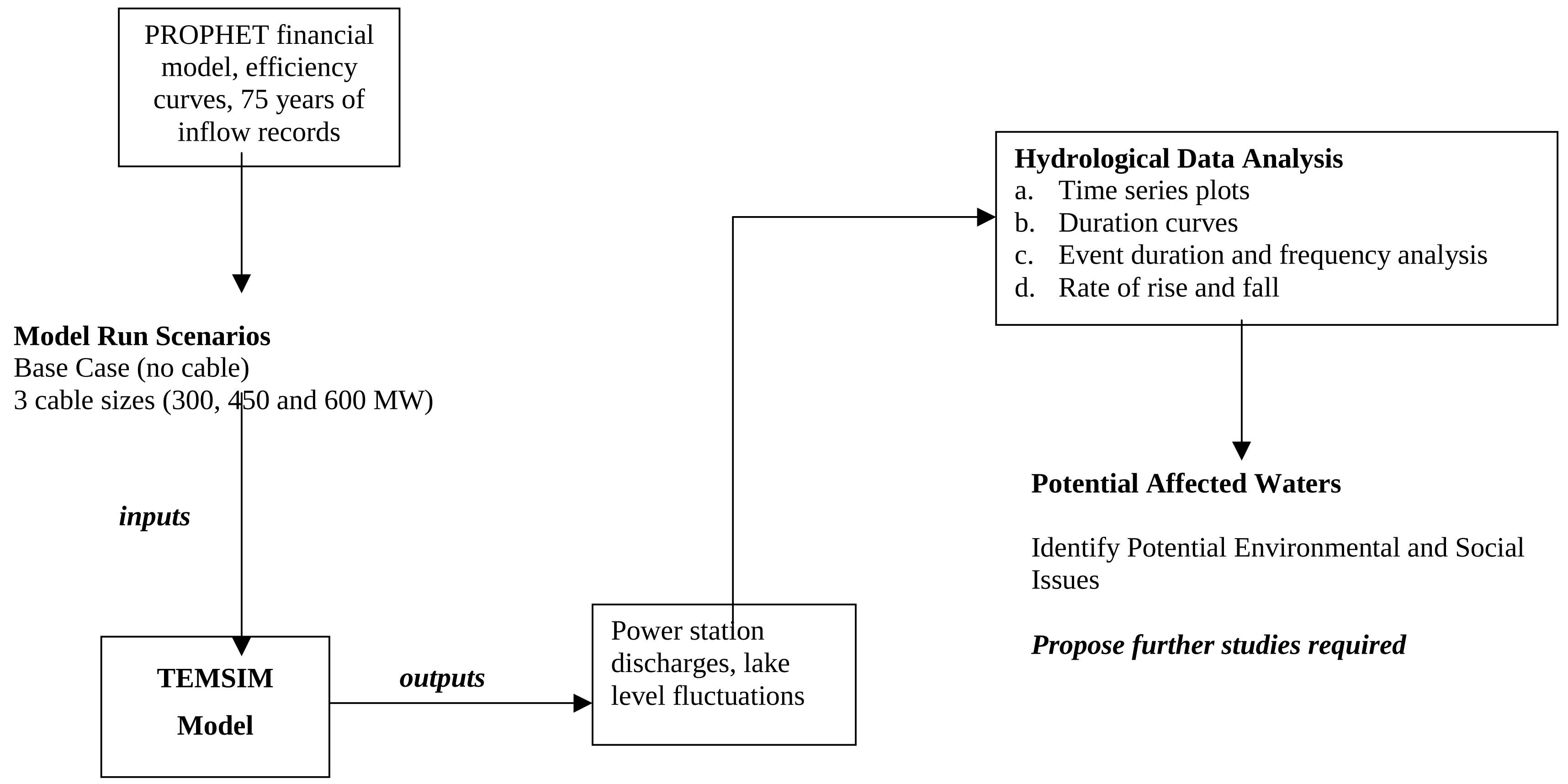

Figure 2.1 – Study Methodology

2.2 Description of the TEMSIM model

2.2.1 Overview

TEMSIM, the Tasmanian Electricity Market Simulation model, is a detailed simulation model of the Tasmanian generating system operating according to market rules within the National Electricity Market (NEM). A finite connection to the Victorian region (Basslink) is included in the model. The model sets a generating schedule based on a NEM-type dispatch process that is founded on generation offers from participating generators.

The five major catchments of the Tasmanian hydro system are interpreted as the five virtual generators of TEMSIM. These virtual generators offer generation in a coordinated manner in order to achieve efficient use of Tasmanian supply resources. Basslink transfers are determined using forecasts of System Marginal Price (explained in Section 2.4.1). The operation of TEMSIM consists of three stages, as outlined in Figure 2.2:

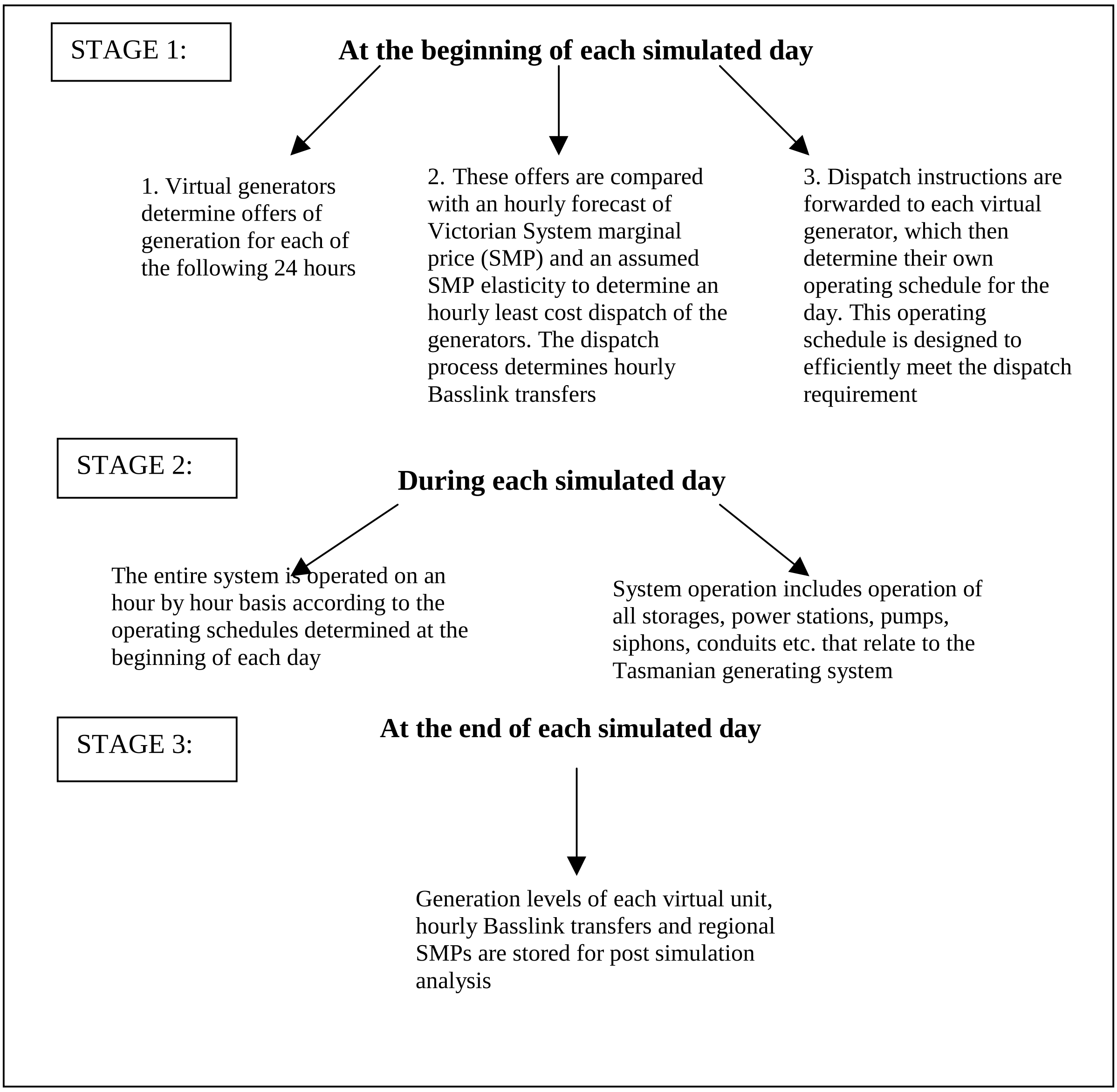

Figure 2.2 – Overview of TEMSIM Operation

2.2.2 Modelling of the Tasmanian Generating System

In TEMSIM, the Tasmanian generating system is modelled in considerable detail and is based on existing infrastructure. All 40 significant water storages, all 27 power stations, all conduits, pumps and siphons are included in the model. The power stations are represented individually, with all machine/turbine efficiency characteristics modelled.

The TEMSIM model can also incorporate the thermal control rule (as it relates to Bell Bay Thermal Station), setting the threshold approximately where there is a 2% annual risk of storage depletion to a critical ('emergency') level, below which, the system may be unable to meet power demand (see Section 1.5.5). This is only incorporated in the no Basslink scenario (See section 2.5.1 - case 1).

75 years (1924-98) of historical inflow data is available and used in the model (the inflow data base is explained in more detail in Section 2.4.2). TEMSIM can be operated using a single sequence of inflows into water storages or with multiple sequences in order to evaluate the effects of hydrological variability. For the purposes of this scoping study, a single sequence of 75 years of inflow data was used.

System demand is determined hourly and is derived from average annual load forecasts. These forecasts are disaggregated into hourly fragments that reflect seasonal, weekday/weekend and within day variations. Constraints on generation resulting from current environmental or riparian requirements (e.g. lake level agreements) are included in the model.

2.2.3 Offers in TEMSIM

At the start of each simulated day offer prices and volumes are determined for the following 24 hours for each virtual generator.

For the long term storage generators (Gordon and Great Lake), prices are based on the long-term marginal cost (LTMC) function, which relates LTMC to total energy in storage (TEIS). Figure 2.3 illustrates the modelled price curve for long term storages in TEMSIM.

Figure 2.3 shows that prices are lower when more water is held in storage in Great Lake and Lake Gordon/Lake Pedder. As storage levels decrease, usually during summer months, the price per MW hour increases towards Value of Lost Load (VoLL). The LMTC curve differs for each month of the year.

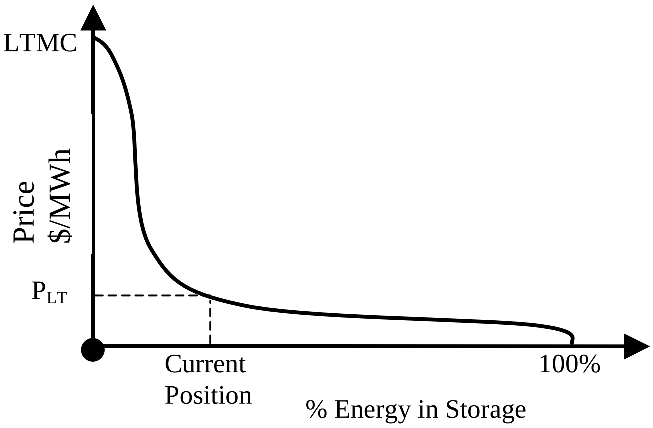

Figure 2.3 – Long term storages price curve. PLT is Price Long-term

For the intermediate storage/downstream cascade systems (see Figure 2.4), head storage prices are set using empirical relationships between storage and price. This relationship is based on the assumption that the value of water in these storages is equal to the long-term marginal cost (P_{LT} – price of Gordon and Poatina electricity) when the storage is at its seasonal target level/economic operating level. Each storage has a 'target level' or 'economic operating level' (EOL) for each month of the year.

In order to determine offers for the intermediate storage/downstream cascade systems, TEMSIM uses the following approach:-

The current storage situation is assessed (i.e. current level in Figure 2.4, including inflows for the coming day) and available generation volumes (V1 to V5) are estimated. Classification of generation volumes are outlined in Table 2.1.

Table 2.1: Classification of available generation.

1.	Energy generation to avoid spill	V1
2.	Operation of run-of-river storages to target level	V2
3.	Operation of head storages to target level	V3
4.	Operation of run-of-river storages to NMOL	V4
5.	Operation of head storages NMOL	V5

In general, prices associated with these volumes are also based on the LTMC function for the system in total together with empirical price functions for the intermediate (head) storages.

Figure 2.4 illustrates a case where the intermediate storage price is less tan the long term storage price (P_{LT}). This would result in the use of the intermediate storage (in this case Lake Burbury and John Butters Power Station) prior to the long term storages (Great Lake and Lake Gordon).

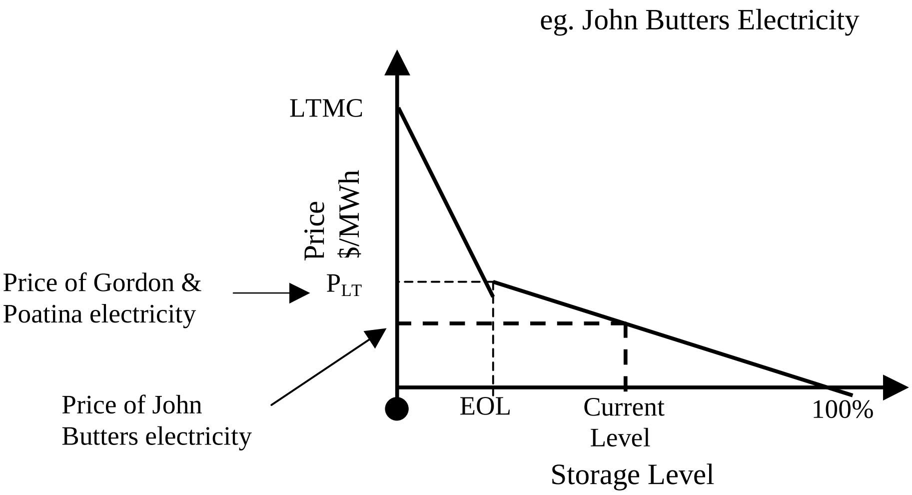

Figure 2.4 – An example of an intermediate storages/downstream cascade systems price curve.

2.2.4 Dispatch in TEMSIM

The dispatch module in TEMSIM determines dispatch of generated electricity in two regions connected by a Basslink cable. The module receives generation offers from the 5 virtual generators operating in the Tasmanian region. Offers for notional Victorian generators are constructed around forecasted System Marginal Price (SMP). These notional offers are submitted to the dispatch algorithm along with real offers from the Tasmanian generators.

The dispatch process involves "taking" generation from a prioritised list of offers (lowest price offered first) to meet demand in the two regions. Initially, offers from generators are placed against demand in the region that the generator is located in. If demand has been met in that region, offers may then be used against demand in the other region by means of a link transfer. The list of offers is thereby transformed into a generation dispatch schedule for both regions.

2.3 Model Inputs

2.3.1 Determination of System Marginal Price (SMP)

The Basslink TEMSIM model requires a projection of hourly mainland electricity spot prices to be input, which provides an hourly time series of mainland prices. These prices are based on a forecast of mainland pool prices provided by the PROPHET model which was developed by Intelligent Energy Systems (IES 1997).

The PROPHET model simulated the currently interconnected systems of NSW, Victoria, Snowy, South Australia and the proposed NSW – Queensland interconnection. The model is designed to implement the principal NEM rules and was used to generate price distribution in Victoria under future scenario assumptions. TEMSIM modelling was based on the results generated for 2003, as this is when it is likely Basslink will become operational.

The SMP set in each region is influenced by whether the cable is constrained or not. When demand in both Tasmania and Victoria have been met, or all offers have been dispatched, the SMP is determined for these two regions. If the link is constrained by Basslink being at full capacity, a region's SMP is set by the last dispatched offer of a generator in that region. If the link is unconstrained, the SMPs in the two regions are equal (ignoring link losses) and set to the last dispatched generator in the importing region. If demand has not been met in a region, the SMP for that region is set to Value of Lost Load (VoLL which is currently set at $5000/MWh). SMPs can never exceed VoLL.

Generally, if the SMP for Tasmania is less than the SMP for Victoria, then electricity will be exported from Tasmania to Victoria, usually during Victorian peak price periods. If the SMP for Tasmania is greater than the SMP for Victoria, then cheaper electricity will be imported from Victoria. A possible scenario leading to a link transfer from Victoria is during summer when our storages are low and prices are higher (refer to Figure 2.3).

In determining link transfers, an assumed 10% loss has been incorporated into the model. This dictates that there must be at least a 10% differential in SMPs for a transfer to occur, and for each 1MW sent over the link only 0.9MW arrives at the other end.

The key point for this study is that the mainland electricity market model (PROPHET) which forms an important input to the Basslink TEMSIM model is derived from a detailed and complex study. There are uncertainties in prediction of future market behaviour, but price data input into the Basslink TEMSIM model is based on the best analysis available. The dispatch process in TEMSIM was reviewed and approved by Macquarie Bank in August 1999.

2.3.2 Inflow Database

The TEMSIM model relies on a database of storage inflows comprising 75 years of record between 1924 and 1998. Wherever possible, Hydro has used direct flow measurements to determine inflow sequences for various basins. This is considered the most reliable method and provides a true picture of daily and seasonal variations.

The TEMSIM model is based upon the SYSOP model, which is currently used to model the Hydro system. BC Hydro (1996) audited SYSOP and the inflow database that both it and TEMSIM are based upon. The BC Hydro audit team estimated uncertainties in the inflow database for the SYSOP model. These varied with catchment, and were generally between ±3% to ±5%. The audit team noted that "uncertainty in the basin inflow estimates do not necessarily translate into the same uncertainty in system energy estimates, as there is expected to be a random variation in the sign of uncertainties between basins" (BC Hydro 1996, p.2-12). Errors in data used in the simulation were assumed to be in the order of ±5%, and the error in energy output significantly lower than that, in the order of 1.5% (BC Hydro 1996). It is considered that the conclusions drawn by the BC Hydro audit team were reasonable, in so far as they were based on a fairly broad overview of SYSOP's performance and historical database. SYSOP is a suitable basis for the development of TEMSIM.

The TEMSIM model utilises the 75 years of inflow data for the system with its present day infrastructure. Changes in infrastructure in the Hydro operating system over the 75 year period are not considered in the model. Model outputs are a simulation of what the power station discharges and lake level fluctuations would have been during the 75 year period of inflow record if the present day infrastructure had been in place over those 75 years. The aim is to forecast outcomes under the current system operations.

2.3.3 2.4.3 Efficiency Curves

TEMSIM estimates all discharges from power stations using a suite of 'efficiency curves'. These curves are plots which show the effective turbine kW per cumec at different turbine discharges (in cumecs). An example of the shape of one of these curves is provided in Figure 2.5. In Figure 2.5, point A is the most efficient load for a single turbine power station.

These curves are unique to each power station turbine. For power stations where there are multiple turbines, the efficiency curve becomes a series of the shapes, such as that shown in Figure 2.6 for a hypothetical power station with three turbines.

In Figure 2.6, the overall power station efficiency curve (shown with the solid line) is created from the overlap of three efficiency curves, one for each turbine. Point A in Figure 2.6 is the most efficient load for the first turbine, which corresponds with a particular discharge rate. Point B is the efficient load for the first and second turbine together, which corresponds with a higher discharge but lower efficiency. Point C is the efficient load for all three turbines.

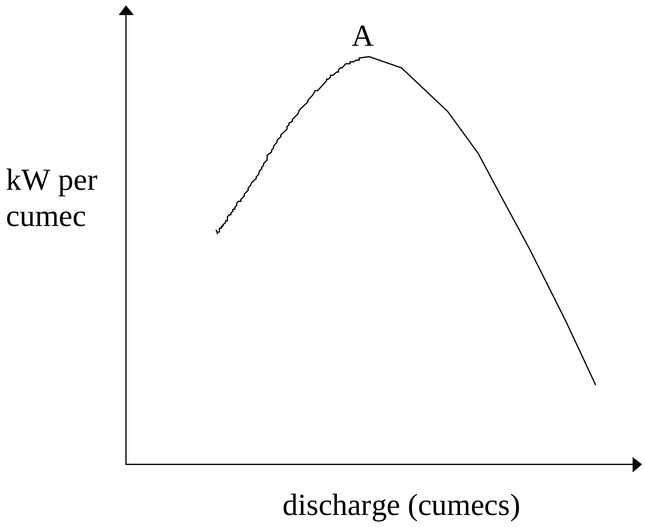

Figure 2.5 – Typical Efficiency Curve for a Single Turbine (denoted A)

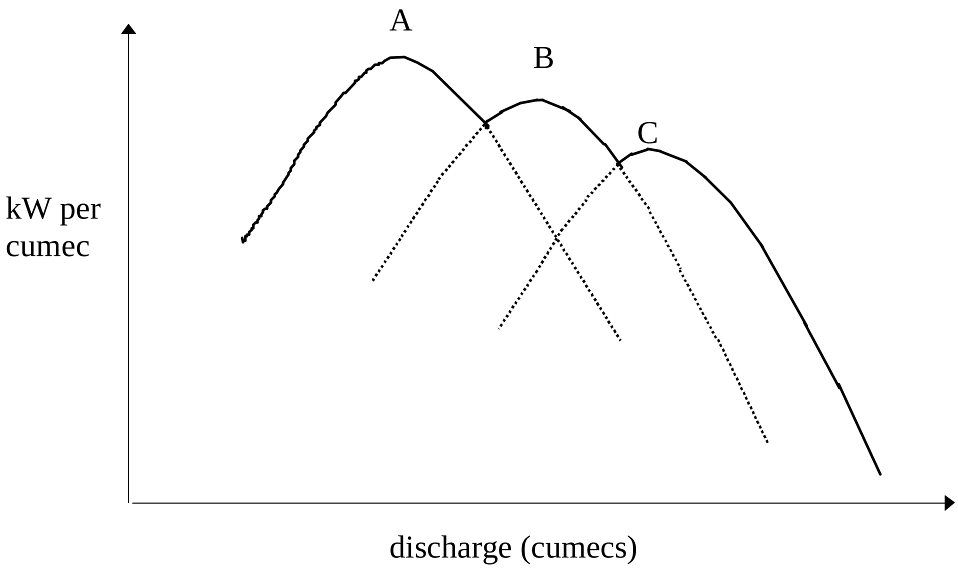

Figure 2.6 – Typical Efficiency Curve Shape for Multiple Turbines (denoted A, B and C)

For TEMSIM modelling, individual curves were used for all turbines in the system. Most efficiency curves were provided by the turbine manufacturer, and there may be a degree of unquantified error in their exact form. These efficiency curves do not originate at zero discharge and do not detail low flows, because flows close to zero are not in the range for which the turbines were intended to generate energy. Most turbines are operated as close to the maximum efficiency as possible.

2.4 TEMSIM Model Outputs

Information obtainable as outputs from the model include:

- Hourly SMP values in the Tasmanian and Victorian regions;

- Hourly storage volumes (cumec-days);
- Power station discharges (cumecs); and
- Hourly Basslink transfers.

The large amounts of data generated by the TEMSIM model runs posed a number of logistical difficulties for this study. Each run generated an output file that had separate results for each of the hydro-power stations (both spill and discharge) and the storages. Power station discharge and spills needed to be detailed on an hourly time-step over the 75 years of record, in order to capture the rapid fluctuations in water releases which may occur with a change to supply of peak load power. Lake level changes were run on a daily time-step as they would not change as rapidly.

To reduce the amount of data analysed, point sources in the generating system where power station discharges occur were carefully assessed. Discharges from power stations which went directly into another hydro storage were not modelled as there was no riverine receiving system (e.g. many of the power stations in the run-of-river cascades in the Mersey-Forth, Pieman and Derwent).

2.5 Model Runs

2.5.1 General

There were four model runs conducted for this study. These were:

Case 1 (0MW): 0MW import/0MW export, present day infrastructure and operating constraints, without the Basslink cable but includes competition within the system, and operation of Bell Bay;

Case 2 (300MW): 300MW import/300MW export and includes a Basslink loss factor of 10% export/import, with no operation of Bell Bay;

Case 3 (450MW): 450MW import/450MW export, including the 10% loss factor, with no operation of Bell Bay; and

Case 4 (600MW): 600MW import/600 MW export including the 10% loss factor, with no operation of Bell Bay.

Case 1 is the base case (TEMSIM 0MW). This was used to predict system operation in 2003 if the Basslink cable was not available. It is based on the TEMSIM model and so treats the current system as divided into five “virtual” generator groups (based on hydro-catchments), in a competitive electricity market with each other. The operation of Bell Bay is included in the prediction, as it would still be required for additional system security if the installation of a Basslink cable was not undertaken. The other three cases modelled three different cable sizes, only one of which would be implemented under Basslink.

2.5.2 Assumptions

For all three cable sizes (300 MW, 450 MW and 600 MW), Bell Bay was excluded from modelling, as it would not be part of the system under Basslink, as Victoria would provide security of supply.

The TEMSIM model also incorporated the current system operational constraints. These include lake level agreements and downstream maximum or minimum flow discharges which are present on a number of lakes and rivers. Major operational constraints are shown in Table 2.2. Constraints also exist on a number of other minor storages, for example Penstock Lagoon, Shannon Lagoon, Little Pine Lagoon, Bronte Lagoon and Woods Lake.

Table 2.2 – Current Operational Constraints on the Hydro System

Lake level Agreements	**NMOL (m ASL)**	**FSL**	**min LLA**	**max LLA**	**Reason, duration, other info.**
Arthurs Lake	943.05	952.82	948	-	Habitat enhancement
Lake Augusta	1141.63	1150.62	1146.86	-	To prevent sand blowing into intake area
Lake Meadowbank	67.06	73.15	71.86		Maintain irrigation offtakes under water. Water level maintained within 0.15m of FSL
Lake Pedder	305.41	308.46	306.93	308.46	Protection of lake from excessive erosion. Additionally, water is released through McPartlans canal only when L. Pedder is 1 m or more higher than L. Gordon
Lake Rosebery	151	159.4	156	-	Maintain town and mine water supply intakes under water. Only drops below min LLA for maintenance
Lake St Clair	734.58	736.72	-	735.6	Protection of lake from excessive erosion. Above this level less than 6% of time - for model 735.6 was taken as a max lake level.
Lake Trevallyn	117.96	126.49	124.97	-	Drawn down for flood events, to prevent damage to urban areas.
Downstream Rules			**min discharge (cumecs)**	**max discharge (cumecs)**	**Reason, duration, other info.**
Poatina PS			2		For Cressy town water supply
Butlers Gorge PS				20	To prevent downstream canal from spilling
Meadowbank PS			20		Hobart water supply - riparian valve used when PS is off
Parangana Dam			up to 2		Environmental flow for Mersey River

NB. See Glossary for explanation of acronyms / abbreviations

The forecast annual Tasmanian system load, as calculated by forward load predictions to 2003 (when Basslink would come on line), was set at 1135 MW for all cases. This was taken from the System Controller 1998 planning statement and is the official load forecast. Start storages for the model were determined by taking the storage levels at June 1999 (76%) and running SYSOP to predict the storage levels at January 1, 2003.

2.5.3 Limitations of the TEMSIM Model

As with any model, TEMSIM has a number of limitations. The first is that it models the current generation system in Tasmania, and does not allow for any new infrastructure such as wind power and gas. It also does not take into account future cloud seeding activities (the historical inflow database includes the influence of past cloud seeding activities on the catchments, however future projections do not). The way the storages are "bid in" reflects best available future predictions, but this may change or be refined in the future. The mainland market is also modelled as is, in regards to current infrastructure and bidding system. There is also an assumption of a degree of price elasticity, however the import of power into the Tasmanian system may affect prices on the mainland in slightly different ways to that predicted and modelled.

Maintenance can involve some periods of power station shutdown. Maintenance shutdown scheduling is not present in TEMSIM, as it is not possible to predict timing and level of maintenance as a result of Basslink-induced changes to operations. With the additional security provided by Basslink, scheduling of maintenance is anticipated to be significantly more flexible (S. Stolp, pers. comm.) although still constrained by power production demands.

TEMSIM does not simulate any transmission constraints. Transend have an ongoing program to address existing system weaknesses. Overall, TEMSIM provides the best available prediction of how Basslink will affect the Tasmanian system in the future. The Hydro is refining the modelling of its system, and will continue to review the environmental implications of any changes to the waterways predicted by the model.

2.6 Hydrological Analyses

2.6.1 Hydrological Changes of Ecological Significance

The output data consisted of hourly power station discharges and daily lake level fluctuations over 75 years of record. Detailed consideration was given to how the output data from the model runs would be analysed for this study. Hydrological statistics were selected which best indicated the potential for environmental impacts. Environmental and social risks were assessed where significant difference occurred between future predictions without Basslink (0MW) compared to predictions with a cable (300MW etc.) in place. Comparison was also made between historical and predicted system operations.

The components of the hydrological regime which are most critical for maintenance of downstream ecosystem integrity have been the subject of widespread investigation for the purpose of setting environmental flows. For example, Clausen and Biggs (1997) undertook a rigorous analysis of 35 streamflow variables for use in ecological studies. Such rigour was beyond the scope and resources of the present study, and it drew on the more general guidelines provided in the 1996 State of the Environment Australia report.

The State of the Environment Australia report flags the following five changes in river flows as significant in affecting channel form, sediment transport, water quality, habitats and biota of Australian streams (Wasson *et al*. 1996):

1. decreases in the volume of discharge or occasional increases (e.g. with interbasin transfers);
2. changes in and reversal of seasonal flow patterns (e.g. higher summer instead of winter flows);
3. reduction or enhancement of the natural variability of flows on scales of hours, months or years;
4. changes in the frequency (typically suppression) of small to medium floods; and
5. changes in the form of floods, especially the rate of rise and fall.

In addition, the following was considered to be of significance:

- the incidence (frequency and duration) of extreme low or zero flow events; and
- the frequency and magnitude of rates of rise and fall about specific river levels or discharges.

For lakes, the following were important:

- the long term and seasonal pattern of lake levels;
- the duration and incidence of low lake level events at long time scales; and
- the relationship between lake levels and key bathymetric and biological features.

Each of these aspects of flow regimes were considered, and a suite of outputs selected for the TEMSIM model runs to ensure assessment of these key aspects could be made.

2.6.2 Data Analyses and Presentation for Lakes

For lakes, three sets of statistics were conducted, as shown in Table 2.3. These show the effect of Basslink in regards to magnitude, frequency, duration and timing of lake level fluctuations.

Table 2.3 –Lake Level Data

Statistical Indicator	Time Step
Lake Level Duration	Daily
Monthly Average Lake levels	Daily
Lake Level over Time	Daily

2.6.3 Data Analyses and Presentation for Power Stations

Table 2.4 summarises the statistics that were generated for power stations discharge. These statistics are easier to display graphically so explanation is deferred until Section 3, with the presentation of results.

Table 2.4 –Power Station Discharge Data

Statistical Indicator	Time Step
Monthly Medians	hourly
Monthly Maximums	hourly, daily
Annual time series	daily
Weekly time series	hourly
Zero event duration analysis	hourly
Positive event duration	hourly

2.6.4 Method and Statistical Analyses for Assessment of Downstream River Reaches

For those power stations outflows shown to be most subject to hydrological change under Basslink, additional analyses were conducted to demonstrate how changes at the power station would be manifested downstream. This was done with the construction of hydrological models of the downstream reaches, which utilised tributary flows, rainfall records, rating curves and stream level data, catchment areas, and any other relevant data.

2.7 Assessment of Environmental and Social Issues

'Environmental and social issues' examined in this study include impacts on aquatic ecosystems, supply to downstream users, and changes in recreational and aesthetic values.

Environmental risks were assessed using the following techniques:

- review of relevant literature;
- review of relevant historical environmental data;
- downstream hydrological analyses;
- initial stakeholder consultation; and
- specialist consultation.

Initial consultation on environmental issues was conducted with Dr P Davies, Freshwater Systems, Tasmania, during 1998 and 1999. This was limited to staff of relevant government agencies responsible for managing water, fishery and other natural values, as well as for abstractive use, and was designed to identify which environmental issues were relevant, what their relationship with Basslink might be, and what various actions (mitigation and studies) might be required. Consultations took the form of meetings and/or phone conversations, and were largely limited to seeking information on the nature of the environmental issues.

Stakeholder consultation will continue as part of the Hydro's Basslink environmental investigations into Tasmanian waterways. On-going public and stakeholder consultation regarding the Hydro's present and future operations will also be conducted through the Hydro's water management review (as described in Section 1.4.2).

2.8 Limitations and Constraints in Study Methodology

As this report is intended as a scoping document, field assessments were not undertaken. The field knowledge of the study team and consulted specialists and stakeholders was extensive and was felt to provide adequate information for scoping the environmental issues.

The assumptions used in modelling possible scenarios under Basslink are clearly stated in Chapter 3. It is impossible to model all future electricity market and water management scenarios. Nevertheless the output of the modelling should provide a good indication of potential water management issues, upon which to base further study.

3 MODELLING RESULTS

This section describes the modelled response of the Hydro system to changes in electricity demand patterns under various Basslink cable capacity scenarios. The modelled cable capacities are 300MW, 450MW and 600MW for both import and export of electricity to and from the mainland. Additionally a 0MW scenario describes the base case, with no transfers over a Basslink cable but including all the other model assumptions and constraints.

A historical plot line is included in some analyses where available to indicate past water management practices. Comparison with historical trends should be interpreted with awareness of changes in the generating system over time; for example, the Pieman system was completed in 1987, and King scheme in 1992, and the Anthony scheme in 1994. Generally, historical analyses were restricted to the period reflecting current operations to provide the most realistic comparison.

The results of the modeling are presented on a catchment by catchment basis. Within the discussion of each catchment, modelled results for lakes are presented first, then river discharges downstream of power stations.

As there are 51 main storages and 27 hydro power stations in the Hydro system, not all of the results are presented in this report. Power stations which discharge to major riverine environments have received particular attention in the analyses conducted for this report – notably downstream of the Gordon and Poatina Power Stations. Results are not presented for power stations which discharge directly to lake environments. Minor and run-of-river storages exhibiting similar characteristics are discussed as a group and are illustrated by one or two examples typical of their operation.

3.1 Performance of the model

The TEMSIM model used in the current study is an improvement on previous models in that it factors in a competitive electricity market in Tasmania where 5 ‘virtual’ generators (based on the 5 major power generating catchments) bid into the market. This model allows assessment of the impacts of a competitive electricity market within Tasmania as well as the effect of the Basslink cable itself.

As with any model, there are a number of constraints in the TEMSIM model that need to be considered when interpreting the modelled results. Particular constraints to be aware of with the TEMSIM model are:

- TEMSIM uses full-gate operation for many of the power stations even when there is no imminent risk of spill, and so modelling results indicate a marked increase in full gate discharges from power stations. This represents inefficient usage of the Hydro’s water resource. In reality, full gate discharge is likely to occur only when the electricity market is accepting high priced bids.

- The TEMSIM model is, on average, about 5% less water efficient than the preceding SYSOP model. The inefficiencies arise from competition between the 5 virtual Tasmanian generators bidding against each other, and the need for each of the 5 major catchments to supply a larger proportion of its own system security.

- There are inadequacies in the scheduling of small to medium-sized power stations in the lower parts of cascade systems (ie. Derwent and Mersey Forth). This results in the electricity load being met by generation from the upper power stations in a run-of-river cascade without fully utilizing this water as it travels (spills) down subsequent lakes in the cascade. This would not occur in reality and leads to some of the inefficiencies noted above. As a consequence, the discharge patterns downstream of Meadowbank and Paloona Power Stations in particular are not correctly represented by the TEMSIM model. Balancing of multiple head storage operation (Derwent and

Mersey Forth) is also not fully optimised in the TEMSIM model. Future improvements in the system modelling will address these issues.

A detailed discussion of the modelling results is presented on a catchment by catchment basis in the rest of this section.

3.2 Gordon Catchment

The Gordon Power Scheme consists of two large storages – Lake Pedder and Lake Gordon. Lake Pedder acts as a diversion storage and is constrained in operating range to 1.53 m through legislation, to protect it from erosion. Levels in this lake are governed by natural seasonal inflows. The lake level does not fluctuate in response to electricity demand and will therefore not affected by changes in operation of the Gordon Power Station. The main outflow from Lake Pedder is via McPartlan Canal to Lake Gordon.

The Gordon Power Station draws water from Lake Gordon and principally controls downstream discharges to the Gordon River. There is also a facility to release water from Lake Pedder via riparian valves at Serpentine Dam to the Serpentine River and subsequently to the Gordon River. This facility acts as the spillway for the Pedder-Gordon system, but has only been operated to test the riparian valves.

3.2.1 Lake Gordon

Lake Gordon lake levels have historically cycled up and down on a time scale of decades. TEMSIM modelling indicates that Lake Gordon will continue to operate on the long- term cycling basis under different Basslink scenarios. The major change is that the operating range is reduced under a TEMSIM market model (0 – 600MW) in comparison to historical operations. The overall variation in lake level for historical operations is 40m, under a market model this is reduced to a 30 m range with the top 10 m of the storage not utilised under the modelled scenarios. The 300 MW and 0 MW scenarios show greater variability and lower levels of operation than do the 450 and 600 MW scenarios.

Behaviour of the lake under the different cable sizes is a function of the Long Term Marginal Cost (LTMC) curve and of the ability of a Basslink cable to import power during times of high electricity demand when the system security of the lake is compromised. When the lake is drawn low, the price of the water is higher (see Section 2.2.3) and consequently, bids for energy generated from this water are less likely to be accepted by the market. This negative feedback therefore prevents the lake from being drawn too low. Alternatively, high lake levels result in a low price being assigned to the water and it is successfully bid into the market.

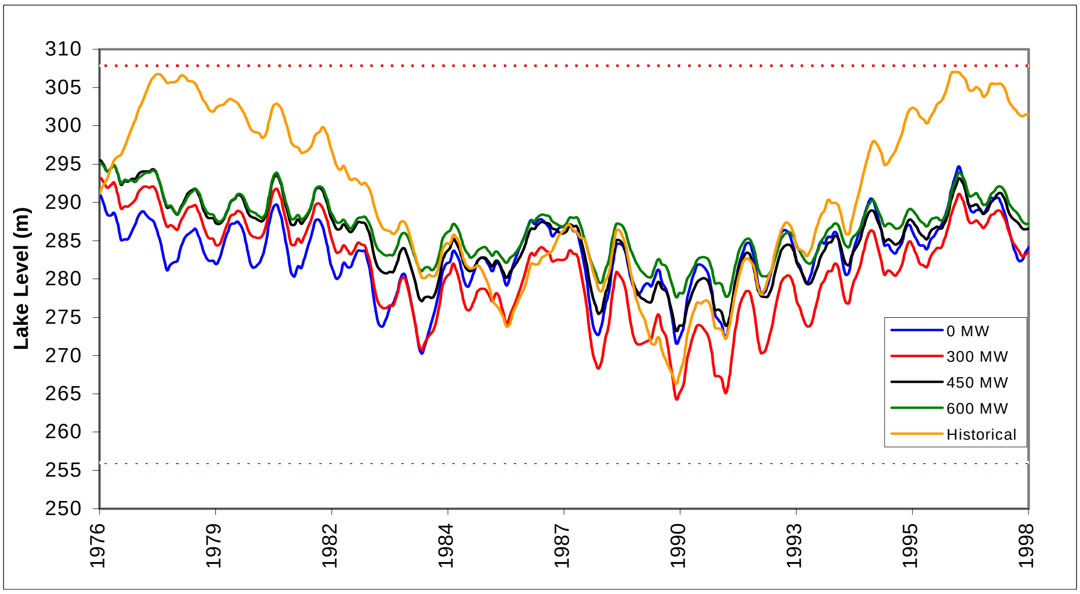

Figure 3.1 – Lake level time-series plot for Lake Gordon. The time period shown (1976 to 1998) represents the time since the filling of the impoundment after dam closure in 1974. The top and bottom lines indicate FSL and NMOL for the storage.

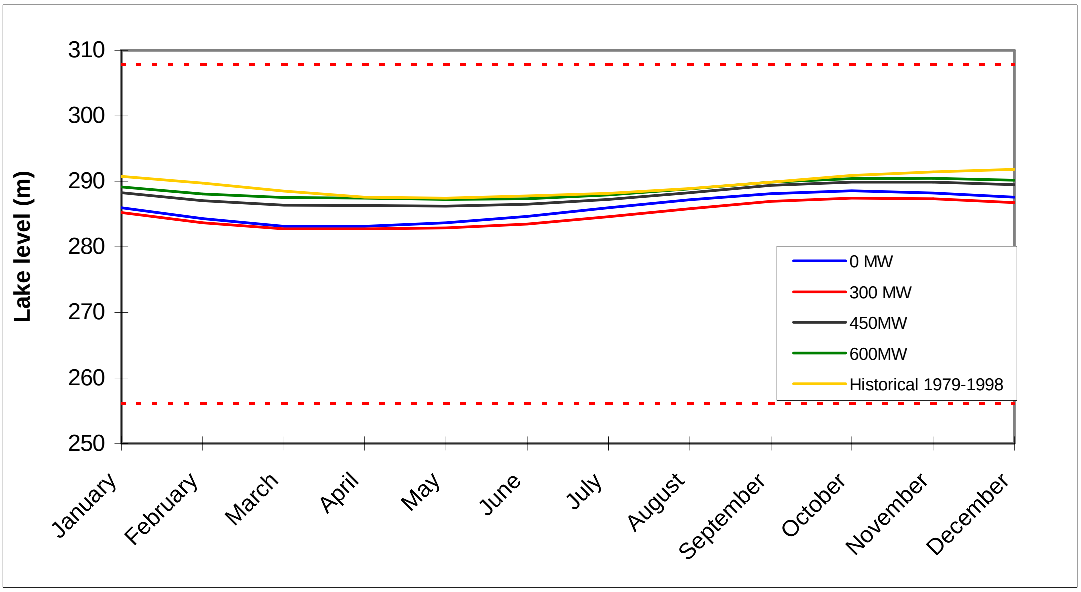

Figure 3.2 – Average monthly lake levels for Lake Gordon based on the 65 year modelling period. The historical averages for the period 1979 - 1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

The lower lake levels under the 300 MW cable scenario (see Figure 3.1) are a result of low inflows during the warmer months into other Tasmanian storages and therefore a shortfall in the ability of the run-of-river stations to meet electricity demand. At the same time, no Bell Bay thermal backup is available and there is only limited (300MW) security provided by the Basslink cable. Under such conditions high priced energy bid into the market by Gordon Power Station would be accepted to take up the unsatisfied demand and Lake Gordon would be drawn lower than normal. This variation is still within the historical fluctuation range.

Larger cable scenarios (450 and 600 MW) display a reduced propensity to react in this way due largely to the increased ability to import power from the mainland when Lake Gordon's price is high (lake level is low). This results in the larger cables on average holding the lake higher than both the 300 MW cable and the 0MW (no cable) scenarios (Figure 3.2). Figure 3.2 also shows that the seasonality of lake level fluctuations changes somewhat between historical operations and the TEMSIM simulations, with highest levels being attained in October rather than December. The difference in level between these times in any of the cable sizes is less than 1 m and is not considered an issue in the management of this lake.

Overall no significant environmental or social disadvantages have been identified relating to changes in the management of Lake Gordon under Basslink. Consequently, no studies are recommended as part of the detailed environmental investigations to be conducted by the Hydro on the potential effects of Basslink. In fact, it is likely that the maintenance of the lake level below the top 10m of the storage would have some environmental benefits:

- The possibility of redfin perch being able to invade Lake Pedder is greatly reduced. This is an aggressive introduced piscivorous fish that inhabits Lake Gordon. It has been able to disperse into McPartlan Canal when Lake Gordon has been at high levels. Reduced levels in Lake Gordon will increase the exposure of barriers to this fish's ability to move into the canal, thereby significantly reducing the possibility of this fish invading Lake Pedder. The Hydro currently has an operational rule in place to maintain a water flow velocity barrier at the canal gate to exclude this fish from Lake Pedder for the protection of the threatened Pedder and swamp galaxias, and the recreational trout fishery. Operation of this rule will be significantly reduced under the different Basslink scenarios, and its associated enhanced risk of spillage from the Serpentine valve will be avoided.

- The absence of high lake levels within Lake Gordon also limit the potential movement of Redfin perch into some tributary streams of the Lake that are known to harbour remnant populations of swamp galaxias, and therefore Basslink could help to protect these colonies.

- The overall reduction in lake level fluctuation will result in sustainable vegetation regeneration in the upper dewatered zones, and the possible need for weed management.

3.2.2 Gordon River

There is only a short period of record available for pre-dam flows in the Gordon River (Figure 3.3). The hydrograph for this period shows a significant level of variability with floods reaching up to approximately 475 cumecs, and almost zero flows in December 1965. It is likely that floods would have reached far higher magnitudes as monitoring did not appear to identify any low-frequency floods during the three year period of pre-dam record.

The presence of the dams on the Gordon and Serpentine rivers has reduced the incidence of large floods, with the maximum amount of water discharged under normal operations being ~260 cumecs (3 turbines at full gate). Only under exceptional circumstances would the Serpentine Dam valve be opened to release large volumes of water (a maximum of 242 cumecs), and this scenario would only be likely when the river would naturally be in flood.

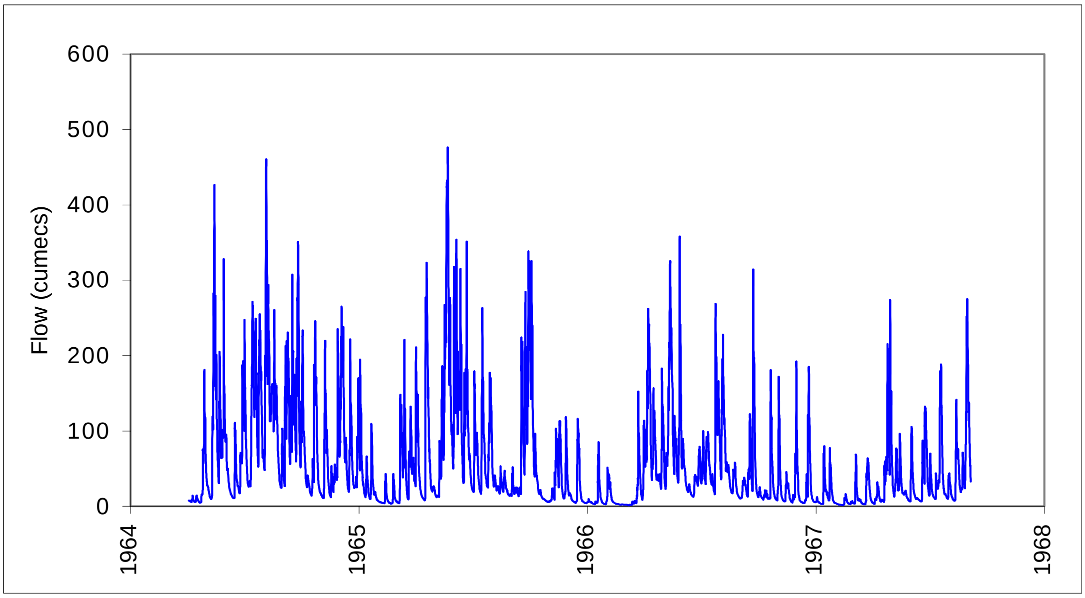

Figure 3.3 – Natural (pre-dam) flow time-series for the Gordon River at the Gordon dam site.

Historically, the operation of the Gordon Power Station is determined largely by the availability of water in other catchments in the state. During wet years there is plenty of water available for the run-of-river power stations, particularly during winter. The water in the run-of-river schemes is utilized before it spills, whilst inflows to Lake Gordon are stored and the power station is operated minimally during the wetter months. The historical time series plot in Figure 3.4 shows that in a typical wet year, the station operates over much of summer and autumn, but is largely shutdown for over 6 months of the year which include winter.

With the introduction of a competitive electricity market in Tasmania but with no Basslink cable (the 0MW scenario Figure 3.4), there is still a notable seasonal difference in power station operation. There is, however, more power station operation in winter whereas historically there was minimal, because with the market scenario generation bids get accepted over winter/spring during short dry periods when the smaller storages are at relatively lower levels. During the driest part of the year (February-March), the station operates largely at full gate due to limited amounts of water being available within the intermediate storages.

Increases in Basslink cable size introduce more frequent changes in operation from efficient load discharge (~210 cumecs) to zero flow (known as hydro peaking) throughout the year in comparison to historical. The larger cables increase the peaking frequency, with many of the shutdowns corresponding to weekend low load periods. This pattern reflects the ability of the larger cables to export power to the mainland during weekdays periods, and the ability for the thermal power stations on the mainland to undercut the Tasmanian market on the weekends when these slower reacting power stations have surplus energy available. Hydro-electric power stations can change their generating load in a few minutes, in comparison to thermal power stations which can take a few hours to change their generating load. Hydro station can also switch on and of and on again in minutes whereas it takes a few days for a thermal station to turn on and off and on again.

Figure 3.5 shows the times series of Gordon Power Station operation for a typical dry year. In the historical case, Gordon is discharging base load throughout most of the year, as there is insufficient water in the run-of-river storages to provide base flow. The modelled market and Basslink scenarios all show an increase in the incidence of step load operation of the power station. Similar patterns of frequent on-off operation are seen with larger cables sizes for both dry and wet years. This indicates that system security is less of an issue with these cable sizes, and that market forces are the major driver of power station operation.

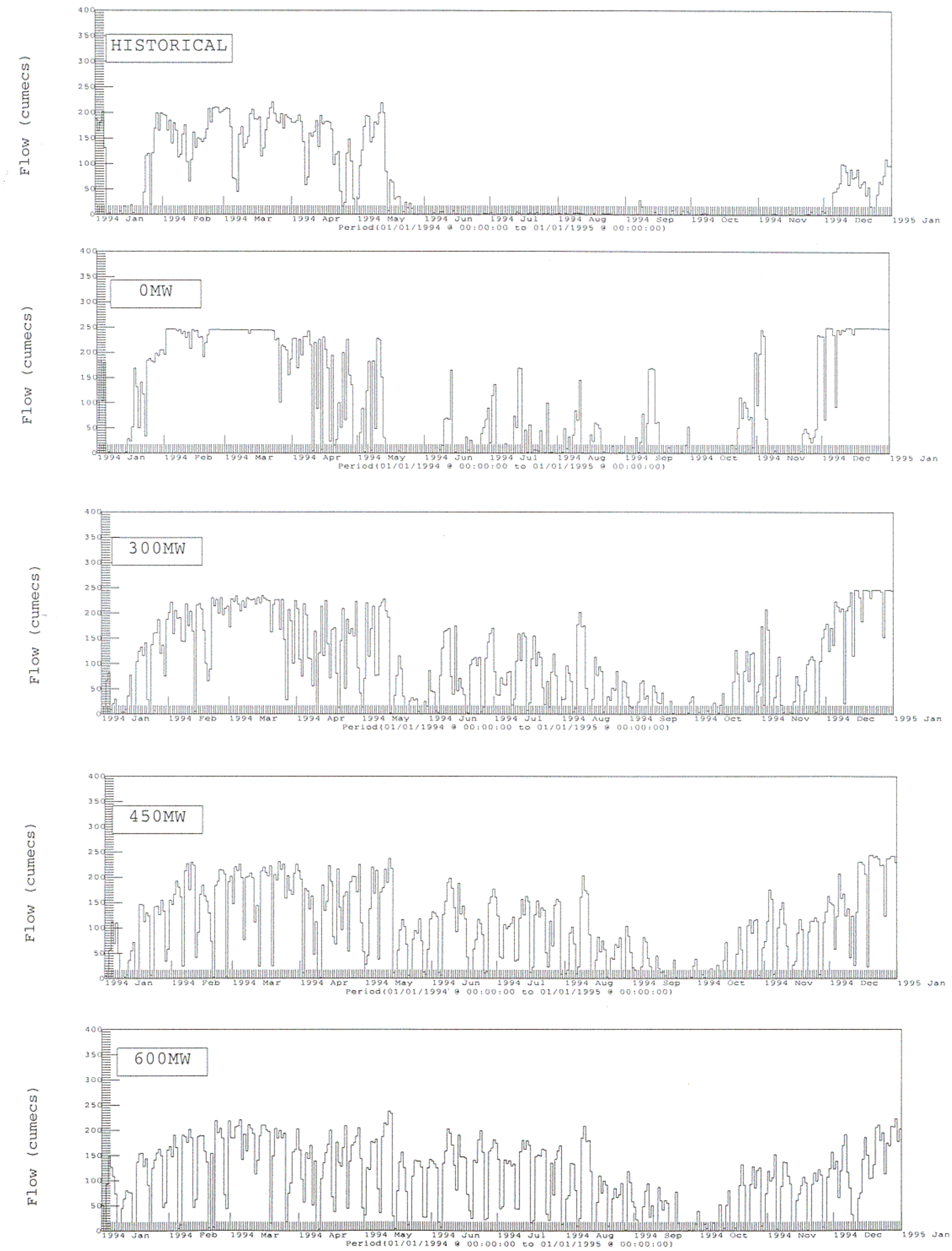

Figure 3.4 – Discharge time-series plots for Gordon Power Station during a wet year (1994) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

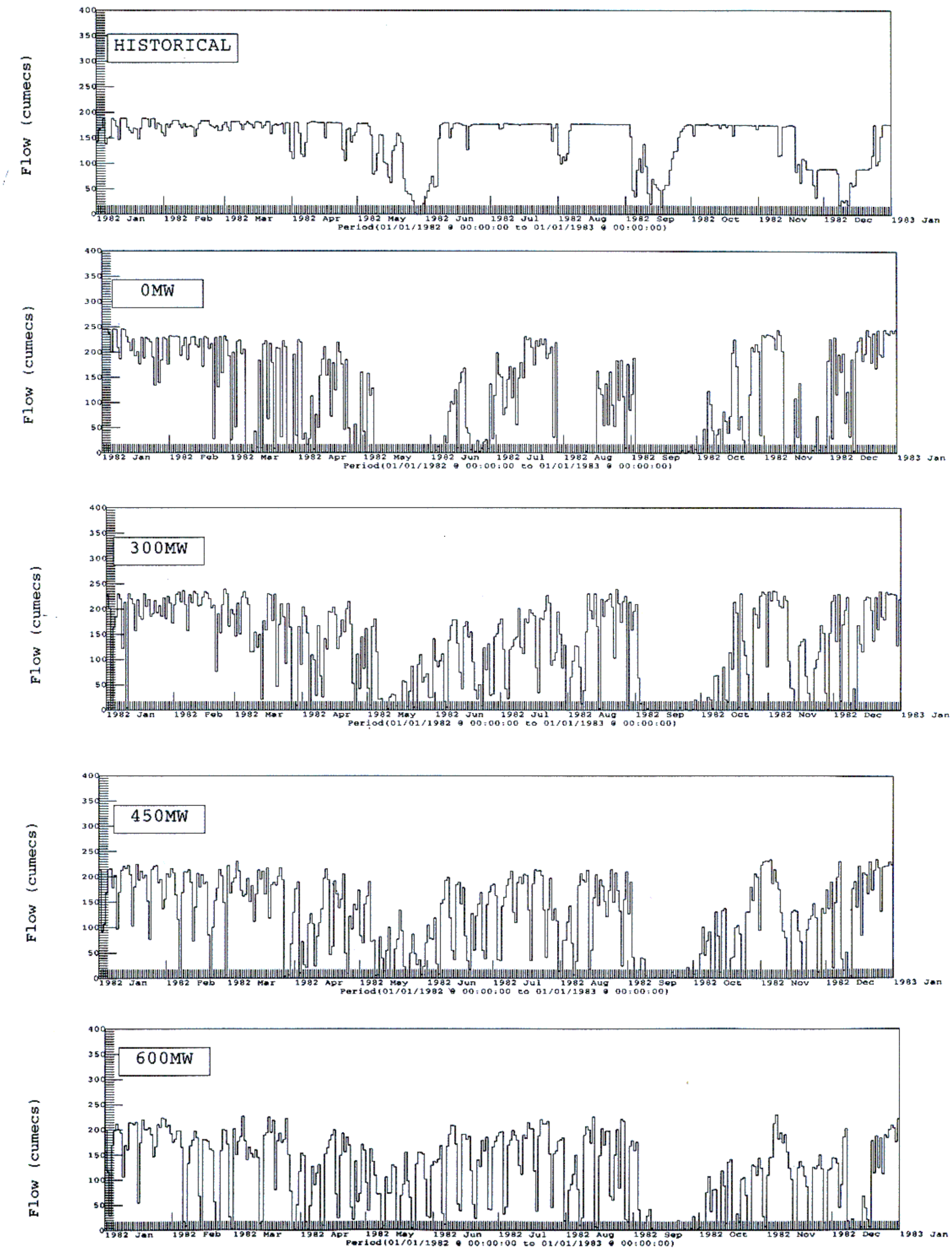

Figure 3.5 - Discharge time-series plots for Gordon Power Station during a dry year (1982) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

Figure 3.6 shows monthly median flows for the Gordon Power Station. The historical plot shows a pattern of relatively high summer discharge, and almost no discharge in winter. This trend is exaggerated with the 0 MW scenario, with higher than historical summer discharges and virtually no discharge for a longer winter period. Care should be taken when interpreting this result; monthly medians of zero only indicate that the power station was operating less than 50% of the time during that month, and do not necessarily indicate a total shutdown of the power station.

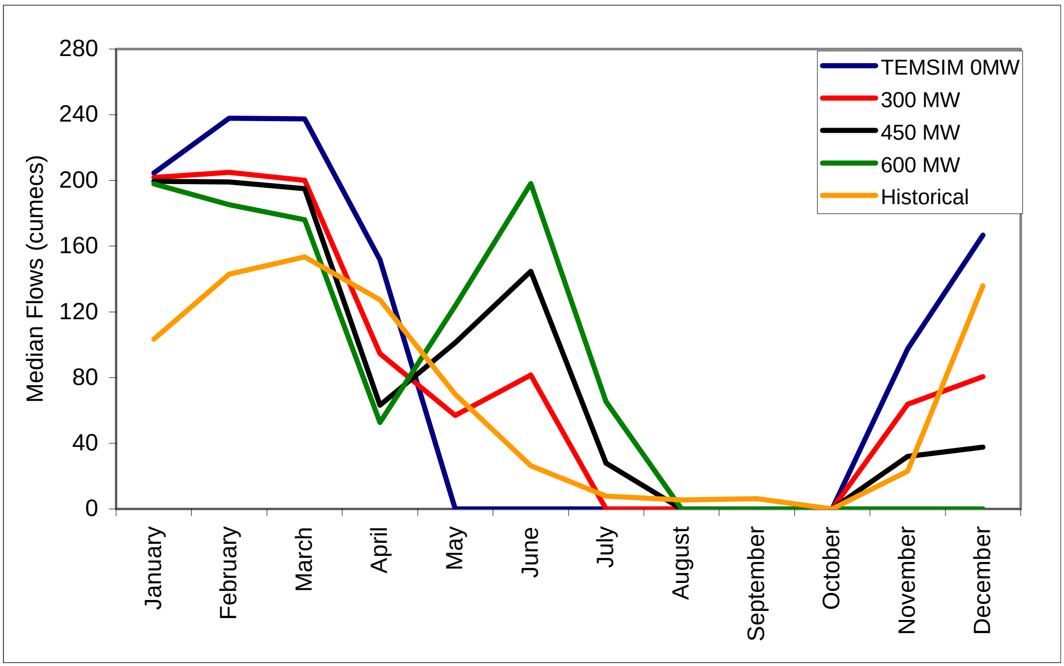

Figure 3.6 – Monthly median flows for Gordon Power Station. Monthly medians of zero indicate that the power station is operating less than 50% of the time during that month and does not necessary designate a total shutdown over that period.

The 300 – 600 MW cable scenarios in Figure 3.6 show quite a different pattern to the historical or 0 MW case. The same high summer discharges are shown, but there is a notable second peak in early winter. This reflects the increased discharge of the power station during winter months that was evident in the annual time series. The progressively larger cable sizes show a gradual decrease in the summer discharges and increase in the winter discharges, reflecting the increasingly market driven operation of the power station during winter months with the larger cable sizes.

There is a notable difference in the incidence of power station shutdown periods between the 0 MW and the three Basslink cable scenarios. The duration of modelled shutdown events (zero flows) is presented in Figure 3.7a. The x-axis is the duration of the shutdown event in hours, the y-axis is the average number of shutdown events in a given year. Figure 3.7a clearly shows an increase between the 0MW and various Basslink cable sizes in short-term shutdown events of less than 24 hours. There is an increase in the number of very short-term (<12 hours) shutdown events for the larger cables, reflecting the increased peak load operation shown in Figs. 3.4 and 3.5. Similarly, the incidence of 72 hour (weekend) shutdowns is increased under Basslink as shown in these figures. Longer duration shutdowns are minimised with the Basslink scenarios.

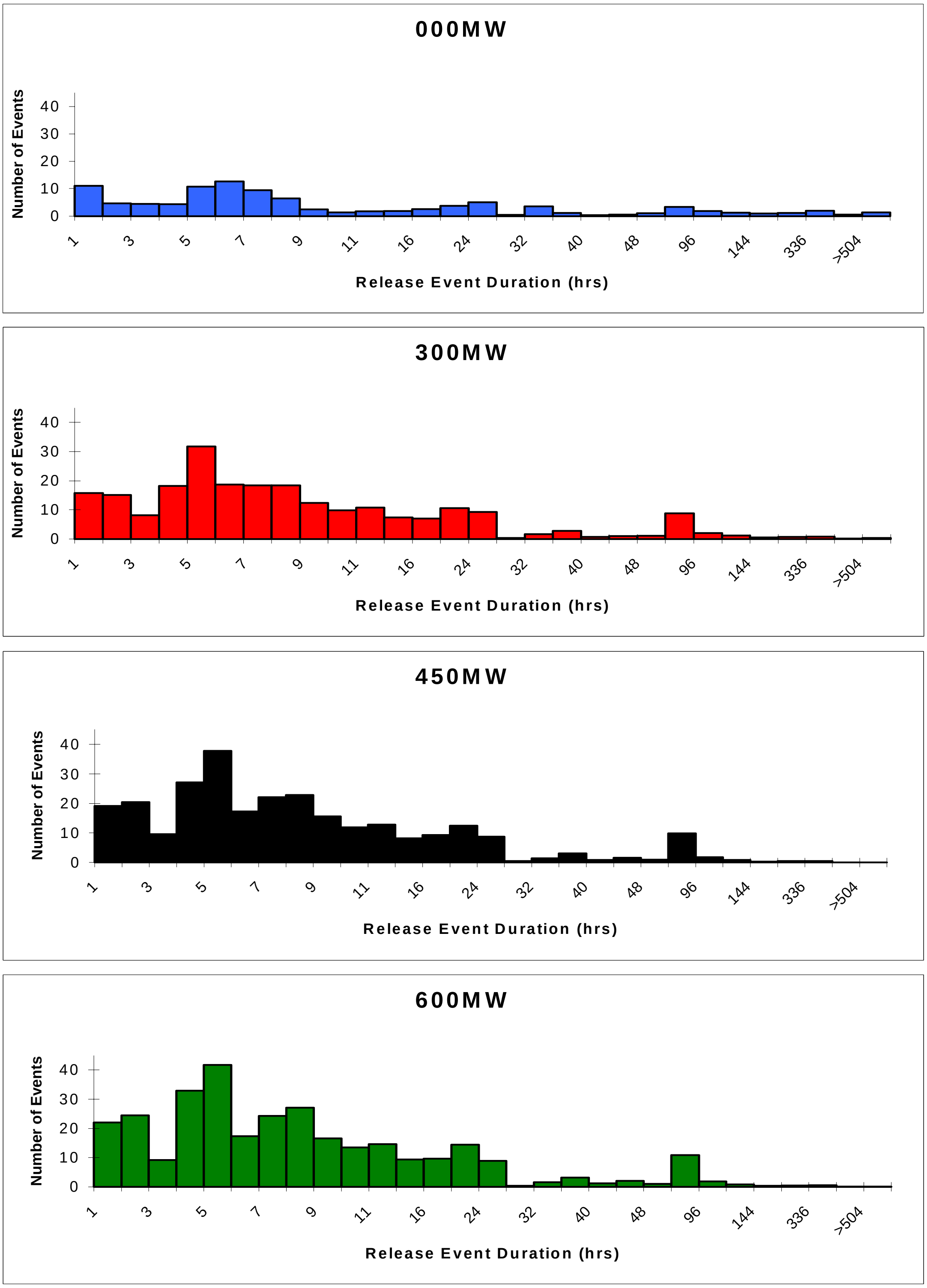

Figure 3.7a – Shutdown (zero flow) event duration analysis for the Gordon River. Bars represent average number of shutdown days per year for each duration category.

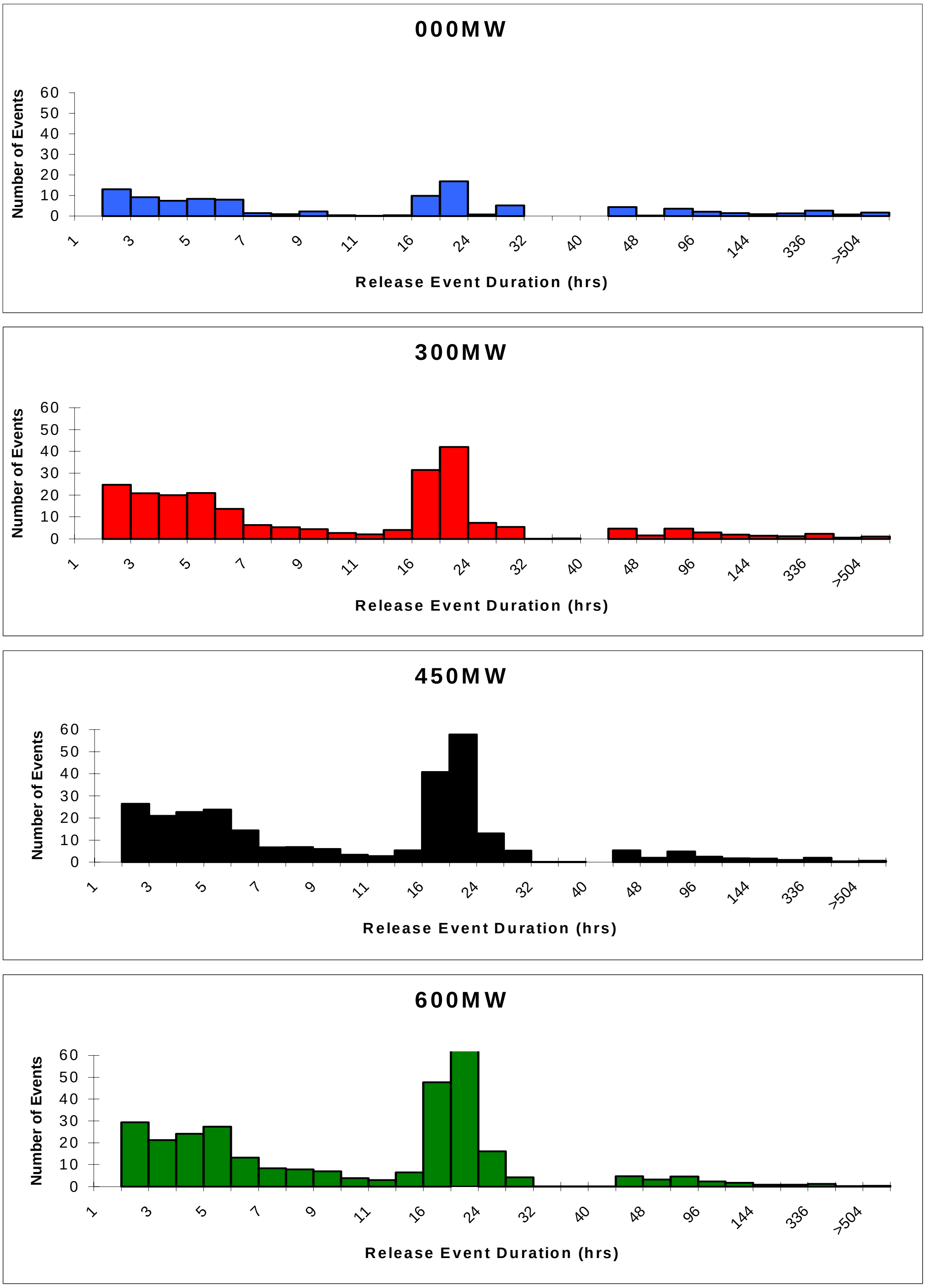

Figure 3.7b – Event (above zero flow) duration frequency analysis for Gordon Power Station. Bars represent average number of shutdown days per year for each duration category.

The number of short-duration startup events is increased within increasing Basslink cable size (Figure 3.7b). Conversely, there is a decrease in the number of long-term events indicating more hydro-peaking under Basslink. The major increases in event frequency related to durations of less than 10 hours and in the 24 to 72 hour range. The event analysis shown here indicates flow increases above zero cumecs and does not highlight variability in non-zero flows. The discharge time-series shown in Figures 3.4 and 3.5 (wet and dry years), shows that there are additional fluctuations above this level for the larger cable sizes. The increase in peaking exhibited here is likely to be a function of diurnal peaking of mainland power demand coupled with the varying ability of the other Tasmanian power stations to bid generation in at competitive prices.

Figure 3.8 shows a comparison of hydrographs for the Gordon Power Station tailrace and the Warners (Jones) Landing Gauge site in the tidally influenced reach of the Gordon River. This was examined because of the presence of the unique meromictic lakes on the Lower Gordon River floodplain. This figure indicates that the Gordon Power Station discharges have only a small influence on short-term level fluctuations of the tidal sections of the river. Changes in stage height at the tailrace of up to 5 m (3 turbines) appears to raise the level of the estuary if discharged over a prolonged period, however short-term fluctuations corresponding to power station output do not appear in the hydrographic record at the estuary. This is mainly due to the attenuation of flow pulses over the length of the river, frictional losses (and slowing down of the pulse) due to the river bed and the various hydraulic constrictions at a number of locations along the river (e.g. Abel Gorge, the Splits). External factors affecting the estuary height such as tide, wind over Macquarie Harbour, barometric pressure and the increased cross-sectional area of the river channel in the estuary all combine to dampen the effect that power station has on river level at this point. These are important considerations to take account of when making management strategies for the meromictic lakes on the Lower Gordon River floodplain.

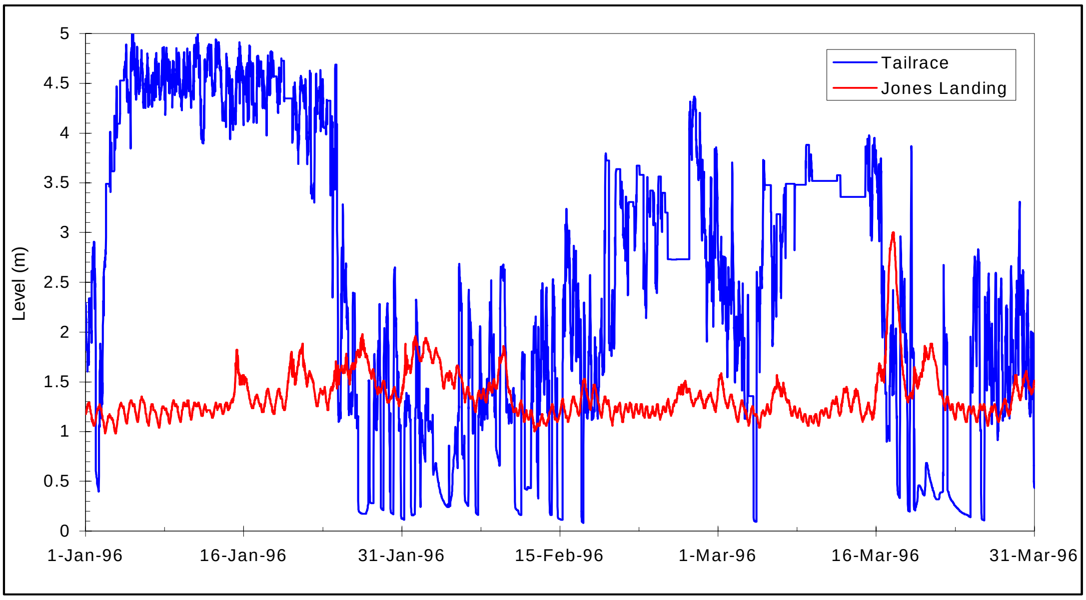

Figure 3.8 – Comparison of hydrographs for the Gordon Power Station tailrace and the Warners (Jones) Landing gauge site showing minimal influence of the power station on river levels in the tidal sections of the river.

Although the river levels may not be greatly affected much in the estuary, it has been well documented that the Gordon Power Station has a major influence on the intrusion of the salt wedge into the estuary (Hodgson & Tyler, 1996). The inverted seasonal flow regime under historical operations has all but eliminated the saline recharge of the meromictic lakes of the lower Gordon River floodplain. The return to more natural seasonal flow regimes may provide more effective penetration of the salt-wedge into the Gordon River estuary. Combined with the additionally security offered by the larger Basslink cables, this may provide opportunities to protect these unique ecosystems through carefully timed shutdowns of the power station to allow saline recharge into these lakes.

In summary, the Hydro is likely to significantly alter the way it operates the Gordon Power Station under Basslink. The main changes are:

- Increased short-term variability in flow discharges;
- Increased frequency of short duration (and weekend) shutdowns; and
- Changes in the seasonality of flows.

There is no change in the magnitude of peak flows. The environmental issues associated with these changes are discussed in Chapter 4.

3.3 Great Lake / South Esk Catchment

The Great Lake catchment consists of two highland storages (Lake Augusta and Arthurs Lake) that divert water into Great Lake, the major storage of the catchment. Great Lake supplies water to Poatina Power Station, which then discharges water to Brumbys Creek and eventually into Lake Trevallyn. Trevallyn Power Station takes this water and discharges directly to the Tamar Estuary. Woods Lake is a small impounded natural lake downstream of Arthurs Lake that is used for irrigation purposes.

3.3.1 Arthurs Lake, Woods Lake, Lake Augusta

Arthurs Lake, Woods Lake and Lake Augusta all have lake level agreements and are therefore constrained to operating within these ranges under the TEMSIM model. Additionally, there are constraints on the rates of change in lake levels due to constricted discharges. Lake Augusta discharges water to Great Lake via Liawenee Canal, which has a maximum capacity of approximately 18 cumecs and Arthurs Lake water is pumped to Great Lake via the Pumphouse Bay pump, which has a maximum capacity of 4.7 cumecs. Because of these constraints, these lakes do not have the flexibility to change their operation, and so are not considered to present any issues under any of the Basslink scenarios.

3.3.2 Great Lake

The operation of Great Lake is very similar to Lake Gordon. This is expected as both storages are linked via the LTMC and will therefore react similarly in response to the inflow time series. Figure 3.9 shows that the operation of Great Lake under a Basslink scenario occurs within the historical parameters, with the TEMSIM outputs showing a slight flattening of operation in comparison to the historical operation of the lake. The 300MW cable shows the most pronounced changes and produces the lower lake levels than other Basslink scenarios.

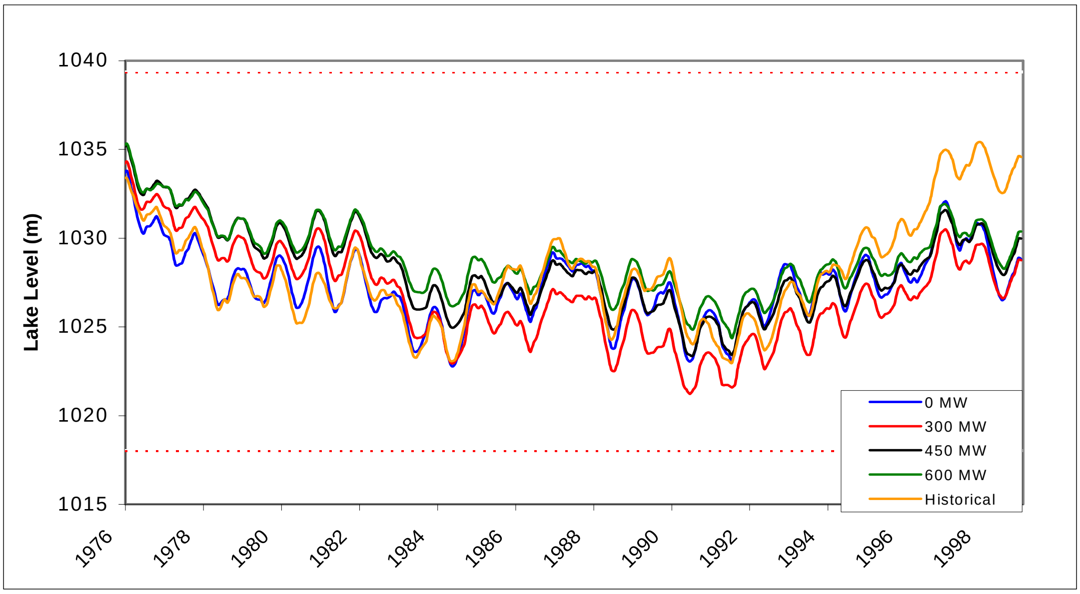

Figure 3.9 - Lake level time-series plot for Great Lake. The time period shown in this figure (1976 - 1998) represents the operation of this lake since the commissioning of the Poatina Power Station and therefore gives the most valid comparison to recent historical operation. The top and bottom lines indicate FSL and NMOL for the storage.

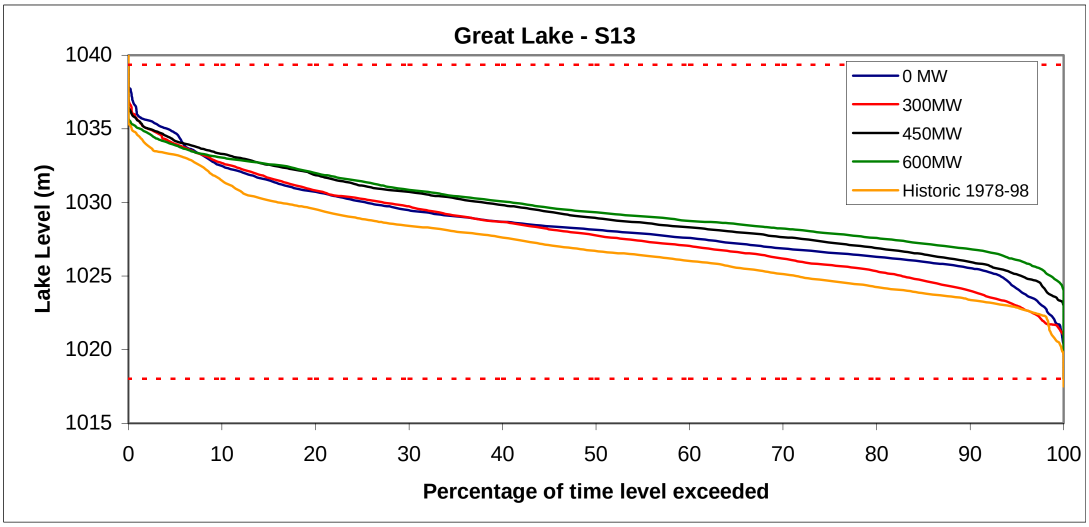

Figure 3.10 – Lake level duration plot for Great Lake. The historical averages for the period 1978 -1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

An analysis of the long-term average lake level duration for Great Lake (Figure 3.10) shows that the larger cable sizes (450 and 600 MW) consistently hold the lake higher than the 300 MW or 0 MW options. Seasonality of level fluctuations within Great Lake shows a similar pattern between historical and all the TEMSIM scenarios. The peak average lake level with the TEMSIM models is in October, one month earlier than historical operation (Figure 3.11). The annual variation in the timing of the peak level is a reflection of a combination of factors including the timing of inflows and the timing of power station discharges.

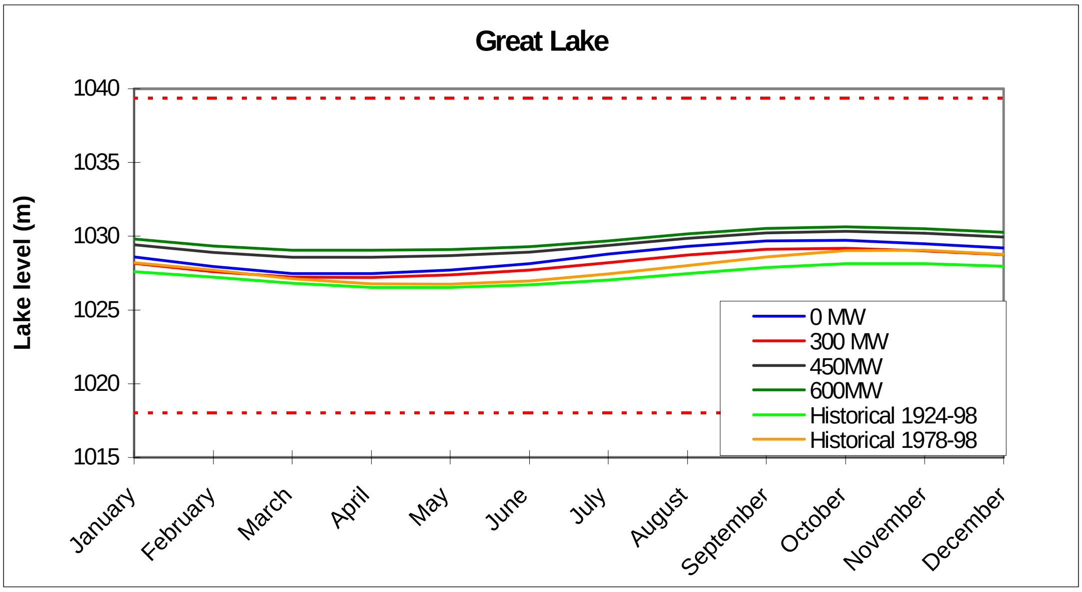

Figure 3.11 – Average monthly lake levels for Great Lake based on the 65 year modelling period. The historical averages for the period 1924-98 (all operations) and 1978-98 (recent operations) are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

As with Lake Gordon, there are no significant changes to the operation of Great Lake between historical and the modelled TEMSIM scenarios. Consequently, there are no direct environmental issues associated with Basslink for Great Lake, and no Basslink related studies are recommended for this lake.

The Hydro recognises the importance of this waterbody for numerous threatened species residing in the lake as well as its importance as a recreational fishery. The Hydro is committed to ensuring that it manages this waterway in a sustainable manner and will be addressing any stakeholder concerns as part its Water Management Review process.

3.3.3 Lake Trevallyn

Lake Trevallyn is a designated recreational area and is maintained at a minimum level of 124.9 mASL for recreational and water supply purposes under an agreement between the Hydro and the Launceston City Council. The lake is normally operated to this level, but may be drawn down for maintenance purposes or in order to create more storage capacity when a flood event is predicted. As there is a lake level agreement in place for the operation of Lake Trevallyn, it is envisioned that there will be no issues with the management of this lake under any Basslink scenarios. This was reflected in the modelling outputs for this lake (Figure 3.12).

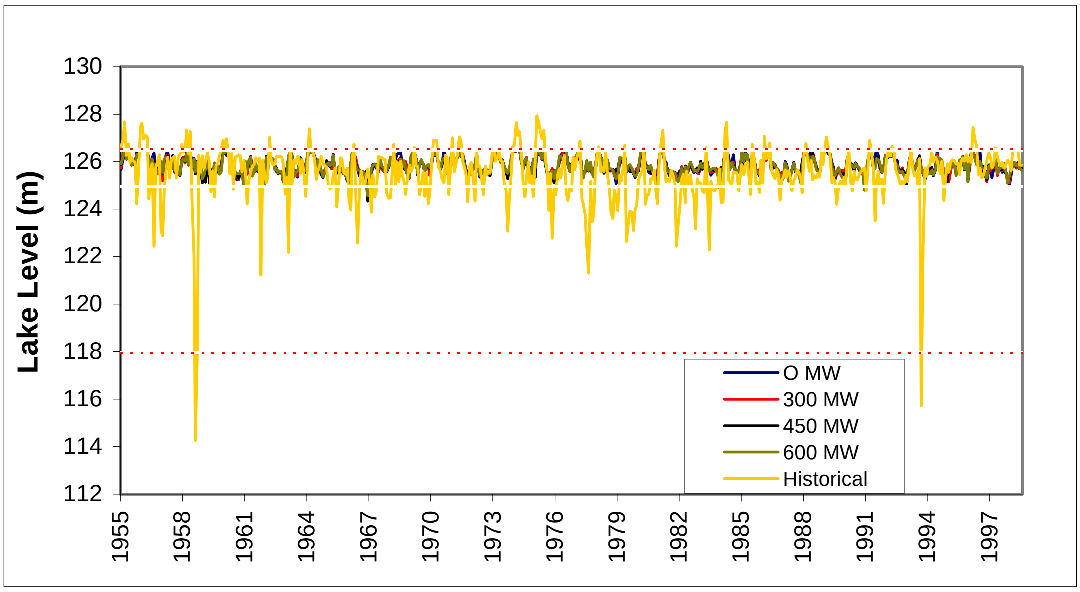

Figure 3.12 - Lake level time-series plot for Lake Trevallyn. The time period shown in this figure (1955 - 1998) represents the operation of this lake since the commissioning of the Trevallyn Power Station. The top and bottom lines indicate FSL and NMOL for the storage, and the middle line indicates the minimum level to be met by the lake level agreement.

3.3.4 Poatina Power Station Discharges

The discharge regime for Poatina Power Station shows change in response to Basslink. The historical operation of the station in a wet year (Figure 3.13) shows that there is minimal operation during the wetter months, but the station is heavily scheduled most of the other months. (The dip in generation over February-March of this year may be due to a maintenance shutdown.) Over the comparative period in the TEMSIM 0MW scenario, Poatina was run at full gate almost continuously for two summer months, indicating that Great Lake was above the LTMC and Poatina was bid in at a favourable price to the run-of-river stations. This 0 MW scenario shows the exaggeration of historical seasonal trend that was indicated by the Gordon monthly median flows (Figure 3.6). The 300 – 600 MW cable scenarios show a notable increase in step load operation, with possibly an increased number of discharge events with increasing cable size. There appears to be a steady relationship between increasing cable size and the number of peaking events.

Historically, during dry years (Figure 3.14), Poatina Power Station is critical in supplying power as the run-of-river stations would not have enough water, and so is run steadily throughout the year. During these times Great Lake levels would begin to fall as shown in Figure 3.9. The 0MW scenario shows similar operation to historical, although the period of shutdown is slightly greater and is interrupted less by short-duration discharges. The 300 – 600 MW cable scenarios show the same increasing on-off trend as they did for the wet year, showing as did the Gordon Power Station plots that system security is less of an issue with these Basslink cable sizes, and that market forces are the major driver of power station operation with these cables.

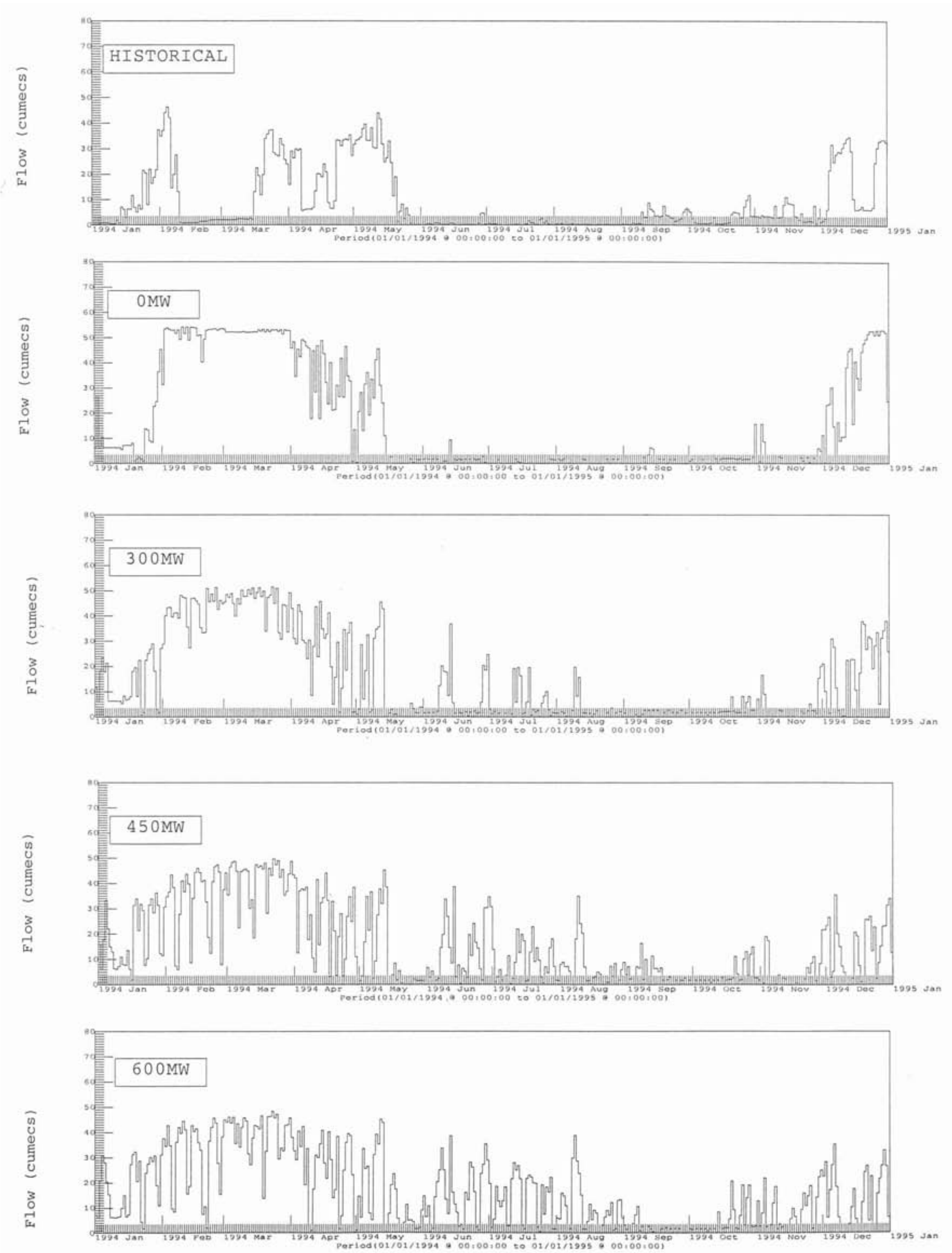

Figure 3.13 – Discharge time-series plots for Poatina Power Station during a wet year (1994) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

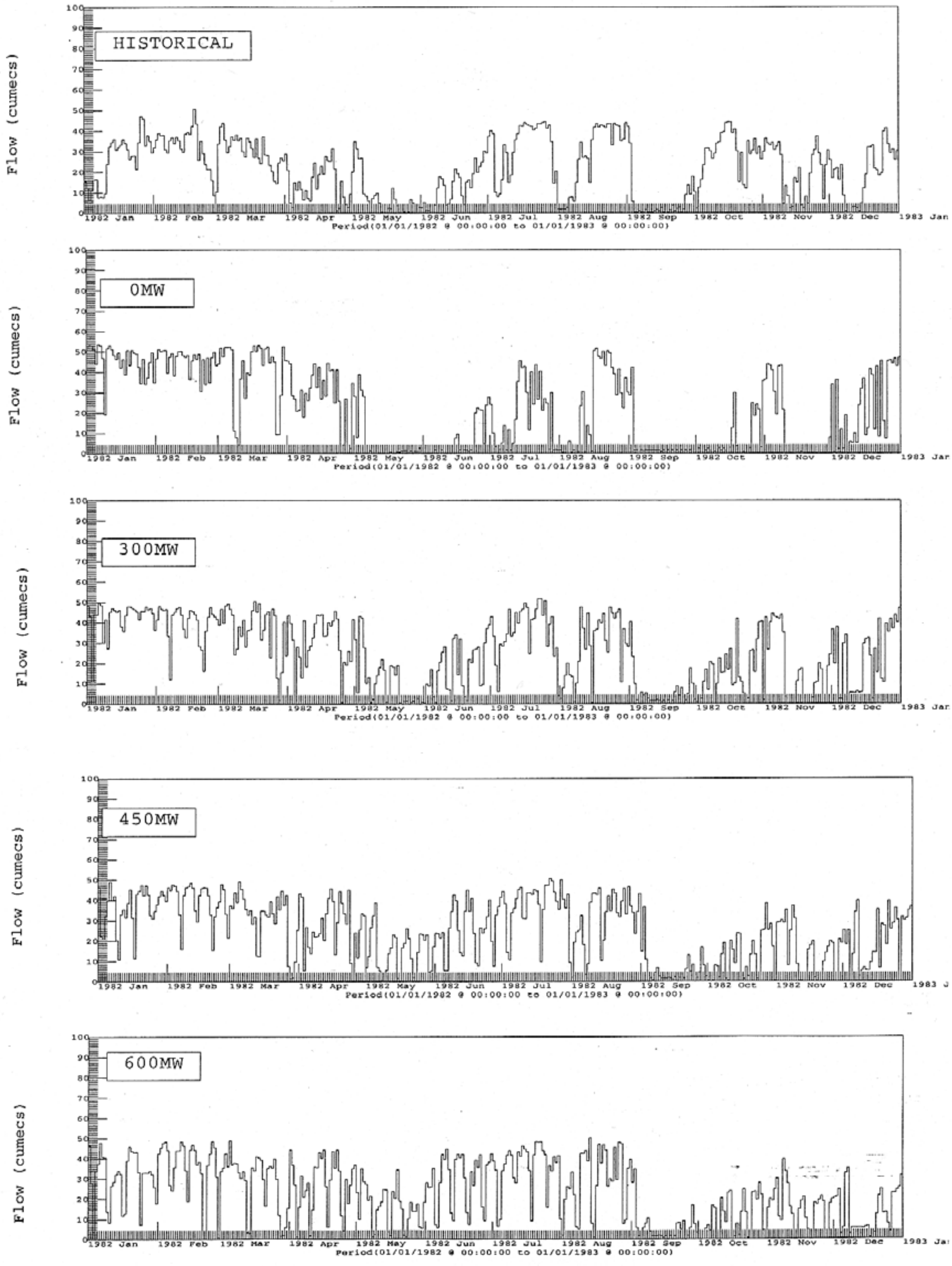

Figure 3.14 – Discharge time-series plots for Poatina Power Station during a dry year (1982) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

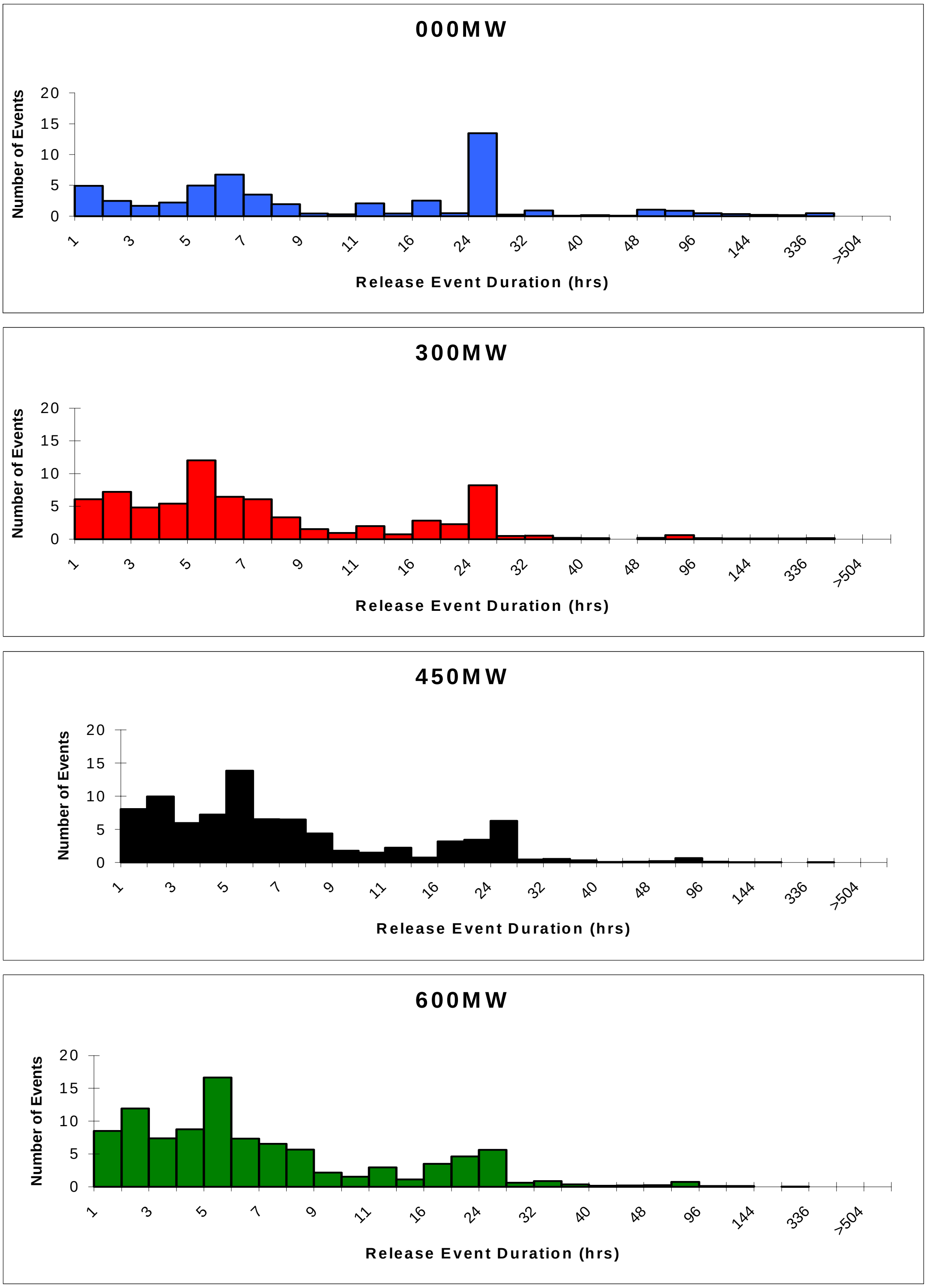

Figure 3.15 – Shutdown (zero flow) event duration analysis for Poatina Power Station. Bars represent average number of shutdown days per year for each duration category.

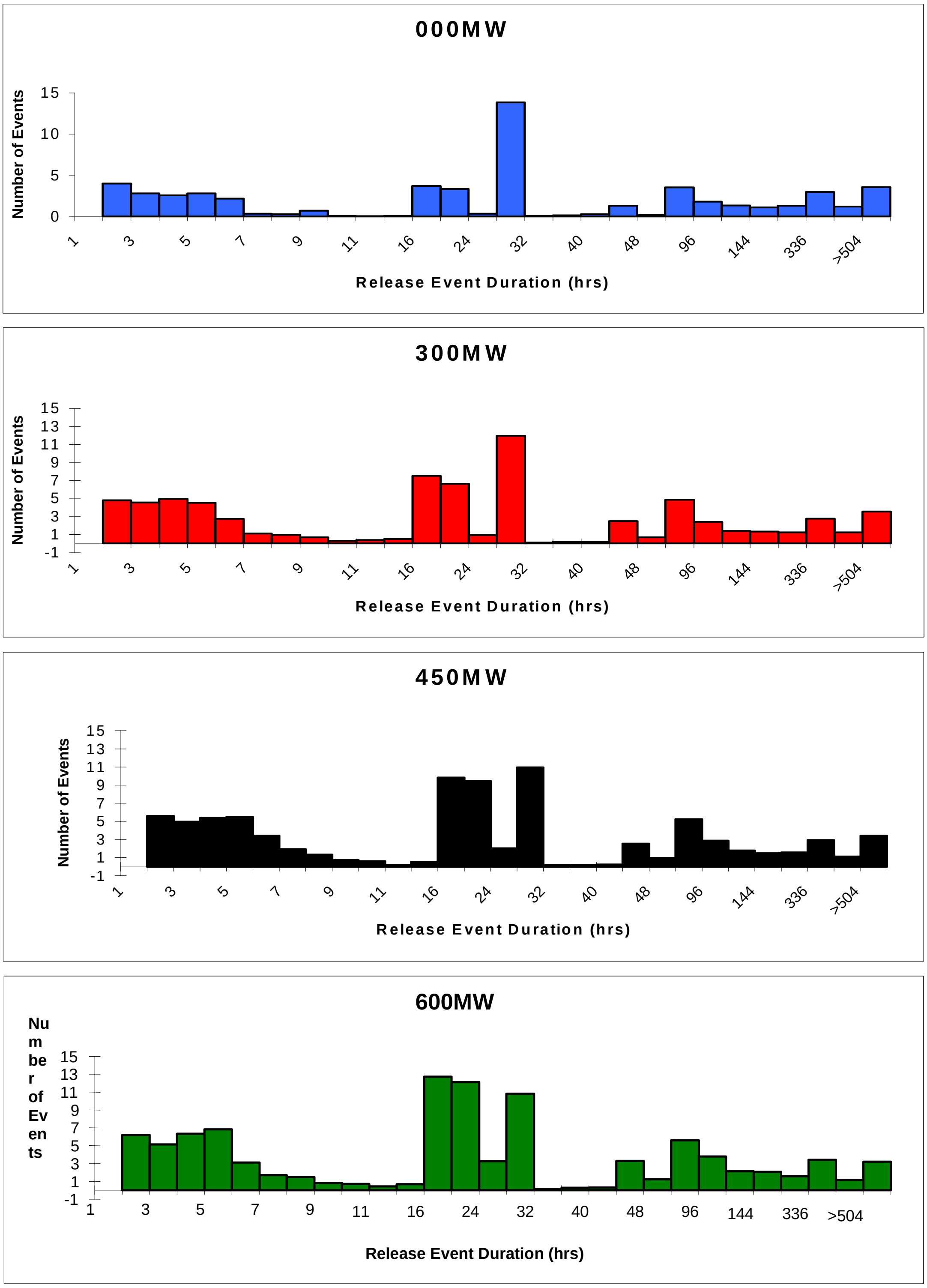

Figure 3.16 – Event (above 2 cumecs) duration frequency analysis for Poatina Power Station. Bars represent average number of shutdown days per year for each duration category.

An analysis of minimum flow events for the Poatina Power Station (Figure 3.15) shows that long duration low flows (>48 hours) are less likely with increasing cable capacity. Correspondingly, the number of short-duration low flows (<12 hours) increases with cable size, indicating more extensive hydro-peaking as this station takes advantage of peaks in the power demand curve from the mainland. As per the Gordon Power Station, it is likely that the mainland power demand variations will produce these short-term low flows over weekends when power demand is lower.

Poatina Power Station must discharge a minimum flow release for the pumps at the township of Cressy, on the Macquarie River. Analysis of the duration of events above this minimum flow of 2 cumecs (Figure 3.16) shows a slight increase in the number of long duration events (>48 hours) for the 300 – 600 MW cable scenarios compared to the 0MW option. The number of short duration events particularly between 4 and 24 hours increases significantly with the Basslink cables compared to the 0 MW case, as was indicated by the time series.

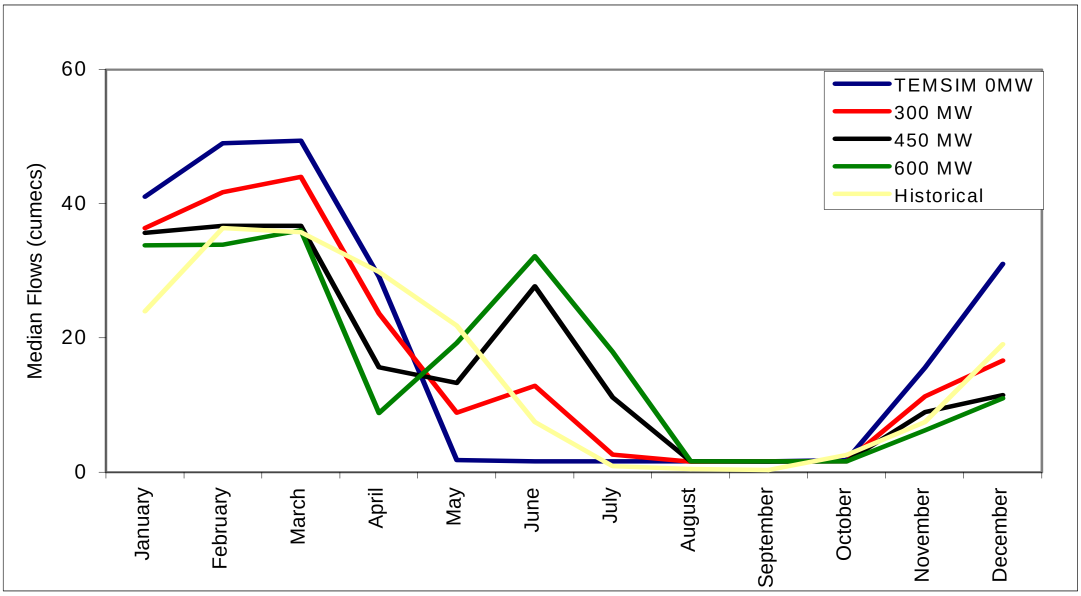

Figure 3.17 – Median monthly flows from the Poatina Power Station. Monthly medians of zero indicate that the power station is operating less than 50% of the time during that month and does not necessary designate a total shutdown over that period.

Figure 3.17 shows the monthly median flows for the historical and modelled scenarios. The trends are almost identical to those shown for the Gordon Power Station (Figure 3.6). Larger Basslink cables tend to have an equalising effect on the monthly seasonality of flows downstream during both wet (Figure 3.13) and dry (Figure 3.14) years, reflecting the ability of the cable to export power from Poatina Power Station to the mainland. This results in a distinct change in the monthly flow pattern for the two largest Basslink cables. The peaks in winter flows that are introduced to the river system with the Basslink cables reflect a more natural pattern of flow seasonality. This may be of benefit to aquatic biota downstream that rely of flow induced natural cues as part of their life-cycle.

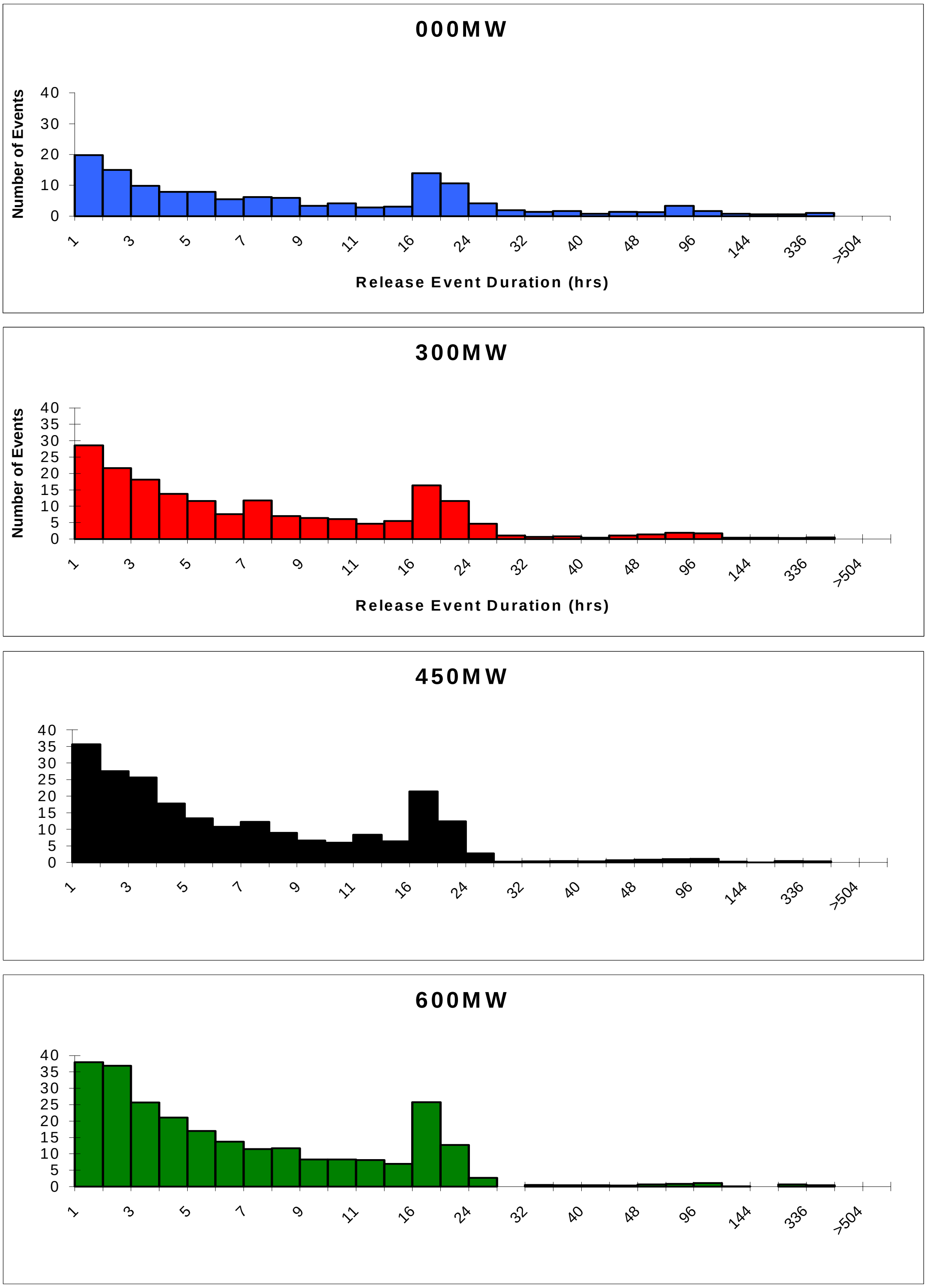

Figure 3.18 – Event (above 50 cumecs) duration frequency analysis for OMW, 300MW, 450MW and 600MW TEMSIM scenarios below the junction of Brumbys Creek and the Macquarie River. This level corresponds to the level at which a minor flood alert is given for this region of the river.

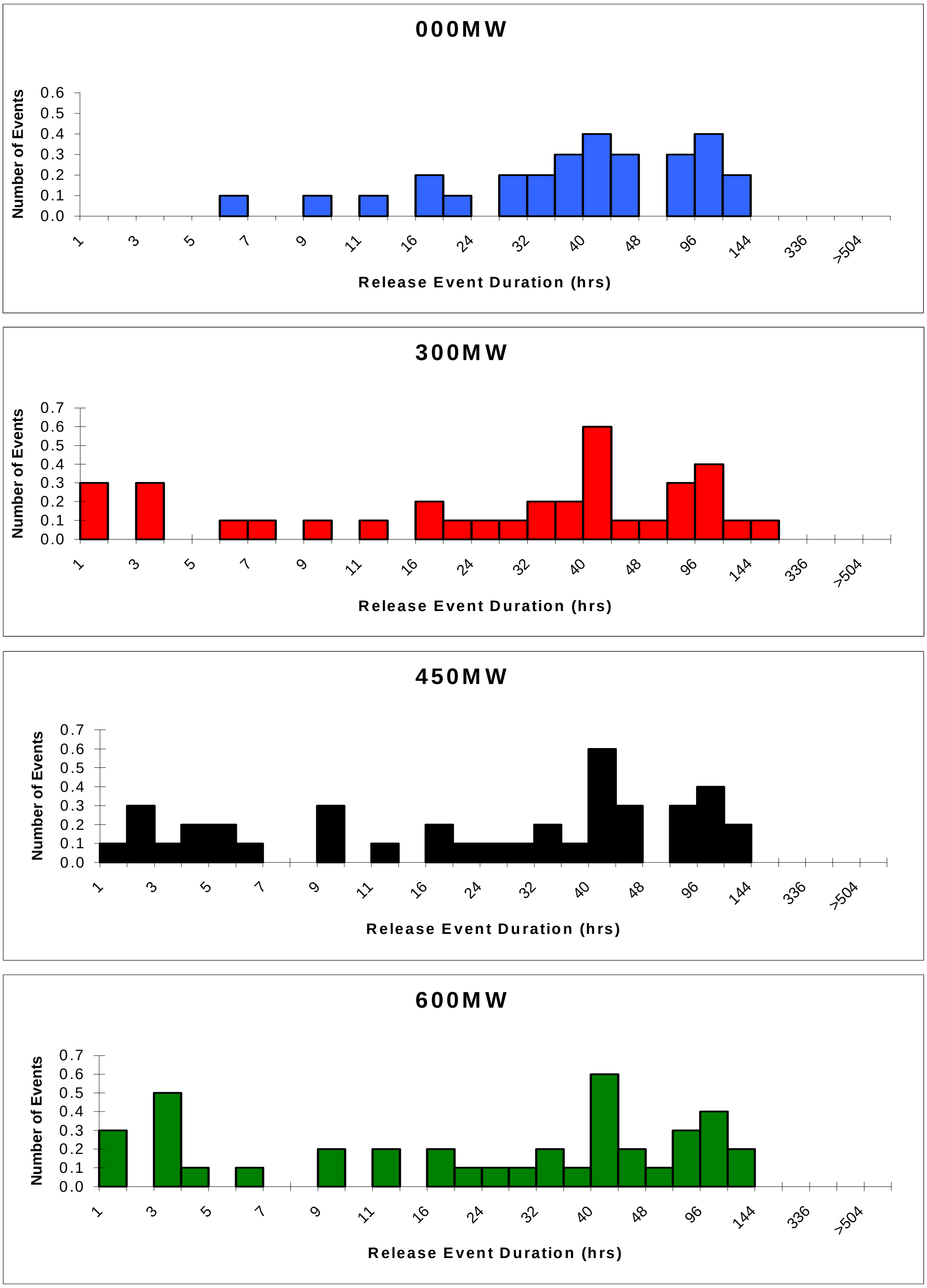

Figure 3.19 – Event (above 320 cumecs) duration frequency analysis for OMW, 300MW, 450MW and 600MW TEMSIM scenarios below the junction of the Macquarie and South Esk rivers. This level corresponds to the level at which a minor flood alert is given for this region of the river.

The increase in winter discharges out of the Poatina power has implications for downstream flooding. A preliminary assessment of the risk of enhanced flood peaks during natural flooding events in the lower Macquarie and South Esk Rivers was conducted, using exceedance of the Bureau of Meteorology (BOM) flood alert levels as an indication of flood risk. The frequency of flow events corresponding to minor flood alert below the junction of Brumbys Creek and the Macquarie River is presented in Figure 3.18, and below the junction of the Macquarie and the South Esk rivers in Figure 3.19. Figure 3.18 shows an increase in the number of short-term minor flood events (<24 hours) in the Macquarie River with the Basslink cables, which can easily be related to the increased winter operation of the power station. Figure 3.19 shows that the Basslink cables add to the incidence of short-duration (<6 hour) flood events in the South Esk River, and introduces some alteration to the longer duration events.

In summary, changes to the operation of Poatina Power Station due to Basslink are likely to be very similar to those for the Gordon Power station. Notably, the main changes are increased short term flow variability, increased frequency of short duration (and weekend) shutdowns, and changes in the seasonality of flows. The implications of these changes downstream of the Poatina Power Station are somewhat different than downstream of the Gordon River, because of the very different land tenure, catchment features and magnitude of discharges. All environmental implications of the hydrological changes shown for the Poatina Power Station are examined fully in Chapter 4.

3.3.5 Trevallyn Power Station

Trevallyn Power Station discharges directly to the Tamar River Estuary, therefore bypassing the section of the South Esk River below Trevallyn Dam. Changes in the estuary due to any changes in Trevallyn Power Station operation are assumed to be negligible, because the water level fluctuations due to current operations are minimal, and the volume of water in the estuary largely dampens any effects.

3.4 West Coast Catchments

The West Coast catchment consists of two major schemes – the King and the Pieman-Anthony Power Developments. Both schemes are relatively recent and therefore have short historical records for both lake operations and power station discharges. The King Scheme was completed in 1992 and consists of one medium sized storage (Lake Burbury), and one power station (John Butters) that discharges into the King River and ultimately into Macquarie Harbour. The Pieman Scheme was operational by 1986 and consists of a cascade of medium-sized lakes and power stations, terminating with Lake Pieman and the Reece Power Station. The Anthony Power Development was completed in 1994 and incorporates a number of small diversions that supply water to Lake Plimsoll from where it is passed through the Tribute Power Station and discharged into the top of the Pieman Scheme.

3.4.1 Lake Burbury

The historical record for Lake Burbury is very short and occurs over a relatively wet period, therefore the operation of this lake on a historical basis does not reflect its future operations under differing climatic and load conditions. TEMSIM modelling showed that the level of fluctuation under a 0MW scenario was comparable to historic operations and utilised around 75% of the active storage range (Figure 3.20). The Basslink cable scenarios followed a more conservative pattern, with less fluctuation and slightly lower lake levels than found with historical operations or the 0MW scenario. The average lake levels under all of the TEMSIM modelling (averaged over a 65 year period) was lower than historical. This can be accounted for by the relatively wet and short (seven year) period of historical record.

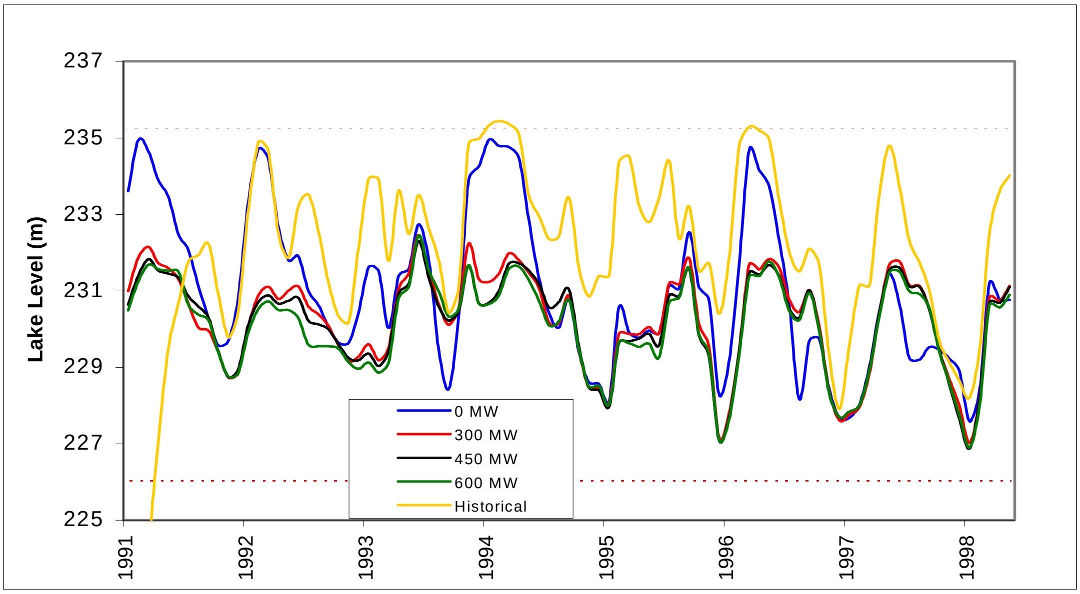

Figure 3.20 - Lake level time-series plot for Lake Burbury. The short period of record is due to the recent construction of this reservoir. The top and bottom lines indicate FSL and NMOL for the storage.

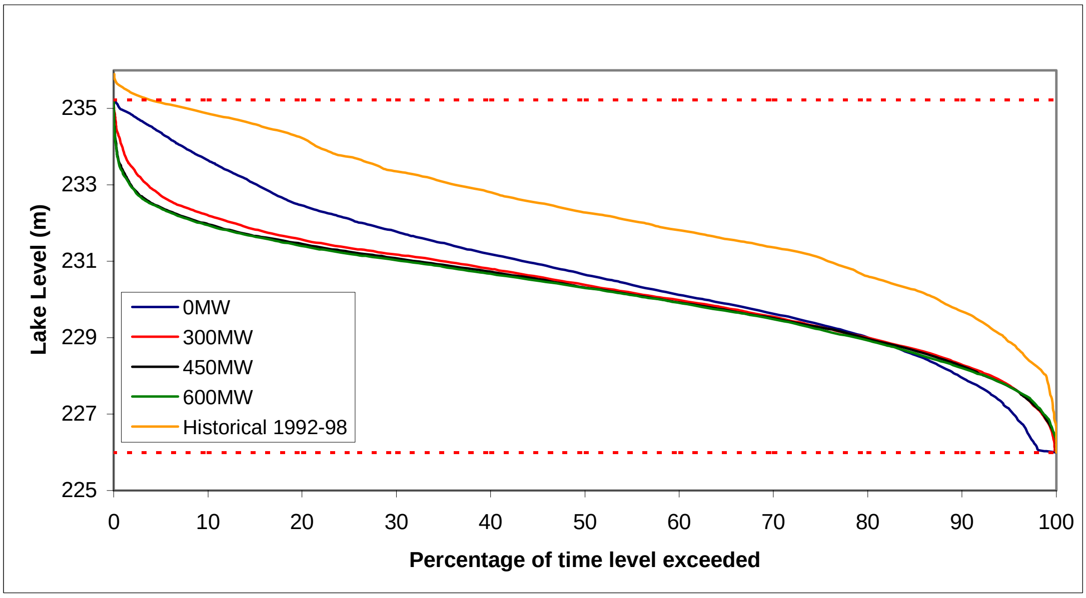

Figure 3.21 – Lake level duration plot for Lake Burbury. The historical averages for the period 1992-1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

The 0MW scenario tended to hold Lake Burbury fuller (Figure 3.21) than any of the Basslink cable scenarios for a greater period of time, and is a function of the price curve for this lake in relation to mainland demand. The seasonality of lake levels under Basslink (Figure 3.22) remains similar to historical, and therefore does not present an issue.

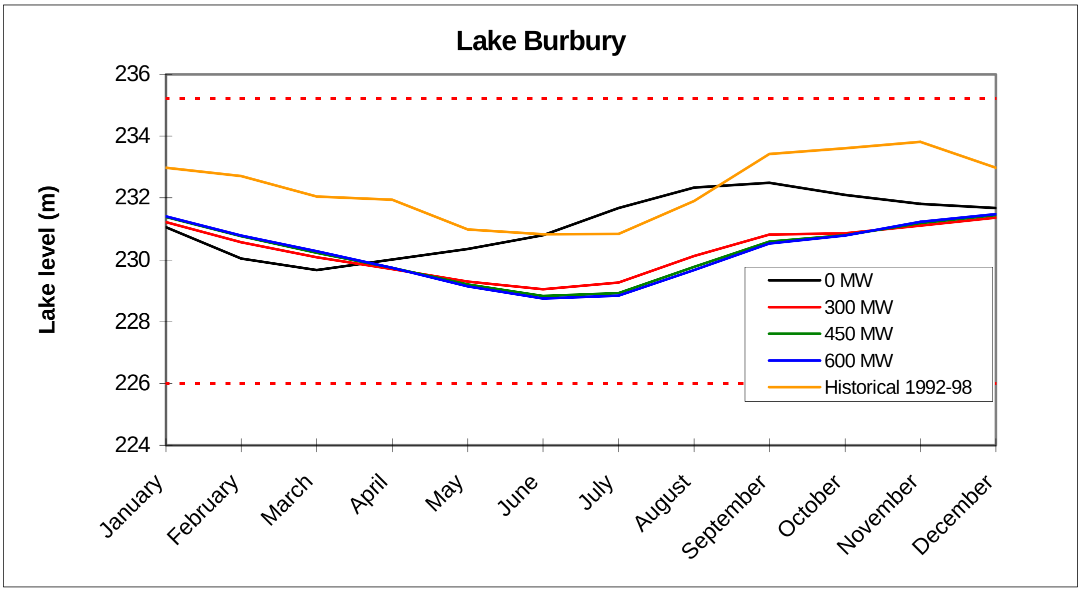

Figure 3.22 – Average monthly lake levels for Lake Burbury based on the 65 year modelling period. The historical averages for the period 1992-1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

3.4.2 King River

As shown in the annual time series for the John Butters Power Station (Figures 3.23 and 3.24), discharges out of this power station are highly variable under current operating conditions. John Butters plays a key role in the Hydro's operating system as a provider of step and deficit load, and is generally not operated for base load power. As a consequence, the increase in provision of peak load power which is likely under a Basslink scenario fits in with the way John Butters has always been operated.

The only notable trend for the wet year time series (Figure 3.23) is a seasonal shift showing more consistent and higher discharge periods in winter than in summer. This is an interesting trend in that it would mimic natural seasonal patterns more closely. This same seasonal pattern is shown for the dry year (Figure 3.24).

The monthly median flows are shown in Figure 3.25. The historical operation of the power station shows a bimodal pattern, with peaks in April/May (late Autumn) and Sep-Nov (Spring). The 0 MW case shows a flattening of the peaked pattern, with a very slight peak during winter. The 300 – 600 MW cable scenarios have a strong unimodal peak during the winter months, much more similar to a natural river system.

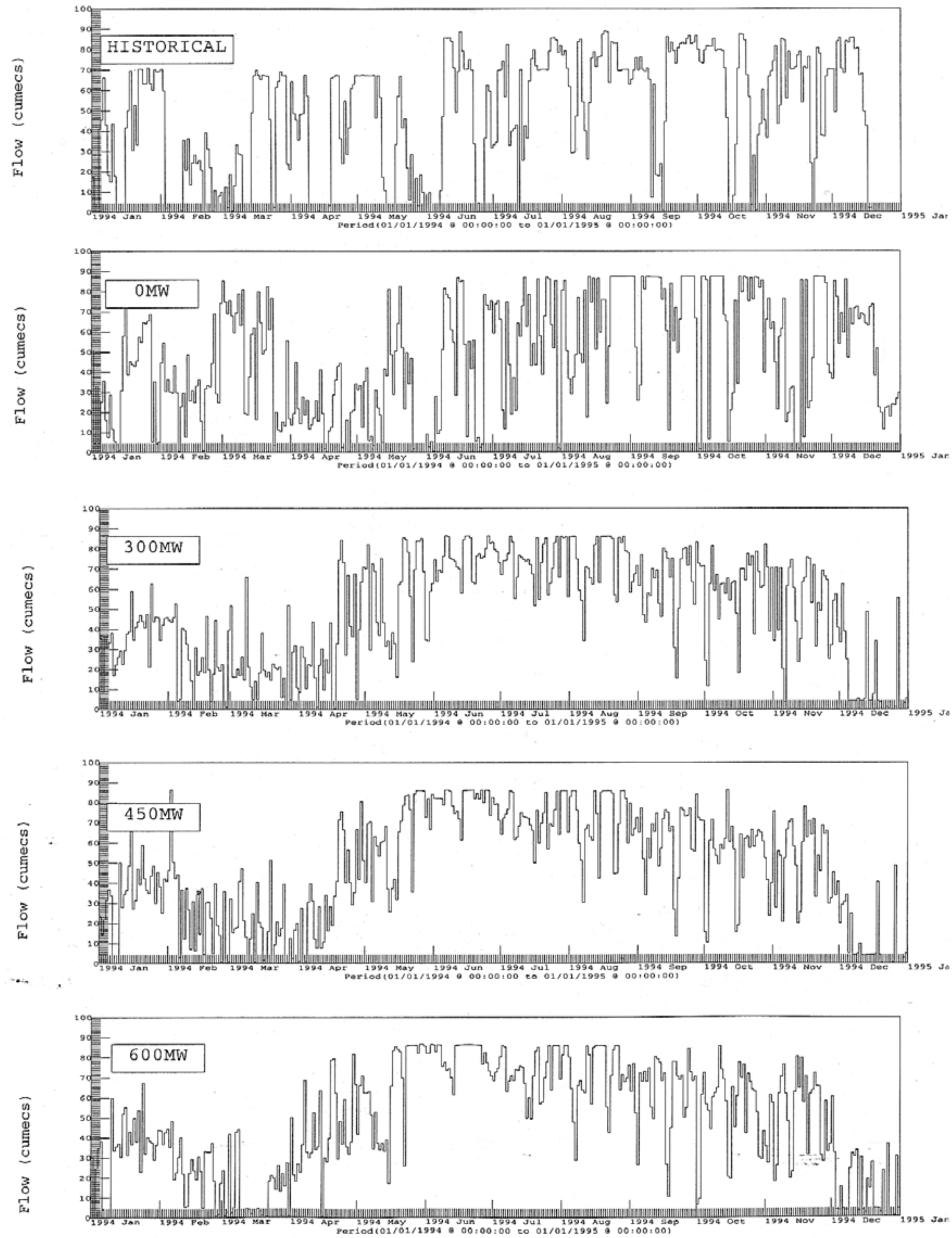

Figure 3.23 – Discharge time-series plots for John Butters Power Station during a wet year (1994) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

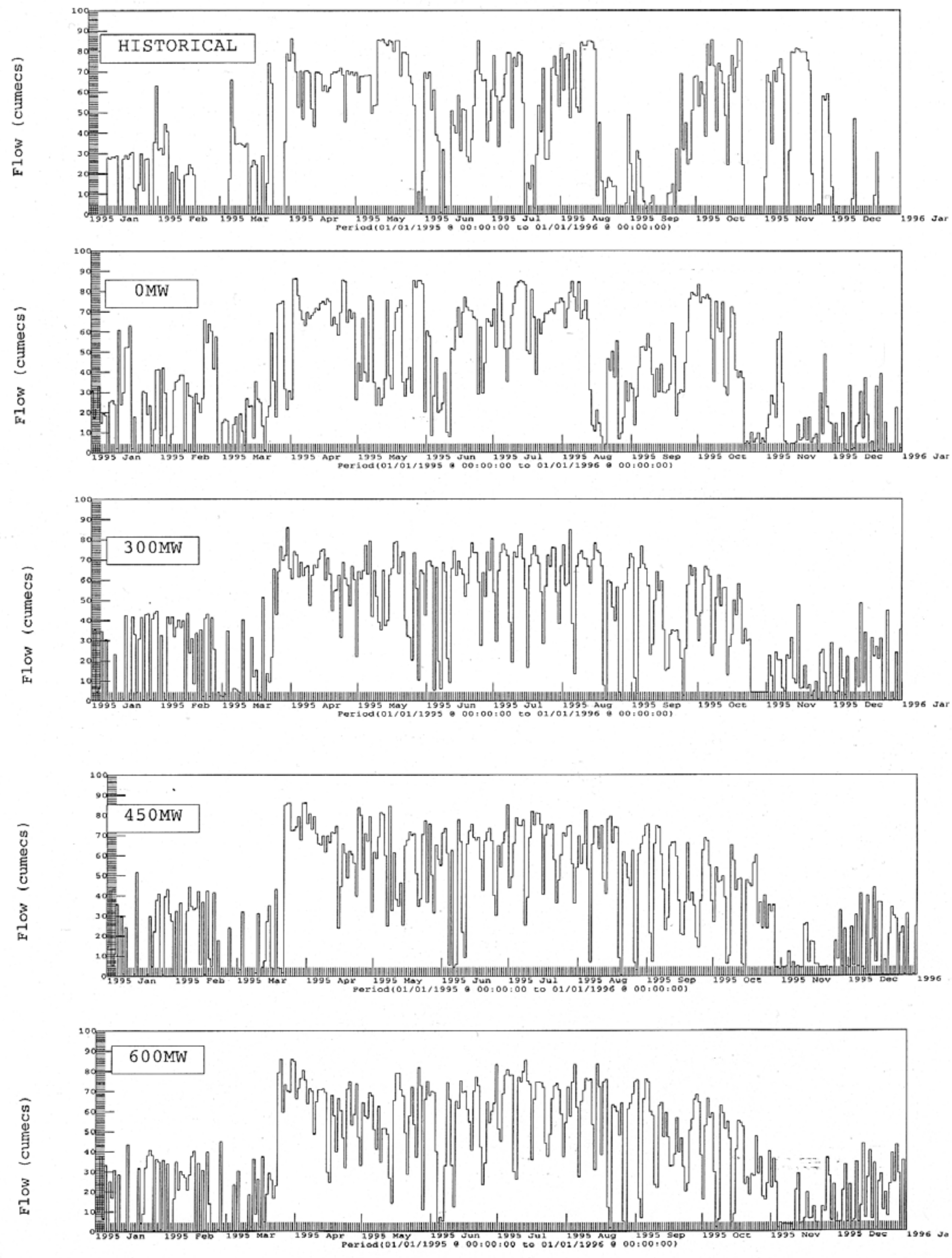

Figure 3.24 – Discharge time-series plots for John Butters Power Station during a dry year (1995) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

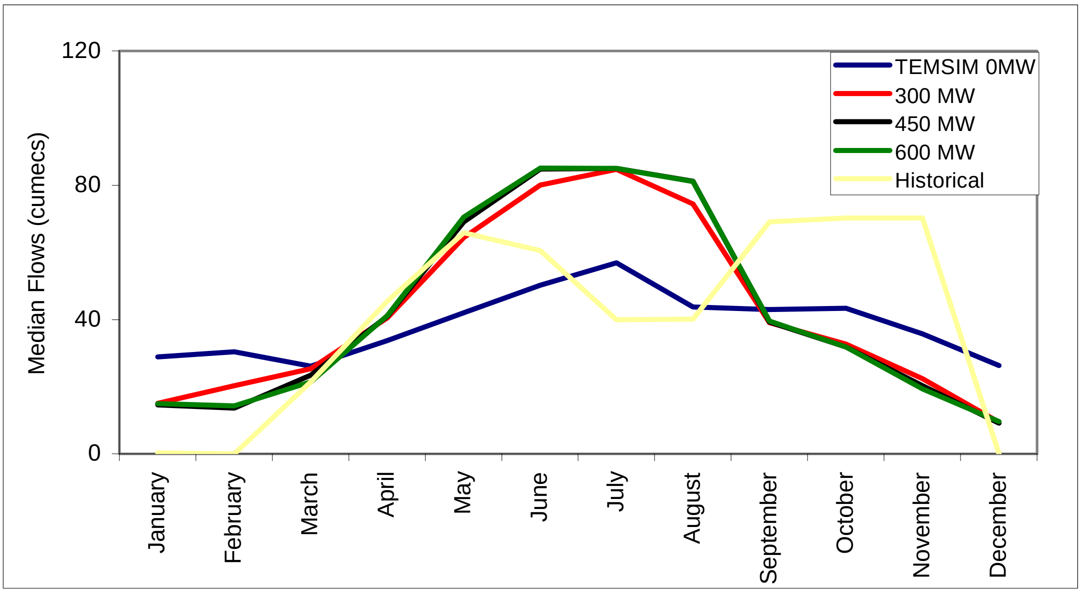

Figure 3.25 – Median monthly flows from the John Butters Power Station. Monthly medians of zero indicate that the power station is operating less than 50% of the time during that month and does not necessary designate a total shutdown over that period.

3.4.3 Pieman-Anthony Scheme Lakes

Lake Plimsoll shows very little variation between any of the TEMSIM modelling results (Figure 3.26) and does not appear to present any Basslink related issues.

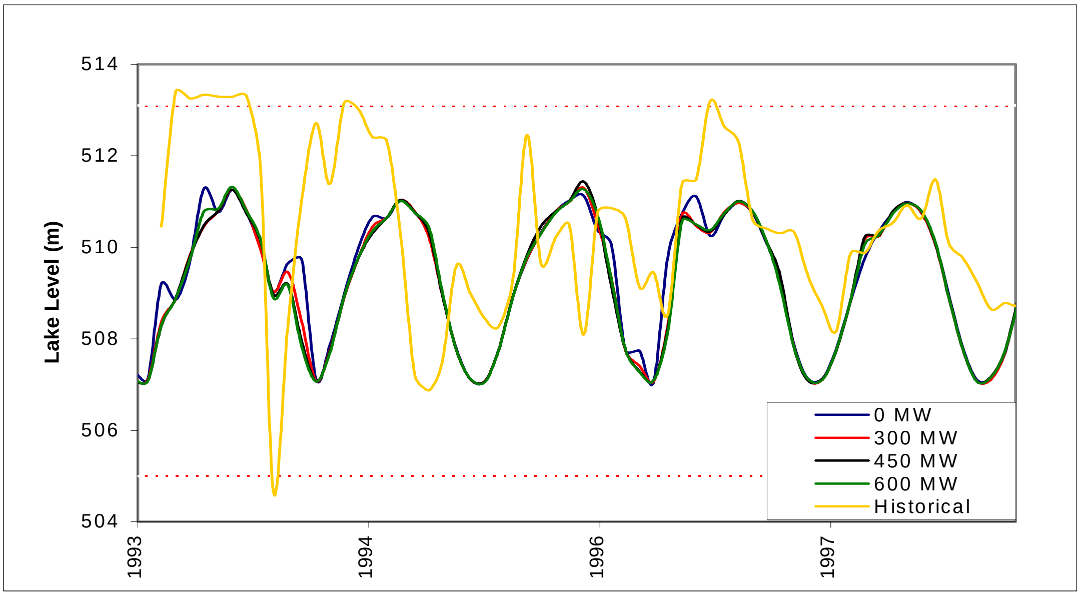

Figure 3.26 - Lake level time-series plot for Lake Plimsoll. The short period of record is due to the recent construction of this lake. The top and bottom lines indicate FSL and NMOL for the storage.

The operation of Lake Mackintosh is very similar to historical under all TEMSIM scenarios (Figures 3.27, 3.28, 3.29). The historical plot shown in Figure 3.27 utilizes most of the storages active range, however TEMSIM appears to be somewhat conservative in the management of this lake and tends to operate slightly higher within the storage. Lake Murchison (not shown) exhibits very similar characteristics. Lake Rosebery is significantly constrained to an operating range of 3.4 m by an existing lake level agreement.

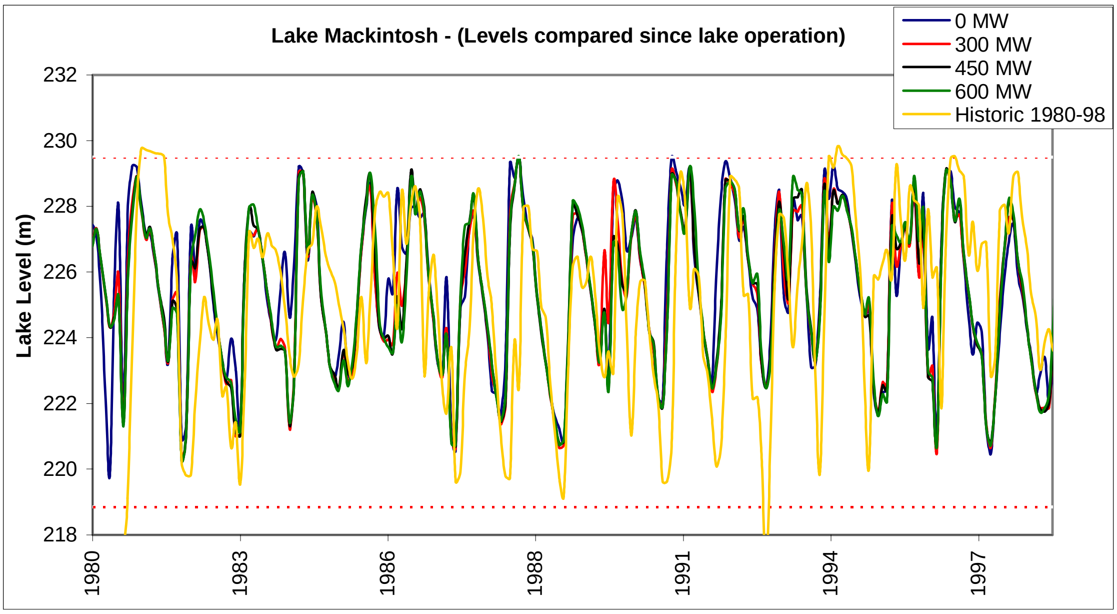

Figure 3.27 - Lake level time-series plot for Lake Mackintosh. The time period shown in this figure (1971 - 1998) represents the operation of this lake since it was built. The top and bottom lines indicate FSL and NMOL for the storage.

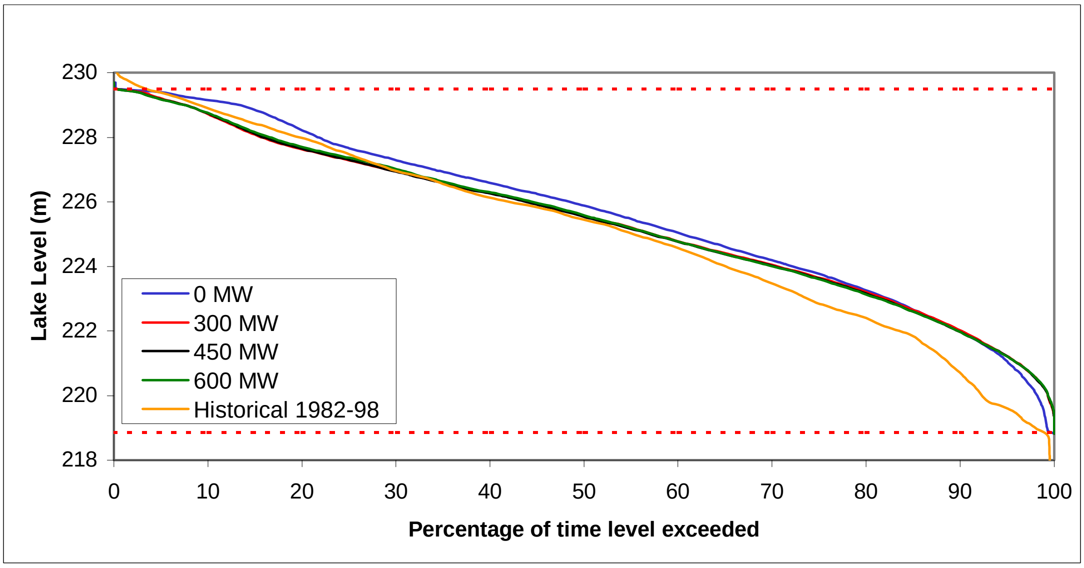

Figure 3.28 – Lake level duration plot for Lake Mackintosh. The historical averages for the period 1982 - 1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

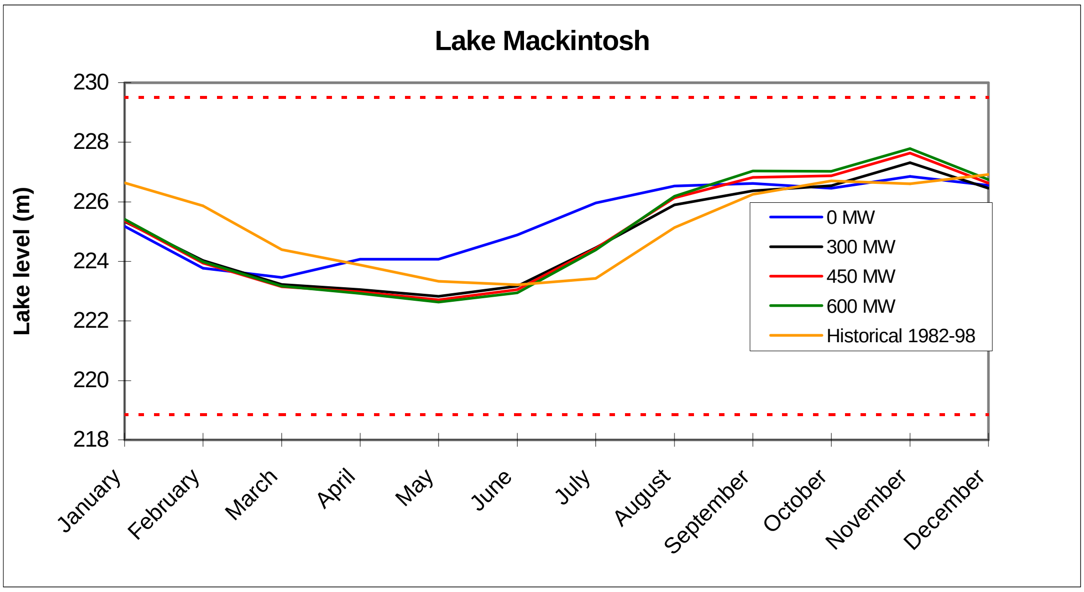

Figure 3.29 – Average monthly lake levels for Lake Mackintosh. The historical averages for the period 1982 - 1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

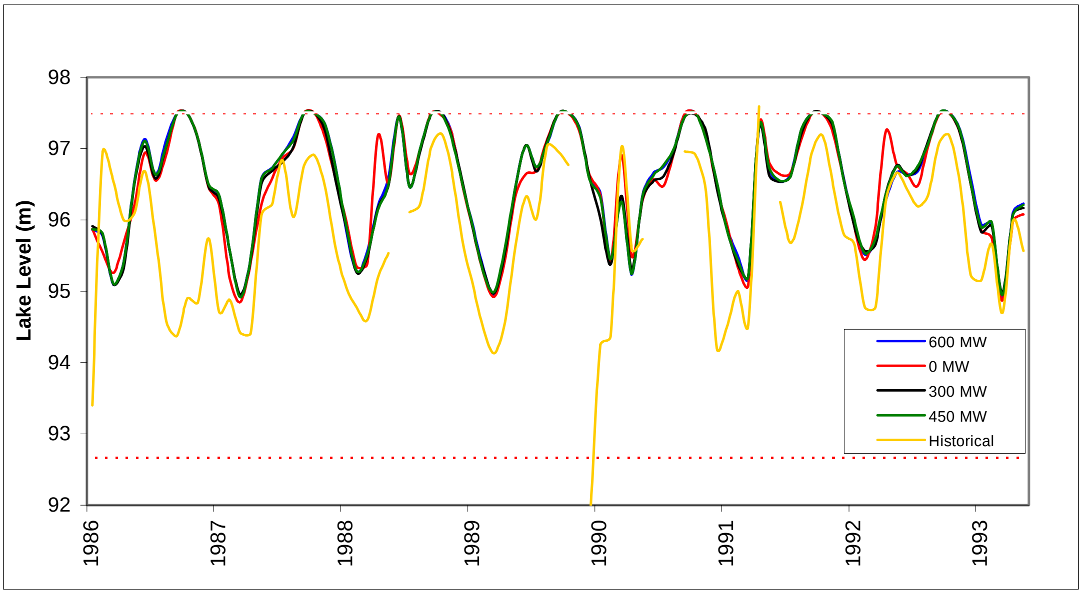

Figure 3.30 - Lake level time-series plot for Lake Pieman. The time period shown in this figure (1986 - 1998) represents the operation of this lake since it was built. The top and bottom lines indicate FSL and NMOL for the storage.

The modelled results for Lake Pieman (Figure 3.30) also closely follow historical operations, although the lake is held higher and spills more often under Basslink. The low historical lake level recorded in 1990 is due to a drawdown for maintenance purposes and does not reflect normal operation. The modelling results for this lake suffer from some of the problems discussed in section 3.1, and this accounts for this increased spill. In reality, it is most likely that the lake will be operated in a very similar pattern to historical in order to ensure maximum efficiency in the use of water from this lake.

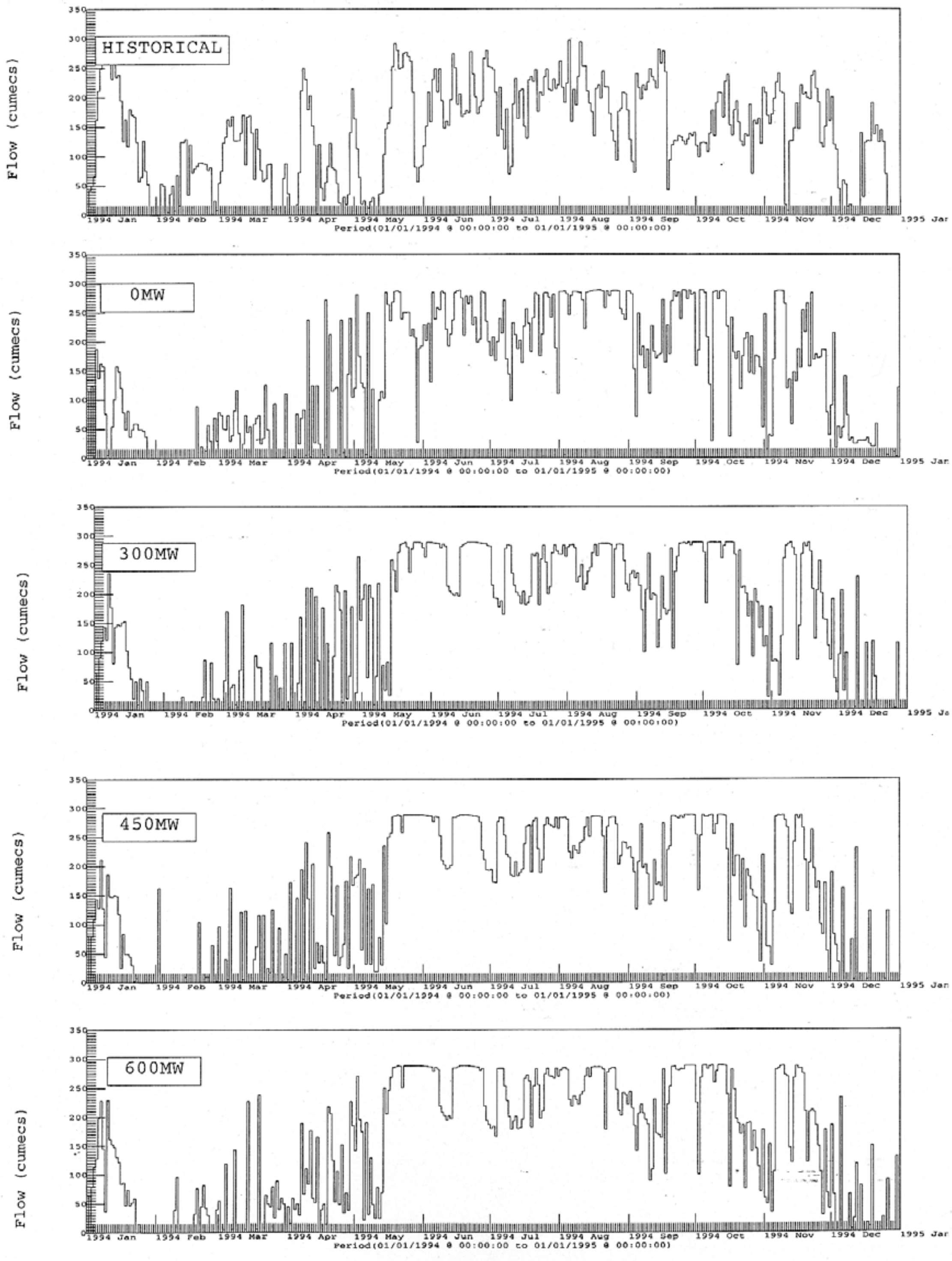

Figure 3.31 – Discharge time-series plots for Reece Power Station during a wet year (1994) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

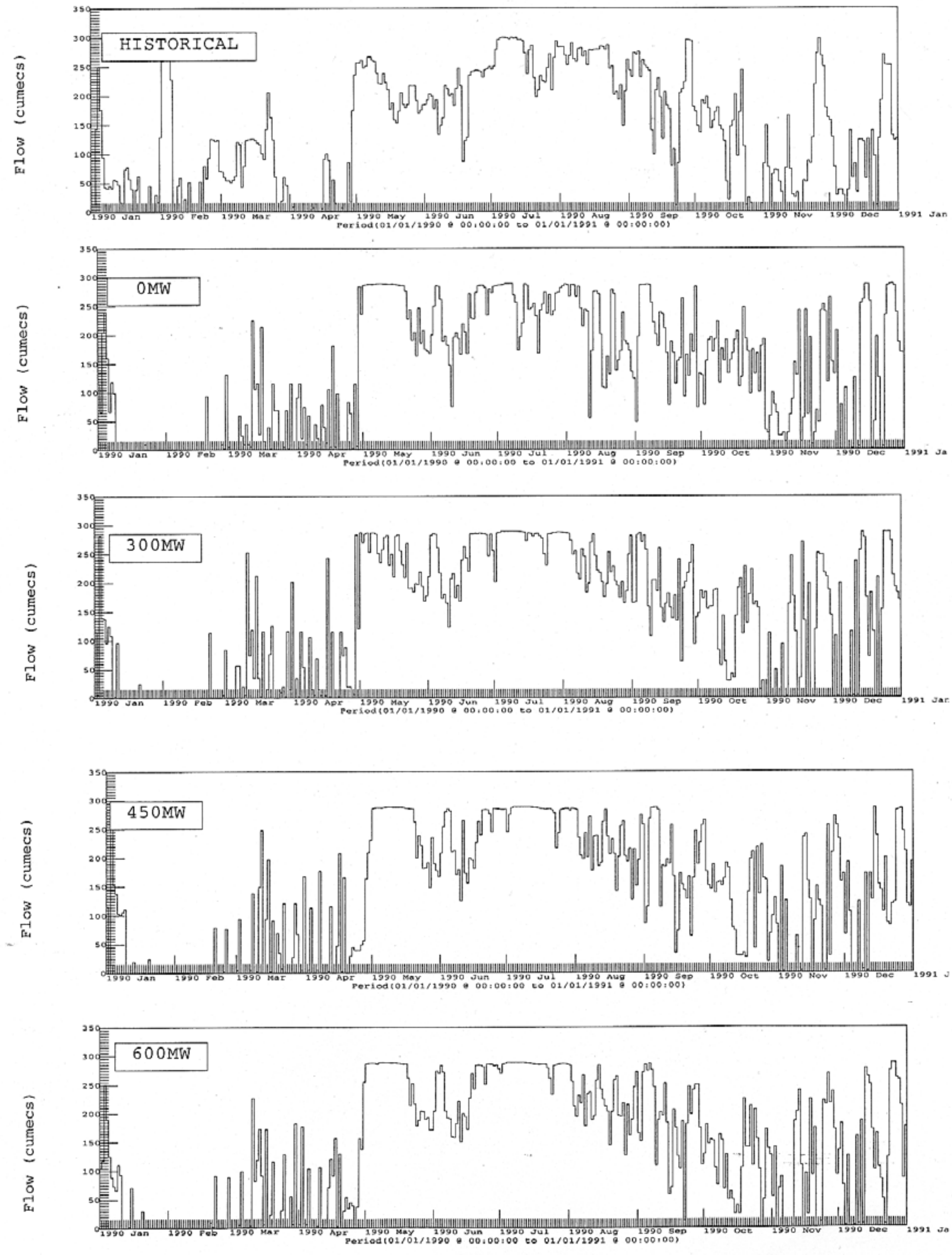

Figure 3.32 – Discharge time-series plots for Reece Power Station during a dry year (1990) for historical operations (top), OMW, 300MW, 450MW and 600MW TEMSIM scenarios.

The modelling results indicate that none of these lakes present issues associated with a Basslink cable, and do not warrant study as part of the environmental investigations for Basslink.

3.4.4 Reece Power Station Discharges

Historically, Reece Power Station operates similarly between wet (Figure 3.31) and dry (Figure 3.32) years. Under the 0MW scenario, the discharges tend to stay at full gate more often, but exhibit similar rates of fluctuation to the historical.

Median monthly flows (Figure 3.33) from this power station are similar for all TEMSIM scenarios, and follow the historical pattern closely. The zero median flows shown in this figure for January to March indicate that the power station is operated for less than 50% of the time during these months, but do not indicate a total shutdown over this period.

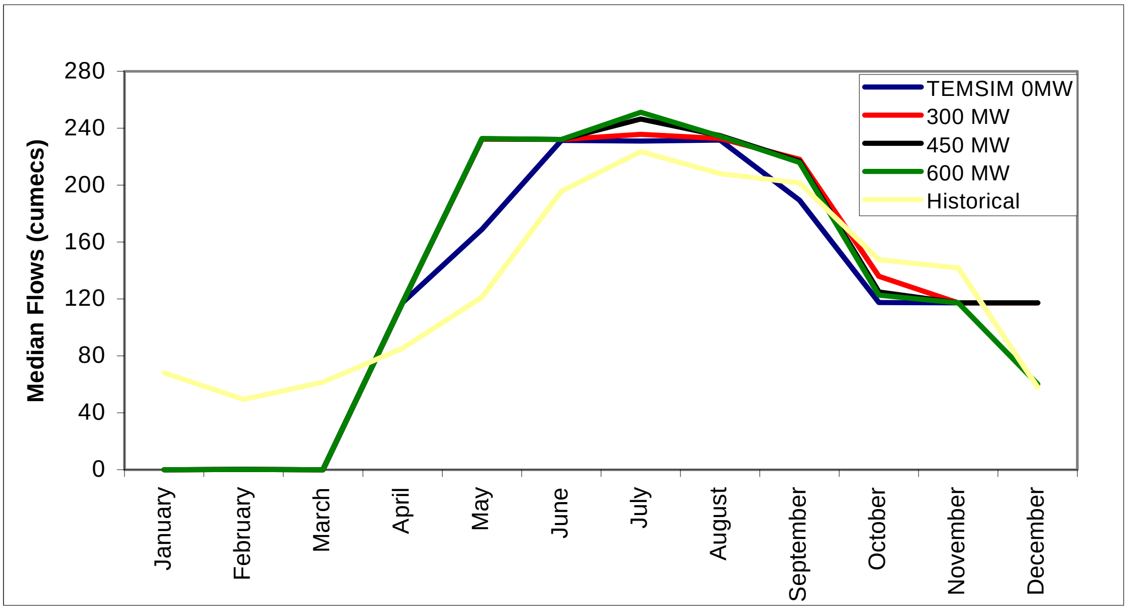

Figure 3.33 – Median monthly flows from the Reece Power Station. Monthly medians of zero indicate that the power station is operating less than 50% of the time during that month and does not necessary designate a total shutdown over that period.

There is a small increase in the number of short-term (<12 hour) shutdown events with increasing Basslink cable size (Figure 3.34), and a slight increase in the number of 16-32 hour flow release events with the larger cables (Figure 3.35).

In general there are minimal changes in the operation of the Reece Power Station arising due to Basslink, suggesting an absence of Basslink related issues for this power station.

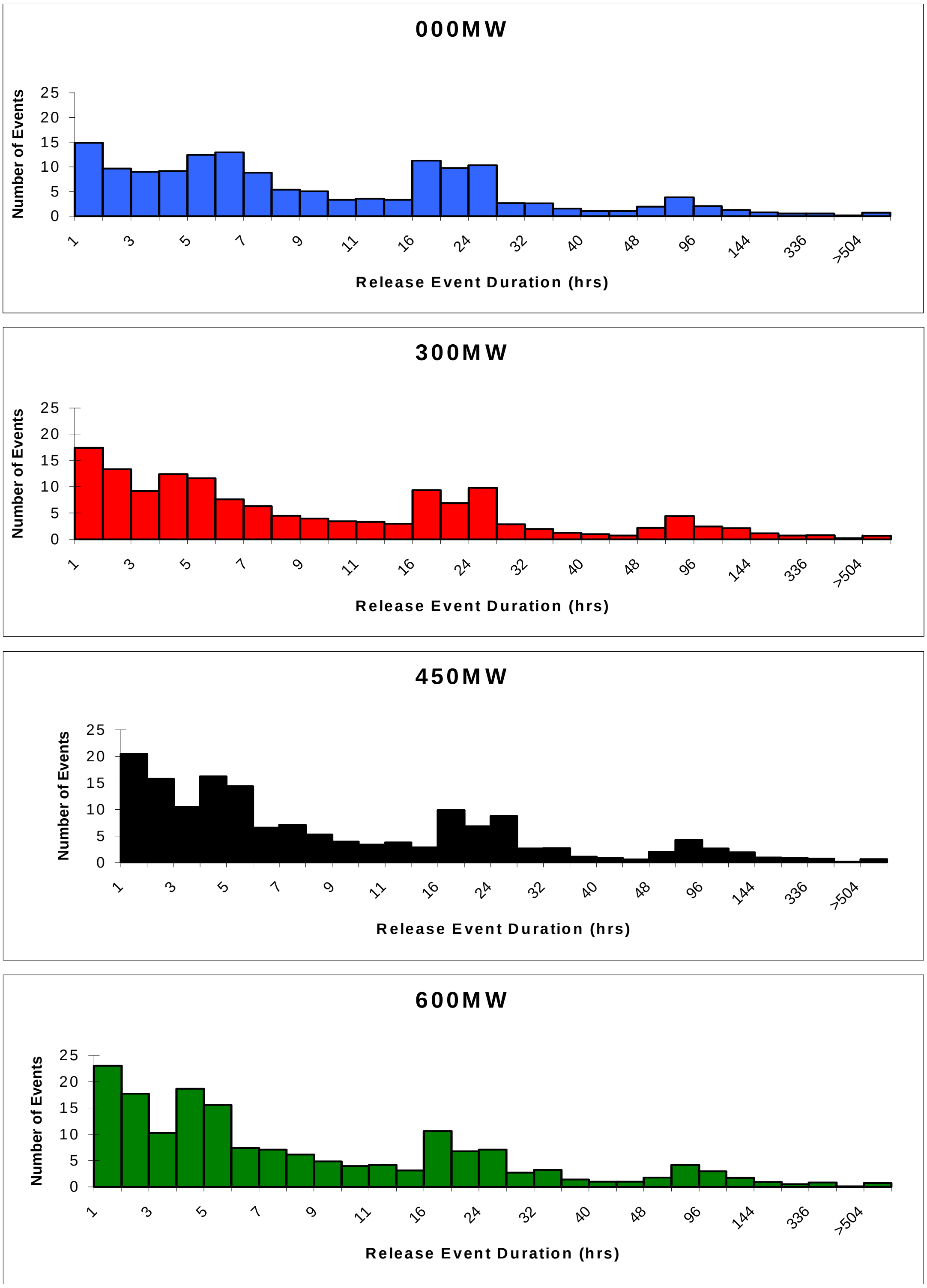

Figure 3.34 – Shutdown (zero flow) event duration analysis for Reece Power Station. Bars represent average number of shutdown days per year for each duration category.

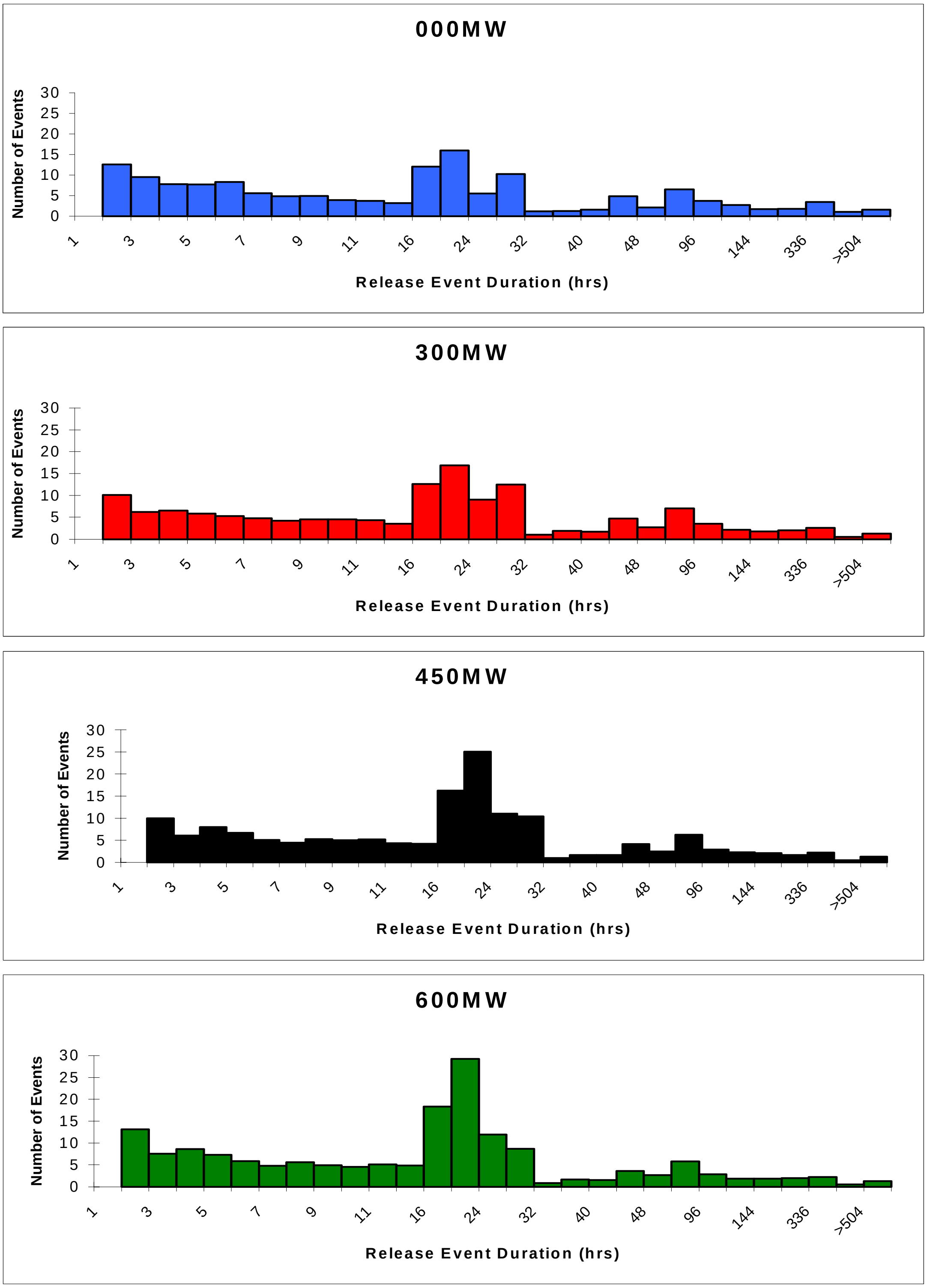

Figure 3.35 – Event (above 0 cumecs) duration frequency analysis for Reece Power Station. Bars represent average number of shutdown days per year for each duration category.

3.5 Derwent Catchment

The Derwent catchment consists of a long sequence of run-of-river power stations fed by two headwater storage chains. Lake St. Clair and Lake King William are at the head of the natural Derwent River and form one of these storage chains. Lake Echo feeds into Dee Lagoon, Bradys Lake, Lake Binney and Tungatinah Lagoon to form the other main head storage. There are also numerous diversions, canals and pipelines within the upper parts of this catchment. The main cascade sequence of lakes and power stations begins at Lake Liapootah and follows through Wayatinah Lagoon, Lake Catagunya, Lake Repulse, Cluny Lagoon and Lake Meadowbank before discharge to the lower Derwent River via Meadowbank Power Station. There is a significant length of river below this last dam extending downstream to Hobart and the Derwent Estuary.

3.5.1 Storages

The complexity of the Derwent system and the relatively small size of most of the storages make it very difficult to model the effect of operation changes accurately. The numerous interactions between the upper storages mean that generation has to be balanced effectively to optimally utilise these storages. The TEMSIM model does not fully optimise the management of these lakes.

Modelling data have only been presented for the two major head storages within this catchment. Lake King William (Figure 3.36) is held higher under TEMSIM modelling than it has been historically, suggesting that this lake is not being used as efficiently as it could be for water storage and power generation. This is also true for Lake Echo (Figure 3.37), however recent operation of this lake has been more conservative than before the 1970s.

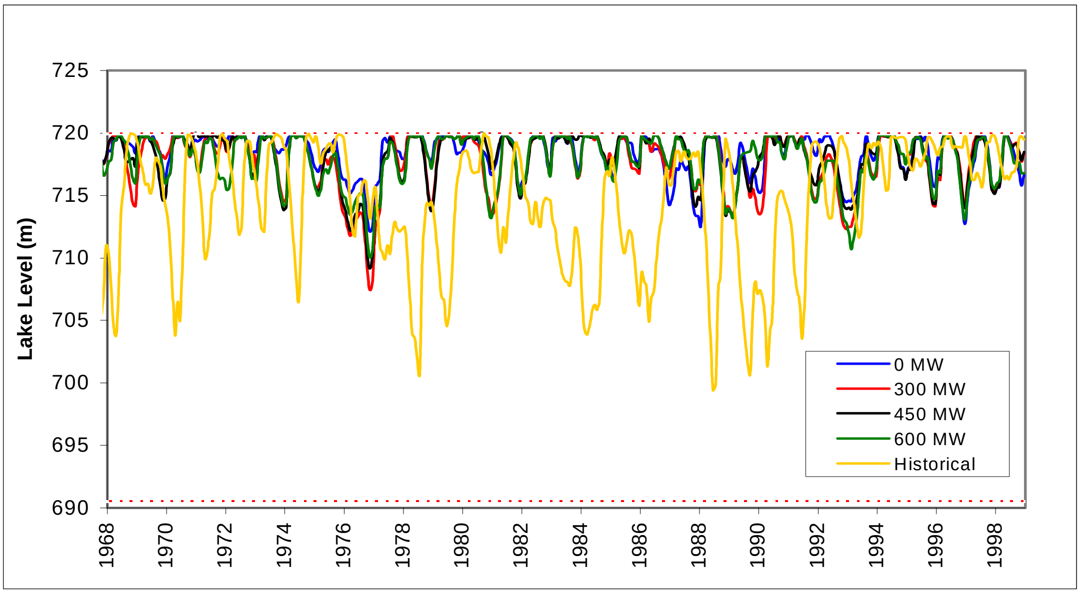

Figure 3.36: Lake level time-series plot for Lake King William. The time period shown in this figure (1968 - 1998) represents the operation of this lake since it was built. The top and bottom lines indicate FSL and NMOL for the storage.

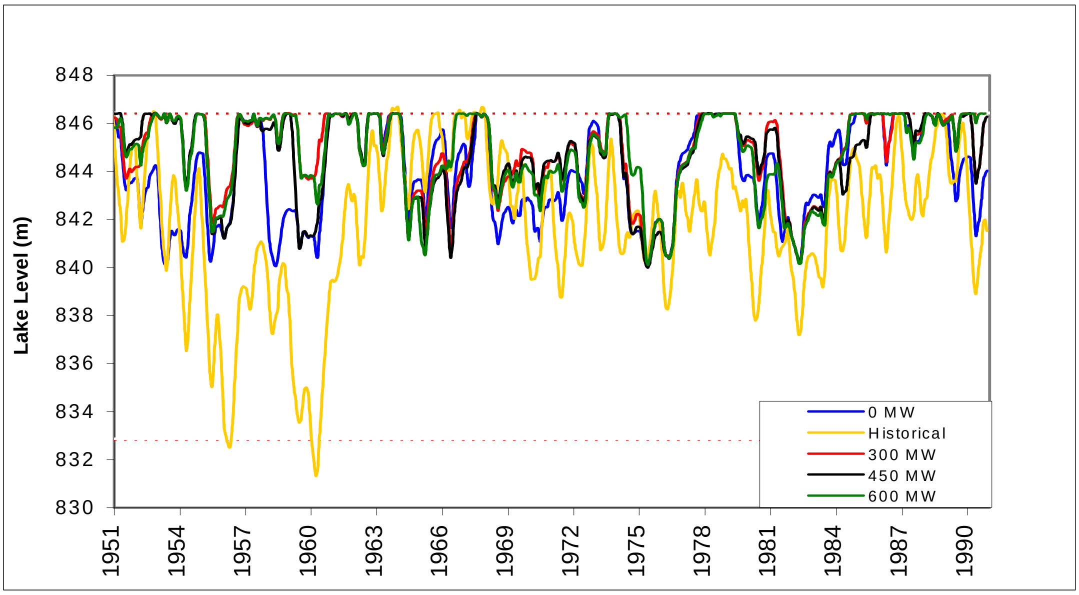

Figure 3.37 - Lake level time-series plot for Lake Echo. The time period shown in this figure (1951 - 1998) represents the operation of this lake since it was built. The top and bottom lines indicate FSL and NMOL for the storage.

The TEMSIM model provides good indicative information for the header lakes, but the sequence of small to medium sized run-of-river power stations in the cascade has not been properly optimised by the TEMSIM model. In reality, the lakes down the cascade are likely to be managed very similarly to present, and are not expected to change significantly with the connection of a Basslink cable. Lake Meadowbank, the lowest in the cascade sequence, has a lake level agreement. There are not believed to be any Basslink related issues in relation to the Derwent storages, and existing environmental issues will be addressed through the Hydro's Water Management Review process. The Hydro is committed to ensuring sustainable management of all of its waterways, and will continue to abide by any existing lake level agreements.

3.5.2 Meadowbank Power Station Discharges

Meadowbank Power Station is the last in the run-of-river cascade on the Derwent River. Much of its operation is governed by the requirement to maintain a continuous 20 cumec flow down the river for the control of salinity intrusion downstream at Fletcher Challenge Paper and Bryn Estyn (Hobart water supply) intakes. Provision of the minimum 20 cumec flow is maintained during power station maintenance by releasing water through a riparian valve.

Despite some of the problems relating to modelling of the Derwent system, it is not envisaged that there will be any significant environmental issues below Meadowbank Power Station associated with introduction of Basslink.

3.6 Mersey-Forth Catchment

The Mersey-Forth power development harnesses the waters of the Mersey, Forth, Wilmot and Fisher Rivers. Similar to the Derwent catchment, this scheme consists of two main head storages (Lake Mackenzie and Lake Rowallan) and a run-of-river series of stepped lakes (Lakes Cethana, Barrington and Paloona). The Wilmot River is diverted to Lake Cethana by Wilmot Dam (Lake Gairdner). Lake Parangana is a medium storage that receives the waters of Rowallan and Fisher Power Stations before diverting water to Lake Cethana. Discharge from the whole scheme is via Paloona Power Station to the Forth River.

3.6.1 Storages

Results for Lake Rowallan showed that when modelled under TEMSIM, the lake behaved very similarly to historical operations. TEMSIM did not attain the extremely low lake levels featured in the historical record (Figure 3.38), and indicates generation bids from Rowallan Power Station in the TEMSIM model were not low enough in comparison to other competitors in the market. This results in more conservative management of Lake Rowallan. The lake level duration plot (Figure 3.39) shows that the TEMSIM runs hold the lake slightly lower than historical in the top part of the lake's active range, leading to fewer spills. The Basslink cables draw the lake down slightly more than the 0MW case, showing that water is sold off with Basslink when the storage is above its EOL.

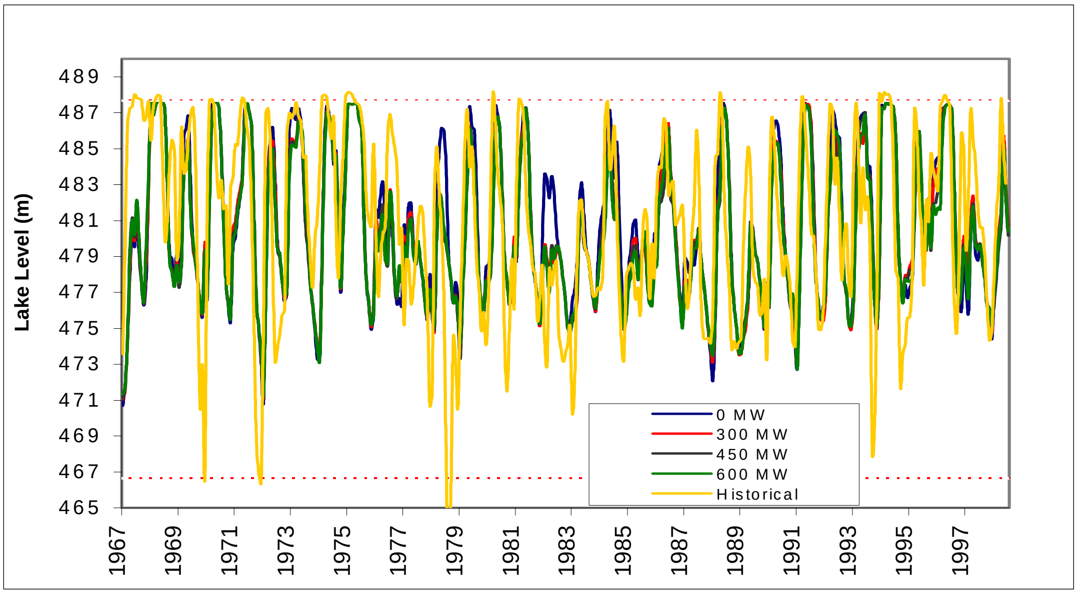

Figure 3.38 - Lake level time-series plot for Lake Rowallan. The time period shown in this figure (1967 - 1998) represents the operation of this lake since it was built. The top and bottom lines indicate FSL and NMOL for the storage.

There is a slight shift in the average seasonal variations of the lake under the 0MW and Basslink cable scenarios (Figure 3.40). This is similar to other medium storages that were modelled, which produced a peak approximately one month earlier than historical operation. This is not considered to raise any significant environmental issues.

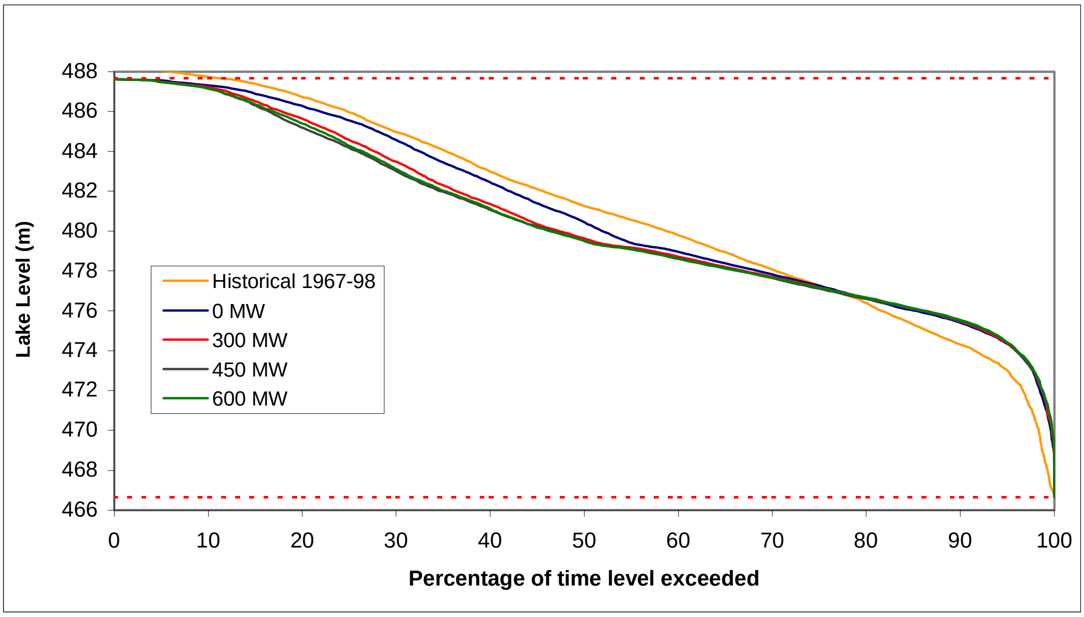

Figure 3.39 – Lake level duration plot for Lake Rowallan. The historical averages for the period 1967 - 1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

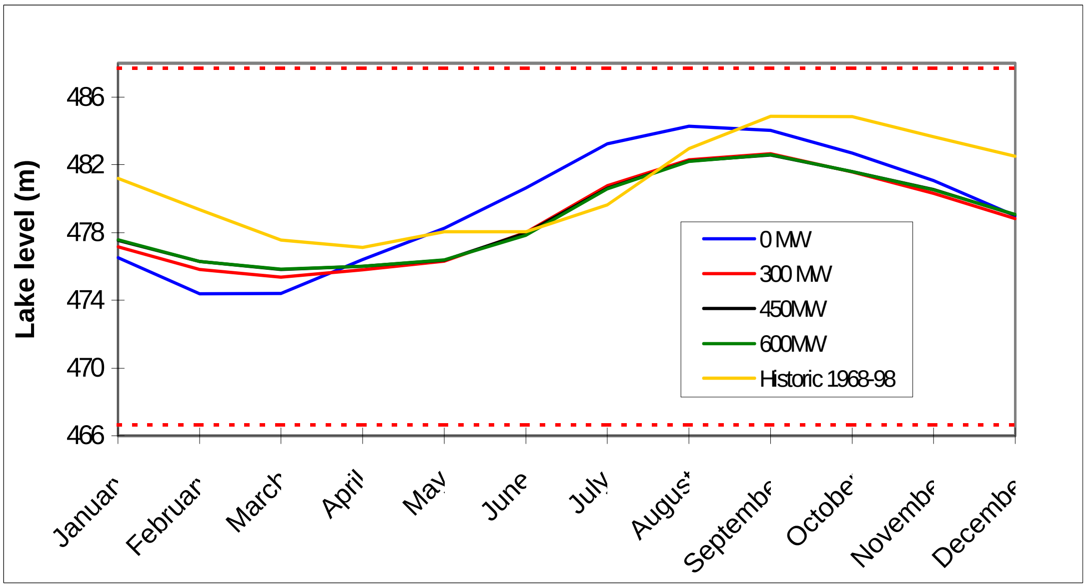

Figure 3.40 – Average monthly lake levels for Lake Rowallan. The top and bottom lines indicate FSL and NMOL for the storage.

Lake Gairdner behaves similar to historical trends in the TEMSIM model. Most of the active range of the lake is utilised as is the case presently (Figure 3.41). The lake level duration curves (Figure 3.42) show that the lake is held more consistently in the middle ranges of its storage with Basslink than under the 0MW or historical scenarios. The deviation between the 0MW and Basslink cables is due to the ability of the cable to import electricity when the lakes are approaching their EOLs. There are no significant variations between the various Basslink scenarios, indicating that cable size does not influence the management of this lake. The analysis of lake level seasonality (Figure 3.43) shows that the lake is historically variable throughout the year, but is maintained higher during the warmer months with TEMSIM. No environmental issues appear to be raised by this mode of operation.

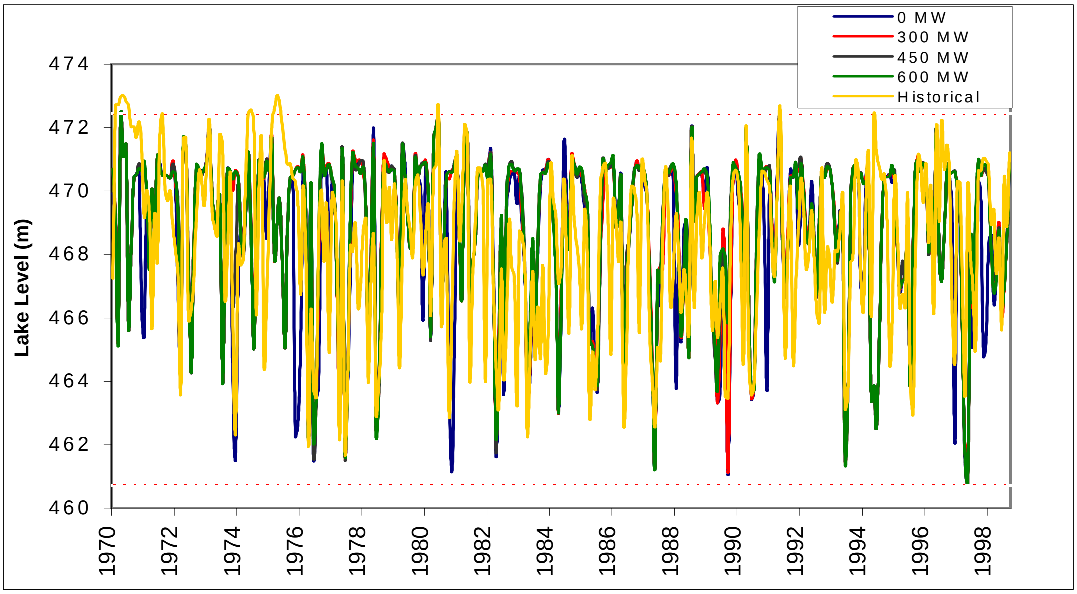

Figure 3.41 - Lake level time-series plot for Lake Gairdner. The time period shown in this figure (1970 - 1998) represents the operation of this lake since it was built. Top and bottom lines indicate FSL and NMOL.

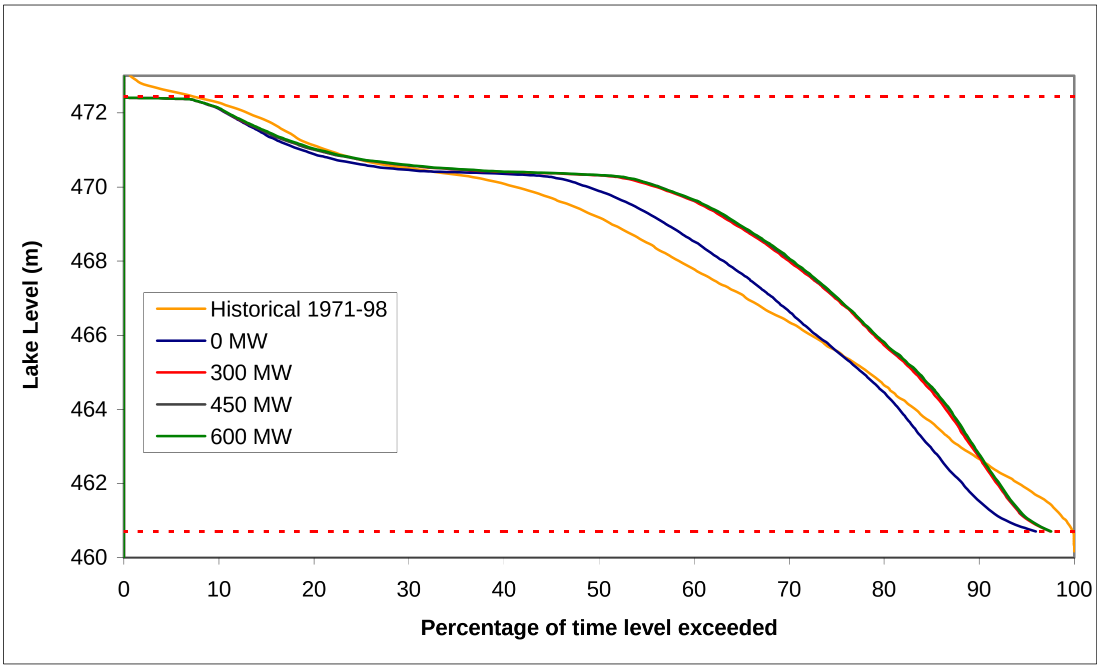

Figure 3.42 – Lake level duration plot for Lake Gairdner. The historical averages for the period 1971 -1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

Lake Barrington is held higher under the Basslink model than has been shown by historical management of the lake (Figure 3.44). The 0MW scenario occasionally draws the lake down closer to NMOL, and signifies acceptance of high priced generation bids from Devils Gate Power Station. Figure 3.45 illustrates the similarities in water level management of the lake in the upper part of the storage, and indicates slightly more spill when the level exceeds the FSL. The Basslink scenarios are clearly shown here to hold the lake above ~120 m. Monthly average levels (Figure 3.45) indicate that the lake is maintained at similar average levels year round. Based on the results of this modelling there are no issues relating to Lake Barrington that warrant detailed environmental studies in relation to Basslink.

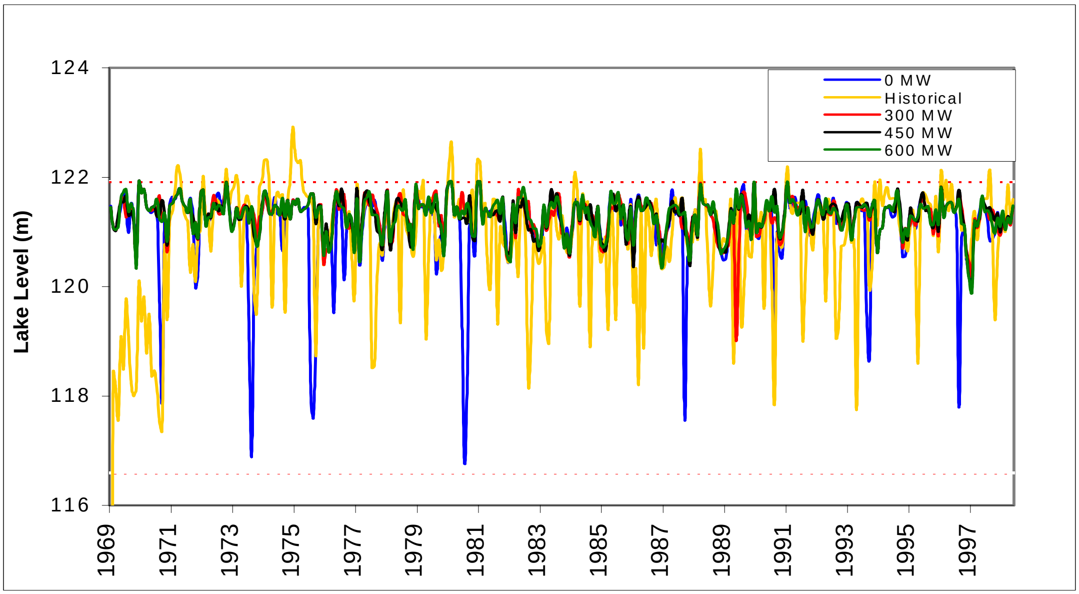

Figure 3.43 - Lake level time-series plot for Lake Barrington. The time period shown in this figure (1969 - 1998) represents the operation of this lake since it was built. The top and bottom lines indicate FSL and NMOL for the storage.

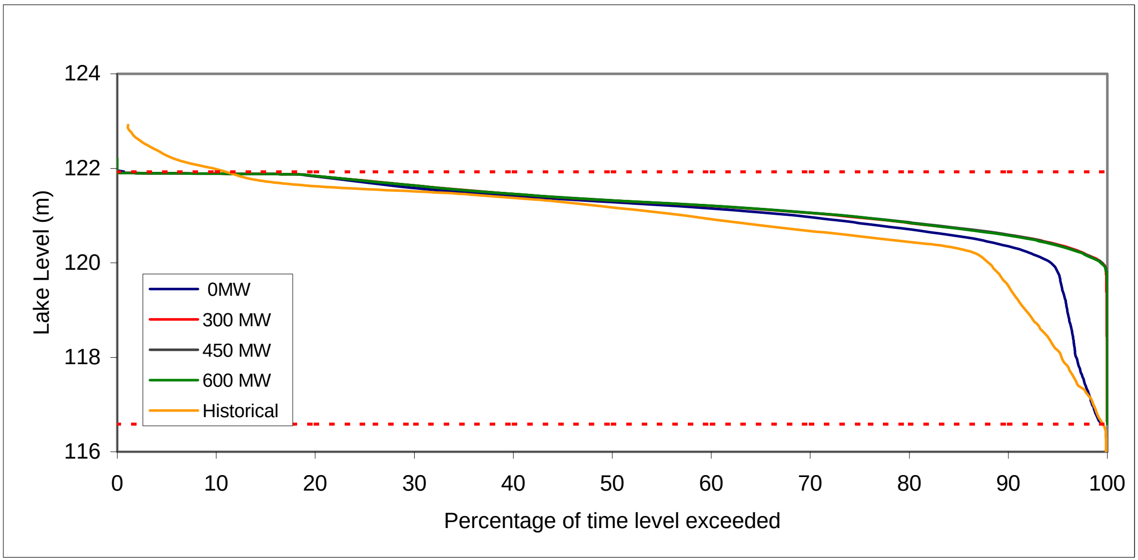

Figure 3.44 – Lake level duration plot for Lake Barrington. The historical averages for the period 1971-1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

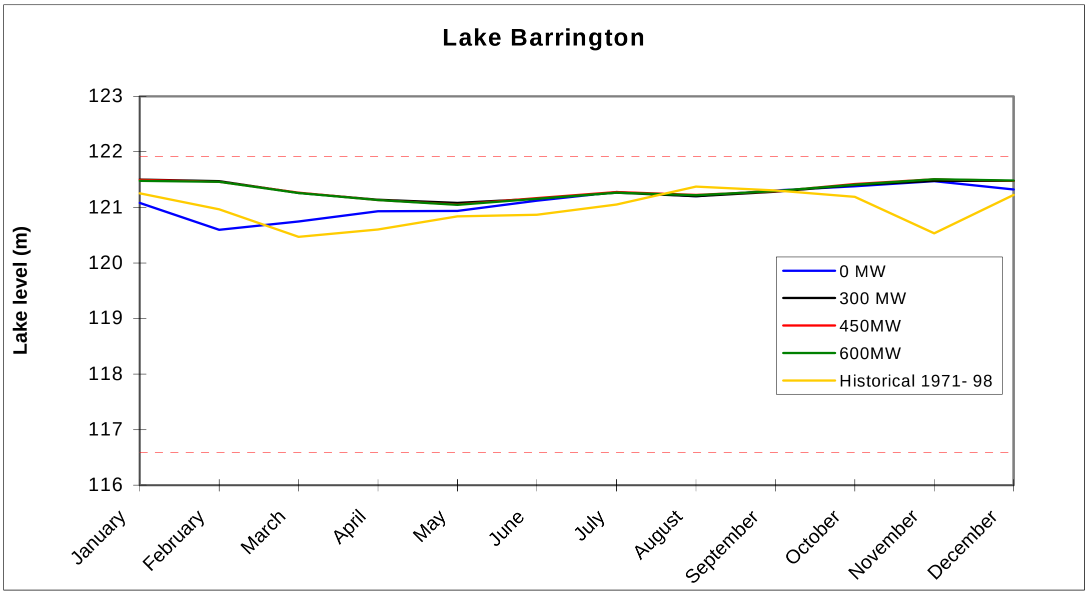

Figure 3.45 – Average monthly lake levels for Lake Barrington based on the 65 year modelling period. The historical averages for the period 1971-1998 are shown for comparison. The top and bottom lines indicate FSL and NMOL for the storage.

3.6.2 Downstream Discharges for the Mersey-Forth

The TEMSIM model did not adequately model discharges from Paloona Power Station nor the likely frequency of spill events over Paloona Dam. This is largely due to the run-of-river scheduling problems described in Section 3.1 and will be refined as part of the system model development work being undertaken by the Hydro.

Paloona Power Station startups are staged (ramped) in order to give downstream users warning of rising water levels to maximise the safety of users downstream. Once loaded, the station is run to ensure water supply for the North West Regional Water Authority and in the interests of public safety. This pattern of operation is unlikely to change under Basslink.

3.7 Summary

It is apparent from the modelled results presented in this chapter that the most significant changes to Hydro waterways will be downstream of the major storages in the system. Discharges out of both the Gordon and Poatina Power Stations are likely to show the same trends under Basslink. Notably, these are:

- increased short-term variability in flow discharges;
- increased frequency of short duration (and weekend) shutdowns; and
- changes in the seasonality of flows.

Changes in the seasonal nature of discharges out of the John Butters Power Station are indicated, and possibly some alterations in the already highly variably pulses of discharge.

No significant changes in lake level are indicated by the modelled results for any of the lakes within the Hydro's generating system. Modelling has shown that these lakes are managed similarly to historical patterns. In addition, many lakes are currently constrained by lake level agreements. These constraints will continue in operation after the commissioning of Basslink. The present lake level agreements will be reviewed and assessed in relation to environmental and social issues as part of the Water Management Review process that the Hydro is engaging in with Department of Primary Industries, Water and Environment.

Some areas of the Hydro system could not be modelled effectively by TEMSIM. These areas include the downstream reaches of run-of-river cascades with small to medium power stations, and the balancing of multiple head storages (in both the Derwent and Mersey-Forth catchments). These modelling issues are being addressed by the Hydro. It is considered unlikely that minor adjustments required for the model will raise issues not already identified in this chapter. As a guiding principle, the Hydro recognises the ecological and multiple use values of all of its waterways and will ensure that these areas are managed sustainably into the future through its Water Management Review process.

4 ENVIRONMENTAL ISSUES

4.1 Overview

From the analysis of the modelling results, changes in the Hydro operating system under a Basslink cable primarily affect discharges out of the Gordon and Poatina Power Stations, and to a lesser degree out of the John Butters Power Station. The Gordon and Poatina Power Stations are likely to experience increased short-term variability in flow discharges, increased frequency of short duration (and weekend) shutdowns, and changes in the seasonality of flows. Changes in the seasonal nature of discharges out of the John Butters Power Station are indicated, and possibly some alterations in the already highly variably pulses of discharge. Notably, the magnitude of releases from any of the power stations will be no greater than the present full gate capacities.

The expected hydrological changes may have consequences for aquatic biota, fluvial geomorphology, water quality and other users of the waterways.

This chapter discusses the environmental implications of the changes in flow regimes observed as a result of the introduction of Basslink. It addresses downstream of the Gordon Power Station, the Poatina Power Station and the John Butters Power Station in turn. It describes the key environmental issues in these waterways, and how they may be affected by the hydrological changes anticipated by Basslink. The following chapter will describe the environmental investigations planned in these waterways to more definitively quantify the environmental issues and management options.

4.2 Downstream Gordon Power Station

4.2.1 Introduction

Almost the entire catchment of the Gordon Power Scheme and the Gordon River downstream of Gordon Dam (Figure 4.1) are within either the Franklin-Gordon Wild Rivers National Park or the South-West National Park. These National Parks form part of the Tasmanian Wilderness World Heritage Area (WHA). The key uses of the Gordon River downstream of the Gordon Dam are tourism, recreation and wilderness experiences. In the lower Gordon River area, tourist boat tours and scenic wilderness flights are popular, and rafting and canoeing trips are conducted on the tributary rivers such as the Franklin River. A key overarching issue in the Gordon River is to ensure that any environmental impacts attributed to the Basslink development do not jeopardise the natural and cultural heritage values for which this area was nominated as a WHA.

A number of fundamental environmental changes to the Gordon River occurred as a result of construction and operation of the Gordon River power scheme. Because of the remoteness and inaccessibility of particularly the middle Gordon River (downstream of the Gordon Dam), the environmental effects of the dam development itself are not well quantified. In these investigations, the environmental issues that may arise due to Basslink must be separated out from those which are attributed to the dam development.

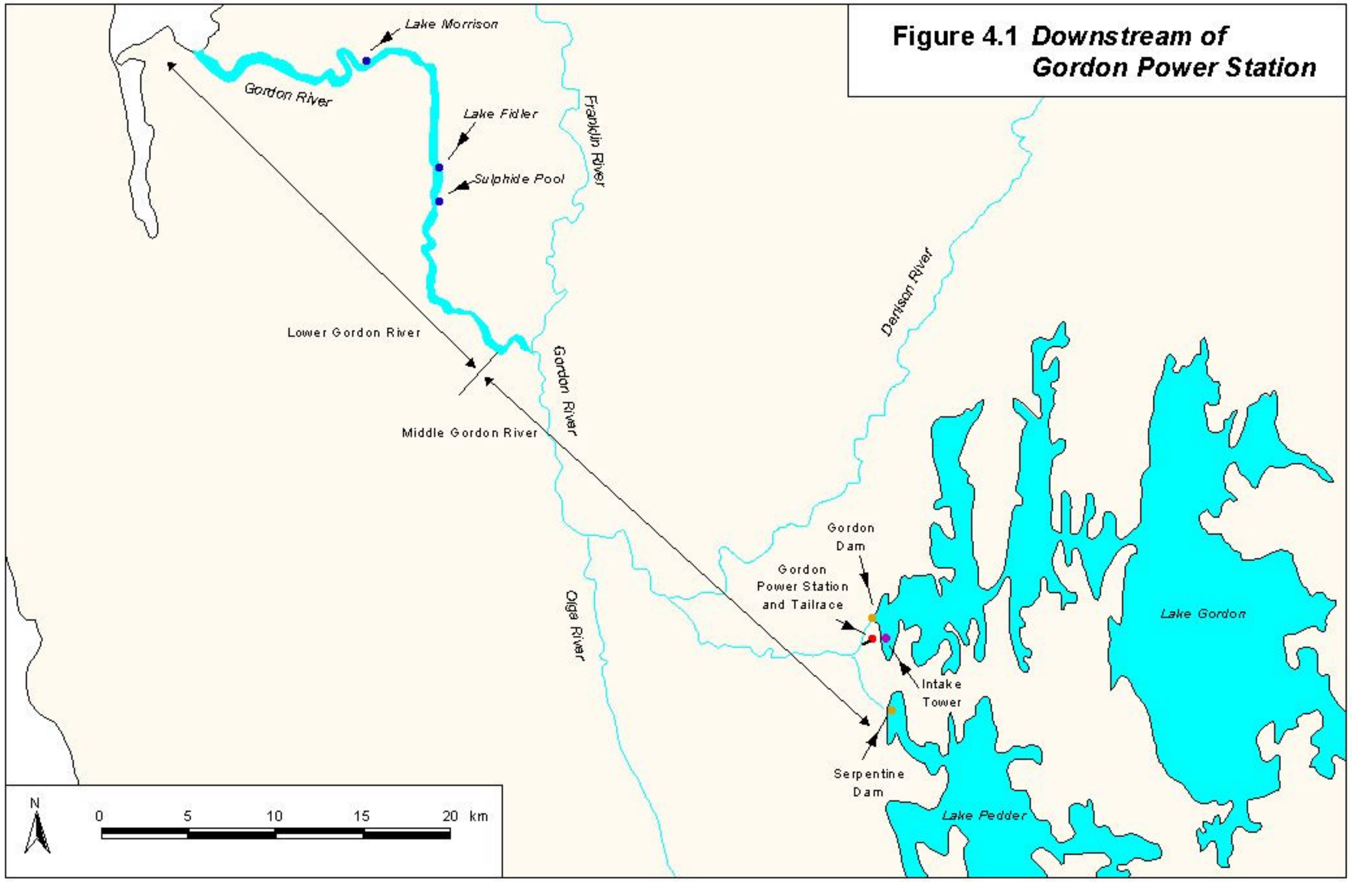

Figure 4.1 – Downstream of Gordon Power Station

In evaluation of the modelling results and discussions with specialists, the issues of geomorphology, cultural heritage, instream ecological health, ecological health of the meromictic lakes, water quality and public use are considered the key environmental issues which are subject to alterations under Basslink.

4.2.2 Geomorphology

Erosion in the lower tidal section of the Gordon River is considered a major geomorphic issue. These banks have been extensively mapped and monitored by Bradbury *et al*. (1995). The Tasmanian Parks and Wildlife Service attributes the bank erosion most predominantly to boat wakes from tourist vessels, as the Hydro influence on water levels so far downstream of the Gordon Power Station is minimal.

The shift from a predominantly base load power station operation during summer months to a more step load dominated operation throughout the year may have implications for the geomorphology of the Gordon River. The key area of risk is that the increase in rapid fluctuation (hydro-peaking) on-off power station discharges will exacerbate sediment bank erosion. In consultation with the Parks and Wildlife Service, it was agreed that geomorphic investigations related to Basslink should be conducted in the middle Gordon River, from the Gordon Dam down to the Franklin River tributary (Figure 4.1).

Hydro-peaking can contribute to river bank erosion in situations where water tables are left suspended within cohesive banks during rapid river level drawdown. Depending on the exact composition and permeability of the banks, these can be prone to slumping as water drains out of the banks toward the river channel. This fallen material may be mobilised by the next high flow event, leading to increased rates of bank retreat and sediment transport.

Key questions related to the risk of draw-down induced erosion which must be answered in field investigations are:

- Is river level drawdown a dominant bank erosion mechanism given the composition and permeability of the Gordon River sediment banks; and

- Do the frequency and rates of river level drawdown vary under a Basslink scenario as compared to present?

Geomorphic investigations in the Gordon River must seek to understand the current geomorphic processes that are occurring in the post-dam river. Depending on the bank materials and channel hydraulics, transport of river bank sediments may be driven more by prolonged high flow events than by fluctuations in river level. Transport of the river bed material depends on exceedance of the critical shear stress, a parameter strongly influenced by the particle diameter and the water surface slope; do these sediment transporting events increase or decrease with the Basslink scenarios? The dominant processes are likely to vary with distance downstream as natural tributary inflows dilute the influence of the power station. The zone of impact due to the power station under current conditions must be discerned, and any adjustments to this current zone of impact due to Basslink predicted.

In relation to all these questions, it is critical to understand the downstream propagation of the flow wave created by the turning on of the power station, and how this propagation is influenced by increased fluctuations in power station discharges.

Another geomorphic question, which will need to be addressed, relates to the occurrence of tributary rejuvenation, which is channel adjustment at tributary mouths in response to changed flow regimes (Germanoski & Ritter 1988). If such a process is identified as occurring in any of the Gordon River tributaries, the potential for exacerbation of this process due to Basslink must be considered in the Basslink environmental investigations.

The increased operation of the Gordon Power Station in winter will alter the flood frequency statistics for the Gordon River, with consequent effects on the sediment transporting events in the river. Alterations to current geomorphic processes associated with alterations to the flooding regime will need to be investigated.

Finally, there are notable occurrences of karst in the Gordon and Franklin River systems, with associated cave features and cave fauna. Geomorphic investigations into Basslink must consider any possible affects on these karst features.

An issue interlinked with geomorphological changes is that of the preservation of cultural heritage artefacts. No systematic surveys have been carried out in the Gordon River, and the only evidence of Aboriginal occupation is a chance find artefact scatter just upstream of the junction with the Denison River (Collett 1996). However, a number of the Gordon River tributaries have undergone surveys, including the Franklin and Denison rivers, and these have shown significant evidence of Aboriginal occupation and use of the area (Blain *et al*. 1983; Jones *et al*. 1983; Kiernan *et al*. 1983, all cited in Collett 1996). Because of these surveys it is considered likely that the Gordon River was used in a similar fashion, and any implications of a Basslink development on cultural heritage artefacts in the Gordon River will need to be assessed.

4.2.3 Instream Ecological Health

Recent work by Davies *et al*. (1999) has shown that the diversity of invertebrates sampled from riffle areas within the Gordon River is reduced in the reaches immediately downstream of the power station compared to other river reaches in the catchment. Diversity gradually increases below the confluence of other tributaries, in particular the Denison River (Figure 4.1). Clearly the power station operation affects instream biota, however, the extent of its influence downstream is not yet known.

Increased flow fluctuations due to hydro-peaking are known to put stresses on aquatic organisms in rivers. They create changes in aquatic habitat availability, shear-stress fluctuations on the bed of the river, stranding of organisms during rapid drawdown and disruption of flow and water quality related cues that trigger biological responses (such as breeding behaviour) in aquatic organisms. These changes in combination with changes in seasonality have the potential to further alter the biota of the Gordon River.

As with the geomorphological issues, it is critical to understand downstream propagation of the flow wave created by the turning on of the power station to quantify any likely changes to key hydraulic parameters such as bed shear stresses. It will be important to make predictions on any alterations to the existing zone of impact which may be attributed to Basslink operations. Alterations to the existing zone may in fact vary seasonally, and the implications of the seasonal alterations in flow on the instream biota will need to be identified.

The work of Davies *et al*. (1999) will need to be extended as part of the Basslink assessment process to include more sites below the Denison River, and to incorporate sampling of other major instream habitats for both invertebrates and fish. In order to address issues of aquatic habitat availability within the river channel, cross-sectional habitat and hydraulic surveys using methods such as Instream Flow Incremental Methodology (IFIM) or related techniques should be employed (Bovee, 1982). Shear stress conditions, which dictate biotic impacts on biota from hydro ‘peaking’ operations, should also be assessed in key bar-riffle habitats during typical peak on-off sequences. These observations should be used to assist in recommending flow recession or ‘ramping’ rates to minimise impacts on instream biota.

A number of rare species of plant and birdlife occur within the Gordon River catchment, but there are no rare, threatened or vulnerable species currently reported from the Gordon River or immediate environs that might be affected by Basslink. Major exceptions are the unique microbial and planktonic species found in the lower Gordon meromictic lakes. The issues associated with these lakes are discussed in the following section.

4.2.4 Meromictic Lakes

The lower Gordon River contains several unique, highly stratified meromictic lakes of global conservation significance. These lakes are characterised by a saline water layer overlain by a freshwater layer. ‘Recharge’ of these lake systems with semi-saline water from the Gordon River is critical to their ecological integrity, as unique microbial and planktonic life forms are dependent on the stable stratification of these dark water lakes. In addition, the stratified waters have protected the fragile layering of silt on the bottom of these lakes which contains a valuable palaeolimnological record of particularly high resolution (Bowling & Tyler, 1984).

Recharge is dependent on three critical events which provide an appropriate combination of tidal conditions and river flows for saline water to flow into the lakes and maintain their meromictic state. The three conditions required for recharge to occur are as follows:

1. salt wedge penetration upstream in the vicinity of the lakes;

2. turbulent mixing of the salt wedge into the upper water column; followed by

3. high river levels to ensure flow from the river into the lakes.

Tyler (1986) and Hodgson & Tyler (1996) assessed the effects of Gordon Power Station operations on the stability of lake meromixis. They concluded that meromixis has declined and become more unstable in Lake Fiddler, Sulphide Pool and Lake Morrison since the mid-1970’s, due to operation of the Gordon Power Station. They recommended a management strategy for recharging these lakes and maintaining their meromictic state that requires:

- a power station shutdown during periods of low river flows (summer – autumn); and

- an ensuing power station startup timed so that flow would occur from the river into the lakes.

These previous studies have demonstrated that the Gordon meromictic lakes have been negatively impacted by the flow regulation resulting from the operation of the Gordon Power Station to provide base-load during the summer months. This has limited the penetration of the salt wedge into the Gordon Estuary. Hodgson & Tyler (1996) observed that only limited recharge has occurred during Gordon Power Station shutdown events. Current historical and the modelled 0MW scenario shutdown events occur primarily during late winter and spring (August to October) when run-of-river stations are capable of supplying maximum power.

Power station maintenance under Basslink is likely to be more flexible in both timing and duration (S. Stolp, Hydro, pers. comm.). Thus, maintenance scheduling may be able to occur during summer low flows. This presents a potential environmental benefit for restoring and/or maintaining meromixis in these internationally significant World Heritage Area lakes.

Carefully planned re-scheduling of maintenance shutdown events under Basslink may result in a significant benefit. The possibility of managing meromictic stability through pumping of saline water has not been investigated, and may also be an effective management option. However, it would be preferable to facilitate natural recharge mechanisms to remain consistent with the values of a World Heritage Area. The potential for enhancement of the natural recharge mechanisms in the Gordon meromictic lakes under Basslink should be investigated as part of the Basslink environmental studies.

4.2.5 Water Quality

There are three identified water quality issues associated with flow regulation in the Gordon River. These are release of anoxic water, upstream migration of the saline wedge, and mercury concentrations.

Lake Gordon has been identified as having the ability to stratify, and first stratified during construction with a layer of oxygen deficient water forming at about the same depth as the intake. Release of anoxic water through the power station may raise environmental problems downstream, although none have been identified to date. Bowles (1998) recently documented the seasonal stratification in Lake Gordon, and describes the mechanisms by which it forms and the factors that influence it. Lake level variations in Lake Gordon attributed to Basslink are relatively minor, but the implications of these in conjunction with the increased variability in power station discharges on release of anoxic water needs to be addressed.

Alterations to upstream migration of the saline wedge arising from Basslink predominantly raise issues associated with the meromictic lakes, which have been discussed in the previous section and are planned to be investigated in the Basslink environmental studies.

Lake Gordon has naturally high levels of mercury, which overall is within safe limits. Mercury in waters discharged out of the Gordon Power Station are not believed to be a significant environmental issue, but should be considered in any water quality assessment (Bowles 1998).

The aquaculture industry in Macquarie Harbour is reliant on clean flows from the Gordon River to maintain water quality. The Gordon River dilutes the polluted flows from the King River. Aquaculture activities within Macquarie Harbour have generally been concentrated on the southern side of the harbour mouth to take advantage of the flushing effect of the cleaner Gordon River water in this area. The Basslink water quality investigations should confirm that the altered operations of the Gordon and John Butters Power Stations which are predicted by the TEMSIM modelling will not create water quality risks for the Macquarie Harbour aquaculture industry.

4.2.6 Public Use

The water resources in the Gordon catchment are under less pressure from multiple uses than are most other waters in the State, as the region is virtually unpopulated. Wilderness tourism, recreation and aquaculture in Macquarie Harbour are the major uses. Wilderness appreciation is the main focus of recreational activities in the Gordon River and its tributaries.

No particular public use studies are proposed as part of the Basslink environmental investigations, because the anticipated changes due to Basslink affect the middle Gordon River which is largely inaccessible. Visitation rates to the middle Gordon are minimal, due in part to restricted access, rafting is recognized as dangerous in the middle Gordon as a result of the existing fluctuating flow regime, and warnings about fluctuating flow levels are posted at major access points.

Safety for recreational fishers and tourists in the lower Gordon River is unlikely to be compromised due to Basslink, as changes in levels resulting from power station releases under present operations are minimal so far downstream of the dam.

Extreme changes in flows as experienced below hydro-peaking stations can result in the decline of fish populations due to loss of stable rearing and spawning habitat conditions. Recreational fishing in the lower Gordon catchment is largely focussed on brown trout fishing in the tidal reaches. It is unlikely that trout and native fish populations found in the lower Gordon River will be adversely affected by changes in upstream flow regimes resulting from Basslink. Examination of relationships between rearing and spawning habitat for native fish and trout and flows would assist in evaluating this issue further, and will be conducted as part of the studies on instream ecological health.

4.2.7 Summary of Gordon River Environmental and Social Investigations

In summary, the planned environmental investigations into the effects of the Basslink cable on the Gordon River will address geomorphology, instream ecological health, meromictic lakes, water quality and cultural heritage issues.

In order to maintain its reputation as an environmentally responsible supplier of renewable energy, the Hydro will be addressing any current (i.e. not associated with Basslink) management issues associated with the Gordon catchment in its Water Management Review process. As previously stated, this is a long-term strategy with a goal to develop community-accepted Water Management Plans under the new Water Management Act 1999. As part of this commitment, the Hydro is continuing to monitor water quality and other aspects of the ecology of Lake Gordon and Lake Pedder through its Aquatic Environment Program.

4.3 Downstream Poatina Power Station

4.3.1 Introduction

In contrast to the unpopulated and unmodified nature of the Gordon River catchment, the rivers downstream of the Poatina Power Station are in highly modified catchments. The primary land use downstream of the Poatina Power Station is agriculture. Water abstractions for agricultural irrigation, domestic purposes, township supplies and even aquaculture occur in Brumbys Creek, the Macquarie River and the South Esk River downstream of Poatina Power Station. The riparian zones of these streams are highly modified due to clearing, invasion of willows, bank erosion and stock access.

The most fundamental change downstream since the commissioning of Poatina Power Station has been greatly increased flow volumes discharged into the river systems, due to the diversion of Great Lake water into this catchment area. The response of the downstream rivers to the Poatina Power Station discharges is complicated by the influence of the numerous other variables, which have been modified by human uses. As with the Gordon River studies, environmental issues that may arise due to Basslink must be separated out from those that are attributed to the Poatina power development itself.

In evaluation of the modelling results and discussions with specialists, geomorphology, cultural heritage, instream ecological health, water quality and public use issues are considered the key environmental issues which are subject to alterations under Basslink. These are discussed in the following sections in turn.

4.3.2 Geomorphology

Discharges from Poatina Power Station flow through the Poatina tailrace and into Brumbys Creek, which is now a major tributary of the lower Macquarie River (Figure 4.2). Bank erosion due to enhanced discharge and fluctuating water levels has been a significant issue in Brumby's Creek for the historical pattern of power station discharges. Major channel adjustment has occurred since 1964, with the addition of large volumes of high velocity, low turbidity alpine water to what was a small, lowland agricultural stream.

Much of this was anticipated by the then Hydro-Electric Commission, which purchased much of the land adjacent to Brumbys Creek during the 1960's. Landowners adjacent to Brumbys Creek have expressed concerns regarding bank erosion and sedimentation for a number of years and in recent years the Upper Brumbys Landcare group has been formed. In response to existing issues, a rehabilitation and management plan was prepared in December 1998. This report aimed to identify and quantify the problems as well as to investigate and describe options for rehabilitation or mitigation strategies. During 1999, the Hydro also initiated activities on weed management.

Rapid, short-term fluctuations in discharge are known to cause bank slumping and collapse in alluvial river channels, the primary factor being the frequency of occurrence and rate of flow decline (Simons & Li 1982). The potential for further bank erosion and channel adjustment under Basslink in both Brumbys Creek and the lower Macquarie River requires further evaluation. Modelling results for the Basslink cable scenarios indicate that there will be more intermittency in flows with a greater number of short-term low flows. This represents a change to a more erosive flow regime, given that the major areas of erosion are immediately downstream of the power station tailrace canal discharge.

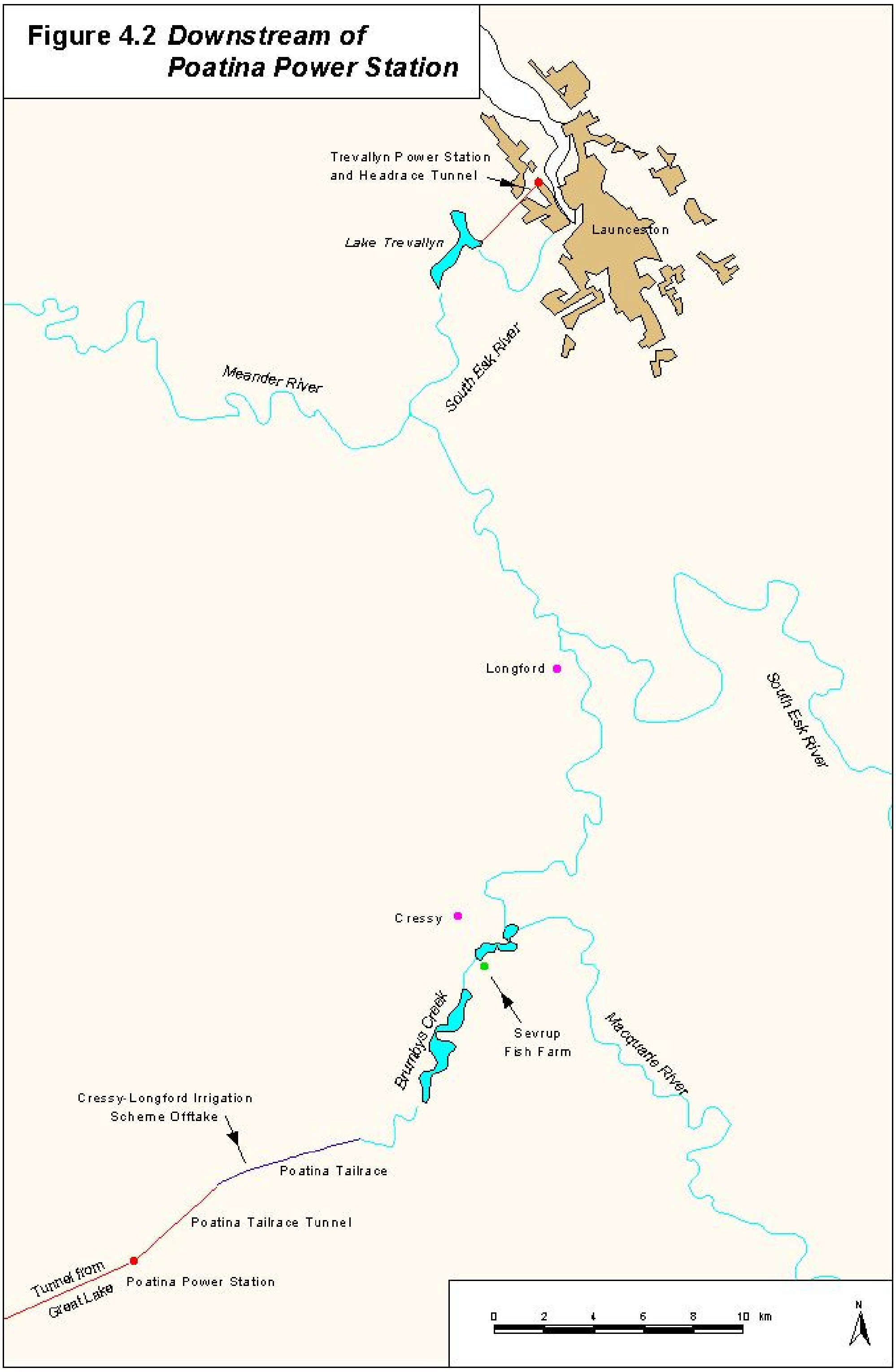

Figure 4.2 – Downstream of Poatina Power Station

As discussed for the Gordon River, it is important to ascertain the downstream propagation of the flow releases out of the Poatina Power Station. There are three weir ponds in the downstream part of Brumbys Creek which may dampen much of the flow variability, which would mean that the erosive effects of this change to the discharge pattern is largely confined to discrete sections of Brumbys Creek.

If flow variability affects downstream of Brumbys Creek into the Macquarie River, it will be necessary to understand the role of drawdown on these sediment banks. Bank erosion and channel changes have been long observed on the Macquarie River, and it will be important to discern the role of flow regulation on erosive processes.

Flooding is a key issue downstream of the Poatina Power Station, and will need to be assessed in the geomorphic studies because of the ensuing channel changes which can occur during times of flood. With the increased operation of the power station in winter, there is the potential to exacerbate winter floods in the Macquarie and South Esk rivers. The Hydro has an existing flood rule which curtails the operation of Poatina during times of flood, and because flood restrictions would remain in place under Basslink it is unlikely that there will be any changes to the major floods. It is likely that there will be an increased incidence of bankfull (i.e. the water level will reach to the top of the river bank) releases during the winter period which has implications for the geomorphology, and this will need to be assessed.

Associated with channel erosion is the potential for cultural heritage sites to be impacted. Consultation with the Cultural Heritage Branch of the Parks and Wildlife Service indicated an area of Holocene sandsheets which have the potential to contain cultural heritage sites (Don Ranson, Manager Cultural Heritage Branch, 2 August 1999). Consequently, cultural heritage investigations downstream of the Poatina Power Station are planned to be included as part of the Basslink environmental investigations.

4.3.3 Instream Ecological Health

An increased incidence of low flow events and flow pulses may result in some loss of habitat as well as a decline in habitat suitability for invertebrates, fish and platypus in Brumbys Creek. The extent of changes in habitat availability in Brumbys Creek and the lower Macquarie and South Esk Rivers requires evaluation. Changes in seasonality also need to be considered. The potential for mitigating the impact of changes in flow regimes on the Brumbys Creek fishery by physical habitat manipulation should be assessed.

Changes to channel form through bank erosion are known to impact on bank-associated fauna and flora. A species of burrowing crayfish, Engaeus nulloporius, is endemic to the lower Macquarie, South Esk and west Tamar valleys. Enhancement of bank erosion in the lower Macquarie and South Esk Rivers may impact on the status of this species, and this should be considered in the Basslink investigations.

4.3.4 Water Quality

Water quality downstream of Poatina Power Station is generally considered to be good, particularly when the power station is discharging because the water quality in the Great Lake storage is relatively pristine. Releases into Brumbys Creek are often cooler than the surrounding streams because Great Lake is situated at a much higher elevation.

Water quality issues in the agricultural catchments downstream of Poatina include turbidity and electrical conductivity (EC), and these are most notable when Poatina is not discharging water. Unacceptable levels of faecal indicators have been found in the Macquarie River where stock have direct access to the river. Turbidity due to bank erosion is the only water quality issue which could be directly linked to Hydro operations, and in general the Hydro improves water quality through dilution.

Because water quality is an issue of concern to stakeholders in the rivers downstream of Poatina, an assessment will be made in these Basslink investigations of changes to water quality which may arise due to Basslink. These changes may in fact be positive if Poatina discharges more regularly throughout the year.

4.3.5 Public Use

In this highly modified catchment area, there are multiple uses of the waterways affected by Poatina. These can be grouped into broadly into abstractive uses, which includes agriculture, irrigation, industry, township and domestic water supply (Figure 4.2); and recreational uses which includes boating and fishing. Each is discussed in turn.

4.3.5.1 Abstractive Uses

Downstream water entitlements for irrigation vary, and will be converted into licences under the Water Management Act 1999. The main abstraction for irrigation in Brumbys Creek is from the Cressy-Longford Irrigation Scheme, to which the Hydro supplies 12,000 ML of water per annum sourced from the Poatina tailrace canal. Peak demand for water from the tailrace occurs in December and January. The current system has no buffering storage, and therefore requires flow throughout the irrigation season (October-April), with a peak demand of 150 ML/day. Security of supply is a major issue to the Cressy-Longford Irrigation Scheme.

Irrigators in the Macquarie River downstream of Brumbys Creek as far as Longford (where the Macquarie meets the South Esk) are assured of sufficient irrigation water by the Hydro as a Statutory Right. This right was under the Electricity Supply Industry Restructuring (Savings and Transitional Provisions) Act 1995, and is now under the Water Management Act 1999. Irrigators in the South Esk River would have entitlements to water such as Commissional Water Rights, which will be converted to water licences under the new legislation. The Hydro makes available a quantity of water (approximately 18,000 ML/yr) in the South Esk catchment, for allocation by the Department of Primary Industries, Water and Environment.

Sevrup is a commercial trout farm on Brumbys Creek which has a Commissional Water Right. It is dependent on Brumbys Creek for its water supply, and draws water from Weir 3 via a culvert and open channel to the fish farm. Water which passes through the fish farm is eventually returned to Brumbys Creek.

Several townships rely on Poatina Power Station water, namely Poatina (from the Poatina Power Station penstock), Cressy (from the Macquarie River), and Longford (Back Creek and the Macquarie River). Discussions with Northern Midlands Council staff indicated that water supply to Cressy and Longford is only affected by Poatina Power Station operations during prolonged shutdowns of the order of 1–2 months. Short term flow fluctuations and shutdowns do not pose a risk to supply security. Poatina township draws water from the Poatina penstock (i.e. upstream of the power station). It is unlikely to be affected by power station operations except under the case of prolonged shutdowns for tunnel maintenance.

The implications of altered flow regimes arising from Basslink on these abstractive users will need to be discussed in a consultative fashion. Basslink investigations will include explanation of the hydrological changes to the key stakeholders and exploration of any issues that may be raised in these discussions. This will include an assessment of any flood risk issues that may arise due to Basslink. If necessary, mitigation options will need to be explored to ensure compatibility of any Basslink flow regimes with these users.

4.3.5.2 Recreational Uses

Popular recreational uses of the waterways downstream of Poatina Power Station are boating, swimming and fishing. Boating is particularly popular in a designated recreational area in Longford, at the confluence of the Macquarie and South Esk rivers. It is unlikely that this area would be greatly affected by hydrological changes due to Basslink, but this will be able to be stated with more certainty with more precise downstream hydrological analysis of the Basslink changes.

Fishing is particularly of interest, as Brumby's Creek and the lower Macquarie and South Esk Rivers (downstream of the Brumbys Creek junction) have high recreational angler visitation rates. Brumbys Creek receives some 11,000 angler days fishing effort a year from around 2,100 anglers and ranks fourth in the state's riverine fisheries (in the top ten of the state's trout fisheries, Inland Fisheries Commission unpub. data). It has a high national profile as a valued fly fishery and has a relatively high proportion of tourist anglers. Overall, fishing effort represents some $0.5M annual expenditure by anglers in these reaches (P. Davies unpub. data).

The South Esk downstream of the Macquarie River receives 3,900 angler days fishing effort per year, 42% of the total angling effort expended in the South Esk River (Davies & Humphries 1996). The Macquarie River downstream of Brumbys Creek receives 3,000 angler days fishing effort, 54% of the total angling effort expended in the Macquarie River (Davies & Humphries 1996).

The effects of a more intermittent, pulsed flow regime in Brumbys Creek on the fishery in the creek and in the lower Macquarie River needs to be assessed in terms of changes to fish and macroinvertebrate habitat suitability and hence fishery productivity, and any public safety issues. The public safety issues need to be addressed in the same consultative fashion as the abstractive issues, and rely on good hydrological information on likely Basslink changes at identified sites downstream of Poatina. Existing on-site warning signage of variable flows may need to be reviewed in relation to the safety of bankside anglers and swimmers.

In order to maintain its reputation as an environmentally responsible supplier of renewable energy, the Hydro will be will be addressing any current (i.e. not associated with Basslink) management issues in the Great Lake – South Esk catchment in its Water Management Review process. This is a long-term strategy to assist in the development of community accepted Water Management Plans under the new Water Management Act 1999. As part of this commitment, the Hydro is continuing to monitor water quality and other aquatic aspects of Great Lake and river reaches downstream of Poatina through its Aquatic Environment Program. This process will be carried out in conjunction with some of the Basslink studies.

4.3.6 Summary of Downstream Poatina Environmental and Social Investigations

In summary, the planned environmental investigations into the effects of the Basslink cable on the waterways downstream of Poatina Power Station will address geomorphology, instream ecological health, water quality, cultural heritage, and public use issues.

As with the Gordon catchment, the Hydro will be addressing any current (ie. not associated with Basslink) management issues in the Great Lake–South Esk catchment in its Water Management Review process. This process has already commenced, and the Hydro will ensure that consultation for the Water Management Review and for the Basslink investigations is carefully planned and interlinked as appropriate.

4.4 Downstream John Butters Power Station

4.4.1 Introduction

The King River downstream of the John Butters Power Station (Figure 4.3) is unpopulated but has a history of human interaction. The most notable catchment activity is the Mount Lyell Copper Mine in Queenstown, which for 78 years discharged tailings (very fine grained sediments) and waste water into the Queen River. The Queen River transported these discharges to the King River and from there on into Macquarie Harbour. The tailings discharge continued until as recently as December 1994, several years after commissioning of the John Butters Power Station. Acidic, metal-rich waste waters continue to be discharged from the mine site into the King catchment.

Considerable research has been conducted into interactions of power station operations with the tailings and waste water from Mount Lyell (Koehnken 1996, 1997; Locher 1997). Of major concern was the risk these waste discharges posed to the growing aquaculture industry in the downstream receiving body, Macquarie Harbour (see Locher & Koehnken 1993). These environmental investigations commenced while tailings were still being discharged, and continued for several years after tailings discharges had permanently ceased. The main conclusions of these studies were that the vast majority of effort towards remediation of this river system should be directed at treatment of waste water off of the Mount Lyell lease site.

At present, considerable effort and cost is going into identification of appropriate treatment technologies, and construction of a full-scale treatment plan at Mount Lyell. A treatment plant is planned for construction during 2001, and so would be operational prior to a Basslink cable. Basslink environmental investigations must address whether or not the Basslink operating patterns would in any way jeopardise the success of the remediation efforts being undertaken for this river system.

The hydrological changes downstream of the John Butters Power Station predicted by the TEMSIM model are not major. Typical power station discharges under the present operating regime are highly variable, and this frequent on-off pattern may increase very slightly. There is a difference in the seasonality of discharges, with increased winter discharges.

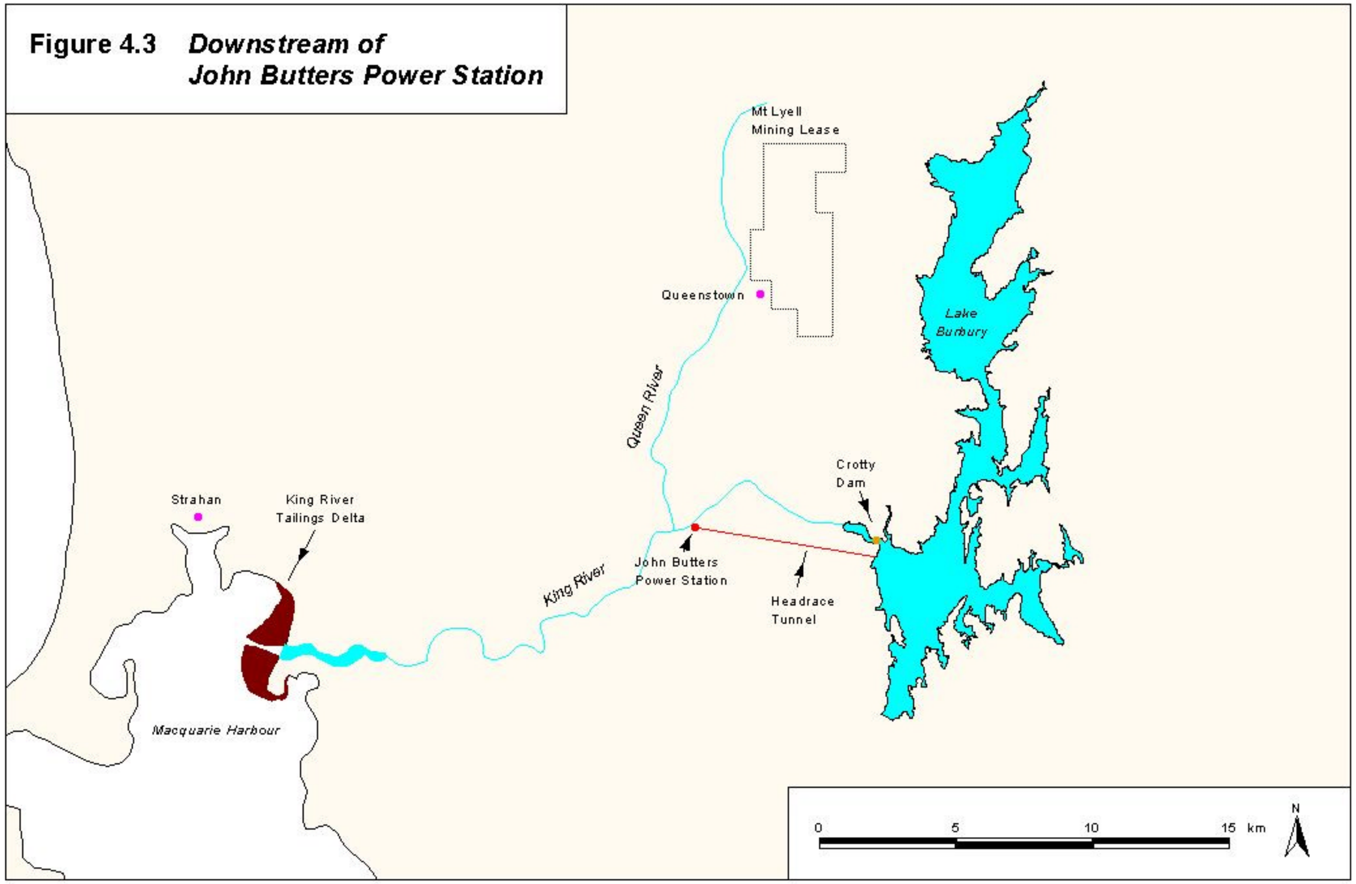

Figure 4.3 – Downstream of John Butters Power Station

In evaluation of the John Butters modelling results and discussions with specialists, the issues of geomorphology, water quality, ecological health and tourism are considered the key environmental issues in the King River to be addressed by these Basslink investigations. The King River will increasingly become a focus of tourism visitation with the development of the Abt Railway. Water quality in Macquarie Harbour is also a key issue. These are discussed in the following sections in turn.

4.4.2 King River

4.4.2.1 Geomorphology

The geomorphology of the lower King River was heavily impacted by historical operations of the Mount Lyell mine, with major changes in sediment transport dynamics, sediment storage and channel form. Prior to commencement of power station operations, massive mine sediment loads resulted in the development of tailings banks in the lower King River, infilling of the river bed, and formation of a major delta at the mouth of the river (Figure 4.3).

The power station discharges no longer interact with these continuous tailings inputs to the river, as there is now a tailings dam located at the Mount Lyell mine site. Consequently, over the past 4 to 5 years the river has been adjusting to a new set of conditions of ongoing flow regulation and the absence of fresh sediment inputs. The result has been erosion of the sediment banks, possibly some lowering and movement of the bed sediments, and erosion off of the outer (harbour) face of the delta. It is unknown at this stage to what degree of equilibrium the river has obtained to these new conditions, nor to what degree natural and assisted revegetation and stabilisation of the river banks has been achieved.

It is important that any new developments affecting the King River do not introduce a new set of influencing variables that will affect the geomorphological equilibrium towards which the river is moving. An understanding of the current rates and processes of the key geomorphological processes - bank erosion, and river channel and delta adjustment – will allow analysis of the likely changes which could be linked to the Basslink discharge pattern.

4.4.2.2 Water Quality

In the post-tailings river system (post-1994), acid mine drainage from the Mount Lyell lease site is the most major environmental issue affecting the King River system. Extremely acidic water containing high levels of iron, copper, aluminium, sulphate and manganese enters the King River via the Queen River just one kilometre downstream of the John Butters tailrace. Discharges from John Butters are a major influence on the dilution and transport of this water in the King River. Not surprisingly, dilution is greatest when the power station is discharging, and least when the power station is off.

The worst case scenario arises when the power station is off for prolonged periods, for example during maintenance shutdowns. This allows relatively large volumes of metal-laden Queen River water into the King with very little dilution. When the power station eventually comes back on line, this 'block' of highly concentrated water is pushed out of the King River as a mass, creating a plume in Macquarie Harbour.

Seasonality is a factor in this scenario; in winter there are high fluxes of metals into the Queen River (derived from the lease area surface run-off) but at relatively low concentrations, whereas in summer there are lower fluxes at higher concentrations. Therefore the key Basslink issues affecting King River water quality are the duration of the shutdown periods between discharge events, the scheduling of maintenance shutdowns, and the implications of a seasonal shift in discharge patterns.

4.4.2.3 Instream Ecological Health

Fish are completely absent from the lower King River, but a study by Davies *et al*. (1996) found native galaxiids and eels occurring in tributary streams within the lower King catchment. These fish were of an age range which suggested they migrated prior to commencement of power station operations when late winter to early summer floods sufficiently diluted heavy metals.

An initial remediation target for the lower King River is to improve water quality to the point at which migratory fish species can migrate into the King River tributaries. Present research being conducted at Mount Lyell into the most appropriate treatment technologies involves toxicity tests to determine the relative toxicity of the different metals (notably copper and aluminium) on the organisms likely to colonise downstream. The selection of treatment technology will have a certain remediation target related to biological recovery. Evaluation of the impact of more frequently low flows on the toxicity of Queen inflows on King River biota (and its potential to recover) is required.

Seasonal variation in flows from the power station for all the Basslink cable scenarios mimics naturally high flows in winter and may be of benefit to instream biota by restoring natural seasonal flow cues. Some assessment of the implications on the seasonal changes in John Butters operation with regard to the biological remediation targets needs to be included in the King River studies. Under the present operating conditions at John Butters, it has been estimated that 99% of the acid drainage from the lease site requires remediaiton to encourage the re-establishment of a modified but healthy ecosystem in the Lower King River (Dr. L. Koehnken, Technical Advice on Water, pers. comm.). Based on this, it is evident that the implementation of Basslink could not increase the level of remediation required, and might provide more flexibility for environmental management.

4.4.2.4 Tourism

Tourism is a growing use of the King River system. Jet boat tours and driving tours of the lower King River have been conducted for a number of years. The Abt Railway development is a major and costly effort to reinstate the historical railway which runs along the Queen and King rivers. The implications of the Basslink changes on the viability of this industry must be considered.

4.4.3 Macquarie Harbour Water Quality

There is a strong interaction between the regulated flow regimes in the King and Gordon rivers with water quality conditions in Macquarie Harbour. Fish farms are concentrated in the western part of the harbour because of its proximity to Strahan, but they have to balance this logistical convenience against the poor water quality emanating out of the King River. Consequently the fish farms are mostly located on the southern shore of the harbour, taking advantage of clean water from the Gordon River.

The fish farms encounter three distinct types of water in Macquarie Harbour – clean freshwater out of the Gordon River, polluted freshwater out of the King River, and more dense saline ocean water entering through Hells Gates. The Gordon River contributes five times the flow of the King. In winter a thick freshwater layer from natural inflows into Macquarie Harbour blocks intrusion of salt water into the harbour; this blockage is reduced in summer and more salt water is allowed to intrude. Seasonal shifts in both the Gordon and John Butters Power Stations may have implications for the interactions of these different waters.

The hydrodynamics of Macquarie Harbour as they relate to water quality were intensively investigated as part of the Mount Lyell Remediation Research and Development Program (Koehnken 1997). A simple mixing model of the harbour exists (Koehnken pers. comm), which should be used to assess implications of Basslink induced changes in the Gordon and King River flows on Macquarie Harbour hydrodynamics, water quality and biological suitability. These findings should be reviewed in light of the predicted changes to Gordon and John Butters Power Station operation, to ascertain whether there are water quality issues which will influence the viability of the harbour aquaculture industry.

4.4.4 Summary of Downstream John Butters Environmental and Social Investigations

In summary, the planned environmental investigations into the effects of the Basslink cable on the waterways downstream of the John Butters Power Station will address geomorphology, water quality, instream ecological health and tourism issues in the King River, and water quality in Macquarie Harbour.

As with the other hydro catchments, the Hydro will be addressing any current (i.e. not associated with Basslink) management issues through its Water Management Review process.

4.5 Summary of Aquatic Environmental and Social Investigations Associated with Basslink

Planned environmental investigations into the effects of the Basslink cable on the Gordon River will address geomorphology, instream ecological health, meromictic lakes, water quality and cultural heritage issues.

Environmental investigations on the waterways downstream of Poatina Power Station will address geomorphology, instream ecological health, fishery, water quality, cultural heritage, and public use issues.

Investigations downstream of the John Butters Power Station will address geomorphology, water quality, instream ecological health and tourism issues in the King River, and water quality in Macquarie Harbour.

5 PROPOSED STUDIES

5.1 Overview

In this chapter, the studies proposed to address the environmental issues identified in the previous chapter are outlined. In accordance with the Ministerial direction to the Resource Planning and Development Commission (RPDC) on the Basslink assessment process, these studies must consider:

- the likely environmental impacts on Tasmanian waterways arising from Basslink, with particular attention to WHA impacts;
- any social, economic and community impacts associated with the likely environmental impacts; and
- means proposed for managing any of these impacts.

Section 5.2 describes the Gordon River studies, Section 5.3 the downstream Poatina studies, and Section 5.4 the downstream John Butters studies. These are summarised in Table 5.1. An outline of each study is provided. Each study summary clearly states the key research question, specific study objectives, essential elements of the methodology, and study outcomes.

Table 5.1 – Summary of Recommended Studies

River System	Issue to be Studied	Broad Study Description
DOWN-STREAM GORDON POWER STATION	Geomorphology	*Bank erosion and altered geomorphological processes in the middle Gordon River; karst features.*
	Instream Ecological Health	Habitat assessment of representative reaches, using Gordon River catchment species habitat data; assessment of shear stress conditions.
	Meromictic Lakes	Modelling and evaluation of meromictic lake stability study in relation to Gordon River flow, tidal and power station operational regime.
	Water Quality	Evaluation of deoxygenated water releases under Basslink.
	Cultural Heritage	Assessment of cultural heritage sites in the Gordon River and potential impacts on those sites.
DOWN-STREAM POATINA POWER STATION	Geomorphology	Brumbys Creek channel erosion, sediment transport, Macquarie River channel adjustments, role of flooding
	Instream Ecological Health	Assessment of possible effects on instream biota and the trout fishery downstream of Poatina Power Station.
	Water Quality	Assessment of possible effects on water quality downstream of Poatina Power Station.
	Cultural Heritage	Assessment of cultural heritage sites downstream of Poatina Power Station and potential impacts on those sites.
	Public Use Issues	Consultative process involving discussion of Basslink hydrological changes with key stakeholders
DOWN-STREAM JOHN BUTTERS POWER STATION	King River Geomorphology	Analysis of potential issues associated downstream flows below John Butters Power Station including Macquarie Harbour – stakeholder consultation, water quality modelling.
	King River Water Quality	Assessment of implications of Basslink on water quality in the King River, particularly in relation to the Mount Lyell remediation program.
	King River Instream Ecological Health	Assessment of possible effects on ecological health in the King River, particularly in relation to the biological recovery targets associated with the Mount Lyell remediation program.
	King River Tourism	Consultative process involving discussion of Basslink hydrological changes with key tourism ventures.
	Macquarie Harbour Water Quality	Assessment of the implications of altered Gordon and John Butters Power Stations discharges on Macquarie Harbour water quality, particularly with regard to their implications for the aquaculture industry, stakeholder consultation.
General	Tasmanian Wilderness World Heritage Area	Analyse world heritage area values in regards to Basslink

5.2 Gordon River Basslink Environmental Investigations

Planned environmental investigations into the effects of the Basslink cable on the Gordon River will address geomorphology, instream ecological health, meromictic lakes, water quality and cultural heritage issues.

5.2.1 Gordon River Geomorphology Study

5.2.1.1 Key Research Question

Will Basslink alter the current geomorphological processes in the middle Gordon River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.2.1.2 Specific Study Objectives

- Ascertain current geomorphic processes in terms of bank erosion mechanisms, sediment transport and depositional patterns, channel adjustments, movement of bed material, and stability of tributary streams.
- Relate these processes to hydrological and hydraulic conditions under the present operating regime.
- Examine modelled Basslink hydrological data for key locations downstream of the power station and identify implications.
- If possible or necessary, consider management options which would alleviate any negative impacts arising from the Basslink changes.

5.2.1.3 Essential Elements of the Methodology

- Identification of geomorphological zones in the middle Gordon River.
- Establishment of monitoring and investigative stations in selected zones, including hydrological monitoring.
- Installation of erosion pins and scour chains.
- Augering and analysis of sediment bank materials.
- Monitoring of water table dynamics in the near river sediment banks, associated with monitoring of river level.
- Mapping of bed material in cobble bars, and experimental monitoring of transport of these materials.
- General reconnaissance and mapping of notable geomorphic features.
- Investigation of any identified karst features and assessment of their vulnerability to Basslink changes.

5.2.1.4 Study Outcomes

- An intensive field-based investigation and baseline monitoring program conducted by a collaborative team involving the Hydro’s Environmental Services Department, the University of Tasmania, Melbourne University, Monash University and the Co-operative Research Centre for Catchment Hydrology.
- Understanding of key geomorphic processes acting in the Gordon River, spatial and temporal variations in these processes, and influencing factors.
- A report section identifying likely changes to these processes and any geomorphic heritage features in the WHA arising from Basslink, and proposing management strategies to address any negative impacts.

5.2.2 Gordon River Instream Ecological Health Study

5.2.2.1 Key Research Question

Will Basslink alter the ecological health of the middle Gordon River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.2.2.2 Specific Study Objectives

- Ascertain the current status of the ecological health of the middle Gordon River, in terms of fish, macro-invertebrates, platypus and aquatic flora.
- Develop relationships between hydrology, instream habitat availability and biological conditions in the middle Gordon River under the present power station operating regime.
- Assess changes in shear stress at different river discharges.
- Examine modelled Basslink hydrological data for key locations downstream of the power station and identify implications for ecological health.
- If possible or necessary, consider management options which would alleviate any negative impacts arising from the Basslink changes.

5.2.2.3 Essential Elements of the Methodology

- Establishment of study reaches in the Gordon for the assessment of instream habitat under selected flow conditions.
- Baseline aquatic fauna surveys, including fish, macro-invertebrate and platypus surveys between the Gordon Power Station and the Franklin River junction. These will build on some existing macro-invertebrate sampling sites and will follow the nationally accepted RIVPACS model;
- Identification of key ecological processes in the Gordon which may be affected by changes to the flow regime under Basslink.
- Development of relationships between biological suitability, habitat and hydrology for the Gordon River, taking into account any key ecological processes, using IFIM and shear stress.
- Use of IFIM and shear stress relationships to formally assess risks to instream biota for flow regimes predicted, using the outputs from TEMSIM, under specific Basslink operational scenarios.
- Identify the optimum operational conditions for the protection and/or maintenance of instream ecological values whilst maximising the Hydro's ability to meet electricity demand.

5.2.2.4 Study Outcomes

- Description of habitat-flow relationships in the middle-lower Gordon for aquatic fauna;
- Identification of threatened species known to exist in the area;
- Assessment of changes to habitat-flow relationships under Basslink;
- Key stakeholder participation in identification of Basslink environmental management needs and agreement on habitat protection required for instream fauna in the Gordon River through flow mitigation under Basslink; and
- A report section detailing the likely impacts of Gordon River Power Station operations under Basslink on the instream biota of the Gordon River

5.2.3 Gordon River Meromictic Lake Study

5.2.3.1 Key Research Question

Will Basslink alter flow regimes affecting the lower Gordon River meromictic lakes, and does it present opportunities to mitigate existing environmental impacts due to flow regulation?

5.2.3.2 Specific Study Objectives

- Review scientific data already available on lakes Morrison, Fidler and Sulphide Pool;
- Determine the relationship between flow regimes in the Gordon River and the mixing dynamics of these meromictic lakes;
- Establish required field instrumentation and infrastructure for the ongoing management of the three lower Gordon River meromictic lakes;
- Determine the current status of meromixis in the three lakes through the measurement of conductivity and temperature profiles and design an on-going monitoring program;
- Conduct two trials to assess the success of summer Gordon Power Station shut-down-startup cycles for the recharge and stabilisation of meromictic state in all three lakes; and
- Develop operational rules under Basslink for the restoration and maintenance of meromixis in the three lakes.

5.2.3.3 Essential Elements of the Methodology

- Utilisation and refinement of existing salinity models for Macquarie Harbour/Gordon River.
- Installation of water quality and flow gauges to monitor salinity and flow characteristics in the lower estuary and in the channels connecting the meromictic lakes to the Gordon River.
- Experimental shutdowns of the Gordon Power Station to allow calibration of salinity models and to investigate the effects of these trials on the water quality within these lakes.
- Development of operating rules for the Gordon Power Station to allow for the continued protection of the meromictic lakes with minimal loss of generation flexibility.

5.2.3.4 Study Outcomes

- Report section detailing an assessment of the meromictic lakes status (current stratification regime) and susceptibility to impact under Basslink;
- Recommendations for operational constraints and flow mitigation to enhance lake meromixis;
- Modelling parameters for system modelling of recommended changes; and
- Infrastructure for on-going management of the meromictic lakes.

5.2.4 Gordon River Water Quality Study

5.2.4.1 Key Research Question

Will Basslink alter any aspects of water quality in the middle Gordon River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.2.4.2 Specific Study Objectives

- Ascertain current water quality status and influencing factors in the middle Gordon River.
- Review hydrological model predictions for Basslink.
- Identify any alterations to water quality in terms of concentrations, zone of impact and seasonality issues which may arise due to Basslink.
- Identify the implications of these alterations on WHA values.

- If possible or necessary, identify management options to mitigate negative impacts.

5.2.4.3 Essential Elements of the Methodology

- Review of available water quality data in Lake Gordon and the Gordon River.
- Desktop review of modelled hydrological data for 0MW and Basslink scenarios.

5.2.4.4 Study Outcomes

- Identification of any implications of Basslink on water quality.

5.2.5 Gordon River Cultural Heritage Study

5.2.5.1 Key Research Question

Will Basslink affect sites of Aboriginal and European cultural heritage significance or any cultural landscape values in the Gordon River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.2.5.2 Specific Study Objectives

- Identification of sites of Aboriginal and European cultural heritage significance, and to identify the cultural landscape values associated with the development area.
- Assessment of risk to these sites and values arising from Basslink.
- Provision of management recommendations for these sites and values.

5.2.5.3 Essential Elements of the Methodology

- Consultation with the Cultural Heritage Branch, Parks and Wildlife Service. Input from an Aboriginal Heritage Officer acceptable to the Tasmanian Aboriginal Land Council (TALC) will be obtained for the Aboriginal heritage component of the work.
- A literature review and possible field assessment of current data on cultural heritage sites in the Gordon River, concentrating on areas most likely to be affected by erosion;
- Access and review the Tasmanian Aboriginal Site Index (TASI) and Tasmanian Historic Places Inventory (THPI) for sites within and adjacent to the study areas.
- Liaison, as necessary, with relevant government and non-government bodies on matters relating to sites of Aboriginal and European cultural heritage significance.
- Identification and documentation of the cultural landscape values associated with the study areas and immediate surrounds.
- An assessment of likely impacts on known sites from the Basslink development.
- Stakeholder consultation, particularly with the Tasmanian Aboriginal community and the Heritage Council.

5.2.5.4 Study Outcomes

- Location, documentation and assessment of sites of Aboriginal and European cultural significance within the study areas.
- Liaison with relevant government and non-government bodies on matters relating to sites of Aboriginal and European cultural heritage significance.
- Identification and documentation of the cultural landscape values.
- Provision of recommendations for managing significant sites and cultural landscape values that may be identified.

5.3 Downstream Poatina Basslink Environmental Investigations

Environmental investigations on the waterways downstream of Poatina Power Station will address geomorphology, instream ecological health, water quality, cultural heritage, and public use issues.

5.3.1 Downstream Poatina Geomorphology Study

5.3.1.1 Key Research Question

Will Basslink alter the current geomorphological processes acting on the waterways downstream of the Poatina Power Station, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.3.1.2 Specific Study Objectives

- Ascertain the influence of power station discharges on current geomorphic processes in the waterways downstream of Poatina Power Station under present operating conditions and those predicted to be due to Basslink.
- Examine modelled Basslink hydrological data for key locations downstream of the power station and identify which geomorphic processes are most vulnerable to change.
- Conduct field assessments to assist these investigations.
- If possible or necessary, consider management options which would alleviate any negative impacts arising from the Basslink changes.

5.3.1.3 Essential Elements of the Methodology

- Run a hydraulic model for the study area under different Basslink operating scenarios.
- Analysis of hydrological and hydraulic data for current operations and Basslink to more clearly identify zones susceptible to geomorphic change.
- Examination of historical and current channel cross sectional surveys to examine channel changes.
- Comparison of historical and recent aerial photography to examine channel changes.
- Establishment of monitoring and investigative stations in selected zones downstream of the Poatina Power Station.
- Installation of erosion pins and long-term monitoring stations.
- Augering and analysis of sediment bank materials to assess characteristics such as permeability and transmissivity.
- Monitoring of water table dynamics in the near river sediment banks, associated with monitoring of river level, to assess processes such as drawdown induced erosion.

5.3.1.4 Study Outcomes

- An intensive field-based investigation and baseline monitoring program.
- Understanding of the interrelationships of power station operations with key geomorphic processes downstream of the Poatina Power Station, particularly flow variability and flood risk issues.
- A report section identifying likely changes to these processes, and proposing management strategies to address any negative impacts.

5.3.2 Downstream Poatina Instream Ecological Health and Fishery Study

5.3.2.1 Key Research Question

Will Basslink alter the ecological health of the waterways downstream of the Poatina Power Station, and if so what strategies can be utilised to mitigate any adverse environmental impacts arising from these changes?

5.3.2.2 Specific Study Objectives

- Describe the current ecological health downstream of Poatina Power Station.
- Describe the relationships of key aspects of ecological health in the study area to power station operations.
- Evaluate fish habitat status in Brumbys Creek and lower Macquarie River.
- Examine modelled Basslink hydrological data for key locations downstream of the power station and identify implications for ecological health.
- If possible or necessary, consider management options which would alleviate any negative impacts arising from the Basslink changes.

5.3.2.3 Essential Elements of the Methodology

- Literature review for available information on ecological health downstream of Poatina Power Station.
- Identification of areas of primary habitat, and key indicator species within this primary habitat.
- Desktop assessment of implications of modelled hydrological data for with and without Basslink scenarios.

5.3.2.4 Study Outcomes

- A report section detailing the likely impacts of Poatina Power Station operations under Basslink on the instream biota of Brumby's Creek and the Macquarie / South Esk River.
- If needed, identification of flow mitigation needs for habitat protection and fishery maintenance required for instream fauna under Basslink.

5.3.3 Downstream Poatina Water Quality Study

5.3.3.1 Key Research Question

Will Basslink alter any aspects of water quality downstream of Poatina Power Station, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.3.3.2 Specific Study Objectives

- Ascertain current water quality status and influencing factors downstream of Poatina Power Station.
- Review hydrological model predictions for Basslink.
- Identify any alterations to water quality in terms of concentrations, zone of impact and seasonality issues which may arise due to Basslink.
- If possible or necessary, identify management options to mitigate negative impacts.

5.3.3.3 Essential Elements of the Methodology

- Review of available water quality data downstream of Poatina Power Station.

- Collection of field data particularly on sources of water of varying quality.
- Desktop assessment of implications of modelled hydrological data for with and without Basslink.

5.3.3.4 Study Outcomes

- Report identifying any implications of Basslink on water quality, and proposing management strategies if required.

5.3.4 Downstream Poatina Cultural Heritage Study

5.3.4.1 Key Research Question

Will Basslink affect sites of Aboriginal and European cultural heritage significance or any cultural landscape values downstream of Poatina Power Station, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.3.4.2 Specific Study Objectives

- Identification of sites of Aboriginal and European cultural heritage significance, and to identify the cultural landscape values associated with the development area.
- Assessment of risk to these sites and values arising from Basslink.
- Provision of management recommendations for these sites and values.

5.3.4.3 Essential Elements of the Methodology

- Consultation with the Cultural Heritage Branch, Parks and Wildlife Service. Input from an Aboriginal Heritage Officer acceptable to the Tasmanian Aboriginal Land Council (TALC) will be obtained for the Aboriginal heritage component of the work.
- A literature review and possible field assessment of current data on cultural heritage sites in Brumbys Creek or the downstream Macquarie and South Esk rivers, concentrating on areas most likely to be affected by erosion;
- Access and review the Tasmanian Aboriginal Site Index (TASI) and Tasmanian Historic Places Inventory (THPI) for sites within and adjacent to the study areas.
- Liaison, as necessary, with relevant government and non-government bodies on matters relating to sites of Aboriginal and European cultural heritage significance.
- Identification and documentation of the cultural landscape values associated with the study areas and immediate surrounds.
- An assessment of likely impacts on known sites from the Basslink development.
- Stakeholder consultation, particularly with the Tasmanian Aboriginal community and the Heritage Council.

5.3.4.4 Study Outcomes

- Location, documentation and assessment of sites of Aboriginal and European cultural significance within the study areas.
- Liaison with relevant government and non-government bodies on matters relating to sites of Aboriginal and European cultural heritage significance.
- Identification and documentation of the cultural landscape values.
- Provision of recommendations for managing significant sites and cultural landscape values that may be identified.

5.3.5 Downstream Poatina Public Use Study

5.3.5.1 Key Research Question

Will Basslink disadvantage any users of the waterways downstream of the Poatina Power Station, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.3.5.2 Specific Study Objectives

- Determination of current and Basslink hydrology at selected points downstream of Poatina Power Station.
- Targeted stakeholder consultation to identify any public use issues arising from Basslink changes.
- Integration of consultation with that required for the Hydro's South Esk – Great Lake Water Management Review.

5.3.5.3 Essential Elements of the Methodology

- Detailed hydraulic and hydrological modelling
- Stakeholder consultation, particularly in relation to the requirements of downstream water users and recreational fishing.

5.3.5.4 Study Outcomes

- A report section detailing the perceived impacts of Basslink on water users downstream of Poatina Power Station.
- Recommendations on operating patterns, flood rules, signage and any other aspects of Hydro management of these waterways.

5.4 Downstream John Butters Basslink Environmental Investigations

Investigations downstream of the John Butters Power Station will address geomorphology, water quality, instream ecological health and tourism issues in the King River, and water quality in Macquarie Harbour.

5.4.1 King River Geomorphology Study

5.4.1.1 Key Research Question

Will Basslink alter the current geomorphological processes in the King River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.4.1.2 Specific Study Objectives

- To ascertain the current state of geomorphological equilibrium in the King River.
- To identify the geomorphological implications of hydrological information on current and Basslink power station discharges.

5.4.1.3 Essential Elements of the Methodology

- Field reconnaissance.
- Re-surveying of channel cross-sections and delta profiles and comparison with previous.
- Review of relevant hydrological information on current and Basslink power station operations.
- Literature review.

5.4.1.4 Study Outcomes

- A report section identifying any implications of Basslink on King River geomorphology, and proposing management strategies if required.

5.4.2 King River Water Quality Study

5.4.2.1 Key Research Question

Will Basslink jeopardise the success of improvements in water quality in the King River system, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.4.2.2 Specific Study Objectives

- Understand the implications of the water quality remediation program at Mount Lyell for King River water quality.
- Understand the interrelationships between water quality and John Butters Power Station operations.
- Review the current and Basslink hydrology for the King River.
- Identify any implications of Basslink changes for King River water quality.

5.4.2.3 Essential Elements of the Methodology

- Literature review
- Specialist consultation
- Hydrology review

- Desk-top analysis

5.4.2.4 Study Outcomes

- A report section identifying any implications of Basslink on King River water quality, and proposing management strategies if required.

5.4.3 King River Instream Ecological Health Study

5.4.3.1 Key Research Question

Will Basslink affect biological remediation targets for the King River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.4.3.2 Specific Study Objectives

- Understand the link between water quality objectives arising from the Mount Lyell Remediation Program with biological remediation targets in the King River.
- Review the current and Basslink hydrology for the King River.
- Identify any implications of Basslink changes for King River ecological health.

5.4.3.3 Essential Elements of the Methodology

- Literature review
- Specialist consultation
- Hydrology review
- Desk-top analysis

5.4.3.4 Study Outcomes

- A report section identifying any implications of Basslink on King River ecological health, and proposing management strategies if required.

5.4.4 King River Tourism Study

5.4.4.1 Key Research Question

Will Basslink affect any tourism operations in the King River, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.4.4.2 Specific Study Objectives

- Prepare a summary of current and Basslink hydrology for stakeholder discussions
- Consult with key stakeholders
- Assess implications of stakeholder issues.

5.4.4.3 Essential Elements of the Methodology

- Identification of key stakeholders
- Hydrological analysis and review
- Stakeholder consultation
- Assessment of issues

5.4.4.4 Study Outcomes

- A report section identifying any implications of Basslink on King River tourism, and proposing management strategies if required.

5.4.5 Macquarie Harbour Water Quality Study

5.4.5.1 Key Research Question

Will alterations to the Gordon and John Butters Power Station operating patterns affect water quality in Macquarie Harbour, and if so what are strategies to mitigate any adverse environmental impacts arising from these changes?

5.4.5.2 Specific Study Objectives

- Assess changes to Macquarie Harbour hydrodynamics due to alterations in Gordon and John Butters Power Station operations under Basslink.
- Identify implications of these changes on the aquaculture industry.

5.4.5.3 Essential Elements of the Methodology

- Literature and hydrodynamic model review.
- Hydrology review.
- Stakeholder and specialist consultation.
- Desk-top analysis using hydrodynamic model of harbour.

5.4.5.4 Study Outcomes

- A report section identifying any implications of Basslink on Macquarie Harbour water quality, and proposing management strategies if required.

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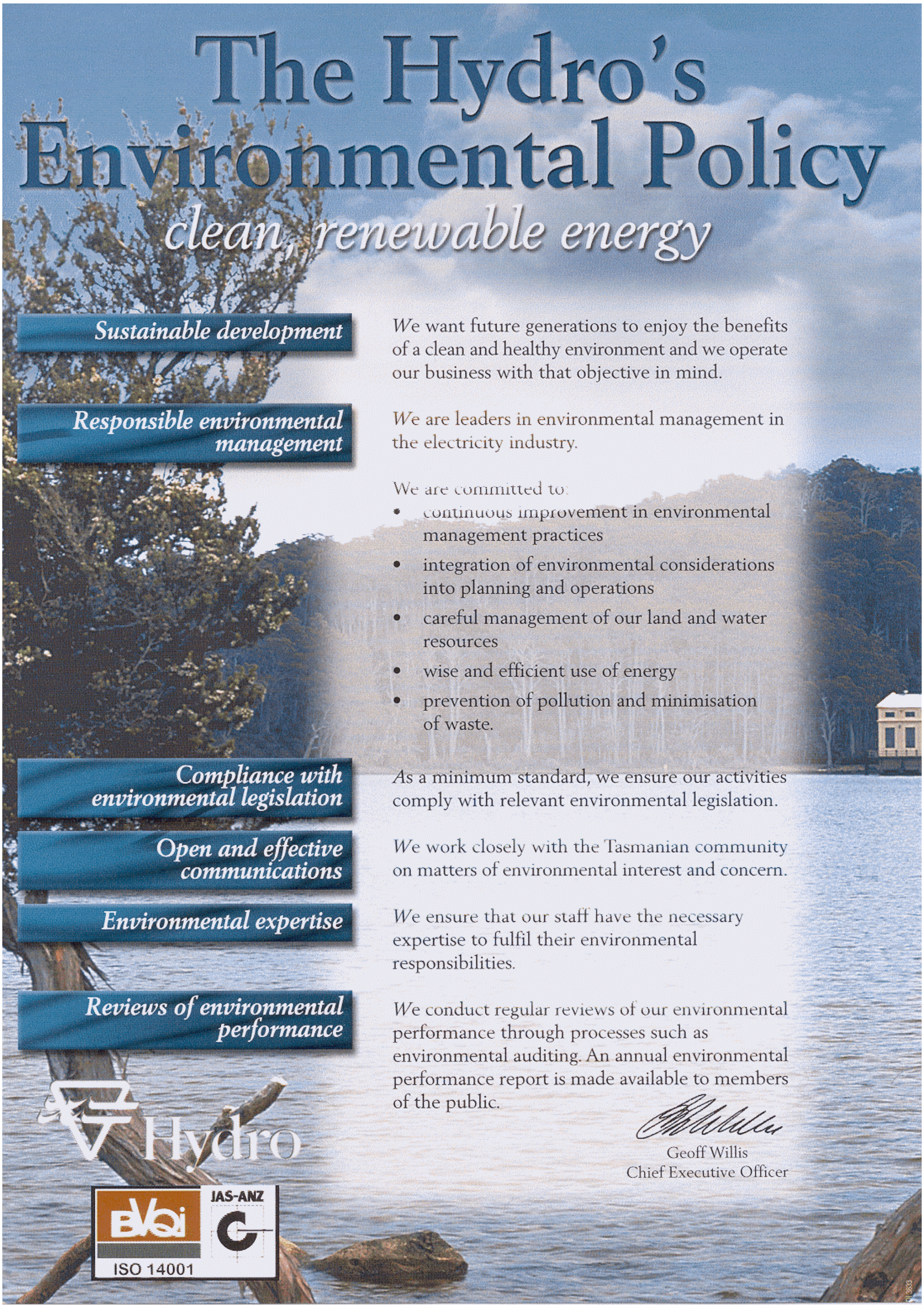
ATTACHMENT 1

THE HYDRO'S ENVIRONMENTAL POLICY AND

THE HYDRO'S AQUATIC ENVIRONMENTAL POLICY


The Hydro's Environmental Policy
clean, renewable energy
Sustainable development
We want future generations to enjoy the benefits of a clean and healthy environment and we operate our business with that objective in mind.
Responsible environmental management
We are leaders in environmental management in the electricity industry.
We are committed to:
• continuous improvement in environmental management practices
• integration of environmental considerations into planning and operations
• careful management of our land and water resources
• wise and efficient use of energy
• prevention of pollution and minimisation of waste.
Compliance with environmental legislation
As a minimum standard, we ensure our activities comply with relevant environmental legislation.
Open and effective communications
We work closely with the Tasmanian community on matters of environmental interest and concern.
Environmental expertise
We ensure that our staff have the necessary expertise to fulfil their environmental responsibilities.
Reviews of environmental performance
We conduct regular reviews of our environmental performance through processes such as environmental auditing. An annual environmental performance report is made available to members of the public.
Geoff Willis
Chief Executive Officer
Hydro
BVQi
ISO 14001
JAS-ANZ

The Hydro's aquatic environmental policy

Sustainable Development

We recognise that water is central to our business, and needs to be managed so that future generations can enjoy the benefits of a clean renewable energy source which is environmentally and economically sustainable for Tasmania.

Responsible Environmental Management

We recognise the modifications our assets and operations have made to the State's natural wetlands, and the multiple uses of lakes and rivers in the Hydro system. We operate our business in a manner which takes into account community views and values, and aims to maintain healthy functioning aquatic ecosystems.

Compliance with Environmental Policy and Legislation

We are committed at a minimum to compliance and co-operation with legislative and policy developments relating to environmental management of the Hydro's waterways.

Water Management Decisions

We work co-operatively with other government agencies and members of the community to find practical solutions to water management issues. We are committed to decision-making based on good scientific information, and involvement and consultation with relevant stakeholders.

Reviews of Environmental Performance

We investigate the influence of our operations on affected lakes and rivers in a systematic manner, and report on our performance in an open and transparent fashion.

Environmental Expertise and Availability

We ensure that our staff have the necessary expertise to fulfil our commitments to management of aquatic environmental issues, and that these staff are available to the community and other agencies to address relevant issues as they arise.

Hydro