



# Hydrology State of the Environment monitoring programme

Annual data report, 2016/17

M Harkness  
Environmental Science Department

For more information, contact the Greater Wellington Regional Council:

Wellington  
PO Box 11646

Masterton  
PO Box 41




T 04 384 5708  
F 04 385 6960  
[www.gw.govt.nz](http://www.gw.govt.nz)

T 06 378 2484  
F 06 378 2146  
[www.gw.govt.nz](http://www.gw.govt.nz)

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[www.gw.govt.nz](http://www.gw.govt.nz)  
[info@gw.govt.nz](mailto:info@gw.govt.nz)

<b>Report prepared by:</b>	M Harkness	Senior Analyst	
<b>Report reviewed by:</b>	M Gordon	Senior Analyst	
<b>Report approved for release by:</b>	L Butcher	Manager, Environmental Science	 <b>Date:</b> December 2017

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# Contents

<b>1.</b>	<b>Introduction</b>	<b>1</b>
<b>2.</b>	<b>Overview of Hydrology SoE monitoring programme</b>	<b>2</b>
2.1	Monitoring objectives	2
2.2	Monitoring network	3
2.2.1	Rainfall	3
2.2.2	River levels and flow	3
2.2.3	Lake levels	4
2.2.4	Wetland levels	4
2.2.5	Tide levels	4
2.2.6	Soil moisture	4
2.2.7	Groundwater levels	5
2.2.8	Whaitua areas	5
<b>3.</b>	<b>Results</b>	<b>10</b>
3.1	Rainfall	10
3.1.1	Annual rainfall	10
3.1.2	Monthly and seasonal rainfall	12
3.1.3	Maximum rainfalls	15
3.1.4	Low rainfall	17
3.2	River flows	18
3.2.1	Mean flows	18
3.2.2	Maximum recorded flows	20
3.2.3	Lowest recorded flows	21
3.2.4	Low flow threshold exceedances	23
3.2.5	Floodwarning alarm level exceedances	24
3.3	Groundwater levels	27
3.4	Lake and wetland levels	29
3.5	Soil moisture	31
	<b>References</b>	<b>32</b>



## 1. Introduction

Greater Wellington Regional Council (GWRC) operates a hydrometric network for measuring rainfall, river levels, lake levels, groundwater levels, tide levels and soil moisture.

This report contains key results from the Hydrology State of Environment (SoE) monitoring programme for the period 1 July 2016 to 30 June 2017 inclusive. Summaries of the recorded data are compared to long term averages, and any significant hydrological events are detailed.

The Hydrology SoE programme is solely concerned with collecting data on the 'quantity' of the Region's water resources. GWRC operates other monitoring programmes which gather information on water quality and ecosystem health that are reported on separately. Refer to:

- Rivers Water Quality and Ecology monitoring programme: Annual Data Report 2016/17 (Martin, Morar & Heath, 2017)
- Groundwater Quality State of the Environment monitoring programme: Annual Data Report 2016/17 (Baker, 2017)
- Lakes Water Quality and Ecology monitoring programme: Annual Data Report 2016/17 (Perrie, 2017)
- Coastal Water Quality and Ecology monitoring programme: Annual Data Report 2016/17 (Conwell & Oliver, 2017)
- Terrestrial Ecology State of the Environment monitoring programme: Annual Data Report 2016/17 (Uys, 2017)
- Soil Quality State of the Environment monitoring programme: Annual Data Report 2016/17 (Drewry, 2017)

## 2. Overview of Hydrology SoE monitoring programme

Rainfall and river levels have been monitored for many years in the Wellington Region. Some of the earliest rainfall records date back to 1878 at the Karori Reservoir site and 1890 at the Wainuiomata Reservoir site. Over the years the Region's hydrometric network has evolved and grown and now comprises:

- 62 rainfall sites
- 57 river level/flow recording sites
- 6 lake level sites
- 8 wetland water level sites
- 2 tide level sites
- 7 soil moisture sites
- 60 groundwater level sites (plus a further 71 manually monitored sites).

All hydrological data are captured, processed and archived in accordance with national and international standards and quality assurance procedures. Telemetered rainfall, river, lake, groundwater and tide data are available at <http://graphs.gw.govt.nz/>.

### 2.1 Monitoring objectives

The information collected is used for:

- Providing information on the state of our water resources and the baseline quantity of water
- Detecting long and short term trends in climate and water resources
- Making informed decisions on the state of the Region's freshwater resources and managing its sustainable allocation and use
- Informing whaitua committees to enable the creation of a unique vision and to prioritise objectives for land and water management
- Policy and Regional Plan development and review
- Providing flood and drought warnings
- Resource consent monitoring.

## 2.2 Monitoring network

### 2.2.1 Rainfall

Figure 2.1 shows the distribution of the 62 rainfall sites maintained by GWRC. There is good coverage across much of the Region with the exception of the Eastern Wairarapa hill country where the distribution of sites is sparse.

Currently 13 rainfall sites are operated on behalf of Wellington Water and one on behalf of NZTA.

All rainfall sites are automatic and record rainfall amounts into a data logger on site. The majority of sites are telemetered back to the GWRC database to allow real time monitoring.

There are two measuring devices at each site; an automatic tipping-bucket rain gauge that records rainfall amounts in 0.5mm or 0.2mm increments and a check/storage gauge that collects and stores all rainfall between site visits by the monitoring team when it is measured and emptied.

A number of rainfall sites have alarm levels that are automatically triggered if a high intensity rainfall above a certain threshold occurs. Alarms are received by flood-warning staff and a flood event will be monitored at any time of the day with warnings issued to relevant authorities and landowners if dangerous flood levels are predicted.

### 2.2.2 River levels and flow

River levels are recorded at 57 sites across the Wellington Region. The distribution of the sites is shown in Figure 2.2 and is similar to the rainfall network. During the 2016/17 year one site was operated solely by NIWA, another three were jointly maintained by NIWA and GWRC and one was jointly maintained by NZTA and GWRC.

River level sites were originally installed for a number of reasons including flood warning, public water supply and water resource monitoring. As such the network tends to concentrate on the larger rivers and the upper parts of catchments. This has been changing over time as GWRC undertakes more monitoring in agricultural and urban areas and in the lower reaches of the catchments to manage abstractions, maintain environmental flows and ensure regional plan rules are being met.

All river sites are automatic and typically record river levels every five to 15 minutes. Data are stored on loggers at the site, as well as being sent back to the GWRC database via telemetry to allow for real time monitoring.

GWRC staff also physically measure the amount of flow in rivers and streams by completing a 'flow gauging' using specialised equipment, and can measure from a trickle in a ditch to a major flood in the Ruamahanga River. The gauged flow and the water level at the time of the flow gauging are used to build up a flow-rating relationship that is used to convert the continuously measured river water levels into flow values. The flow-rating relationships at each site change often due to events such as a flood which might alter the river bed level,

therefore gaugings are undertaken regularly to ensure the correct flows are being calculated from the recorded water levels.

Most river sites have flood alarm levels that are automatically triggered if a river level rises above a certain threshold. Alarms are received by flood-warning staff and a flood event will be monitored at any time of the day with warnings to relevant authorities and landowners issued if dangerous flood levels are predicted.

### 2.2.3 Lake levels

The location of the six lake sites are shown in Figure 2.3. Three are situated on Lake Wairarapa to monitor compliance with minimum water levels and to monitor lake levels for flood control. The prescribed minimum lake water levels are set out in the Lake Wairarapa Wetlands Management Guidelines (Lake Wairarapa Co-ordinating Committee 1991), the Regional Freshwater Plan (GWRC 1999), and the Proposed Natural Resources Plan for the Wellington Region (GWRC 2015).

The site at Lake Onoke is monitored for flood control purposes, particularly if the lake opening to the sea becomes blocked.

The other two lake sites have been operating since 2007 and monitor the levels of Lake Kohangapiripiri and Lake Kohangatera (collectively known as the Parangarahu Lakes). These lakes are part of East Harbour Regional Park and are of national significance.

### 2.2.4 Wetland levels

Wetland monitoring is a relatively recent development in GWRC's hydrological network. GWRC currently operate eight continuous water level recorders on two wetland areas. Four of those are sited in the Te Hapua wetland complex near Te Horo on the Kapiti Coast. The remaining sites are situated on the Nga Manu wetland near Waikanae, the Taumata Lagoon near the confluence of the Waiohine and Ruamahanga rivers in the Wairarapa, and Tent Lagoon and Boggy Pond on the eastern shores of Lake Wairarapa. The locations of these sites are shown in Figure 2.3.

### 2.2.5 Tide levels

Tide levels are monitored at two sites; Wellington Harbour at Queens Wharf and Porirua Harbour at the Mana Cruising Club. The locations of these sites are shown in Figure 2.3.

Two other sites (Hutt River at Estuary Bridge and Lake Onoke at Lake Ferry) can also be used to infer tide levels as they are situated at the mouths of the Hutt and Ruamahanga rivers respectively.

### 2.2.6 Soil moisture

Soil moisture is monitored at nine sites in the Region. The locations of these sites are shown in Figure 2.3.

Knowing the water content of soil is important for managing groundwater recharge, assessing agricultural irrigation needs and soil chemistry. It is also



used for analysis of long-term climate trends, measuring how often plant growth is restricted by soil moisture and providing an indication for early intervention and drought management decisions.

### 2.2.7 Groundwater levels

The groundwater monitoring network covers the three principal groundwater areas in the Region; Lower Hutt Valley, Kapiti Coast and Wairarapa Valley. The network utilises dedicated monitoring boreholes as well as privately owned boreholes, the location of sites are shown in Figure 2.4.

Continuous data on groundwater levels are collected at 60 bores. These are automatic sites where the groundwater level is recorded every five to 15 minutes and stored in a data logger at the site. The majority of sites are also linked to GWRC's database via telemetry. Some of the sites have separate recorders in two bores (for example, a deep bore and a shallow bore).

In addition to the automatic monitoring sites, GWRC also manually measures groundwater levels at a further 71 sites every four to seven weeks. Data from these manual sites can be compared to data from automatic sites to provide a fuller picture of the state of the Region's groundwater resource.

A number of these sites are also part of the groundwater quality network which is reported on separately (Baker, 2017).

### 2.2.8 Whaitua areas

Managing the water resources of our Region in a way that meets current needs and those of future generation's means that we need to understand what is important to people in their local area.

GWRC has identified five areas that place different demands on land and water resources and has enlisted the support of community groups called whaitua committees to help understand local needs and make recommendations on how they are to be managed. The Māori word whaitua means a designated space or catchment.

Whaitua committees will be established for the Wairarapa East Coast, Ruamāhanga Valley, Wellington/Hutt Valley, Porirua Harbour and Kāpiti Coast over the next few years. They will combine the knowledge and experience of the community who live in the catchment: iwi, householders, farmers, scientists, recreationalists and environmentalists.

The Ruamāhanga Whaitua Committee and the Te Awarua-o-Porirua Whaitua Committee have been established to date.

The whaitua areas are referenced throughout this report and in particular the areas are shown on the maps of the monitoring network in Figures 2.1 to 2.4.

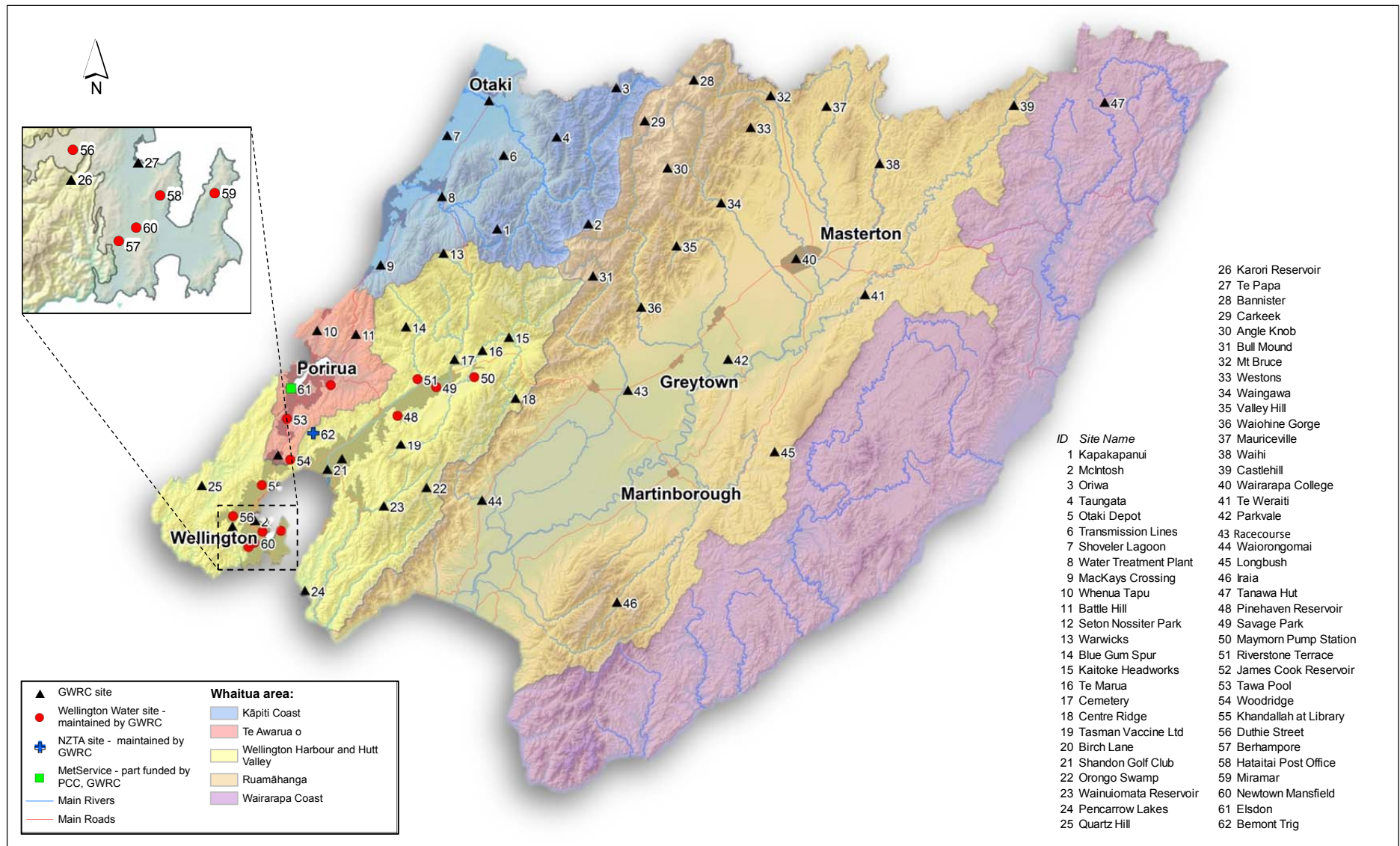


Figure 2.1: Automatic rainfall monitoring sites 2016/17

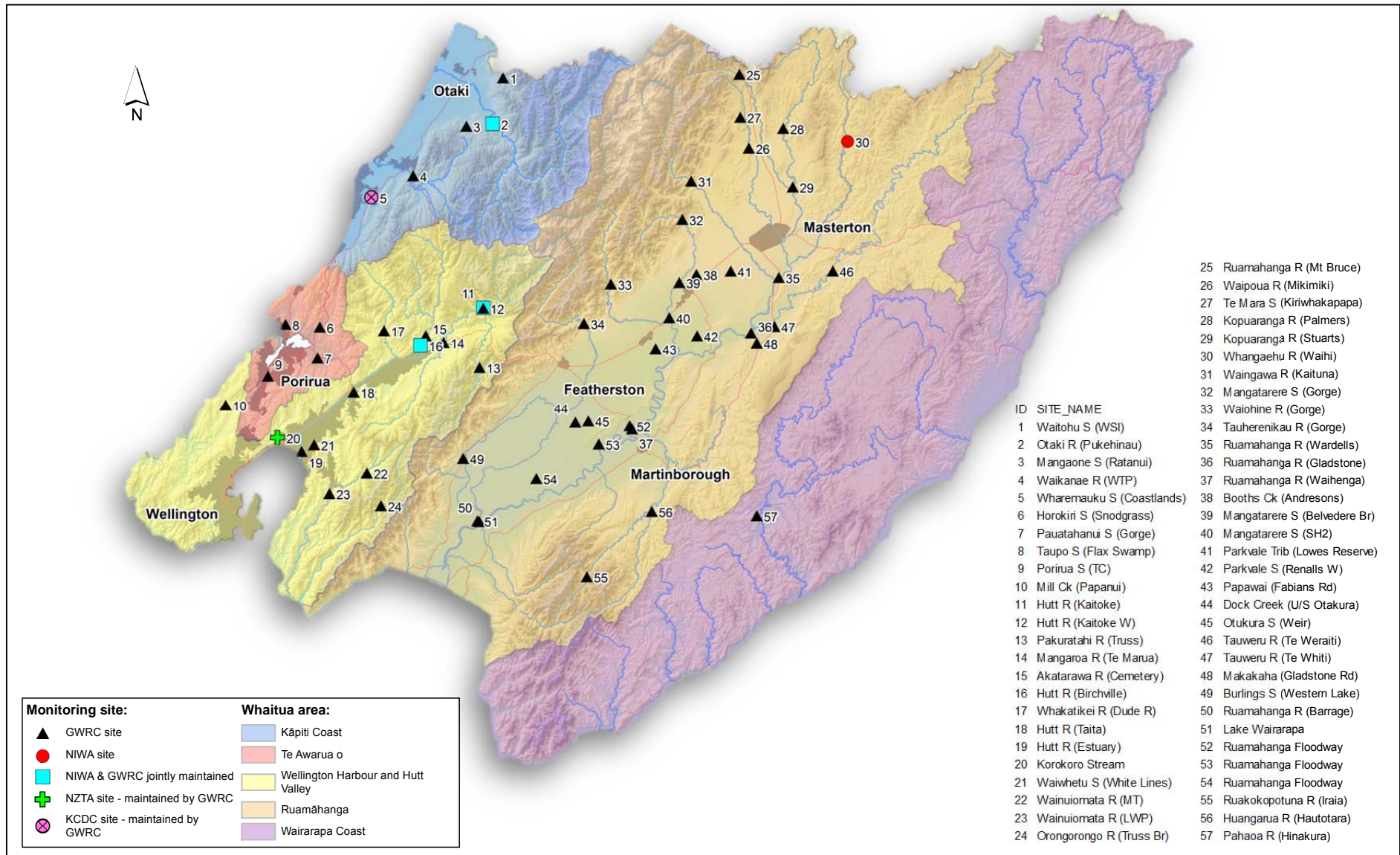


Figure 2.2: Automatic river level/flow monitoring sites 2016/17



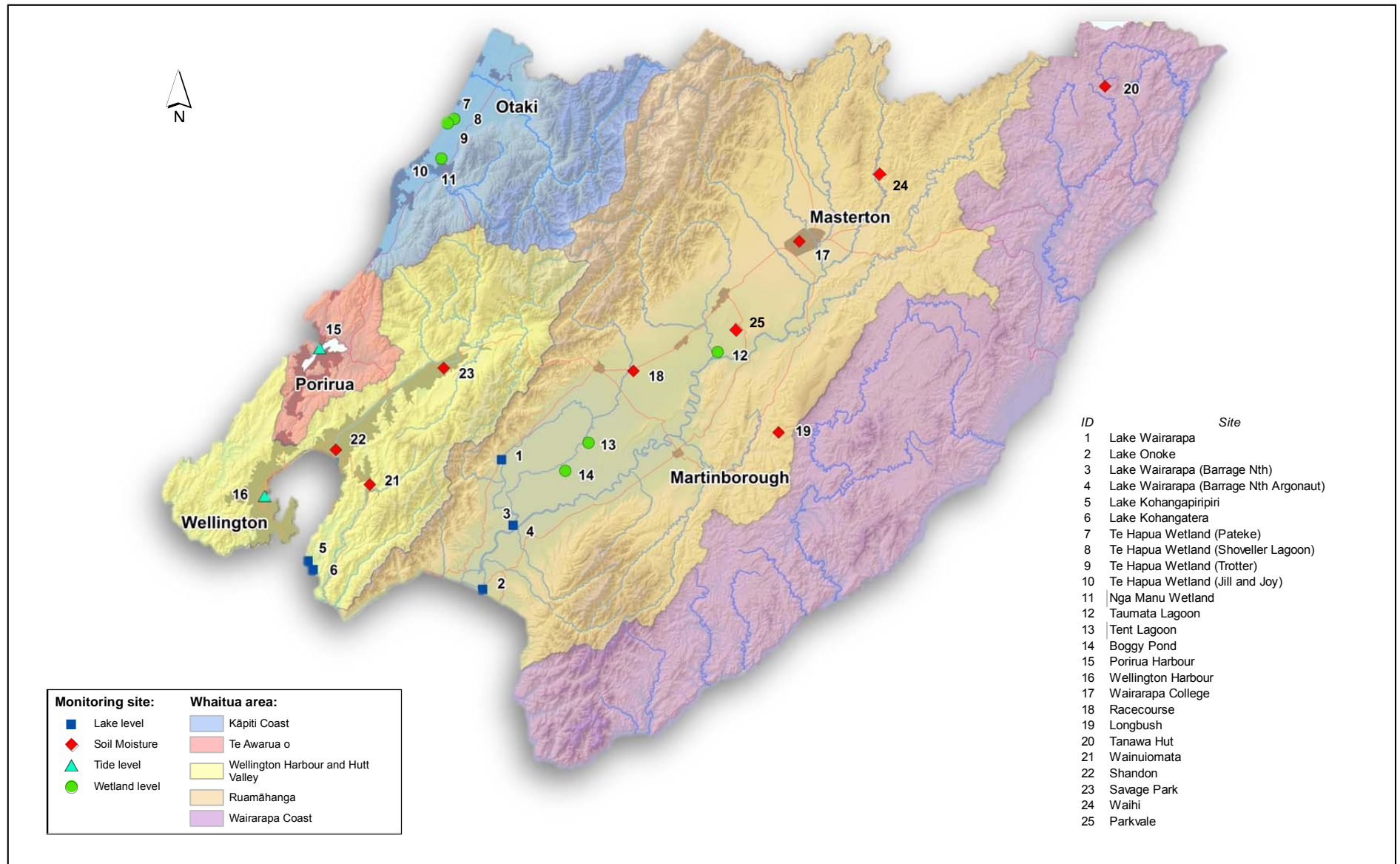


Figure 2.3: Automatic lake level, wetland level, tide level and soil moisture monitoring sites 2016/17

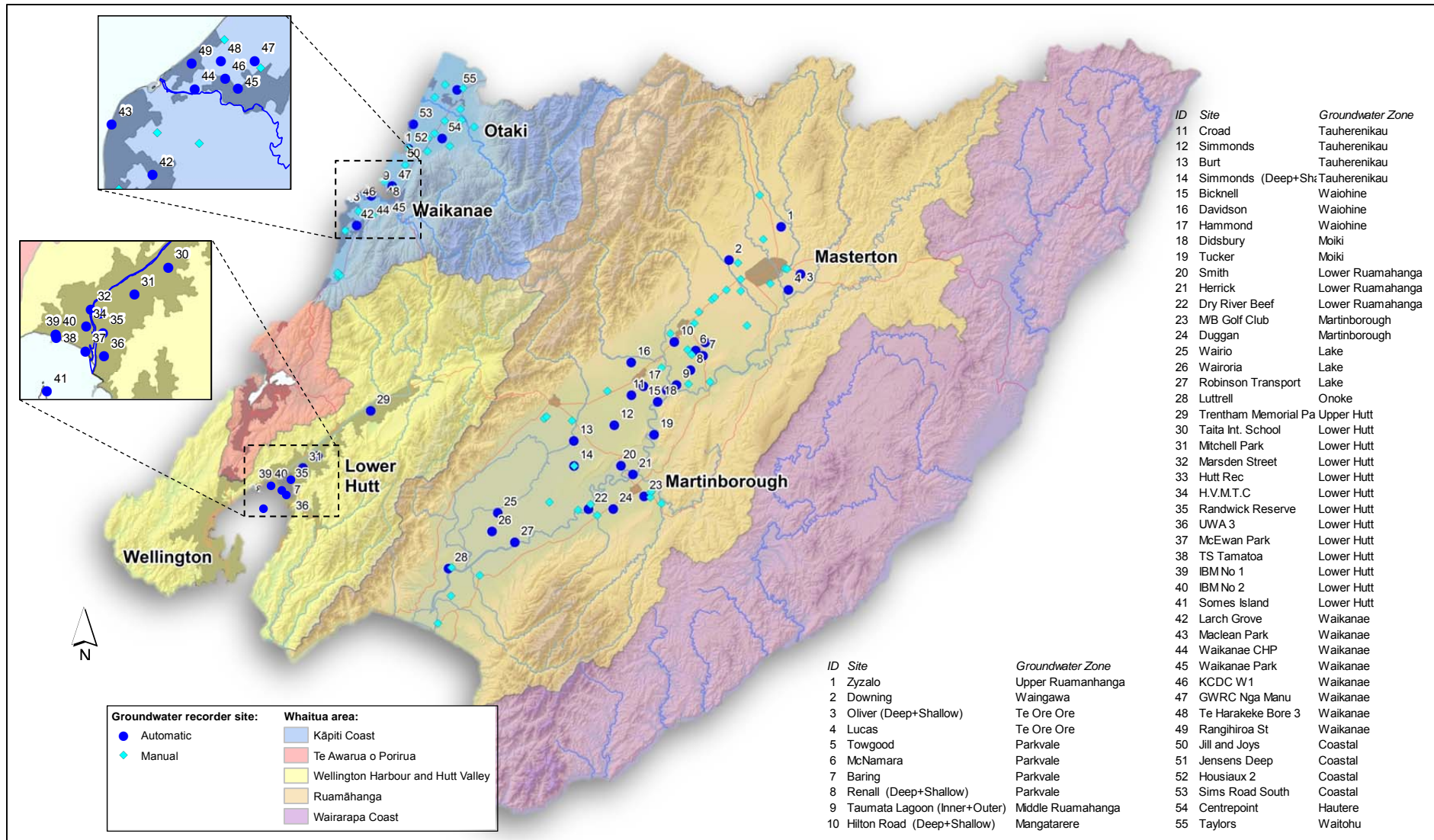


Figure 2.4: Groundwater level sites 2016/17

### 3. Results

#### 3.1 Rainfall

##### 3.1.1 Annual rainfall

Table 3.1 summarises the total annual rainfall for 2016/17 at a range of monitoring sites across the Region, grouped by whitua area. Sites with greater than 20 percent difference from their long term average are shaded orange (below average) and blue (above average).

**Table 3.1: Annual rainfall totals (2016/17) and percentage of long term average**

Rainfall Site	Catchment	2016/17 total (mm)	Average (mm) <i>(Data period)</i>	% of long term average
<b>Kāpiti Coast whitua</b>				
Oriwa (Tararua)	Otaki	6686	4700 <i>(1991-2016)</i>	142
McIntosh (Tararua)	Otaki	6637	5133 <i>(1991-2016)</i>	129
Taungata (Tararua)	Otaki	4076	2932 <i>(1991-2016)</i>	139
Kapakapanui (Tararua)	Otaki	3532	2427 <i>(1991-2016)</i>	155
Transmission Lines	Mangaone	2270	1658 <i>(1992-2016)</i>	137
Otaki Depot	Otaki	1353	1022 <i>(1984-2016)</i>	132
Shoveler Lagoon	Te Hapua Wetlands	1197	933 <i>(2008-2016)</i>	128
Water Treatment Plant	Waikanae	1649	1231 <i>(1991-2016)</i>	134
McKay's Crossing	Whareroa	1313	1195 <i>(1991-2016)</i>	110
<b>Wellington Harbour and Hutt Valley whitua</b>				
Warwicks	Akatarawa	3145	2260 <i>(1980-2016)</i>	139
Blue Gum Spur	Whakatikei	2567	1907 <i>(1991-2016)</i>	135
Kaitoke Headworks	Hutt	2702	2270 <i>(1950-2016)</i>	119
Te Marua	Hutt	2277	1839 <i>(1993-2016)</i>	124
Tasman Vaccine Ltd	Mangaroa	1828	1560 <i>(1968-2016)</i>	117
Cemetery	Akatarawa	2113	1681 <i>(1988-2016)</i>	126
Pinehaven	Hutt	1583	1402 <i>(1978-2016)</i>	113
Birch Lane/Mabey Rd	Hutt	1386	1220 <i>(1995-2016)</i>	114
Shandon Golf Club	Hutt	1301	1013 <i>(2000-2016)</i>	128
Quartz Hill	Makara	1185	1086 <i>(2007-2016)</i>	109
Khandallah at Library	Wellington City	1484	1203 <i>(1996-2016)</i>	123
Karori Reservoir	Kaiwharawhara	1499	1322 <i>(1951-2016)</i>	113
Te Papa	Wellington City	1396	958 <i>(1996-2016)</i>	146
Hataitai Post Office	Wellington City	1166	970 <i>(1997-2016)</i>	120
Newtown Mansfield	Wellington City	1335	1022 <i>(1996-2016)</i>	131
Orongo Swamp	Orongorongo	2821	2436 <i>(1980-2016)</i>	116
Wainuiomata Reservoir	Wainuiomata	1817	1888 <i>(1951-2016)</i>	96
Pencarrow Lakes	Pencarrow Lakes	1142	875 <i>(2007-2016)</i>	131

Table 3.1 (continued)

Rainfall Site	Catchment	2016/17 total (mm)	Average (mm) (Data period)	% of long term average
<b>Te Awarua-o-Porirua whaitua</b>				
Battle Hill	Horokiri	1642	1161 (2003-2016)	142
Whenua Tapu	Taupo	1298	1047 (1990-2016)	124
Tawa Pool	Porirua	1290	1115 (1996-2016)	116
Seton Nossiter Park	Porirua	1469	1138 (1992-2016)	129
<b>Ruamāhanga whaitua</b>				
Bannister (Taranua)	Ruamahanga	8033	6140 (1974-2016)	131
Carkeek (Taranua)	Waiohine	5428	4540 (1976-2016)	120
Mt Bruce	Ruamahanga	2814	2383 (1997-2016)	118
Westons	Waipoua	2913	2421 (2007-2016)	120
Angle Knob (Taranua)	Waingawa	8356	6982 (1974-2016)	120
Bull Mound (Taranua)	Tauherenikau	4729	4490 (1976-2016)	105
Waiohine Gorge	Waiohine	2600	2131 (1974-2016)	122
Mauriceville	Kopuaranga	1721	1434 (2007-2016)	120
Waihi	Whangaehu	1113	1112 (2001-2016)	100
Castlehill	Tauweru	1127	1142 (1991-2016)	99
Wairarapa College	Ruamahanga	967	878 (2002-2016)	110
Racecourse	Tauherenikau	1228	1038 (1999-2016)	118
Matthews	Waiorongomai	1494	1424 (2008-2016)	105
Longbush	Waikoukou	937	928 (1955-2016)	101
<b>Wairarapa Coast whaitua</b>				
Tanawa Hut	Whareama	1256	1294 (1955-2016)	97



### 3.1.2 Monthly and seasonal rainfall

Monthly rainfall totals at a number of rainfall monitoring sites across the Region are shown in Figure 3.1.

The 2016/17 totals are compared to the long term monthly average.

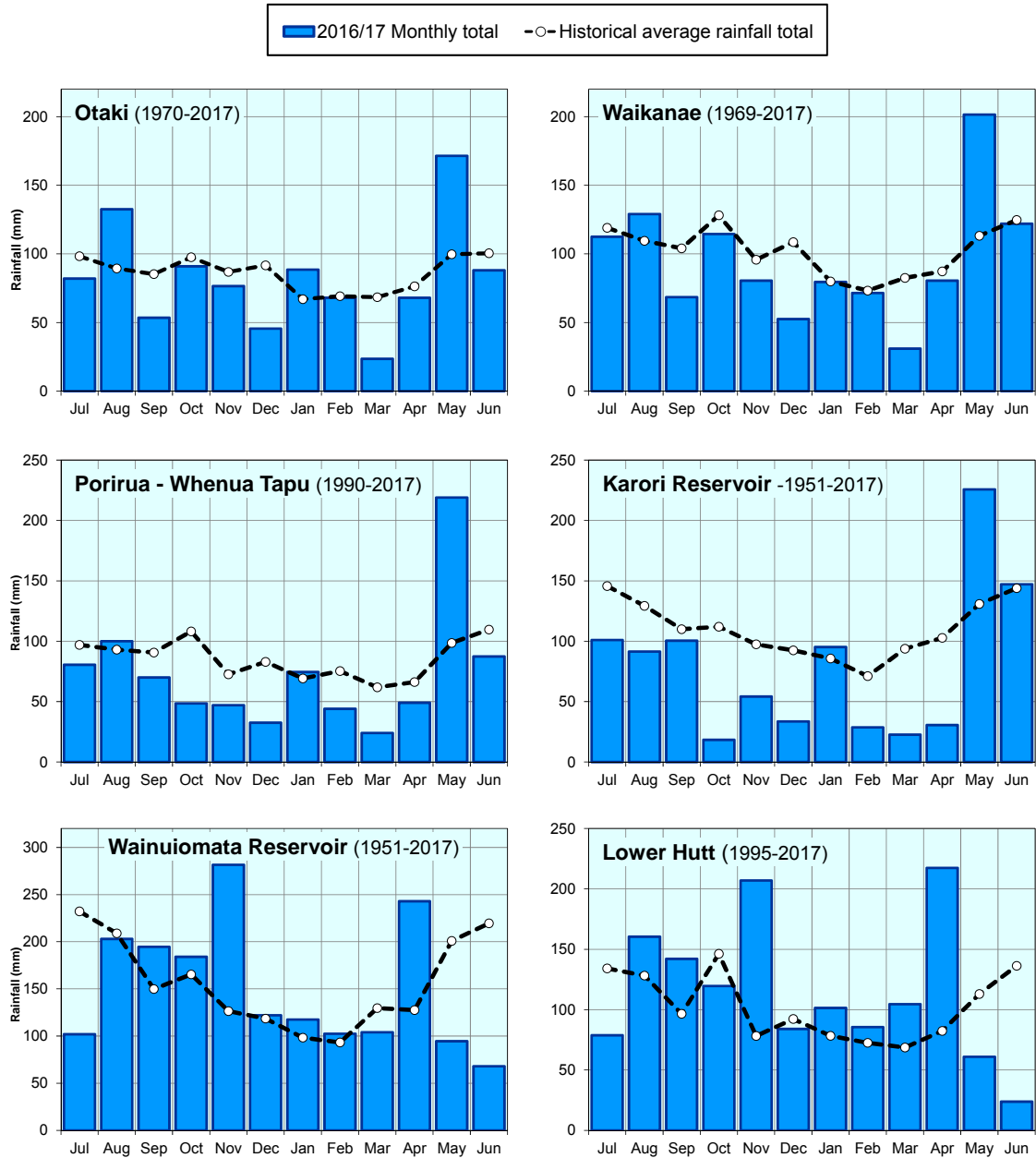


Figure 3.1: Monthly rainfall totals (2016/17) and long-term averages



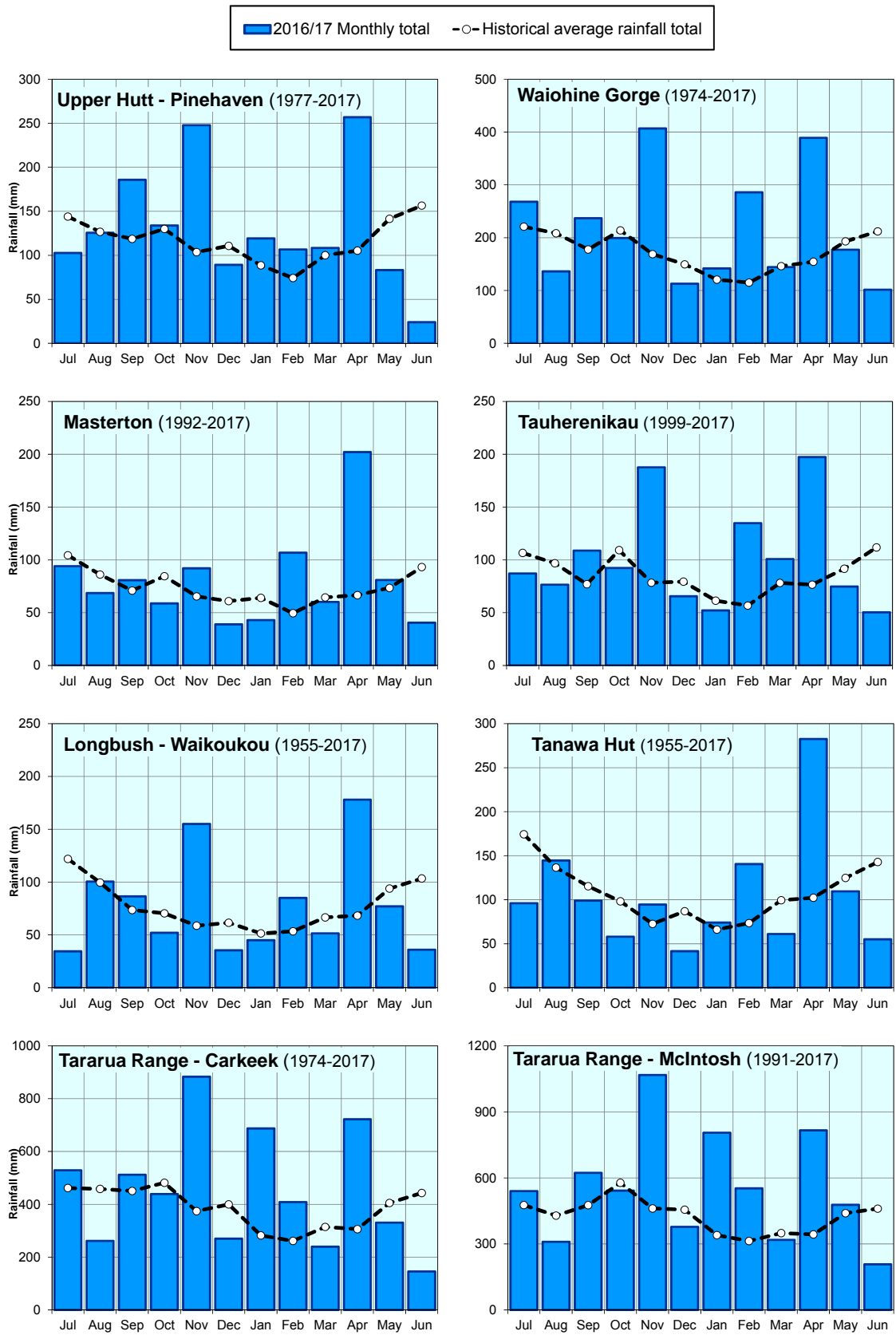


Figure 3.1 (continued)

Seasonal rainfall totals for locations across the Wellington Region are presented in Table 3.2.

Sites that have a greater than 20 percent difference from their long term seasonal average are shaded orange (below average) or blue (above average).

**Table 3.2: Seasonal rainfall totals as percentage of long-term mean**

Whaitua area	Rain gauge location	Rainfall as a percentage of the long term average			
		Winter 2016	Spring 2016	Summer 2016/17	Autumn 2017
Kāpiti Coast	Otaki	102%	157%	124%	180%
	Waikanae	89%	178%	133%	175%
	McKay's Crossing	73%	168%	117%	152%
	McIntosh (Tararua Range)	103%	147%	160%	142%
Te Awarua-o-Porirua	Whenua Tapu	88%	169%	94%	187%
	Paparangi	89%	168%	108%	148%
Wellington Harbour and Hutt Valley	Kaitoke	90%	147%	135%	132%
	Lower Hutt	95%	146%	110%	147%
	Wainuiomata	80%	146%	101%	92%
	Newtown	90%	180%	121%	168%
	Karori	92%	177%	97%	134%
	Makara	87%	151%	97%	119%
Ruamāhanga	Mt Bruce	111%	114%	147%	134%
	Waihi	75%	99%	105%	174%
	Castlehill	76%	85%	113%	158%
	Masterton	75%	109%	113%	168%
	Featherston	76%	147%	124%	150%
	Longbush	63%	144%	100%	135%
	Carkeek (Tararua Range)	96%	142%	144%	130%
Wairarapa Coast	Tanawa Hut	53%	88%	113%	136%

### 3.1.3 Maximum rainfalls

An analysis of the maximum recorded rainfall totals during the 2016/17 year for specific time periods of 1, 6 and 12 hour durations is detailed in Table 3.3.

Return periods have been estimated by frequency analysis. Values in blue shaded cells indicate a rainfall total with a 5-year return period or greater.

**Table 3.3: Maximum short duration rainfall totals during 2016/17**

Site	1 hour		6 hours		12 hours	
	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)
Otaki Depot (Otaki)	13mm <i>30 Apr 2017</i>	<2	34.2mm <i>30 Apr 2017</i>	<2	46.4mm <i>30 Apr 2017</i>	<2
McKay's Crossing (Paekakariki) <sup>1</sup>	16.9mm <i>12 Mar 2017</i>	<2	46.8mm <i>15 Nov 2016</i>	2	66mm <i>12 Mar 2017</i>	3
Warwicks (Akatarawa)	28.5mm <i>18 Feb 2017</i>	4	86.8mm <i>2-Feb-2017</i>	6	136.2mm <i>2-Feb-2017</i>	10
Te Marua (Upper Hutt)	16.2mm <i>2-Feb-2017</i>	<2	67.8mm <i>2-Feb-2017</i>	3	97.1mm <i>2-Feb-2017</i>	3
Tasman Vaccine Ltd (Mangaroa)	24.4mm <i>16 Apr 2017</i>	3	74.7mm <i>15 Nov 2016</i>	12	91.1mm <i>15 Nov 2016</i>	6
Birch Lane (Lower Hutt)	16.8mm <i>12 Mar 2017</i>	<2	55.4mm <i>15 Nov 2016</i>	3	64.6mm <i>15 Nov 2016</i>	2
Wainuiomata Reservoir (Wainuiomata)	14.1mm <i>15 Nov 2016</i>	<2	59.3mm <i>15 Nov 2016</i>	3	67.5mm <i>15 Nov 2016</i>	2
Seton Nossiter Park (Paparangi)	17.6mm <i>23 Dec 2016</i>	<2	47.2mm <i>15 Nov 2016</i>	3	64.3mm <i>18 Sep 2016</i>	3
Karori Reservoir (Wellington City)	16.7mm <i>23 Dec 2016</i>	<2	53.3mm <i>5-Apr-2017</i>	4	71.9mm <i>12 Nov 2016</i>	5
McIntosh (W Tararua Range)	38.6mm <i>24 May 2017</i>	50	124.6mm <i>2-Feb-2017</i>	6	206.5mm <i>2-Feb-2017</i>	9
Bannister Basin (E Tararua Range)	34mm <i>15 Dec 2016</i>	3	147.2mm <i>2-Feb-2017</i>	6	275.6mm <i>2-Feb-2017</i>	21
Waiohine Gorge <sup>2</sup> (Waiohine)	28.7mm <i>18 Feb 2017</i>	7	72.5mm <i>18 Feb 2017</i>	4	80mm <i>17 Feb 2017</i>	2
Wairarapa College (Masterton) <sup>1</sup>	14.4mm <i>17 Feb 2017</i>	2	30.2mm <i>17 Feb 2017</i>	<2	50.8mm <i>17 Feb 2017</i>	3
Tauherenkau Racecourse (Featherston) <sup>3</sup>	10.6mm <i>12 Mar 2017</i>	<2	38mm <i>17 Feb 2017</i>	4	56.6mm <i>7-Nov-2016</i>	5
Castlehill (Tauweru)	10.3mm <i>13 Apr 2017</i>	<2	37.1mm <i>17 Feb 2017</i>	2	61.2mm <i>17 Feb 2017</i>	2
Tanawa Hut (Whareama)	19mm <i>13 Apr 2017</i>	3	51mm <i>13 Apr 2017</i>	3	70.5mm <i>17 Feb 2017</i>	2

<sup>1</sup> Return period estimated using HIRDS v3.0 (NIWA 2011).

<sup>2</sup> Return period estimated using neighbouring 'Waiohine at Phelps' site that was closed in January 2010.

<sup>3</sup> Return period estimated combining Racecourse data with 'Alloa' site that was closed in November 2012

An analysis of the maximum recorded rainfall totals during the 2016/17 year for longer duration events of 24, 48 and 72 hour durations is detailed in Table 3.4.

Return periods have been estimated by frequency analysis. Values in blue shaded cells indicate a rainfall total with a 5-year return period or greater.

**Table 3.4: Maximum long duration rainfall totals during 2016/17**

Site	24 hour		48 hours		72 hours	
	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)	Rainfall Start date	Return period (years)
Otaki Depot (Otaki)	56.7mm <i>17 Sep 2016</i>	2	94.5mm <i>17 Sep 2016</i>	5	96mm <i>17 Sep 2016</i>	4
McKay's Crossing (Paekakariki) <sup>1</sup>	79.9mm <i>12 Mar 2017</i>	2	109mm <i>11 Mar 2017</i>	4	110.5mm <i>12 Mar 2017</i>	3
Warwicks (Akatarawa)	150mm <i>2-Feb-2017</i>	3	186.1mm <i>17 Sep 2016</i>	3	195.5mm <i>17 Sep 2016</i>	3
Te Marua (Upper Hutt)	107.1mm <i>17 Sep 2016</i>	2	152.5mm <i>17 Sep 2016</i>	4	156.5mm <i>17 Sep 2016</i>	3
Tasman Vaccine Ltd (Mangaroa)	102.5mm <i>15 Nov 2016</i>	3	108.3mm <i>17 Sep 2016</i>	2	120.6mm <i>16 Nov 2016</i>	2
Birch Lane (Lower Hutt)	76.8mm <i>15 Nov 2016</i>	2	97mm <i>5-Apr-2017</i>	2	109.8mm <i>5-Apr-2017</i>	2
Wainuiomata Reservoir (Wainuiomata)	81mm <i>15 Nov 2016</i>	<2	107.1mm <i>5-Apr-2017</i>	<2	123mm <i>5-Apr-2017</i>	<2
Seton Nossiter Park (Paparangi)	90.1mm <i>6-Apr-2017</i>	7	115.6mm <i>5-Apr-2017</i>	8	131.4mm <i>5-Apr-2017</i>	8
Karori Reservoir (Wellington City)	95.2mm <i>12 Nov 2016</i>	9	103.2mm <i>5-Apr-2017</i>	3	120.4mm <i>11 Nov 2016</i>	3
McIntosh (W Tararua Range)	227.5mm <i>2-Feb-2017</i>	3	280.5mm <i>17 Sep 2016</i>	2	304mm <i>11 Nov 2016</i>	2
Bannister Basin (E Tararua Range)	320mm <i>2-Feb-2017</i>	7	422mm <i>2-Feb-2017</i>	8	448.5mm <i>1-Feb-2017</i>	6
Waiohine Gorge <sup>2</sup> (Waiohine)	100.7mm <i>18 Feb 2017</i>	2	165mm <i>17 Feb 2017</i>	4	177mm <i>18 Feb 2017</i>	4
Wairarapa College (Masterton) <sup>1</sup>	71.6mm <i>5-Apr-2017</i>	2	113.6mm <i>4-Apr-2017</i>	7	135.8mm <i>4-Apr-2017</i>	9
Tauherenikau Racecourse (Featherston) <sup>3</sup>	65.6mm <i>7-Nov-2016</i>	3	87.6mm <i>17 Feb 2017</i>	4	111mm <i>4-Apr-2017</i>	8
Castlehill (Tauweru)	84.2mm <i>4-Apr-2017</i>	3	130.8mm <i>4-Apr-2017</i>	7	151mm <i>4-Apr-2017</i>	9
Tanawa Hut (Whareama)	95.5mm <i>4-Apr-2017</i>	3	144.5mm <i>4-Apr-2017</i>	3	167mm <i>4-Apr-2017</i>	4

<sup>1</sup> Return period estimated using HIRDS v3.0 (NIWA 2011).

<sup>2</sup> Return period estimated using neighbouring 'Waiohine at Phelps' site that was closed in January 2010.

<sup>3</sup> Return period estimated combining Racecourse data with 'Alloa' site that was closed in November 2012

### 3.1.4 Low rainfall

The lowest recorded rainfall totals over periods of 14 days, 28 days and 3 months are detailed in Table 3.5 for sites across the region.

**Table 3.5: Lowest rainfall totals during 2016/17**

Site	14 days		28 days		3 months	
	Rainfall (mm)	Start Date	Rainfall (mm)	Start Date	Rainfall (mm)	Start Date
Otaki Depot (Otaki)	0	20 Feb 2017	15.5	25 May 2017	265.5	17 Nov 2016
Water Treatment Plant (Waikanae)	0	20 Feb 2017	22.5	30 May 2017	332.2	17 Nov 2016
McKay's Crossing (Paekakariki)	0	20 Feb 2017	6.5	30 May 2017	233.6	17 Nov 2016
Battle Hill (Horokiri)	0	20 Feb 2017	14.8	24 May 2017	330.5	17 Nov 2016
Tawa Pool	0	20 Feb 2017	15.4	24 May 2017	235.4	17 Nov 2016
Karori Reservoir	0	19 Feb 2017	32.2	7 Feb 2017	218.6	17 Nov 2016
Newtown	0	20 Feb 2017	31.2	23 Dec 2016	191.2	17 Nov 2016
Birch Lane (Lower Hutt)	0.2	20 Feb 2017	10.2	23 May 2017	252.6	17 Nov 2016
Wainuiomata Reservoir	0	20 Feb 2017	35	7 Feb 2017	310.3	1 Jan 2017
Savage Park (Upper Hutt)	0	20 Feb 2017	12.6	24 May 2017	361.4	15 Mar 2017
Kaitoke Headworks	0.2	20 Feb 2017	44	24 May 2017	548.3	6 Aug 2016
McIntosh (Taranua - Penn Creek)	20.3	19 Feb 2017	154	24 May 2017	396.5	20 Feb 2017
Bannister Basin (Taranua - Ruamahanga R)	16.5	29 May 2017	160	27 May 2017	411	20 Feb 2017
Waiohine River Gorge	1	20 Feb 2017	51.2	7 Aug 2016	400.5	17 Nov 2016
Wairarapa College (Masterton)	0	19 Feb 2017	18	24 May 2017	111	17 Nov 2016
Tauherenikau Racecourse (Featherston)	0.4	20 Feb 2017	16.4	24 May 2017	157.8	17 Nov 2016
Tanawa Hut (E Wairarapa - Whareama)	5	4 Jan 2017	26.5	13 Nov 2016	148	13 Nov 2016
Longbush (E Wairarapa, Waikoukou)	0	4 Jan 2017	18	13 Dec 2016	102.5	17 Nov 2016

### 3.2 River flows

#### 3.2.1 Mean flows

Mean monthly river flows for selected monitoring sites are detailed in Figure 3.2. The plots cover main rivers in the Kapiti Coast, Porirua, Hutt Valley, Wairarapa Valley and the Eastern Hills areas.

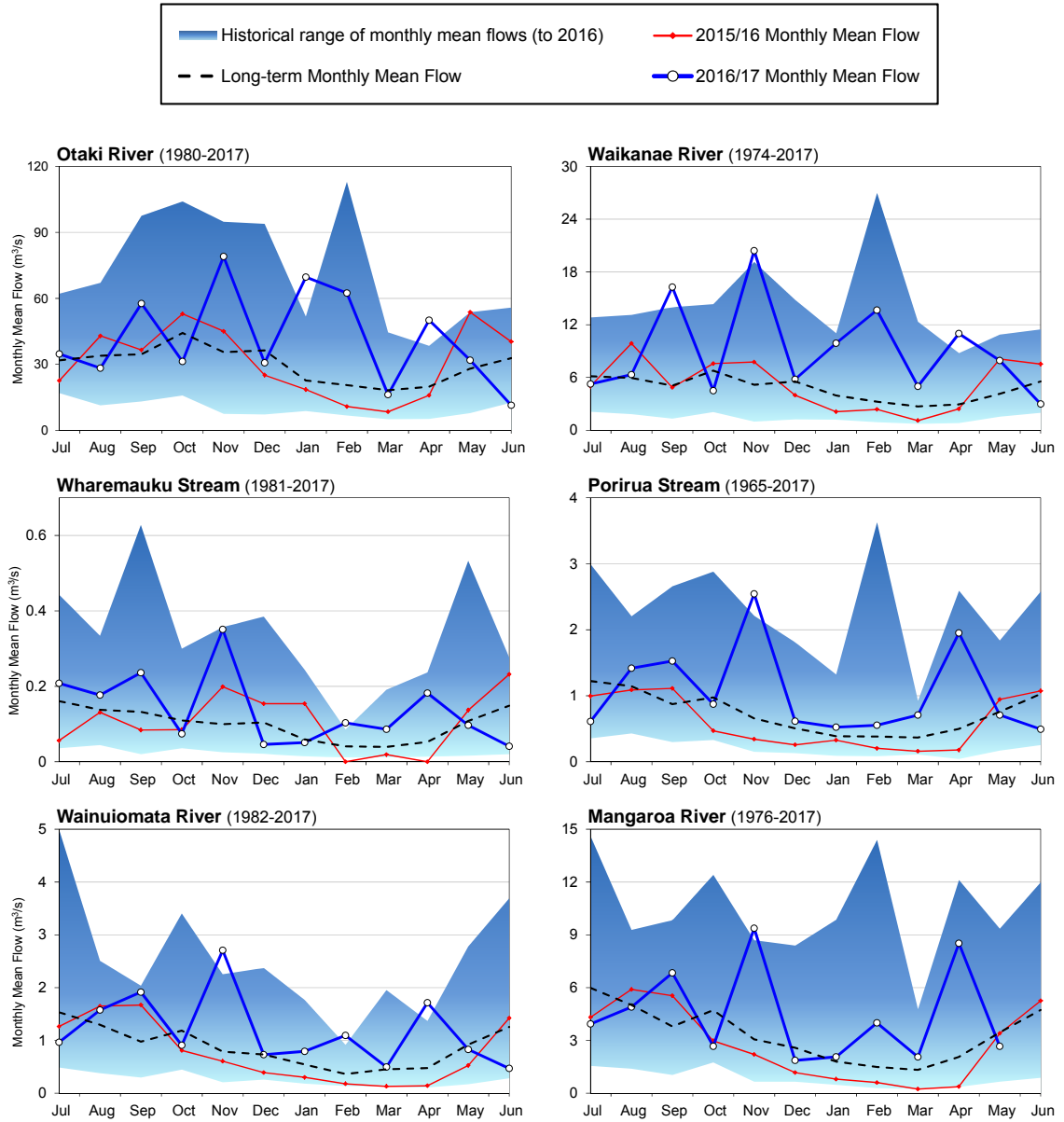


Figure 3.2: Mean monthly river flows and long term averages

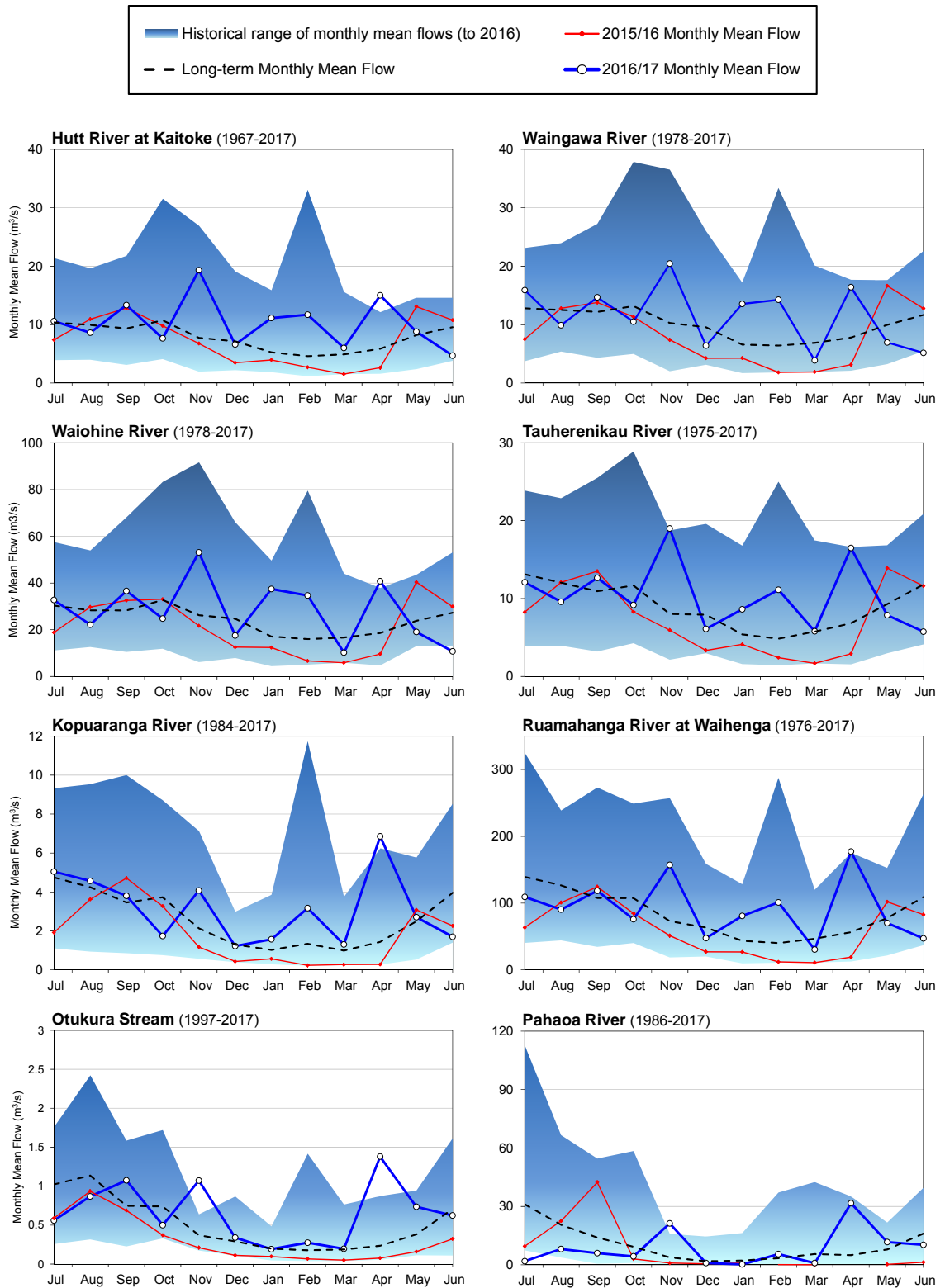


Figure 3.2 (continued)

### 3.2.2 Maximum recorded flows

Maximum recorded river flows for a number of sites are detailed in Table 3.6. The sites highlighted with blue shading indicate a flood flow in excess of a 5-year return period.

**Table 3.6: Maximum river and stream flows during 2016/17**

Site	2016/17 maximum flow (m <sup>3</sup> /s)	Date occurred	Estimated return period (years)
Otaki River at Pukehinau <sup>1</sup>	1271	2 Feb 2017	8
Mangaone Stream at Ratanui	13	2 Feb 2017	2
Waikanae River at Water Treatment Plant	281	2 Feb 2017	14
Hutt River at Kaitoke <sup>1</sup>	321	2 Feb 2017	5
Hutt River at Birchville	891	2 Feb 2017	4
Hutt River at Taita Gorge	1039	15 Nov 2016	5
Pakuratahi River at Truss Bridge	112	15 Nov 2016	5
Mangaroa River at Te Marua	164	15 Nov 2016	4
Akatarawa River at Cemetery	415	2 Feb 2017	5
Whakatikei River at Dude Ranch	92	2 Feb 2017	3
Waiwhetu Stream at Whites Line East	18	15 Nov 2016	5
Wainuiomata River at Manuka Track	47	15 Nov 2016	5
Wainuiomata River at Leonard Wood Park	87	15 Nov 2016	5
Taupo Stream at Flax Swamp	12	15 Nov 2016	30
Horokiri Stream at Snodgrass	56	15 Nov 2016	8
Porirua Stream at Town Centre	54	15 Nov 2016	8
Ruamahanga River at Mt Bruce	266	2 Feb 2017	<2
Ruamahanga River at Wardells	413	5 Apr 2017	<2
Ruamahanga River at Gladstone Bridge	811	5 Apr 2017	<2
Ruamahanga River at Waihenga Bridge	913	6 Apr 2017	<2
Waipoua River at Mikimiki Bridge	109	18 Feb 2017	<2
Waingawa River at Kaituna	184	14 Apr 2017	<2
Mangatarere River at Gorge	151	18 Feb 2017	20+
Waiohine River at Gorge	595	2 Feb 2017	<2
Tauherenikau at Gorge	212	24 Jul 2016	<2
Kopuaranga at Palmers Bridge	63	5 Apr 2017	<2
Taueru River at Te Weraiti	134	6 Apr 2017	<2
Huangaaru at Hautotara	295	8 Nov 2016	6
Pahaoa River at Hinakura <sup>1</sup>	540	8 Nov 2016	4

<sup>1</sup> Data provided by NIWA but frequency analysis performed by GWRC



### 3.2.3 Lowest recorded flows

Minimum recorded river flows (averaged over 7 and 28 day periods) during the 2016/17 year are detailed in Table 3.7 for the western part of the Region, and Table 3.8 for the eastern part of the Region. Significant low flow events (5-year return period or greater) are shaded orange.

**Table 3.7: Lowest 7-day and 28-day mean flows during 2016/17 in the western Wellington Region**

Site	Data begins	7-day duration			28-day duration		
		2016/17 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)	2016/17 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)
Otaki River at Pukehinau <sup>2</sup>	1980	7.473	16-Jun-2017	<2	11.194	2-Jun-2017	<2
Mangaone Stream at Ratanui	1993	0.163	17-Jun-2017	<2	0.187	2-Jun-2017	<2
Waikanae River at WTP	1974	2.074	4-Mar-2017	<2	2.838	2-Jun-2017	<2
Hutt River at Kaitoke <sup>2</sup>	1968	2.191	4-Mar-2017	<2	4.700	2-Jun-2017	<2
Hutt River at Birchville <sup>1,2</sup>	1970	5.331	16-Jun-2017	<2	9.348	2-Jun-2017	<2
Hutt River at Taita Gorge <sup>1</sup>	1979	11.261	4-Mar-2017	<2	14.589	2-Jun-2017	<2
Pakuratahi River at Truss Bridge	1978	0.481	16-Jun-2017	<2	1.156	26-May-2017	<2
Mangaroa River at Te Marua	1977	0.807	4-Mar-2017	<2	1.477	25-Dec-2016	<2
Akatarawa River at Cemetery	1979	1.820	16-Jun-2017	<2	2.220	2-Jun-2017	<2
Whakatikei River at Dude Ranch	1976	0.561	16-Jun-2017	<2	0.695	2-Jun-2017	<2
Wainuiomata River at Manuka Track	1982	0.365	26-Mar-2017	<2	0.463	2-Jun-2017	<2
Taupo Stream at Flax Swamp	1979	46.553	8-Jan-2017	<2	64.071	25-Dec-2016	<2
Horokiri Stream at Snodgrass	2002	0.198	4-Mar-2017	<2	0.270	2-Jun-2017	<2
Porirua Stream at Town Centre	1965	0.257	28-Feb-2017	<2	0.356	11-Feb-2017	<2

<sup>1</sup> Low flow likely to have been significantly affected by upstream abstraction.

<sup>2</sup> Data provided by NIWA but frequency analysis performed by GWRC

**Table 3.8: Lowest 7-day and 28-day mean flows during 2016/17 in the Wairarapa**

Site	Data begins	7-day duration			28-day duration		
		2016/17 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)	2016/17 lowest mean flow (m <sup>3</sup> /s)	Start date	Estimated return period (years)
Ruamahanga River at Mt Bruce	1975	2.249	4-Mar-2017	<2	4.340	25-Feb-2017	<2
Ruamahanga River at Wardells <sup>1</sup>	1977	5.148	4-Mar-2017	<2	10.658	26-Feb-2017	<2
Ruamahanga River at Waihenga Br <sup>1</sup>	1976	16.398	4-Mar-2017	<2	30.244	26-Feb-2017	<2
Waipoua River at Mikimiki <sup>3</sup>	2007	0.534	5-Jan-2017	<2	0.813	21-Dec-2016	<2
Waingawa River at Kaituna	1977	2.049	4-Mar-2017	<2	3.737	25-Feb-2017	<2
Mangatarere Strm at Gorge	1999	0.502	5-Jan-2017	<2	0.711	21-Dec-2016	<2
Waiohine River at Gorge	1978	5.139	4-Mar-2017	<2	9.805	25-Feb-2017	<2
Tauherenikau River at Gorge	1976	2.156	4-Mar-2017	<2	5.173	26-May-2017	<2
Kopuaranga River at Palmers <sup>1</sup>	1984	0.483	4-Mar-2017	<2	0.694	22-Dec-2016	<2
Otukura Stream at Weir <sup>1</sup>	1997	0.123	10-Feb-2017	<2	0.161	20-Jan-2017	<2
Pahaoa River at Hinakura <sup>2</sup>	1986	0.100	10-Feb-2017	2	0.146	20-Jan-2017	2

<sup>1</sup> Low flow likely to have been significantly affected by upstream abstraction.

<sup>2</sup> Data provided by NIWA but frequency analysis performed by GWRC.

<sup>3</sup> Short data record at site.

### 3.2.4 Low flow threshold exceedances

GWRC has defined low flow thresholds on a number of rivers and streams across the Region to signify when restrictions on abstractions should begin (restriction thresholds) and when all abstractions shall stop (minimum flows). These are defined in the Regional Freshwater Plan.

Table 3.9 summarises the number of instances that the first restriction threshold was reached during 2016/17 for rivers and streams as specified in the Regional Freshwater Plan. Results from the previous three years are included for comparison.

**Table 3.9: Number of days where mean daily flow was below the first restriction threshold as specified in the Regional Freshwater Plan**

Area	River or stream	First restriction threshold (m <sup>3</sup> /s)	Number of days below threshold			
			2013/14	2014/15	2015/16	2016/17
Kapiti Coast	Waitohu Stream	0.180	51	55	N/A	0
	Otaki River	4.375	3	34	3	0
	Mangaone Stream	0.045	0	0	0	0
	Waikanae River	0.900	35	24	8	0
Wairarapa	Ruamahanga River (Wardells)	2.700	0	32	52	0
	Ruamahanga River (Waihenga)	9.800	2	49	57	0
	Waiohine River	3.040	0	23	9	0
	Tauherenikau River	1.350	1	54	39	0
	Waingawa River	1.900	21	69	84	2
	Kopuaranga River	0.270	0	50	55	0
	Waipoua River	0.300	0	46	60	0
Wellington/Hutt Valley	Mangatarere Stream (Gorge)	0.330	26	87	107	0
	Hutt River (Birchville)	1.450	0	0	0	0
	Wainuiomata River (Leonard Wood Park)	0.360	13	70	91	0
	Orongorongo River	0.100	0	0	0	0

### 3.2.5 Floodwarning alarm level exceedances

As part of its floodwarning service, GWRC sets high river level alarms on many of its monitoring sites to provide early warning of rising river levels and possible flooding. Table 3.10 lists the rivers and sites where flood warning alarms were triggered during 2016/17.

**Table 3.10: Flood warning alarms triggered during 2016/17**

Event Date	Sites where alarms were triggered
<b>8 July 2016</b>	<ul style="list-style-type: none"> <li>• Waipoua at Mikimiki</li> </ul>
<b>15 July 2016</b>	<ul style="list-style-type: none"> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> </ul>
<b>19-20 July 2016</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> </ul>
<b>24 July 2016</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waipoua at Mikimiki</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Otaki at Pukehinau</li> </ul>
<b>13 August 2016</b>	<ul style="list-style-type: none"> <li>• Porirua at Town Centre</li> <li>• Horokiri at Snodgrass</li> </ul>
<b>16-19 September 2016</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waipoua at Mikimiki</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Lake Onoke</li> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> <li>• Hutt at Birchville</li> <li>• Porirua at Town Centre</li> <li>• Horokiri at Snodgrass</li> </ul>
<b>10-11 November 2016</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> <li>• Hutt at Birchville</li> <li>• Horokiri at Snodgrass</li> </ul>

<b>15-17 November 2016</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> <li>• Mangaroa at Te Marua</li> <li>• Hutt at Birchville</li> <li>• Hutt at Taita Gorge</li> <li>• Horokiri at Snodgrass</li> <li>• Wainuiomata at Manuka Track</li> <li>• Wainuiomata at Leonard Wood Park</li> <li>• Waiwhetu at Whites Line East</li> </ul>
<b>27 November 2016</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> </ul>
<b>1-2 January 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Otaki at Pukehinau</li> <li>• Lake Onoke</li> </ul>
<b>12 January 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> </ul>
<b>18 January 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waiohine at Gorge</li> </ul>
<b>22-23 January 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> <li>• Hutt at Birchville</li> </ul>
<b>25 January 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> </ul>
<b>2 February 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Waitohu at Water Supply Intake</li> <li>• Otaki at Pukehinau</li> <li>• Mangaone at Ratanui</li> <li>• Waikanae at Water Treatment Plant</li> <li>• Akatarawa at Cemetery</li> <li>• Mangaroa at Te Marua</li> <li>• Hutt at Kaitoke</li> <li>• Hutt at Birchville</li> <li>• Hutt at Taita Gorge</li> <li>• Wainuiomata at Manuka Track</li> <li>• Horokiri at Snodgrass</li> </ul>

<b>13 February 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Ruamahanga River at Gladstone</li> </ul>
<b>17-19 February 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Waipoua at Mikimiki</li> <li>• Mangatarere at Gorge</li> </ul>
<b>12 March 2017</b>	<ul style="list-style-type: none"> <li>• Akatarawa at Cemetery</li> <li>• Hutt at Birchville</li> <li>• Horokiri at Snodgrass</li> </ul>
<b>4-6 April 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Waipoua at Mikimiki</li> <li>• Waiohine at Gorge</li> <li>• Taueru at Te Weraiti</li> <li>• Hutt at Birchville</li> <li>• Horokiri at Snodgrass</li> </ul>
<b>14 April 2017</b>	<ul style="list-style-type: none"> <li>• Ruamahanga River at Mt Bruce</li> <li>• Waipoua at Mikimiki</li> <li>• Waiohine at Gorge</li> <li>• Ruamahanga River at Wardells</li> <li>• Ruamahanga River at Gladstone</li> <li>• Ruamahanga River at Waihenga</li> <li>• Hutt at Birchville</li> </ul>
<b>20 April 2017</b>	<ul style="list-style-type: none"> <li>• Taueru at Te Weraiti</li> </ul>
<b>21 May 2017</b>	<ul style="list-style-type: none"> <li>• Lake Onoke</li> </ul>
<b>24-26 May 2017</b>	<ul style="list-style-type: none"> <li>• Waiohine at Gorge</li> <li>• Barrage Gates South</li> <li>• Lake Onoke</li> <li>• Otaki at Pukehinau</li> <li>• Waikanae at Water Treatment Plant</li> </ul>
<b>28 June 2017</b>	<ul style="list-style-type: none"> <li>• Barrage Gates South</li> </ul>

### 3.3 Groundwater levels

Figure 3.3 shows mean monthly groundwater levels for 2016/17 (blue line) compared to historical mean monthly groundwater levels (dotted line) at selected monitoring bores in the Wairarapa Valley. The shaded areas represent the range of historic minimum and maximum mean monthly groundwater levels at each site.

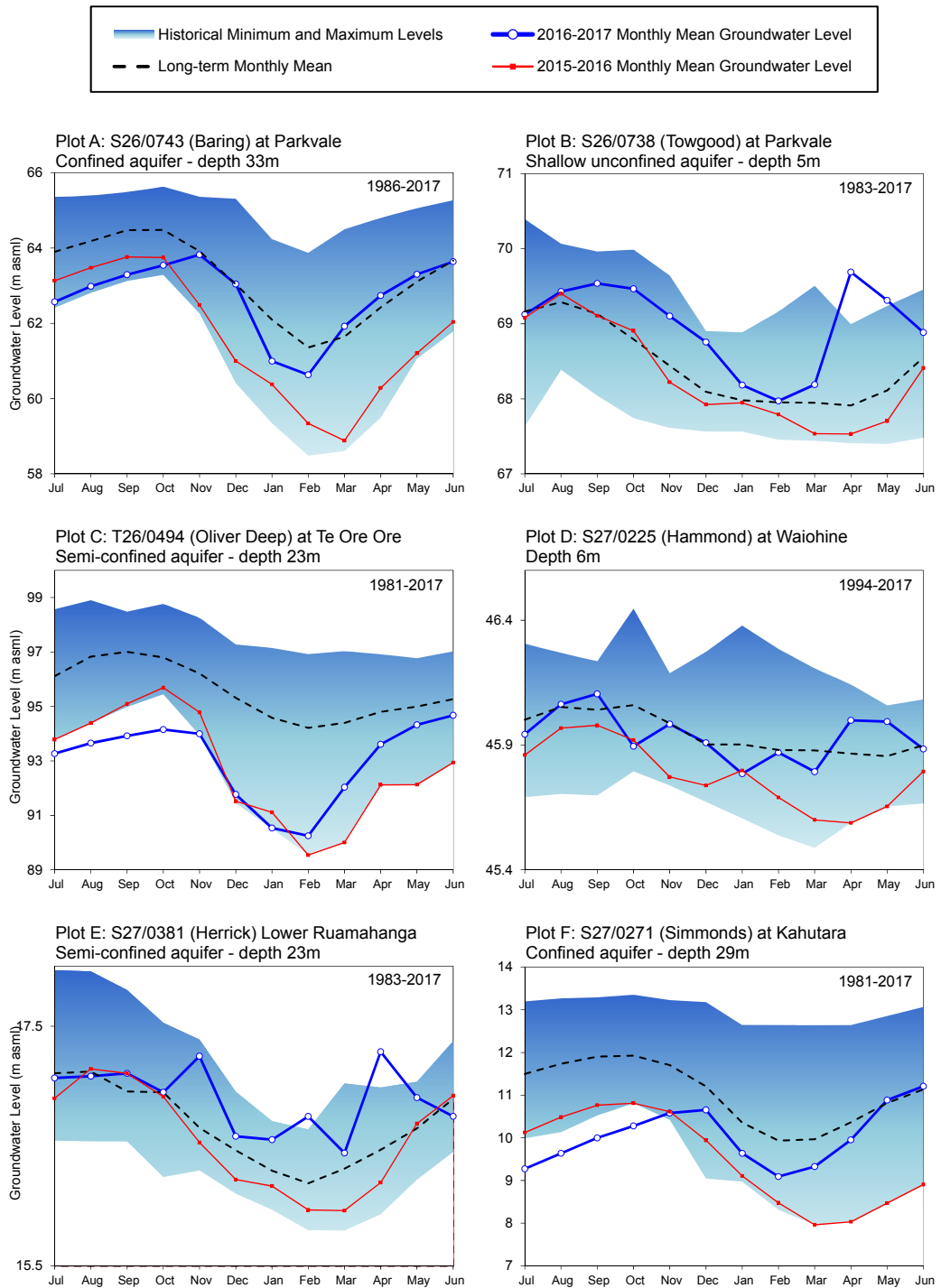
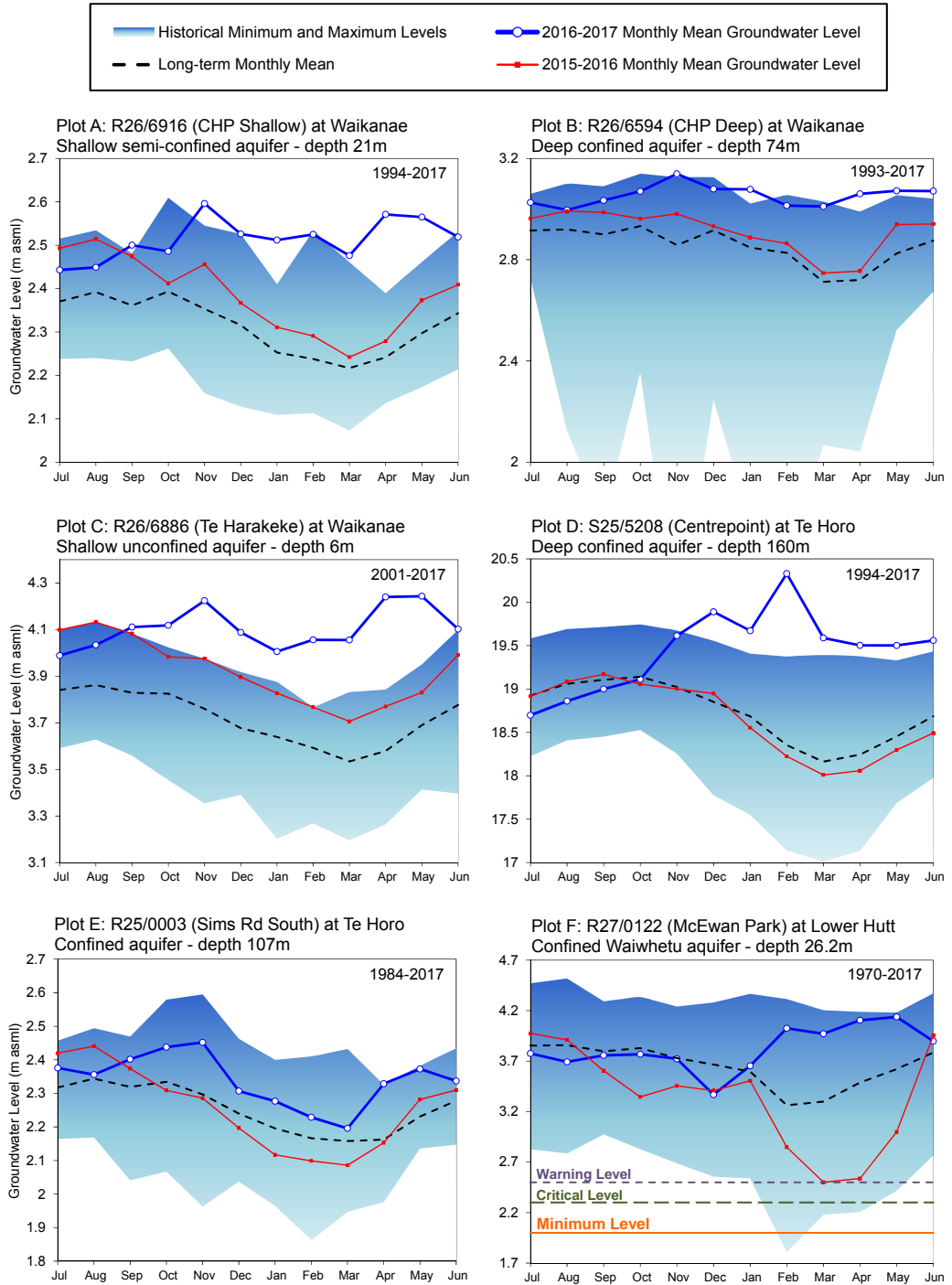


Figure 3.3: Mean monthly groundwater levels in the Wairarapa

Figure 3.4 shows mean monthly groundwater levels for 2016/17 (blue line) compared to historical mean monthly groundwater levels (dotted line) at selected monitoring bores in the Hutt Valley and on the Kapiti Coast. The blue shaded areas represent the range of historic minimum and maximum mean monthly groundwater levels at each site.

The bottom right graph shows alarm levels defined on the Waiwhetu Artesian Aquifer to manage the risk of saltwater intrusion.



**Figure 3.4: Mean monthly groundwater levels in the Hutt Valley and on the Kapiti Coast**



### 3.4 Lake and wetland levels

Recorded lake levels at Lake Wairarapa and Lake Onoke are shown in Figure 3.5. The 2016/17 data are presented as a daily mean level (thin blue trace) and a monthly mean level (bold blue trace).

The long-term mean (dashed black trace) is plotted for comparison. The minimum lake water level for Lake Wairarapa (as specified in the Regional Freshwater Plan) is shown by the red shaded area.

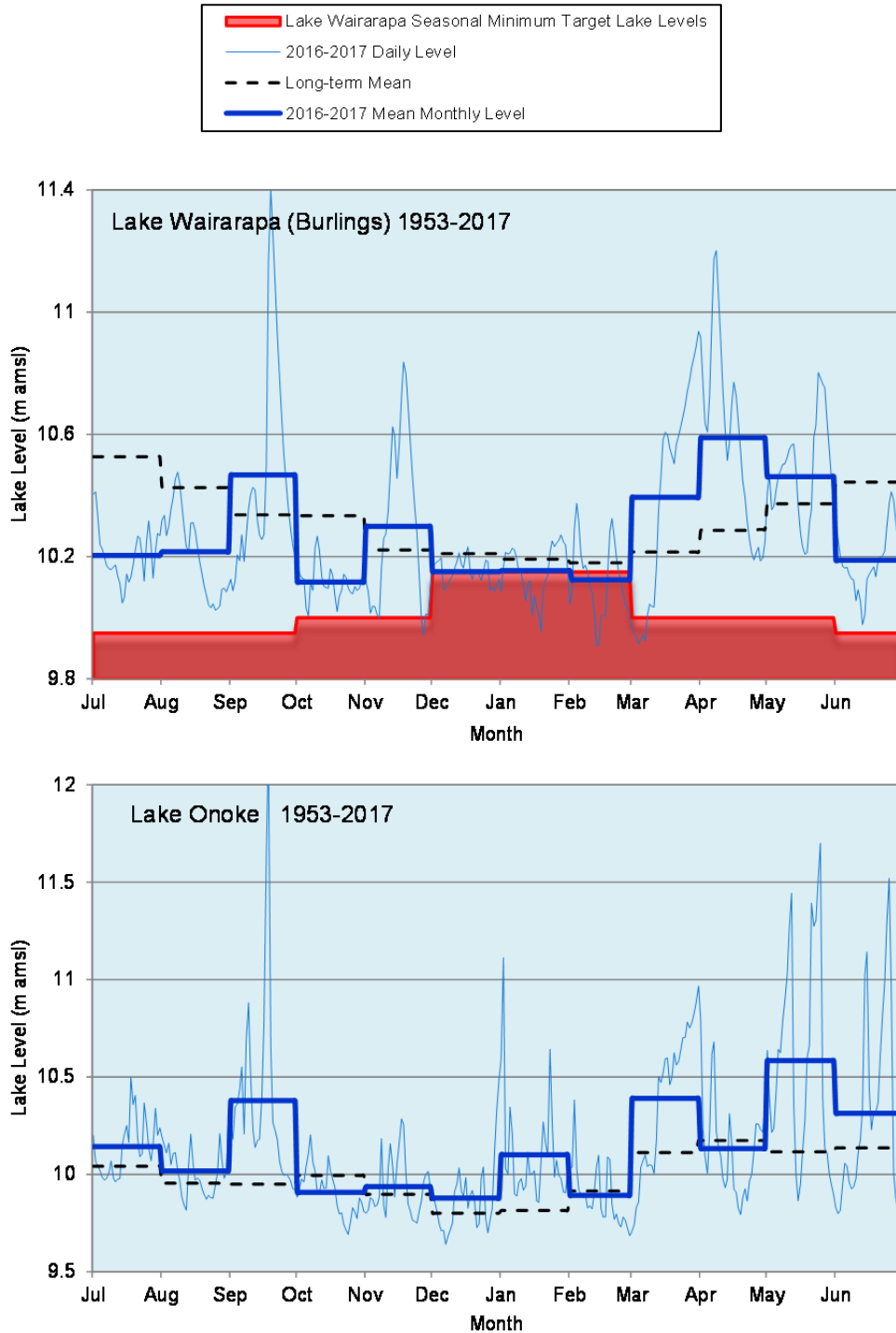
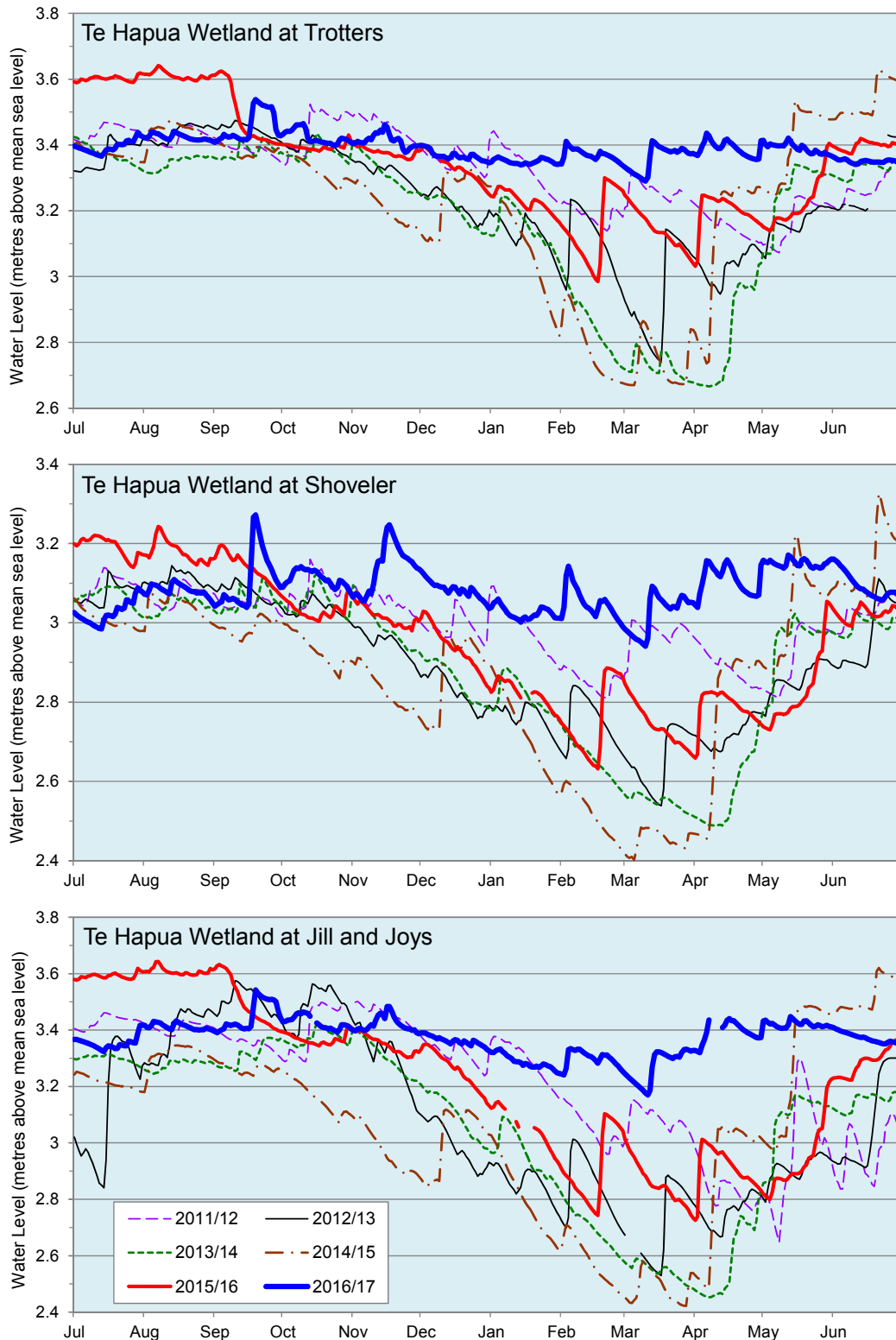


Figure 3.5: Mean monthly lake levels 2016/17

Water levels have been recorded at three monitoring sites within the Te Hapua wetland complex on the Kapiti Coast since 2008. Figure 3.6 shows the 2016/17 recorded daily mean water levels (bold blue trace) at each site in comparison to the previous five years of record.



**Figure 3.6: Daily mean water levels in Te Hapua wetland complex (Kapiti Coast)**

### 3.5 Soil moisture

Monitoring results for soil moisture content are detailed in Figure 3.7 for the Tanawa Hut (near Tinui) and Longbush monitoring sites.

The long-term mean and historical range of recorded values are also shown.

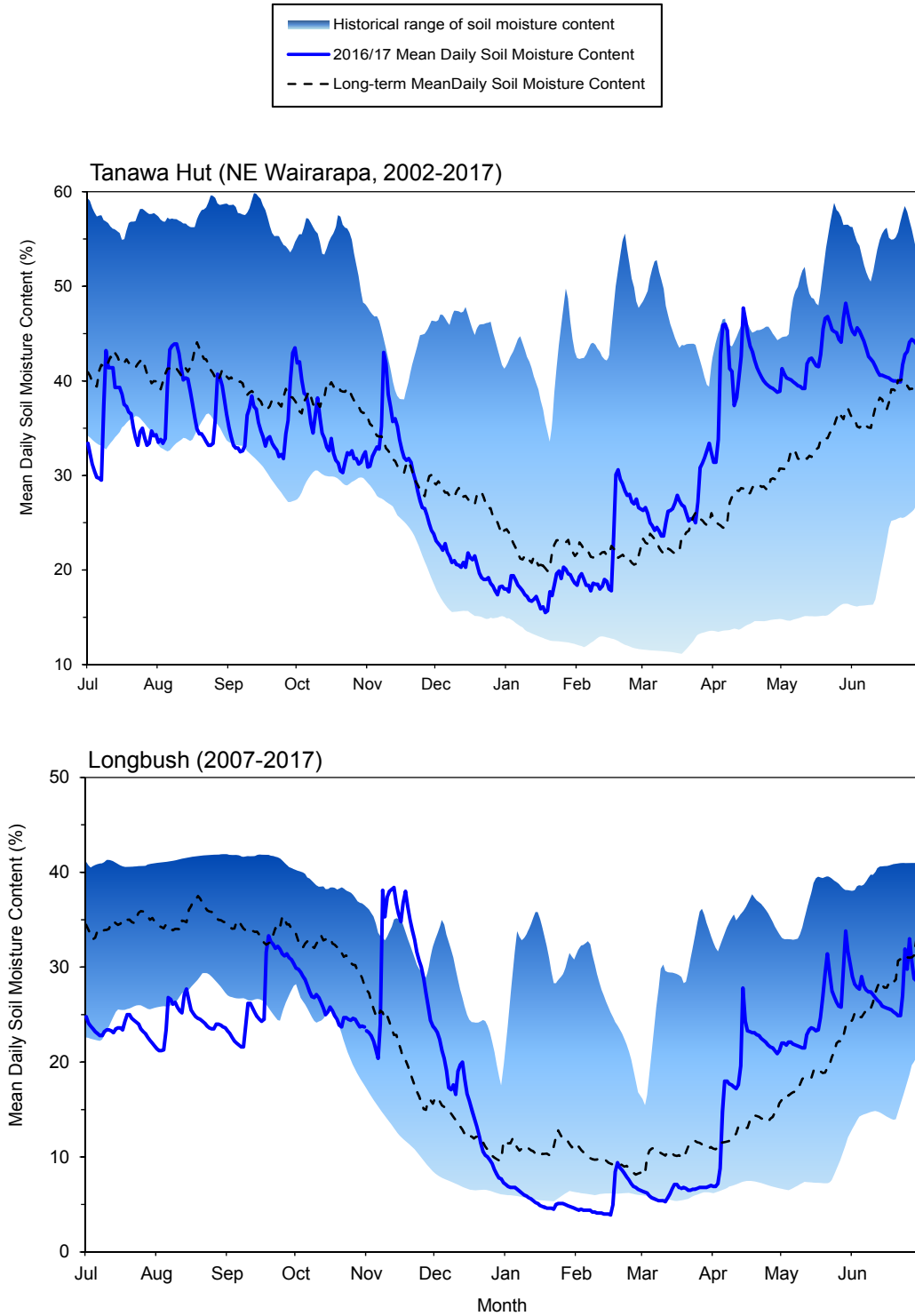


Figure 3.7: Mean daily soil moisture content 2016/17

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