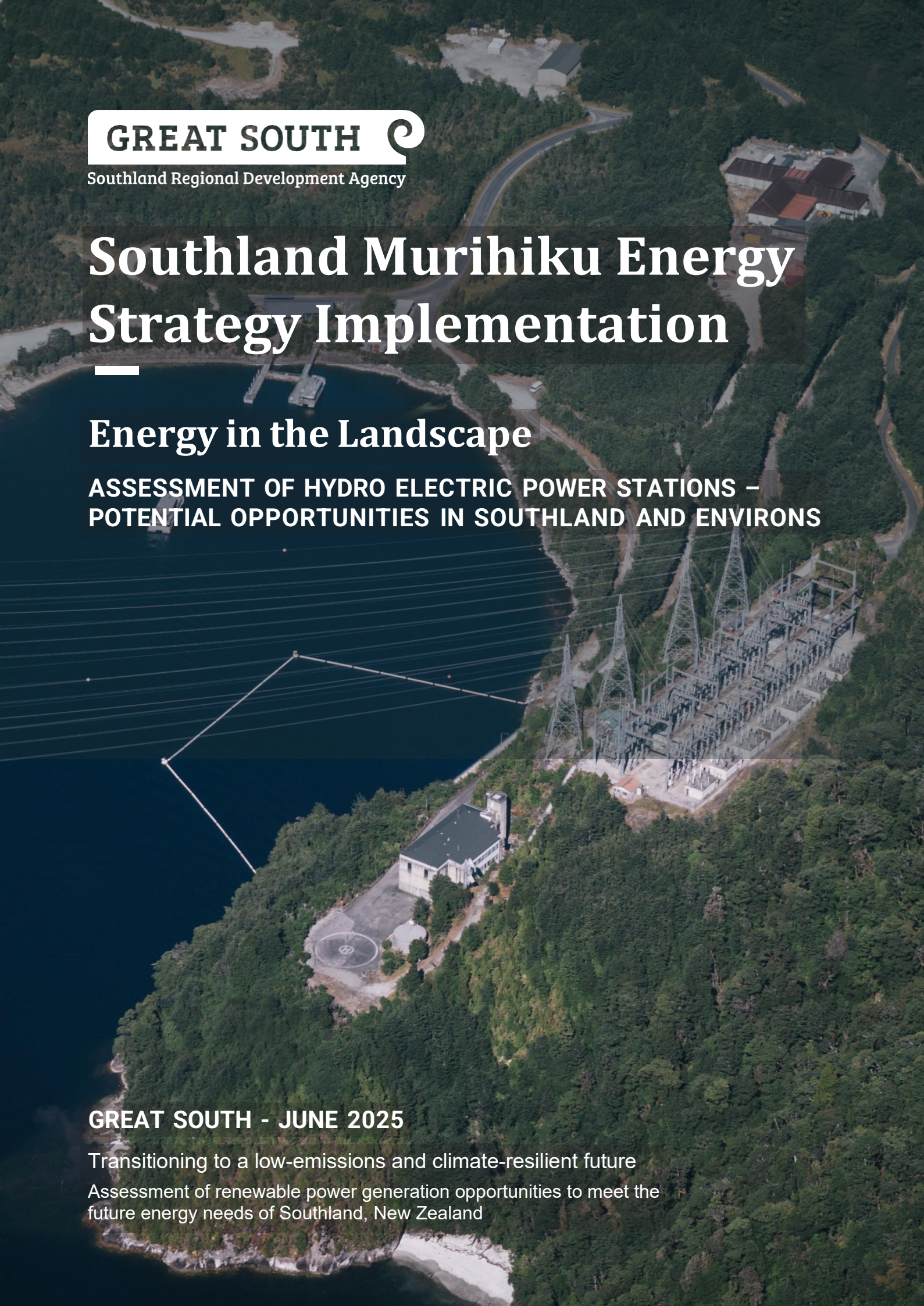
GREAT SOUTH

Southland Regional Development Agency

Southland Murihiku Energy Strategy Implementation

Energy in the Landscape

ASSESSMENT OF HYDRO ELECTRIC POWER STATIONS – POTENTIAL OPPORTUNITIES IN SOUTHLAND AND ENVIRONS



GREAT SOUTH - JUNE 2025

Transitioning to a low-emissions and climate-resilient future

Assessment of renewable power generation opportunities to meet the future energy needs of Southland, New Zealand

REPORT TITLE

Assessment of Hydro Electric Power Stations – Potential Opportunities in Southland and Environs.

REPORT VERSION

2

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PROJECT TEAM

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Abbreviations

Term	Definition
DEM	Digital Elevation Model
GIS	Geograhic Information Systems
LiDAR	Light Detection and Ranging
mamsl	Height (metres) above mean sea level
MBIE	The Ministry of Business, Innovation and Employment

Glossary

Term	Definition
Geological unit	A geological unit is a rock or ice volume of known origin and age based on the geological time scale.
Hydraulic head	Hydraulic head or piezometric head is a specific measurement of liquid pressure above a vertical datum.
Lithology	Description of its physical characteristics visible at outcrop, in hand or core samples, or with low magnification microscopy. Physical characteristics include colour, texture, grain size, and composition.
Topography	Study of the forms and features of land surfaces.

Introduction

The Southland region wants to significantly reduce emissions by effective use of renewable energy. The demand for energy requires a fresh approach to identifying new electricity generation opportunities.

The ‘Energy in the Landscape’ series of reports identifies locations within Southland and Otago with sufficient natural energy potential to stimulate new energy generation investment in wind power, solar power and hydroelectric power.

This report is the third of three volumes for the Energy in the Landscape project. It identifies a group of ten potential locations with sufficient water resources in Southland and environs. Potential locations are determined by a geomorphological analyst and other relevant information. In addition, this investigation considers an updated assessment of potential small-scale embedded hydro electricity generation in New Zealand presented in 2020 by The Ministry of Business, Innovation and Employment (MBIE) .

The report describes the areas within Southern New Zealand with sufficient water resources, however it does not explore the amount of potential energy that each site could deliver nor the detailed geotechnical and hydraulic characteristics of the soils.

This study is a high-level report aimed at identifying potential hydroelectric sites in Southland and Otago environs and hasn't considered impacts on infrastructure, liquefaction, land use, and residential dwellings. Therefore, this report should be used as background information for the preliminary selection of potential locations. Feasibility and expected generation of potential dams will be the responsibility of the interested parties.

1. Methodology

To identify the locations with potential for hydroelectric power in Southland and Otago environs, the following factors were considered and assessed.

1.1 DATA SOURCES

Digital elevation model (DEM)

A DEM for Southland was considered in the water assessment. The DEM used is an amalgamation of a few different datasets compiled by Great South with a spatial resolution of 1 metre. The layer is derived from available Regional LiDAR, groundwater bore collar heights, geodetic vertical marks, and protected survey marks.

Geology

A geology map of New Zealand from 'the quarter million mapping (Qmap) programme' by GNS (The institute of Geological and Nuclear Sciences Limited) was acquired and considered. The Qmap project consists of 21 geological maps at 1:250,000 scale that cover all New Zealand. For the area of interest, the Murihiku (2003) and Wakatipu (2000) maps were used.

MBIE report

The Embedded Hydro Generation Opportunities in New Zealand report made by MBIE (2020)[3] was undertaken to determine whether previous studies had identified new potential hydro generation opportunities.

1.2 POTENTIAL LOCATION SELECTION CRITERIA

This report considered topography as the main factor to identify and select the potential sites. This factor was interpreted using GIS tools. The locations were named after nearby toponyms.

MBIE report

Some of the locations proposed by MBIE report were considered in this study.

Topography

It is acquired from the Southland and Otago DEM. Topography plays an important role in water resources: v-Valley zones with steeply sloping sides are desirable.

Geology

One of the key considerations in designing a dam is its geological suitability to withstand water pressure, dead load of the dam structure, etc. Suitable foundations must be available. In this report, geology is not a ruling out criterion, but it is considered an important factor to be mentioned.

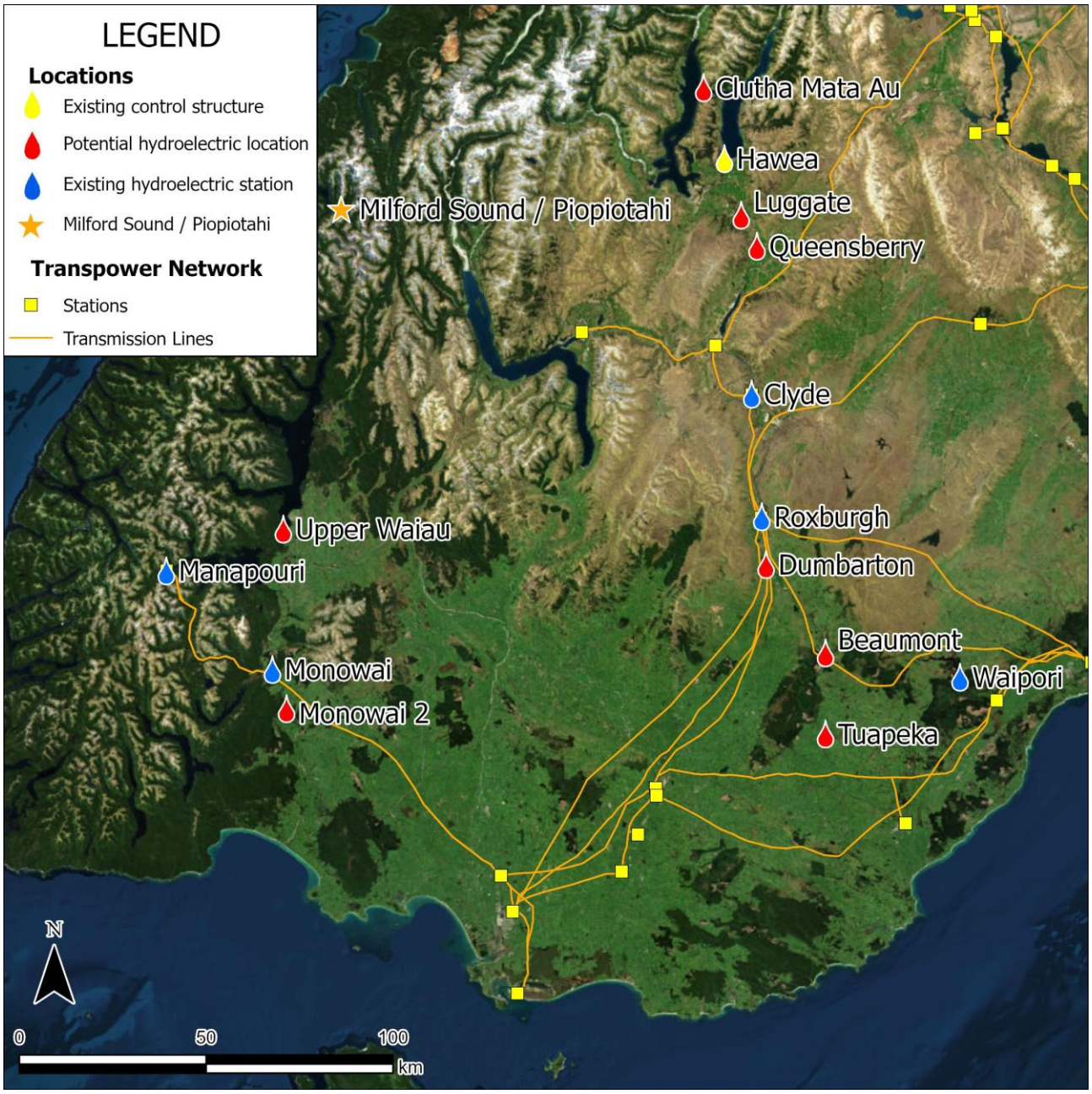
[2]https://www.gns.cri.nz/data-and-resources/qmap-geological-maps-at-1250000/

[3] MBIE. Embedded Hydro Generation Opportunities in New Zealand. 2020

2. Results

A total of ten locations have been identified with hydroelectric generation potential. Figure 1 shows the geographical location and name of each new proposed dam site, control structures and some special cases. The map also shows five existing dams: Manapouri, Monowai, Clyde, Roxburgh and Waipori.

Figure 1: General locations



3. Existing control structures

One existing control structure was identified as an option to generate power. The following section provides some information about this site.

3.1 HAWEA

The Hawea site is located in the upper Clutha area of Otago at the southwestern extremity of Lake Hawea and immediately adjacent to Hawea township. The lake was naturally dammed 10,000 years ago by an ancient terminal moraine, and was artificially raised 20 metres in 1958 by the construction of a 390 m long earth embankment dam that averages 30 m in height.

This existing control facility at the outflow from Lake Hawea to the Hawea River makes this site a leading potential candidate for a hydroelectric station. The dam would need to be modified to accommodate turbines. Additional generation in the upper Clutha area would create much needed power resilience and redundancy into the local area power networks. The ability to augment existing structures and to utilise an established storage dam minimises the potential for environmental damage and would likely have greater acceptance in the community.

Currently, Lake Hawea is the ninth largest lake in New Zealand, with an area of 141 km² and up to 392 metres deep. Geology identified in this location is Late Quaternary glacial outwash deposits of muddy to sandy gravel.

Figure 2: Hawea location

4. Potential Hydro Electric Station locations

The following sections provide more detailed information for each new potential location. For the purposes of this report the consentability of the potential sites has not been explored and it would be expected that consenting and all other Resource Management Act requirements form part of the detailed design, cultural, environmental and feasibility study for advancing individual projects. All the suggested sites have previously been identified as potential hydro electricity generation sites and are cited in The Embedded Hydro Generation Opportunities in New Zealand report made by MBIE4 2020

4.1 CLUTHA RIVER SYSTEM

4.1.1 Lake Hāwea–Wānaka Scheme (The Neck)

This potential hydroelectric scheme is located at The Neck, the narrow landform separating Lake Hāwea and Lake Wānaka within the Clutha River system. The concept involves transferring water from Lake Hāwea to Lake Wānaka to utilise the natural elevation difference of approximately 50–65 m, with Lake Hāwea at the higher elevation. The scheme would generally require lake level control and a short tunnel connection to convey flow between the lakes, enabling power generation near the lower reservoir. Historical engineering assessments indicate a tunnel length of approximately 1.4 km, with the total conveyance system extending to around 2 km across The Neck, including associated canal and pipeline
sections. The Hāwea–Wānaka scheme has been identified in historical studies as a potentially viable site due to favourable topographic conditions and the close proximity of the two lakes. Figure 3 shows the location of the site, clearly showing the minimal separation between the two lake systems at their closest point.

Figure 3: Lake Hāwea-Wānaka location.

[4]MBIE. Embedded Hydro Generation Opportunities in New Zealand. 2020

4.1.2 Luggate

This potential dam site is located on the Clutha River about 2 km east of Luggate township. The geology identified in this location is Quaternary muddy to sandy gravel. Figure 4 shows the location, Figure 5 presents the section profile of this site and Table 1 contains the section attributes. The Luggate site has been a focus of interest over many years.

Figure 4: Luggate location.

Figure 5: Luggate cross section

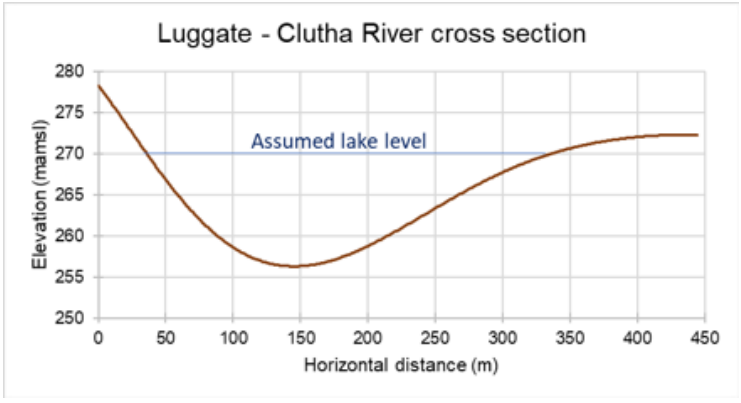


Table 1: Luggate - Section attributes.

Attributes	
River invert (mamsl)	258
Assumed lake level (mamsl)	270
Hydraulic head (m)	12
Cross-section length (m)	444
Geological unit	Late Quaternary glacial outwash deposits
Lithology	Muddy to sandy gravel.

4.1.3 Queensberry

The Queensberry site is located on the Clutha River about 13 km downstream from Luggate. The geology here is Quaternary muddy to sandy gravel. Figure 6 shows the location of the site and Figure 7 its profile, and Table 2 contains the section attributes.

Figure 6: Queensberry location.

Figure 7: Queensberry cross section

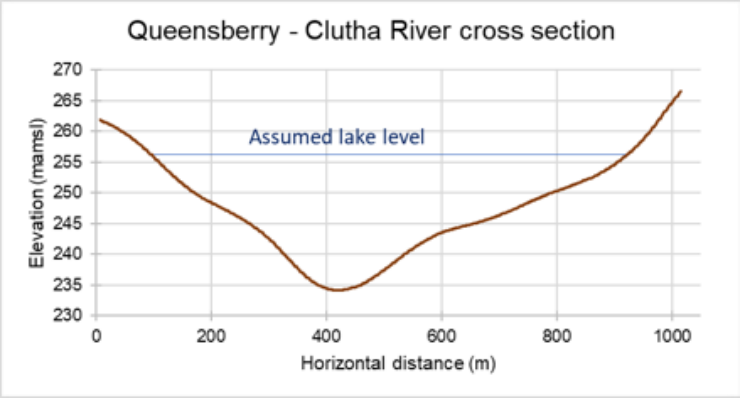


Table 2: Queensberry - Section attributes.

Attributes	
River invert (mamsl)	235
Assumed lake level (mamsl)	256
Hydraulic head (m)	21
Cross-section length (m)	1015
Geological unit	Late Quaternary glacial outwash deposits
Lithology	Muddy to sandy gravel.

4.1.4 Dumbarton

Dumbarton site is located on the Clutha River, ~5 km south of Roxburgh township. The geology identified in this location is Caples Group TZIII schist, compound of Schistose (TZIII) volcaniclastic sandstone, quaternary compound of muddy to sandy gravel. Figure 8 shows the location of this site, Figure 9 its profile, and Table 3 contains the section attributes.

Figure 8: Dumbarton location.

Figure 9: Dumbarton cross section

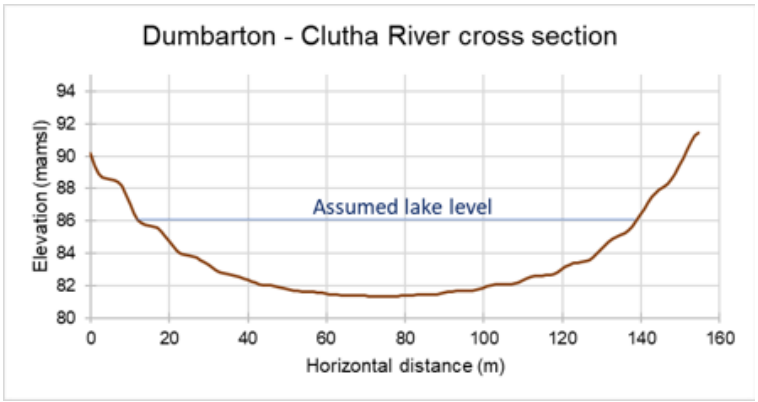


Table 3: Dumbarton- Section attributes.

Attributes	
River invert (mamsl)	81
Assumed lake level (mamsl)	86 (up to 90)
Hydraulic head (m)	5
Cross-section length (m)	155
Geological unit	Late Quaternary alluvium and colluvium
Lithology	Unconsolidated to poorly consolidated mud, sand, gravel and peat of alluvial and colluvial origin.

4.1.5 Beaumont

Located 1.5 km upstream from the bridge over the Clutha River at Beaumont. Geology identified in this location is Late Quaternary glacial outwash deposits of muddy to sandy gravel. Figure 10 shows the location of this site, Figure 11 its profile, and Table 4 contains the section attributes.

Figure 10: Beaumont location.

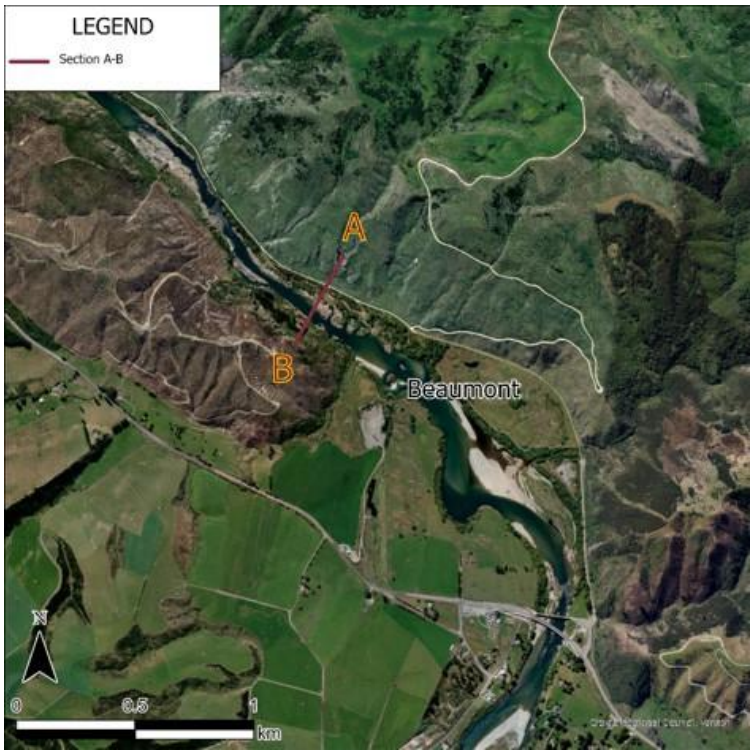


Figure 11: Beaumont cross section

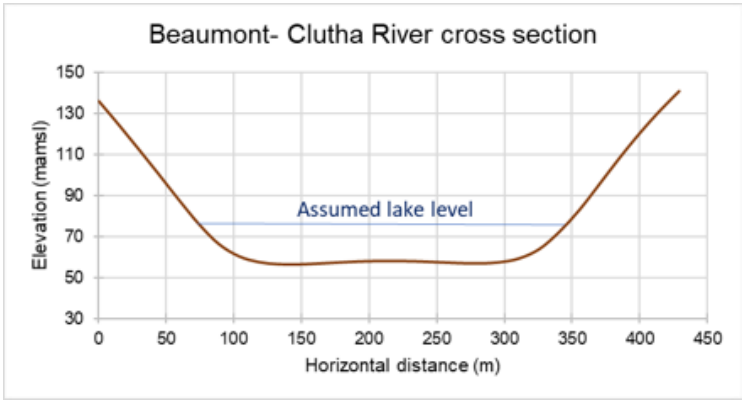


Table 4: Beaumont- Section attributes.

Attributes	
River invert (mamsl)	55
Assumed lake level (mamsl)	75
Hydraulic head (m)	20
Cross-section length (m)	429
Geological unit	Late Quaternary glacial outwash deposits
Lithology	Muddy to sandy gravel.

4.1.6 Tuapeka

A dam located on the Clutha River just over 1 km North of Tuapeka. Geology identified in this location is Late Quaternary till deposits, compound of Pebbly to bouldery gravel, sand, silt and mud. Figure 12 shows the location of this site, Figure 13 its profile, and Table 5 contains the section attributes.

Figure 12: Tuapeka location.

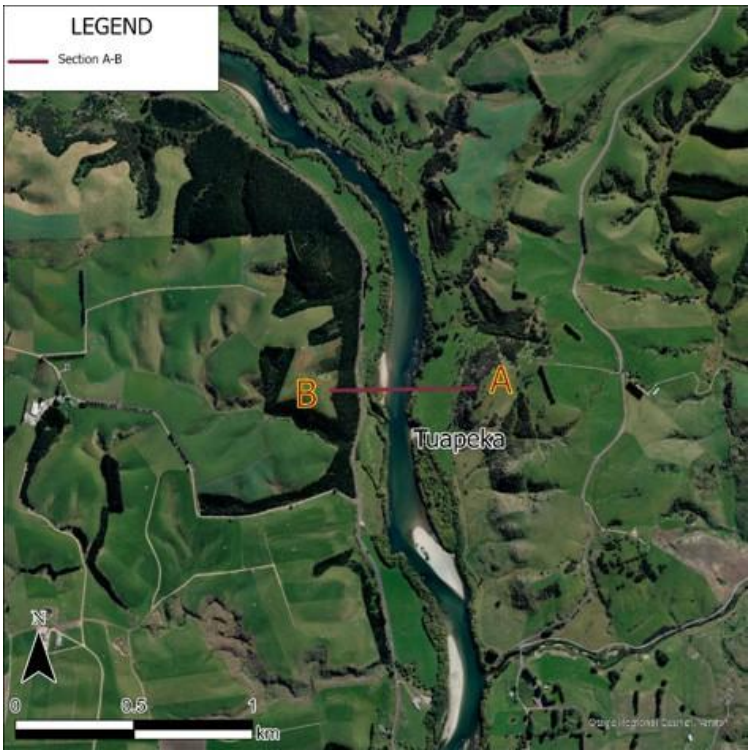


Figure 13: Tuapeka cross section

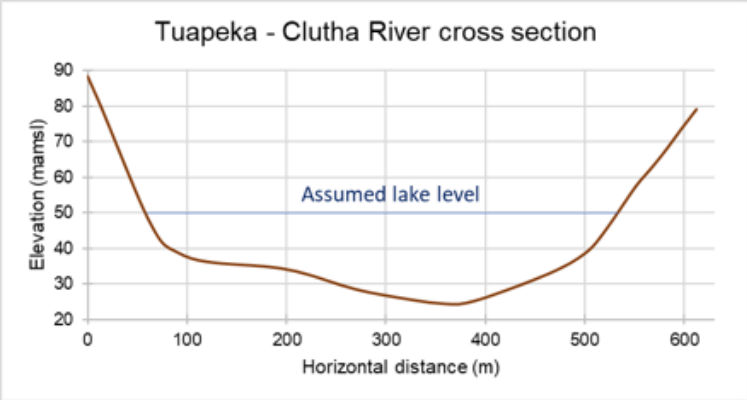


Table 5: Tuapeka- Section attributes.

Attributes	
River invert (mamsl)	25
Assumed lake level (mamsl)	50
Hydraulic head (m)	25
Cross-section length (m)	613
Geological unit	lQt, Late Quaternary till deposits
Lithology	Pebbly to bouldery gravel, sand, silt and mud.

4.2 WAIAU RIVER SYSTEM

4.2.1 Upper Waiau

Situated on the Waiau River between Lakes Manapouri adjacent to the discharge from Lake Te Anau. Geology identified in this location is Late Quaternary till deposits of pebbly to bouldery gravel, sand, silt and mud.

Figure 14: Upper Waiau location.

This site is challenging because any generation potential would have to truly operate as run-of-river generation. Te Anau lake levels are tightly controlled and increasing the head at this site would not be practical. Figure 14 shows the location of this site and Table 6 contains the section attributes.

Table 6: Upper Waiau- Section attributes.

Attributes	
River invert (mamsl)	213.5
Assumed lake level (mamsl)	215
Hydraulic head (m)	1.5
Geological unit	Late Quaternary till deposits
Lithology	Pebbly to bouldery gravel, sand, silt and mud.

4.2.2 Monowai 2

Located on the Waiau River, this new proposed site is named Monowai 2 to distinguish it from the existing Monowai Power Station, which is located on the west bank, some distance upstream. Geology identified in this location is Late Quaternary alluvium and colluvium, consisting of unconsolidated to poorly consolidated mud, sand, gravel and peat. Figure 15 shows the location of this site, Figure 16 its profile, and Table 7 contains the section attributes.

It should be noted that there has over many years been controversy over the tension between providing sufficient water to the Manapouri Power Station and the need to maintain minimum river flows on the lower Waiau River. This being the case, advancing the Monowai 2 option may be fraught with some difficulty.

Figure 15: Monwai 2 location.

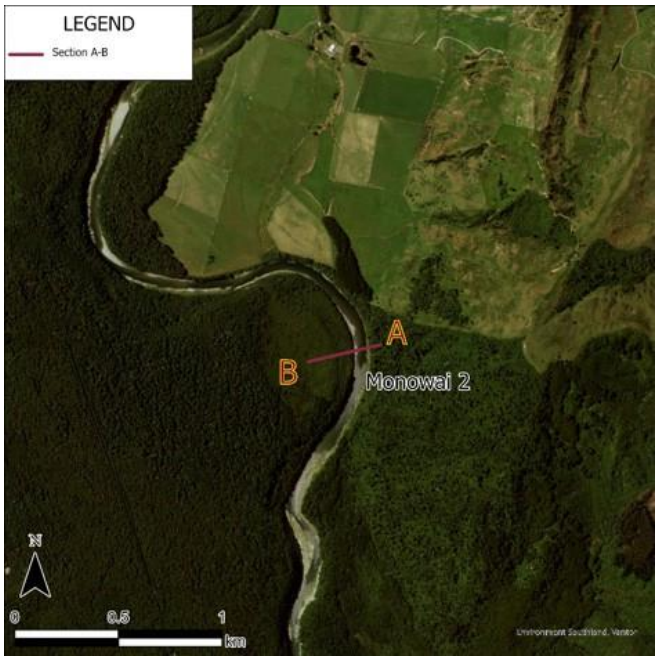


Figure 16: Monowai 2 cross section

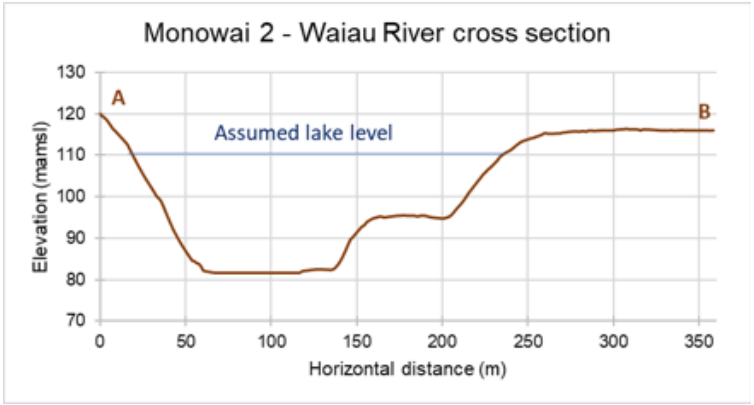


Table 7: Monowai 2 - Section attributes.

Attributes	
River invert (mamsl)	81
Assumed lake level (mamsl)	110
Hydraulic head (m)	29
Cross-section length (m)	358
Geological unit	Late Quaternary alluvium and colluvium
Lithology	Unconsolidated to poorly consolidated mud, sand, gravel and peat of alluvial and colluvial origin.

5. Special mention

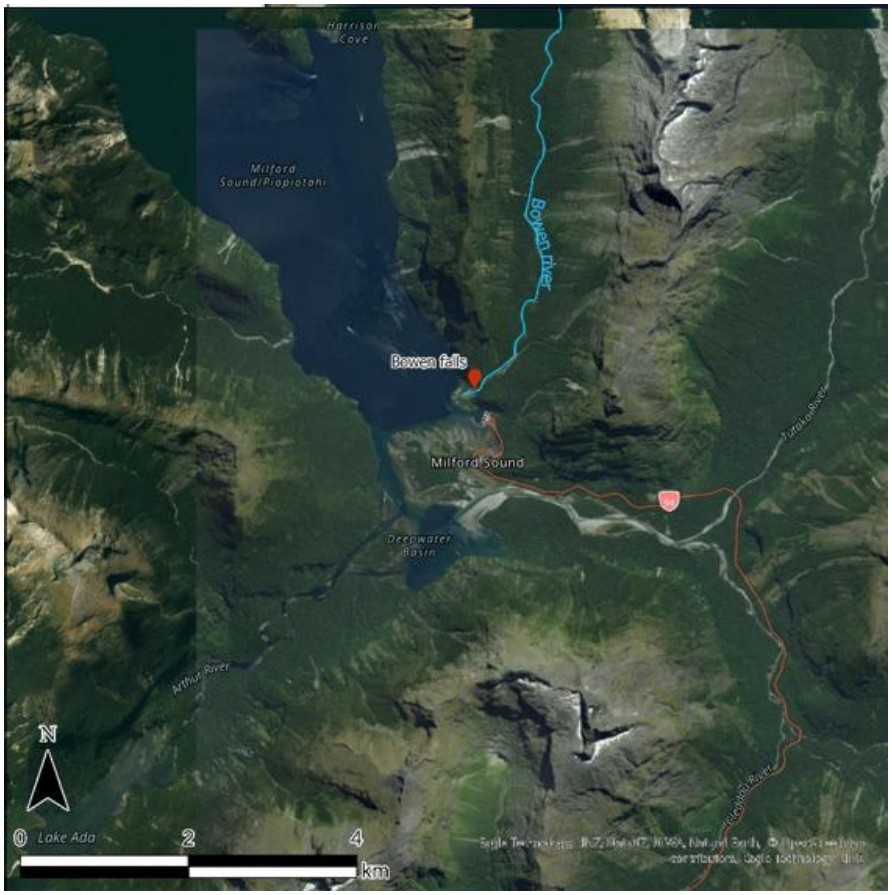
This section provides a location with special conditions that should be considered carefully due to controversial social and environmental issues and conflicts.

5.1.1 Milford Sound / Piopiotahi

Milford Sound's electricity system is privately owned and operated. Electricity is generated at Milford from hydroelectric and diesel sources. The mean annual rainfall in Milford Sound is 6,813mm, and it rains there on average 182 days a year. Over the course of 24 hours, 250mm of rain can fall in the area. Despite the high average annual rainfall the existing hydropower system often experiences periods of very low flow in the Bowen River, where the hydro intake is situated. The low flow events restrict peak generation requiring active load management and greater use of diesel generators to meet energy demands. Often low flows in the Bowen River coincide with peak load on the network, which typically occurs during the October to April period.

The increase in demand for decarbonization of transport and electricity generation as well as visitor expectations, would suggest that significant efforts should be made to plan a robust pathway for renewable energy generation to meet existing and future demands at Milford Sound, taking account of climate change sea level impacts.

Figure 17: Milford Sound location



This report doesn't investigate specific options as this work needs to be a collaborative exercise with the current infrastructure operators, local stakeholders and should be considered as part of the Government funded Milford Opportunities program which is charged with investigating the future planning and investment pathway for Milford Sound.

Summary

- Topography plays an important role in water resources. v-Valley zones with steeply sloping sides are desirable.
- The assessment of potential small scale embedded hydro electricity generation in New Zealand made in 2020 by The Ministry of Business, Innovation and Employment (MBIE), was considered in this report.
- A total of ten points were identified with water energy potential, with one of them being an existing control structure. The next table summarises the relevant information about each proposed location.

Table 8: Monowai 2 - Section attributes.

EXISTING CONTROL STRUCTURES	
Location	**Description**
Hawea	Existing control structure with a hydraulic head of up to 30m. The earth embankment would need to accommodate turbines and generate energy. The actual lake size and hydraulic head make this site the leading potential candidate for a hydroelectric station.

POTENTIAL HYDRO ELECTRIC STATIONS						
Location	**River System**	**River invert (MAMSL)**	**Assumed lake level (MAMSL)**	**Hydraulic head (m)**	**Cross-section length (m)**	**Geological unit**
Luggate	Clutha	258	270	12	444	Late Quaternary glacial outwash deposits
Queensberry	Clutha	235	256	21	1015	Late Quaternary glacial outwash deposits
Dumbarton	Clutha	81	86	5	155	Schistose (TZIII) volcaniclastic sandstone and Late Quaternary glacial outwash deposits
Beaumont	Clutha	55	75	20	429	Late Quaternary glacial outwash deposits
Tuapeka	Clutha	25	50	25	613	Late Quaternary till deposits
Upper Waiau	Waiau	213.5	215	1.5	-	Late Quaternary till deposits
		The discharge site from Lake Te Anau to the Waiau river has potential for a special hydro generation. This challenging site would have to work as run-of-river generation with a hydraulic head of up to 1.5m. Environmental and social aspects, along with the pres-ence of the settlement of Te Anau, limits the capability for a higher hydraulic head.				
Monowai 2	Waiau	81	110	29	358	Late Quaternary alluvium and colluvium

SPECIAL MENTION	
Location	**Consideration**
Lake Hāwea–Wānaka Scheme (The Neck)	Short conveyance across The Neck between adjacent lakes, with a hydraulic head of approxi-mately 50–65 m, as Lake Hāwea is higher than Lake Wānaka. Historical assessments indicate a tunnel length of around 1.4 km within a total conveyance of approximately 2 km, offering strong generation potential with required tunnelling and lake level control.
Milford Sound / Piopiotahi	The increased demand for decarbonization implies that Milford Sound requires a robust path-way for renewable energy generation. This means reducing the use of diesel generators which currently supplement hydroelectric generation from the Bowen River. A collaborative exercise is required to investigate the future planning and investment pathway for Milford Sound.

Limitations

- This report is limited to identifying areas with potential water resources based on geomorphology. It does not analyse specific performance of each of the structures, geotechnical, environmental factors or social impacts of the proposal. It is recognised however that some of the locations such as Milford Sound and Upper Waiau have known social and environmental impact limitations. This is also true of many of the potential sites on the Clutha River. All these factors would need to form a vital part of individual development opportunities.
- Other factors such as soil type and climate change are not directly considered in this report.
- Geology was mentioned briefly in this report, but as it is an important consideration, more research is required for a later stage of development along with its geotechnical and hydraulic characteristics.
- The hydraulic head of each site is an approximation as the potential lake may be higher or lower.
- Land use and infrastructure inundation haven't been considered in this investigation.
- The financial viability of each one of these projects has not been considered.

Recommendations

- Locations of interest would require detailed analysis and comprehensive evaluation and consultation.
- The need to advance immediate investigations of renewable energy opportunities would appear to be a priority.
- The development of new generation at Lake Hawea would appear to be the most viable generation option and Contact Energy should be encouraged to look seriously at this option.
- Iwi consultation, cultural and environmental impacts of individual projects are critically important considerations as are the community and wider social license aspect of individual projects.
- Where projects are to be considered it is important that these potential developments are contemplated and woven into the individual Territorial Local Authority's spatial plans, Long Term Plans and RMA planning processes.

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