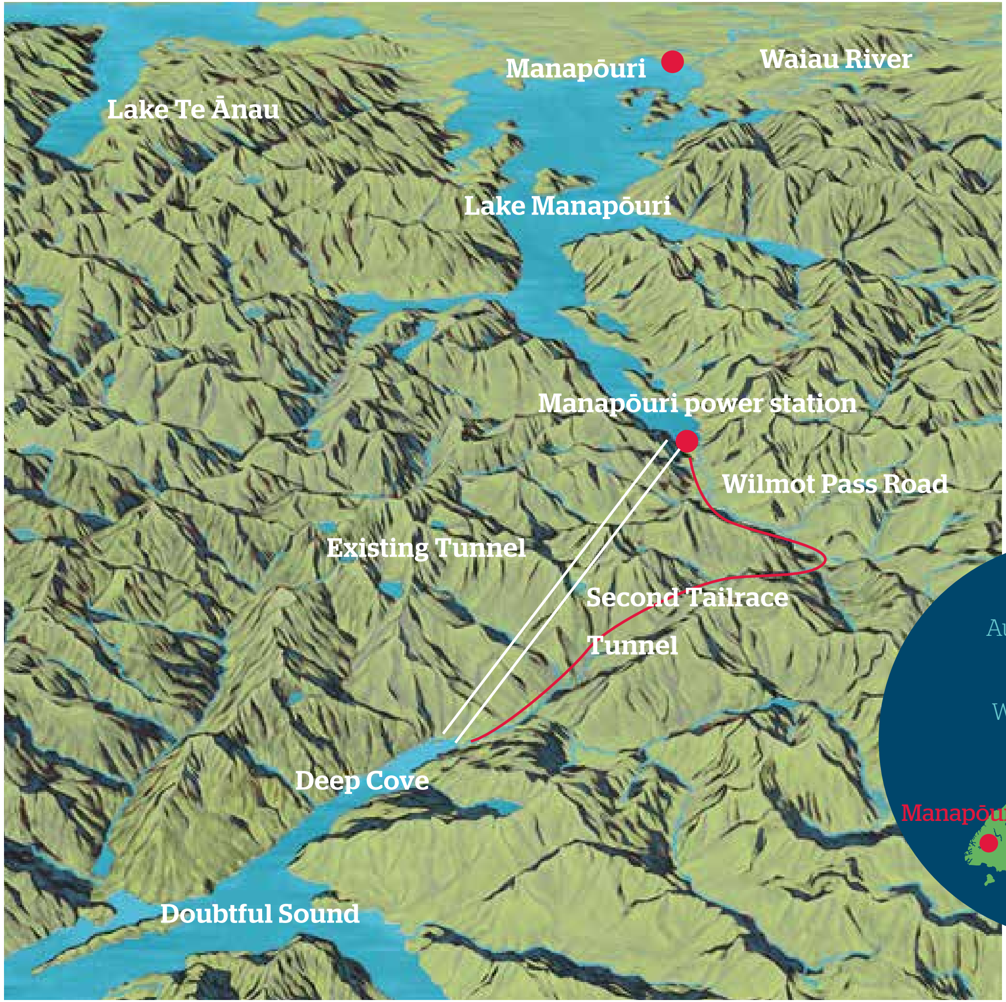
Discover

Manapōuri

meridian



Facts and figures of interest

Turbines

- Revolutions per minute: 250
- Diameter of runner (turbine): 3.2 metres
- Vertical Francis built by General Electric Canada International Inc
- Weight: 16 tonnes

Generators

- Made by Siemens Aktiengesellschaft, Germany
- Rated voltage: 13,800 volts
- Weight of rotating generator parts: 284 tonnes
- Rated output: 135MVA

Transformers

- Made by Savigliano, Italy
- Rated voltage: 13.8kV to 220kV
- Overall weight: 133 tonnes
- Continuous rating: 135MVA

Did you know?

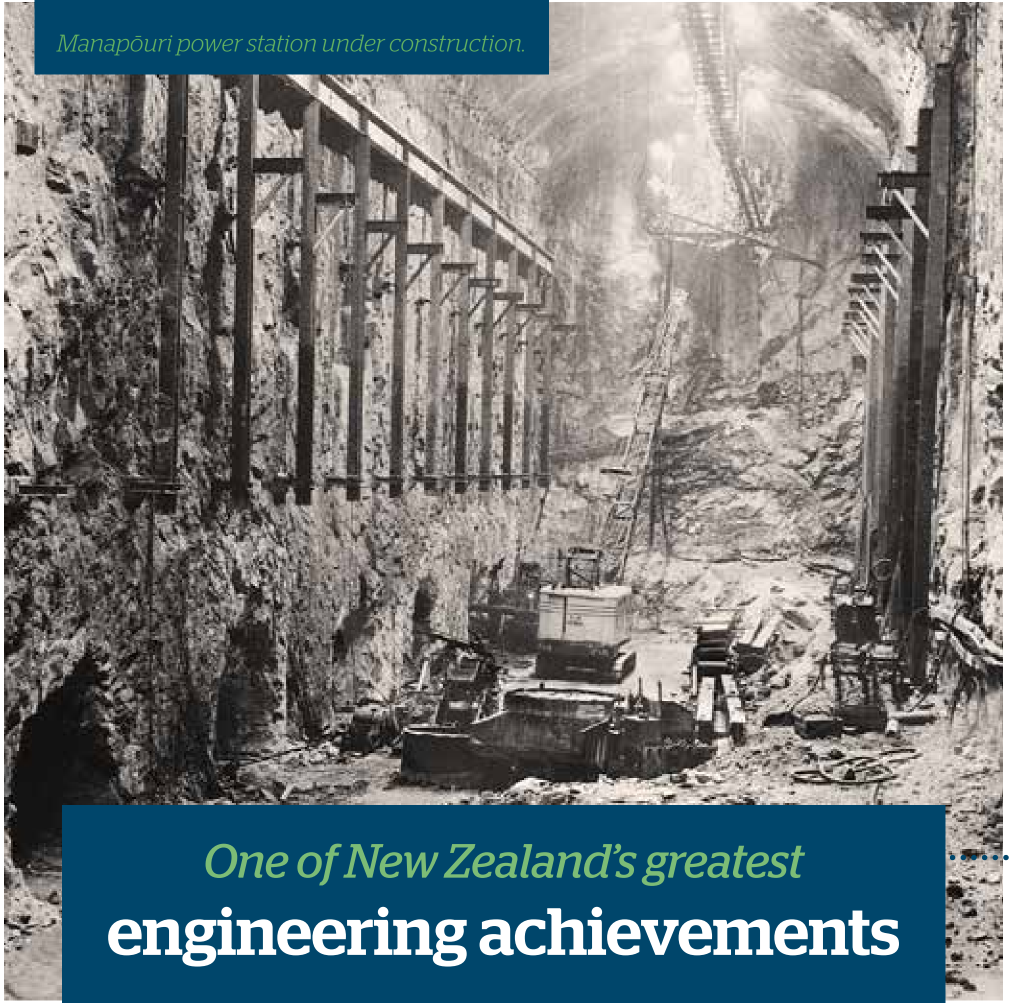
The most recent sizeable earthquake, of 7.1 on the Richter scale, occurred on 23 August 2003 at 12.12 (am). No one was in the station at the time. It caused minor damage in the local towns but no damage to the station.

Manapōuri is the largest hydro power station in New Zealand, and one of the most efficient in the world. It is located on the edge of Lake Manapōuri's West Arm in Fiordland National Park. Manapōuri is an underground power station, with its generating units housed in a cavern excavated from rock 200 metres below the surface of Lake Manapōuri.

Did you know?

The tailrace tunnels are 10 kilometres long and 10 metres in diameter (they are 75 metres apart). The first tunnel was built by the 'drill and blast' methods. It has been concrete lined to leave a smooth surface. The second tunnel was built using a tunnel-boring machine and the majority of the tunnel is not lined.

Deep Cove



Manapōuri power station under construction.

One of New Zealand's greatest engineering achievements

The original construction of Manapōuri hydro power station was a huge engineering achievement.

The idea of building a power station at Lake Manapōuri was first suggested in 1904 by Mr P S Hay of the Public Works Department. But the remoteness of the location and the scale of the engineering task – drilling an outfall tunnel through 10 kilometres of Fiordland mountain – meant the project was shelved until the 1960s.

The idea was revived in the late 1950s when Consolidated Zinc Pty of Australia set up a company called Comalco to build an aluminium smelter at Bluff. The proposal was to use power generated from Lake Manapōuri. However, they had difficulty financing both projects, and in 1963 the New Zealand Government took over the building of the power station, while Comalco built the smelter.

In 1964, work began on the tunnel that would link Lake Manapōuri to the sea.

The project took 1,800 workers eight years to complete in extremely harsh conditions. The project involved constructing the power station in an underground cavern, building several access and service tunnels and excavating the 10-kilometre tailrace tunnel, which takes the water that flows out of the station into Deep Cove in Doubtful Sound. All this was completed using 'drill and blast' excavation methods to carve through the hard Fiordland rock.

The first power was generated in September 1969 and the station was fully commissioned in 1972.

Did you know?

The road tunnel is two kilometres long and nine metres wide. It was built to fit the largest piece of machinery needed for the construction. Trucks had to back down the tunnel when delivering machine parts, which sometimes took up to seven hours.

It was hard and **dangerous work**

The workers put in many long, arduous hours underground. Water pouring in from the excavation face had to be pumped out continuously as they bored holes for explosives in the rock face with massive pneumatic drills. They carefully placed the explosives in darkness after the electric lighting was switched off for safety, then retreated for the blast.

It was dangerous work. Tragically, 16 men were killed either underground or in the construction of the road over Wilmot Pass, which links the West Arm of Lake Manapōuri with Deep Cove, Doubtful Sound. The names of those killed are recorded on a memorial plaque in the power station they helped to carve from the rock.

Some of the workers were housed on board the ship *Wanganella*, which was moored in Deep Cove, Doubtful Sound from 1963 until 1970. During the 1930s the ship had been the top trans-Tasman passenger liner, with accommodation for 304 first-class passengers. For the Manapōuri project she offered the construction workers more modest conditions.

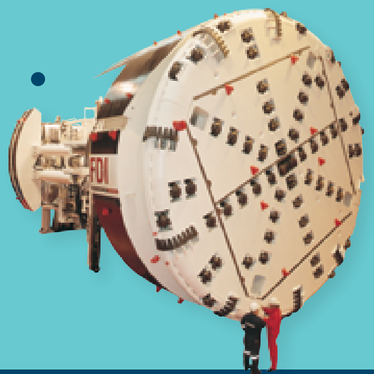
1968: Justice Minister Ralph Hanan fires the last shot in the first tunnel, which was packed with too much dynamite.

Did you know?

In the years since the first tunnel was built, tunnelling technology has taken massive leaps forward. Gone are the days of drilling and blasting – the second tailrace tunnel was drilled with a mammoth 25-metre-long tunnel-boring machine.

1965 – West Arm supervisors.

Soon after the power station began generating electricity in 1972, it became apparent that it wasn't able to generate at the peak levels as originally planned.



The need for a **second tailrace tunnel**

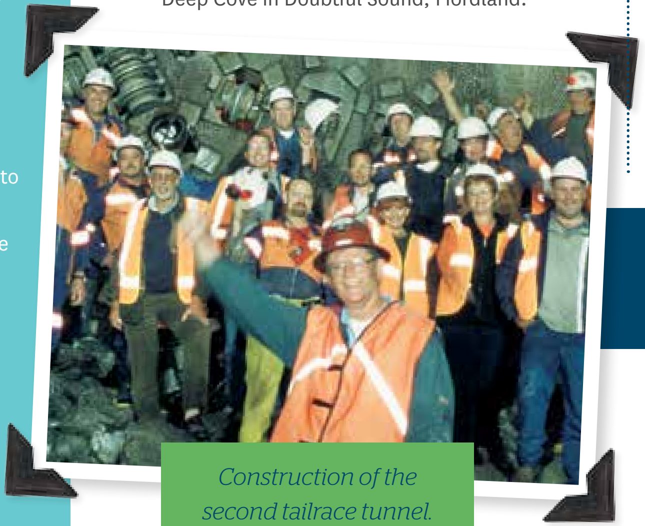
Greater-than-anticipated friction between the water and the walls of the tailrace tunnel meant that the water couldn't escape from the station fast enough and resulted in a loss of hydraulic head. The head is the distance the water falls down to the station and it determines the potential energy that can be extracted from the water. The hydraulic head should have been 178 metres, but was only 148 metres.

This meant that the station could not achieve its planned peak generating capacity of 800MW until 2002.

The station could only be safely operated at a peak capacity of 585MW. Many options to increase capacity were considered, but were dismissed because they required the station to be closed down for long periods of time, and the losses in generation would have made the change uneconomic.

In 1993, engineers investigated building a second tunnel parallel to the existing tunnel using a new tunnel-boring machine. The two tunnels would allow the water to flow away much more quickly, increasing the hydraulic head and therefore productivity. This option required only a short station shutdown.

In May 2002, the first water passed through the second tailrace tunnel at Manapōuri – channelling the water out of the station and into Deep Cove in Doubtful Sound, Fiordland.



Construction of the second tailrace tunnel.

This milestone marked the end of a significant project using state-of-the-art equipment to tunnel 10 kilometres underground through dense Fiordland rock. Manapōuri power station already had one tailrace tunnel and the second tunnel significantly improved the station's productivity. The increased output, generated from the same amount of water passing through the station, provided enough power for 64,000 more homes.

The project was successfully carried out in a World Heritage Area, where preservation of the unique and fragile environment is of paramount concern. Meridian's commitment to the highest environmental standards made the project a finalist in the Financial Times Global Energy Awards.

Did you know?

Manapōuri is a remote-controlled station.

Manapōuri

– the birthplace of our environmental awareness

Located in Fiordland National Park, Manapōuri power station is regarded as the birthplace of New Zealand's environmental consciousness.

The original plans for the power station were developed in the 1960s and involved raising Lake Manapōuri by up to 30 metres. But Lake Manapōuri's famed wooded islands would have disappeared, and the fragile shoreline beech forest would have been left to rot in the water.

An increasing number of New Zealanders realised the extent of the environmental impacts, and protest became widespread and passionate.

In 1972, the Government confirmed that the lake level would not be raised and in February 1973 it created the Guardians of Lakes Manapōuri, Monowai and Te Ānau to oversee the management of the lake levels.

Prime Minister John Marshall, met by protesters in Te Ānau, July 1972.

Meridian's continuing commitment

to working with the environment

In 1984, Fiordland National Park was designated a World Heritage Area, and Meridian's responsibility to preserve this spectacular, unique environment is taken very seriously.

In 1996, minimum flows were restored to the lower Waiau River to help restore the river's important environmental and recreational values. Meridian carries out extensive monitoring to track the recovery of these values and works with a range of stakeholders, including:

Guardians of Lakes Manapōuri, Monowai and Te Ānau, Waiau Working Party, Te Waiau Mahika Kai Trust, Waiau Fisheries and Wildlife Habitat Enhancement Trust, Department of Conservation, and Fish and Game Southland.

The Waiau River habitat restoration work of the Waiau Fisheries and Wildlife Habitat Enhancement Trust was recognised nationally with a Ministry for the Environment Green Ribbon Award in 2012.

Did you know?

The power station was built here because of the volume of water it has access to and its proximity to sea level. Annual mean rainfall: Manapōuri: one metre, West Arm: three metres, Deep Cove: eight metres.

Replanting Deep Cove

More than one million cubic metres of rock excavated from the second tailrace tunnel was deposited near the tunnel exit in Deep Cove and shaped to fit the natural contours of the land. Then it was replanted with more than 235,000 native plants, which had been propagated from seeds sourced from the same local area within the National Park.

The rock's ability to absorb the sun's warmth, combined with the high Fiordland rainfall, has produced phenomenal new growth, and native weka have already started to return to the area to breed.

Eel trap and transfer scheme

Did you know that an eel's instinct to travel upstream is so strong it can climb straight up a concrete wall? However, even the most determined young eels (known as elver) can find it tough going scaling a dam. And once they're on the dam, they face other dangers, such as predatory seagulls, which delight in snatching up the elver. Meridian traps these elver on their journey up the river and transfers them safely into the lakes to grow and mature.

Once they become 'migratory' (mature and ready to breed) the eels begin their return journeys to the sea by heading downstream. Meridian has a programme to capture these migratory eels and transfer them to below the lower Mararoa Lake Control structure, allowing them to migrate back downstream to the sea and their breeding grounds beyond. Some of these eels can be up to 80 years old and weigh between 4 and 10 kilograms.

Interesting facts about Manapōuri

The building

The machine hall

- 111 metres long, 18 metres wide
- Total height from penstock gallery to top: 39 metres
- Corrugated ceiling to rock above: 2.7 metres.

Machine hall floor

- 7.9 metres above sea level
- Machine hall floor to corrugated ceiling: 13.4 metres
- The blue machines that are visible on the machine hall floor (in the photo on the left) are exciters. The exciter stimulates the rotor of the main generator below it to produce electricity. By controlling the output of the exciter, we can control the output of the main generator.

Below the machine hall floor is the stator floor

- 3.7 metres above sea level
- On the stator floor are the generators, which each provide 121.5MW of electricity
- The transformers weigh 133 tonnes each. Once the voltage of the electricity has been stepped up in the transformer, it goes into the cables and up the cable shaft to the switchyard
- There is one cable shaft for each generator. The cable shafts are three metres in diameter and over 240 metres high.

Did you know?

The electrical cables running from the turbines to the switchyard are 263 metres long. They weigh 23 kilograms per metre and almost eight tonnes per cable (there are 22 tonnes of cable in each cable shaft).

Below the stator floor is the turbine floor

- 0.3 metres below sea level
- This is where the turbine shaft spins at 250 revolutions per minute. At the bottom of the turbine is a structure like a large snail shell, where the water comes in from the penstocks to drive the turbine. Above the turbine shaft is the generator.

Below the turbine floor is the penstock gallery

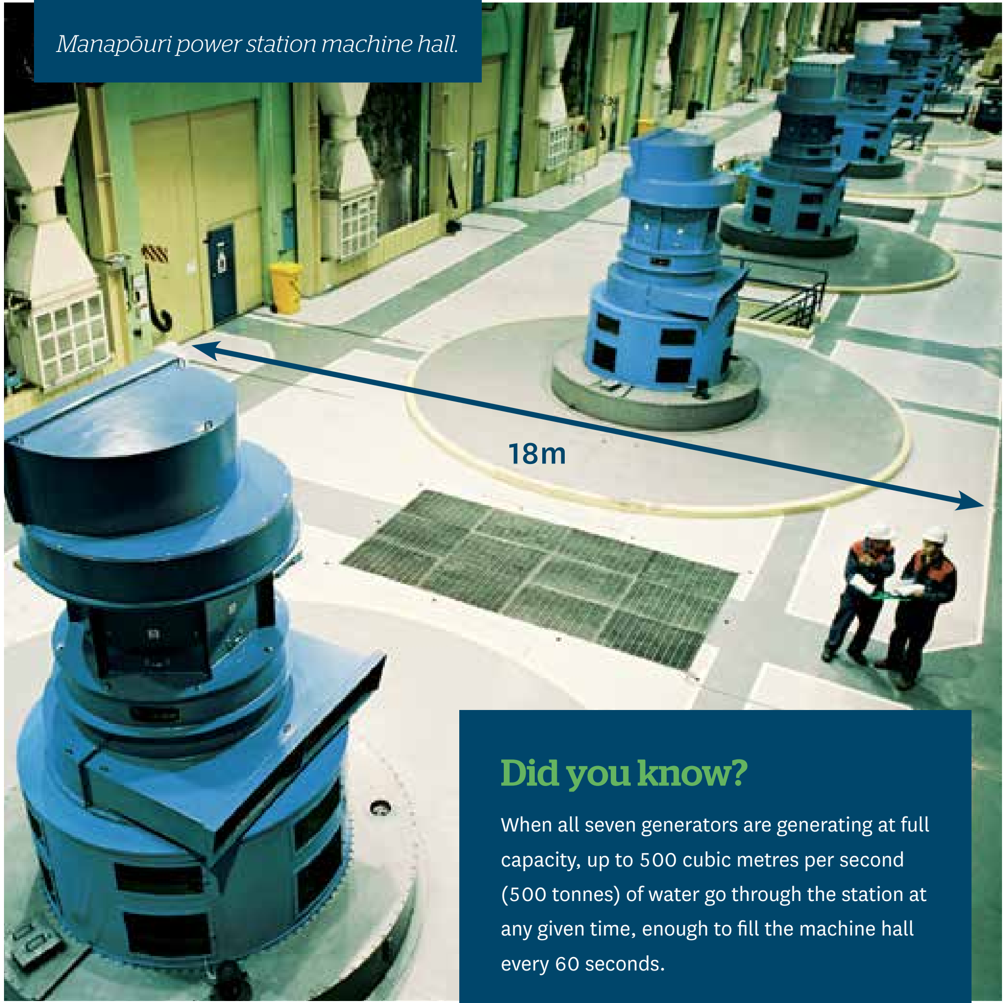
- 6.7 metres below sea level
- On this floor you are actually below the large penstocks that carry the water into the turbines. Water goes through the turbines at a combined rate of approximately 500 cubic metres per second (500 tonnes per second). Below the penstock level are the draft tubes where the water leaves each of the machines to exit the station via the manifold and tailrace tunnels, flowing out to Doubtful Sound.

The two tailrace tunnels – how they work

The first tailrace is a horse-shoe-shaped tunnel, nine metres in diameter. It leaves the powerhouse at near sea level and descends to 40 metres below sea level, rising again to discharge into Deep Cove nine metres below sea level. The second tailrace was constructed parallel to the existing one. It does not allow more water to flow through the station, but rather allows it to flow more efficiently (like blowing through two straws instead of one). Before the second tailrace was built, the station could produce no more than 585MW. Now that all the turbines have been refurbished they are able to produce well over 730MW.

Did you know?

The Wilmot Pass road took two years to build and cost approximately $80 per square metre.



Manapōuri power station machine hall.

Did you know?

When all seven generators are generating at full capacity, up to 500 cubic metres per second (500 tonnes) of water go through the station at any given time, enough to fill the machine hall every 60 seconds.

The tears of the two sisters

Lake Manapōuri, according to Māori legend, was formed from the tears of two sisters, Motorau and Korowae, daughters of an old chief in the region.

The name is a combination of two possible names – Manawapouri (manawa, heart; pouri, sorrowful) or Manawapopore (manawa, heart; popore, sobbing) – and is usually translated as 'Lake of the Sorrowing Heart' or 'Lake of the Throbbing Heart'.

The lake's original name is believed to have been Roto-ua (Rainy Lake). The name later became Moturau (Many Islands).

The lake's present name was given to it by mistake – an early settler is said to have called it by the name of one of the Mavora Lakes, which lie between Lake Te Ānau and Wakatipu.

Manapōuri's European discovery was in 1852, by the explorers Charles J Nairn and W H Stevens. However, except for occasional forays by trampers and explorers, the lake was rarely visited and its treasure lay ignored for many years.

Wilmot Pass

Māori legend tells how the demi-god Tuterakiwhanoa carved the present-day Fiordland landscape using his 'ko' to dig out the steep-sided valleys and mountains. Ancient mountain building forces followed by long periods of glaciation created the fiords we see today.

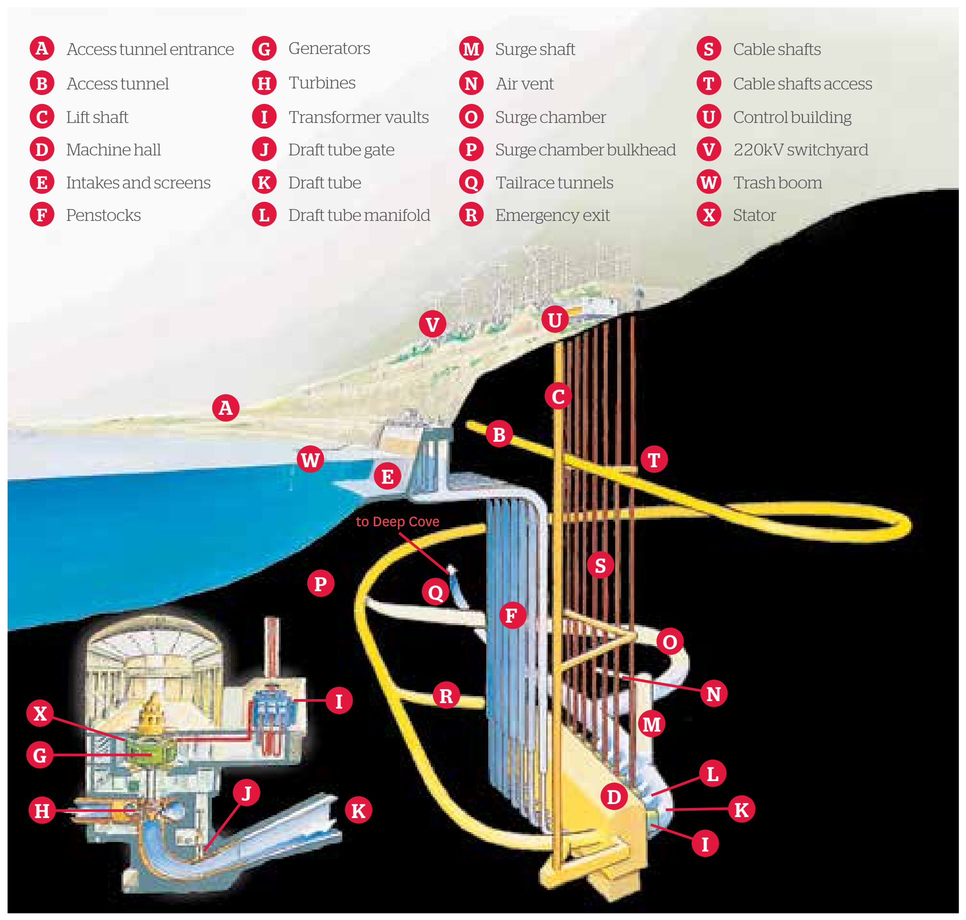
The first visitors were Māori who used the pass as a route to the seasonal food supply of the fiords. In 1770, Captain James Cook named the area Doubtful Sound – being doubtful that if he entered the fiord he would be able to get out again. The Italian explorer Malaspina arrived in 1793, his Spanish crew reminding us of their visit by the names they left behind. Among the later explorers was Ernest Wilmot, who discovered the pass in 1897.

For many years, tourists travelled on foot from Lake Manapōuri to Doubtful Sound. Today, the Wilmot Pass road provides a less arduous journey to the wild Fiordland coast.

Hydro power

– how does it work?

A hydro power station works by harnessing the energy from falling water. The water held above the power station in a lake or reservoir is channelled through pipes or penstocks (F) to the turbine (H). The height from which the water falls from the reservoir to the turbine, known as the head, determines the amount of energy that can be extracted from a given volume of water. The turbine extracts the energy from the water, turning it into mechanical energy that spins the generator rotor (G). Similar to a car alternator, the generator rotor carries a set of electromagnets that spin within a stationary set of insulated copper windings embedded in an iron core called the stator (X). The motion of the magnets within the stator generates electricity in the windings. Most large hydro generators in New Zealand generate at between 11,000 and 16,000 volts (at Manapōuri we generate at 13,800 volts) alternating current (AC), which is not suited to the energy-efficient, long-distance transmission of electricity. Instead, the generator is connected to a transformer (I), which steps up the voltage – usually to 110,000 or 220,000 volts AC – to make long-distance transmission more practicable and energy efficient. The transformer connects to the national grid at a switchyard, which contains the circuit breakers and other connecting switches that allow the generator to be connected and disconnected from the grid as required. Some of the electricity generated into the grid is also converted from AC to direct current (DC), which makes transmission between the North and South Islands, using special high-voltage undersea cables in Cook Strait, much more practicable. After passing through the turbine, water exits through a draft tube (K), back to a river, canal or lake.



Did you know?

The only form of travel to Manapōuri power station is by boat. Access into the station itself is either by a two-kilometre vehicle access tunnel, which spirals down from the surface, or by a lift that travels underground from within the control building.

About Meridian Energy

Meridian Energy is the largest electricity generator in New Zealand, generating power from 100% renewable resources. We retail electricity to homes, farms and businesses across the country, through our Meridian and Powershop brands.

Meridian is creating a better energy future by leading the way in harnessing the power of renewable energy sources – water and wind. In New Zealand, the company owns and operates seven hydro stations, six within the Waitaki hydro scheme, and five wind farms throughout New Zealand.

We also own and operate two wind farms in Australia and have a strong pipeline of new generation options in both countries. We've also built solar facilities in California and Tonga.

Sustainability is fundamental to our operational approach, reflecting our long-term focus. We work with organisations to preserve the natural environment and protect native plant and animal life, and support local communities through our community fund programme and national and local sponsorships.

To help our customers manage their energy use, we offer a range of innovative, energy-efficient products and services.

WANT TO BE A CUSTOMER?

Please feel free to contact our Energy Centre Team.

Phone	**0800 496 496**
Fax	**0800 497 498**
Email	**info@meridianenergy.co.nz**
Website	**meridian.co.nz**
Address	**Meridian Energy Ltd** **PO Box 2146** **Christchurch Mail Centre 8011** **New Zealand**

meridian

11/15 JR