Pieman Sustainability Review

Information review of the Anthony-Pieman hydropower scheme February 2015

Hydro Tasmania

The power of natural thinking

About this report and where to find additional information

This report completes Stage 1 of the Pieman Sustainability Review. It is provided to the community as an information resource to assist the process of community consultation and feedback. The report provides information about the Anthony–Pieman hydropower scheme and how it is operated, and a summary of the social and environmental aspects of the scheme and how they are managed by Hydro Tasmania.

Section	Title	Content
1	Introduction	Introduces the sustainability review process, including timelines and how stakeholders can become involved. Provides background information about the structure, operation and governance of Hydro Tasmania
2	The Pieman Study Area	Describes the location, governance, land use, climate, people and values of the area covered by the Pieman Sustainability Review
3	The Anthony–Pieman hydropower scheme and assets	Information about the scheme, its lakes, dams, power stations and other infrastructure
4	The Anthony–Pieman hydropower scheme	Information about lake levels, river flows, operating rules and cloud seeding
5	Benefits of the Anthony–Pieman hydropower scheme	An outline of the social and economic benefits of the Anthony–Pieman hydropower scheme
6	Social aspects related to Anthony–Pieman hydropower operations	Summary of issues that have been raised about potential social impacts of the scheme, including public safety, cloud seeding, lake levels, recreational use and heritage
7	Environmental aspects related to Anthony–Pieman hydropower operations	Summary of issues that have been raised about potential environmental impacts of the scheme, including threatened species, weeds, pests and pathogens, fish migration and water quality
8	Next steps	Details about the next stages in the review, including how to become involved and where to find more information

This report is supplemented by more detailed information on the Hydro Tasmania website, including:

- detailed information on previous reviews in other catchments, including their technical studies and outcomes
- Pieman Sustainability Review Fact Sheets which include more detailed data and information on water management, environmental aspects and water quality
- a downloadable version of this report
- an overview of the sustainability review process, and news and updates on the progress of the Pieman Sustainability Review.

Visit: **www.hydro.com.au/pieman-sustainability-review**

For information on how to be involved in the Review process, see page 31

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1. Introduction

The Pieman River at Corinna, below Reece Power Station

Hydro Tasmania conducts hydropower sustainability reviews for each of our catchments as a way to periodically assess and improve practices associated with managing our hydropower schemes.

The sustainability review for the Anthony–Pieman hydropower scheme is Hydro Tasmania's fourth review. Previous reviews were done for the Great Lake–South Esk, Derwent and Mersey–Forth catchments between 1999 and 2013. The review process has broadened over time and this has resulted in a name change from 'Water Management Review' to 'Sustainability Review'. Information about previous reviews is available on the Hydro Tasmania website at **www.hydro.com.au/environment/water-management-reviews**

The Pieman Sustainability Review relates to the activities of Hydro Tasmania in our operation of the Anthony–Pieman hydropower scheme.

The objectives of the Pieman Sustainability Review are to:

- proactively assess issues and opportunities associated with Hydro Tasmania's operations using a consultative and transparent process
- implement more sustainable practices where feasible and cost effective
- participate in a co-operative approach to catchment management by building mutually beneficial relationships with communities where Hydro Tasmania operates.

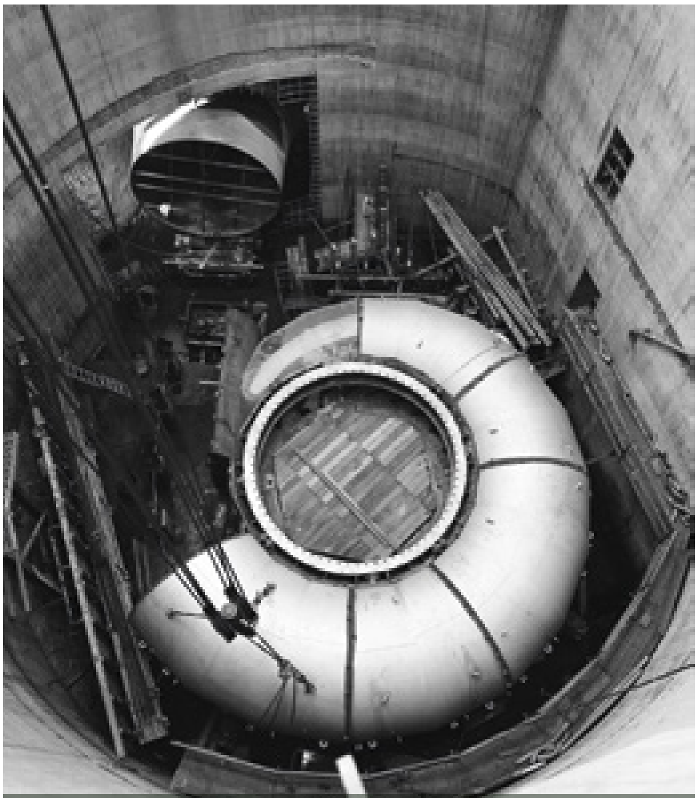
The Pieman Sustainability Review process

The Pieman Sustainability Review commenced in mid-2014. It will be conducted over two years and will include four stages, summarised in Table 1.

Table 1: The Pieman Sustainability Review stages

Review stage
Stage 1: Information review. This stage involves collecting, summarising and publishing information on operational, social and environmental aspects of the Anthony–Pieman hydropower scheme. It includes some preliminary stakeholder interviews. This report completes Stage 1.
Stage 2: Stakeholder consultation. This stage involves a community survey and follow-up discussions to collect feedback and build better understanding of issues and opportunities relating to the scheme. Information and advice gained in this stage will be used to prioritise issues for further study in Stage 3.
Stage 3: Technical studies. This stage involves follow up studies to investigate issues and opportunities raised and assess the feasibility of potential opportunities for improvement identified in Stage 2.
Stage 4: Commitments. This stage involves development of a program to improve management practices based on the feedback provided, the findings of studies and evaluation of costs and benefits.

The Review process will conclude by the end of December 2016. Information on progress will be available on the Hydro Tasmania website.
Visit **www.hydro.com.au/pieman-sustainability-review**



Turbine housing under construction, Reece Power Station

About Hydro Tasmania

Hydro Tasmania is Australia's largest generator of renewable energy and the nation's largest water manager. Hydro Tasmania is owned by the State of Tasmania and celebrated 100 years of history in 2014. We currently employ over 1000 people locally, nationally and internationally and manage $5 billion worth of energy generation and related assets. We have a total installed energy generation capacity of 2653 MW including hydropower, wind and gas generation developments.

The past to the present

In 1914, the Tasmanian Government bought a small electricity company in financial difficulty and created the Hydro-Electric Department. The first power station at Waddamana in the Great Lakes area was opened in 1916. By the 1920s, hydro-electric power was revolutionising Tasmanian farms, businesses, mines and factories, but electricity was not yet widely available for household use.

After the Second World War, the renamed Hydro-Electric Commission recruited large numbers of European migrants to construct dams and power stations. Many of these workers settled permanently and stayed with the organisation for decades, even creating multi-generational Hydro families.

During the 1950s, increasing demand stretched electricity supplies to the limit. Severe drought that began in the late 1950s saw power restrictions introduced, new developments proposed and construction taking place through the 1960s. The 1970s and 1980s saw growing controversy over the flooding of Lake Pedder and plans for the Lower Gordon scheme. Ultimately, planning on the scheme ended in 1983 when the High Court prevented the Franklin Dam from being built. The Pieman scheme was built in the 1980s. The Anthony scheme was the last hydropower scheme to be completed (in 1994) and marked the end of Tasmania's hydro-industrialisation era.

From the 1990s until today, Hydro Tasmania has been exploring new renewable energy technologies including wind farms in Tasmania. In mid-1998, the Hydro-Electric Commission was disaggregated into three government-owned businesses. Today, these separate government-owned businesses are:

- Hydro Tasmania (electricity generation)
- TasNetworks (transmission and distribution of electricity)
- Aurora Energy (sale of electricity to consumers).

Regulatory and governance context

Our business is complex and evolving, but we always hold in mind our overarching vision, to be Australia's leading clean energy business inspiring pride and building value for our owners, our customers and our people.

Hydro Tasmania operates in accordance with the *Government Business Enterprises Act 1995* (GBE Act), the *Hydro-Electric Corporation Act 1995*, and our Ministerial Charter. The GBE Act requires Hydro Tasmania to act commercially, and sets out the principles and practices applying to our corporate governance. As a government business enterprise (GBE), our performance is subject to public scrutiny by the Parliament of Tasmania.

Hydro Tasmania has compliance obligations under a range of state and federal legislation. Our water licence is issued under the *Tasmanian Water Management Act 1999* and is regulated by the Department of Primary Industry, Parks, Water and Environment (DPIPWE). The water resource managed by Hydro Tasmania is defined by the boundaries of the hydro-electric water districts under the *Water Management Act 1999*.

2. The Pieman Study Area

Location and land use

The Pieman Study Area includes the Pieman and Henty hydro-electric water districts, as declared under the *Water Management Act 1999*. The Anthony- Pieman hydropower scheme refers to all components and resources (such as storages, rivers, dams, tunnels and hydropower stations) used for the purpose of hydropower generation purposes in the Pieman Study Area.

Figure 1 shows the boundary of the Pieman Study Area and the components that make up the Anthony–Pieman hydropower scheme.

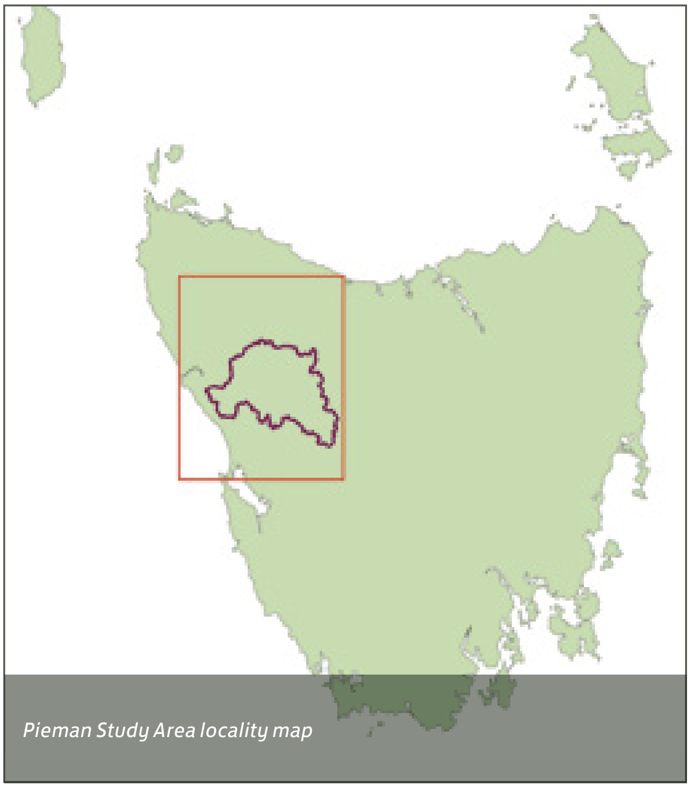
The Pieman Study Area is located almost entirely in the West Coast Council municipality however the northern and western areas fall within the Waratah–Wynyard and Circular Head municipal areas.

Land tenure within the Pieman Study Area is predominantly national park, conservation area and state reserve (Figure 2). Approximately 297 500 ha (68 per cent) is protected for environmental reasons and these natural areas are also used for recreation and tourism. Forestry is also a major land use, with approximately 106 200 ha of production forest (20 per cent), 9100 ha of which is plantation forests.

Land use for power generation constitutes approximately 15 800 ha (3.6 per cent) and includes water storages (lakes and dams), power stations and transmission line easements. DPIPWE manages 14 500 ha of native forest on Crown land. Mining (3900 ha), grazing (500 ha) and residential land (100 ha) constitute the remainder of land use within the Pieman Study Area.

Climate

The Pieman Study Area experiences a mild marine climate with mild winters and cool summers close to the coast, but is colder at higher altitude and further from the sea. July is the wettest month and January and February are driest, with annual rainfall ranging from 2000 to 3000 mm. Snowfalls are common above 600 metres and may persist into summer at higher altitudes. Table2 shows the average annual rainfall and the winter and summer temperatures for two weather stations representative of the Pieman Study Area. Mount Read is in the upper catchment and Savage River Mine is mid-catchment.



Pieman Study Area locality map

Table 2: Pieman rainfall and temperature

BOM Station (station number)	Mount Read	Savage River Mine
Elevation (m above sea level)	1119	352
Annual rainfall (mm)	3608	1929
Average July temperature range (°C)	3.6–10.0	3.3–9.4
Average February temperature range (°C)	6.3–14.3	9.9–20.1

Source: Australian Bureau of Meteorology, 2013, Climate Data Online, viewed 27 May 2013, www.bom.gov.au/climate/data/

Did you know?

The Pieman River was named after the escaped convict Thomas Kent, a pastry chef from Southampton known as the "Pie Man",who was recaptured at the mouth of the river.

Figure 1: The Pieman Study Area and the Anthony–Pieman hydropower scheme

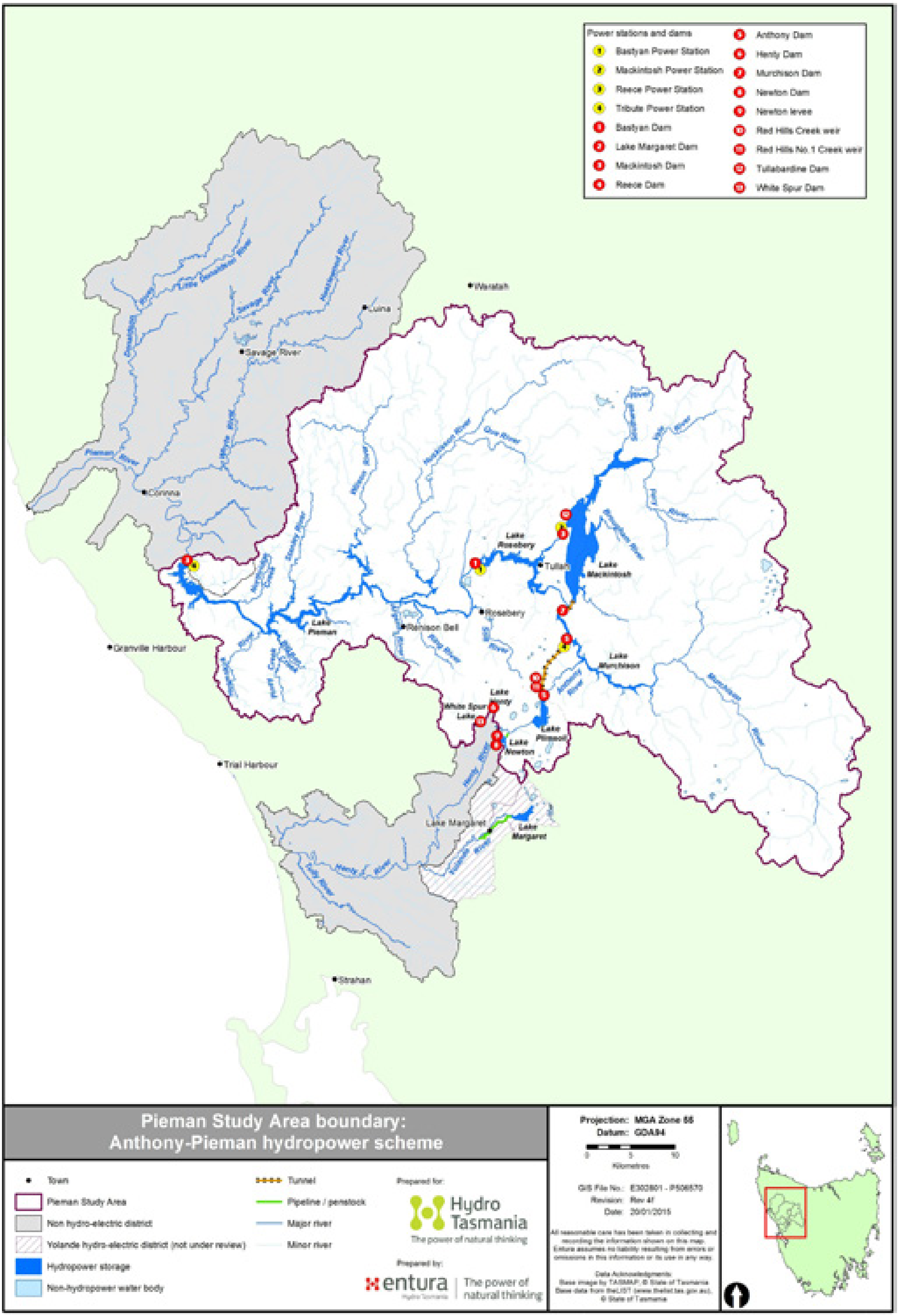
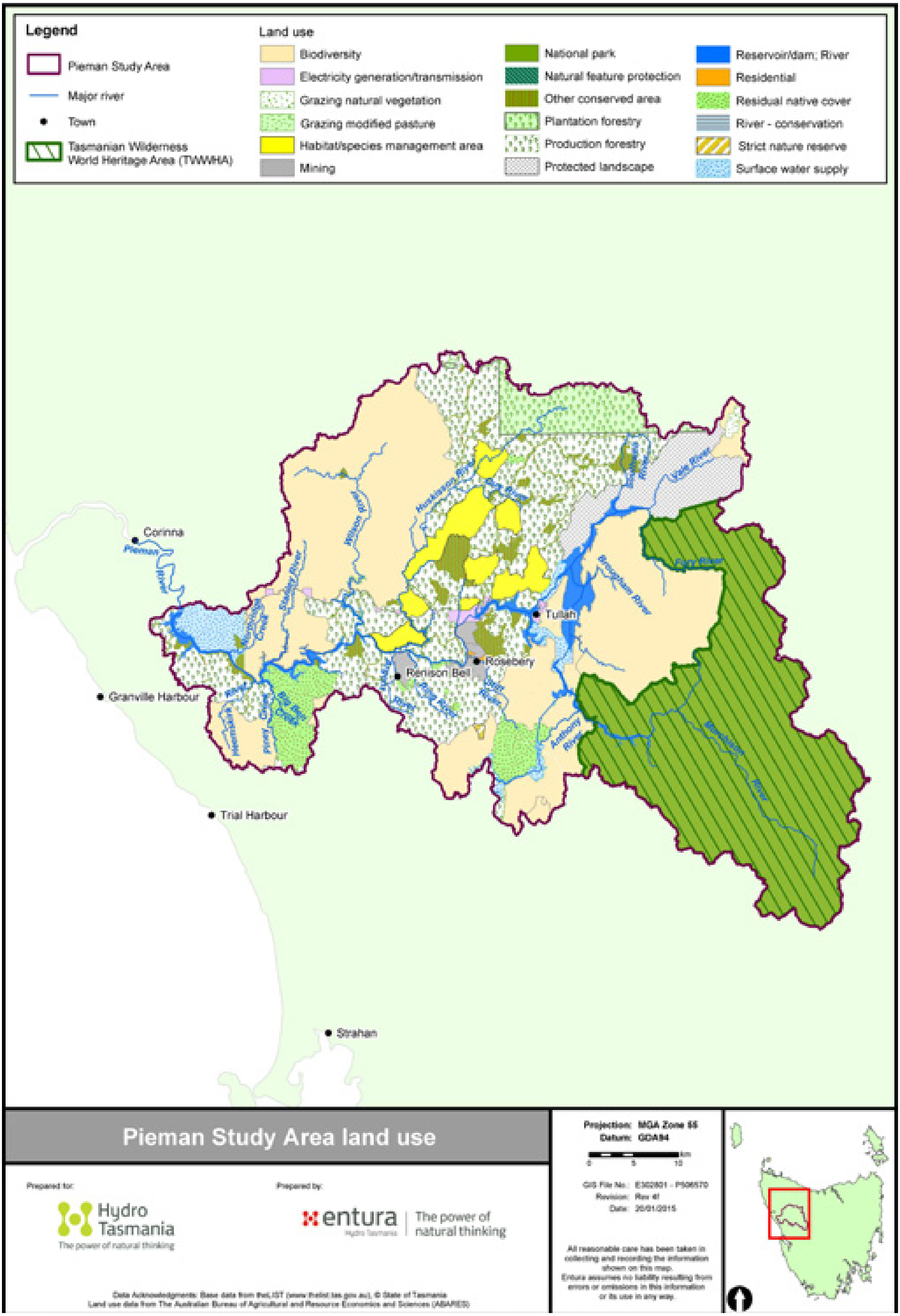


Figure 2: Pieman Study Area land use



Communities and local industries

The Pieman Study Area includes small remote communities that developed during the mining and hydro-industrialisation era on the West Coast of Tasmania. The main townships are Tullah and Rosebery, and Zeehan is nearby. The townships are highly dependent on mining and tourism for livelihoods. In 2011, the population of Tullah was 192 residents, Rosebery had 922 residents and Zeehan 728 residents (Australian Bureau of Statistics Census, 2011).

Mining is an important industry in the region and includes mineral outputs such as tin, iron ore, copper, nickel, zinc, silver and gold. Employment in mining has experienced major fluctuations dependent on volatile global market prices for ore. Today, the mining industry in the Pieman Study Area is dominated by drive in–drive out workforce patterns and mining activities are centred on the townships of Rosebery and Zeehan. Other industries in the catchment include water treatment facilities, quarrying and manufacturing of timber products.

The town of Tullah was originally established as a mining town named Mount Farrell but was later expanded as a Hydro village during construction of the Anthony–Pieman hydropower scheme. At the peak of construction the population of Tullah was around 2500 people. Today the town of Tullah is a peaceful town surrounded by a beautiful landscape of lakes and mountain ranges.

Aboriginal heritage values

Aboriginal heritage in the Pieman Study Area is not as well understood as in surrounding areas including the coastal areas to the west, the Tasmanian Wilderness World Heritage Area to the east, the Surrey Hills to the north and in the King River valley to the south. A combination of factors is involved including: a lack of archaeological survey over large areas (particularly around the Huskisson-Wilson-Stanley rivers, the Pieman River and other tributaries, between the Vale and Fury rivers and the upper reaches of the Murchison River); the inaccessibility of much of the region; the poor ground-surface visibility; and processes of geological change over time concealing sites.

Recreation

Recreation and tourism are increasingly important in the Pieman Study Area and the broader West Coast region. The lakes created for the hydropower scheme were developed primarily for storage of water for power generation, but the lakes and rivers are also used for recreation, in addition to mine and town water supply, wastewater and tailings dam treatment outfalls. Tourist operators are increasingly promoting the West Coast as a holiday destination because of its natural beauty and recreational opportunities. Key attractions include museums, ferry boats, historical sights, walking trails and numerous water bodies supporting recreational trout fishing and other activities.

Lake Rosebery during the Tullah Challenge

The Tullah Challenge event sponsored by Hydro Tasmania

The lakes and rivers are key destinations for anglers from across the state.

Hydro Tasmania liaises with the Inland Fisheries Service (IFS) and Marine and Safety Tasmania (MAST) to consider the needs of recreational users in the processes associated with lake level management. Trout were introduced to the Henty River in the 1880s. Further introduction of trout into West Coast waters accompanied the settlement of the area. Lake Plimsoll includes populations of brook trout while Lake Rosebery is stocked with Atlantic salmon. Lake Rosebery and Lake Mackintosh are stocked with rainbow trout. Brown trout are widely dispersed throughout the Pieman Study Area and are self-sustaining populations; no brown trout have been stocked in the catchment since 1980.

Lake Rosebery is one of the few lakes across the state where water-skiing is a significant activity. The Lake Rosebery Ski Lodge on the western banks of the lake has a large number of members who water-ski on a regular basis and the lake has also been the focus of water-skiing competitions.

Camping occurs sporadically on Hydro Tasmania land within the Pieman Study Area. Most camping occurs adjacent to boat ramps. Generally, camping is undertaken by short-term visitors to the region and makes use of unofficial camp grounds.

Protected environmental values

The State Policy on Water Quality Management (1997) provides a framework to manage water quality for all Tasmanian surface waters. As part of this framework, Protected Environmental Values (PEV) were developed for the Pieman River catchment and West Coast municipal areas following community consultation in 2000.

The community water values identified for the Pieman Study Area were diverse, including:

Ecosystem values: adequate water for the environment; maintenance of populations of native fish (including eels and whitebait runs), platypus, bird life and other animals dependent on waterways; and maintenance of trout throughout the catchment. A particular emphasis was placed on native fish in the Pieman River.

Recreational values: river boat cruises; tourism; water skiing; fishing; bushwalking; canoeing; and swimming.

Industrial water values: power generation was identified as an important industrial water value.

3. The Anthony–Pieman hydropower scheme

The Anthony–Pieman hydropower scheme is the youngest of the Tasmanian hydropower schemes. The Anthony-Pieman scheme has a total generating capacity of 507 megawatts (MW). In the 2013-14 financial year, generated power from the Anthony-Pieman scheme was 2237 gigawatt hours (GWh) out of a total of 11 932 GWh from the overall Hydro Tasmania generating scheme, or almost 19 per cent.

The first stage of hydropower development in this catchment was the Pieman scheme, comprising the Mackintosh, Bastyan and Reece power stations. Development of the scheme was completed in 1987. It harnesses the flows of the Pieman River and its two major tributaries, the Mackintosh and Murchison rivers.

The second stage of the development, the Anthony scheme, was completed in 1994 to divert additional water into the Pieman scheme. It includes three dams (Henty, White Spur and Newton), 7.4 kilometres of canals and the Newton pumping station.
The Anthony scheme diverts water from the Anthony, Henty and surrounding rivers. The water flows via Lake Plimsoll through 7 kilometres of tunnels to Tribute Power Station before flowing to Lake Murchison. This water is then used again in the three stations in the Pieman scheme.

The Anthony–Pieman scheme has four power stations, summarised below. More detail is on page 14.

Other key assets in the Anthony-Pieman scheme include:

- Newton pumping station
- eight major dams with storages
- one major road
- eight intake structures
- canals and tunnels.

Henty Dam under construction

Figure 3 (overleaf) shows an overview of the scheme and Figure 4 (pages 12-13) is a schematic version showing how water is conveyed in the system and used for power generation.

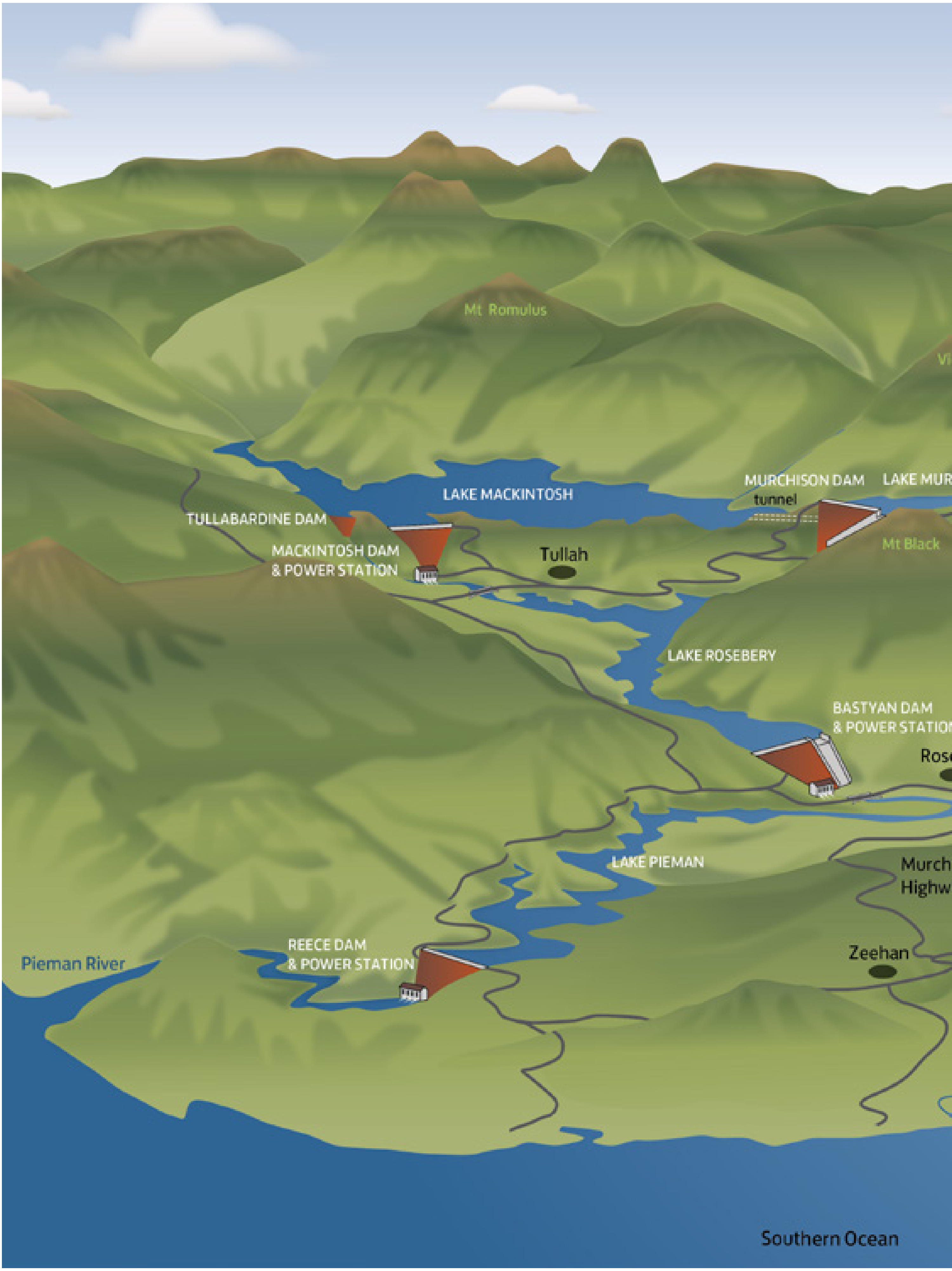
Did you know?

Tribute Power Station was named as a tribute to the estimated 30 000 people who helped to build the State's hydro-electric system from 1914 to 1994.

Table 3: Power stations in the Anthony-Pieman hydropower scheme

Power station	Associated water body	Generation capacity (MW)
Tribute	Lake Plimsoll	92
Mackintosh	Lake Mackintosh	88
Bastyan	Lake Rosebery	89
Reece	Lake Pieman	238

Figure 3: Overview of the Anthony–Pieman hydropower scheme



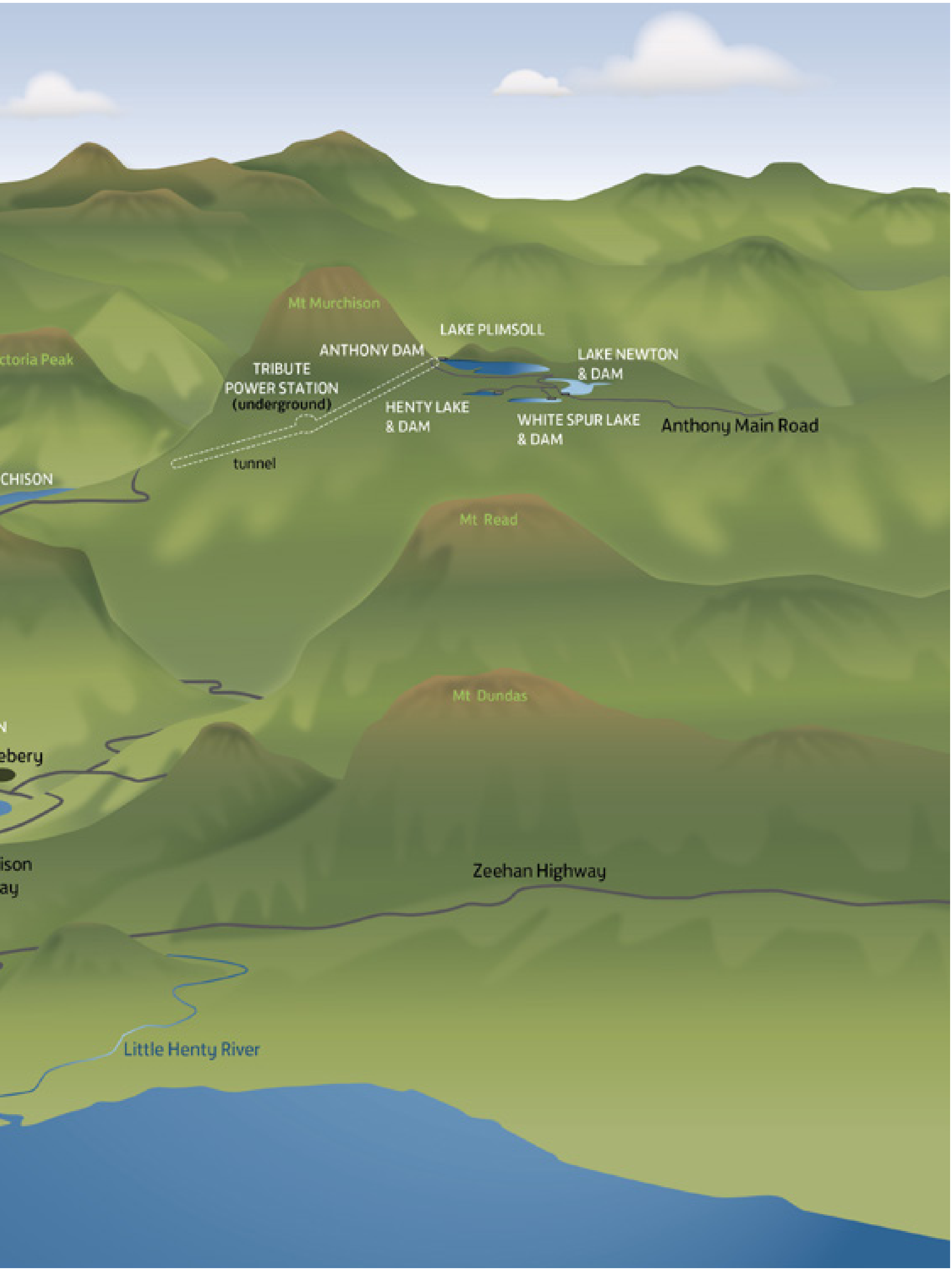
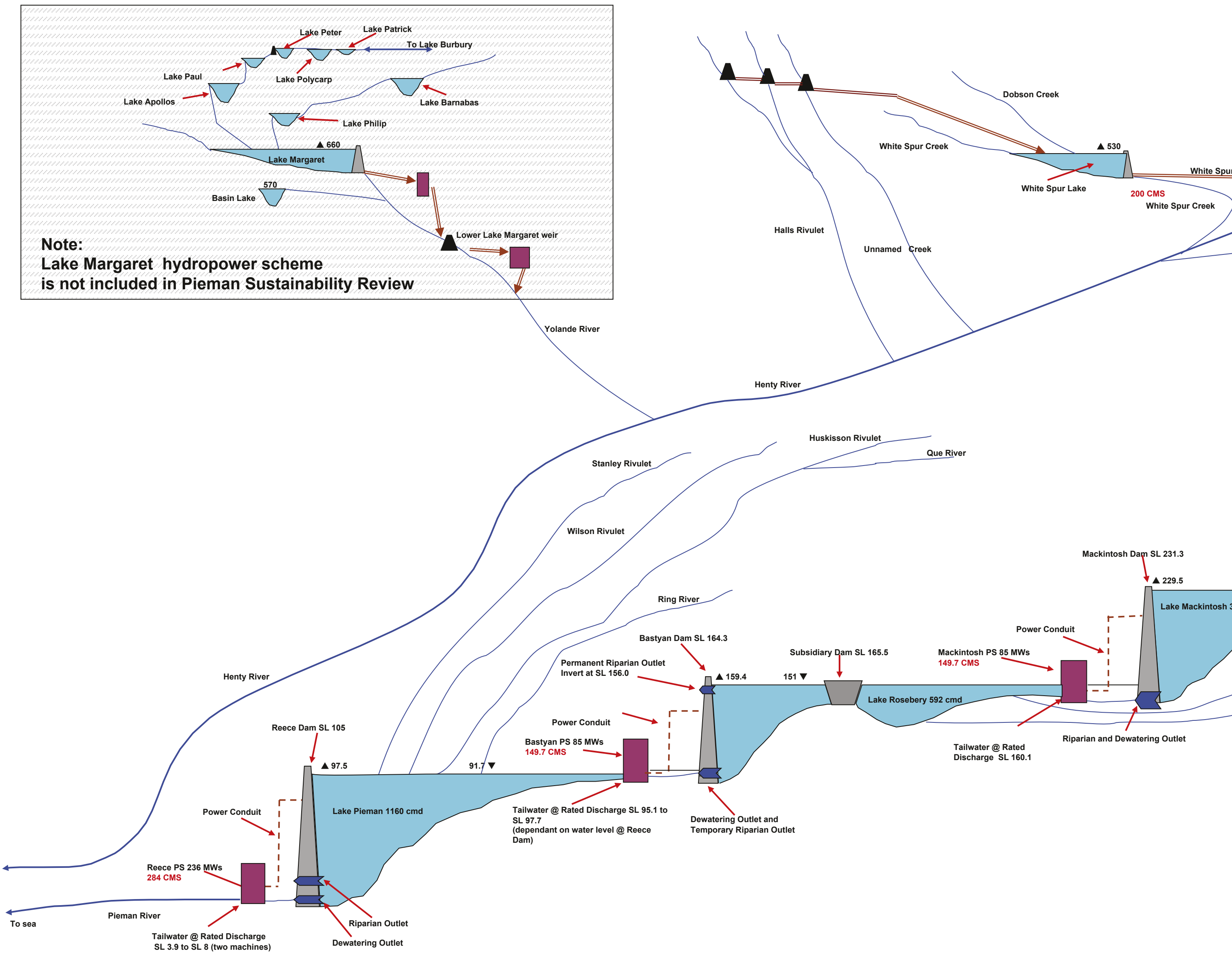
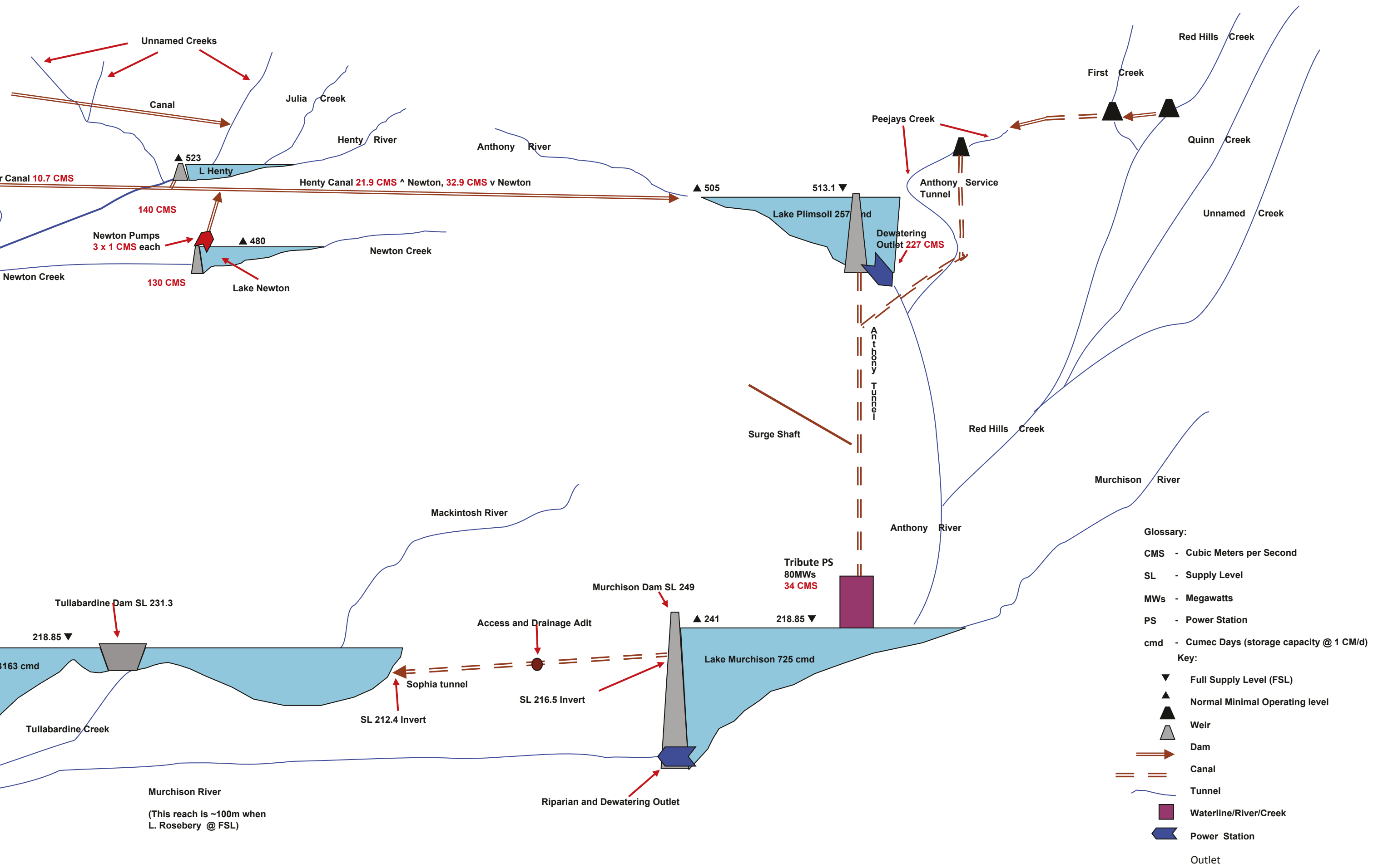

Mt Murchison
ctoria Peak
LAKE PLIMSOLL
ANTHONY DAM
TRIBUTE
POWER STATION
(underground)
LAKE NEWTON
& DAM
HENTY LAKE
& DAM
WHITE SPUR LAKE
& DAM
Anthony Main Road
tunnel
CHISON
Mt Read
Mt Dundas
ebery
ison
ay
Zeehan Highway
Little Henty River

Figure 4: Schematic representation of the Anthony–Pieman hydropower scheme




Unnamed Creeks
Canal
Julia Creek
Henty River
Anthony River
▲ 523
L Henty
Canal 10.7 CMS
Henty Canal 21.9 CMS ^ Newton, 32.9 CMS v Newton
140 CMS
Newton Pumps
3 x 1 CMS each
▲ 480
Newton Creek
Newton Creek
130 CMS
Lake Newton
▲ 505
513.1 ▼
Lake Plimsoll
Peejays Creek
Anthony Service Tunnel
Dewatering Outlet 227 CMS
Red Hills Creek
First Creek
Quinn Creek
Unnamed Creek
Anthony Tunnel
Surge Shaft
Red Hills Creek
Murchison River
Anthony River
Mackintosh River
Tribute PS
80MWs
34 CMS
Murchison Dam SL 249
▲ 241
218.85 ▼
Lake Murchison 725 cmd
Tullabardine Dam SL 231.3
218.85 ▼
163 cmd
Access and Drainage Adit
Sophia tunnel
SL 216.5 Invert
SL 212.4 Invert
Tullabardine Creek
Murchison River
(This reach is ~100m when L. Rosebery @ FSL)
Riparian and Dewatering Outlet
Glossary:
CMS - Cubic Meters per Second
SL - Supply Level
MWs - Megawatts
PS - Power Station
cmd - Cumec Days (storage capacity @ 1 CM/d)
Key:
Full Supply Level (FSL)
Normal Minimal Operating level
Weir
Dam
Canal
Tunnel
Waterline/River/Creek
Power Station
Outlet

Power stations and pumping station

Tribute Power Station

The only power station in the Anthony scheme that diverts water into the Pieman scheme, Tribute Power Station is underground and uses water from a number of diverted rivers. Water flows from Lake Plimsoll into Tribute Power Station via 7 kilometres of tunnels.

Date commissioned	1994
Generating capacity	92MW
Number of turbines	1
Type of turbines	Francis

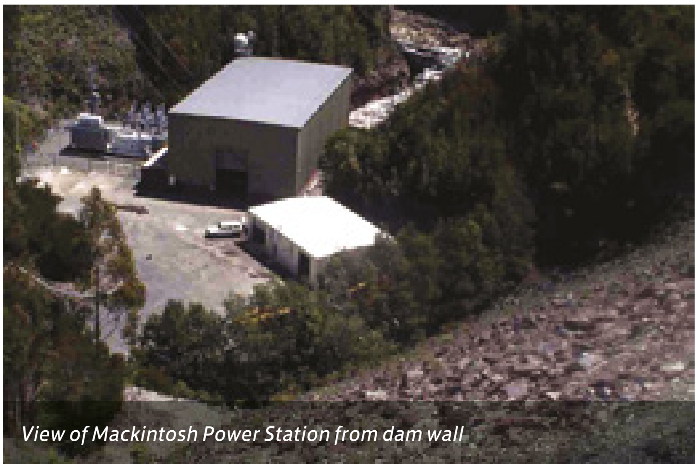

Inside Tribute Power Station

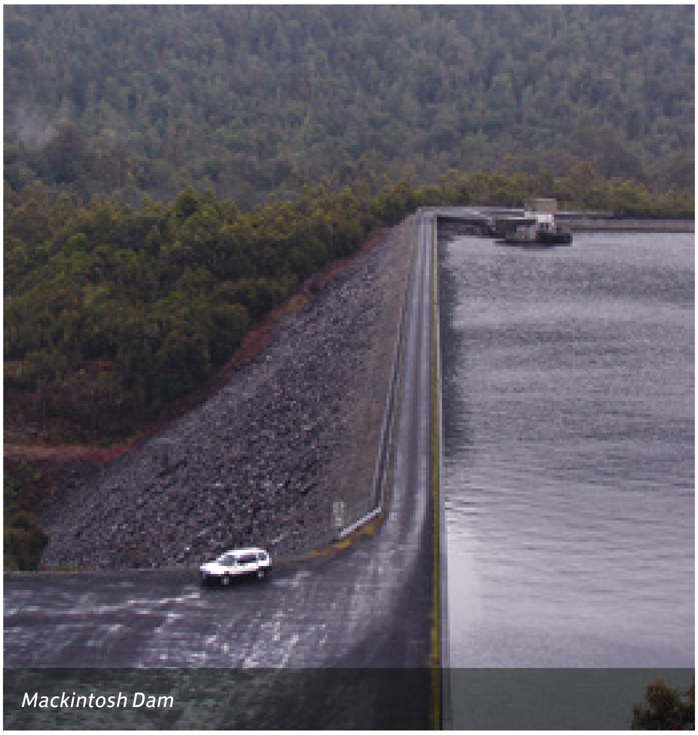

Anthony Dam

Mackintosh Power Station

From Lake Murchison water travels via Sophia tunnel to Lake Mackintosh. The Mackintosh Power Station is at the foot of the Mackintosh Dam on Lake Mackintosh. The water is discharged to Lake Rosebery which feeds the Bastyan Power Station.

Date commissioned	1982
Generating capacity	88MW
Number of turbines	1
Type of turbines	Francis


View of Mackintosh Power Station from dam wall


Mackintosh Dam

Bastyan Power Station

The Bastyan Power Station is at the foot of Bastyan Dam on Lake Rosebery. Water is discharged to Lake Pieman which feeds the Reece Power Station.

Date commissioned	1983
Generating capacity	89MW
Number of turbines	1
Type of turbines	Francis


Bastyan Power Station

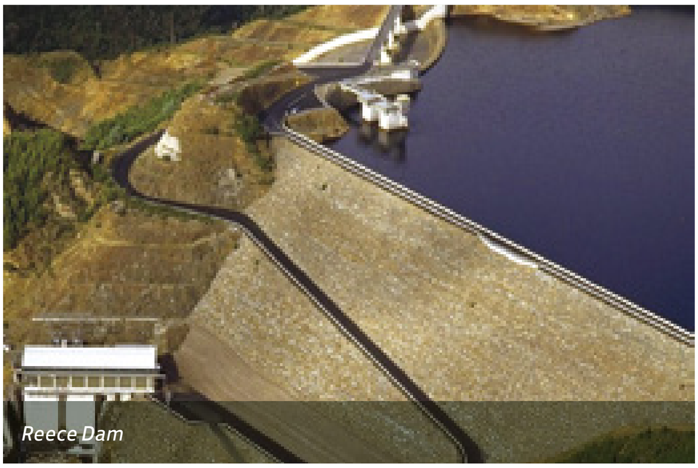

Bastyan Dam

Reece Power Station

The last power station before the water runs out to sea, Reece Power Station is at the foot of the Reece Dam on Lake Pieman.

Date commissioned	1987
Generating capacity	238MW
Number of turbines	2
Type of turbines	Francis


Reece Power Station


Reece Dam

Newton pumping station

The Newton pumping station pumps water from Lake Newton to Henty Canal which discharges into Lake Plimsoll. The station operates automatically and has three pump sets.


Inside Newton pumping station


Lake Plimsoll

Dams and lakes

White Spur Dam and levee

White Spur Dam is a 43-metre high concrete-faced rockfill dam, with a crest length of 146 metres. White Spur levee is a 4-metre high rockfill embankment with an upstream geotextile clay liner covered in concrete rubble. It is located approximately 300 metres south-west of the dam. White Spur Dam forms White Spur Lake which is a diversion storage for the Anthony scheme.

Henty Dam and levee

Henty Dam is a 24-metre-high concrete gravity dam on the Henty River which diverts the river into the Henty Canal. The crest length is about 110 metres. A 70-metre-long earth core embankment/levee forms the left bank dam extension and is 0.4 metres higher than the dam. Henty Dam forms Lake Henty.

Anthony Dam and levee

Lake Plimsoll is formed by the 40-metre high, concrete-faced rockfill Anthony Dam and the 17-metre-high Anthony levee, made of rockfill with a clay core. Lake Plimsoll is the main head storage for the Anthony scheme that feeds water to Tribute Power Station.

Murchison Dam

Murchison Dam is a 93-metre-high concrete-faced rockfill dam with a crest length of 217 metres located on the Murchison River approximately 7 kilometres from Tullah. Murchison Dam forms Lake Murchison, a diversion storage that discharges water to Lake Mackintosh via Sophia tunnel.

Tullabardine Dam

Tullabardine Dam is located on Tullabardine Creek approximately 1.4 kilometres from the Mackintosh spillway. The dam is a 25-metre-high concrete-faced rockfill embankment, with a crest length of 214 metres. Tullabardine Dam is one of the dams that form the head storage of Lake Mackintosh.

Mackintosh Dam

Mackintosh Dam is a 75m-high concrete-faced rockfill embankment. The crest length is 465 metres (640 metres including the right bank crest wall extension). Mackintosh Dam is the second dam that forms the head storage of Lake Mackintosh.

Bastyan Dam and levee

Bastyan Dam is a concrete-faced rockfill dam located 13 kilometres downstream of Mackintosh Dam on the Pieman River. The dam is 75 metres high and has a crest length of 510 metres. Bastyan levee is a 14-metre-high earthfill embankment saddle dam. Bastyan Dam and the levee form Lake Rosebery.

Reece Dam

Reece Dam is the largest rockfill embankment dam in Tasmania, containing more than 2.6 million cubic metres of fill. It is a 122-metre-high concrete-faced rockfill dam with a crest length of 374 metres. The spillway at Reece Dam is a free overflow, frontal approach 'converging chute' design which is constructed in a saddle to the right of the embankment. Reece Dam forms Lake Pieman.

4. Operation of the Anthony–Pieman hydropower scheme

Hydro Tasmania manages storages and water releases to generate electricity. Operational decisions are made using storage operating rules and short-and long-term modelling of water availability. The actual power output for any year varies according to rainfall patterns, plant outages, electricity demand and transmission constraints. Generation operations for Hydro Tasmania are operated as a statewide portfolio, with the Anthony–Pieman hydropower scheme providing a highly valued and reliable resource.

The total water storage for the Pieman Study Area is 512 Gigalitres and the average annual generation is 2367 GWh.

Changing lake levels

Lake levels fluctuate between full supply level (FSL) and the normal minimum operating level (NMOL) as a result of hydropower operations. The 'operating range' is the difference between FSL and NMOL. Operating ranges in the catchment vary from 4.5 metres at Lake Henty to 22.1 metres at Lake Murchison. Lakes can be emptied below NMOL for maintenance of dams and power stations.

Sometimes lakes exceed their FSL when high rainfall causes water to flow over the dam (a 'spill event').

Lake level rules that describe how water levels and releases from the storage are to be managed may also be voluntarily adopted by Hydro Tasmania to manage environmental or social values (e.g. recreational values) or for other operational reasons. The *Pieman Sustainability Review: Water Management Fact Sheet* provides more detailed information about lake storage and operations is available on the Hydro Tasmania website. Information about water level management is also available on the website.

Did you know?

The Anthony Pieman hydropower scheme produces about 20 per cent of Hydro Tasmania's electricity generation and Reece Power Station alone could power all the homes in Hobart.

Bastyan Dam spillway

Spills

Dams will fill during periods when inflows exceed the power station discharge (e.g. during periods of high rainfall). Spill of water from storages will occur when the water level exceeds the FSL. Spills are usually made via a spillway near the dam wall, but may occur via tunnels, canals or the opening of gates. It is important that the spill is controlled to ensure water is released from the dam safely. Spills represent a loss of energy and hence revenue to Hydro Tasmania as they do not pass through the turbines and every effort is made to minimise spill events.

Storage operating rules

Storage operating rules are an important tool used by Hydro Tasmania to guide how storages are managed for power generation and other purposes. The storage operating rules take into account:

- power station operation and constraints including operating to reduce the risk of spills, maintenance and outages and efficient running of machines
- environmental and social considerations such as water quality, biodiversity impacts and recreational uses
- economic considerations e.g. Basslink operation, electricity pricing and demand and optimisation of generation.

Table 4 shows examples of storage operating rules relating to environmental considerations and public use of the storages in the Anthony–Pieman hydropower scheme.

For example Lake Rosebery's water level is normally maintained within an operating range of 1 metre to provide stable water levels for recreational use of the lake, while the other storages fluctuate regularly within their respective operating ranges. Lake Pieman has storage operating rules that are designed to avoid the release of water with very high levels of oxygen that can harm fish downstream.

Downstream flows below power stations

There have been changes in the natural flow regime of rivers in the Pieman Study Area as a result of hydropower development. In the Pieman Study Area, Hydro Tasmania has the ability to shut off all or a portion of the flows in the following rivers:

- Pieman River below Reece Dam
- Murchison River below Murchison Dam
- Henty River below Newton Dam
- Anthony River below Lake Plimsoll.

Depending on rainfall and operational requirements there may be periods without flow that extend over the full year, or flow may be intermittent. Flow duration curves provide a useful depiction of changes in the natural flow regime downstream of dams. Flow duration curves for the Anthony–Pieman hydropower scheme are available in the *Pieman Sustainability Review: Water Management Fact Sheet* available on the Hydro Tasmania website.

The Pieman River downstream of Reece Dam is largely tidal. Tidal flows maintain water in the river below the power station when it is not operating.

Table 4: Operational characteristics of water storages in the Anthony-Pieman hydropower scheme

Storage	Operating range[a] (metres)	FSL (metres ASL[b])	Storage volume (GL)	Storage operating rules	Storage type[c]
Lake Henty	4.5	523.0	0	n/a	Diversion storage
Lake Mackintosh	10.6	229.5	273	Operational and environmental monitoring when below NMOL	Head storage
Lake Murchison	22.1	241.0	63	No public access	Diversion storage
Lake Newton	5.0	480.0	2	n/a	Diversion storage
Lake Pieman	4.8	97.5	100	Water quality control operating limit	Run-of-river
Lake Plimsoll	8.10	513.1	22	n/a	Head storage
Lake Rosebery	8.40	159.4	51	Typically operated within one metre of FSL for recreation	Run-of-river
White Spur Pond	8.50	530.0	1	n/a	Diversion storage

a Operating range is defined as the difference between full supply level and normal minimum operating level

b ASL = above sea level

c Storage type: see Glossary

This part of the Pieman River experiences periods with no freshwater flow from the discharge point of the power station, particularly in spring and summer (approximately 18 per cent and 12 per cent of the time respectively). Periods with no freshwater flows would have occurred only occasionally at this point of the river before development of the hydropower scheme . Median flows are now approximately 30–50 per cent higher in all seasons largely due to diversion of water from the Anthony scheme into the Pieman scheme. The magnitude of flood events (including rare and extreme events) has been reduced, particularly in spring and summer. The increase in low or no freshwater flow events, and altered median and flood events, are significant changes to the fluvial geomorphological and ecological processes in the Pieman River.

Post-development changes in the flow regime of the rivers in the Anthony scheme are more significant as the scheme has diverted water out of the Anthony, Henty and other rivers into the Pieman scheme. These changes include a substantial increase in the time that the watercourses below the Anthony scheme dams and weirs receive no flows from the headwater storages, which ranges from 92 per cent for Henty River to 99 per cent in Newton Creek. Flood events have been reduced since dam construction with the watercourses only receiving water during spill events.

In 2000, an assessment of the hydrological impacts on flows downstream from dams associated with the Anthony–Pieman scheme showed that the Henty River downstream of the Anthony scheme and the Pieman River downstream of Reece Dam were the most hydrologically altered compared to pre-development. Below the dam, flows in the Henty River are supplemented by numerous tributary and lateral inflows.

There are no downstream flow release rules from dams in the Anthony-Pieman hydropower scheme.

Cloud seeding

Cloud seeding is a technique for increasing precipitation (e.g. rain or snow) using naturally occurring clouds. It involves the introduction of additional particles into suitable clouds to encourage the formation and growth of ice crystals or raindrops and thus increase the amount of precipitation that will fall from the cloud. Cloud seeding only occurs when the Bureau of Meteorology forecasts rain, and even then only if conditions are favourable for cloud seeding to be successful. A successful cloud seeding operation will make it rain a little harder for a little longer than would have occurred naturally. Cloud seeding is only effective if suitable clouds are present. Information on how cloud seeding works and the Hydro Tasmania cloud seeding program is available on the Hydro Tasmania website: **www.hydro.com.au/cloud-seeding**

Hydro Tasmania's cloud seeding program includes the eastern section of the Pieman Study Area, targeting Lake Mackintosh. The aim of the cloud seeding program is to increase flows into hydropower storages when weather conditions are suitable.

The cloud seeding season runs from 1 May to 31 October each year, a period of 183 days. The number of days that cloud seeding occurs depends on how often favourable conditions are found. Table 5 shows how many times Hydro Tasmania has undertaken cloud seeding over each of our target catchments since 2010.

Cloud seeding is much less frequent in the Pieman Study Area than elsewhere in Tasmania and, due to a lack of suitable conditions, there has not been any cloud seeding over the study area since August 2012. Cloud seeding may occur in future depending on whether there are suitable conditions during the cloud seeding season. Community concerns regarding cloud seeding have been raised; these are discussed in section 6 (p 22).

Table 5: Hydro Tasmania cloud seeding events, 2010–2014

Catchments targeted	2010	2011	2012	2013	2014
Great Lake	7	1	1	2	1
Upper Pieman	2	1	1	0	0
Mersey Forth	4	2	0	0	1
Gordon	17	12	14	9	12
Upper Derwent	7	6	3	3	1

5. Benefits of the Anthony–Pieman hydropower scheme

Lake Rosebery Ski Club

Hydropower schemes deliver a number of direct and indirect benefits to communities.

The Anthony–Pieman hydropower scheme was originally developed to meet growing demand for electricity in Tasmania, which is now part of Australia's National Electricity Market. In addition to the provision of electricity, and returns to the State Government resulting from the sale of that electricity, there are a number of indirect benefits relating to the development and operation of the scheme. Indirect benefits include the creation of recreational lakes, the creation and maintenance of public roads and the provision of water supply storages. These benefits have to be managed in a sustainable way.

There are a number of stakeholders involved in management of benefits in collaboration with Hydro Tasmania. TasWater, for example, manages town water supply, and the Inland Fisheries Service is involved in fisheries management in hydropower storages.

Direct benefits

Electricity

The four power stations of the Anthony–Pieman scheme are among thirty in the Hydro Tasmania system. The importance and value of the assets relative to the overall generating system is very high.

Returns to government

The Anthony–Pieman generation plant contributes approximately 19 per cent of Hydro Tasmania's generation. It is an important contributor to Hydro Tasmania's financial returns to the State Government.

Indirect benefits

Development and maintenance of public roads

Hydro Tasmania owns and maintains approximately 100 kilometres of public roads in the Anthony–Pieman scheme, many of which are popular scenic routes. These include the Pieman Road from the Murchison Highway to just past Reece Dam, Howards Road, the road to Mackintosh Dam from the Murchison Highway turn-off, and the Anthony Road to Tribute Power Station from the Murchison Highway turn-off. Hydro Tasmania maintains these roads to ensure they are suitable for safe public use. The roads we built for the Anthony–Pieman scheme are still the only roads connecting some remote communities and are important tourist gateways to the 'wild west' of Tasmania.

Local employment and procurement

Hydro Tasmania uses local contractors and suppliers where possible for various goods and services to ensure support for the local economy. Maintenance activities for the scheme include major projects for which local contractors are often used. When workforces are brought in to the region for such projects, they contribute to the local economy through use of local accommodation and catering providers.

Water supply storage

Lake Rosebery is a source of water for the township of Tullah. Lake Pieman is a source of water for the township of Rosebery and to the MMG Rosebery mine. Lake Henty is a source of water for the Henty Gold Mine. Town water supply infrastructure and water quality is managed by TasWater.

Land use

Hydro Tasmania owns land around the various Anthony–Pieman infrastructure and waterways. We permit others to access this land when it is safe to do so and does not interfere with hydropower operations. To date, requests for licences to use land in the Pieman Study Area have related to development of recreation facilities, beekeeping, communications facilities, helicopter refuelling, private access and rights of way, pipelines, quarrying and shooting.

New associated industries

A project to recover underwater timber from Lake Pieman, HydroWood, is currently in its early stages. It is managed by SFM Environmental Solutions. Funding for the $5 million project was approved by the Australian Government under the Tasmanian Jobs and Growth Package. The project, if it proceeds, would create up to 20 full-time positions in the construction phase with additional downstream processing employment as timber is made available.

Data collection and sharing

Hydro Tasmania collects detailed rainfall, hydrological and water quality information in various areas of the scheme. In general, we make data available upon request unless it is commercially sensitive. It is used by a range of stakeholder groups including mining companies and government agencies. Water level information is available on our website at **www.hydro.com.au/water**

Lake Rosebery recreation

Hydro Tasmania provides relatively stable lake levels to enhance recreational and aesthetic benefits for the public. We also cleared the timber from this lake to support safe recreational use. Stable lake levels benefit fishers, water skiers and the local tourism industry including the Tullah Lakeside Lodge which was formerly part of a hydro construction village.

Tourism assets including scenic viewpoints

Hydro Tasmania maintains a track to a good viewpoint of Mount Read along the Pieman Road. We also maintain two scenic viewpoints of Mackintosh and Reece dams. There are other scenic viewpoints along the Anthony Road that we established at the time of scheme development.

Contribution to local fire management

Hydro Tasmania contributes to the Western District Fire Management Team which is a group of West Coast-based land managers and organisations established to collaborate on planning for fire prevention and management. In addition, we actively manage vegetation and weeds on our land to reduce fire risk.

Public amenities

Hydro Tasmania provides and maintains a number of public amenities associated with the development and operation of the Anthony–Pieman hydropower scheme.

- *Recreational fishing:* Members of local angling clubs and community members are major recreational users of the lakes for fishing.
- *The local water ski club at Lake Rosebery:* Hydro Tasmania has permitted establishment of a water ski club with permanent buildings on the shore of Lake Rosebery.
- *Boat ramps:* During construction of the original scheme, Hydro Tasmania built boat ramps at lakes Mackintosh, Rosebery, Pieman and Plimsoll.
- *Lake Rosebery public jetty:* Hydro Tasmania built a public jetty at Lake Rosebery in Tullah at the time of scheme development.
- *Lake Rosebery walking track:* Hydro Tasmania built a walking track in front of the (now) Tullah Lakeside Lodge when the scheme was built and it has recently been upgraded.
- *Sponsorship:* Hydro Tasmania has been a naming sponsor for the Tullah Challenge and Hydro Tasmania staff often volunteer at this event and we usually enter at least one team.
- *Scheme models for public viewing:* There are several models of the Pieman and Anthony schemes for viewing and education in the Tullah Village Café and Post Office.
- *Interpretive signage:* Hydro Tasmania provides interpretive information in the Anthony–Pieman hydropower scheme.

Did you know?

Hydro Tasmania owns and maintains around 100 kilometres of roads for public use in the Pieman Study Area.

6. Social aspects related to Anthony–Pieman hydropower operations

Lake Mackintosh signage for recreational users

Communities interact with hydropower schemes in a number of ways. Social aspects of hydropower include both positive and negative impacts to the livelihoods of communities affected by the development and operation of the scheme. There are a number of social issues and potential impacts associated with the current operation of the scheme that are managed by Hydro Tasmania relating to public safety, cloud seeding, lake levels, recreational use and heritage and these are discussed below.

Public safety

Public safety considerations associated with the Anthony–Pieman hydropower scheme fall into two main categories:

- risks associated with potential dam failure
- public safety issues around Hydro Tasmania's infrastructure (power stations, dams, spillways, tunnels, lakes) and roads (~100 kilometres of roads, including the Pieman Road from Tullah to Reece Dam).

Hydro Tasmania operates a dam safety surveillance program that is continually reviewed in accordance with the Australian National Committee on Large Dams (ANCOLD) Guidelines on Dam Safety Management (2003). Assessment of the potential for dam failure is undertaken through stringent risk assessment procedures to determine the risk position for each dam and the required risk management. Assessment of the Anthony–Pieman hydropower scheme has been undertaken as part of the statewide assessment of Hydro Tasmania's portfolio. Our dam safety approach meets the requirements of Tasmanian dam safety legislation (*Water Management Act 1999* and *Water Management (Safety of Dams) Regulations 2011)* and is consistent with contemporary industry best practice in Australia (ANCOLD 2003).

Hydro Tasmania funded the preparation of a Pieman River Flood Evacuation Plan for the West Coast Council in 2013. This plan fulfils the requirement for a Special Emergency Management Plan under section 35 of the *Emergency Management Act 2006* and applies to a particular risk or emergency associated with either a natural flood or a flood resulting from a dam break within the Pieman River system. The plan was developed in conjunction with the West Coast Emergency Management Committee.

Management of roads within the Anthony-Pieman hydropower scheme includes monitoring and maintaining roads to ensure public safety. Public safety issues around Hydro Tasmania's infrastructure are managed in various ways including signage, barriers and exclusion zones.

Cloud seeding

Community concerns have been raised regarding public health issues associated with cloud seeding and the impact of cloud seeding on rainfall patterns in the eastern section of the Pieman Study Area and nearby townships. In particular, the West Coast Council expressed concerns about adverse impacts of cloud seeding-induced rainfall in the municipality. In response to these community concerns, Hydro Tasmania and the West Coast Council instigated a study of the socio-economic impacts of cloud seeding on the West Coast of Tasmania during 2006–2007. The study concluded that the overall socio-economic impact of cloud seeding was positive for the West Coast, but a number of community concerns remained. These concerns related to public health impacts of chemicals used in cloud seeding, a lack of information on cloud seeding and potential impacts of rainfall.

Hydro Tasmania has taken a number of actions in response to concerns. We have:

- shortened the cloud seeding season to 1 May to 31 October. Previously the cloud seeding season was 1 April to 30 November
- improved communication about cloud seeding flights by reporting in to the local radio station, 7XS, and the council, immediately after a successful flight has been completed, as well as reporting on any non-seeding flights
- provided cloud seeding information on the Hydro Tasmania website, which includes responses to frequently asked questions and a summary of all Tasmanian cloud seeding activities
- regularly updated the Hydro Tasmania website as soon as practicable after a successful cloud seeding flight with details of the flights and the target area.

More recently, a soil and water sampling program was conducted in April and November 2014 at two locations in each of the townships of Queenstown, Rosebery and Zeehan. Water samples were also collected from water bodies or creeks in or near these townships. The samples were tested for acetone and dichlorobenzene as these two chemicals make up over 95 per cent of the cloud seeding solution. Neither chemical was detected in any of the samples.

Did you know?

Information on how cloud seeding works and the Hydro Tasmania cloud seeding program is available on the Hydro Tasmania website: www.hydro.com.au/cloud-seeding

Lake drawdown

Periodically, water levels in lakes need to be lowered (drawn down) to allow access to hydropower infrastructure for maintenance or during periods of drought. Community members using lakes in the Anthony–Pieman hydropower scheme for recreational purposes can be affected during these times. These impacts can be greater during holiday periods when the number of recreational users increases. The storage operating rules and communication plans include management measures to reduce the impact of lake draw-downs and to notify key stakeholders, such as recreational users, of draw-downs ahead of time. These rules include avoiding holiday periods (Christmas to New Year and Easter holidays) for draw-downs where possible. It is not always possible to avoid lake draw-downs on recreational lakes during holiday periods although we make every effort to do so.

Use of Hydro Tasmania land

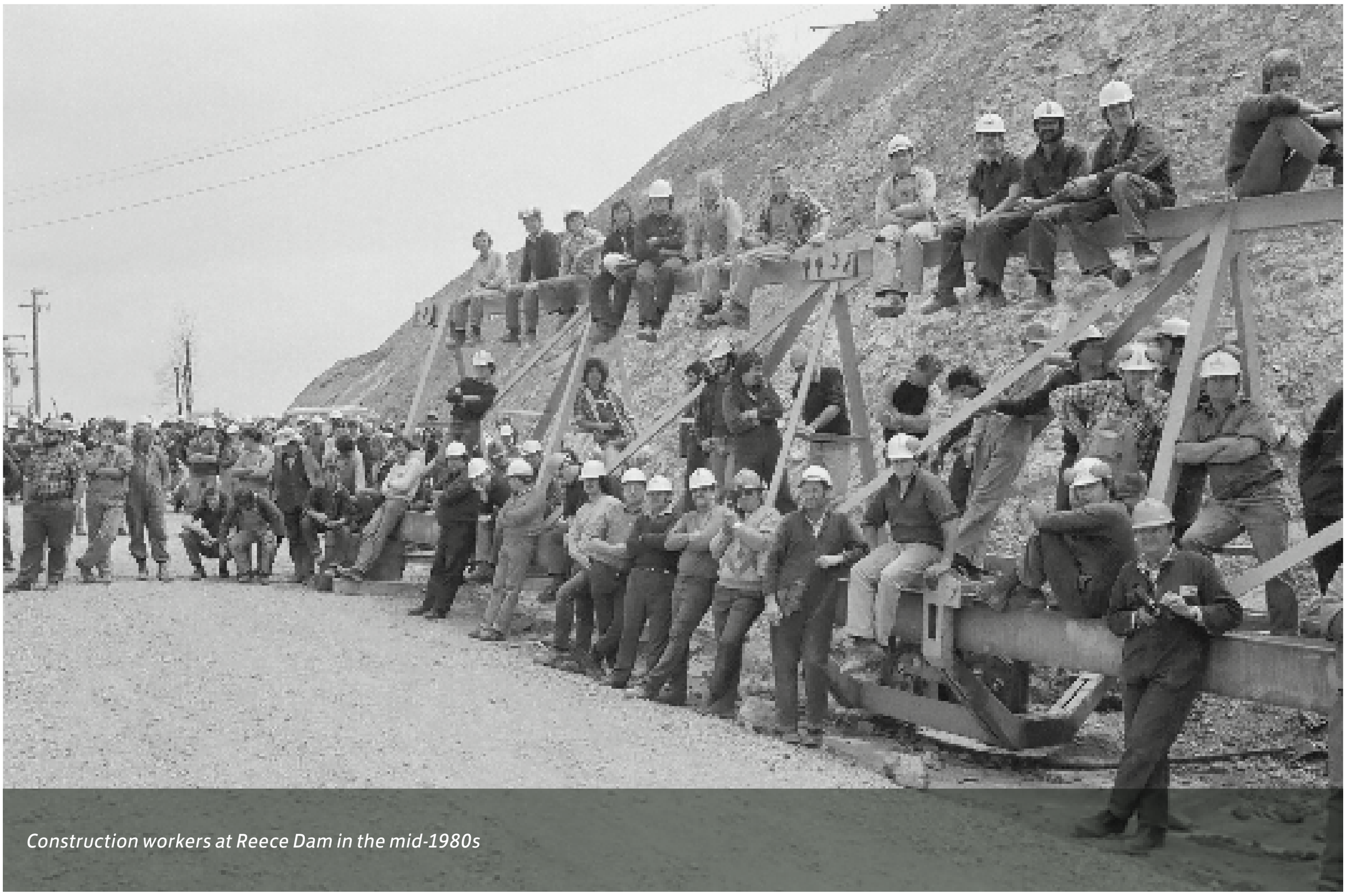
Hydro Tasmania has a licencing system in place for applications to use Hydro Tasmania land for commercial or other purposes. Each application is assessed for impacts to Hydro Tasmania operations, public safety and environmental risks before it is authorised and conditions may apply.

The land adjacent to some Hydro Tasmania lakes in the Anthony–Pieman scheme, in particular Lake Mackintosh, is used for informal camping during holiday periods even though unlicensed camping is not allowed. There is potential for crowding at these informal campgrounds and potential public health issues associated with a lack of sanitation facilities.

Identification and protection of heritage values

Hydropower schemes have the potential to impact on cultural heritage values through damage to cultural heritage sites or values during both development and operation of the schemes. Hydro Tasmania has assessed the heritage value of all our assets against the criteria of the *Historic Cultural Heritage Act 1995* and maintains an inventory of heritage assets. While no sites in the Anthony–Pieman scheme are listed on the Tasmanian Heritage Register, we voluntarily identify and manage historic cultural heritage associated with the scheme through procedures in our Health Safety and Environment System. New works that may have an impact are required to have a heritage management plan in place.

Aboriginal heritage values are identified and managed in consultation with the Tasmanian Aboriginal community and Aboriginal Heritage Tasmania. An Action Plan for Aboriginal Heritage in Hydro Tasmania Catchments was developed in 2013 in collaboration with the Aboriginal community, to guide how Hydro Tasmania manages Aboriginal cultural heritage.



Construction workers at Reece Dam in the mid-1980s

7. Environmental aspects related to Anthony–Pieman hydropower operations

Galaxiid Research using a fyke net

The development and operation of hydropower schemes results in a number of modifications to the natural state of developed river systems. Changes that arise as a result of hydropower schemes may include conversion of river systems to lakes, inundation of land and loss of terrestrial and riverine habitats, changes in water flows and water quality, and barriers to fish migration. Many of these impacts are permanent changes that result from the development of the scheme and others are impacts associated with the operation of the scheme that can be managed in various ways. This section provides an overview of some of the environmental issues and impacts associated with the Anthony–Pieman hydropower scheme. *The Pieman Sustainability Review: Environmental Aspects Fact Sheet* provides more detailed information about biodiversity, pest species, river health and fish and is available on the Hydro Tasmania website.

Biodiversity

Threatened species

Tasmania is known for its biodiversity values; there is a high degree of species endemism and over one third of the land area is protected. There are twenty-three waterway and wetland associated animals and plants within the Pieman Study Area that are listed as rare, vulnerable or endangered under the Tasmanian *Threatened Species Protection Act 1995* (TSP Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Of the eleven listed waterway and wetland associated animals in the Pieman Study Area, four have been recorded within Hydro Tasmania-managed areas (caddis fly, *Oxyethira mienica*; grey goshawk, *Accipiter novaehollandiae*; hydrobiid snail, *Beddomeia bowryensis*; and the Zeehan freshwater snail, *Beddomeia zeehanensis*) and two have been recorded in the Pieman and Henty rivers downstream of Hydro Tasmania storages (Australian grayling, *Prototroctes maraena*; and azure kingfisher, *Alcedo azurea*). Of the twelve threatened waterway and wetland associated plant species recorded in the Pieman Study Area, nine have been recorded from within Hydro Tasmania-managed areas (alpine candles, *Stackhousia pulvinaris*; alpine violet, *Viola cunninghamii*; drooping pine, *Pherosphaera hookeriana*; lichen, *Menegazzia minuta*; liverwort, *Pseudocephalozia paludicola*; longleaf milligania, *Milligania longifolia*; smooth heath, *Epacris glabella*; Tadgells leek-orchid, *Prasophyllum tadgellianum*; and western tridentbush, *Micrantheum serpentinum*).

In addition, there are twenty-three terrestrial animal and plant species within the Pieman Study Area that are listed as rare, vulnerable and endangered. Of these, five animals and seventeen plants have been recorded in Hydro Tasmania-managed areas. Risks to threatened species are evaluated when changes in operations occur and during major maintenance activities. Mitigation measures are put in place as needed.

Terrestrial weeds

There are a number of invasive weeds on the West Coast that have potential to cause large infestations. They are listed under the *Weeds Management Act 1999* and declared Weeds of National Significance.

The spread of weeds by Hydro Tasmania operations may occur as part of construction or land management activities. We use established wash-down procedures for machinery and vehicles, and have established and implemented weed management plans in conjunction with the West Coast Council to reduce the spread of weeds.

Aquatic pests and pathogens

A number of aquatic pests and pathogens have been recorded in the Pieman Study Area from the DPIPWE Natural Values Atlas. Two of these pathogens have the potential to significantly affect native populations of flora and fauna on the West Coast:

- *Root-rot fungus* (*Phytophthora cinnamomi*) In the Pieman Study Area, confirmed records of Phytophthora are scattered throughout the catchment, with larger numbers of observations along the Pieman River, near Savage River and for lakes Pieman and Rosebery. There are also records in the south of the catchment around lakes Plimsoll and Margaret and along the Henty River.
- *Chytrid frog fungus* (*Batrachochytrium dendrobatidis*) Two endemic frog species, the Tasmanian froglet (*Crinia tasmaniensis*) and the Tasmanian tree frog (*Litoria burrowsae*) occur in the Pieman Study Area. The Tasmanian tree frog is known to be highly susceptible to chytrid and the Tasmanian froglet is considered to be potentially at risk from the chytrid fungus which has been recorded from the Pieman Study Area *(Phillips et al. 2010 Tasmanian Chytrid Management Plan, Biodiversity Branch, DPIPWE, Tasmania)*.

Platypus mucor (*Mucor amphiborum*), an ulcerative disease that infects platypus, has been recorded from waterways in north central Tasmania however it is currently not known in the Pieman Study Area (DPIPWE, 2009). It is currently not known how mucormycosis disease affects the abundance or distribution of platypus in Tasmania but there is concern that the disease may spread to other parts of the state.

Hydro Tasmania has wash-down procedures in place to prevent the spread of pests and pathogens.

Galaxiid monitoring

Fish

Thirteen fish species have been recorded for the Pieman Study Area. These include ten native species (including the threatened species Australian grayling, *Prototroctes maraena*) and three introduced angling species. There are a number of hydropower related potential impacts to fish in the Pieman Study Area, these are listed in Table 6.

Did you know?

Diadromous fish are fish that migrate between freshwater and saltwater habitats at different stages in their lifecycle.

Non-diadromous native species remain in fresh water throughout their lifecycle, although they may undertake extensive migrations within river systems to feed and reproduce.

Dams act as a barrier that limits access to upper or lower parts of the catchment for diadromous fish species to complete their lifecycle. For example, dams are a barrier to migration of both adult and juvenile eels. Adult eel passage downstream of dams is generally only possible via spillway flows as survival of eels passing through power station turbines is low. Survival through turbines is influenced by factors such as power station head and turbine type.
The Reece Dam and Reece Power Station is a major barrier for migrating diadromous fish species in the Pieman River. As a result, migrating native fish such as eels, whitebait and Australian grayling are unable to migrate upstream of this structure.

Regulation of river flows as a result of hydro operations can also impact on fish species by altering migration cues (e.g. restricting minor floods and impacts on temperature). Loss of in-stream fish habitats in the Pieman Study Area threatens fish through the loss of woody debris, increased siltation and erosion. Other impacts unrelated to hydro operations may also arise, including potential releases of mining effluent or other contaminants, over-fishing of eels, whitebait and introduced salmonids and predation of native fish by introduced species.

Hydro Tasmania has conducted a number of fish migration projects for native fish species to determine species abundance and migration activities. We have found that eels, lamprey, galaxiid, whitebait and Australian grayling collect at the base of the Reece Dam (mainly galaxiids). We are now collaborating with the Inland Fisheries Service to investigate the feasibility of facilitating fish migration over Reece Dam. To date, the project has involved a trial trapping program during the migration season at the diversion tunnel and tailrace. We have observed and caught eels, lampreys, galaxiids and Australian grayling. We intend to survey upstream sites to determine population abundances in Lakes Pieman and Plimsoll (including assessing whether there are any self-sustaining populations of galaxiids), and downstream between Corinna and Stringers Creek.


Galaxiid monitoring

Elver migration at Lake Trevallyn: a case study

Hydro Tasmania has been tackling the elver migration issue at Lake Trevallyn since 1996. The Trevallyn elver ladder provides safe passage for elvers over Trevallyn Dam.

The current elver ladder and automated trap, completed in 2009, has proven to be highly successful. It was built at the eastern abutment of the dam to utilise the internal drainage channels and runs up the side of the stairwell rising 30 metres through the dam wall, making it the highest operational ladder in the southern hemisphere.

The ladder is very efficient at facilitating the migration of elvers past Trevallyn Dam and is effective throughout the season, handling periods of low and high migrations without mortalities.

The elvers climb up the ladder and are automatically transferred into waters to continue their journey throughout the South Esk catchment where they can mature.


Trevallyn Dam with the elver entry ramp shown at the bottom right corner

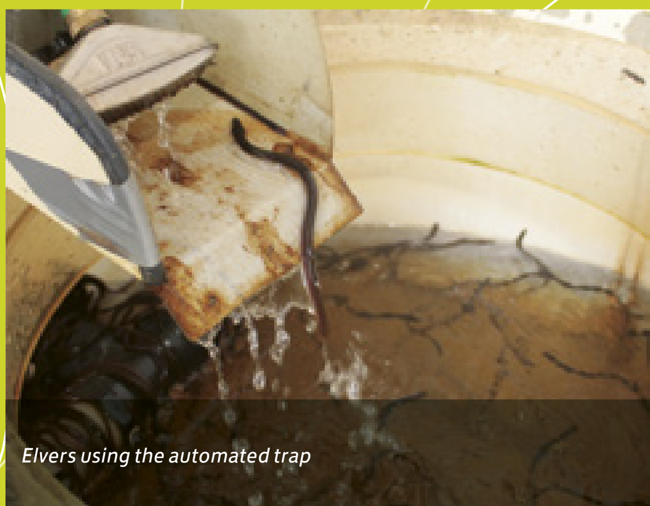

Elvers using the automated trap

Table 6: Threats to native and introduced angling fish species in the Pieman Study Area

Common name	Threats
Diadromous fish species including: • Australian grayling • climbing galaxias • jollytail • sandy/ freshwater flathead • southern short finned eel • Tasmanian mudfish • Tasmanian smelt • Tasmanian whitebait • trout galaxias	In-stream barriers prevent migration and dispersal; and loss of access to salt water interferes with lifecycles River regulation, including suppression of minor flooding and elevated temperatures during low flows, altering migration cues Loss of riparian and in-stream habitat resulting from: stream channel damage from sand and gravel extraction, including stream siltation from erosion; channelisation; drainage of large areas of swamps and wetlands; and loss of dry weather flow Predation by introduced species, particularly salmonids Contaminants entering the waterway Over-fishing (eels, whitebait) Mining effluent (metals, acid drainage)
Non-diadromous native fish species: • blackfish	Loss of in-stream habitat, particularly woody debris Habitat fragmentation River regulation, through increased water flows and reduced water temperatures during spawning season Extensive stream siltation from erosion Predation by introduced species, particularly salmonids Contaminants entering the waterway Mining effluent (metals, acid drainage)
Non-diadromous introduced angling species: • brook trout • brown trout • rainbow trout	Loss of in-stream habitat Erosion leading to increased sedimentation smothering spawning habitat Low flows prior to juveniles emerging from gravel nests Over-fishing

(Source: Natural Values Atlas at www.naturalvaluesatlas.tas.gov.au)

Water quality

Influences on water quality

The Anthony-Pieman hydropower scheme has modified the natural state of the waterways in the catchment by creating lakes and modifying the natural flow of rivers. These changes have a number of influences on water quality. The natural regional water has a very low salt content and low pH (acidic) with a relatively high level of dissolved organic carbon. This accounts for the characteristic brown colour of the water, often referred to as 'tannin stained'. Turbidity in the waterways is low due to naturally low sediment inputs.

Hydropower operations have the potential to affect water quality while water is stored in lakes or passes through a power station. In the Pieman Study Area, there are several processes related to hydropower that can affect water quality, including:

- thermal stratification during summer (separation of warm and cold layers of water), which limits mixing between surface and sub-surface water and leads to low oxygen levels in colder waters at the bottom of lakes. This can affect the quality of water discharged from the lake
- gas bubble disease, which results from the over-saturation of water with air as it passes through a power station and can cause fish kill events below power stations.

Other activities in the catchment, unrelated to hydropower operations, can also affect water quality:

- Mining operations may discharge storm water and treated process water into lakes and rivers in the Pieman Study Area. Active or historic mine sites are located within the catchments of Lake Anthony, Lake Mackintosh, Lake Rosebery, Lake Pieman and the Pieman River downstream of Reece Dam. Most sites are near Lake Mackintosh and Lake Pieman.
- Forestry operations may increase runoff from harvested sites.


Macroinvertebrate sampling

- Treated waste water from Rosebery, Tullah and Cradle Mountain discharges into the Pieman Study Area.
- Municipal, roadway and railroad runoff accumulates in the lakes and rivers of the Pieman Study Area.

Thermal stratification

Thermal stratification of storage lakes (layering of water of different temperatures) is a regular occurrence in the Pieman Study Area. All storages in the catchment, with the exception of Lake Henty, have recorded a degree of thermal stratification and low oxygen levels at the bottom of the lakes. Surface waters in the hydropower storages have also recorded low levels of oxygen, with the exception of Lake Plimsoll.

In stratified lakes, cooler water with low dissolved oxygen levels can be released from power stations into downstream river reaches and has the potential to impact the downstream ecosystem. The risk of this occurring is related to the depth of power station intake relative to the depth of the water column. This risk is considered relatively low in the Anthony-Pieman hydropower scheme because all of the power stations have relatively high level intakes. In addition, downstream of the lowest power station, Reece, there is a series of rapids which promotes aeration of water.

The layering can also control the way inflowing tributary waters mix (or do not mix) with the lake water. In Lake Pieman there is evidence that inflowing tributary water can persist as a separate layer over periods of months and distances of kilometres. Preventing mixing of inflows could minimise the dilution of any metals or other contaminants transported into the lake with the inflows.

Gas bubble disease

A fish kill event related to gas bubble disease occurred in 1990 downstream of Reece Dam. Since that time, management measures have been implemented to reduce gas-saturated water being released from Reece Dam. Measures include maintaining clean trash racks to prevent the agitation of water as it passes through trapped debris entering the power station and minimising air injection during power generation. Since 1990 there has been no re-occurrence of gas bubble disease below Reece Dam.

Nutrients

Nutrient concentrations in many of the lakes in the Pieman Study Area exceed the ANZECC (2000) water quality triggers, which are water quality guidelines set for different water uses . Nutrient load is likely to be natural because there are few land and water uses that contribute to nutrient loads. The consistently low levels of chlorophyll in all of the lakes indicate that the high nutrient levels do not translate into high levels of algal growth, and do not present a water quality risk at present concentrations. Nutrient concentrations are elevated in all storages with the exception of Lake Newton and White Spur Pond.

Metals

Based on water quality monitoring in lakes in the Pieman Study Area it appears that the inflows to some lakes contain elevated concentrations of metals. Elevated metal concentrations are found in all storages throughout the Anthony-Pieman hydropower scheme due to past and present mining activities.

The Pieman River Environmental Monitoring Program investigated water quality and the health of aquatic systems in the Pieman Study Area in 1990–1992. It was the first study of its kind in the state, involving collaboration between Hydro Tasmania, mining companies, the then Department of Environment and Planning and the Zeehan Commission (local municipality). The study found that, while heavy


Lake Macintosh

metal concentrations were high within Lake Pieman, dissolved organic compounds in the water could bind metals thus reducing their biological availability. This hypothesis was supported by metal analysis of brown trout flesh where all metal concentrations were found to be substantially lower than national guidelines.

Further information on water quality

A summary of water quality data for the Anthony-Pieman hydropower scheme is available in the *Pieman Sustainability Review: Water Quality Fact Sheet* on the Hydro Tasmania website.

Environmental flows

Aquatic ecosystems can be impacted below power stations because of changes to river flows resulting from power station operation, including periods with no flow. Some river reaches in the Anthony scheme occasionally have no water flow below diversion weirs and dams, while the Pieman River below Reece Dam occasionally receives flows greater than what would have occurred naturally. No flow or low flow periods below power stations also occur during outages and some maintenance activities. Altered flow patterns can impact on aquatic ecosystems and downstream water quality.

Preliminary river health assessments have been conducted for six downstream river reaches immediately below the dam sites in the Anthony-Pieman hydropower scheme (2013/14). They indicate that macroinvertebrate population composition and structure are impaired, with the degree of impact varying seasonally as measured against similar sites. River health improved markedly downstream in the Henty River approximately 12 kilometres below Henty Dam. The river health in the Henty River at the Zeehan Highway has been consistently equivalent to, or better than, reference sites, most likely due to tributary inflows downstream of dams. Further assessments will improve understanding of the ecological health of the downstream impacted river reaches.

There are no specific environmental flow rules in the Anthony–Pieman hydropower scheme.

Did you know?

Hydro Tasmania is Australia’s largest generator of renewable energy & the nation’s largest water manager.

8. Next steps

Reece diversion tunnel

This report has been produced as an information resource on the Anthony–Pieman hydropower scheme and to provide a basis for stakeholder comments and feedback. In addition to this report, more detailed information is provided about the Pieman Sustainability Review on Hydro Tasmania's website, including detailed fact sheets on a number of technical and environmental topics discussed in this report and current information on the progress of the Review.

It is important for Hydro Tasmania to receive feedback from the community on our activities in the Anthony–Pieman hydropower scheme as part of the Pieman Sustainability Review. All interested groups and individuals are invited to provide comments and feedback to Hydro Tasmania by completing a survey. Please see the section below on how to become involved.

The results of the survey will be collated and follow-up consultation will be conducted to inform Stage 3 of the Pieman Sustainability Review. Stage 3 will involve studies that seek to better understand the issues and opportunities raised by the community and to evaluate the feasibility of measures to address these issues. Measures that will be adopted to improve practices in the scheme will be confirmed at the conclusion of Stage 4 of the Pieman Sustainability Review.

The Review process will conclude by the end of December 2016. Information on progress will be available on the Hydro Tasmania website. Visit **www.hydro.com.au/pieman-sustainability-review**

How to become involved

We want to hear from communities, groups and individuals that live in, or have interests in, the Pieman Study Area and the Anthony–Pieman hydropower scheme.

Get involved in the Review process by:

- contacting the Pieman Sustainability Review team using the contact details below
- providing comments and feedback by completing a Pieman Sustainability Review Stakeholder Survey. You can access this on our website and we will post a copy to all residents in the Pieman Catchment Area. Copies of the survey will also be available at Carols on Main (Zeehan), Rosebery Bakehouse and Tullah Village Cafe and Post Office.

We will keep you up to date during the Review process through advertising locally on the West Coast, and through the Hydro Tasmania website. Visit **www.hydro.com.au/pieman-sustainability-review**

Contact details:

Pieman Sustainability Review team

Post: GPO Box 355, Hobart, Tasmania 7001, Australia

Email: contactus@hydro.com.au

Call: 1300 360 441
(Local call cost Australia-wide)

facebook.com/HydroTasmania

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Glossary

Anthony- Pieman hydropower scheme	The scheme refers to all components and resources (such as storages, rivers, dams, tunnels and hydropower stations) used for the purpose of hydropower generation in the Pieman Study Area
Concrete gravity dam	Concrete gravity dams rely on their own weight to hold back water
Concrete-faced rockfill dam	Locally available, good quality rock material is transported and compacted using heavy machinery. The dam is waterproofed using a thin layer of concrete on the upstream face
Diversion storage	Diversion storages do not have power stations; instead they function to divert water from rivers to the dams that do have power stations, through artificial water courses such as canals
Drawdown	Lowering lake levels
Embankment dam	Embankment dams rely on a large mass of rock, gravels, earth or clay to hold back the water. Concrete, bitumen or clay is used to waterproof the face of the dam
Flow duration curve	The flow duration curve is a plot that shows the percentage of time that flow in a stream is likely to equal or exceed some specified value of interest
Fluvial geomorphology	The study of a river's landscape shape, geology and dynamics
Francis turbine	Francis turbines consist of vertically arranged curved metal blades. Water under very high to moderately high pressure flows down through the blades and makes the turbine spin
Generating capacity (MW)	The total possible electrical output of a power station
Headwater storage	Headwater storages are the lakes that have the highest proportion of storage in a catchment. The water in these storages is of high value as it can be released through multiple lakes and therefore be run through multiple power stations
Levee	An elongated embankment
Macroinvertebrates	Invertebrate animals that are visible to the naked eye
Pieman Study Area	The Pieman Study Area includes the hydro-electric water districts of the Pieman and Henty, as declared under the *Water Management Act 1999*
Run-of-river storage	Run-of-river storages are storages that have limited storage capacity
Saddle dam	A saddle dam is an auxiliary dam constructed to confine the water body created by a primary dam, either to permit a higher water elevation and storage or to limit the extent of a reservoir for increased efficiency. It is constructed in a low spot or 'saddle' through which the water would otherwise escape
Thermal stratification	Layering of water with warm, oxygen-rich water near the surface and cold, oxygen-depleted water at the bottom of a lake or river

Acronyms

ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian and New Zealand guidelines for fresh and marine water quality
BOM	Bureau of Meteorology
DPIPWE	Department of Primary Industry, Parks, Water and Environment
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FSL	Full supply level
GBE	Government Business Enterprise
GBE Act	*Government Business Enterprises Act 1995*
GL	Gigalitres (1 000 000 000 litres)
GWh	Gigawatt hours, a measure of energy produced
IFS	Inland Fisheries Service
MAST	Marine and Safety Tasmania
MW	Megawatt
NMOL	Normal minimum operating level
PEV	Protected environmental value
TSP Act	*Threatened Species Protection Act 1995*

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