greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Hydrology State of the Environment monitoring programme

Annual data report 2013/14

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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 2013 to 30 June 2014 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 State of the Environment Monitoring Programme: Annual Data Report 2013/14 (Heath *et al*, 2014)

- Groundwater Quality State of the Environment Monitoring Programme: Annual Data Report 2013/14 (Tidswell, 2014)

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:

- 58 rainfall sites
- 62 river level/flow recording sites
- 6 lake level sites
- 5 wetland water level sites
- 2 tide level sites
- 4 soil moisture sites
- 73 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 manage 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 58 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.

All rainfall sites are automatic and typically record rainfall amounts at five minute intervals 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 62 sites across the region. The distribution of the sites is shown in Figure 2.2 and is similar to the rainfall network. During the 2013/14 year four of the sites were operated solely by NIWA and another four were jointly maintained by NIWA 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 (as set out in the Lake Wairarapa Wetlands Management Guidelines 1991 and the Regional Freshwater Plan 1999) and to monitor lake levels for flood control.

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 five 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 site is situated on the Taumata Lagoon near the confluence of the Waiohine and Ruamahanga rivers in the 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 four 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, and the location of sites are shown in Figure 2.4. Note that some of the sites actually have two separate monitoring devices within a shallow bore and a deep bore.

Continuous data on groundwater levels are collected at 73 sites. 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.

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 (refer to the 2013/14 Annual Data Report for Groundwater Quality State of the Environment monitoring programme).

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 is enlisting 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.

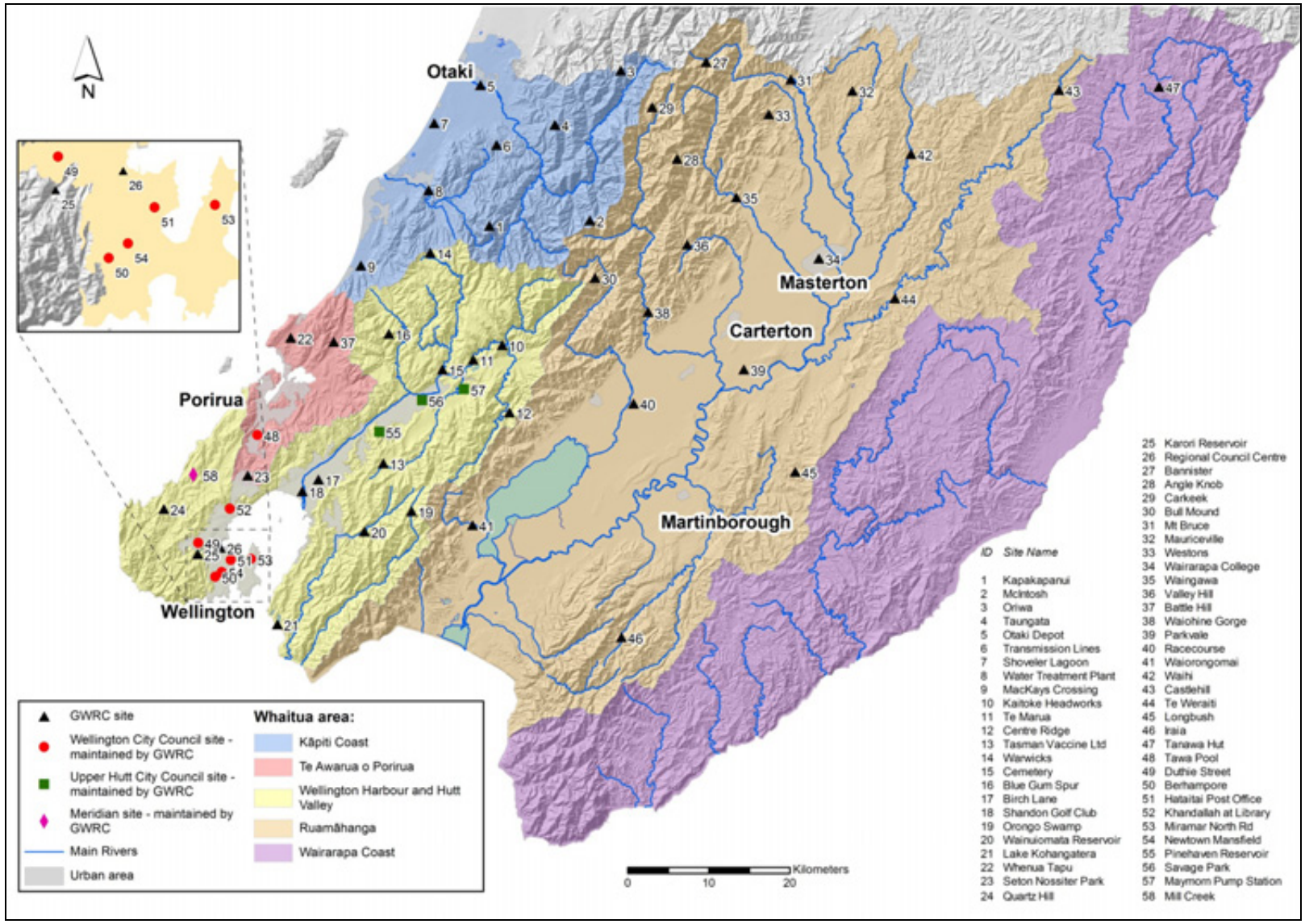

Figure 2.1: Automatic rainfall monitoring sites 2013/14

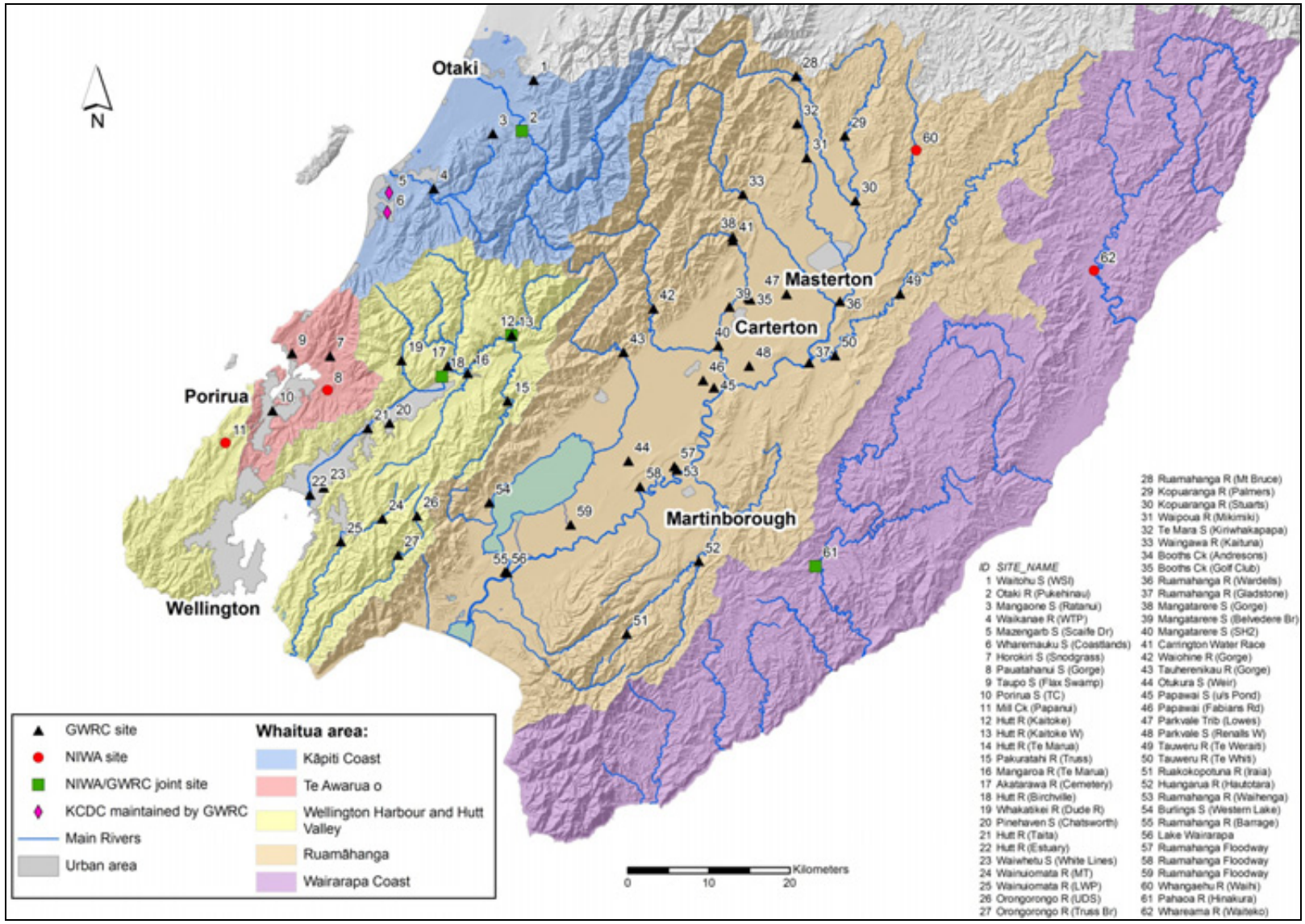

Figure 2.2: Automatic river level/flow monitoring sites 2013/14

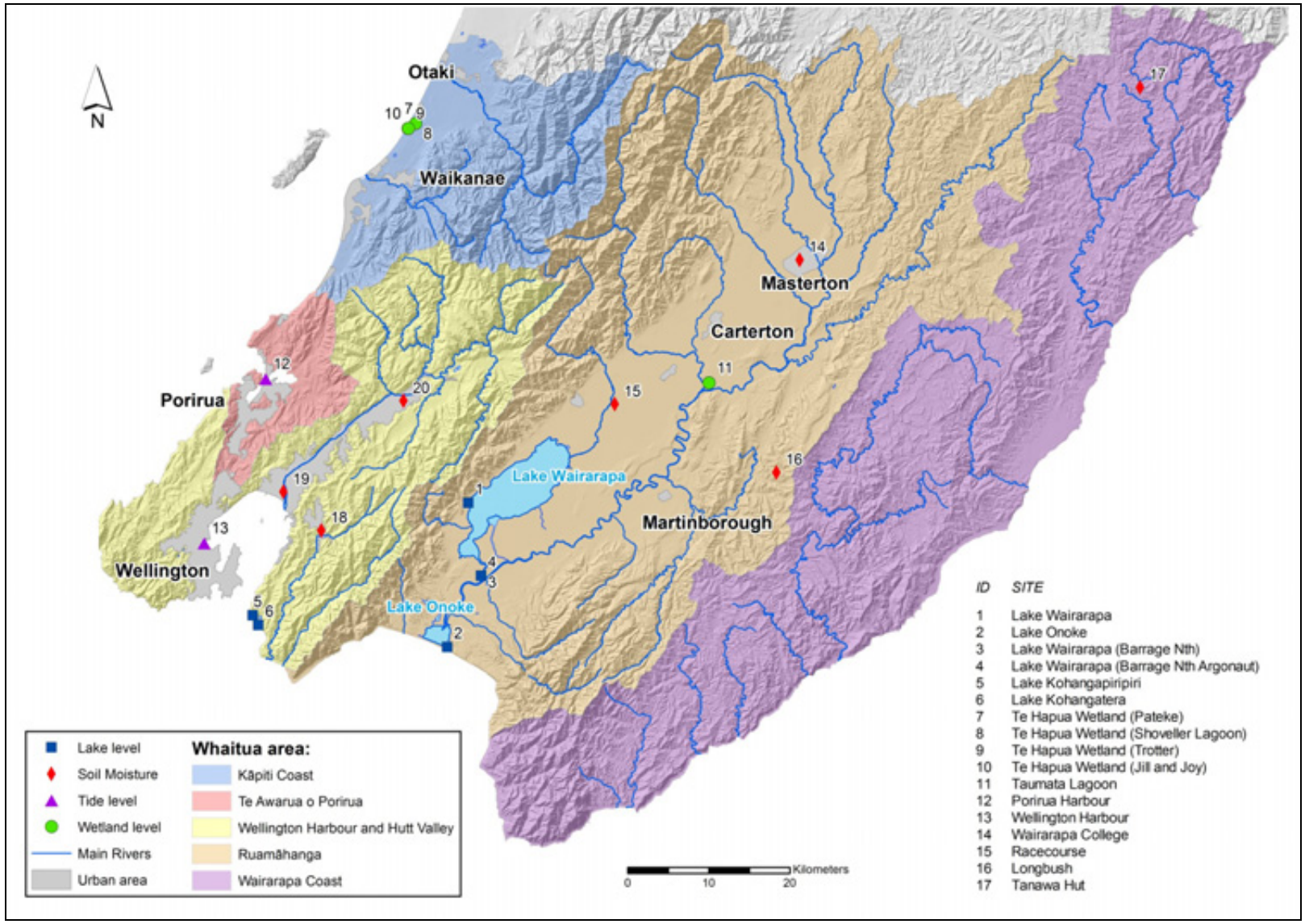

Figure 2.3: Automatic lake level, wetland level, tide level and soil moisture monitoring sites 2013/14

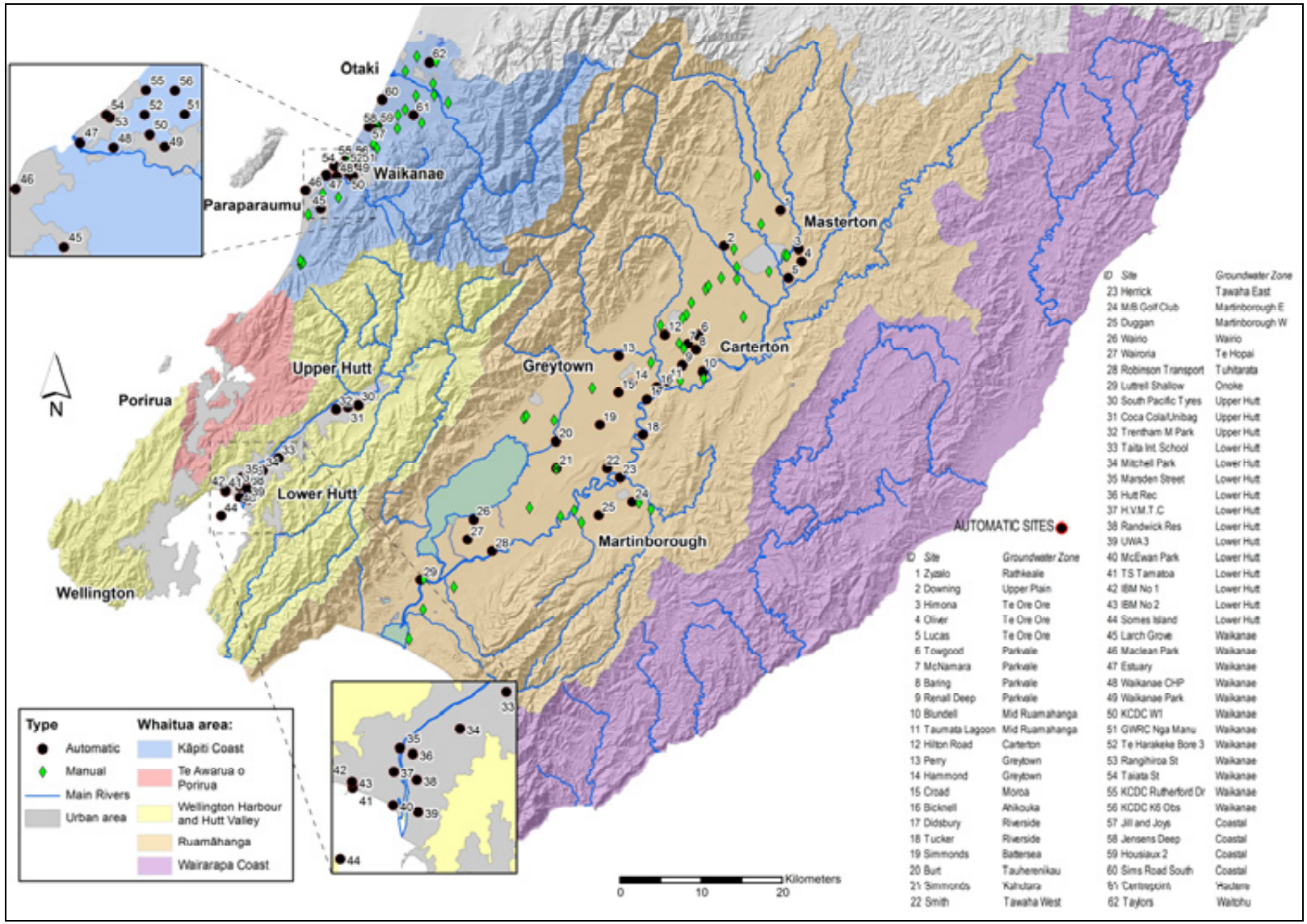

Figure 2.4: Groundwater level sites 2013/14

3. Results

3.1 Rainfall

Table 3.1 summarises the total annual rainfall for 2013/14 at a range of monitoring sites across the region that are grouped by their whaitua area. Sites with greater than 10 percent difference from their long term average are shaded orange (below average) and blue (above average).

Table 3.1: Annual rainfall totals (2013/14) and percentage of long term average

Site	Catchment	2013/14 total (mm)	Average (mm) *(Data period)*	% of long term average
Kāpiti Coast whaitua				
Oriwa (Tararua)	Otaki	4778	4633 *(1991-2013)*	103
McIntosh (Tararua)	Otaki	5778	5015 *(1991-2013)*	115
Taungata (Tararua)	Otaki	2753	2807 *(1991-2013)*	98
Kapakapanui (Tararua)	Otaki	2209	2349 *(1991-2013)*	94
Transmission Lines	Mangaone	1595	1633 *(1992-2013)*	96
Otaki Depot	Otaki	849	990 *(1970-2013)*	86
Shoveler Lagoon	Te Hapua Wetlands	873	NA[1]	
Water Treatment Plant	Waikanae	1228	1280 *(1969-2013)*	96
MacKays Crossing	Whareroa	913	1075 *(1972-2013)*	85
Wellington Harbour and Hutt Valley whaitua				
Warwicks	Akatarawa	2030	2227 *(1980-2013)*	91
Blue Gum Spur	Whakatikei	1738	1920 *(1981-2013)*	91
Kaitoke Headworks	Hutt	2449	2295 *(1950-2013)*	107
Te Marua	Hutt	1900	2277 *(1993-2013)*	103
Centre Ridge	Pakuratahi	2367	2013 *(1984-2013)*	118
Tasman Vaccine Ltd	Mangaroa	1557	1561 *(1968-2013)*	100
Cemetery	Akatarawa	1669	1702 *(1988-2013)*	98
Birch Lane/Mabey Rd	Hutt	1100	1271 *(1995-2013)*	87
Shandon Golf Club	Hutt	1063	1019 *(2000-2013)*	104
Quartz Hill	Makara	1134	NA[1]	
Khandallah at Library	Wellington City	1223	1130 *(1996-2013)*	108
Karori Reservoir	Kaiwharawhara	1337	1337 *(1951-2013)*	100
Regional Council	Wellington City	954	931 *(1996-2013)*	103
Hataitai Post Office	Wellington City	1015	965 *(1997-2013)*	105
Newtown Mansfield	Wellington City	1131	1044 *(1996-2013)*	108
Berhampore	Wellington City	1076	1112 *(1996-2013)*	97
Miramar North Rd	Wellington City	1014	928 *(2004-2013)*	109
Orongo Swamp	Orongorongo	2635[2]	2455 *(1980-2013)*	107
Wainuiomata Reservoir	Wainuiomata	1868	1884 *(1951-2013)*	99
Pencarrow Lakes	Pencarrow Lakes	1273	NA[1]	

[1] Insufficient number of years of data recorded to calculate average rainfall

[2] Some missing record during the 2013/14 year and total derived using storage gauge data

Table 3.1 (c*ontinued*)

Site	Catchment	2013/14 total (mm)	Average (mm) *(Data period)*	% of long term average
Te Awarua o Porirua whaitua				
Battle Hill	Horokiri	1102	NA[1]	
Whenua Tapu	Taupo	920	1058 *(1990-2013)*	87
Tawa Pool	Porirua	1118	1023 *(1996-2013)*	109
Seton Nossiter Park	Porirua	1124	1195 *(1992-2013)*	94
Ruamāhanga whaitua				
Bannister (Tararua)	Ruamahanga	6613	6119 *(1974-2013)*	108
Carkeek (Tararua)	Waiohine	5031	4479 *(1976-2013)*	112
Mt Bruce	Ruamahanga	2705	2411 *(1997-2013)*	112
Westons	Waipoua	2975	NA[1]	
Angle Knob (Tararua)	Waingawa	8525	6879 *(1974-2013)*	124
Kaituna	Waingawa	2094	1971 *(1994-2013)*	106
Valley Hill	Mangatarere	3417	2825 *(1997-2013)*	121
Bull Mound (Tararua)	Tauherenikau	4955	4536 *(1976-2013)*	109
Waiohine Gorge/Phelps	Waiohine	2606	2200 *(1974-2013)*	118
Mauriceville	Kopuaranga	1591	NA[1]	
Waihi	Whangaehu	1147	1117 *(2001-2013)*	103
Castlehill	Tauweru	1469	1148 *(1991-2013)*	128
Wairarapa College	Ruamahanga	995	886 *(2002-2013)*	112
Te Weraiti	Tauweru	803	833 *(1997-2013)*	96
Alloa/Racecourse	Tauherenikau	1073	1027 *(1999-2013)*	105
Matthews	Waiorongomai	1562	NA[1]	
Longbush	Waikoukou	1059	925 *(1955-2013)*	114
Wairarapa Coast whaitua				
Tanawa Hut	Whareama	1613	1300 *(1955-2013)*	124

[1] Insufficient number of years of data recorded to calculate average rainfall

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

The 2013/14 totals are compared to the long term monthly average.

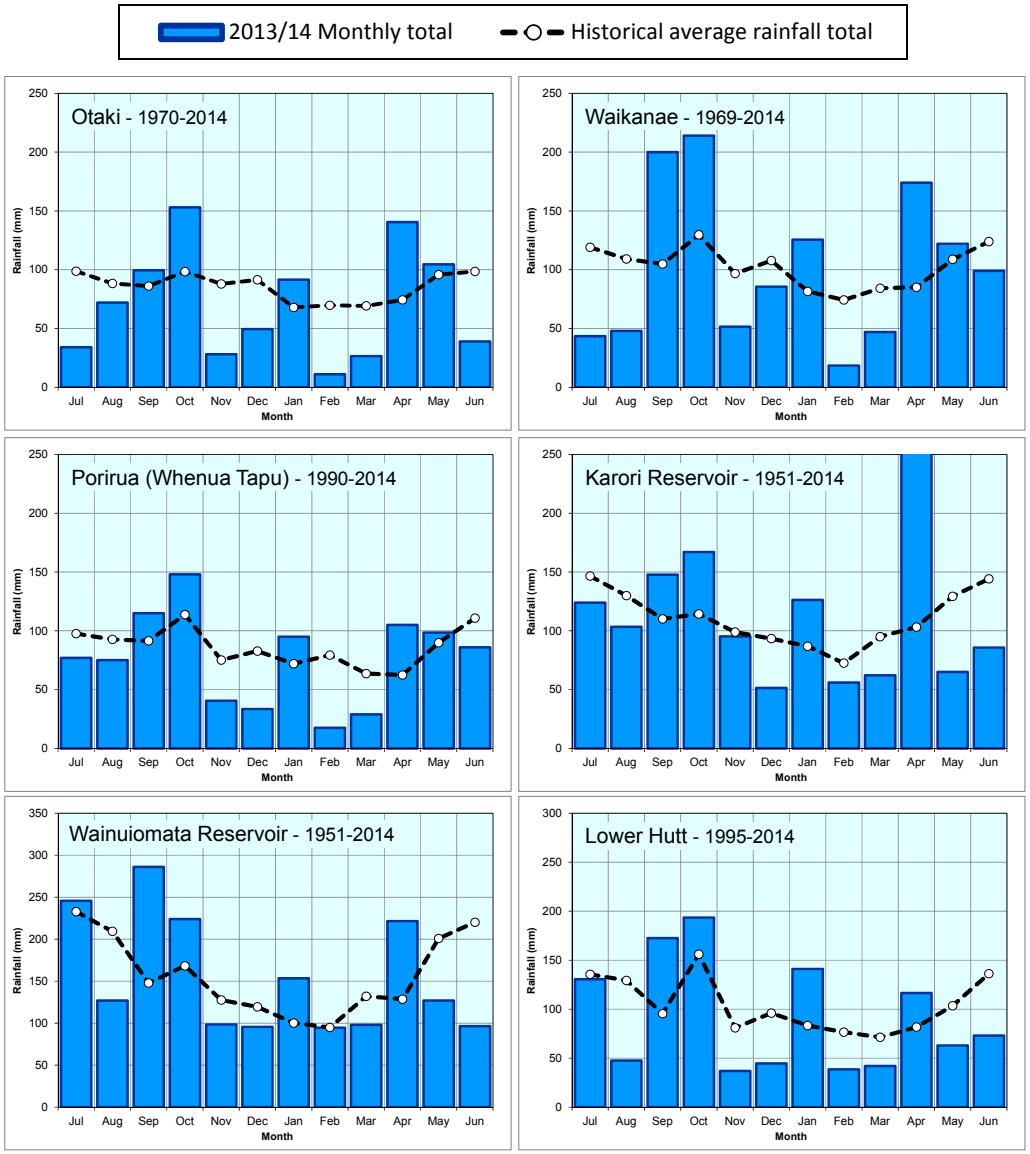

Figure 3.1: Monthly rainfall totals (2013/14) and long-term averages

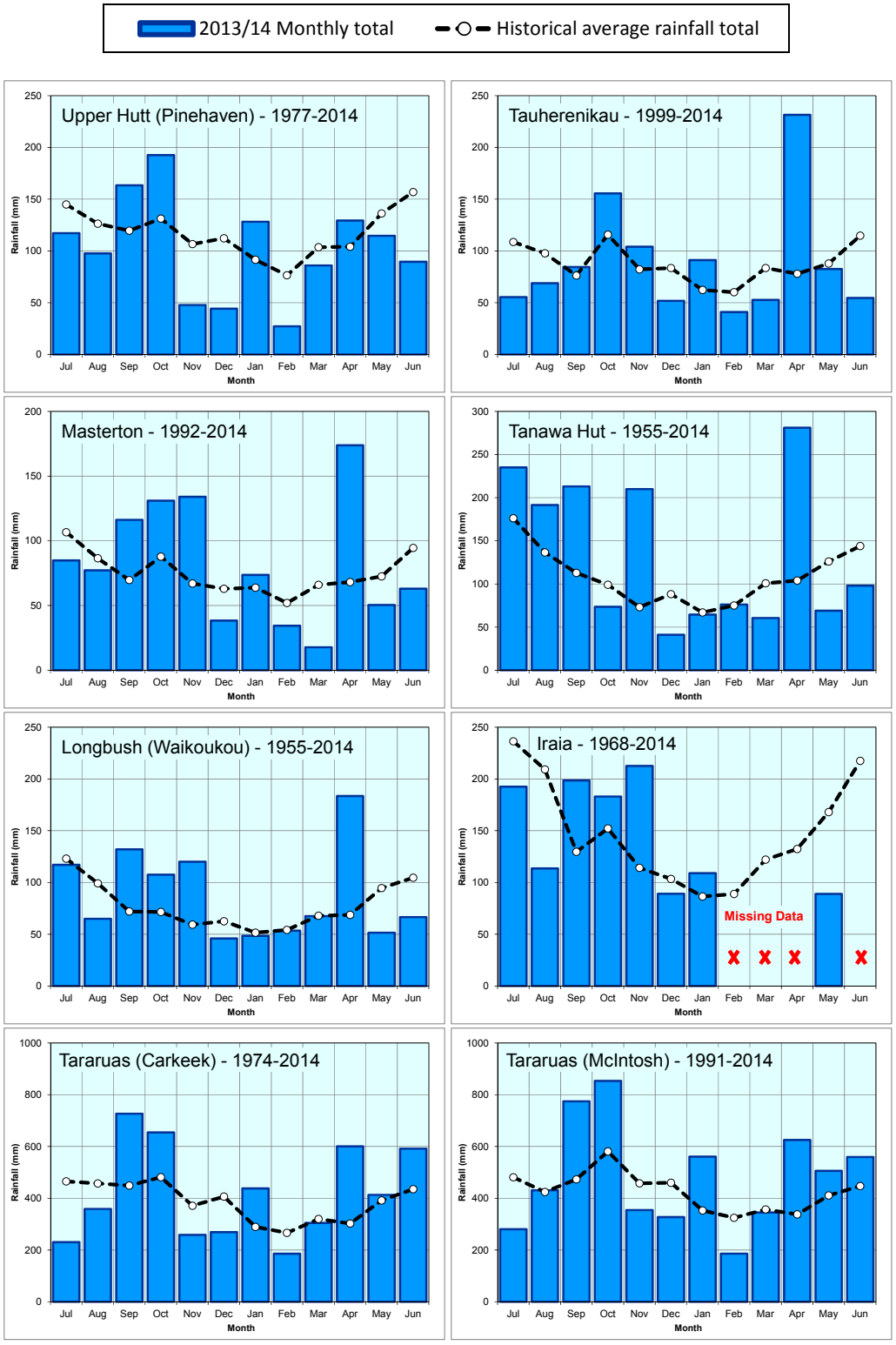

Figure 3.1 (*continued*)

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

Sites that have a greater than 10 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 2013	Spring 2013	Summer 2013/14	Autumn 2014
Kāpiti Coast	Otaki	87%	105%	62%	127%
	Waikanae	64%	87%	72%	125%
	McKays Crossing	86%	97%	57%	98%
	McIntosh (Tararuas)	88%	132%	97%	138%
Te Awarua o Porirua	Whenua Tapu	121%	109%	60%	109%
	Paparangi	92%	114%	82%	121%
Wellington Harbour and Hutt Valley	Kaitoke	101%	156%	73%	109%
	Lower Hutt	111%	121%	82%	89%
	Wainuiomata	121%	135%	101%	93%
	Berhampore	86%	98%	100%	101%
	Karori	133%	139%	95%	124%
	Makara	94%	116%	81%	93%
Ruamāhanga	Mt Bruce	105%	121%	97%	130%
	Waihi	111%	113%	70%	113%
	Castlehill	139%	134%	97%	136%
	Masterton	106%	185%	80%	112%
	Featherston	84%	126%	87%	143%
	Longbush	100%	180%	88%	132%
	Carkeek (Tararuas)	69%	128%	93%	129%
Wairarapa Coast	Tanawa Hut	138%	176%	78%	123%

An analysis of the maximum recorded rainfall totals during the 2013/14 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 2013/14

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)
Water Treatment Plant (Waikanae)	22.5mm *28 Apr 2014*	2	45mm *28 Apr 2014*	2	48mm *28 Apr 2014*	1
QE Park (Paekakariki)[1]	20.5mm *3 Jan 2014*	2	29.5mm *11 Nov 2013*	1	40mm *30 Oct 2013*	1
Warwicks (Akatarawa)	24mm *24 May 2014*	2	63.5mm *31 Oct 2013*	1	89mm *30 Oct 2013*	1
Te Marua (Upper Hutt)	30mm *3 Jan 2014*	4	68.5mm *31 Oct 2013*	3	88mm *30 Oct 2013*	2
TVL (Mangaroa)	23mm *3 Jan 2014*	2	56.5mm *3 Jan 2014*	3	57mm *3 Jan 2014*	1
Birch Lane (Lower Hutt)	22.5mm *3 Jan 2014*	2	43mm *3 Jan 2014*	1	43mm *3 Jan 2014*	1
Wainuiomata Reservoir (Wainuiomata)	19.5mm *3 Jan 2014*	2	55.5mm *4 Sep 2014*	2	73mm *4 Sep 2013*	1
Seton Nossiter Park (Porirua)	16mm *20 Sep 2013*	1	35.4mm *16 Apr 2014*	1	42mm *16 Apr 2014*	1
Karori Reservoir (Wellington City)	20.4mm *9 Aug 2013*	2	31.4mm *16 Apr 2014*	2	42mm *8 Apr 2014*	2
McIntosh (W Tararua Range)	35mm *11 Sep 2013*	18	126mm *11 Sep 2013*	5	183mm *5 Jan 2014*	5
Bannister Basin (E Tararua Range)	31mm *5 Jan 2014*	2	128mm *4 Jan 2014*	3	219mm *4 Jan 2014*	7
Waiohine Gorge[2] (Waiohine)	21mm *14 Oct 2013*	2	83mm *14 Oct 2013*	11	105mm *17 Apr 2014*	5
Wairarapa College (Masterton)[1]	14.4mm *10 Apr 2014*	2	24.6mm *28 Nov 2013*	1	39mm *27 Nov 2013*	1
Racecourse (Featherston)[3]	11.4mm *17 Apr 2014*	1	34.2mm *11 Oct 2013*	2	51mm *11 Oct 2013*	3
Castlehill (Tauweru)	19.5mm *11 Jul 2013*	8	61mm *11 Jul 2013*	10	89mm *11 Jul 2013*	10
Tanawa Hut (Whareama)	27mm *11 Jul 2013*	7	83mm *11 Jul 2013*	16	116mm *11 Jul 2013*	5

[1] Return periods estimated using HIRDS v3.0 (NIWA 2002).

[2] Return periods estimated using neighbouring 'Waiohine at Phelps' site that was closed in January 2010.

[3] Return periods estimated using neighbouring 'Alloa' site that was closed in November 2012

An analysis of the maximum recorded rainfall totals during the 2013/14 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 2013/14

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)
Water Treatment Plant (Waikanae)	62mm *30 Oct 2013*	1	75mm *3 Jan 2014*	1	76mm *2 Jan 2014*	1
QE Park (Paekakariki)[1]	51mm *30 Oct 2013*	1	54mm *3 Jan 2014*	1	54mm *2 Jan 2014*	1
Warwicks (Akatarawa)	114mm *30 Oct 2013*	1	140mm *3 Jan 2014*	1	140mm *2 Jan 2014*	1
Te Marua (Upper Hutt)	112mm *30 Oct 2013*	2	120mm *30 Oct 2013*	2	120mm *29 Oct 2013*	1
TVL (Mangaroa)	75mm *30 Oct 2013*	1	94mm *3 Jan 2014*	1	95mm *2 Jan 2014*	1
Birch Lane (Lower Hutt)	58mm *30 Oct 2013*	1	75mm *3 Jan 2014*	1	76mm *2 Jan 2014*	1
Wainuiomata Reservoir (Wainuiomata)	80mm *4 Sep 2013*	1	97mm *10 Jul 2013*	1	145mm *9 Jul 2013*	1
Seton Nossiter Park (Porirua)	70mm *16 Apr 2014*	2	88mm *15 Apr 2014*	2	93mm *16 Apr 2014*	1
Karori Reservoir (Wellington City)	68mm *16 Apr 2014*	2	99mm *15 Apr 2014*	3	101mm *15 Apr 2014*	2
McIntosh (W Tararua Range)	213mm *11 Sep 2013*	3	291mm *3 Jan 2014*	3	299mm *2 Jan 2014*	2
Bannister Basin (E Tararua Range)	256mm *4 Jan 2014*	3	353mm *3 Jan 2014*	3	359mm *2 Jan 2014*	2
Waiohine Gorge[2] (Waiohine)	155mm *17 Apr 2014*	8	197mm *16 Apr 2014*	7	200mm *15 Apr 2014*	5
Wairarapa College (Masterton)[1]	61mm *27 Nov 2013*	1	84mm *26 Nov 2013*	2	102mm *25 Nov 2013*	3
Racecourse (Featherston)[3]	71mm *17 Apr 2014*	4	103mm *16 Apr 2014*	6	103mm *15 Apr 2014*	5
Castlehill (Tauweru)	107mm *11 Jul 2013*	3	132mm *10 Jul 2013*	4	144mm *9 Jul 2013*	4
Tanawa Hut (Whareama)	127mm *11 Jul 2013*	6	161mm *10 Jul 2013*	4	179mm *11 Jul 2013*	3

[1] Return periods estimated using HIRDS v3.0 (NIWA 2002).

[2] Return periods estimated using neighbouring 'Waiohine at Phelps' site that was closed in January 2010.

[3] Return periods estimated using neighbouring 'Alloa' site that was closed in November 2012

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 2013/14

Site	14 days		28 days		3 months	
	Rainfall (mm)	Start Date	Rainfall (mm)	Start Date	Rainfall (mm)	Start Date
Otaki Depot (Otaki)	0	11-Feb-14, 18-Mar-14	9.5	11-Feb-14	60	6-Jan-14
Water Treatment Plant (Waikanae)	0	14-Feb-14	18.5	26-Jan-14	109.5	5-Jan-14
McKays Crossing (Paekakariki)	0	12-Feb-14	10	26-Jan-14	83.5	5-Jan-14
Battle Hill (Horokiri)	0	12-Feb-14	16.5	26-Jan-14	110	5-Jan-14
Tawa Pool	0	12-Feb-14	15.4	12-Feb-14	115	5-Jan-14
Karori Reservoir	0	13-Feb-14	20.2	28-Nov-13	178.4	5-Jan-14
Miramar North Rd	0	10-Feb-14	7	28-Nov-13	120	5-Jan-14
Birch Lane (Lower Hutt)	0	12-Feb-14, 8-Dec-13, 16-Jul-13	12	28-Nov-13	132	5-Jan-14
Wainuiomata Reservoir	0	10-Feb-14, 16-Jul-13	23.5	28-Nov-13	250	5-Jan-14
Savage Park (Upper Hutt)	0	8-Nov-13	18.8	27-Jan-14	129	9-Jan-14
Kaitoke Headworks	1.0	14-Feb-14	30.5	27-Jan-14	243.5	5-Jan-14
McIntosh (Tararuas - Penn Creek)	30.5	22-Mar-14	146	15-Feb-14	757.5	5-Jan-14
Angle Knob (Tararuas - Waingawa River)	24	18-Jul-13	176.5	14-Feb-14	968	5-Jan-14
Waiohine River Gorge	0	13-Feb-14	52	10-Jul-13	317	5-Jan-14
Wairarapa College (Masterton)	0	11-Feb-14	10.6	11-Feb-14	117.4	5-Jan-14
Tauherenikau Racecourse (Featherston)	0	10-Feb-14, 8-Nov-13, 16-Jul-13	16.2	14-Jul-13	151.4	5-Jan-14
Tanawa Hut (E Wairarapa - Whareama)	0	10-Feb-14, 16-Jul-13	22	29-Nov-13	177	29-Nov-13
Longbush (E Wairarapa, Waikoukou)	0	10-Feb-14, 16-Jul-13	11.5	28-Nov-13	135	29-Nov-13
Iraia (SE Wairarapa, Ruakokoputuna)	0	10-Feb-14	23.5	28-Nov-13	286	29-Nov-13

3.2 River 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.

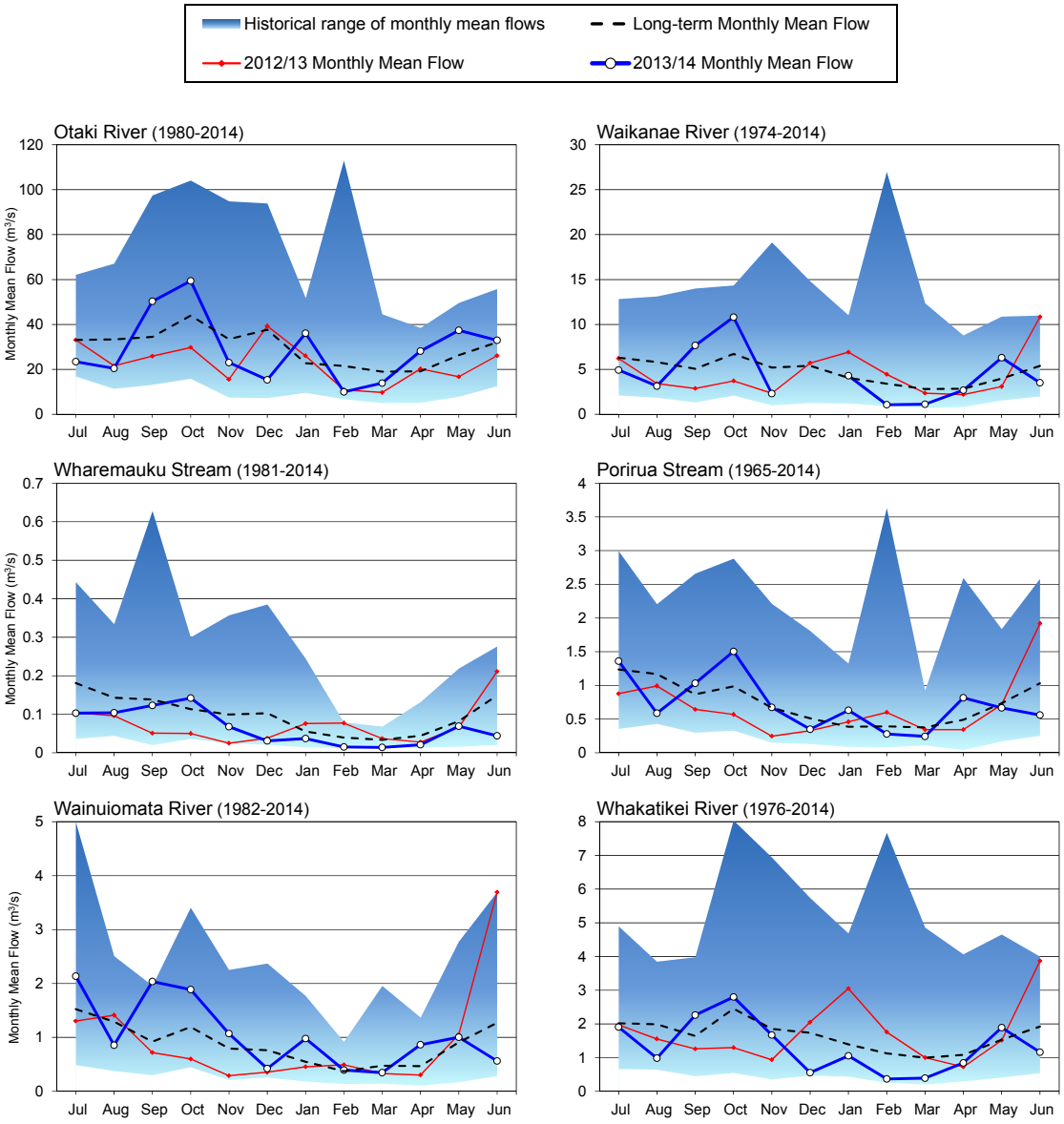

Figure 3.2: Mean monthly river flows (2013/14) and long term averages

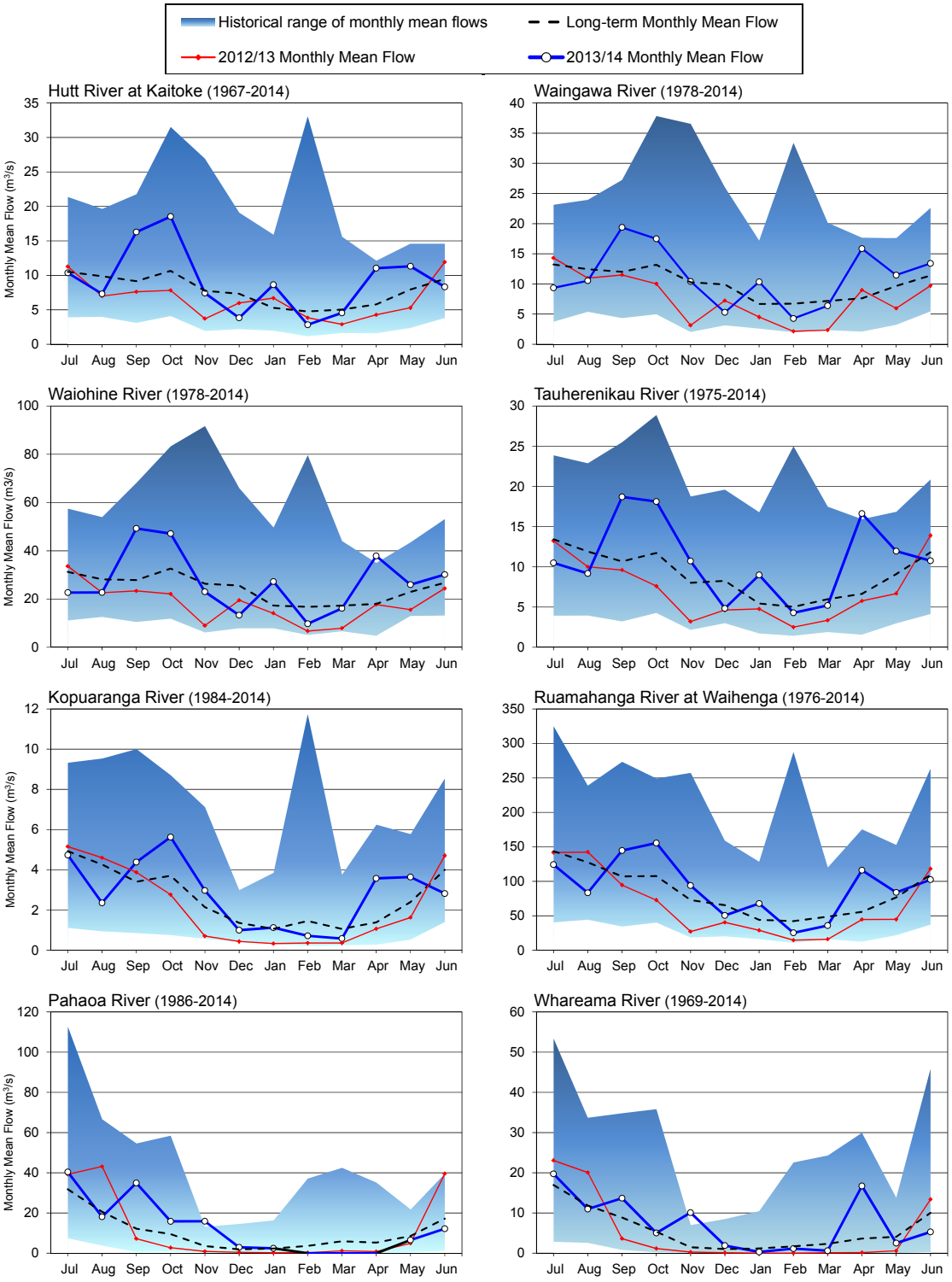

Figure 3.2 (*continued*)

Maximum recorded river flows for a number of sites are detailed in Table 3.6. The two sites highlighted in blue shading indicate a flood flow in excess of a 5-year return period. The peak recorded flow for the 2013/14 year for the Hutt River at Kaitoke is estimated at a 25-year return period.

Table 3.6: Maximum river and stream flows during 2013/14

Site	2013/14 maximum flow (m^3/s)	Date occurred	Estimated return period (years)
Waitohu Stream at Water Supply Intake	18	21-Sep-2013	< 2
Otaki River at Pukehinau[1]	852	11-Sep-2013	< 2
Mangaone Stream at Ratanui	13	11-Sep-2013	2
Waikanae River at Water Treatment Plant	125	5-Jan-2014	< 2
Hutt River at Kaitoke[1]	415	24-May-2014	25
Hutt River at Birchville	696	31-Oct-2013	2
Hutt River at Taita Gorge	798	31-Oct-2013	2
Pakuratahi River at Truss Bridge	95	11-Sep-2013	3
Mangaroa River at Te Marua	95	25-Sep-2013	< 2
Akatarawa River at Cemetery	268	31-Oct-2013	< 2
Whakatikei River at Dude Ranch	53	31-Oct-2013	< 2
Waiwhetu Stream at Whites Line East	10	3-Jan-2014	< 2
Wainuiomata River at Manuka Track	26	3-Jan-2014	< 2
Wainuiomata River at Leonard Wood Park	29	3-Jan-2014	< 2
Orongorongo River at Upper Dam Site	32	3-Jan-2014	3
Taupo Stream at Flax Swamp	2	15-Oct-2013	< 2
Horokiri Stream at Snodgrass	7	31-Oct-2013	< 2
Porirua Stream at Town Centre	25	16-Apr-2014	< 2
Ruamahanga River at Mt Bruce	313	11-Sep-2013	2
Ruamahanga River at Wardells	470	12-Sep-2013	2
Ruamahanga River at Gladstone Bridge	843	12-Sep-2013	4
Ruamahanga River at Waihenga Bridge	920	12-Jul-2013	2
Waipoua River at Mikimiki Bridge	141	15-Oct-2013	2
Waingawa River at Kaituna	314	12-Sep-2013	3
Mangatarere River at Gorge	72	18-Apr-2014	2
Waiohine River at Gorge	943	11-Sep-2013	3
Tauherenikau at Gorge	361	15-Oct-2013	4
Kopuaranga at Palmers Bridge	64	12-Jul-2013	3
Taueru River at Te Weraiti	359	12-Jul-2013	8
Huangarua at Hautotara	179	12-Jul-2013	2
Whareama River at Waiteko	437	12-Jul-2013	3
Pahaoa River at Hinakura[1]	589	12-Jul-2013	3

[1] Data provided by NIWA but frequency analysis performed by GWRC

Minimum recorded river flows (averaged over 7 and 28 day periods) during the 2013/14 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 2013/14 in the western Wellington region

Site	Data begins	7-day duration			28-day duration		
		2013/14 lowest mean flow (m^3/s)	Start date	Estimated return period (years)	2013/14 lowest mean flow (m^3/s)	Start date	Estimated return period (years)
Waitohu Stream at WSI	1994	0.122	8 Apr 2014	2	0.146	2 Apr 2014	5
Otaki River at Pukehinau[2]	1980	4.581	5 Apr 2014	3	7.639	2 Mar 2014	2
Mangaone Stream at Ratanui	1993	0.069	13 Mar 2014	1	0.077	2 Apr 2014	2
Waikanae River at WTP	1974	0.794	4 Apr 2014	5	0.891	2 Apr 2014	8
Hutt River at Kaitoke[2]	1968	1.465	4 Apr 2014	2	2.511	2 Mar 2014	1
Hutt River at Birchville[1,2]	1970	3.001	4 Apr 2014	1	4.967	2 Mar 2014	1
Hutt River at Taita Gorge[1]	1979	3.848	4 Apr 2014	1	5.605	2 Mar 2014	1
Pakuratahi River at Truss Bridge	1978	0.335	3 Apr 2014	1	0.589	27 Feb 2014	1
Mangaroa River at Te Marua	1977	0.384	4 Apr 2014	1	0.613	25 Mar 2014	1
Akatarawa River at Cemetery	1979	0.930	4 Apr 2014	3	1.140	19 Feb 2014	4
Whakatikei River at Dude Ranch	1976	0.253	4 Apr 2014	5	0.300	2 Apr 2014	5
Wainuiomata River at Manuka Track	1982	0.188	4 Apr 2014	1	0.258	25 Mar 2014	1
Orongorongo River at UDS	1980	0.044	20 Dec 2013	1	0.130	13 Dec 2013	1
Taupo Stream at Flax Swamp	1979	0.008	1 Mar 2014	2	0.012	2 Mar 2014	2
Horokiri Stream at Snodgrass	2002	0.081	4 Apr 2014	2	0.100	2 Mar 2014	2
Porirua Stream at Town Centre	1965	0.155	3 Apr 2014	1	0.207	24 Mar 2014	1

[1] Low flow likely to have been significantly affected by upstream abstraction.

[2] Data provided by NIWA but frequency analysis performed by GWRC

Table 3.8: Lowest 7-day and 28-day mean flows during 2013/14 in the Wairarapa

Site	Data begins	7-day duration			28-day duration		
		2013/14 lowest mean flow (m^3/s)	Start date	Estimated return period (years)	2013/14 lowest mean flow (m^3/s)	Start date	Estimated return period (years)
Ruamahanga River at Mt Bruce	1975	1.349	4 Apr 2014	1	2.487	2 Mar 2014	1
Ruamahanga River at Wardells[1]	1977	3.019	4 Apr 2014	1	4.872	2 Mar 2014	1
Ruamahanga River at Waihenga Br[1]	1976	10.444	4 Apr 2014	1	18.672	2 Mar 2014	1
Waipoua River at Mikimiki[3]	1995	0.428	11 Mar 2014	1	2.176	14 Dec 2013	1
Waingawa River at Kaituna	1978	1.782	12 Mar 2014	1	3.025	2 Mar 2014	1
Mangatarere Strm at Gorge	1999	0.294	27 Feb 2014	1	0.453	2 Mar 2014	1
Waiohine River at Gorge	1978	4.323	4 Apr 2014	1	8.284	2 Mar 2014	1
Tauherenikau River at Gorge	1975	1.455	3 Apr 2014	1	4.083	12 Feb 2014	1
Kopuaranga River at Palmers[1]	1984	0.347	3 Apr 2014	1	0.456	3 Mar 2014	1
Otukura Stream at Weir[1]	1997	0.091	25 Feb 2014	1	0.109	24 Mar 2014	1
Papawai Stream u/s Oxi Pond[1]	2006	0.289	11 Mar 2014	1	0.323	22 Mar 2014	1
Pahaoa River at Hinakura[2]	1986	0.145	23 Nov 2013	1	0.703	7 Jan 2014	1
Whareama River at Waiteko	1969	0.167	17 Jan 2014	1	0.279	2 Mar 2014	1

[1] Low flow likely to have been significantly affected by upstream abstraction.

[2] Data provided by NIWA but frequency analysis performed by GWRC.

[3] Short data record at site.

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 2013/14 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^3/s)	Number of days below threshold			
			2013/14	*2012/13*	*2011/12*	*2010/11*
Kapiti Coast	Waitohu Stream	0.180	51	*13*	*43*	*17*
	Otaki River	4.375	3	*21*	*4*	*1*
	Mangaone Stream	0.045	0	*0*	*0*	*0*
	Waikanae River	0.900	35	*0*	*0*	*0*
Wairarapa	Ruamahanga River (Wardells)	2.700	0	*50*	*0*	*6*
	Ruamahanga River (Waihenga)	9.800	2	*54*	*0*	*18*
	Waiohine River	3.040	0	*22*	*0*	*2*
	Tauherenikau River	1.350	1	*32*	*0*	*4*
	Waingawa River	1.900	21	*70*	*13*	*51*
	Kopuaranga River	0.270	0	*34*	*0*	*0*
	Waipoua River	0.300	0	*64*	*0*	*13*
	Mangatarere Stream (Gorge)	0.330	26	*103*	*22*	*96*
Wellington/Hutt Valley	Hutt River (Birchville)	1.450	0	*0*	*0*	*0*
	Wainuiomata River	0.360	13	*38*	*0*	*0*
	Orongorongo River	0.100	0	*2*	*0*	*0*

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 2013/14.

Table 3.10: Flood warning alarms triggered during 2013/14

Event Date	Sites where alarms were triggered
12 July 2013	• Waipoua at Mikimiki Bridge • Ruamahanga at Wardells • Taueru at Te Weraiti • Ruamahanga at Waihenga • Huangarua at Hautotara
5 September 2013	• Orongorongo at Truss Bridge
11-12 September 2013	• Orongorongo at Truss Bridge • Hutt at Te Marua • Hutt at Birchville • Otaki at Pukehinau • Akatarawa at Cemetery • Mangaroa at Te Marua • Waikanae at Water Treatment Plant • Ruamahanga at Mt Bruce • Waiohine at Gorge • Waipoua at Mikimiki Bridge • Mangatarere at Gorge • Waingawa at Kaituna • Ruamahanga at Wardells • Ruamahanga at Waihenga
20 September 2013	• Porirua at Town Centre
25 September 2013	• Hutt at Birchville • Mangaroa at Te Marua • Hutt at Te Marua • Ruamahanga at Waihenga • Taueru at Te Weraiti
11-12 October 2013	• Ruamahanga at Mt Bruce • Ruamahanga at Waihenga
14-14 October 2013	• Waiohine at Gorge • Waipoua at Mikimiki Bridge • Ruamahanga at Mt Bruce • Ruamahanga at Wardells • Ruamahanga at Waihenga

Table 3.10 (*continued*)

Event Date	Sites where alarms were triggered
24-25 October 2013	• Otaki at Pukehinau • Hutt at Kaitoke • Ruamahanga at Mt Bruce • Waiohine at Gorge • Ruamahanga at Wardells • Ruamahanga at Waihenga • Waipoua at Mikimiki Bridge
31 October - 1 November 2013	• Ruamahanga at Mt Bruce • Waiohine at Gorge • Ruamahanga at Waihenga • Hutt at Kaitoke • Akatarawa at Cemetery • Hutt at Birchville • Hutt at Te Marua • Waikanae at Water Treatment Plant • Hutt at Taita Gorge • Orongorongo at Truss Bridge
28 November 2013	• Waipoua at Mikimiki Bridge • Ruamahanga at Wardells • Ruamahanga at Waihenga • Taueru at Te Weraiti
30 November 2013	• Waiohine at Gorge • Waipoua at Mikimiki Bridge • Ruamahanga at Wardells • Ruamahanga at Waihenga
3 January 2014	• Porirua at Town Centre • Waiwhetu at Whites Line East • Wainuiomata at Manuka Track • Hutt at Kaitoke • Otaki at Pukehinau • Waiohine at Gorge • Ruamahanga at Mt Bruce • Ruamahanga at Wardells

Table 3.10 (*continued*)

Event Date	Sites where alarms were triggered
5 January 2014	• Otaki at Pukehinau • Waikanae at Water Treatment Plant • Hutt at Birchville • Hutt at Kaitoke • Akatarawa at Cemetery • Ruamahanga at Mt Bruce • Waiohine at Gorge • Ruamahanga at Wardells • Waipoua at Mikimiki Bridge • Ruamahanga at Waihenga
17 March 2014	• Hutt at Kaitoke • Ruamahanga at Mt Bruce • Waiohine at Gorge • Ruamahanga at Waihenga • Waipoua at Mikimiki Bridge
17-18 April 2014	• Ruamahanga at Waihenga • Waipoua at Mikimiki Bridge • Ruamahanga at Mt Bruce • Waiohine at Gorge • Ruamahanga at Wardells • Mangatarere at Gorge • Taueru at Te Weraiti
25 May 2014	• Hutt at Kaitoke • Hutt at Te Marua • Hutt at Birchville • Waipoua at Mikimiki Bridge • Ruamahanga at Mt Bruce • Ruamahanga at Wardells • Ruamahanga at Waihenga
26 May 2014	• Waipoua at Mikimiki Bridge • Ruamahanga at Mt Bruce • Ruamahanga at Wardells
11 June 2014	• Ruamahanga at Waihenga

3.3 Groundwater levels

Figure 3.3 shows mean monthly groundwater levels for 2013/14 (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.

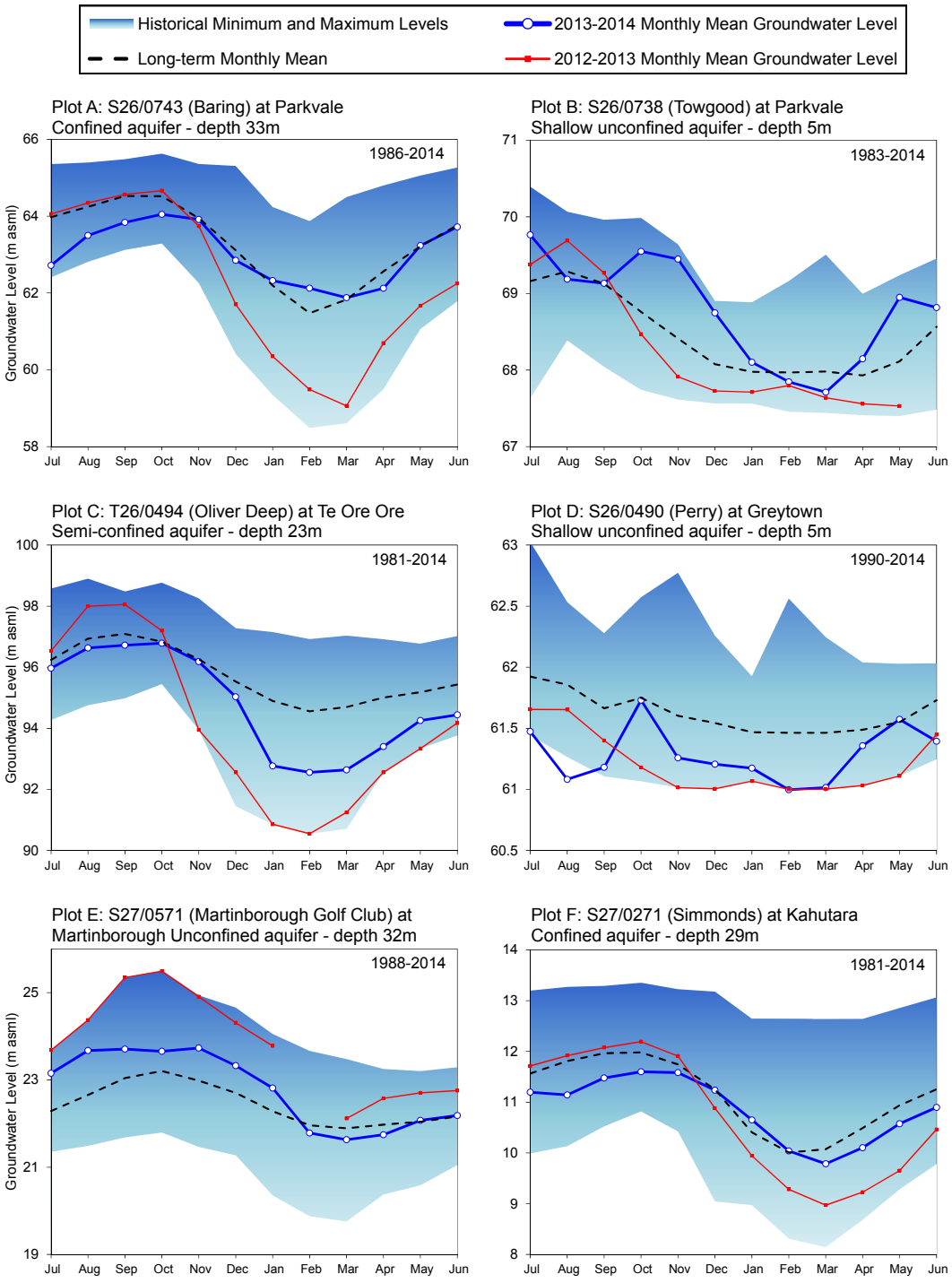

Figure 3.3: Mean monthly groundwater levels in the Wairarapa 2013/14

Figure 3.4 shows mean monthly groundwater levels for 2013/14 (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.

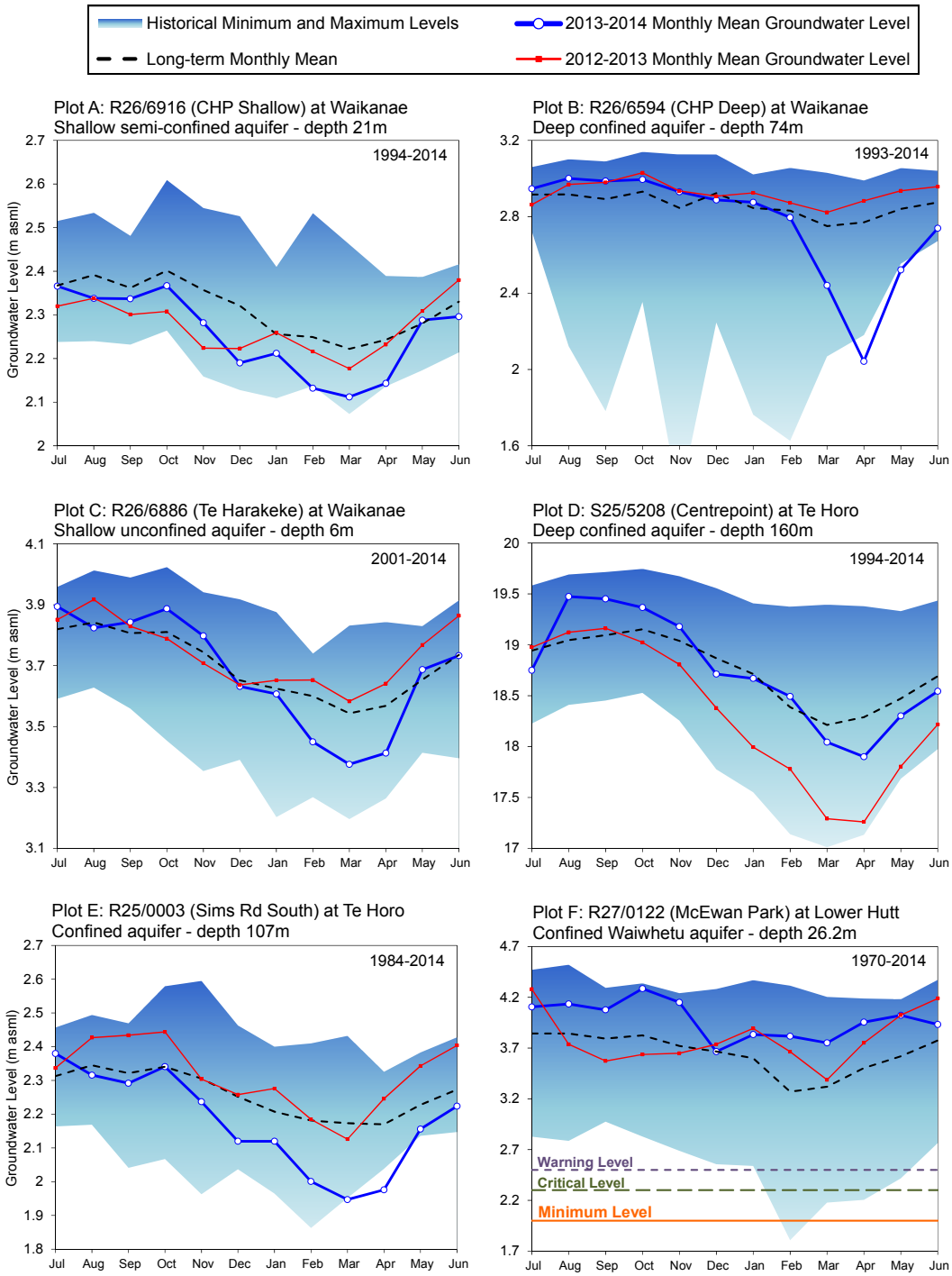

Figure 3.4: 2013/14 mean monthly groundwater levels in the Hutt Valley and on the Kapiti Coast 2013/14

3.4 Lake and wetland levels

Recorded lake levels at Lake Wairarapa and Lake Onoke are shown in Figure 3.5. The 2013/14 data are presented as a daily mean level (thin blue trace) and a monthly mean level (bold blue trace).

For comparison the long-term mean and historical range are also plotted. The minimum lake water level for Lake Wairarapa (as specified in the Regional Freshwater Plan) is shown by the red shaded area.

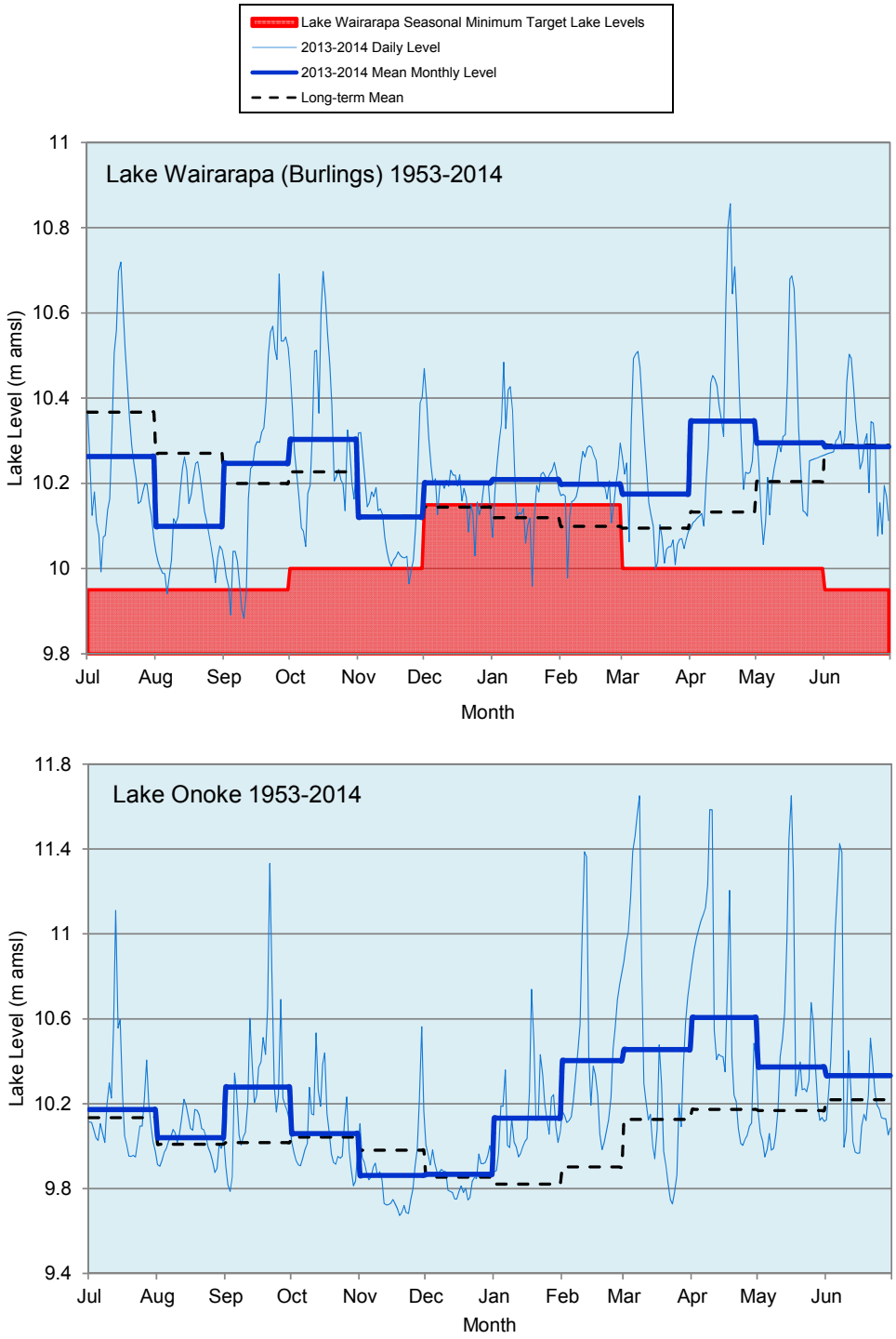

Figure 3.5: Mean monthly lake levels 2013/14

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 2013/14 recorded daily mean water levels at each site in comparison to all previous years of record.

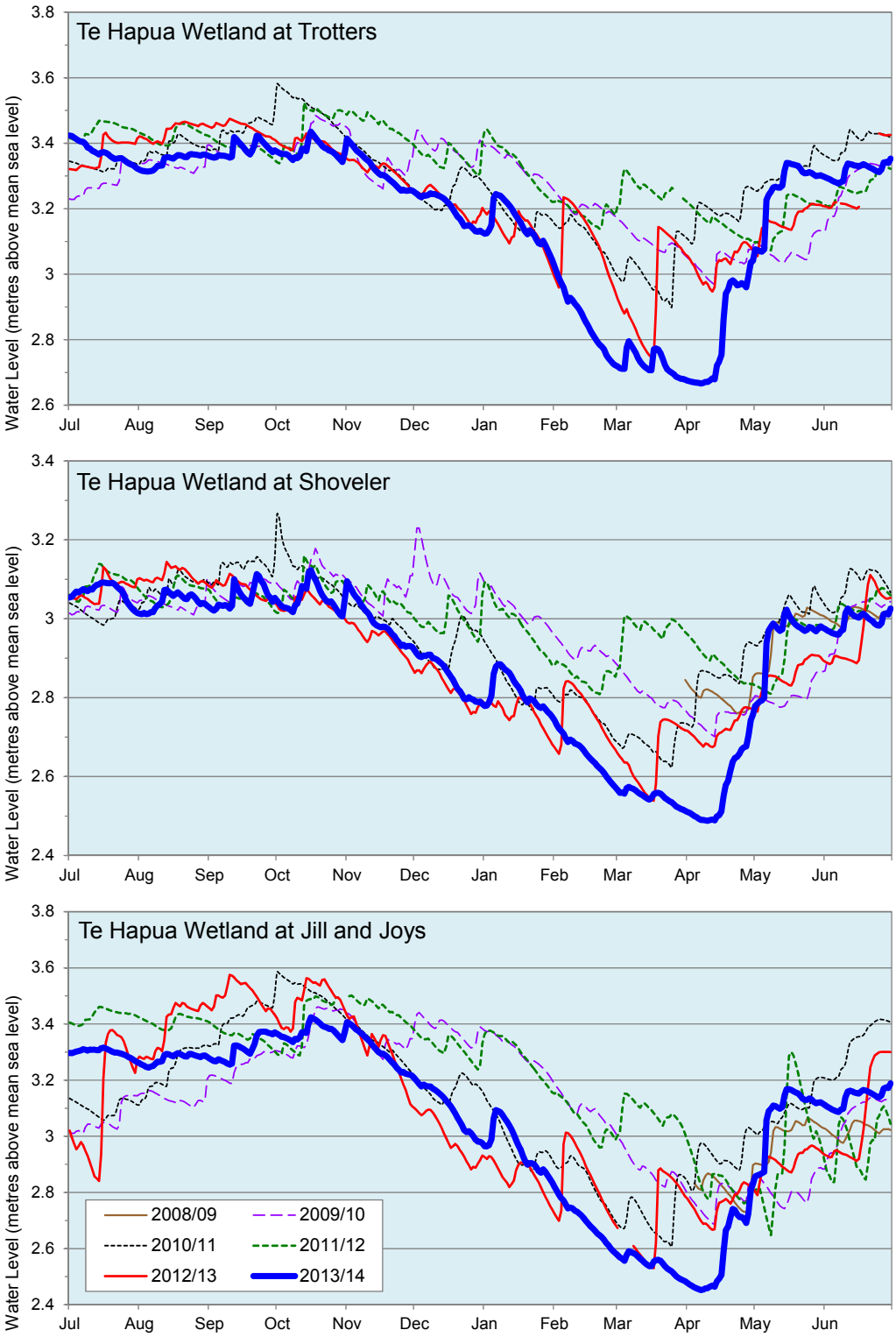

Figure 3.6: Daily mean water levels in Te Hapua wetland complex (Kapiti Coast)

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.

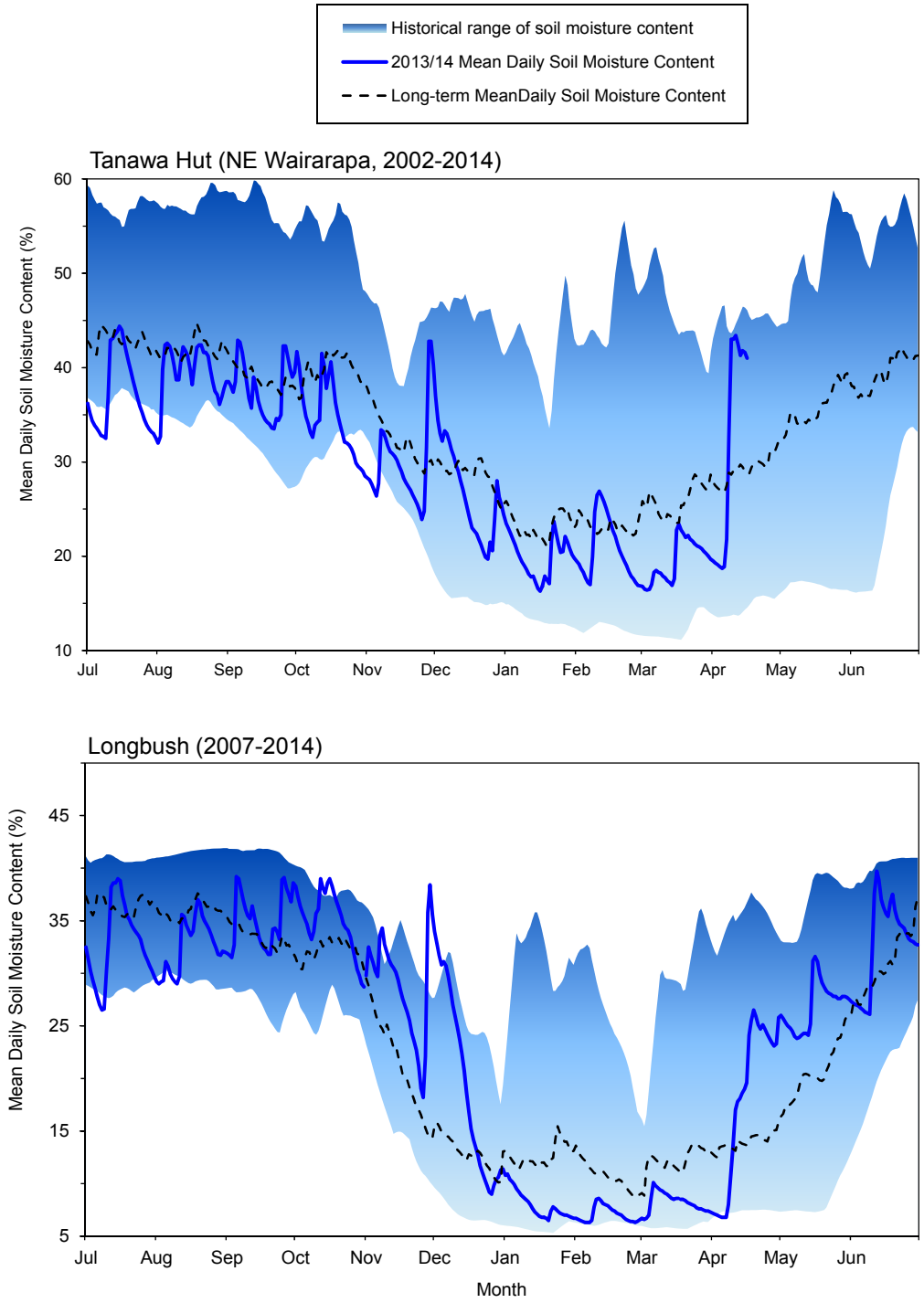

Figure 3.7: Mean daily soil moisture content 2013/14

Acknowledgements

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