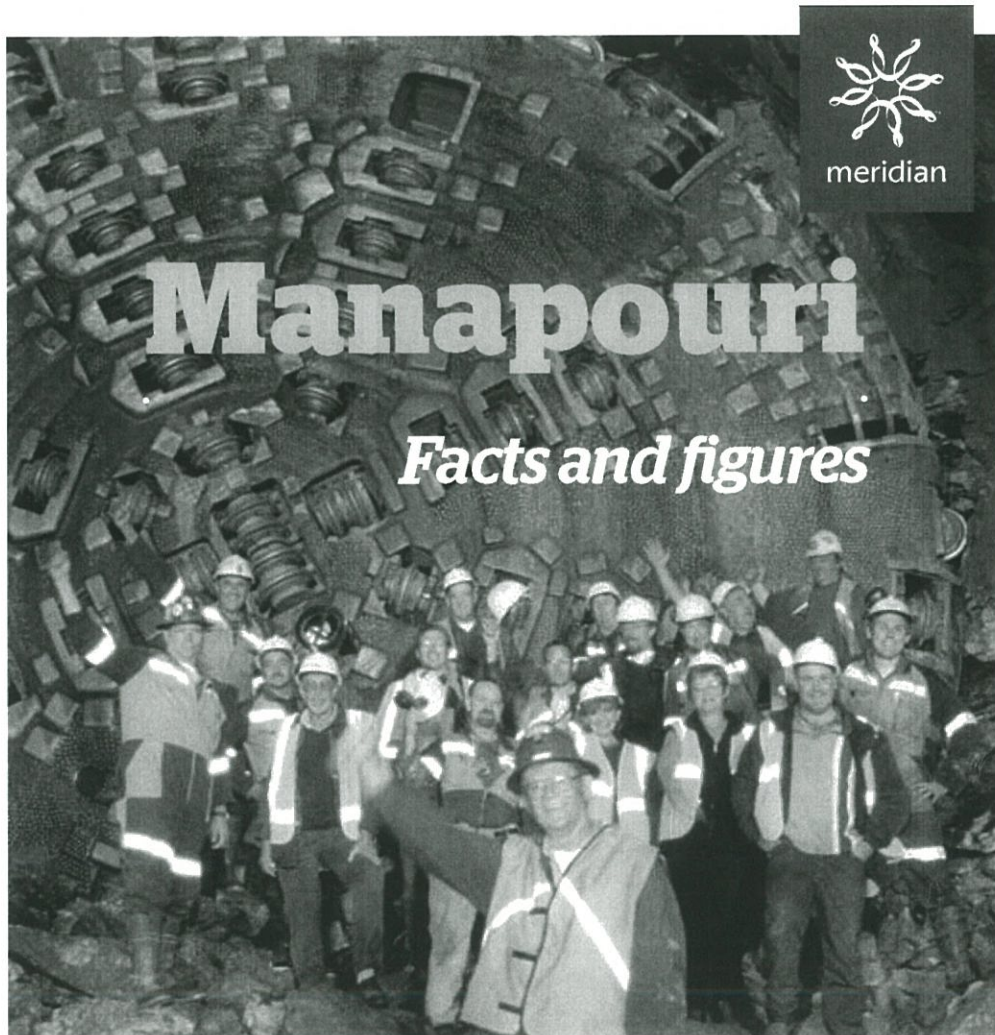


(Meridian Energy, 2008)



Significant dates

Lake Manapouri discovered by Europeans	1852
Potential for a hydro scheme first recognised by Mr P S Hay of Public Works Department	1904
Public Works Department survey parties investigate the area	1927
Aluminium Co. of Canada examines water resources	1947
Ministry of Works reports on various possible schemes	1954
Building restrictions on Crown Land within 100 feet (30m) of average water level of Lake Manapouri	1955
NZ Government invites Consolidated Zinc to consider hydro-electric potential of Lakes Manapouri and Te Anau	1959
Consolidated Zinc Prop. Ltd. granted rights to develop power from Manapouri/Te Anau lakes, Waiau and Mararoa rivers	1960
Petition of 25,000 signatures against raising of Lake Manapouri	1960
Manapouri Development Validity Act enacted	1960
Bechtel Corporation's investigations for Consolidated Zinc begin	1961
Power station site reached by vertical tunnel	1961
Work and investigation suspended	Apr, 1962
Government to build power station	Jan, 1963
Bechtel instructed by Ministry of Works to start construction	Feb, 1963
Manapouri - Te Anau Development Act enacted	Aug, 1963
The Wanganiella arrives at Deep Cove	29 Aug, 1963
Wilmot Pass Road commenced	Sept, 1963
First shot fired on Tailrace Tunnel	4 Feb, 1964
Wilmot Pass Road completed	1 Nov, 1965



1963 Act amended to let Crown take more power from Manapouri for National Grid	1966
Transmission Line started	June, 1966
Manapouri controlled level 610ft (185.9m) ASL 27.5 ft (8.4m) above natural mean level	July, 1966
Pilot shoreline clearing carried out	1967



Tailrace Tunnel hole through	5.42am, 22 Oct, 1968
Work on Tailrace Tunnel completed	29 Aug, 1969
Tunnel filled with water	6 Sep, 1969
First power transmission	14 Sep, 1969
Second machine commissioned	29 Sep, 1969
Third machine commissioned	16 Oct, 1969
Fourth machine commissioned	30 Oct, 1969
Wanganiella leaves Deep Cove for Hong Kong	17 Apr, 1970
Second petition of 264,900 signatures presented	Dec, 1970
First aluminium smelted at Tiwai Point	Apr, 1971
Power Station complete	Sept, 1971

Significant dates *continued*

Manapouri Lake Control started
 Mission lines completed
 Manapouri Lake control started
 Guardians of the Lake established
 Te Anau outlet into Waitai river diverted
 Manapouri to be operated within natural levels
 Guardians of the Lake Guidelines announced
 Government endorses the Guardians' guidelines
 Second Manapouri Tailrace Tunnel (2MTT) given go-ahead
 2MTT: First blast of construction at West Arm
 2MTT: First blast of construction at Deep Cove
 Tunnel Boring Machine (TBM) arrives at Deep Cove
 Work continued 24 hours a day, seven days a week
 TBM demobilisation completed
 Second tailrace fully operational

Feb, 1972
 28 Apr, 1972
 July, 1972
 10 Feb, 1973
 Apr, 1974
 Nov, 1975
 17 Sep, 1977
 22 Dec, 1977
 10 Dec, 1997
 9 Jun, 1997
 23 Sep, 1997
 10 Apr, 1998
 12 Jun 1998
 13 Mar, 2001
 12 May, 2001
 5 May, 2002



refurbishment

March, 2008

Major quantities

(Approximation only)

Original project

Total underground rock excavated from all areas	1,391,490 m ³ 1,820,000 yards ³
Total open cut excavation in all areas	1,758,476 m ³ 2,300,000 yards ³
Total concrete poured in all areas	298,176 m ³ 390,000 yards ³
Approximate tonnage hauled over Wilmot Pass	86,000 tonnes
Total quantity of explosives	3,300 tonnes
Total reinforced steel used in all areas	3,333 tonnes
Total power consumed in all areas	2.4 GWh

Largest load to be hauled over Wilmot Pass was 97 tonnes of transformers.

Transmission line

Length - Manapouri to Invercargill	145 km/90 miles
First span of transmission line from switchyard	1.18 km/3,870 ft
Weight of cable on first towers	21 tonnes
Conductor cables	7 x 19 x 146 ACSR
Distance between each phase	9.14 m/30 ft
Voltage	220,000 volts
Number of towers to Invercargill	352

Rainfall

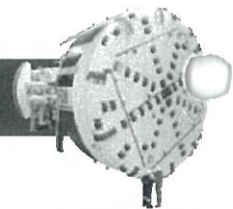
At 4am on 26 August 1980 the Mararoa flow reached 950 cumecs, taking out the centre support for the bridge at Red Cliffs. With Manapouri control gates fully open, an estimated 500 cumecs flowed into Lake Manapouri. The contaminated flood water reached half-way to Stony Point.

Deep Cove	
802.6 mm (31.6 inches) of rain in three days	22-25 April, 1967
400 mm (15.75 inches) of rain in one day	25 April, 1967
West Arm	
276.4 mm (10.9 inches) on 27 January 1984	
1975 was the second wettest year on record in Te Anau, with a rainfall of 1303 mm (51.3 inches). West Arm recorded 4565 mm (179.7 inches), Milford 7792 mm (306.8 inches).	

Generators

Made by Siemens Aktiengesellschaft, Germany	
Rated voltage	13,800 volts
Weight of rotating generator parts	284 tonnes
Diameter of stator bore	5.6 m/18 ft 4.5 in
Diameter of rotor	5.55 m/18 ft 2.5 in
Total thrust bearing load	477 tonnes
Original:	
Rated current	4,390 amps
Rated output	1 4, 105 MVA 5-7, 120 MVA
Upgraded:	
Rated current	5,648 amps
Rated output	1-7, 135 MVA

Type was Atlas Copco Robbins, built by Markhams, Sheffield, England.



Tunnel Boring Machine (TBM)

Weight	1,500 tonnes
Total length (including trailings)	500 m/1640 ft
Average advance rate achieved	10m per day/32.81 ft
Best advance rate achieved	April 2000, 20m per day, 65.62 ft
Total number of cutters on face of TBM	68
Total cutters replaced	4084

Original power station project

Total man hours on contract	7,999,136
Total reported accidents	1,707
Total fatal accidents on the job	16

Second tailrace tunnel

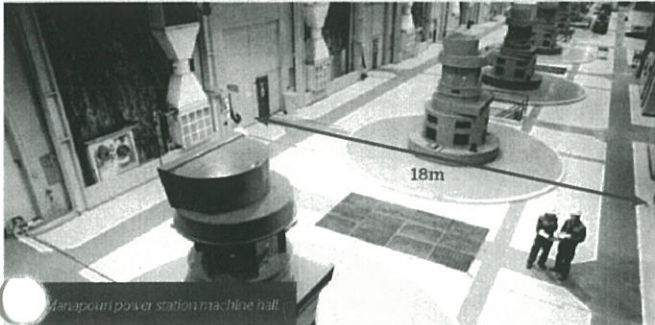
Total man hours on contract	1,500,000
Total fatal accidents on the job	nil



Machine hall

Height (total excavation)	111 m/364 ft
Average temperature (at floor level)	18 m/59 ft
Number of units	39 m/127.5 ft
	20 °C/68 °F
	7, 12.8 m/42 ft apart

Floor levels (el*):	
Machine floor	7.9 m/26 ft
Stator floor	3.66 m/12 ft
Turbine floor	0.3 m/ 1 ft
Penstock Gallery	-6.7 m/-22 ft
Draft Tube Gallery	-8.33 m/-27.33 ft
Drainage Gallery	-13.87 m/-45.5 ft



Cranes

Made by Savigliano, Italy	
Main	150 tonnes capacity
Auxiliary	15 tonnes capacity
Span	17 m/55.5 ft

Costs (Approximations in NZD)

1963 – 1971	\$ NZD
Original Tailrace Tunnel	41,000,000
Powerhouse and access tunnel (including installation of four machines)	47,000,000
Equipment (purchase of four machines)	7,000,000
Transmission line (four circuits)	18,500,000
Machines 5, 6, and 7 (purchase and installation)	12,000,000
Minor items	2,000,000
Engineering	8,000,000
OVERALL COST OF ORIGINAL PROJECT	135,500,000
1997 – 2002	
Second Tailrace Tunnel	200,000,000
November 1999 – August 2001	
Upgrade of Transformers	10,265,000
1999 – 2007	
Refurbishment of Generators & Mechanical Equipment (Includes Exciters, Generators, Turbine & Wicket Gates)	90,000,000

220 KV cables

Length of cable (from generator to switchyard)	263 m/862.9 ft
Height of cable shaft (from stator floor to switchyard)	233 m/765 ft
Diameter of shaft	1.83 m/6 ft

Original Cable:

Single core - oil filled - paper insulated	
Conductor cross section	Copper 1.94 cm ² /0.3 in ²
Sheath	Lead Alloy

Replacement Cable:

XLPE (Cross link polyethylene) cable	
Conductor cross section	Copper 6.26 cm ² /0.97 in ²
Sheath	Alloy 1/2 C

Turbines

Original:	
Vertical Francis built by Harland Engineering Co. Ltd., Scotland	
Nominal output	105 MW
Operating speed	250 rpm
Diameter of runner (turbine)	3.2 m/10.5 ft
Centre line of turbine	(el*) 3.1 m/10 ft
Weight of turbine	18 tonnes
Replacement:	
Vertical Francis built by General Electric Canada International Inc	
Nominal output	121.5 MW
Weight of turbine	16 tonnes

Intakes and penstocks

Diameter - Concrete section:	3.65 m/12 ft
Diameter - Steel section (el*) 32.5 m (110 ft) to bottom:	3.35 to 2.9 m 11 to 9 ft 8 1/4"
Volume of water at full load	80 m ³ /s, 104.6 yd ³ /s
Speed of water - Concrete section:	6-7.6 m/s, 20-25 ft/sec
Speed of water - Steel section:	9-11.6 m/s, 30-38 ft/sec
Thickness of steel at: (el*) 32.5 m (110 ft) bottom of vertical section dresser coupling	19 mm/3/4" 41 mm/1 5/8" 57 mm/2 1/4"
Intake area (per unit)	914.4 m ² /1584 ft ²
Clear space between bars	11.4 cm/4 1/2"
Water velocity through intake	1.25 m/s, 4.1 ft/sec
Trashrack sill	(el*) 169.5 m/556 ft
Size of headgate opening	5 m x 3.6 m, 16.5 ft x 12 ft
Weight of headgate	27 tonnes
Size of stop log	5.4 m x 5 m, 17.7 ft x 16.5 ft
Weight of stop log	12.5 tonnes

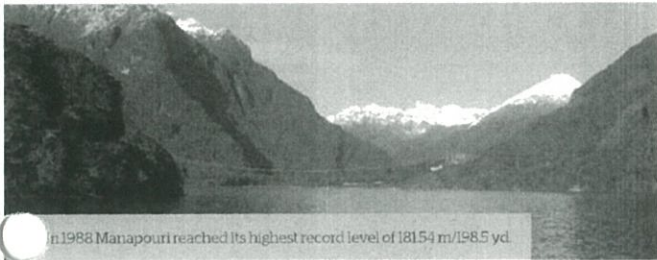
Weight of headgate - 27 tonnes.

Wilmot Pass Road

Height of pass	671 m/2,100 ft
Length of road	21.6 km/12.75 miles
Material excavated	865,889 m ³ /1,132,540 yds ³
Cost of building	\$2 per 25mm/\$2 per inch

Hydrology

Calcium dissolved solids	6.4 to 6.8
	23 parts per million
Very soft with 90% saturation of dissolved oxygen even at 443.5 m deep (1455 ft)	
Summer temperature, surface up to:	22 C / 71.6 F
Upper 50 ft	16 C / 60.8 F
Below 300 ft (yearly constant)	8 C / 46.4 F
Winter temperature, surface down to:	7 C / 44.6 F
Lake Te Anau area	357 km² / 138 miles² (35,612 hectares) (88,000 acres)
Shoreline	281 km / 175 miles
Normal operating levels	201.5 m to 202.7 m 220 yd to 221.7 yd
Catchment area	3,302 km² 1,275 miles²
Lake Manapouri area	142 km² / 55 miles² (14,164 hectares) (35,000 acres)



In 1988 Manapouri reached its highest record level of 181.54 m / 198.5 yd.

Shoreline	161 km / 100 miles
Normal operating levels	176.8 m to 178.6 m 193 yd to 195 yd
Catchment area	1,320 km² / 510 miles²
Catchment for Mararoa River	1,256 km² / 485 miles²
Total catchment for both lakes and Mararoa River	5,879 km² 2,270 miles²
The maximum recorded levels of both lakes before control gates were installed were: (recorded in October 1928)	
Te Anau	204.9 m / 224 yd
Manapouri	181.2 m / 198 yd
During construction of the control structures in 1975 the lakes reached:	
Te Anau - 8 April	204.78 m / 223.9 yd
Manapouri - 11 April	180.84 m / 197.8 yd
With the control gate clear of the water, the outflow from Lake Te Anau reached 841 cumecs on 7 April. Inflow into Te Anau on 30 March was 3,848 cumecs, by 6 April this had dropped to 3,141 cumecs.	
In 1988 the lakes reached the highest recorded levels:	
Te Anau	205.11 m / 224.3 yd
Manapouri	181.54 m / 198.5 yd

Lift shaft

Diameter of unlined rock	4.5 m / 14.66 ft
Control room (Equivalent to a 70 storey building)	(el*) 227 m / 745 ft
Machine floor	(el*) 7.9 m / 26 ft
Speed of car	6.4 kmh / 4 mph

*el - Elevation above sea level

Transformers

Made by Savigliano, Italy	13.8 kV to 220 kV
Original:	
Weight of core winding	78 tonnes
Overall weight	133 tonnes
Weight of oil	36 tonnes
Continuous rating	1-4, 105 MVA, 5-7, 120 MVA
Upgraded:	
Weight of core winding	83 tonnes
Overall weight	138 tonnes
Weight of oil	36 tonnes
Continuous rating	1-7, 135 MVA

Tailrace tunnels

Amount of water to pump out if dewatering	567,811,768 litres 150,000,000 gallons
Plus seepage of	34,068 litres p/m, 9,000 gallons p/m
Original: (by drill and blast method)	
Diameter (Horse shoe shaped)	9.1 m/30 ft
Length (fully lined)	10 km/6.25 miles
Outlet (to sea level)	(el*) -9.14 m/-30 ft
Deepest point (to sea level)	(el*) -40.44 m/-132.69 ft
Net head of water	148 m/487 ft
Rock removed during excavation	789,904 m ³ /1,024,000 yds ³
Total concrete to line tunnel	210,906 m ³ /275,855 yds ³
Total concrete for grouting	9,948 m ³ /13,012 yds ³

Grouting pressure, up to	2,200 psi
Discharge velocity - 450 cumecs	20.9 kmh/13 mph
Maximum water inflow during excavation March 1968	43,418 litres p/m, 11,470 gallons p/m
Average labour force 1964 - 68	531
Average terminations 1964 - 68	626
Annual turnover percentage	121%

Second: (9.6km by TBM, 0.2km by drill and blast)	
Diameter (circular)	10.0 m/32.81 ft
Length (70% unlined)	9.8 km/6.09 miles
Outlet (to sea level)	(el*) -4.88 m/-16 ft
Deepest point (to sea level)	(el*) -43.35 m/-142 ft
Net head of water	160 m/524 ft
Rock removed during excavation	approx. 1,630,000 m ³ , 2,132,000 yds ³
Total stresscrete to line tunnel	1094.4 m/3591 ft
Total shotcrete (75mm to 150mm thick)	2000 m/6562 ft
Discharge velocity - 510 cumecs (using both tunnels)	11 kmh/6.8 mph
Maximum water inflow during excavation, October 1999	61,020 litres p/m 16,120 gallons p/m

Approx labour force	200
Total man hours	1,500,000
No loss of life or serious permanent injuries (most serious recorded were broken bones or crushing). Rock spall has created a new "hill" to the left of the original outlet and channel. 1500m long, 250m wide and between 10 - 15 m high, covered by 250,000 native plants grown especially for this project.	

Access tunnel

Diameter	6.7 m/22 ft
Length	2,042 m/6,700 ft
Gradient	1:10

WE'RE HERE TO HELP

Please feel free to contact our Customer Service Team.

Phone 0800 496 496

Fax 0800 497 498

**Monday to Friday, excluding public holidays,
between 7.30am and 7.30pm**

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