

# Hydrological Modelling Dataset

Report 2a: 2018 HMD Flow Series Comparison with 2015





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## Preface

A large proportion of New Zealand's electricity needs are met by generation from hydro power. Information about the distribution of inflows and the capability of the various hydro systems is necessary to ensure a reliable, competitive and efficient market and electricity system.

The hydrological modelling dataset (HMD) is a dataset of hydrological information made available by the Electricity Authority. The dataset was known as the SPECTRA update until 2010. In 2015 the dataset was revised to become the HMD, a comprehensive dataset that can be relied upon by modellers and analysts to test scenarios, provide commentary and inform decisions.

The HMD is comprised of data provided by hydro generators and supplemented with some from other sources. These parties are acknowledged for their contribution and for making this data available.

The HMD consists of three main components:

1. Infrastructure and hydrological constraint attributes:  
This dataset records standing information about the capability of the main hydro schemes.
2. Flows:  
This time series dataset records data for inflows for reservoirs and flows at various existing or potential hydro generating sites.
3. Storage and spill:  
This time series dataset records storage for the main hydro schemes.

This report describes the differences between the 2015 HMD flow series data and the 2018 HMD flow series data.

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# 1. Introduction

## 1.1. Datasets and mean flows

Care is taken to ensure consistency of data between successive HMD updates. A comparison of the mean flows for each flow series is listed in Table 1.1 for the North Island and Table 1.2 for the South Island.

Table 1.1: North Island flow dataset names and mean values derived from the previous HMD update (2015) and this HMD update (2018). "N" denotes a natural flow, uncontrolled flow (i.e. D1), "A" denotes an actual flow (i.e. D2), "N+A" denotes a flow that is both actual and natural.

FLOW	MODEL FLOW NAME	FLOW SITE NUMBER	MEAN FLOW (M <sup>3</sup> /S)		TYPE
			1 Jan 1932 to 31 Dec 2014	1 Jan 1932 to 31 Dec 2017	
Arapuni Tribs	Arapuni	92724 (1)	81.09	81.39	A
Karapiro Tribs	Karapiro	92714 (1)	92.70	91.42	A
Tokaanu	TokaanuTPD	92790 (3)	53.38	52.54	A
Tokaanu	Toka_Linear	22790 (3)	53.20	53.48	A
Taupo	TaupoTPD	92790 (1)	157.68	155.88	A
Taupo	Taupo_Linear	22790 (1)	153.57	154.64	A
Taupo	Taupo_Actual	42790 (1)	152.52	139.90	A
Rangipo	RangipoTPD	92790 (2)	35.63	34.68	A
Rangipo	Rangi_linear	22790 (2)	28.53	28.81	A
Waikaremoana	Waikaremoana	3650 (1)	17.70	17.75	N+A
Matahina	Matahina	93254 (1)	64.40	64.51	A
Wheao	Wheao	15462(1)	12.90	12.88	A
Mangahao	Mangahao	97502(1)	8.63	8.70	A
Patea	Patea	34300(1)	19.03	19.38	A
Kaimai	Wairoa	14130(1)	11.86	11.87	A
Ngaruroro	Whanawhana	123103 (1)	35.30	35.12	N+A
	Kuripapango	123104 (1)	17.73	17.70	N+A
	Chesterhope	123150 (1)	43.81	43.68	N+A
Mohaka	Raupunga	121801 (1)	78.97	79.19	N+A

"N" denotes a natural flow, uncontrolled flow

"A" denotes an actual flow

"N+A" denotes a flow that is both actual and natural

(\*) Denotes item number of Tideda file

Table 1.2 South Island flow dataset names and mean values derived from the previous HMD update (2015) and this HMD update (2018). "N" denotes a natural flow, uncontrolled flow, "A" denotes an actual flow, "N+A" denotes a flow that is both actual and natural.

FLOW	MODEL FLOW NAME	FLOW SITE NUMBER	MEAN FLOW (M <sup>3</sup> /S)		TYPE
			1 Jan 1932 to 31 Dec 2014	1 Jan 1932 to 31 Dec 2017	
Waitaki P.S. Tribs	Waitaki	98714 (2)	152.50	152.03	A
Benmore	Benmore	98614 (4)	125.75	132.61	A
	Ben_tp	98615 (2)	124.01	123.42	A
Ohau (separate Tekapo model)	OhauRes	98614 (6)	70.62	70.33	A
	Ohau	98614 (3)	80.64	80.31	N+A
Pukaki	Pukaki	98614 (2)	206.75	195.20	A
Natural Pukaki	Nat_Puk	98770 (1)	126.57	126.24	N
Tekapo	Tekapo	98614 (1)	80.22	68.99	A
Natural Tekapo	Nat_Tek	98770 (2)	81.96	83.40	N+A
Manapouri	Manawmara	99551 (1)	137.11	137.27	A
	Manapouri	99550 (1)	122.61	122.31	N
	Manareduced	99552 (1)	120.82	121.11	A
Te Anau	Teanau	9570 (1)	283.13	283.16	N+A
Monowai	Mono_Inflow	199540 (1)	12.97	12.93	N+A
Roxburgh	Roxburgh	99110 (1)	445.25	444.78	A
Wanaka	Wanaka	9154 (1)	196.70	196.68	N+A
Hawea	Hawea	9170 (1)	64.83	64.53	N+A
Cobb	Cobb	97904 (2)	5.39	5.41	N+A
Coleridge	Coleridge	97904 (1)	24.66	24.72	A
Highbank	Highbank	7968(1)	13.44	13.40	A
Waipori	Waipori	174395(1)	7.32	7.40	A
Grey+Taramakau-Taipo	Grey_tara	77106(1)	436.15	437.24	A
Waiiau	Clarence	162105 (1)	14.54	14.46	N+A
	Glenhope	164604 (1)	33.36	33.81	N+A
	Marble Point	164602 (1)	94.40	94.03	N+A
Wairau	Dip Flat	160114 (1)	26.46	26.51	N+A
Hurunui	Mandamus	165104 (1)	51.38	51.20	N+A
	SH 1 Bridge	165101 (1)	66.55	66.21	N+A

"N" denotes a natural flow, uncontrolled flow

"A" denotes an actual flow

"N+A" denotes a flow that is both actual and natural

(\*) Denotes item number of Tideda file

## 2. Data Differences for Calculated Flow Sites

Differences between datasets may occur from one update to the next for a variety of reasons. These include: rating changes; data modifications; inflows being recalculated, and various other reasons. Table 2.1 shows if there were any differences in the data between the previous and current updates for North Island flow sites and Table 2.2 shows if there were any differences for South Island flow sites. The following sections highlight the reasons for these differences.

At the time of this update, Trustpower had not provided the entire data series required for a comparison report; therefore no comparison could be made with the 2015 update datasets, and have been excluded from this comparison report.

Table 2.1: *Data differences for previous and current updates for North Island flow sites*

FLOW SITE NUMBER AND ITEM NUMBER	FLOW SITE NAME	DATA DIFFERS
92724 (1)	Arapuni Tributary inflows	No
92714 (1)	Karapiro Tributary inflows	Yes
22790 (1)	Taupo linear Inflows	Yes
22790 (2)	Rangipo linear Inflows	Yes
22790 (3)	Tokaanu linear Inflows	Yes
92790 (1)	Taupo non-linear Inflows	Yes
92790 (2)	Rangipo non-linear Inflows	Yes
92790 (3)	Tokaanu non-linear Inflows	Yes
42790 (1)	Taupo operational inflows	Yes
3650 (1)	Waikaremoana inflows	No
93254 (1)	Matahina Outflows	N/A
15462 (1)	Wheao/Flaxy Outflows	N/A
97502 (1)	Mangahao Inflows	Yes
34300 (1)	Patea Outflows	N/A
14130 (1)	Kaimai Outflows at Ruahihi	N/A
123103 (1)	Ngaruroro - Whanawhana	Yes
123104 (1)	Ngaruroro - Kuripapango	Yes
123150 (1)	Ngaruroro - Chesterhope	Yes
121801 (1)	Mohaka - Raupunga	Yes

Table 2.2: Data differences for previous and current updates for South Island flow sites

FLOW SITE NUMBER AND ITEM NUMBER	FLOW SITE NAME	DATA DIFFERS
98714 (2)	Waitaki Tributaries (Benmore)	Yes
98614 (4)	Benmore Tributary Flows	Yes
98615 (2)	Benmore_tp	Yes
98614 (6)	Ohau Residual Flows	Yes
98614 (3)	Ohau (Ohau B and C)	No
98614 (2)	Pukaki	Yes
98770 (1)	Pukaki natural inflows	Yes
98614 (1)	Tekapo	Yes
98770 (2)	Tekapo natural inflows	Yes
99550 (1)	Manapouri local inflow (no Mararoa)	Yes
99551 (1)	Manapouri local inflow (incl. Mararoa)	Yes
99552 (1)	Manapouri local inflow (no Mararoa + water right reduction)	Yes
9570 (1)	Lake Te Anau inflow	No
199540 (1)	Monowai Inflow	No
99110 (1)	Roxburgh tributary flows	Yes
9154 (1)	Wanaka Outflow	No
9170 (1)	Hawea Inflow	No
97904 (2)	Cobb Inflow	N/A
97904 (1)	Coleridge Inflow	N/A
7968 (1)	Highbank Outflows	N/A
174395 (1)	Waipori Outflows	N/A
77106 (1)	Grey + Taramakau - Taipo	Yes
162105 (1)	Waiau - Jollies	Yes
164604 (1)	Waiau - Glenhope	Yes
164602 (1)	Waiau - Marble Point	Yes
160114 (1)	Wairau - Dip Flat	Yes
165104 (1)	Hurunui - Mandamus	Yes
165101 (1)	Hurunui - SH1 Bridge	Yes

### 3. North Island Flow Sites

#### 3.1. 92724 (1) Arapuni Tributaries

There are no significant differences for the Arapuni Tributaries dataset, as evident by the same summary statistics displayed in Table 3.1.

Table 3.1 Arapuni tributaries (92724 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	81.09	77.09	636.28
2015	0.00	81.09	77.09	636.28

#### 3.2. 92714 (1) Karapiro Tributaries

There is a period of significant change from Jan 1992 to Mar 2012 between the two datasets. This is because the data was recalculated for this period as a new MW curve was provided for the input site for this dataset. The difference has not significantly altered the summary statistics of the site, as displayed in Table 3.2.

Table 3.2 Karapiro tributaries (92714 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	91.62	86.89	572.34
2015	0.00	92.70	87.39	572.34

#### 3.3. 22790 (1) Taupo Inflow Linear

The differences in the Taupo Linear series start from Oct 1979 to the present. This is because Genesis Energy provided an entire new dataset for the Tongariro Power Diversion Foreign Inflows (TPD Inflows), which is used as an input site, as there was review of the ratings for the site which resulted in a change. This only impacts data from 1979 to the present as the TPD Inflows are subtracted from the Taupo Inflows series, which has not been altered. This has impacted the maximum and minimum flows in the dataset, as evident in Table 3.3.

Table 3.3 Taupo Inflow Linear (22790 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	23.76	154.31	134.67	1489.29
2015	21.70	153.57	133.85	1489.29

#### 3.4. 22790 (2) Rangipo Linear

The differences in the Taupo Linear series start from Oct 1979 to the present. This is because Genesis Energy provided an entire new dataset for the Tongariro Power Diversion Foreign Inflows, which is used as an input site, as there was review of the ratings for the site which resulted in a change. This only impacts data from 1979 to the present as the TPD Inflows are subtracted from the Taupo Inflows series, which has not been altered. This has impacted the maximum and minimum flows in the dataset, as shown in Table 3.4

Rangipo Linear (22790 (2)) data difference table

Table 3.4 Rangipo Linear (22790 (2)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	28.72	26.14	92.96
2015	0.00	28.53	25.89	91.33

### 3.5. 22790 (3) Tokaanu Linear

The differences in the Taupo Linear series start from Oct 1979 to the present. This is because Genesis Energy provided an entire new dataset for the Tongariro Power Diversion Foreign Inflows, which is used as an input site, as there was review of the ratings for the site which resulted in a change. This only impacts data from 1979 to the present as the TPD Inflows are subtracted from the Taupo Inflows series, which has not been altered. Because of the constraints of this dataset, it has not impacted the minimum or maximum flows, as shown in Table 3.5.

Table 3.5 Tokaanu Linear (22790 (3)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	7.99	53.41	47.69	226.12
2015	7.97	53.20	47.40	226.12

### 3.6. 92790 (1) Taupo

The main input to the HMD Taupo Inflows data set (92790 (1)) is the Taupo Natural Inflows series (62790). A key input into the natural inflows series is the Tongariro Power Diversion Foreign Inflows (TPD Inflows) dataset. This is provided by Genesis Energy. In 2018 this dataset was recalculated as there was a rating change, which impacted data from Oct 1979 to the present. Therefore, the Taupo Natural Inflows series was recalculated, and correlated back to 1932. This has resulted in differences for all data sets that use Taupo Natural Inflows as an input, specifically all 92790 non-linear data sets. This is evident when comparing the summary statistics for the site in Table 3.6, as the maximum and minimums have changed significantly, though the average values are relatively similar.

Table 3.6 Taupo non-linear (92790 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.47	155.45	135.61	1426.67
2015	17.08	157.68	139.06	1113.28

### 3.7. 92790 (2) Rangipo

Similarly to Taupo Inflows data set (92790 (1)), the main input to the HMD Rangipo Inflows data set (92790 (2)) is a Taupo Natural Inflows series. A key input into the natural inflows series is the Tongariro Power Diversion Foreign Inflows (TPD Inflows) dataset. This is provided by Genesis Energy. In 2018 this dataset was recalculated as there was a rating change, which impacted data from October 1979 to the present. Therefore, the Taupo Natural Inflows series was recalculated, and correlated back to 1932. This has resulted in differences for all data sets that use Taupo Natural Inflows as an input, specifically all 92790 non-linear data sets. The differences have not significantly impacted the summary statistics for the site, as evident in Table 3.7, because of the flow conditions have not been altered as per the consent conditions for this dataset.

Table 3.7 Rangipo non-linear (92790 (2)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	34.61	32.33	63.00
2015	0.00	35.63	32.92	63.00

### 3.8. 92790 (3) Tokaanu

Similarly to Taupo Inflows data set (92790 (1)), the main input to the HMD Tokaanu Inflows data set (92790 (3)) is a Taupo Natural Inflows series. A key input into the natural inflows series is the Tongariro Power Diversion Foreign Inflows (TPD Inflows) dataset. This is provided by Genesis Energy. In 2018 this dataset was recalculated as there was a rating change, which impacted data from October 1979 to the present. Therefore, the Taupo Natural Inflows series was recalculated, and correlated back to 1932. This has resulted in differences for all data sets that use Taupo Natural Inflows as an input, specifically all 92790 non-linear data

sets. The differences have altered the minimum and maximum flow values in the dataset, as evident in Table 3.8.

Table 3.8 Tokaanu non-linear (92790 (3)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	52.40	47.53	158.91
2015	0.71	53.38	48.28	149.11

### 3.9. 42790 Taupo Actual Inflows

The Taupo Actual Inflows dataset is an inflow series that is provided by Mercury. In 2012 the dataset was recalculated based on new MW rating curves provided by Mercury for the Taupo Inflows series. However the corrected data was not included in the output file in the 2015 update, though was incorporated in correlating and extending multiple flow records back to 1932. Therefore, the differences represent the difference between the change in the MW rating curves, as evident by the differences in the summary statistics in Table 3.9. This has resulted in a lower average and maximum value in the dataset when using the corrected rating curve.

Table 3.9 Taupo Actual Inflows (42790 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	2.00	139.07	120.25	1357.31
2015	0.02	152.52	135.69	1426.24

### 3.10. 3650 (1) Waikaremoana

There are no differences in the data provided by Genesis between the 2015 and 2018 updates. However, any negative values have been zeroed as requested by the Electricity Authority. This has resulted in a change to the minimum and average inflows as shown in Table 3.10

Table 3.10 Waikaremoana (3650 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	17.71	11.08	686.14
2015	-3.97	17.70	11.07	686.14

### 3.11. 123103 (1) Ngaruroro - Whanawhana

There are small differences in this dataset from rating additions and changes that have come from NIWA from 1963 to the end of 2014 as evident in Table 3.12. The changes are of a small magnitude; differences range from +/-1m<sup>3</sup>/s on average.

Table 3.11 Ngaruroro at Whanawhana (123103 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	1.40	35.30	26.0	837.36
2015	1.40	35.30	25.78	837.36

### 3.12. 123104 (1) Ngaruroro - Kuripapango

There are small differences in this dataset from rating additions and changes that have come from NIWA from 1963 to the end of 2014 as evident in Table 3.12. The changes are of a small magnitude; differences range from +/-1m<sup>3</sup>/s on average.

Table 3.12 Ngaruroro at Kuripapango (123104 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.85	17.70	12.66	385.09
2015	0.85	17.73	12.57	385.09

### 3.13. 123150 (1) Ngaruroro - Chesterhope

There are differences in this dataset from rating additions and changes that are from NIWA (Table 3.13). The changes are of a small magnitude; differences range from +/-1m<sup>3</sup>/s on average.

Table 3.13 Ngaruroro at Chesterhope(123150 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	1.00	43.68	28.02	1699.38
2015	1.00	43.81	27.84	1699.38

### 3.14. 121801 (1) Mohaka - Raupunga

There are differences in this dataset from rating additions and changes that have come from HBRC (Table 3.14). The changes are of a small magnitude; differences range from +/-1m<sup>3</sup>/s on average.

Table 3.14 Mohaka (121801 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	15.25	79.19	59.92	1619.11
2015	15.25	78.97	59.35	1619.11

### 3.15. 97502 (1) Mangahao

There were no changes to the data pre Jan 2013. There are very minor differences because of alterations to rating curves, between the datasets from Jan 2013 to the end of 2015 as shown in Table 3.15.

Table 3.15 Mangahao Inflows (97502 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	8.625	6.281	320.107
2015	0.00	8.63	6.28	320.11

## 4. South Island Flow Sites

### 4.1. 98714 (2) Waitaki Tributaries

There are differences from Jun 1977 to the present. Alterations to the Tekapo Spill, Tekapo A. and Tekapo B discharge datasets, which are all inputs used in the creation of the Waitaki Tributaries, by Genesis resulted in minor differences for this dataset to the present as shown in Table 4.1.

Table 4.1 Waitaki tributaries (98714 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	152.46	132.34	1567.68
2015	0.00	152.50	132.30	1592.64



#### 4.2. 98614 (4) Benmore Tributary Flows

There are differences in this file that stem from new Tekapo inflows that were provided by Genesis Energy correlated back to 1932. Furthermore, there were changes to the ratings for Ahuriri at South Diadem, which is an input site into the Benmore tributary model. These changes impacted the mean and maximum flows for this dataset as shown in Table 4.2.

Table 4.2 Benmore tributaries (98614 (4)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	7.66	133.28	98.95	2791.82
2015	7.66	125.75	98.46	3562.68

#### 4.3. 98615 (2) Benmore\_tp

There are minor differences between the full updates for this data set because of rating changes to Ahuriri at South Diadem by NIWA. This has minorly altered the mean and median flows for the time period as evident in Table 4.3.

Table 4.3 Benmore tributaries (98615 (2)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	7.66	123.93	98.38	2312.92
2015	7.66	124.01	98.44	2312.92

#### 4.4. 98614 (2) Pukaki

There are differences in this file that stem from new Tekapo inflows that were provided by Genesis Energy correlated back to 1932. As this is an input file in the Pukaki calculation, this has resulted in differences for the entire dataset, as shown in Table 4.4.

Table 4.4 Pukaki (98614 (2)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	195.48	162.26	2829.44
2015	0.00	206.75	178.97	2799.44

#### 4.5. 98614 (1) Tekapo

There are differences in this file that stem from new Tekapo inflows that were provided by Genesis Energy correlated back to 1932. Furthermore, the consent conditions were updated in the script as it was found the maximum threshold for flow in the canal has increased to 130m<sup>3</sup>/s, which has altered the maximum inflow to the downstream Tekapo B power station. This has resulted in differences for the entire dataset, as shown in Table 4.5.

Table 4.5 Tekapo (98614 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	4.48	69.01	61.54	130.00
2015	2.00	80.22	100.01	120.00

#### 4.6. 98770 (2) Tekapo Naturals

There are differences in this file that stem from new Tekapo inflows that were provided by Genesis Energy correlated back to 1932. This required recalculation of the Tekapo Natural inflows, which explains the differences observed in Table 4.6.

Table 4.6 Tekapo Natural (98770 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.03	83.44	66.57	1175.35
2015	2.00	81.96	65.10	1552.15

#### 4.7. 98770 (1) Pukaki Naturals

There are minor differences from June 2011 to January 2013 because of alterations to Tekapo B Discharge, which is provided by Genesis Energy. This has resulted in a slight change to the summary statistics for the site, as shown in Table 4.7. Otherwise the dataset remains unchanged.

Table 4.7 Tekapo Natural (98770 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	126.51	98.24	2699.44
2015	0.00	126.57	98.35	2699.44

#### 4.8. 99550 (1) Manapouri local inflow (no Mararoa)

There are significant differences from 1976 to the present for Te Anau Outflow, which is an input site, which affects the Mararoa data series. The data was not averaged correctly in the last update in the output file; it was averaging from midday to midday, rather than midnight to midnight. There are no differences to the 'raw' data for Te Anau between the updates, however the different timing of the averaged data impacted the resulting Mararoa datasets. This has been rectified in this update. Furthermore, there has been a new rating curve applied to the Mararoa flow site from August 2014 which alters the daily flow values to a minor degree (Table 4.8).

Table 4.8 Manapouri local inflow (99550 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	122.32	79.15	2099.07
2015	0.00	122.61	78.24	2364.19

#### 4.9. 99551 (1) Manapouri local inflow (incl. Mararoa)

There are significant differences from 1976 to the present for Te Anau Outflow, which is an input site, which affects the Mararoa data series. The data was not averaged correctly in the last update in the output file; it was averaging from midday to midday, rather than midnight to midnight. There are no differences to the 'raw' data for Te Anau between the updates, however the different timing of the averaged data impacted the resulting Mararoa datasets. This has been rectified in this update. Furthermore, there has been a new rating curve applied to the Mararoa flow site from August 2014 which alters the daily flow values to a minor degree (Table 4.9).

Table 4.9 Manapouri local inflow (99551 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	-105.79	137.27	97.83	2099.07
2015	-105.79	137.11	96.65	2364.19

#### 4.10. 99552 (1) Manapouri local inflow (no Mararoa + water right reduction)

There are significant differences from 1976 to the present for Te Anau Outflow, which is an input site, which affects the Mararoa data series. The data was not averaged correctly in the last update in the output file; it was averaging from midday to midday, rather than midnight to midnight. There are no differences to the 'raw' data for Te Anau between the updates, however the different timing of the averaged data impacted the resulting

Mararoa datasets. This has been rectified in this update. Furthermore, there has been a new rating curve applied to the Mararoa flow site from August 2014 which alters the daily flow values to a minor degree (Table 4.10).

Table 4.10 *Manapouri local inflow (99552 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	-105.79	121.08	81.56	2099.07
2015	-105.79	120.82	80.14	2364.19

#### 4.11. 199540 (1) Monowai inflows

There are no differences for the Monowai inflow series as there have been no rating or control changes to the dataset (Table 4.11).

Table 4.11 *Monowai (199540 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.00	12.97	8.58	251.80
2015	0.00	12.97	8.58	251.80

#### 4.12. 99110 (1) Roxburgh tributary flows

There are minor differences to this data series because of two rating changes to Hawea River at Campbell Bridge, one of the input flow sites. These changes occurred in December 2012 and July 2013, and only result in small differences to the overall statistics for the site (Table 4.12).

Table 4.12 *Roxburgh (99110 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	2.84	445.23	399.30	3315.37
2015	2.84	445.25	399.34	3315.37

#### 4.13. 77106 (1) Grey + Taramakau - Taipo

This site is no longer newly created, as two of the input sites (Taipo River and Taramakau River) have been closed by NIWA. However, the last ratings have been updated from the last update, resulting in differences, including gap filling over data that was originally assumed to be zero. This has resulted in changes to the summary statistics as evident in Table 4.13.

Note that for both sets of data starting in 1979 to 1997 has been copied from an older update as this data was routinely created and stored on the archive and has a much higher quality.

Table 4.13 *Grey River (77106 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	42.03	436.87	319.60	7740.43
2015	0.00	436.15	317.83	7740.43

#### 4.14. 162105 (1) Waiau - Jollies

There are small differences as data provided by Environment Canterbury has undergone auditing, which involved minor alterations to all ratings for their sites. This has had a minor impact on the overall statistics for the site (Table 4.14).

Table 4.14 *Waiau at Jollies (162105 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	1.71	14.55	10.80	405.65
2015	1.71	14.54	10.73	405.65

#### 4.15. 164604 (1) Waiau – Glenhope

Environment Canterbury has undergone auditing of their data, which involved minor alterations to all ratings for their sites. As this site is no longer rated, a new rating relationship was established between this site and Waiau at Marble Point where the measured flow data overlap. This new correlation was then back calculated to 1932 and to the present. This new correlation used audited data that has undergone modification since the last update, and therefore explains the observed differences in the dataset, as shown in Table 4.15, notably at the top and bottom end of the flow spectrum.

Table 4.15 *Waiau at Glenhope (164604 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	6.60	33.92	26.46	582.84
2015	7.27	33.36	26.82	494.48

#### 4.16. 164602 (1) Waiau - Marble Point

There are small differences as data provided by Environment Canterbury has undergone auditing, which involved minor alterations to all ratings for their sites. This has had a minor impact on the overall statistics for the site (Table 4.16).

Table 4.16 *Waiau at Marble Point (164602 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	19.48	94.35	73.07	1578.58
2015	19.47	94.40	72.43	1578.58

#### 4.17. 160114 (1) Wairau – Dip Flat

There are small differences in this dataset from rating deletions and changes that have come from NIWA. This has had a minor impact on the overall statistics for the site (Table 4.17).

Table 4.17 *Waiau at Dip Flat (160114 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	4.01	26.46	20.23	587.88
2015	4.01	26.46	20.09	587.88

#### 4.18. 165104 (1) Hurunui – Mandamus

There are small differences in this dataset from rating deletions and changes that have come from NIWA. This has had a minor impact on the overall statistics for the site (Table 4.18).

Table 4.18 *Hurunui at Mandamus (165104 (1)) data difference table*

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	7.91	51.30	39.35	1066.08
2015	7.91	51.38	39.29	1066.08

#### 4.19. 165101 (1) Hurunui – SH1 Bridge

There are small differences in this dataset from rating deletions and changes that have come from NIWA. This has had a minor impact on the overall statistics for the site.

Table 4.19 Hurunui at SH1 Bridge (165101 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	9.67	66.39	52.05	1827.52
2015	9.67	66.55	52.07	1827.52

#### 4.20. 9154 (1) Lake Wanaka

There are no changes as the rating shave not changed for this site since the last update (Table 4.20).

Table 4.20 Lake Wanaka (9154 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	38.71	196.70	175.43	1414.18
2015	38.71	196.70	175.43	1414.18

#### 4.21. 9170 (1) Lake Hawea

There are no changes as the rating shave not changed for this site since the last update (Table 4.21).

Table 4.21 Lake Hawea (9170 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	2.00	64.83	47.81	1633.93
2015	2.00	64.83	47.81	1633.93

#### 4.22. 9570 (1) Lake Te Anau

There are no differences to the Te Anau Inflow series, as no ratings or relationships have changed for this site between updates (Table 4.22).

Table 4.22 Lake Te Anau (9570 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	0.03	283.13	184.41	4830.50
2015	0.03	283.13	184.41	4830.50

#### 4.23. 98614 (1) Ohau Inflows

There are no differences to the Ohau Inflows, as no ratings or relationships have changed for this site between updates (Table 4.23).

Table 4.23 Ohau Inflows (98614 (1)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	2.00	80.64	63.61	1605.93
2015	2.00	80.64	63.61	1605.93

#### 4.24. 98614 (2) Ohau Residual Inflows

There changes as it was identified the original simulation from 1996 had the consent conditions entered incorrectly; this resulted in the minimum and maximum flows were calculated incorrectly. This error was not picked up on until this update. It has been rectified in this update, and therefore has resulted in changes, as shown in Table 4.24.

Table 4.24 Ohau Residual Inflows (98614 (2)) data difference table

UPDATE YEAR	MINIMUM (M <sup>3</sup> /S)	MEAN (M <sup>3</sup> /S)	MEDIAN (M <sup>3</sup> /S)	MAXIMUM (M <sup>3</sup> /S)
2018	-10.00	70.65	53.21	1593.93
2015	-8.44	70.62	53.96	1597.93

## 5. Negative Flows in Datasets

The HMD series are derived to indicate potential generation. Therefore, a negative value implies that there is no water for generation. In reality, negative data cannot exist as this implies that water is being lost from the system. Therefore, although a negative data value is not incorrect it shows that there is no water available for generation.

The following four flow sites have negative flows in their dataset.

- Lake Waikaremoana - 3650: Waikaremoana inflows has negatives because of leakage from Lake Waikaremoana. WSP Opus, who previously calculated Waikaremoana inflows on behalf of Genesis, had a minimum inflow value to ensure that no negative inflows were calculated. Genesis prefers to have negative inflows in the data until a solution can be found to quantify and resolve lake leakage. For the purposes of this update, the negatives have been zeroed at the request of the Electricity Authority.
- OhauRes - 98614(6): This dataset has negative data values when the inflow to Lake Ohau drops below the required residual consent flow of 8m<sup>3</sup>/s for 1 May to 31 October and 12m<sup>3</sup>/s for 1 November to 30 April.
- Manareduced - 99552: This dataset simulates the effects of minimum flow regimes, Mararoa dirty water spill, and flushing and recreational flows. The dataset will have negative values if the inflow to Lake Manapouri is less than the required 150m<sup>3</sup>/s flushing and recreational consent flows. In some instances when the Mararoa is in flood, and the spill of dirty water is required (if flow is greater than 40m<sup>3</sup>/s), because of the outflows timing issues inflows to Manapouri will be less than outflows resulting in negative water.
- Manawmara - 99551: This dataset only simulates the effects of dirty water flows. In some instances, when the Mararoa is in flood and the spill of dirty water is required (if the flow is greater than 40m<sup>3</sup>/s), because of timing issues inflows to Manapouri will be less than outflows resulting in negative water.

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