



Public Works
Manly Hydraulics Laboratory

NSW ESTUARY AND RIVER WATER QUALITY ANNUAL SUMMARY 2015–2016

Report MHL2478
October 2016



prepared for
NSW Office of Environment and Heritage



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Foreword

Manly Hydraulics Laboratory (MHL) is a business group within the Department of Finance, Services and Innovation. The NSW water quality database has been developed by MHL to support a number of programs associated with coastal, floodplain and estuary management for the NSW Office of Environment and Heritage (OEH), NSW Department of Primary Industries Water (DPI Water) and Wollongong City Council (WCC).

This summary presents an overview of water quality measurements captured by the automatic recording stations along the coastal estuaries and rivers of New South Wales, from 1 July 2015 to 30 June 2016. MHL maintains the automatic recording stations and catalogues the data collected. During the 2015–2016 monitoring period the overall data recovery rate was 97.8%.

The summary provides information on how to access the data and additional data output types that are available on request.

Requests for further information should be directed to:

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Manly Hydraulics Laboratory	WWW	:	http://mhl.nsw.gov.au/
110B King Street	Telephone	:	(02) 9949 0200
MANLY VALE NSW 2093			

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Electronic copies of the reports in this series can be downloaded at: <http://mhl.nsw.gov.au> under the Publications menu.

Summary

This report contains:

- a brief description of the water quality programs
- guidelines on how to use this report
- information on how to access the database
- significant developments which occurred in 2015–2016
- the data summaries and station location maps for each station
- [Appendix A](#), which details the data available online
- [Appendix B](#), which shows data output formats available at MHL
- [Appendix C](#), a list of other publications which may be of interest.

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1. Water quality monitoring program

This report presents a summary of water quality data currently collected by Manly Hydraulics Laboratory (MHL). The network of automatic recorders and the associated analysis routines enable efficient delivery of water quality data. As well as near real time water quality information at 21 stations in NSW, extracts from the historical database of water quality data can be provided on request (refer to [Appendix A](#)).

The present program is based on a network of automatic recording stations installed at various estuaries (see [Station Location Maps](#)). This network consists of 21 permanent stations funded by the NSW Office of Environment and Heritage (OEH), NSW Department of Primary Industries Water (DPI Water) and Wollongong City Council (WCC) (see Table 1). The logging systems consist of data loggers which record water quality information every 15 minutes. Data is transmitted via telemetry to the database every six hours.

Table 1 Station list

River/estuary system	Station name	Station no.	MGA	Easting	Northing	Station owner	Data start	Overall data capture rate 2015–2016
Richmond	Coraki	203403	56	527976	6793772	DPI Water/OEH	21-Oct-09	100%
Richmond	Oakland Road	203470	56	526684	6791185	DPI Water	06-Mar-12	99.9%
Clarence	Rogans Bridge	204413	56	488813	6723401	DPI Water/OEH	03-Dec-09	95.7%
Clarence	Grafton	204400	56	493398	6715149	DPI Water/OEH	04-Dec-09	97.2%
Macleay	Kempsey	206402	56	485099	6561395	DPI Water/OEH	09-Feb-10	92.9%
Manning	Wingham	208400	56	440523	6473219	DPI Water/OEH	08-Dec-09	100%
Manning	Taree West	208420	56	447161	6469672	DPI Water	30-Apr-10	98.9%
Myall Lakes	Bombah Point	209475	56	434680	6403299	OEH	13-Jul-09	100%
Myall River	Tea Gardens	209480	56	421723	6385111	OEH	20-Oct-09	100%
Paterson	Dunmore	210409	56	369238	6383269	DPI Water/OEH	15-Oct-09	100%
Paterson	Hinton Bridge	210410	56	373245	6379624	DPI Water/OEH	15-Oct-09	85.0%
Hunter	McKimms Corner	210455	56	368162	6378933	DPI Water/OEH	08-Oct-09	100%
Hunter	Hexham	210448	56	376768	6367608	DPI Water/OEH	13-Apr-11	97.4%
Hunter	Fullerton Cove Salinity Buoy	210149	56	386312	6364022	DPI Water	21-Jun-13	95.1%
Hunter	Green Rocks	210432	56	377459	6378142	DPI Water/OEH	15-Oct-09	100%
Williams	Raymond Terrace	210452	56	382352	6375361	DPI Water/OEH	15-Oct-09	100%
Hawkesbury	Sackville	212406	56	303238	6292029	DPI Water/OEH	30-Oct-09	97.4%
Hawkesbury	Leets Vale	212461	56	309195	6299263	DPI Water	22-Jun-10	98.0%
Lake Illawarra	Koonawarra Bay	214440	56	300064	6179621	WCC	15-Jun-93	99.6%
Lake Illawarra	Cudgerie Bay	214416	56	303885	6177264	WCC	09-Feb-93	95.8%
Shoalhaven	Grady's Caravan Park	215430	56	268024	6138282	DPI Water/OEH	06-Oct-10	100%
Overall								97.8

The network features three distinctive water quality probe types for obtaining temperature and conductivity readings:

1. EC1500: designed for long-term deployment at unattended monitoring stations. The sensor head is epoxy encapsulated and has a large toroid to allow the flow of water through it. The sensor measures conductivity from zero to full scale with the probe resolution of electrical conductivity (EC) $\pm 1\%$ at full scale and temperature $\pm 0.2^\circ\text{C}$
2. Aquistar CT2X: a submersible sensor with built-in datalogging. The CT2X incorporates 4-pole electrode cell measurement technology with a probe resolution of EC ± 1 microsiemen/cm and temperature $\pm 0.01^\circ\text{C}$
3. YSI Sonde 600XL: a multi-parameter probe with a probe resolution of EC ± 1 microsiemen/cm and temperature $\pm 0.01^\circ\text{C}$.

In 2010, DPI Water requested that logger programs at all DPI Water-funded sites be modified to output salinity as practical salinity units (psu) and specific conductivity at 25°C (microseimens/cm) in addition to the standard outputs of water level, temperature and conductivity. This request is intended to make the near real-time data more usable by the diverse range of end users.

Temperature and conductivity values are obtained directly from the instrumentation. Specific conductivity at 25°C is calculated using the equation:

$$\text{Specific conductivity } [\mu\text{s/cm}] = C / (1 + 0.0198933 * (T - 25))$$

where C = uncompensated EC, T = temperature

Salinity is calculated using the UNESCO formula (seawater salinity calculation) and the full equation can be found in:

UNESCO Technical Papers in Marine Science, #36 (1981a) 'The Practical Salinity Scale 1978 and the International Equation of State of Seawater 1980', *UNESCO Division of Marine Sciences* (Paris), pp. 25.

Water quality data is transferred to the NSW Data Collection Warehouse, Data Centre 1 and to MHL's data server using a variety of telemetry techniques including internet protocol, landline telephone and cellular networks. The incoming raw data is then made available to external users to view via the web.

The data is stored in a database and subject to a quality assurance process which involves several control steps to ensure data quality is maintained. Computer programs are used to further format and analyse data.

Data is backed up daily and data archived to magnetic tape as a security measure at regular intervals. A backup database is also kept at Data Centre 1.

2. How to use this report

This report aims to streamline access to MHL's services and to the water quality database.

The NSW coastline has been divided into geographic regions based on river systems. Location maps display the station locations and the annual plots confirm the availability and suitability of data for the particular period of interest. Extracts from the historical database of water quality data can be made available on request (refer [Appendix A](#)).

Once a choice has been made of the period for which information is required, data and services can be obtained in a variety of formats, according to their intended use. [Appendix B](#) outlines sample data output types.

There are various factors which can influence the water quality data presented in this report. The reader should be familiar with these factors and data recording limitations when interpreting it. These factors include:

- In coastal streams or estuaries, salt water often mixes with fresh water. The addition of salt water greatly increases conductivity, with the ocean typically recording an approximate level of 36 psu compared with fresh water which is almost zero.
- In inland locations, freshwater inflows associated with rainfall events may lower conductivity. The auto scaling of the conductivity plots can visually over-emphasise these changes. Conversely, during low flow conditions the dissolved solids are more concentrated and therefore conductivity levels are higher. Caution should be exercised when interpreting the conductivity and derived salinity plots in this report recognising different scaling and the proximity of water quality station locations to the ocean.
- At monitoring stations impacted by tides, conductivity will be influenced by natural flows, as well as saltwater intrusion brought upstream with rising tides. The salinity value for any particular monitoring site can vary significantly between high and low tides. For example, during the 2015–2016 monitoring period, the salinity values at Tea Gardens varied by approximately 26 psu between high and low tides, and at Leets Vale variations of approximately 6 psu were observed. This measured variation should not be misread as noisy trace fluctuations (due to instrument limitations or malfunction), but rather it typically represents measured responses to the surrounding environment.

3. How to access the data

MHL provides a full on-line data access service via the internet for its clients, and a restricted service for the general public at <http://mhl.nsw.gov.au/>.

Typically the last four days of data are available on-line in a non-quality controlled form to aid the fastest possible access to data records. The on-line service for clients can provide access to all data catalogued in [Appendix A](#).

Quality controlled data may be ordered via MHL's web page (<http://mhl.nsw.gov.au/>), by emailing data-request@mhl.nsw.gov.au, or via customised decision support tools that can be provided on request.

The MHL website has been updated in association with an updated database and data warehouse capability via the NSW Data Collection Warehouse. The latest website includes updated functionality, data access and availability of water level time-series plots.

[Appendix B](#) describes sample data plots and MHL's products that can be provided upon request.

[Appendix C](#) provides a list of additional publications that may be of interest.

4. Significant events and developments

4.1 Flood events

This section outlines events and developments which have influenced water quality monitoring during this reporting period. Floods introduce significant freshwater inflows which impact on electrical conductivity and temperature, as shown in the data summaries. Table 2 lists the flood events that occurred during the 2015–2016 reporting period. The flood events are classified according to the NSW State Emergency Service’s classification scale.

Table 2 NSW flood classifications 2015–2016

River basin	Date	Flood classification
Richmond River	June 2016	Minor to Moderate
Hunter River	January 2016	Minor to Major
Hawkesbury River	June 2016	Minor
Shoalhaven River	August 2015	Moderate
	June 2016	Moderate

4.2 Cross-sectional profiling

A cross-sectional profile is taken at more than four points across the channel at the surface and at 0.3 m intervals below the surface. The profile information provides a cross-check as to whether the in situ sensor is providing data that is representative of the complete river cross-section.

In May 2016, cross-sectional water quality profiling was undertaken on the Richmond, Clarence, Macleay, Manning, Paterson, Hunter and Hawkesbury rivers, as part of the DPI Water monitoring. The profiling was re-performed at Rogans Bridge, Grafton and Grady’s Caravan Park in August 2016 due to instrument failures in May 2016.

4.3 Station development

The following station developments and upgrades occurred during the 2015–2016 reporting period:

- Rogans Bridge had a new water quality slide installed on 19 May 2016. The previous slide was covered in rocks from a past flood event.
- Grafton received extra mechanical clearing around the water quality slide on 27 April 2016 since siltation was potentially affecting water flow around the probe. Mechanical clearing was a preventative maintenance approach to improve water circulation around the water quality sensor.

- Hinton Bridge was installed with a new YSI water quality sensor and a 90 metre custom made cable on 8 April 2016 which increases the data capture reliability of the site as there is no junction in the cable. The previously installed AqStar CT2X sensor was damaged by the flood in January 2016; the junction box also experienced water ingress over that time.
- Two sites, namely Hexham and Fullerton Cove, were also upgraded with YSI water quality sensors on 21 January 2016 and 10 November 2015 respectively. The upgraded sensors increase the quality of the data and reliability of the data capture.

4.4 Station issues

Hinton Bridge's junction box experienced water ingress during the flood event in January 2016 resulting in sensor and communication cable failure.

The Kempsey site experienced a catastrophic power surge (lightning strike) on the evening of 25 September 2015 which caused damage to the logger, modem and all sensors. New components were installed and data communications re-established on 21 October 2015.

The bank at Grady's Caravan Park site is quite unstable and is eroding, particularly during flood events. The equipment is at risk of damage with future flood events. Bank instability has been recognised as a significant safety issue so access to the sensor has been restricted.

5. Water quality monitoring summary

This section documents locality maps and quality assured water quality monitoring summaries for each station. Table 3 provides an index to the figures presented. Daily rainfall data from the nearest available OEH rain gauge is added to the figure to recognise the influence of rainfall events. Rain gauges associated with the water quality results are indicative only and are not necessarily representative of the location of the water quality probes. Please note that all parameters with the exception of total daily rainfall are presented at 3-hourly intervals for annual plot resolution purposes, which explains the apparent truncated low tides seen on some water level plots.

Table 3 Index of figures

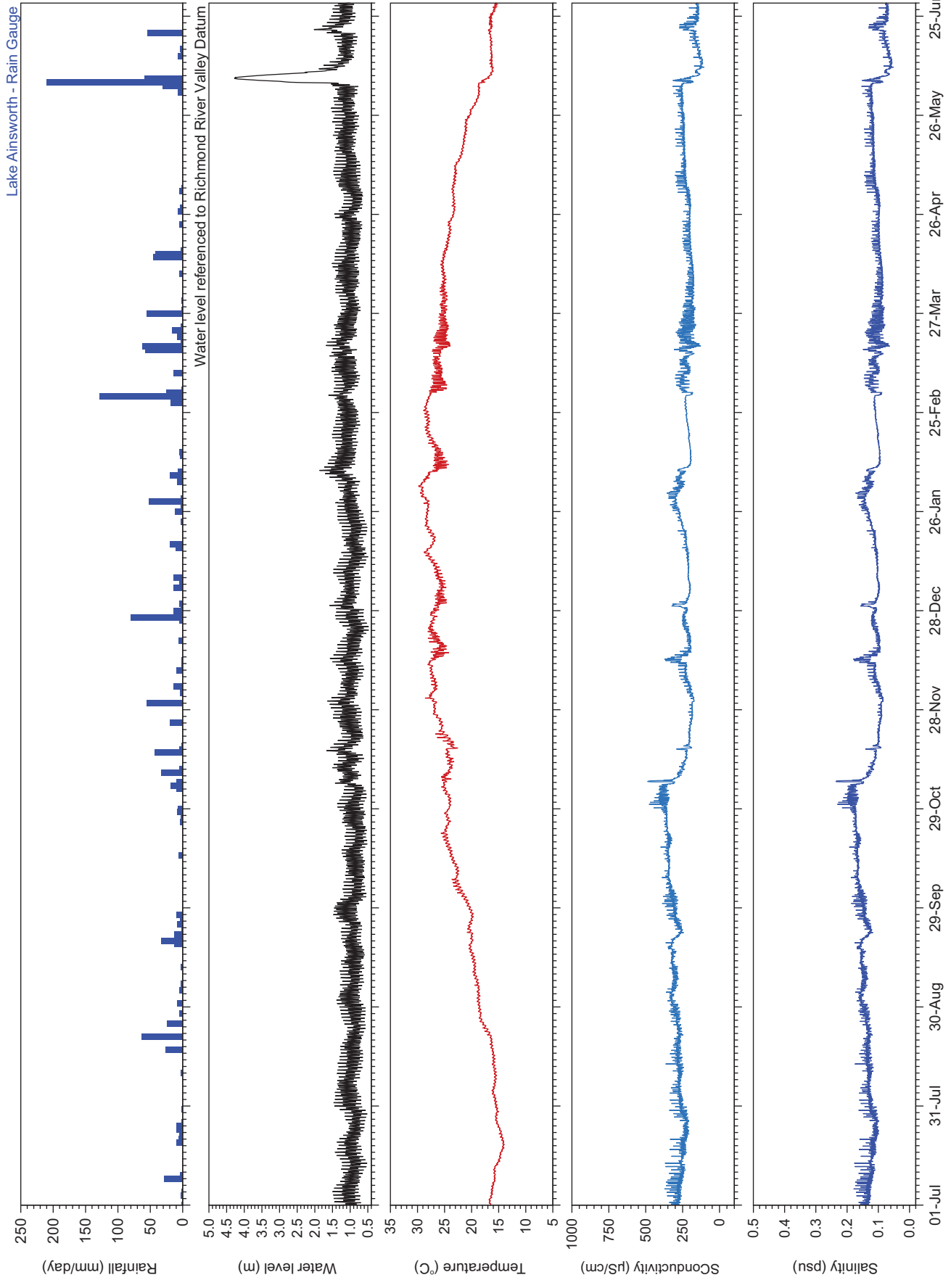
River/estuary system	Station name	Station no.	Comparative OEH rainfall station name	Figure
Station Locality Map	Richmond River Region			1
Richmond	Coraki	203403	Lake Ainsworth	2
Richmond	Oakland Road	203470	Lake Ainsworth	3
Station Locality Map	Clarence River Region			4
Clarence	Rogans Bridge	204413	Wooli Caravan Park	5
Clarence	Grafton	204400	Wooli Caravan Park	6
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Hunter	Green Rocks	210432	Hexham	21
Williams	Raymond Terrace	210452	Hexham	22
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Hunter	Fullerton Cove Salinity Buoy	210149	Hexham	24
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**STATION LOCATIONS
RICHMOND RIVER REGION**

MHL
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Figure
1
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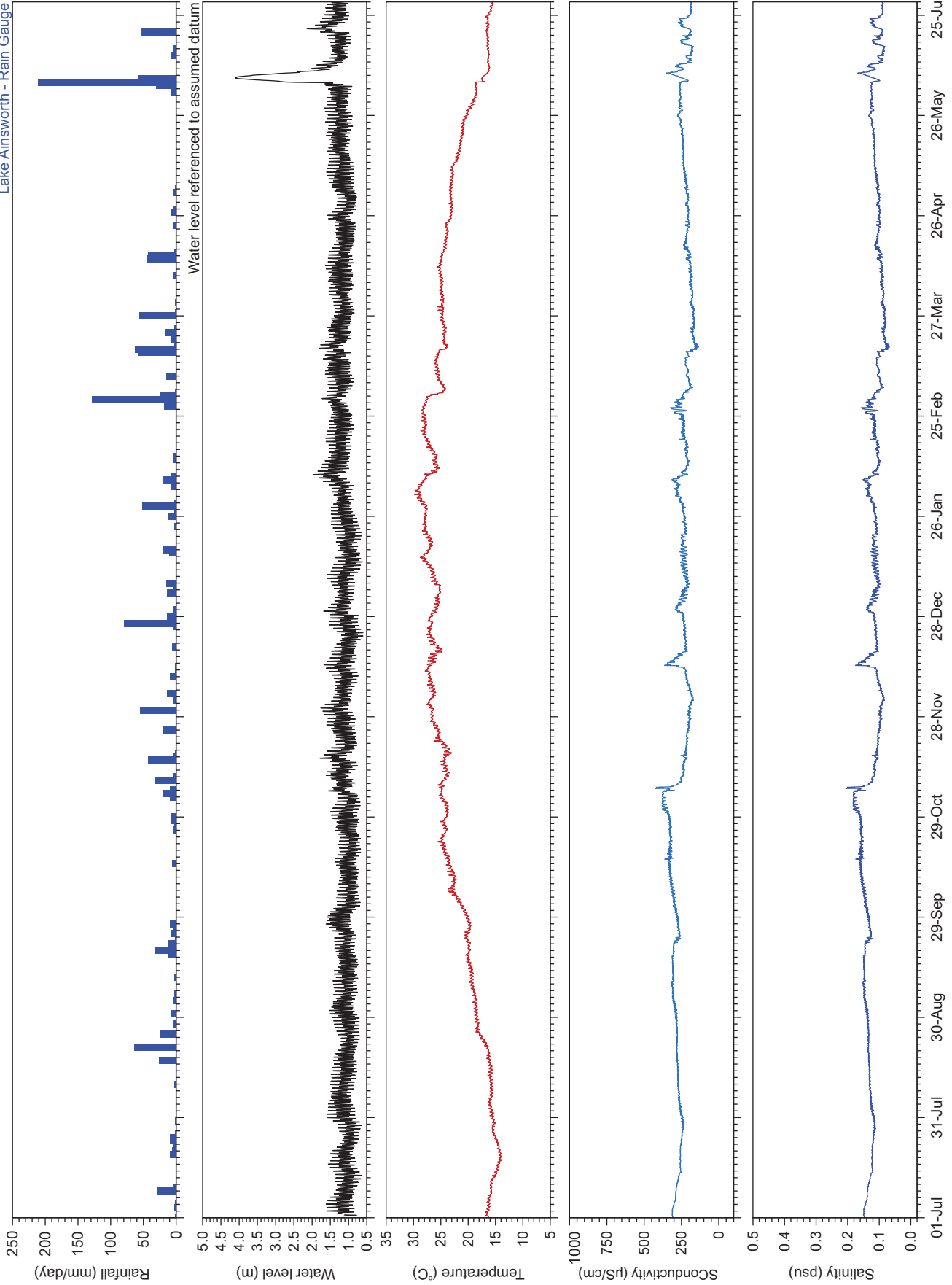
WATER LEVEL AND WATER QUALITY DATA
2015–2016
CORAKI

MHL
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Figure
2

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Lake Ainsworth - Rain Gauge



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WATER LEVEL AND WATER QUALITY DATA
2015–2016
OAKLAND ROAD

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Figure
3

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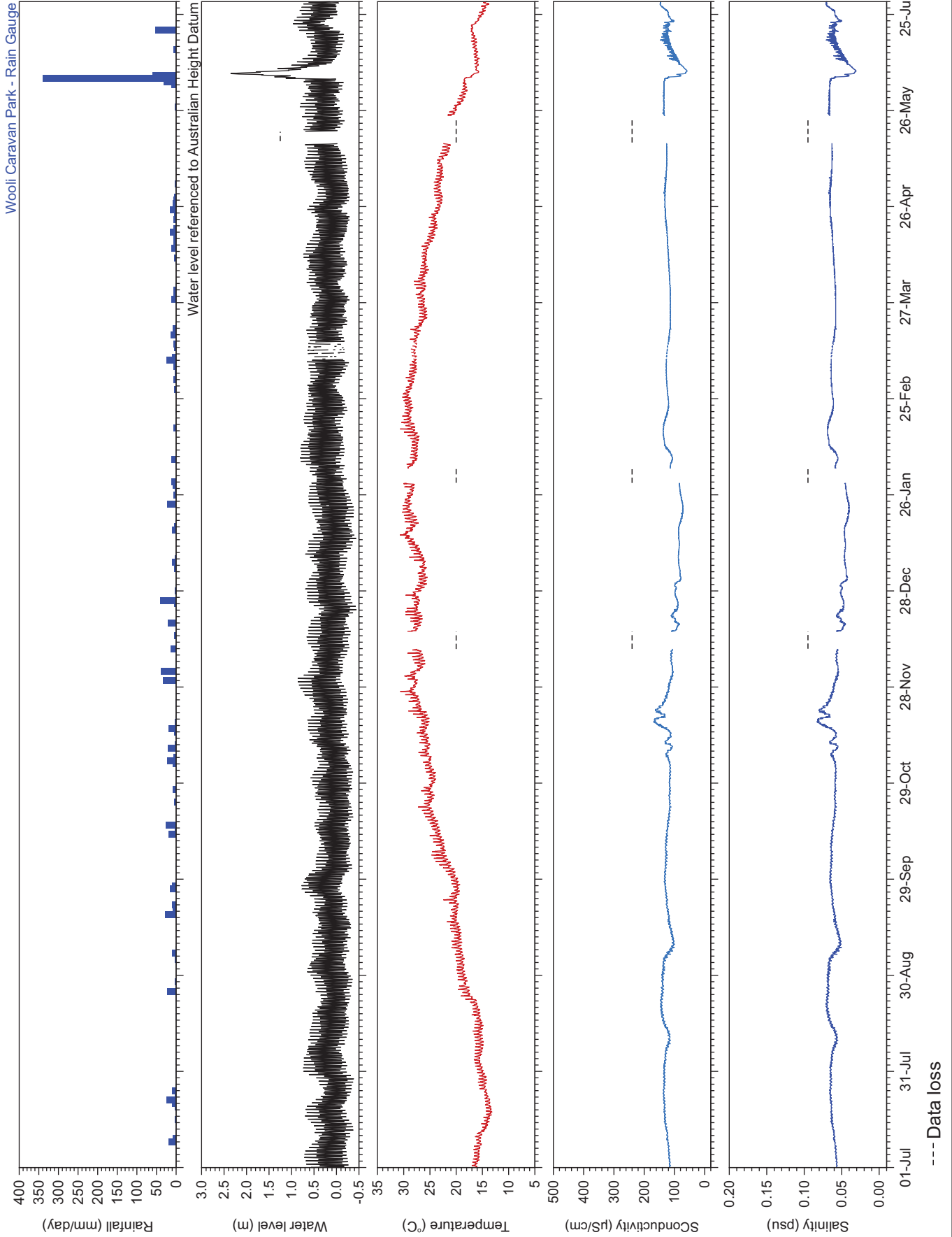
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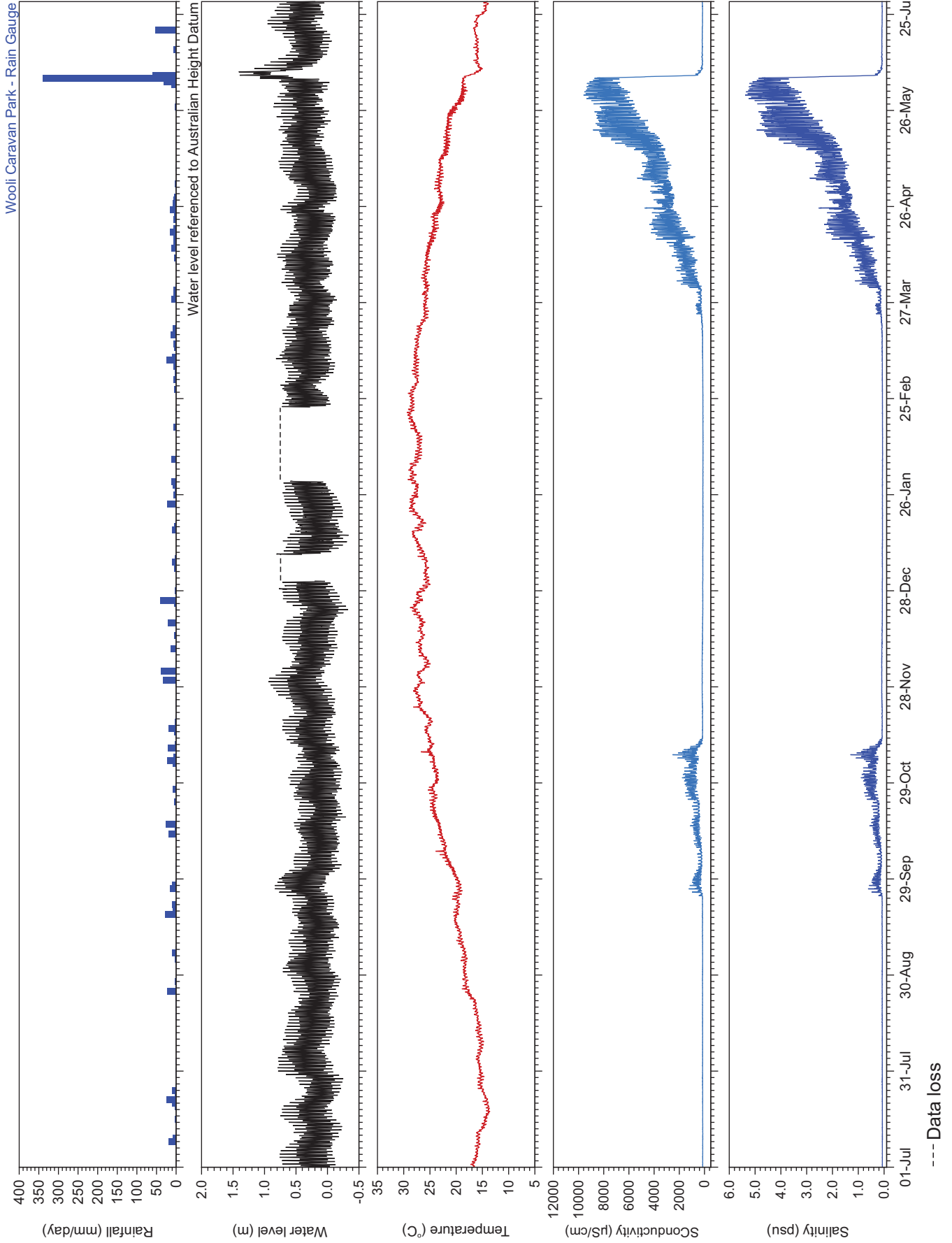
**STATION LOCATIONS
CLARENCE RIVER REGION**

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Figure
4

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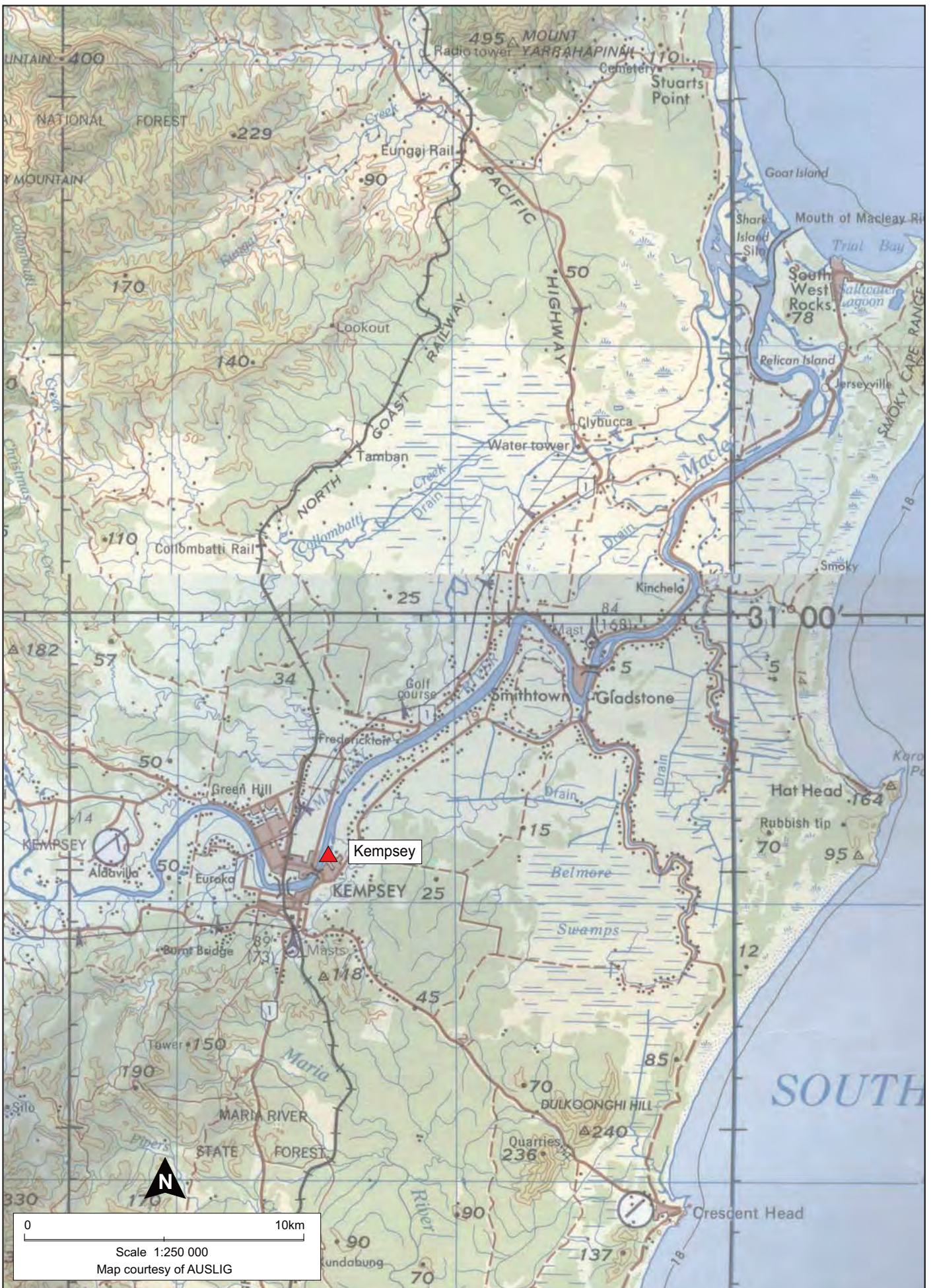
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WATER LEVEL AND WATER QUALITY DATA
2015–2016
GRAFTON

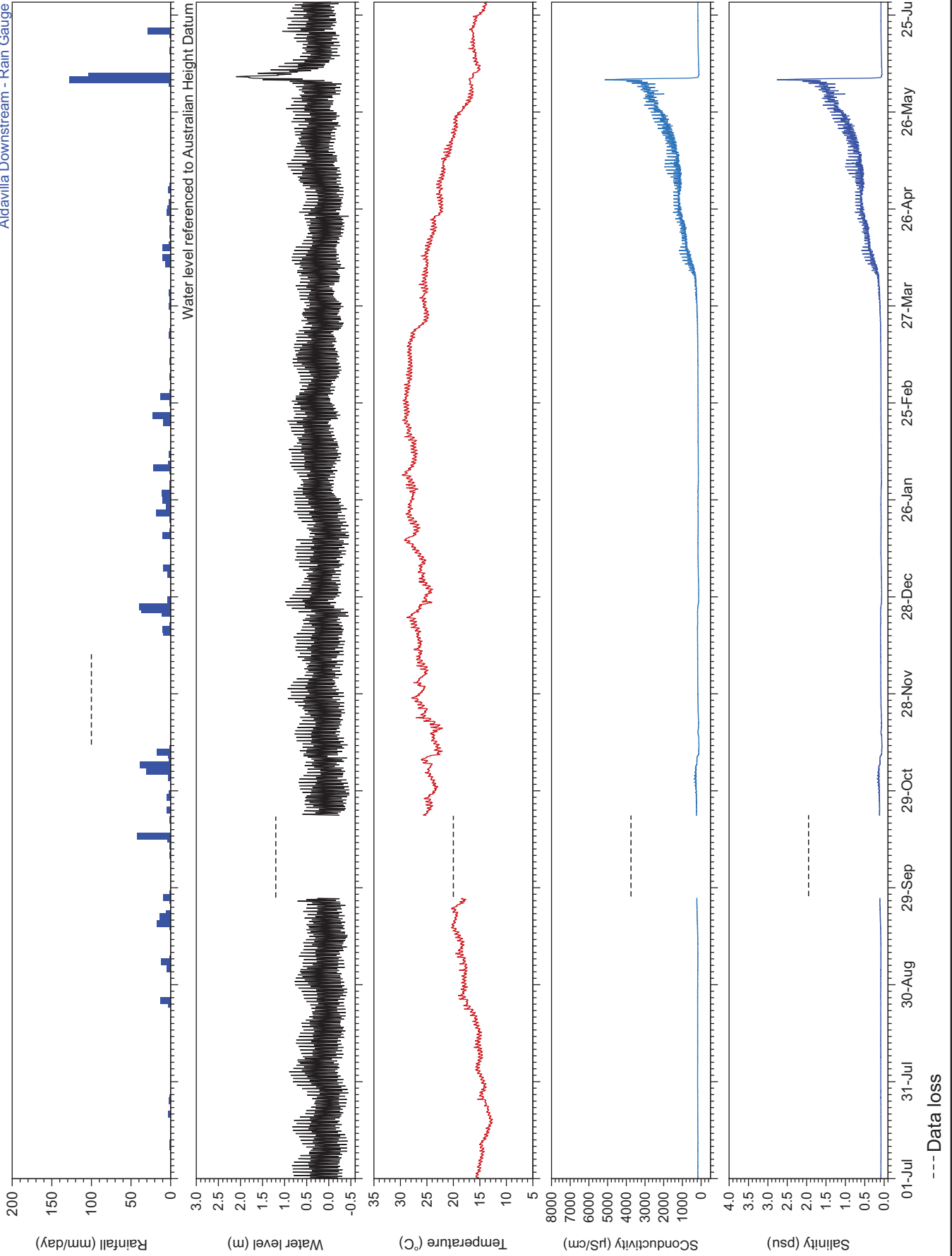
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Figure
6

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Aldavilla Downstream - Rain Gauge



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WATER LEVEL AND WATER QUALITY DATA
2015–2016
KEMPSEY

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Figure
8

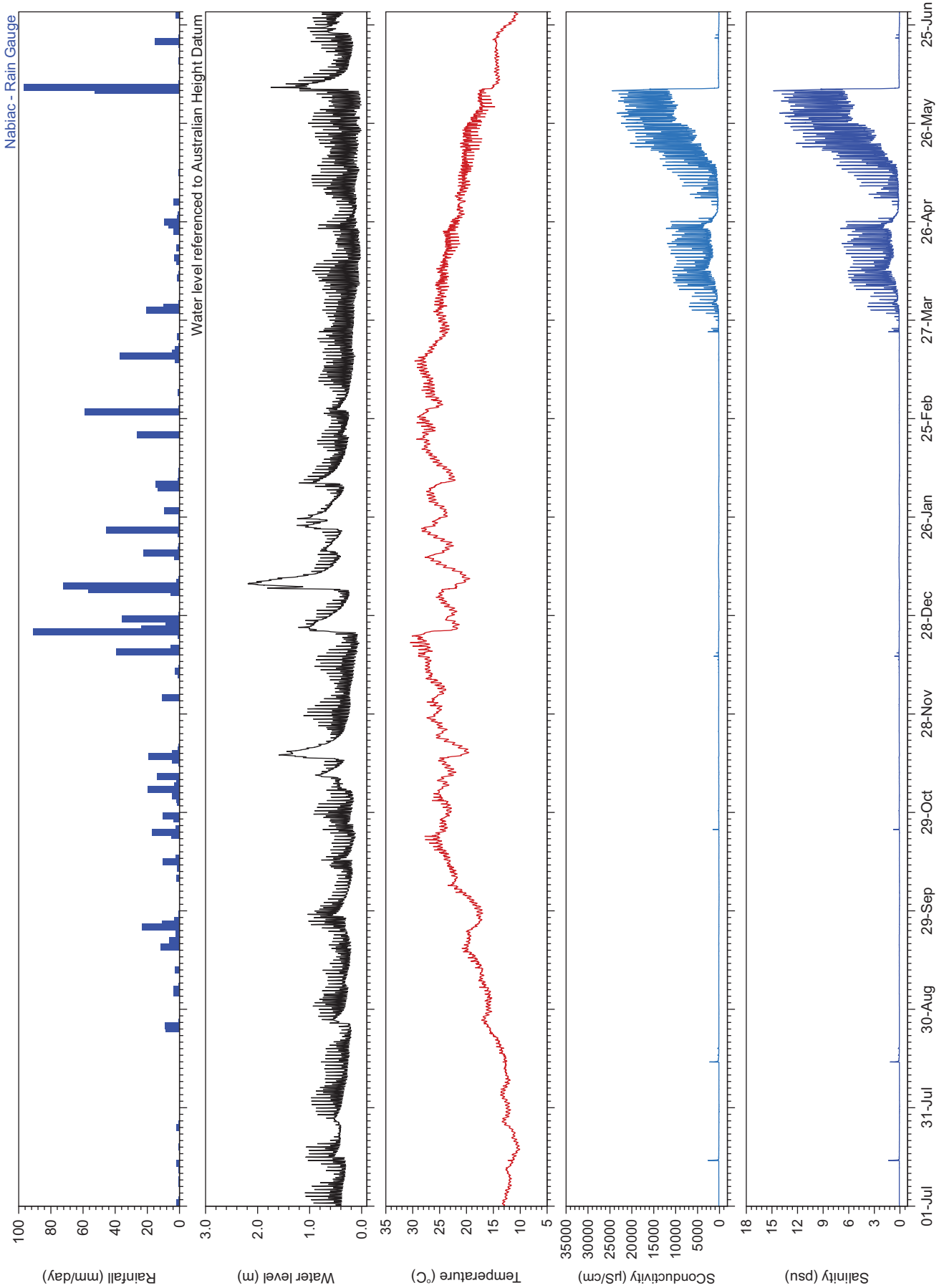
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**STATION LOCATIONS
MANNING RIVER REGION**

MHL
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Figure 9
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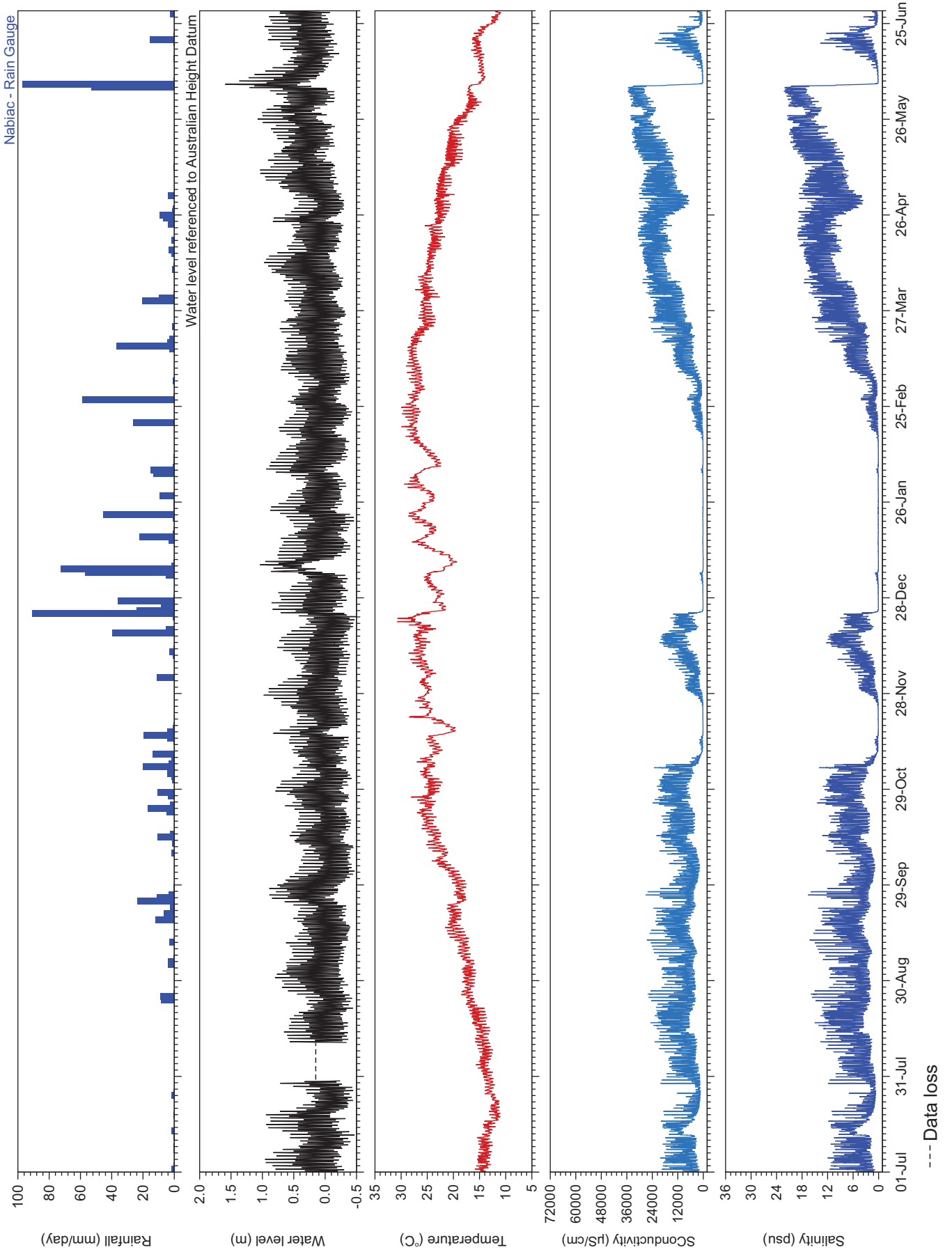
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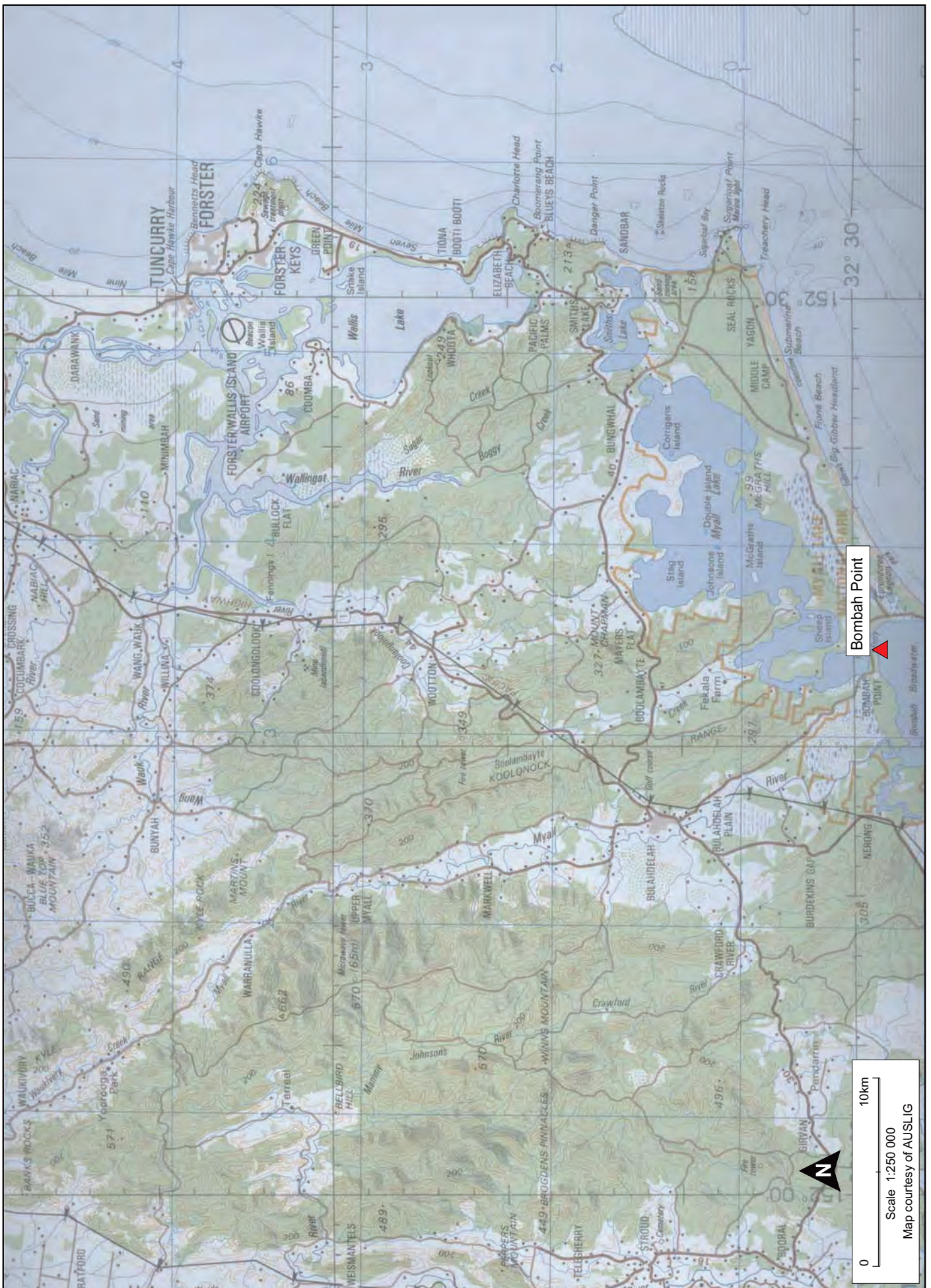
WATER LEVEL AND WATER QUALITY DATA
2015–2016
WINGHAM

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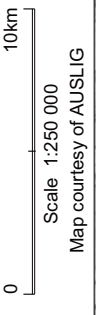
Figure
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Bombah Point



Scale 1:250 000
Map courtesy of AUSLIG

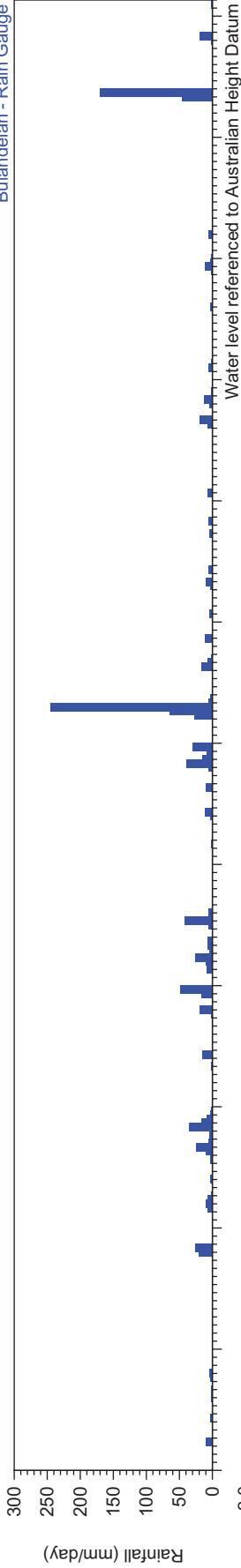


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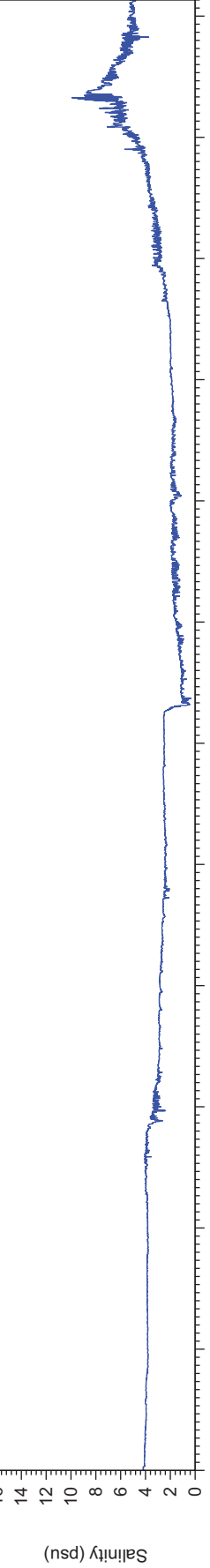
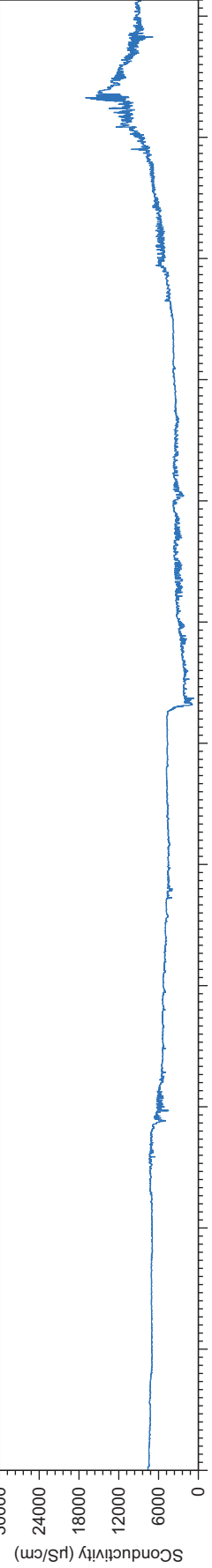
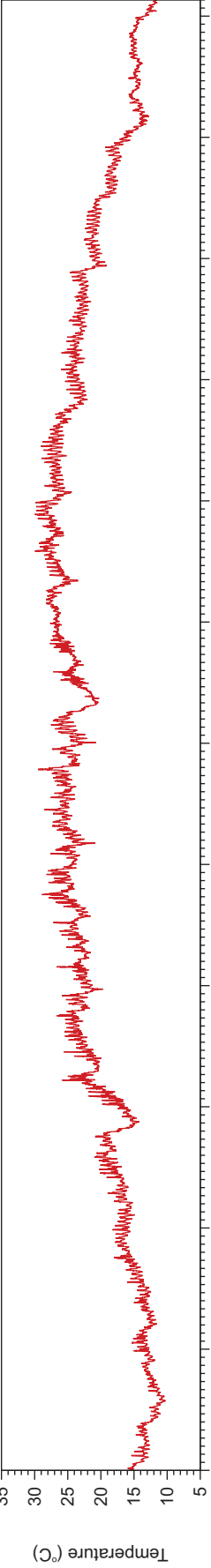
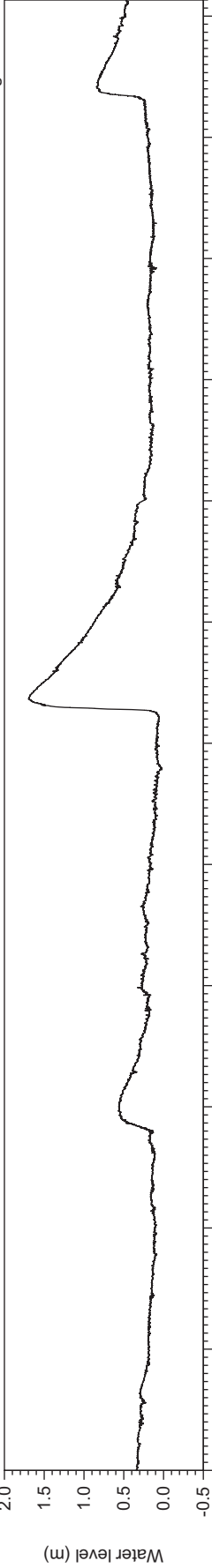
**STATION LOCATIONS
GREAT LAKES REGION**

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**Figure
12**
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Bulahdelah - Rain Gauge



Water level referenced to Australian Height Datum



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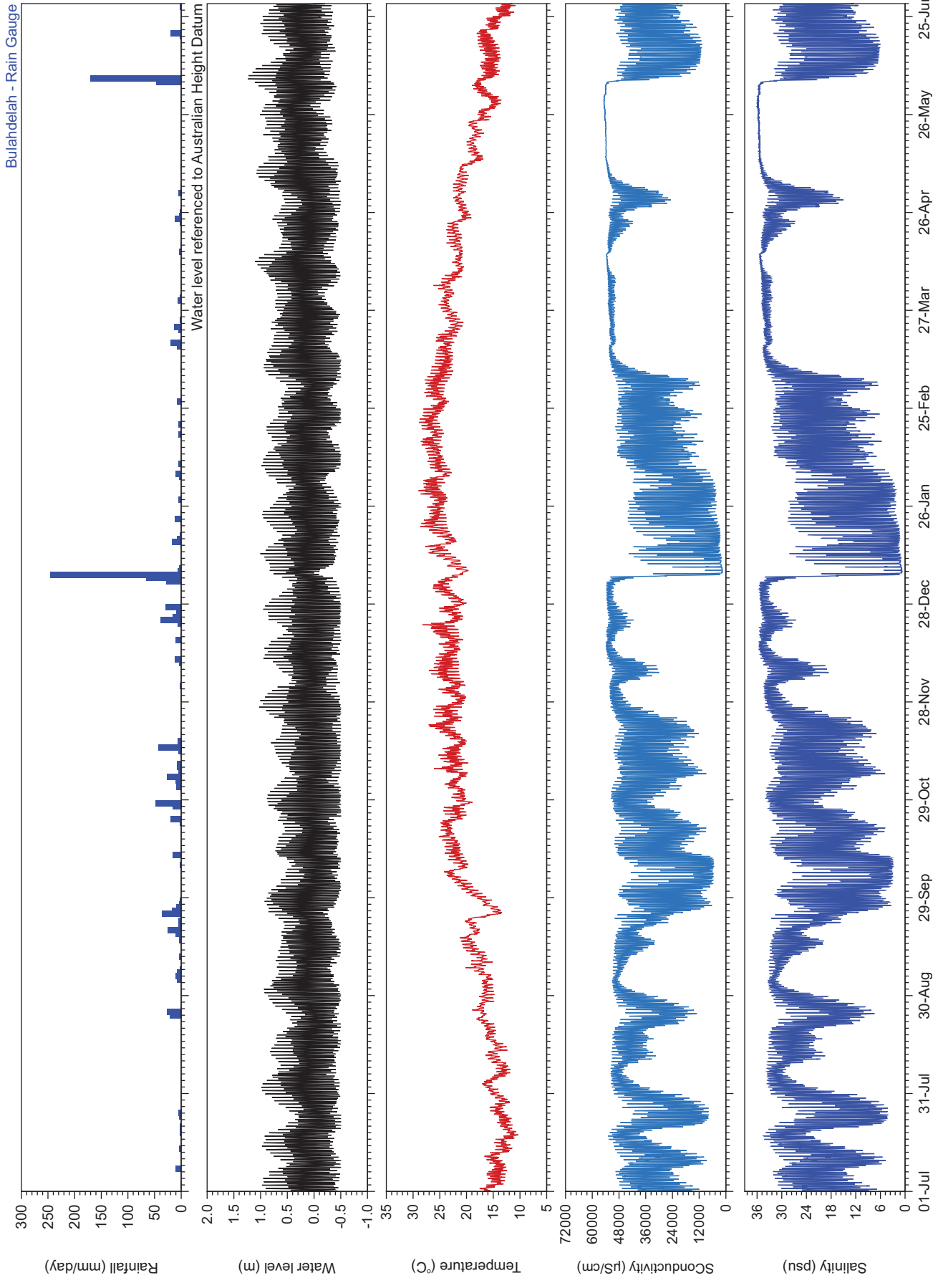
WATER LEVEL AND WATER QUALITY DATA
2015–2016
BOMBAH POINT

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Figure
13

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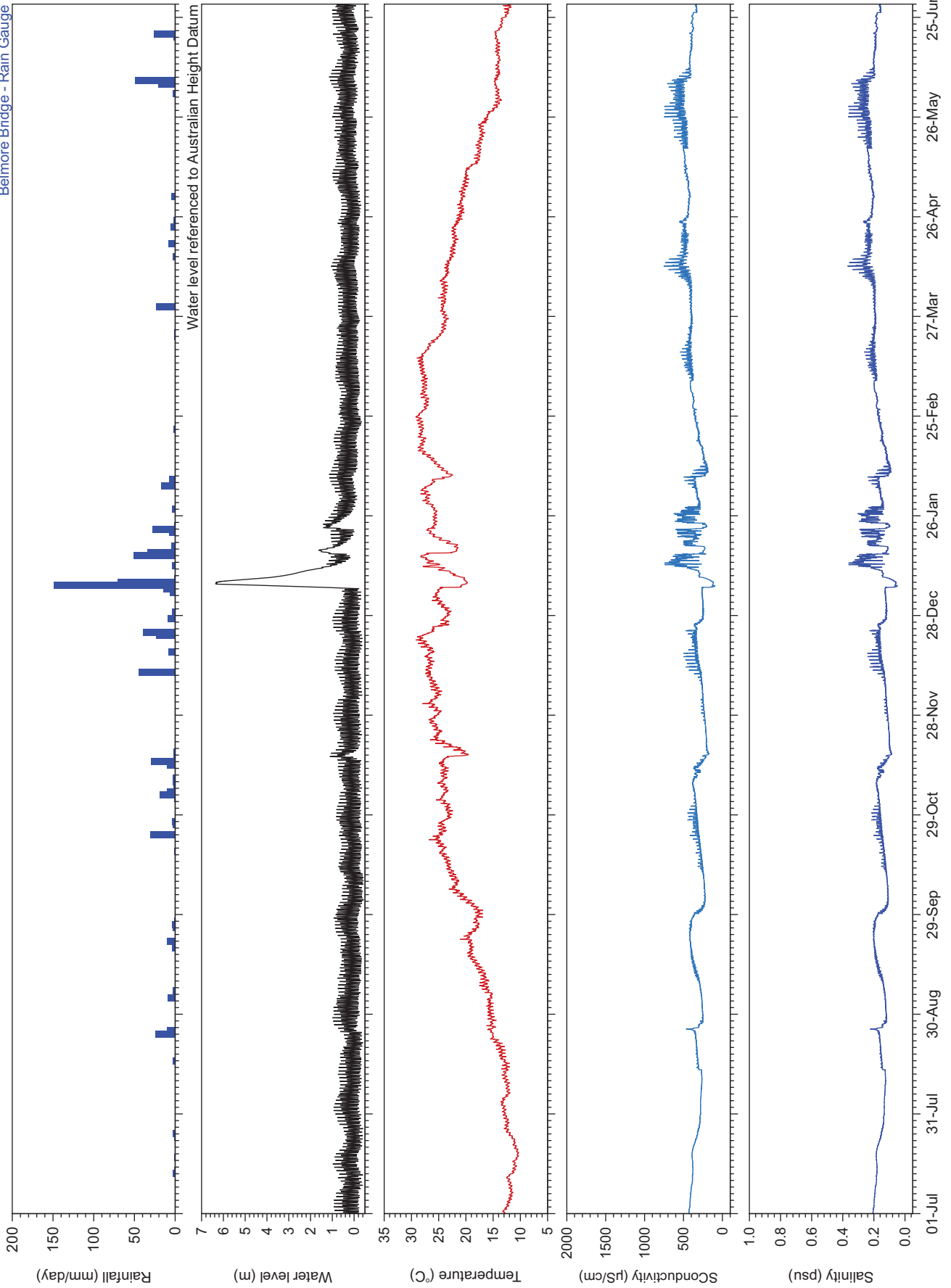


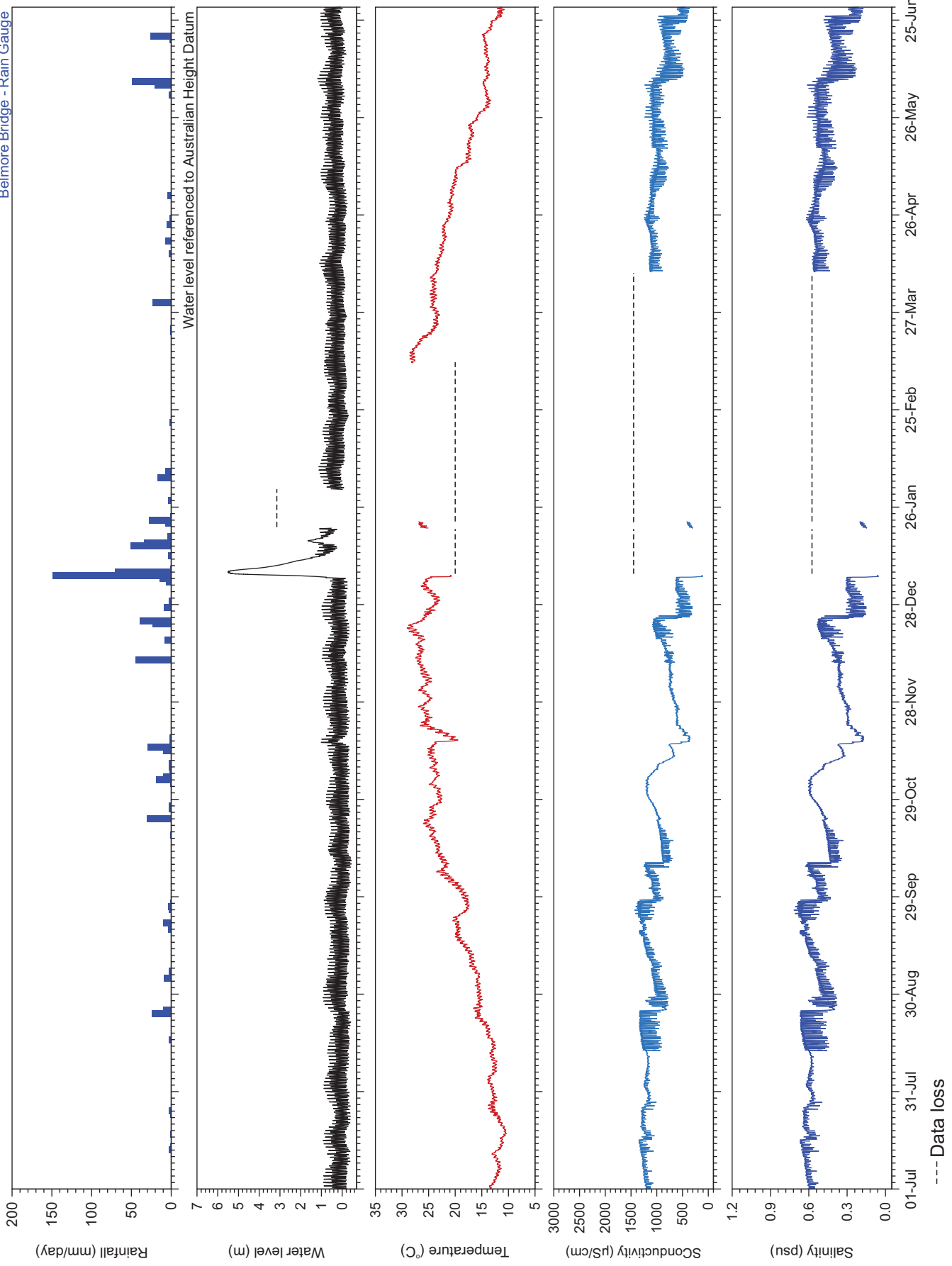


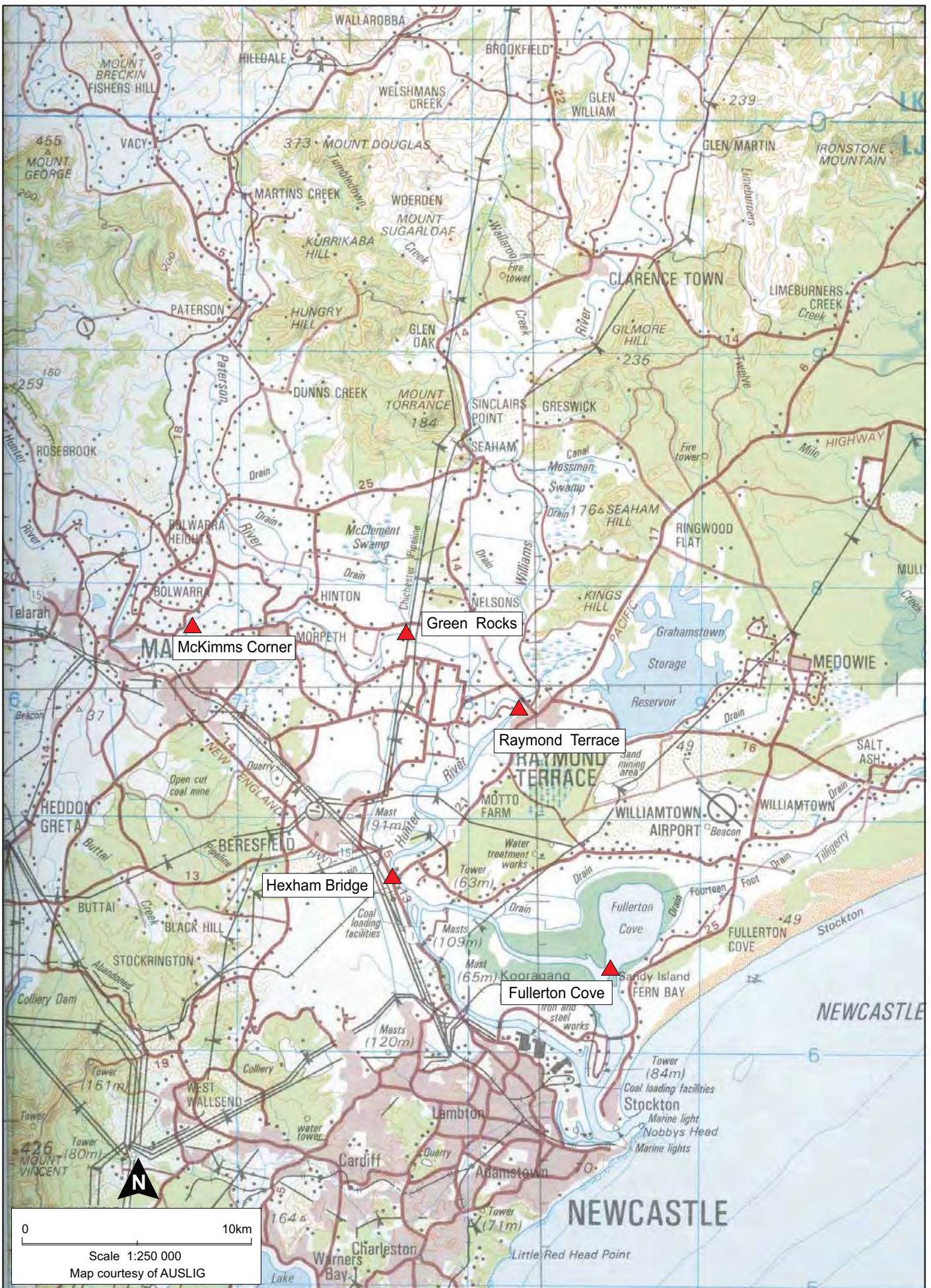
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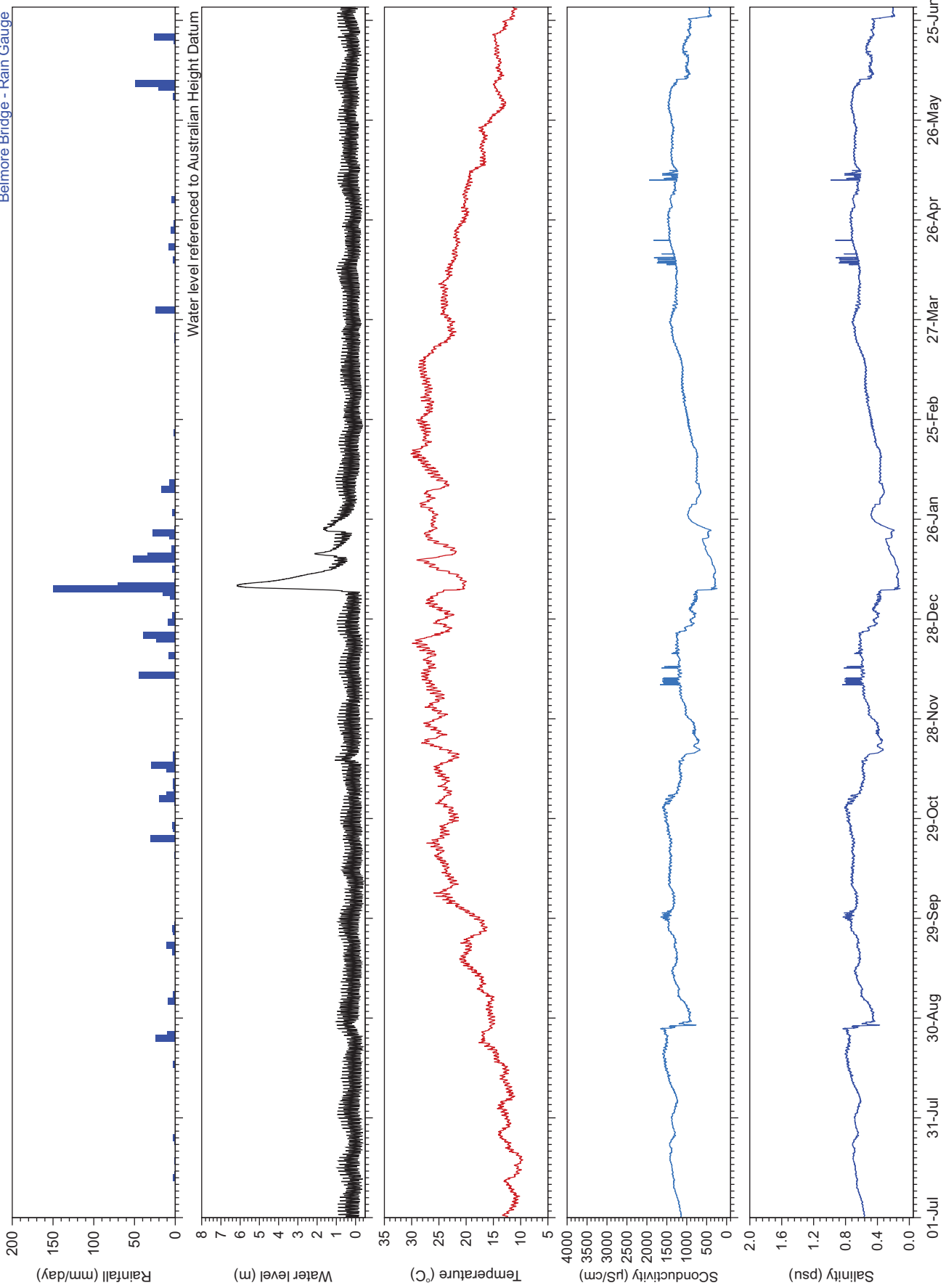
**STATION LOCATIONS
PATERSON RIVER REGION**

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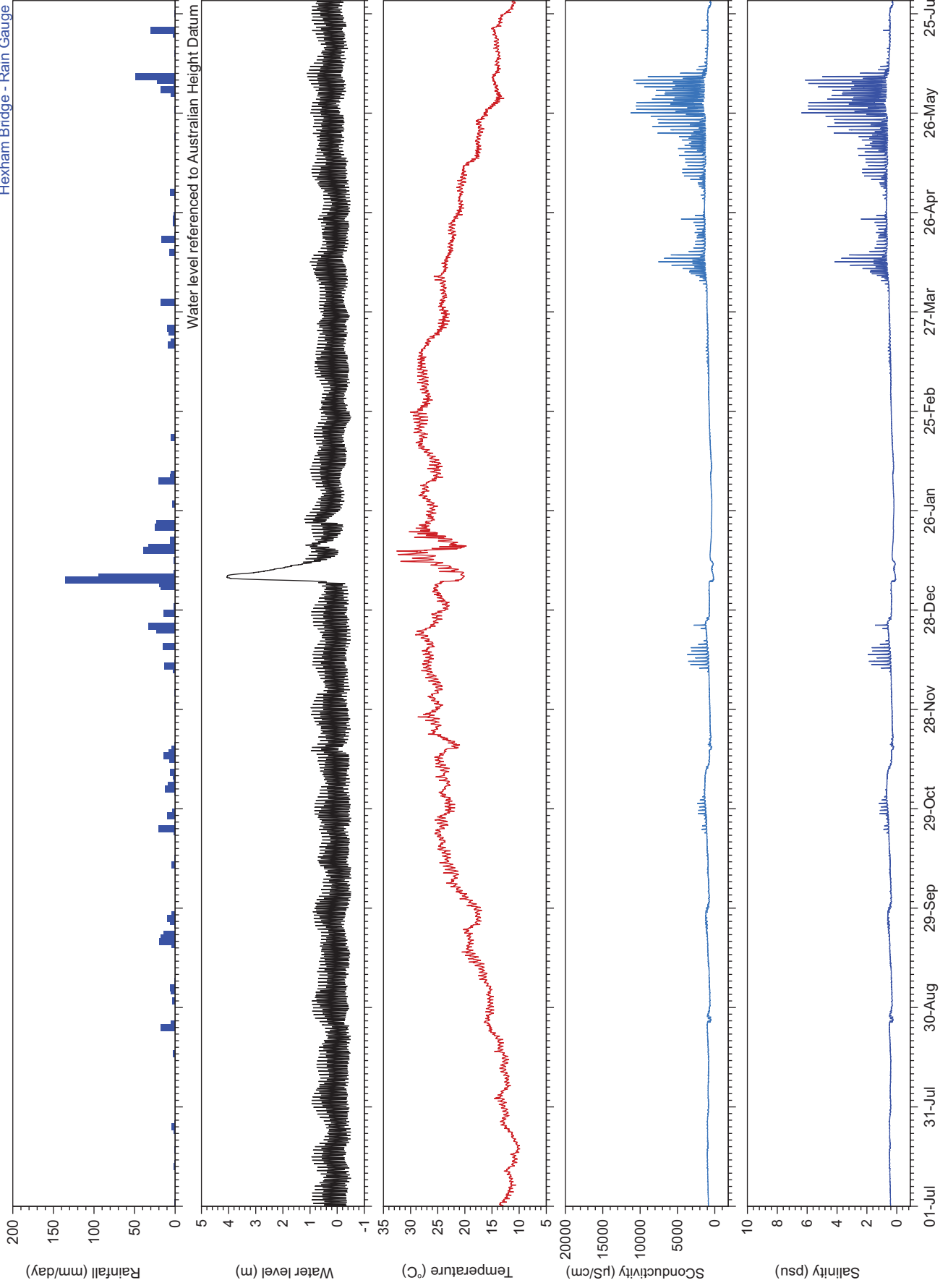








Hexham Bridge - Rain Gauge



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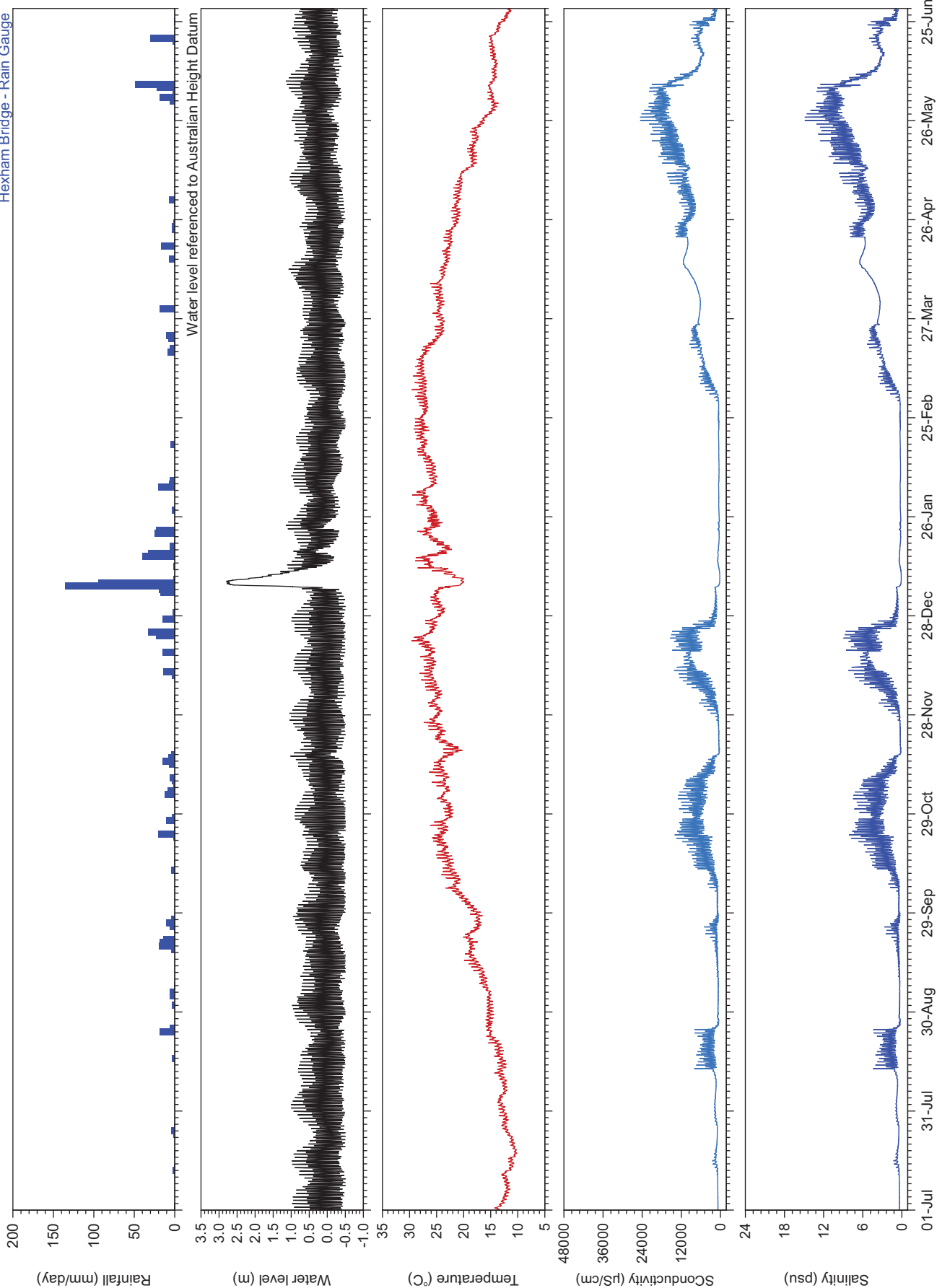
WATER LEVEL AND WATER QUALITY DATA
2015–2016
GREEN ROCKS

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Figure
21

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Hexham Bridge - Rain Gauge



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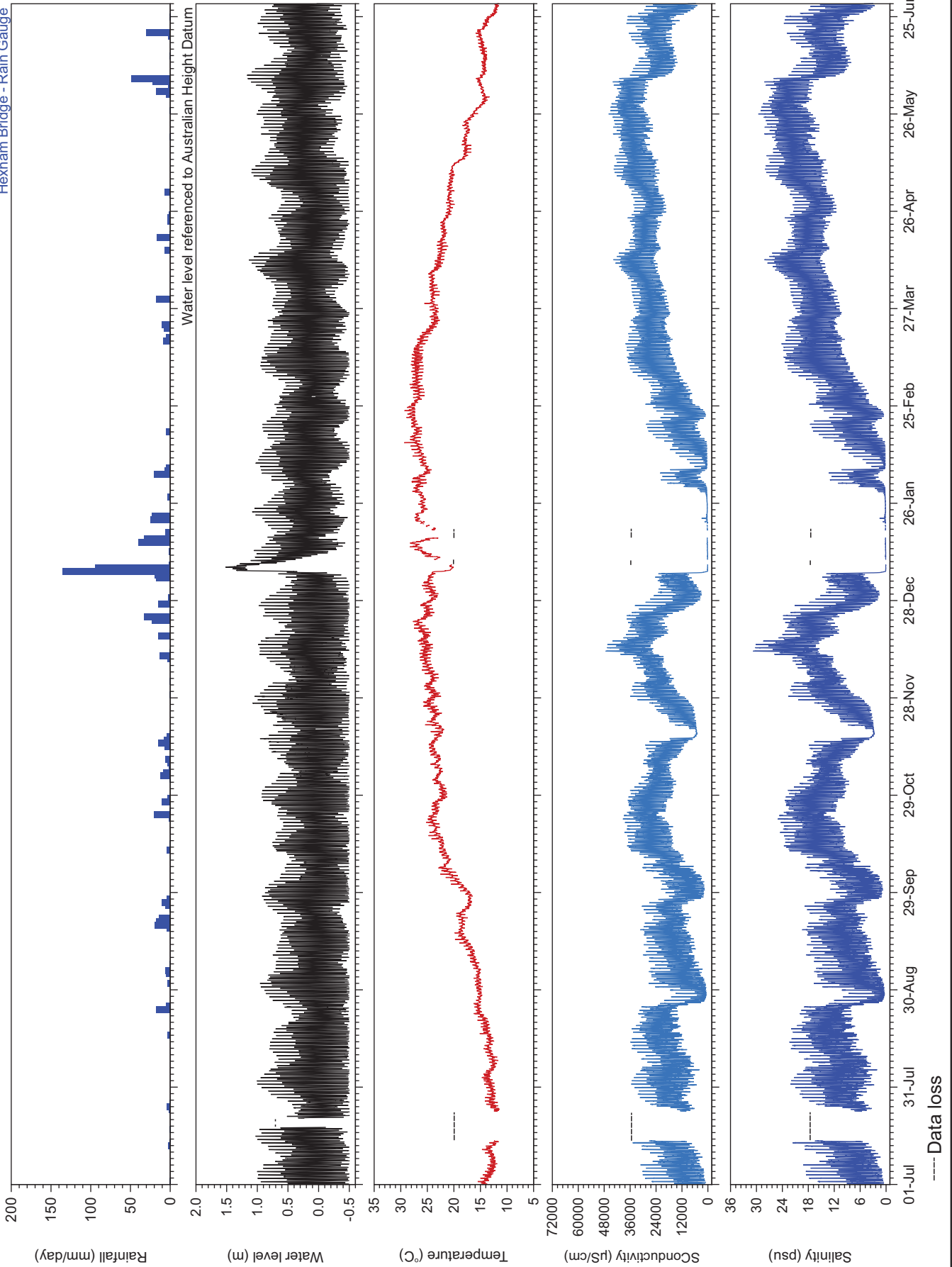
WATER LEVEL AND WATER QUALITY DATA
2015–2016
RAYMOND TERRACE

MHL
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DRAWING 2478-19.cdr

Hexham Bridge - Rain Gauge



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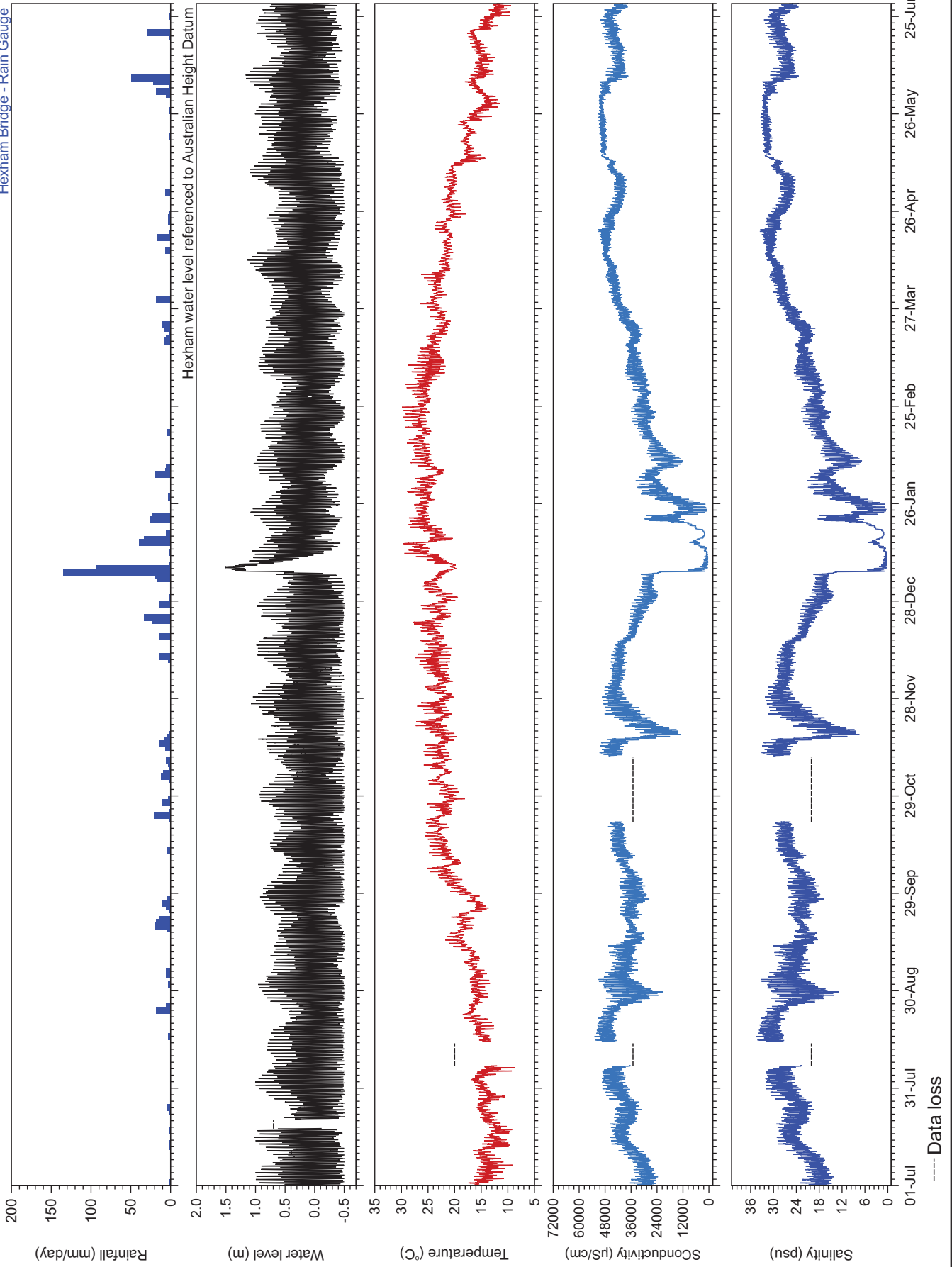
WATER LEVEL AND WATER QUALITY DATA
2015–2016
HEXHAM

MHL
Report 2478

Figure
23

DRAWING 2478-19.cdr

Hexham Bridge - Rain Gauge



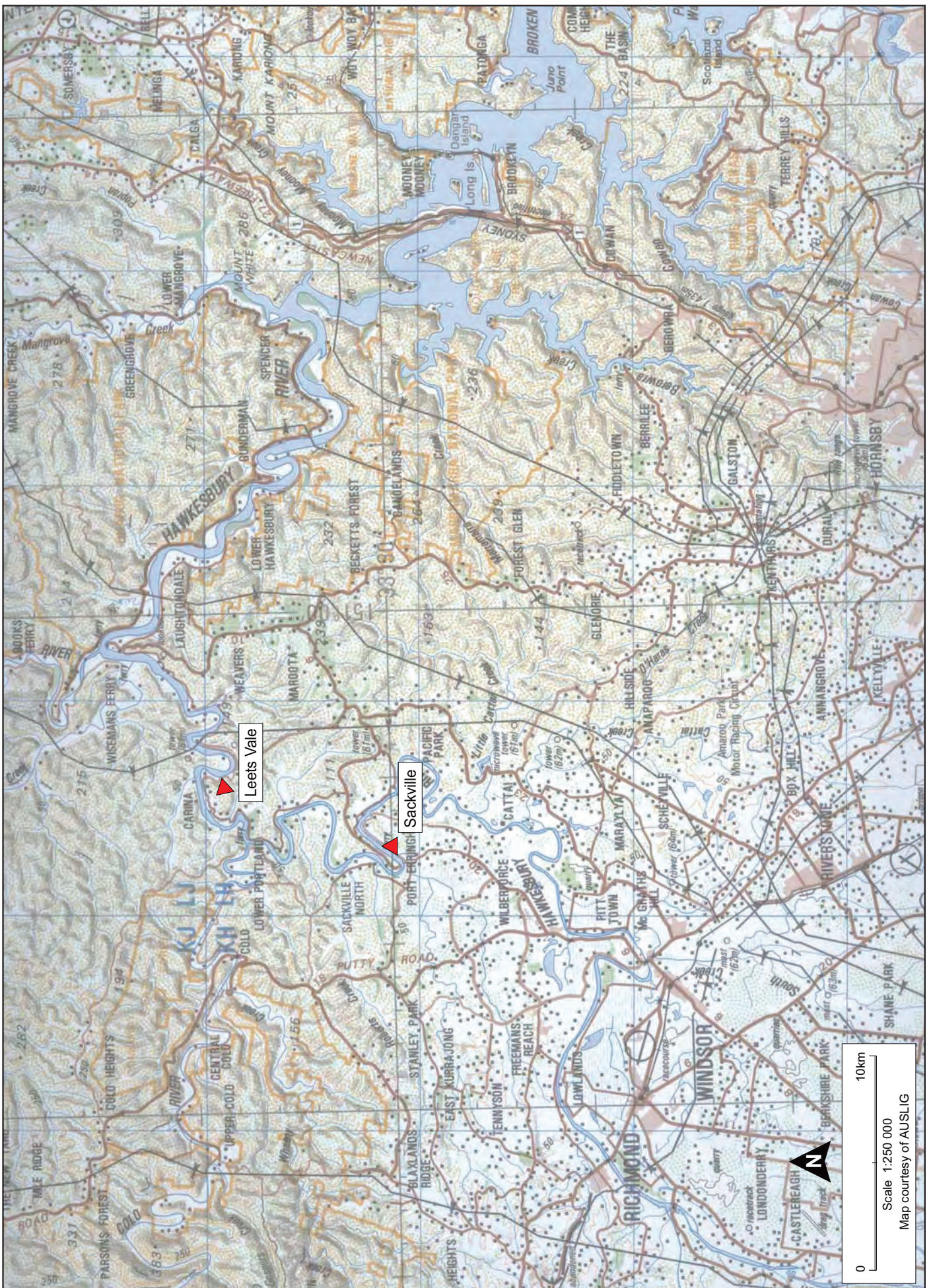
Public Works
Manly Hydraulics Laboratory

WATER LEVEL AND WATER QUALITY DATA
2015–2016
FULLERTON COVE SALINITY BUOY

MHL
Report 2478

Figure
24

DRAWING 2478-19.cdr

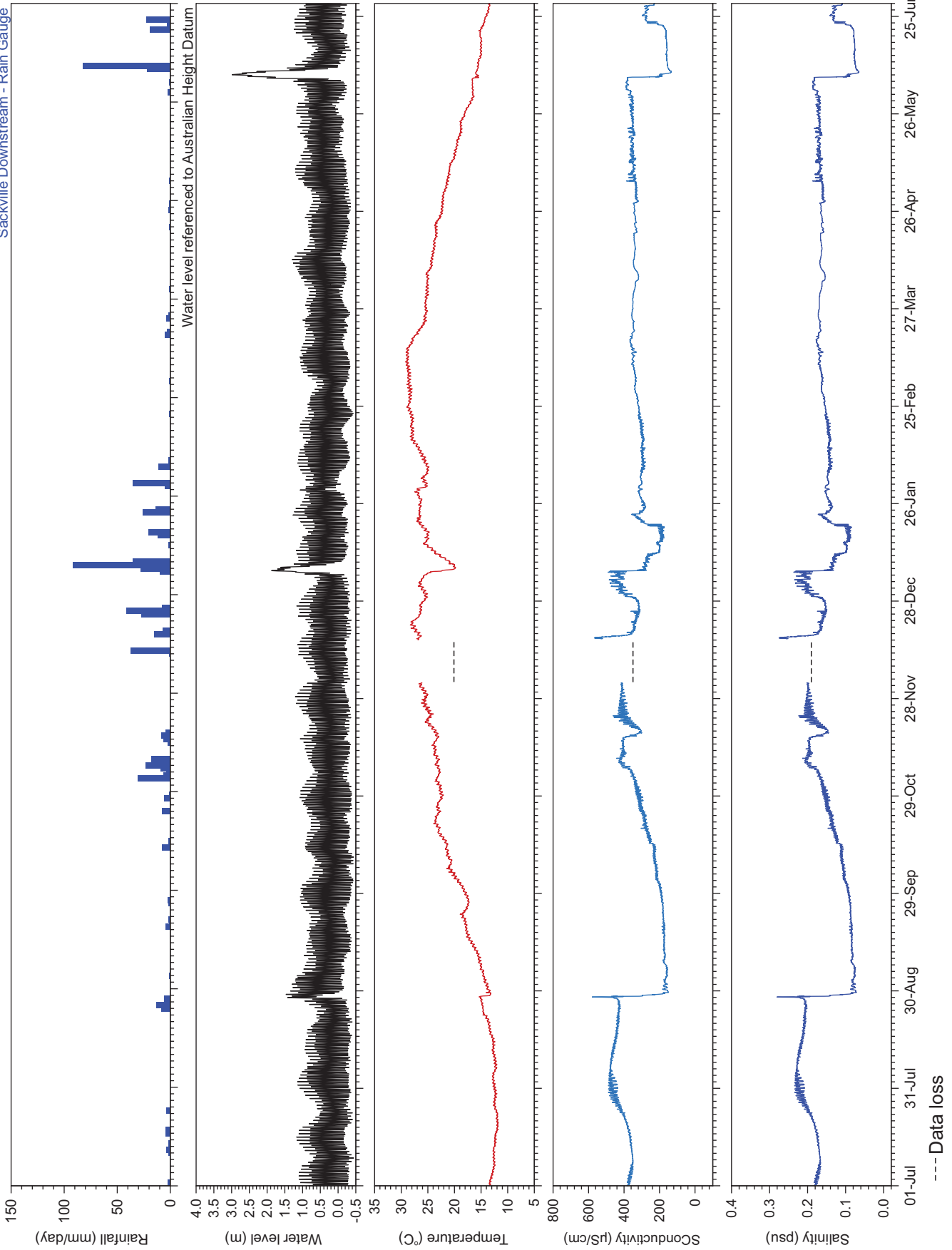


Public Works
Manly Hydraulics Laboratory

**STATION LOCATIONS
HAWKESBURY RIVER REGION**

MHL
Report 2478
**Figure
25**
DRAWING 2478-25.cdr

Sackville Downstream - Rain Gauge



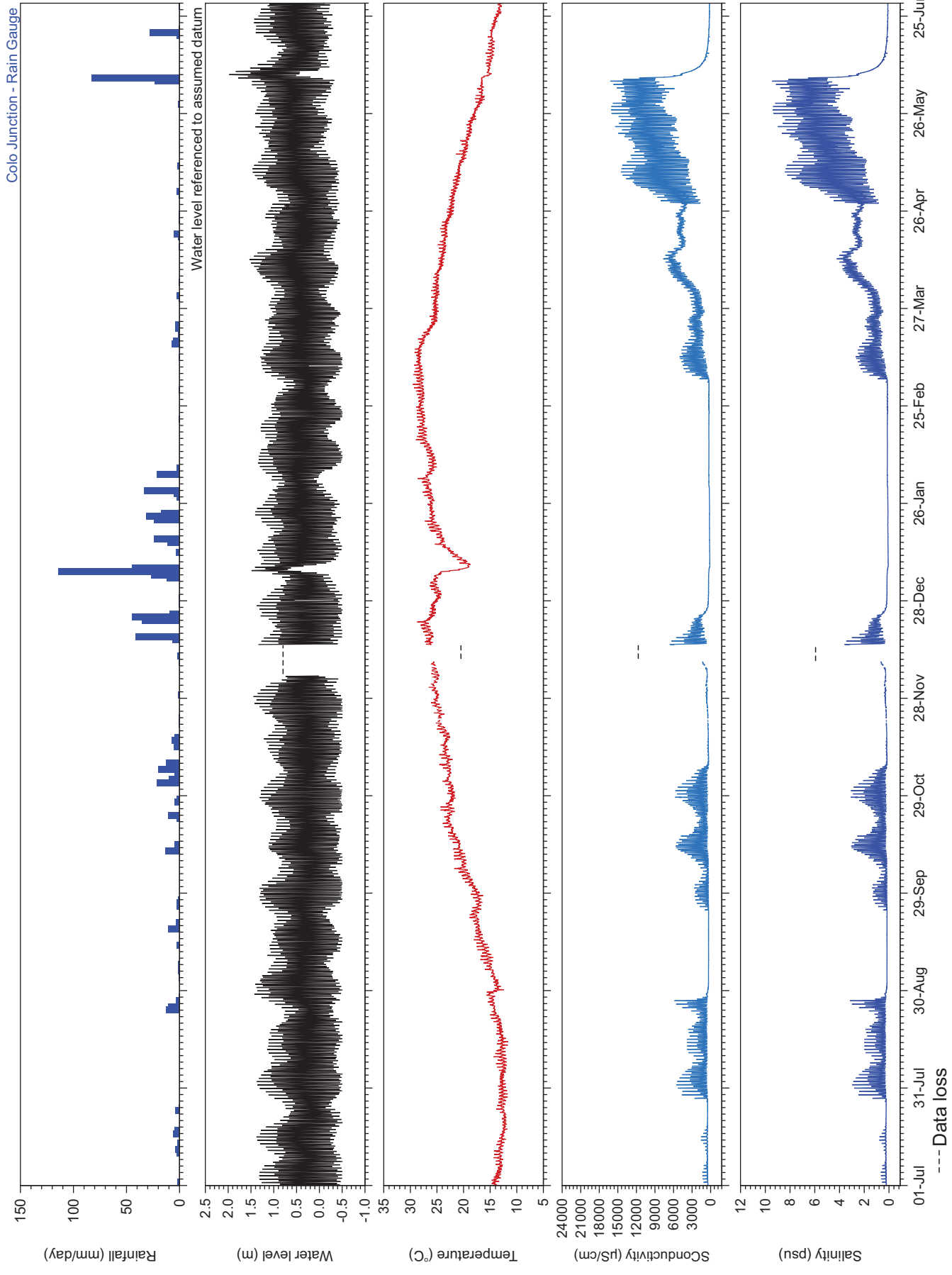
Public Works
Manly Hydraulics Laboratory

WATER LEVEL AND WATER QUALITY DATA
2015–2016
SACKVILLE

MHL
Report 2478

Figure
26

DRAWING 2478-25.cdr



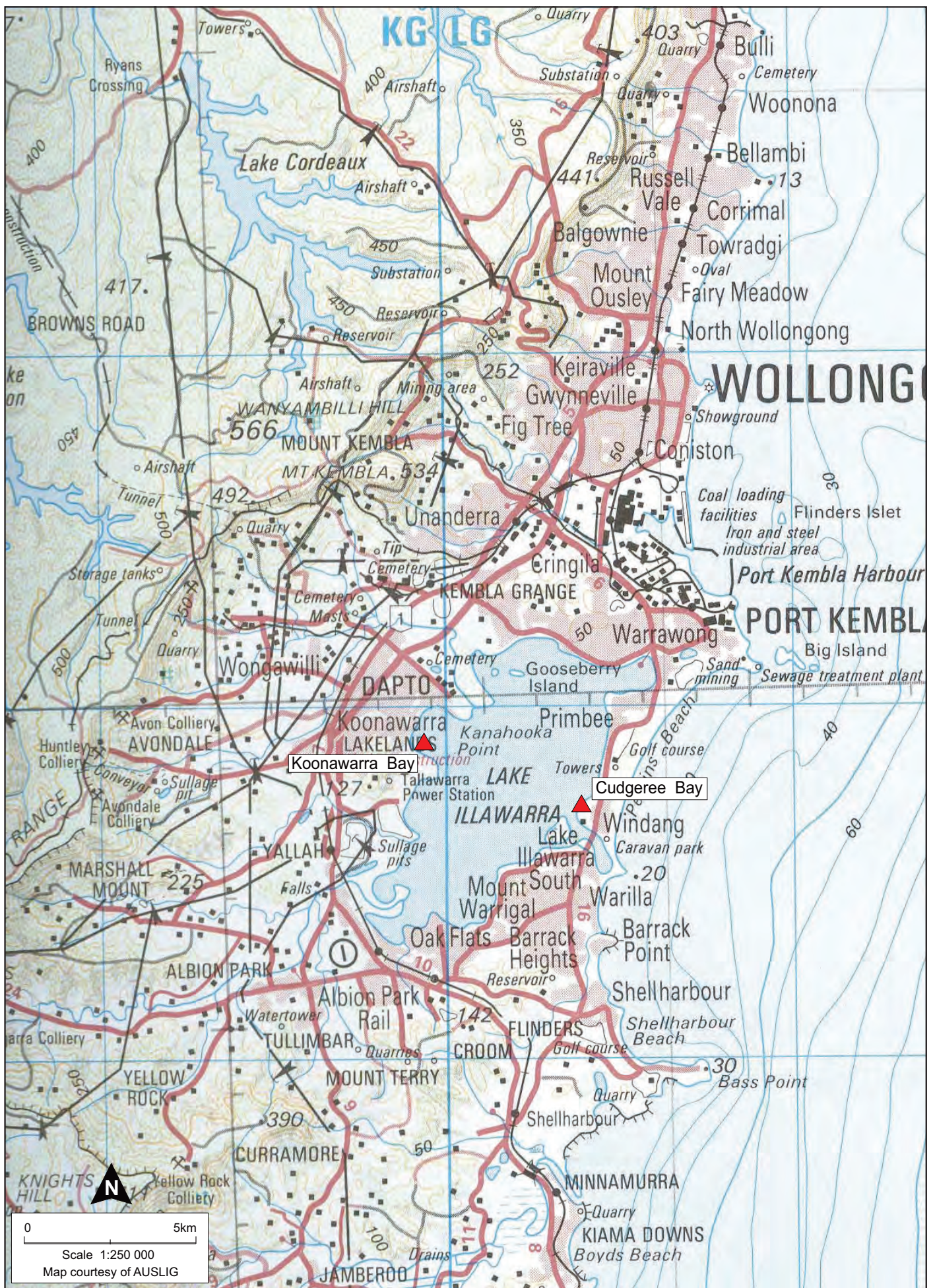
Public Works
Manly Hydraulics Laboratory

WATER LEVEL AND WATER QUALITY DATA
2015–2016
LEETS VALE

MHL
Report 2478

Figure
27

DRAWING 2478-25.cdr



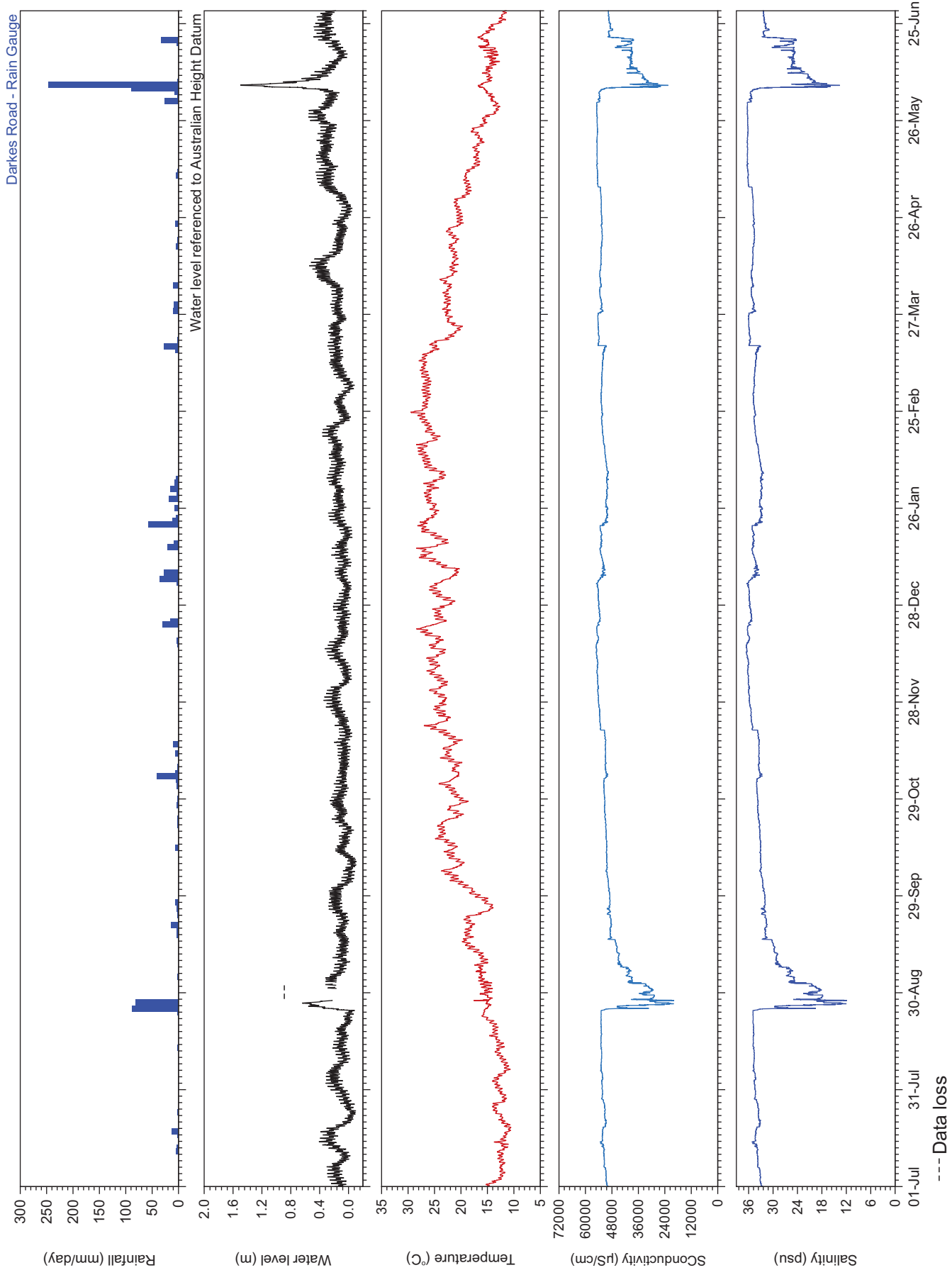
Public Works
Manly Hydraulics Laboratory

**STATION LOCATIONS
LAKE ILLAWARRA REGION**

MHL
Report 2478

Figure
28

DRAWING 2478-28.cdr



Public Works
Manly Hydraulics Laboratory

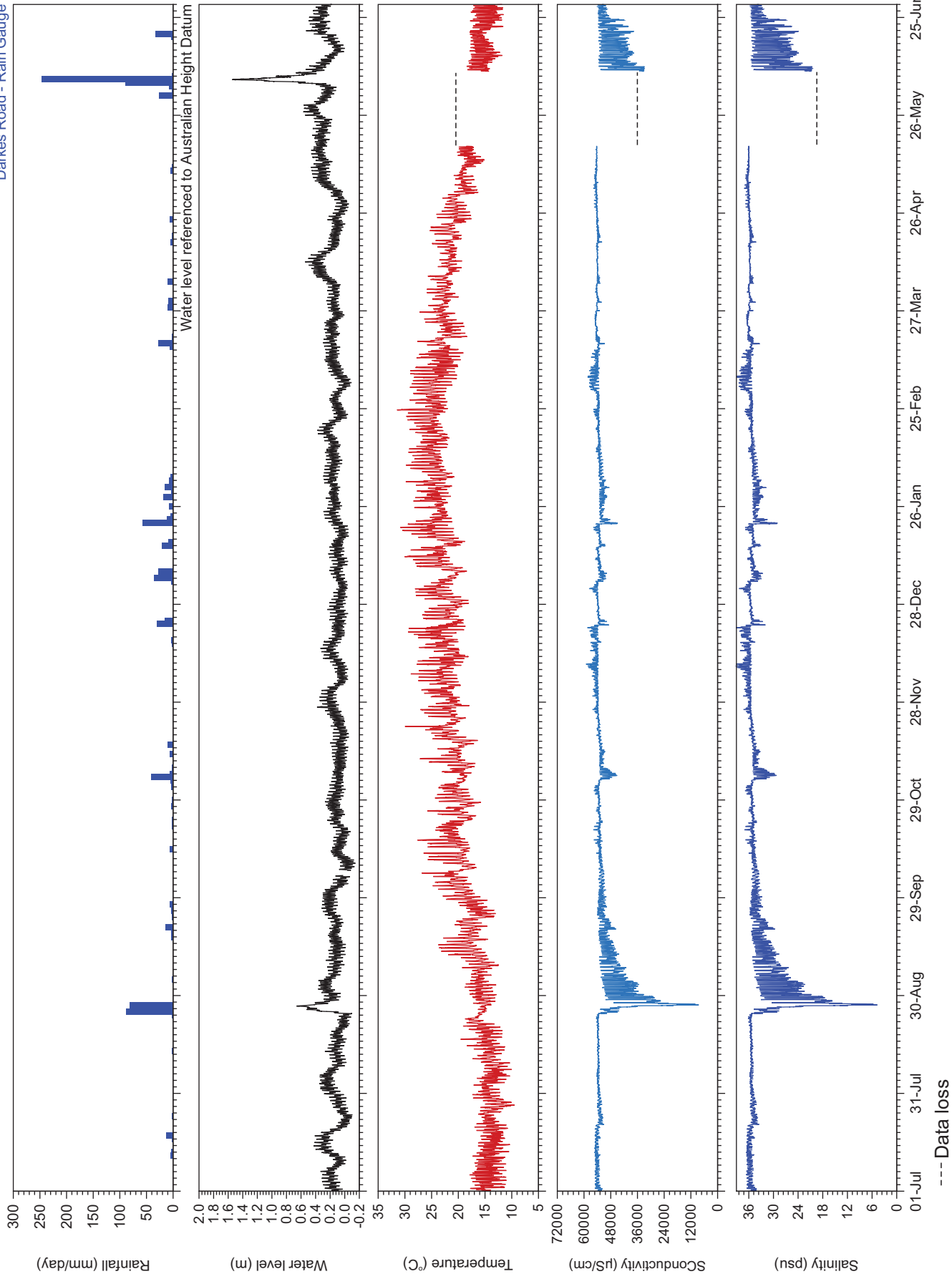
WATER LEVEL AND WATER QUALITY DATA
2015–2016
KOONAWARRA BAY

MHL
Report 2478

Figure
29

DRAWING 2478-28.cdr

Darkes Road - Rain Gauge



Public Works
Manly Hydraulics Laboratory

WATER LEVEL AND WATER QUALITY DATA
2015–2016
CUDGEREE BAY

MHL
Report 2478

Figure
30

DRAWING 2478-28.cdr



Grady's Caravan Park

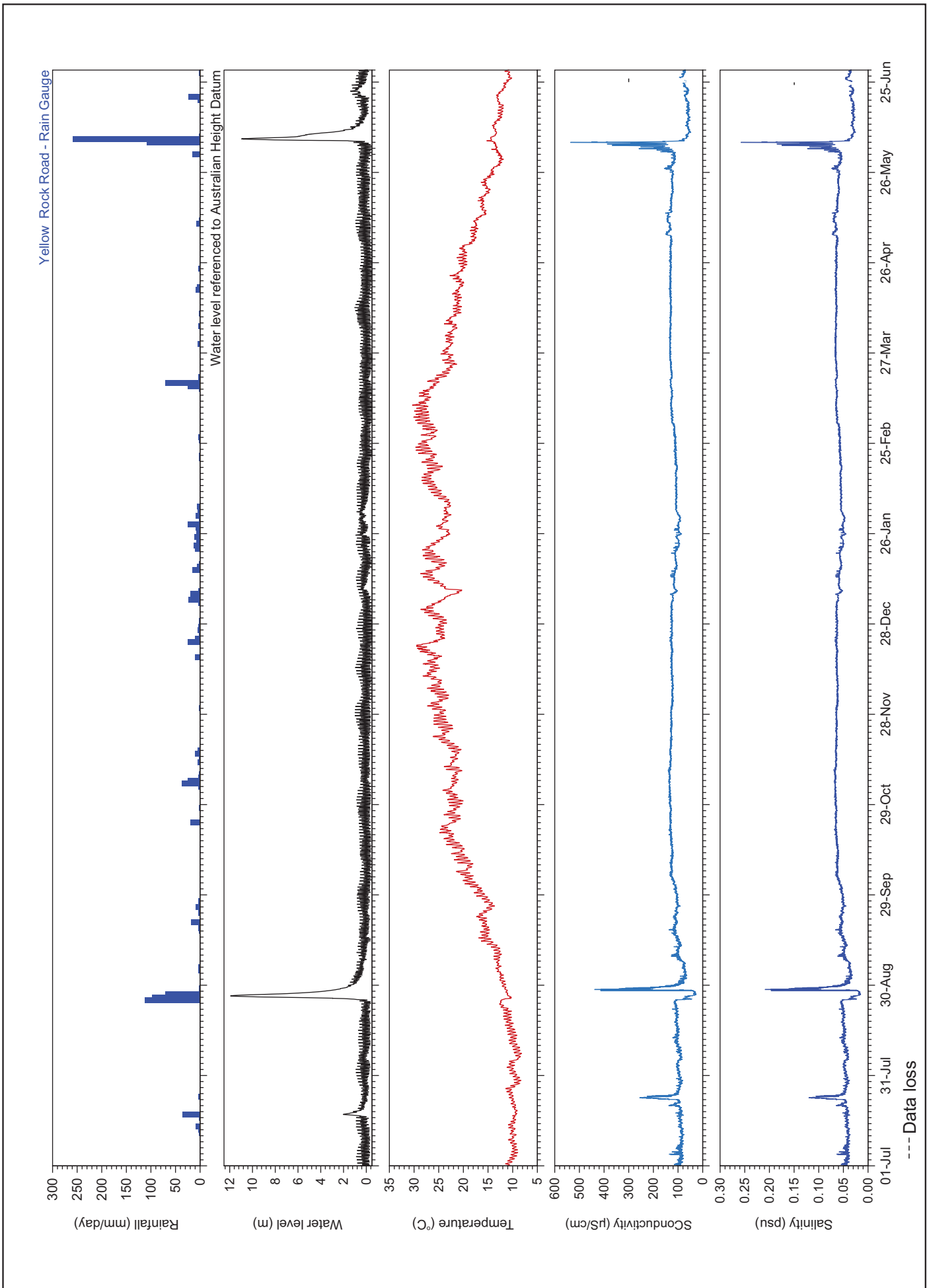


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**STATION LOCATIONS
SHOALHAVEN RIVER REGION**

MHL
Report 2478
**Figure
31**

DRAWING 2478-31.cdr



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Manly Hydraulics Laboratory

WATER LEVEL AND WATER QUALITY DATA
2015–2016
GRADY'S CARAVAN PARK

MHL
Report 2478

Figure
32

DRAWING 2478-31.cdr

Appendix A

Data on-line

Appendix A Data on-line

Station longname	Station name	Station number	Start date	End date	Additional MHL report number reference
Brunswick River at Mullumbimby	Mullumbimby	202402	08-Apr-98	18-Mar-99	1000
Richmond River at Coraki	Coraki	203403	20-Sep-94	ongoing	749
Richmond River at Oakland Road	Oakland Road	203470	06-Mar-12	ongoing	
Tucombil Canal at Tucombil Highway Bridge	Tucombil Highway Bridge	203411	21-Aug-97	29-Aug-98	961
Rocky Mouth Creek at Rocky Mouth Creek	Rocky Mouth Creek	203432	06-Sep-94	21-Aug-96	794
Tucombil Canal at Tucombil Floodgate	Tucombil Floodgate	203434	09-Sep-94	29-Sep-95	961
Richmond River at Bungawalbin	Bungawalbin	203450	09-Sep-94	28-Aug-13	
Lennox Head at Lake Ainsworth	Lake Ainsworth	203455	15-Nov-95	30-Nov-96	851
Clarence River at Grafton	Grafton	204400	02-Mar-99	ongoing	1065
Clarence River at Rogans Bridge	Rogans Bridge	204413	09-Mar-99	ongoing	1065
Clarence River at Mylneford	Mylneford	204460	21-May-10	29-Jan-13	
Nambucca River at Macksville	Macksville	205416	17-Feb-99	22-Feb-00	1050
Coffs Creek at Coffs Creek Highway Bridge	Coffs Creek Highway Bridge	205439	14-Dec-92	23-Nov-96	
Bonville Creek at Bonville	Bonville	205480	08-Aug-97	15-Feb-99	985
Borirgala Creek at Borirgala Creek	Borirgala Creek	206450	06-Apr-01	26-Sep-01	1151
Macleay River at South West Rocks	South West Rocks	206456	01-Mar-96	01-Mar-99	986
Macleay River at Euroka Upstream	Euroka Upstream	206458	07-Dec-09	17-Jun-11	
Macleay River at Kempsey	Kempsey	206402	09-Feb-10	ongoing	
Maria River at Green Valley	Green Valley	207406	30-Sep-94	01-Nov-95	760
Lake Cathie at Lake Cathie	Lake Cathie	207441	18-Aug-93	07-Sep-94	
Manning River at Wingham	Wingham	208400	08-Dec-09	ongoing	
Manning River at Taree	Taree	208410	16-Feb-10	30-Oct-13	
Manning River at Taree West	Taree West	208420	30-Apr-10	ongoing	
Myall River at Bombah Point	Bombah Point	209475	09-Jul-96	ongoing	906

Station longname	Station name	Station number	Start date	End date	Additional MHL report number reference
Myall River at Tea Gardens	Tea Gardens	209480	20-Oct-09	ongoing	
Paterson River at Dunmore	Dunmore	210409	15-Oct-09	ongoing	
Paterson River at Hinton Bridge	Hinton Bridge	210410	03-Dec-93	ongoing	750
Wallis Creek at Wallis Creek Downstream	Wallis Creek Downstream	210428	21-Sep-95	01-Oct-98	965
Hunter River at Green Rocks	Green Rocks	210432	03-Dec-93	ongoing	750
Hunter River at Hexham Bridge	Hexham Bridge	210448	17-Dec-93	ongoing	750
Hunter River at Hexham	Hexham	210448	13-Apr-11	ongoing	
Williams River at Raymond Terrace	Raymond Terrace	210452	15-Oct-09	ongoing	
Hunter River at McKimms Corner	McKimms Corner	210455	08-Oct-09	ongoing	
Hunter River at Belmore Bridge	Belmore Bridge	210458	01-Dec-93	ongoing	750
Nepean River at Castlereagh	Castlereagh	212404	01-Jul-94	01-Jul-98	
Hawkesbury River at Sackville	Sackville	212406	01-Jul-94	ongoing	
Hawkesbury River at Colo Junction	Colo Junction	212407	07-Nov-09	05-Jul-13	
Hawkesbury River at Ebenezer	Ebenezer	212427	01-Jul-94	01-Jul-98	
Hawkesbury at Wisemans Ferry Wharf	Wisemans Ferry Wharf	212460	10-Jun-10	19-Jul-13	
Hawkesbury at Leets Vale	Leets Vale	212461	22-Jun-10	ongoing	
Lake Illawarra at Cudgeree Bay	Cudgeree Bay	214416	09-Feb-93	ongoing	994
Lake Illawarra at Koonawarra Bay	Koonawarra Bay	214440	15-Jun-93	ongoing	994
Shoalhaven at Grady's Caravan Park	Grady's Caravan Park	215430	06-Oct-10	ongoing	
Wollumboola Lake at Wollumboola	Wollumboola	215454	01-Feb-99	06-Jan-11	1145
Crookhaven River at Crookhaven Heads	Crookhaven Heads	215471	06-Mar-95	07-Apr-95	
Currarong Creek at Currarong Creek	Currarong Creek	216405	04-Mar-96	04-Mar-97	858
Swan Lake at Swan Lake	Swan Lake	216425	02-Feb-99	02-Feb-00	
Clyde River at Nelligen	Nelligen	216453	17-Sep-96	17-Sep-97	889
Tomaga at George Bass Drive	George Bass Drive	216455	28-Aug-96	28-Aug-97	890
Tuross River at Coila Lake	Coila Lake	218405	08-Mar-96	21-Nov-96	848
Wagonga River at Barlows Bay	Barlows Bay	218415	30-Aug-96	30-Aug-97	888
Wallaga Lake at Regatta Point	Regatta Point	219405	06-Mar-95	07-Apr-95	
Bega River at Bega	Bega	219410	24-Feb-10	21-May-13	
Back Lagoon at Back Lagoon	Back Lagoon	219415	25-Sep-97	25-Sep-98	963

Station longname	Station name	Station number	Start date	End date	Additional MHL report number reference
Lake Curalo at Lake Curalo	Lake Curalo	220420	09-Mar-96	09-Mar-98	920
Wonboyn River at Agnew Wharf	Agnew Wharf	220425	20-Aug-97	20-Aug-98	964
Bartletts Creek at Bartletts Creek	Bartletts Creek	Station number not assigned	06-Jun-95	19-Mar-96	780
Leddays Creek at Leddays Creek	Leddays Creek	Station number not assigned	02-Jun-95	31-Jul-96	780
Officer Drain at Officer Drain	Officer Drain	Station number not assigned	02-Jun-95	21-Mar-96	780
McLeods Drain at McLeods Drain	McLeods Drain	Station number not assigned	21-Mar-96	31-Jul-96	780
McLeods Drain Offshoot at McLeods Drain Offshoot	McLeods Drain Offshoot	Station number not assigned	21-Mar-96	31-Sep-96	780
Cudgen Lake at Cudgen Lake	Cudgen Lake	Station number not assigned	14-Dec-92	05-Nov-93	674
Cudgen Creek at Cudgen Lake West	Cudgen Lake West	Station number not assigned	08-Oct-93	05-Nov-93	674
Cudgen Creek at Cudgen Creek	Cudgen Creek	Station number not assigned	15-Dec-92	05-Nov-93	674
Simpsons Creek at Belongil	Belongil	Station number not assigned	06-Dec-94	17-Dec-96	
Richmond River at Shaws Bay	Shaws Bay	Station number not assigned	11-Mar-99	12-Apr-00	755, 849
Marshalls Creek at Capricornia Canal	Capricornia Canal	Station number not assigned	24-Mar-97	31-Mar-11	1051
Marshalls Creek at New Brighton	New Brighton	Station number not assigned	17-Mar-97	24-Apr-98	1000
Brunswick River at Pacific Highway Bridge	Pacific Highway Bridge	Station number not assigned	18-Mar-97	18-Mar-99	1000
Simpsons Creek at Simpsons Creek	Simpsons Creek	Station number not assigned	03-Apr-98	18-Mar-99	1000
Tuckean Broadwater at Tuckean	Tuckean	Station number not assigned	30-Oct-95	29-Oct-96	850
Richmond River at Empire Vale Creek	Empire Vale Creek	Station number not assigned	08-May-98	12-Oct-99	1032

Station longname	Station name	Station number	Start date	End date	Additional MHL report number reference
Roberts creek at Roberts Creek	Roberts Creek	Station number not assigned	20-May-94	24-May-96	784
Clarence River at Tarrent Bridge	Tarrent Bridge	Station number not assigned	04-Mar-99	11-Apr-00	1065
Andersons Inlet at Middle Island MM1	Middle Island MM1	Station number not assigned	06-Apr-01	15-Dec-06	986
Andersons Inlet at Middle Island MM2	Middle Island MM2	Station number not assigned	19-Mar-96	03-Feb-99	986
Andersons Inlet at Double Island	Double Island	Station number not assigned	19-Mar-96	03-Feb-99	986
Macleay River at Andersons Inlet	Andersons Inlet	Station number not assigned	06-Apr-01	27-Sep-01	1151
Maria River at Connection Creek	Connection Creek	Station number not assigned	22-Sep-94	26-Oct-95	760
Hastings River at Lake Innes	Lake Innes	Station number not assigned	19-Aug-93	07-Sep-94	760
Scotts Creek at Scotts Creek	Scotts Creek	Station number not assigned	20-Oct-98	22-Oct-99	1029
Wallis Lake at Peach Tree Point	Peach Tree Point	Station number not assigned	30-Jul-97	09-Mar-99	987
Wallis Lake at Wallamba	Wallamba	Station number not assigned	30-Jul-97	25-Aug-98	987
Wallis Lake at Booti Island	Booti Island	Station number not assigned	31-Jul-97	25-Aug-98	987
Wallis Lake at Darawakh Creek	Darawakh Creek	Station number not assigned	26-Aug-98	08-Mar-99	987
Smiths Lake at Smiths Lake	Smiths Lake	Station number not assigned	04-May-95	16-May-96	771
Myall Lake at Mayers Point	Mayers Point	Station number not assigned	10-Jul-96	04-Mar-98	906
Myall River at Monkey Jacket	Monkey Jacket	Station number not assigned	09-Jul-96	04-Mar-98	906
Lake Wollumboola at Lake Wollumboola	Lake Wollumboola Floating	Station number not assigned	07-Dec-00	19-Jun-01	1145

Station longname	Station name	Station number	Start date	End date	Additional MHL report number reference
Tuross Lake at Trunketabella	Trunketabella	Station number not assigned	04-May-94	11-Mar-98	921
Wallaga Lake at Meads Bay	Meads Bay	Station number not assigned	03-Feb-99	10-Feb-00	1048
Hexham Swamp at Ironbark Creek Downstream	Ironbark Creek Downstream	Station number not assigned	08-Aug-02	30-Jun-09	
Hexham Swamp at Ironbark Creek Upstream	Ironbark Creek Upstream	Station number not assigned	09-Aug-02	27-Oct-04	
Hexham Swamp at Morris Jetty	Morris Jetty	Station number not assigned	07-Aug-02	30-Jun-09	
Hunter River at Fishery Creek	Fishery Creek	Station number not assigned	08-Aug-02	07-Mar-03	
Hunter River at Fishery Creek 2	Fishery Creek	Station number not assigned	11-Jun-03	29-Aug-03	
Hexham Swamp at Shortland Wetland Centre	Shortland Wetland Centre	Station number not assigned	10-Mar-99	04-Jul-00	1058
Hexham Swamp at SWC Canoe Trail	SWC Canoe Trail	Station number not assigned	07-Aug-02	09-Jan-03	1221
Lake Macquarie at Swansea Channel Site 4	Swansea Channel Site 4	Station number not assigned	28-Mar-96	14-Jun-96	770
Lake Macquarie at Swansea Channel Site 5	Swansea Channel Site 5	Station number not assigned	15-Apr-96	10-May-96	770
Orphan site at Berowra Water Quality	Berowra Creek Water Quality	Station number not assigned	26-May-95	29-Nov-95	745
Berowra Creek at Berowra Waters Marina	Berowra Waters Marina	Station number not assigned	22-Aug-01	23-Nov-01	
Narrabeen Lagoon at Pittwater Road Bridge	Pittwater Road Bridge	Station number not assigned	23-Feb-96	15-Nov-05	
Manly Lagoon at Riverview Parade	Riverview Parade	Station number not assigned	02-Feb-96	05-Jan-07	
Manly Lagoon at Manly Dam	Manly Dam	Station number not assigned	29-Jan-96	22-Aug-01	
Shoalhaven River at Wharf Road	Wharf Road	Station number not assigned	06-Mar-95	07-Apr-95	

Station longname	Station name	Station number	Start date	End date	Additional MHL report number reference
Shoalhaven River at DPI Waterra Bridge	DPI Waterra Point	Station number not assigned	07-Mar-95	07-Apr-95	
Clyde River at Clyde Site 7	Clyde River Site 7	Station number not assigned	25-Sep-96	08-Oct-96	792
Clyde River at Clyde Site 16	Clyde River Site 16	Station number not assigned	25-Sep-96	08-Oct-96	
Wonboyn River Upstream of Wonboyn Lake	Wonboyn River	Station number not assigned	21-Aug-97	06-Sep-98	

Appendix B
Sample outputs

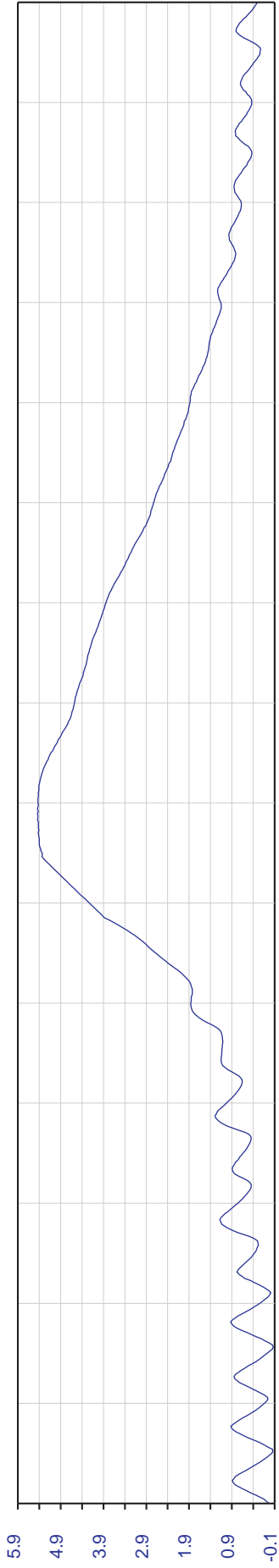
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 Interval 30 Minute Plot End 00:00_25/06/2011

Hinton Bridge

Level (Metres)

Inst.

100.00

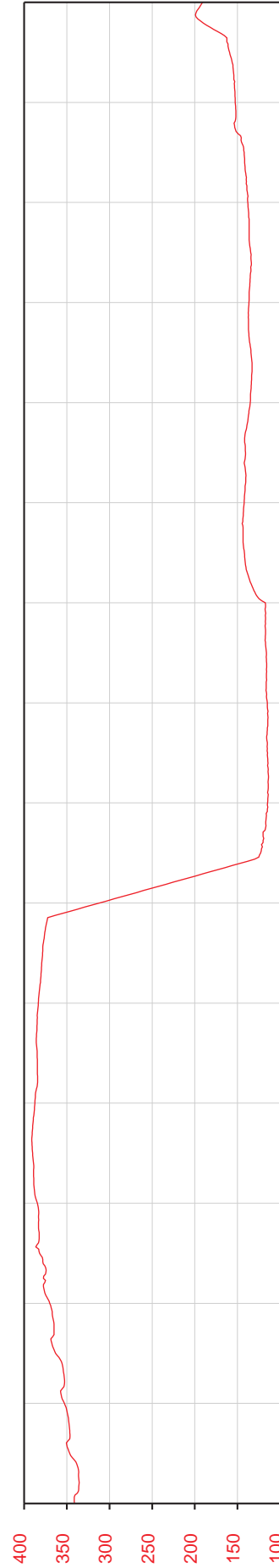


Conductivity ($\mu\text{S}/\text{cm}$)

Inst.

2012.00

Hinton Bridge

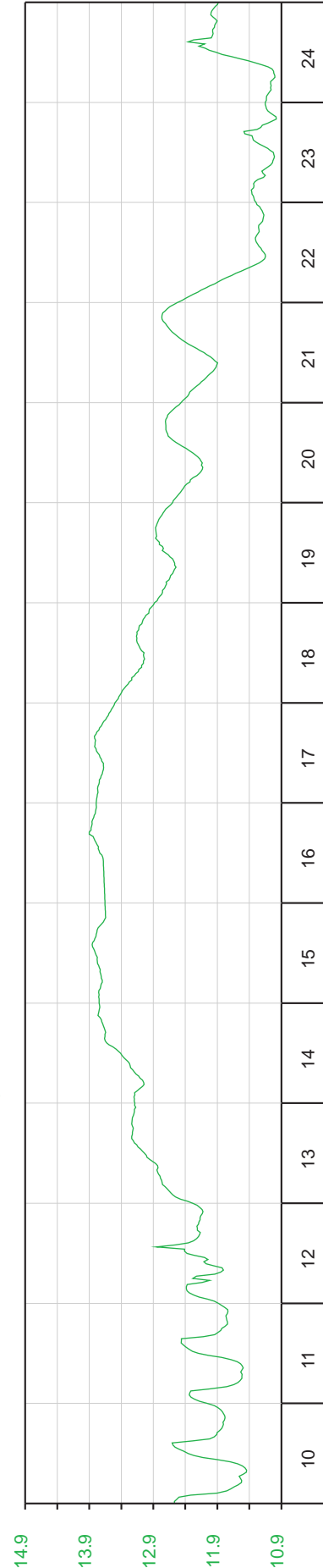


Water Temp ($^{\circ}\text{C}$)

Inst.

2080.00

Hinton Bridge



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 Manly Hydraulics Laboratory

SAMPLE DATA PLOTS

MHL Report 2478

Figure B1

DRAWING 2478-B.cdr

Station Name, Port Stephens (Live),,
Station Number,209471,,
Latitude,+152:10:56.06,,
Longitude,-32:42:53.57,,
Datum,PSHD,,

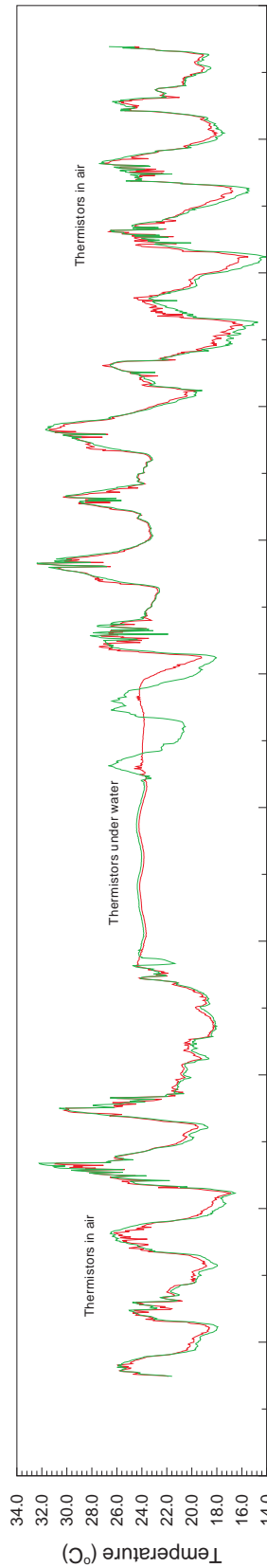
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5/07/2011,0:30:00,1.47403,6 (Good)
5/07/2011,0:45:00,1.39316,6 (Good)
5/07/2011,1:00:00,1.3186,6 (Good)
5/07/2011,1:15:00,1.22369,6 (Good)
5/07/2011,1:30:00,1.10246,6 (Good)
5/07/2011,1:45:00,1.03073,6 (Good)
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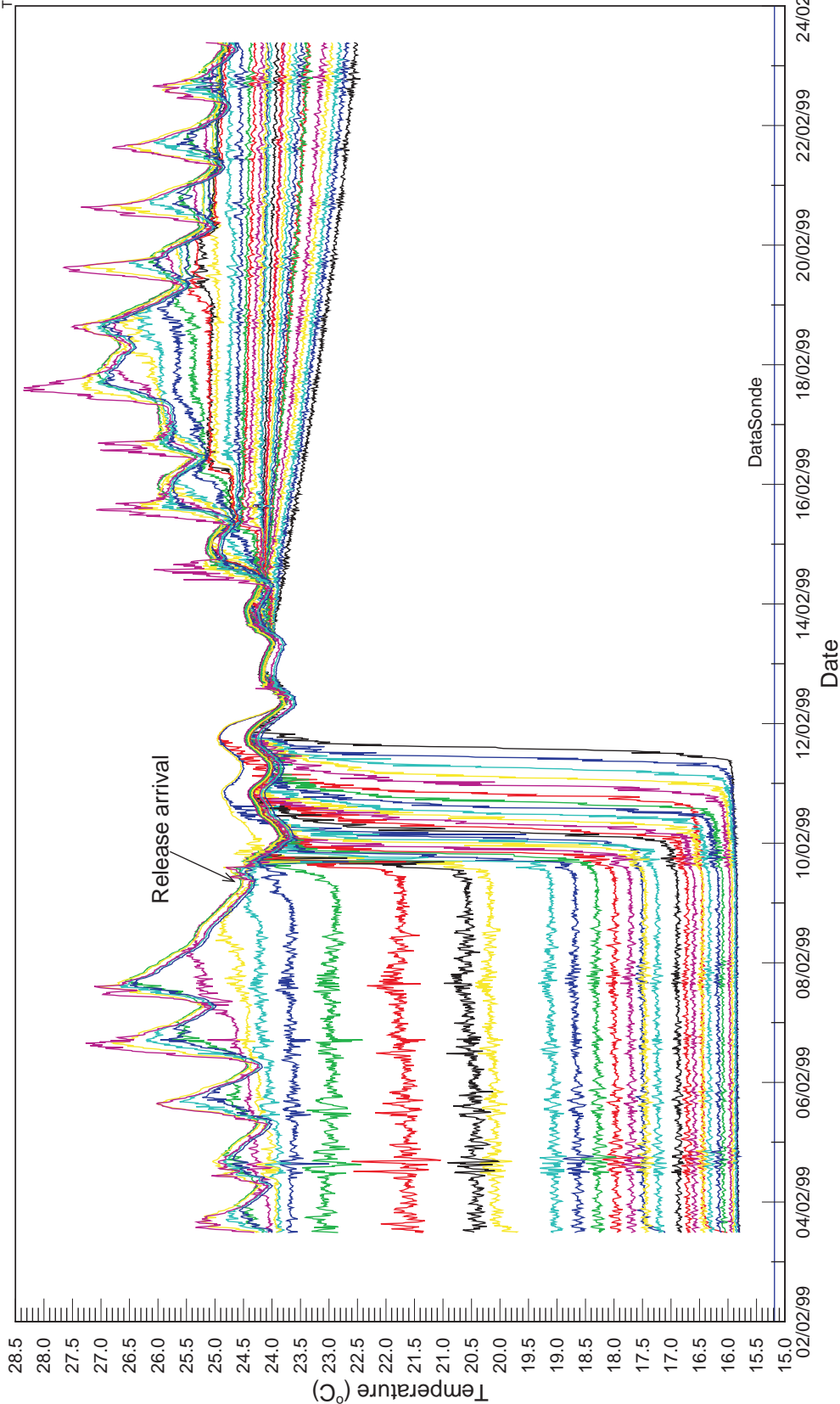
SAMPLE THERMISTOR CHAIN DATA TEMPERATURE DISTRIBUTION TIME SERIES

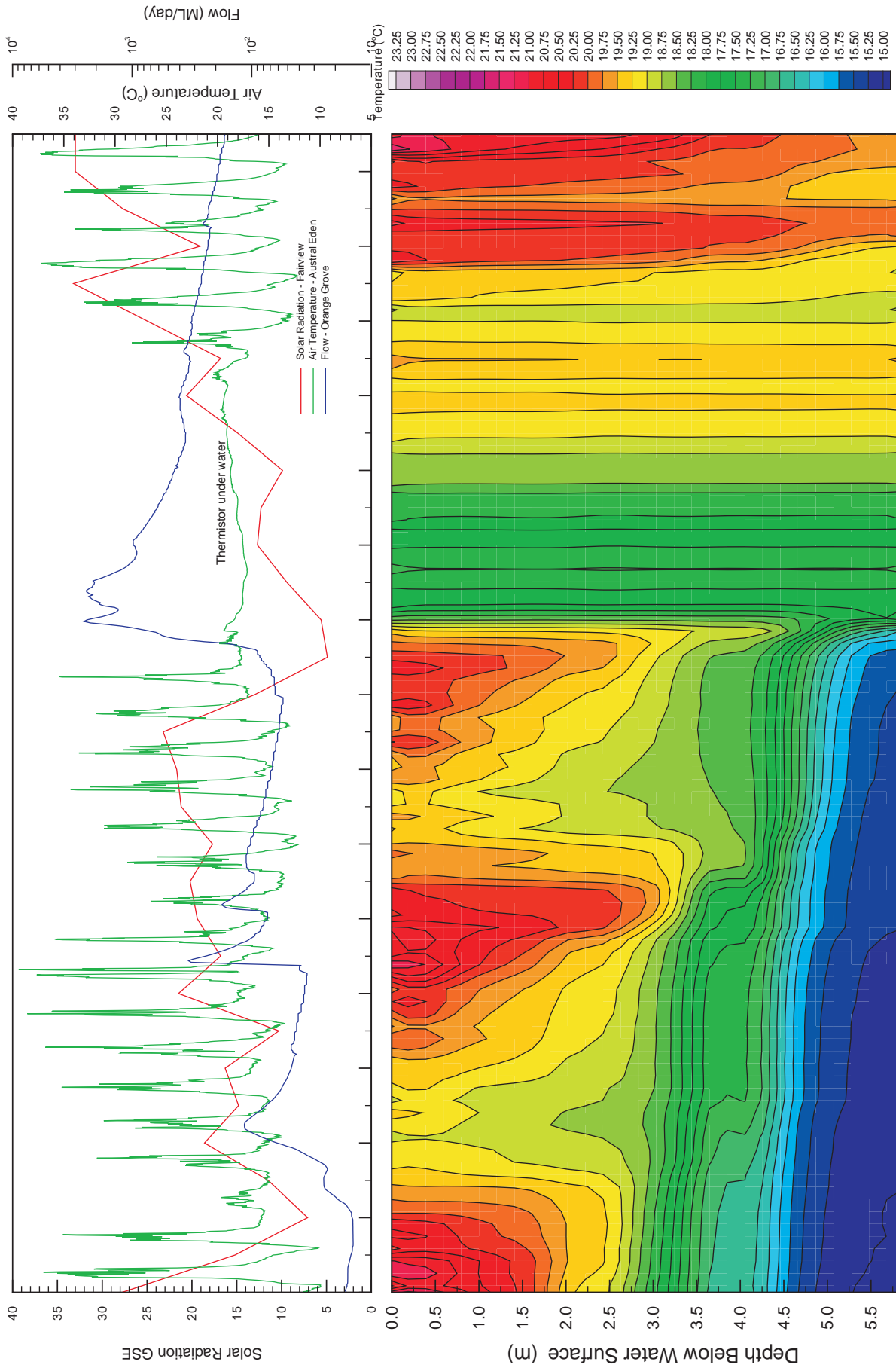
Thermistor and Depth
T37-0.25m
T38-0.75m



Thermistor and Depth

- T1-17.64m
- T2-17.15m
- T3-16.65m
- T4-16.15m
- T5-15.67m
- T6-15.20m
- T7-14.70m
- T8-14.23m
- T9-13.80m
- T10-13.24m
- T11-12.75m
- T12-12.25m
- T13-11.75m
- T14-11.24m
- T15-10.73m
- T16-10.23m
- T17-9.73m
- T18-9.24m
- T19-8.73m
- T20-8.23m
- T21-7.73m
- T22-7.24m
- T23-6.75m
- T24-6.24m
- T25-5.74m
- T26-5.24m
- T27-4.73m
- T28-4.25m
- T29-3.75m
- T30-3.20m
- T32-2.20m
- T33-1.70m
- T34-1.20m
- T35-0.73m
- T36-0.22m





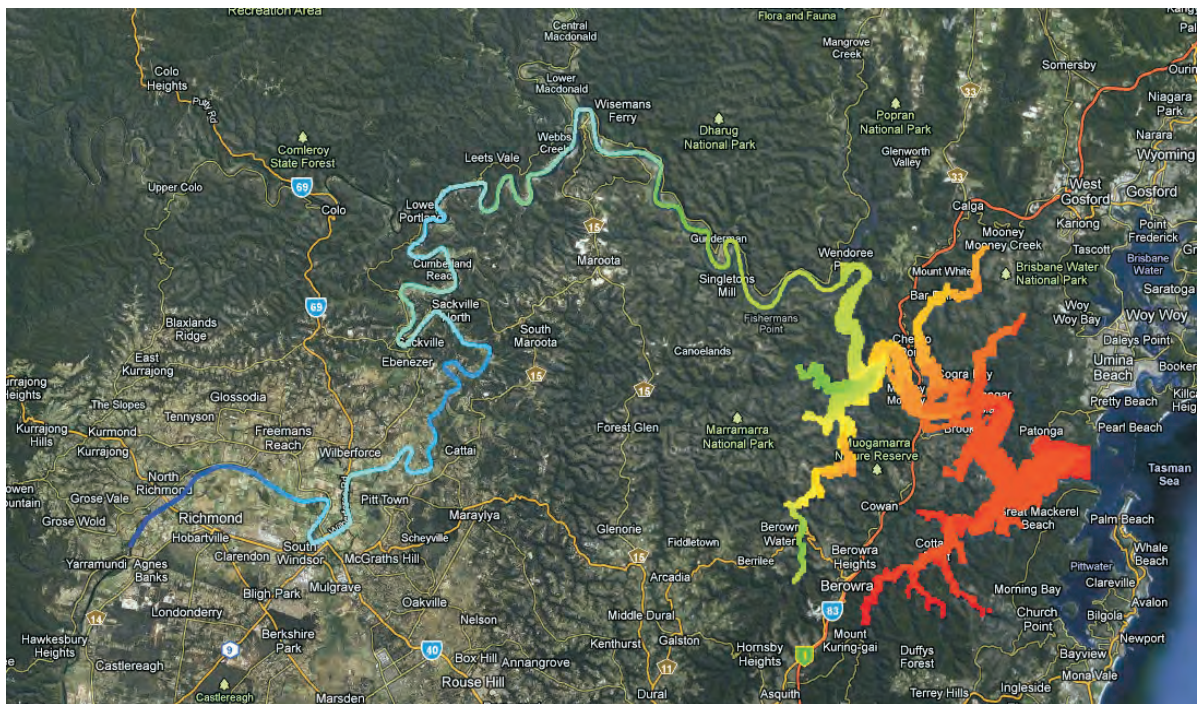
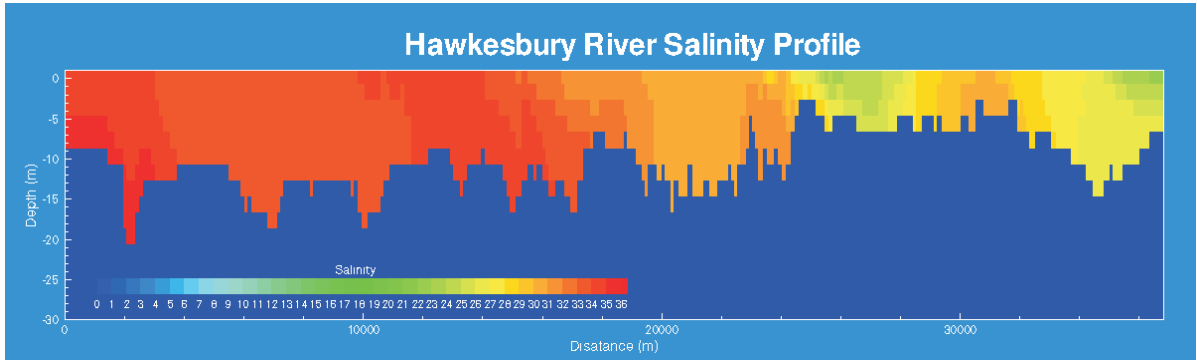
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**SAMPLE FLOW, WEATHER DATA
AND TEMPERATURE CONTOURS**

MHL
Report 2478

Figure
B4

DRAWING 2478-B.cdr



Appendix C

Other publications of interest

Appendix C Other publications of interest

Data reports

MHL Annual Ocean Tide Levels Summaries available:

MHL Report Nos. 515 (86-87), 544 (87-88), 563 (88-89), 585 (89-90), 602 (90-91), 628 (91-92), 658 (92-93), 697 (93-94), 732 (94-95), 777 (95-96), 876 (96-97), 947 (97-98), 1013 (98-99), 1069 (99-00), 1129 (00-01), 1205 (01-02), 1277 (02-03), 1347 (03-04), 1423 (04-05), 1512 (05-06), 1764 (06-07), 1848 (07-08), 1933 (08-09), 2010 (09-10), 2089 (10-11), 2158 (11-12), 2219 (12-13), 2292 (13-14), 2384 (14-15).

MHL Annual Estuary and River Water Levels Summaries available:

MHL Report Nos. 555 (87-88), 564 (88-89), 582 (89-90), 601 (90-91), 625 (91-92), 659 (92-93), 698 (93-94), 731 (94-95), 778 (95-96), 875 (96-97), 947 (97-98), 1014 (98-99), 1070 (99-00), 1130 (00-01), 1206 (01-02), 1276 (02-03), 1346 (03-04), 1422 (04-05), 1511 (05-06), 1763 (06-07), 1847 (07-08), 1932 (08-09), 2009 (09-10), 2088 (10-11), 2157 (11-12), 2218 (12-13), 2291 (13-14), 2383 (14-15).

MHL Annual Coastal Rainfall Summaries available:

MHL Report Nos. 610 (90-91), 624 (91-92), 660 (92-93), 699 (93-94), 730 (94-95), 776 (95-96), 874 (96-97), 946 (97-98), 1015 (98-99), 1071 (99-00), 1131 (00-01), 1207 (01-02), 1278 (02-03), 1348 (03-04), 1424 (04-05), 1513 (05-06), 1765 (06-07), 1849 (07-08), 1934 (08-09), 2011 (09-10), 2090 (10-11), 2159 (11-12), 2220 (12-13), 2293 (13-14), 2385 (14-15).

MHL Annual Wave Climate and Coastal Air Pressure Summaries available:

MHL Report Nos. 547 (87-88), 560 (88-89), 581 (89-90), 600 (90-91), 627 (91-92), 655 (92-93), 695 (93-94), 733 (94-95), 779 (95-96), 877 (96-97), 948 (97-98), 1016 (98-99), 1072 (99-00), 1132 (00-01), 1208 (01-02), 1279 (02-03), 1349 (03-04), 1425 (04-05), 1514 (05-06), 1766 (06-07), 1850 (07-08), 1935 (08-09), 2012 (09-10), 2091 (10-11), 2160 (11-12), 2221 (12-13), 2294 (13-14), 2386 (14-15).

MHL Estuary and River Water Quality Summaries available:

MHL Report Nos. 2161 (11-12), 2222 (12-13), 2295 (13-14), 2387 (14-15).

Salinity profiling

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