



NSW ESTUARY AND RIVER WATER QUALITY ANNUAL SUMMARY 2021–2022

Report MHL2910
June 2023

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NSW Department of Planning and Environment
Biodiversity and Conservation Division

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Michael Galloway
Hydrometric Team Leader
110b King Street
Manly Vale NSW 2093
T: 02 9949 0200
E: michael.galloway@mhl.nsw.gov.au
W: www.mhl.nsw.gov.au

Document control

Issue/ revision	Author	Reviewer	Approved for issue	
			Name	Date
Draft	Melody Wu	Sarah Dakin	Bronson McPherson	1/12/2022
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110B King Street

Manly Vale NSW 2093

T 02 9949 0200

ABN 20 770 707 468 www.mhl.nsw.gov.au

Foreword

Manly Hydraulics Laboratory (MHL) is a business unit within the Water Group of the NSW Department of Planning and Environment (DPE). MHL was commissioned by the Biodiversity and Conservation Division (BCD) of the DPE and WaterNSW to develop the NSW water quality database. MHL maintains the automatic recording stations and catalogues the collected data. The water quality database supports a number of programs associated with coastal, floodplain and estuary management.

This annual summary presents water quality measurements captured by the automatic recording stations along the coastal estuaries and rivers of New South Wales, from 1 July 2021 to 30 June 2022. The overall data recovery rate was 97.0%.

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

Direct requests for further information to:

Manager Environmental Data
Manly Hydraulics Laboratory
110B King Street
Manly Vale NSW 2093

Email : data-request@mhl.nsw.gov.au
WWW : <http://www.mhl.nsw.gov.au/>
Telephone : (02) 9949 0200

Other annual summaries in this series include:

- NSW Estuary and River Water Levels Annual Summary 2021–2022
Manly Hydraulics Laboratory
Report No. MHL 2906
ISSN: 2205-5525 (Print)
ISSN: 2205-5533 (Online)
- NSW Ocean and River Entrance Tidal Levels and Coastal Air Pressure Annual Summary 2021–2022
Manly Hydraulics Laboratory
Report No. MHL 2907
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- NSW Coastal Rainfall Annual Summary 2020–2021
Manly Hydraulics Laboratory
Report No. MHL 2908
ISSN: 2205-5568 (Print)
ISSN: 2205-5576 (online)
- NSW Wave Climate Annual Summary 2020–2021
Manly Hydraulics Laboratory
Report No. MHL 2909
ISSN: 2205-5584 (Print)
ISSN: 2205-5592 (online)

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<http://www.mhl.nsw.gov.au> under the *Publications* menu.

Executive summary

The *NSW Estuary and River Water Quality Annual Summary 2021-22* presents the water quality measurements captured by the automatic recording stations along the coastal estuaries and rivers of New South Wales from 1 July 2021 to 30 June 2022. The overall data recovery rate was 97.0%. The target recovery rate of 95% or more is achieved for the 2021–2022 reporting period.

This report contains:

- a brief description of the water quality measurement program
- guidelines on how to use this report
- information on how to access the database
- significant developments which occurred in 2021–2022
- the data summaries and station location maps for each station
- **Appendix A**, detailing the data available online
- **Appendix B**, 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 the water quality data currently collected by Manly Hydraulics Laboratory (MHL) at 21 monitoring stations in NSW. The network of automatic recorders and the associated analysis routines enable efficient delivery of water quality data. Readers can also request specific water quality data extracts from the historical database (refer to [Appendix A](#)).

The present program is based on a network of automatic recording stations installed at various estuaries (see [Station Location Maps](#) in Section 5). This network consists of 21 permanent stations funded by the Department of Planning and Environment's Biodiversity and Conservation Division (BCD) and WaterNSW (see [Table 1.1](#)). The logging systems consist of data loggers which record water quality information every 15 minutes.

Table 1.1 Station list

River/ estuary region	Station name	Station no.	MGA zone	Easting	Northing	Station owner	Data start	Overall data capture rate 2020–2021
Richmond	Lake Ainsworth	203455	56	557863	6816160	BCD	10-Apr-18	100.0%
Richmond	Coraki	203403	56	527976	6793772	BCD/WaterNSW	21-Oct-09	98.8%
Richmond	Oakland Road	203470	56	526684	6791185	WaterNSW	06-Mar-12	96.5%
Clarence	Rogans Bridge	204413	56	488813	6723401	BCD/WaterNSW	03-Dec-09	88.2%*
Clarence	Grafton	204400	56	493398	6715149	BCD/WaterNSW	04-Dec-09	98.3%
Macleay	Kempsey	206402	56	485099	6561395	BCD/WaterNSW	09-Feb-10	96.0%
Lake Cathie	Lake Cathie	207441	56	486162	6509679	BCD	18-Jun-20	93.7%
Manning	Wingham	208400	56	440523	6473219	BCD/WaterNSW	08-Dec-09	100.0%
Manning	Taree West	208420	56	447161	6469672	WaterNSW	30-Apr-10	100.0%
Myall Lakes	Bombah Point	209475	56	434680	6403299	BCD	13-Jul-09	92.1%*
Myall River	Tea Gardens	209480	56	421723	6385111	BCD	20-Oct-09	100.0%
Paterson	Dunmore	210409	56	369238	6383269	BCD/WaterNSW	15-Oct-09	100.0%
Paterson	Hinton Bridge	210410	56	373245	6379624	BCD/WaterNSW	15-Oct-09	100.0%
Hunter	McKimms Corner	210455	56	368162	6378933	BCD/WaterNSW	08-Oct-09	100.0%
Hunter	Hexham	210448	56	376768	6367608	BCD/WaterNSW	13-Apr-11	100.0%
Hunter	Green Rocks	210432	56	377459	6378142	BCD/WaterNSW	15-Oct-09	99.0%
Williams	Raymond Terrace	210452	56	382352	6375361	BCD/WaterNSW	15-Oct-09	100.0%
Hawkesbury	Sackville	212406	56	303238	6292029	BCD/WaterNSW	30-Oct-09	95.7%
Hawkesbury	Leets Vale	212461	56	309195	6299263	WaterNSW	22-Jun-10	78.5%*
Shoalhaven	Grady's Caravan Park	215430	56	268024	6138282	BCD/WaterNSW	06-Oct-10	100.0%
Wonboyn Lake	Wonboyn Lake	220452	55	758839	5873472	BCD	25-Oct-18	100.0%
Overall								97.0%

* Significant flood events have impacted overall data capture rates at some stations in 2021-22.

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

1. **AquiStar CT2X:** a submersible sensor with built-in data logging. The CT2X incorporates 4-pole electrode cell measurement technology with a probe resolution of EC ± 0.1 microsiemen/cm and temperature $\pm 0.01^\circ\text{C}$.
2. **YSI Sonde 600XL:** a multi-parameter probe with a probe resolution of EC $\pm 1-100$ microsiemen/cm (range dependent) and temperature $\pm 0.01^\circ\text{C}$.
3. **YSI EXO3 Sonde:** a multi-parameter probe with a probe resolution of EC $\pm 0.1-10$ microsiemen/cm (range dependent) and temperature $\pm 0.001^\circ\text{C}$.

Logger programs at all stations output water level, temperature, conductivity and specific conductivity, as well as salinity in practical salinity units (psu). This allows more usable near real-time data for the diverse range of end users.

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

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

where C = uncompensated conductivity, T = temperature

Salinity (psu) is calculated using the UNESCO formula for seawater salinity. The full equation is found at:

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 MHL's collection, processing and storage system hosted on cloud computing platforms, using telemetry techniques based on common internet protocols and data connections over cellular telephone networks. External users can view the near real time raw data via the web.

The raw data is also transferred in a separate process to an MHL database hosted in NSW government data centres (GovDC) where it is subject to a quality assurance process involving several control steps to maintain data quality.

Data is backed up daily and archived to offline storage at regular intervals.

2 How to use this report

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

The NSW coastline is divided into geographic regions based on river systems to present water monitoring information. 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 to **Appendix A**).

All data presented in this report are recorded in Australian Eastern Standard Time (EST). Allowance for daylight saving time needs to be made by the user of the data if required.

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.

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 for salinity compared with almost zero for fresh water.
- 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 station can vary significantly between high and low tides. For example, during the 2021–2022 monitoring period, the salinity values at Tea Gardens varied by approximately 29 psu between high and low tides, and at Lake Cathie variations of approximately 32 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 through the tidal cycle.

3 How to access the data

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

Typically, the last seven days of raw data are available online in a non-quality controlled form to aid the fastest possible access to data records. The online service for clients can provide access to all data catalogued in **Appendix A**.

Order quality controlled data via the MHL web page (<http://www.mhl.nsw.gov.au>) by emailing data-request@mhl.nsw.gov.au. Regular users can request development of customised decision support tools for supply of data using the same email address.

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 4.1** lists the 2021–2022 flood warnings as described by the NSW State Emergency Service’s (SES) classification scale.

Table 4.1 NSW flood classifications 2021–2022

River basin	Date	Flood classification
Richmond River	Feb–Mar 2022	Minor to Major
	Mar–Apr 2022	Major
Clarence River	Feb–Mar 2022	Major
	Mar–Apr 2022	Moderate to Major
	May 2022	Minor to Moderate
Macleay River	Feb–Mar 2022	Minor to Moderate
	Mar–Apr 2022	Minor to Moderate
Manning River	Feb–Mar 2022	Minor
	Mar–Apr 2022	Minor
Myall River	Feb–Mar 2022	Minor
Hunter and Williams River	Feb–Mar 2022	Minor
	Mar–Apr 2022	Minor to Moderate
Paterson River	Feb–Mar 2022	Major
Hawkesbury River	Feb–Mar 2022	Major
	Apr 2022	Minor to Moderate
Shoalhaven	Feb–Mar 2022	Minor to Moderate

The SES defines the level of flooding as follows:

Minor flooding: Causes inconvenience. Low-lying areas next to watercourses are inundated, which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.

Moderate flooding: In addition to the above, the evacuation of some houses may be required. Main traffic routes may be covered. The area of inundation is substantial in rural areas, requiring the removal of stock.

Major flooding: In addition to the above, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood-affected areas may be required.

4.2 Highest recorded salinity readings

Peak salinity levels at each station are reviewed for the 2021–2022 monitoring period. None of those 21 stations showed peak salinity levels higher than previous years’ measurements.

4.3 Cross-sectional profiling

Cross-sectional profiles at monitoring stations are used to indicate how representative in situ sensor readings are of the complete river cross-section for the conditions at the time of profiling. A cross-sectional profile is undertaken within 10 m upstream or downstream of the in situ sensor to the opposite bank. The cross-section is divided into a minimum of five equidistant sections and electrical conductivity readings are taken from the surface to the bed at 0.3 m intervals.

In March, April, May and June 2022, cross-sectional water quality profiling was undertaken on the Richmond, Clarence, Macleay, Manning, Paterson, Hunter, Hawkesbury and Shoalhaven rivers, as part of the monitoring program. Refer to *Monitoring of Estuaries for Water Sharing Plans Annual Summary 2021–2022* (Report MHL2925) for more detail on the cross-sectional profiling results.

4.4 Station development

The following station developments and upgrades occurred during the 2021–2022 reporting period:

- Kempsey (Macleay River) station was replaced with a new water quality sensor on 13 July 2021 and 10 May 2022 after the previous one was damaged by flood.
- Lake Cathie (Lake Cathie) station was upgraded with a new EXO3 water quality sensor and a 15 m cable and slide on 8 September 2021, which increases the quality and reliability of the data capture at the site.
- Wingham (Manning River) station was upgraded with a new EXO3 water quality sensor and a 250 m custom-made cable and slide on 29 April 2022, which increases the quality and reliability of the data capture at the site.

4.5 Station issues

Floods damaged several monitoring stations during the 2021–2022 reporting period and reinstatement was delayed due to bank instability and persistent high water levels. COVID-19 pandemic-related restrictions and new equipment supply issues (due to a worldwide shortage of raw materials, SIM cards and freight impacts) resulted in delays to station repairs. MHL deployed temporary standalone water quality stations to maintain data capture. Readers should exercise caution when using standalone water quality information as the temporary deployment location can be different to the parent station.

The Oakland Road (Richmond River) station's water level sensor's compressor unit failed on 31 December 2021. A standalone water level sensor was deployed on 19 January 2022 to maximise the data capture until supply of a new level sensor unit in May 2022. Level data from the nearest station (Coraki) is displayed in the data plot (refer to **Figure 4**).

The Rogans Bridge (Clarence River) station's water quality sensor and cable were damaged by flood waters on 1 March 2022. A standalone water quality sensor was deployed on 29 April 2022 to maximise data capture until the station was reinstated on 29 June 2022.

The Grafton (Clarence River) station's water quality sensor was damaged by flood waters on 13 May 2022. A standalone water quality sensor was deployed on 6 October 2021 as a backup to maximise data capture following a major flood from March 2021 until a new water quality sensor was installed on 16 June 2022.

The Wingham (Manning River) station's water quality sensor and cable failed after the flood on 28 April 2021. A standalone water quality sensor was deployed on 12 May 2021 to maximise data capture until supply of a new 250 m custom-made cable in April 2022.

The Sackville (Hawkesbury River) station's water quality sensor and water quality cable were damaged during the March 2022 flood event. A standalone water quality sensor was deployed on 19 March 2022 to maximise the data capture until the station was reinstated on 8 September 2022.

The Leets Vale (Hawkesbury River) station's equipment was damaged when the station was inundated during the March 2022 flood after the equipment housing was raised by 0.5 m in November 2021. A standalone water level and water quality sensor were deployed on 25 May 2022 to maximise data capture. WaterNSW is currently reviewing options for the station as it was inundated for the second consecutive year. Water level data from the nearest station (Wisemans Ferry Wharf) is displayed in the data plot (refer to **Figure 29**).

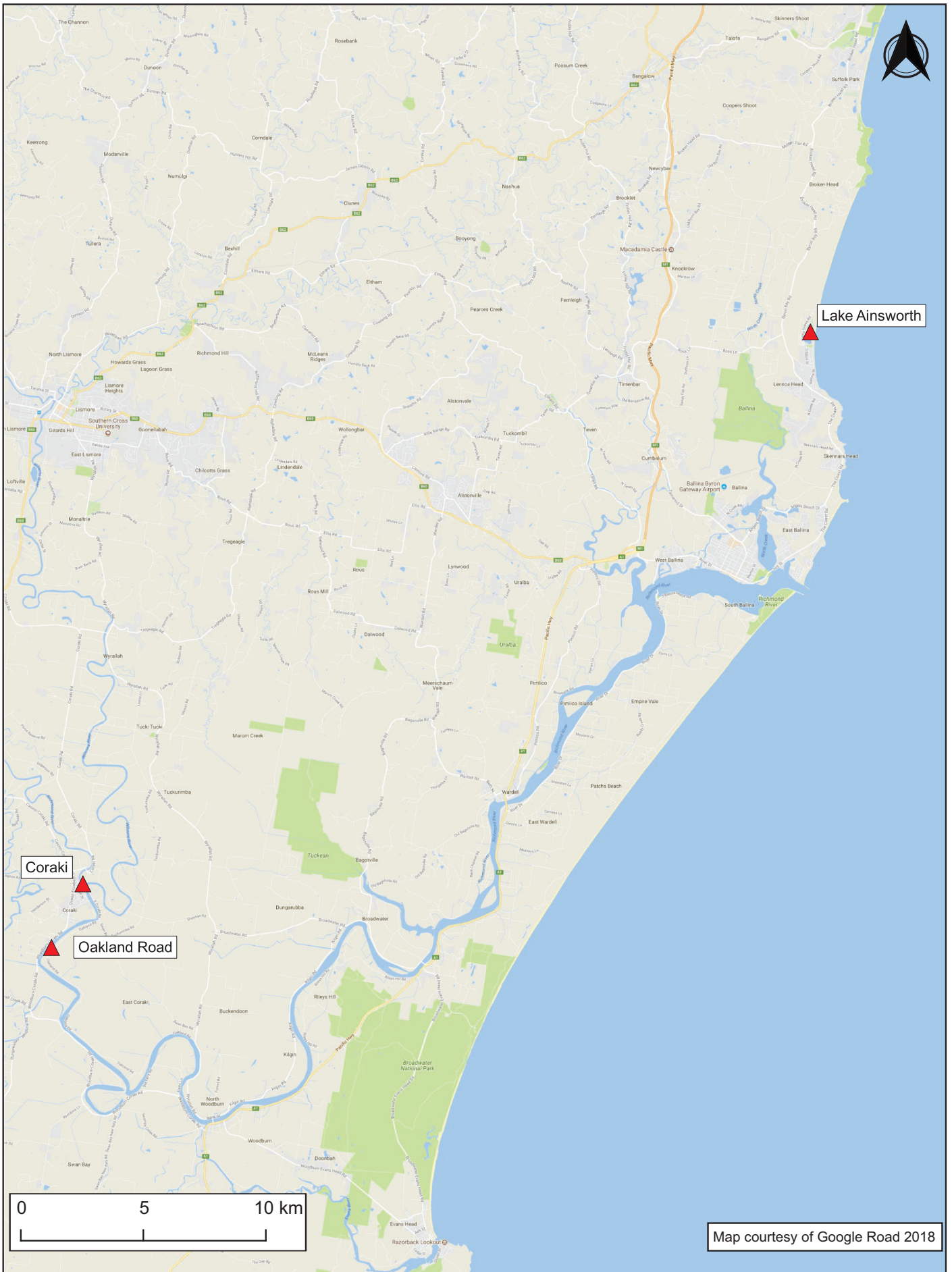
5 Water quality monitoring summary

This section documents locality maps and quality assured water quality monitoring summaries for each station. **Table 5.1** provides an index to the figures presented. Daily rainfall data from the nearest available BCD or Bureau of Meteorology (BoM) 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 rainfall influence on water quality readings at the location of the water quality probes. 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 observed on some water level plots. BCD rainfall stations are presented as midnight daily rainfall totals; BoM rainfall stations are presented as 9am daily rainfall totals.

Table 5.1 Index of figures

River/estuary region	Station name	Station no.	Comparative BCD or BoM rainfall station name	Figure
Station Locality Map	Richmond River Region			1
Richmond River	Lake Ainsworth	203455	Ballina Airport AWS [^]	2
Richmond River	Coraki	203403	New Italy (Vineyard Haven) [^]	3
Richmond River	Oakland Road	203470	New Italy (Vineyard Haven) [^]	4
Station Locality Map	Clarence River Region			5
Clarence River	Rogans Bridge	204413	Grafton Research [^]	6
Clarence River	Grafton	204400	Grafton Research [^]	7
Station Locality Map	Macleay River Region			8
Macleay River	Kempsey	206468	Aldavilla Downstream	9
Station Locality Map	Lake Cathie			10
Lake Cathie	Lake Cathie	207441	Port Macquarie Airport AWS [^]	11
Station Locality Map	Manning River Region			12
Manning River	Wingham	208400	Wingham (Lanark Close) [^]	13
Manning River	Taree West	208420	Wingham (Lanark Close) [^]	14
Station Locality Map	Great Lakes Region			15
Myall Lakes	Bombah Point	209475	Bulahdelah	16
Station Locality Map	Port Stephens Region			17
Myall River	Tea Gardens	209480	Bulahdelah	18
Station Locality Map	Paterson River Region			19
Paterson River	Dunmore	210409	Belmore Bridge	20
Paterson River	Hinton Bridge	210410	Belmore Bridge	21
Station Locality Map	Hunter River Region			22
Hunter River	McKimms Corner	210455	Belmore Bridge	23
Hunter River	Green Rocks	210432	Hexham Bridge	24
Williams River	Raymond Terrace	210452	Hexham Bridge	25
Hunter River	Hexham Bridge	210448	Hexham Bridge	26
Station Locality Map	Hawkesbury River Region			27
Hawkesbury River	Sackville	212406	Sackville Downstream	28
Hawkesbury River	Leets Vale	212461	Webbs Creek	29
Station Locality Map	Shoalhaven River Region			30
Shoalhaven River	Grady's Caravan Park	215430	Nowra RAN Air Station AWS [^]	31
Station Locality Map	Wonboyn Lake			32
Wonboyn Lake	Wonboyn Lake	220452	Green Cape Lighthouse [^]	33

[^] 9am daily rainfall totals is downloaded from the BoM's Climate Data Online website has not been quality controlled by MHL.



STATION LOCATIONS
RICHMOND RIVER REGION

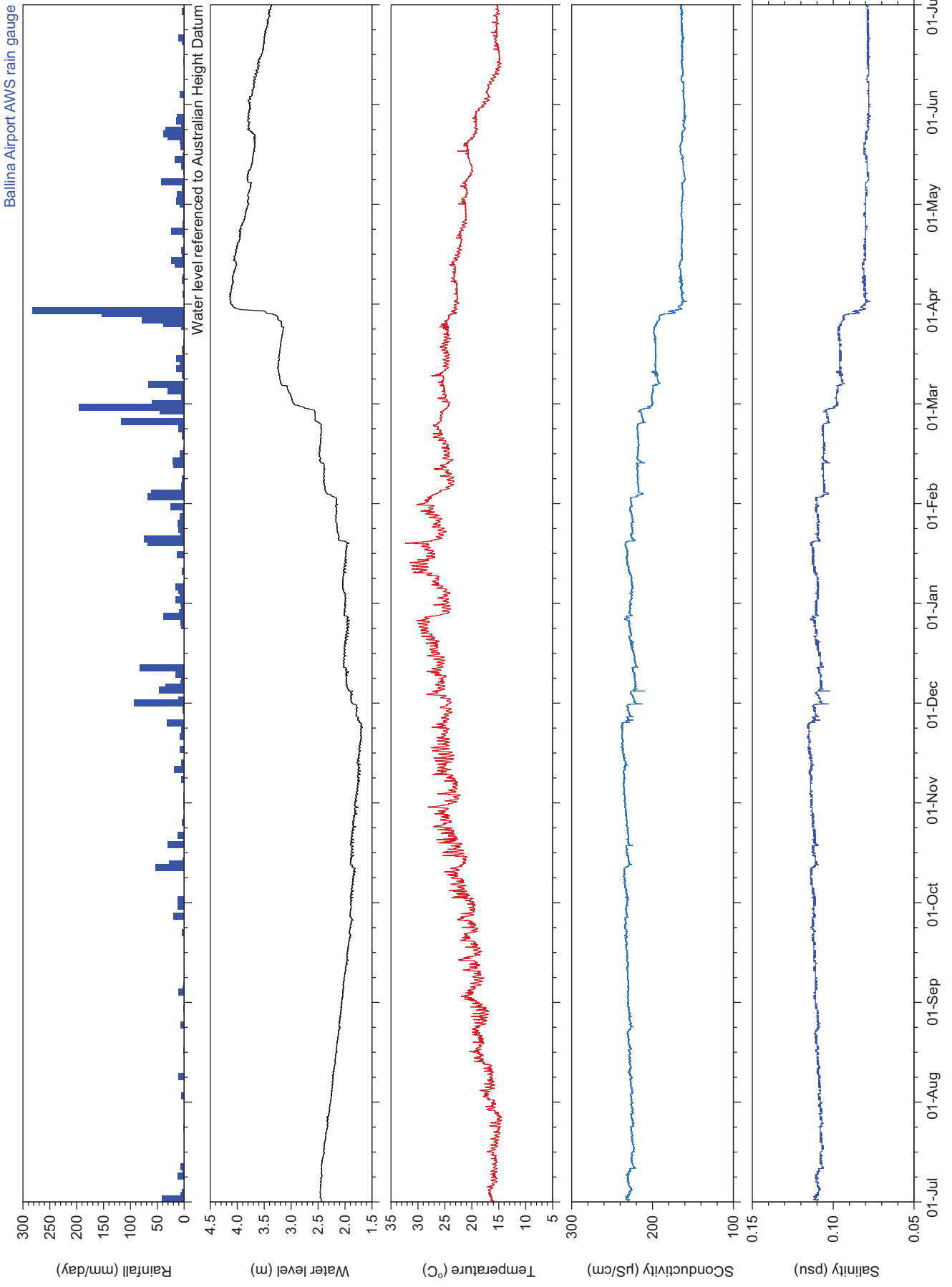
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Figure

1

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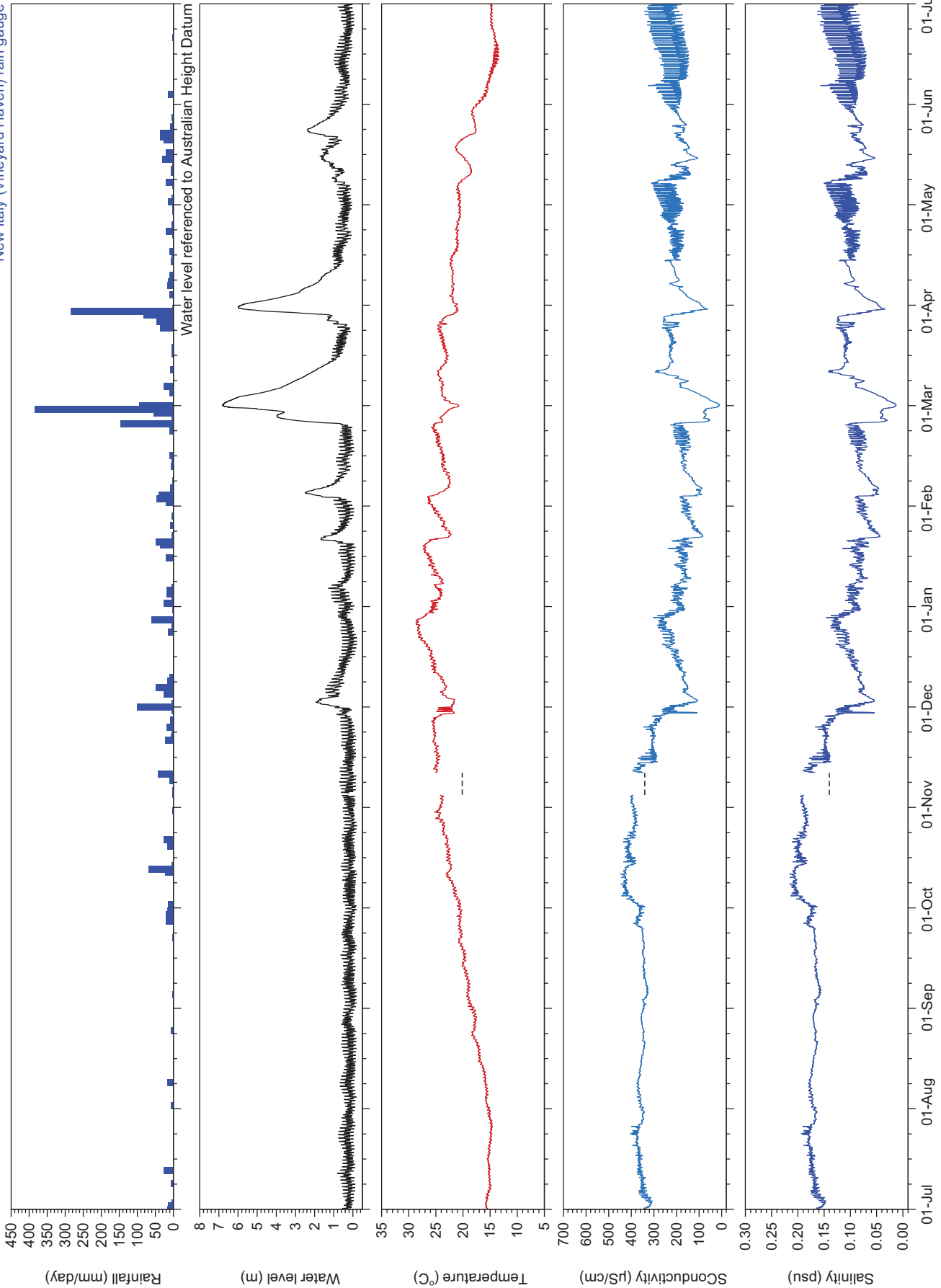
WATER LEVEL AND WATER QUALITY DATA
 2021–2022
 LAKE AINSWORTH

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 Laboratory

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Figure
 2

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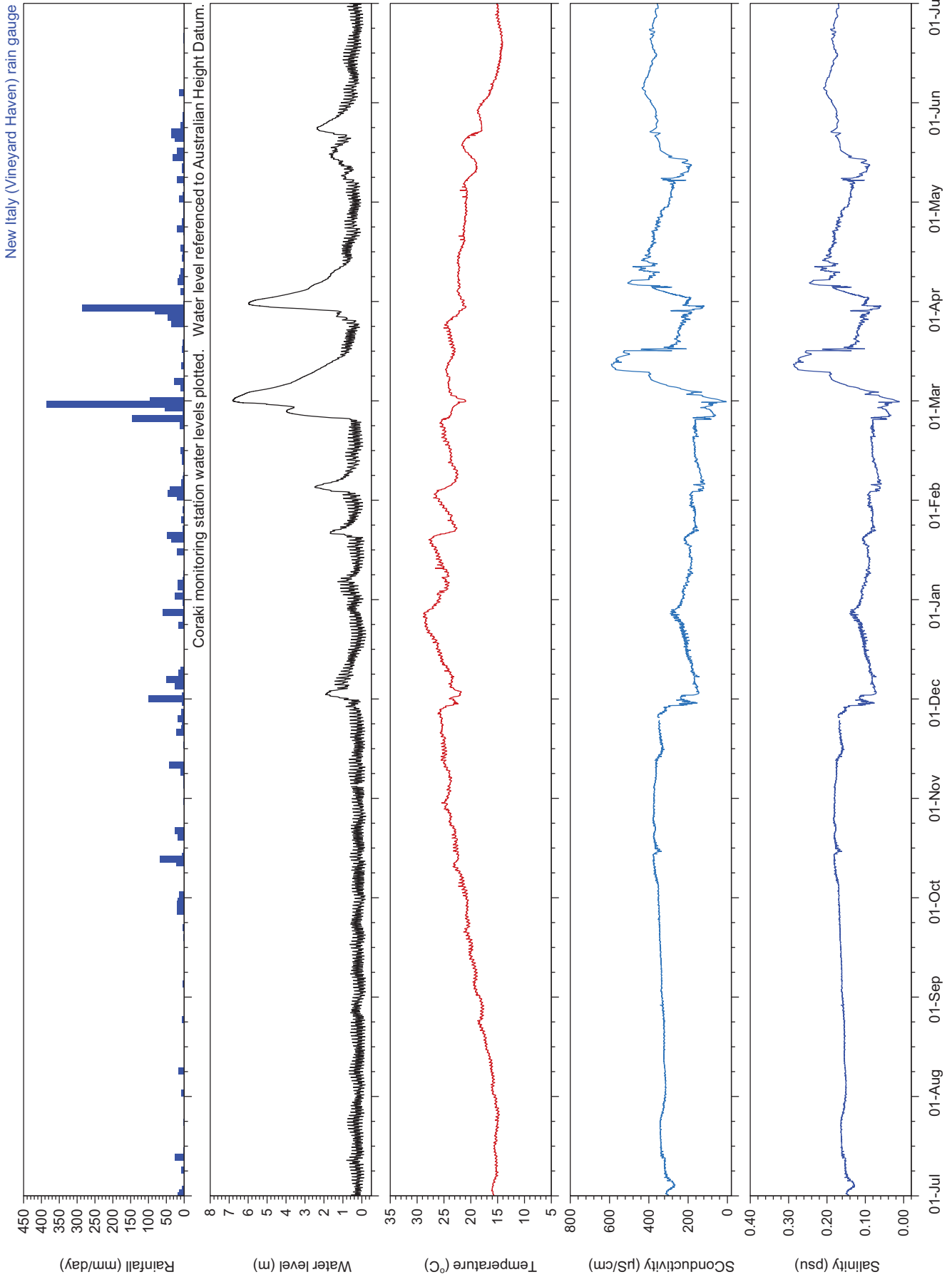


WATER LEVEL AND WATER QUALITY DATA
2021–2022
CORAKI

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Figure
3



WATER LEVEL AND WATER QUALITY DATA
2021–2022
OAKLAND ROAD

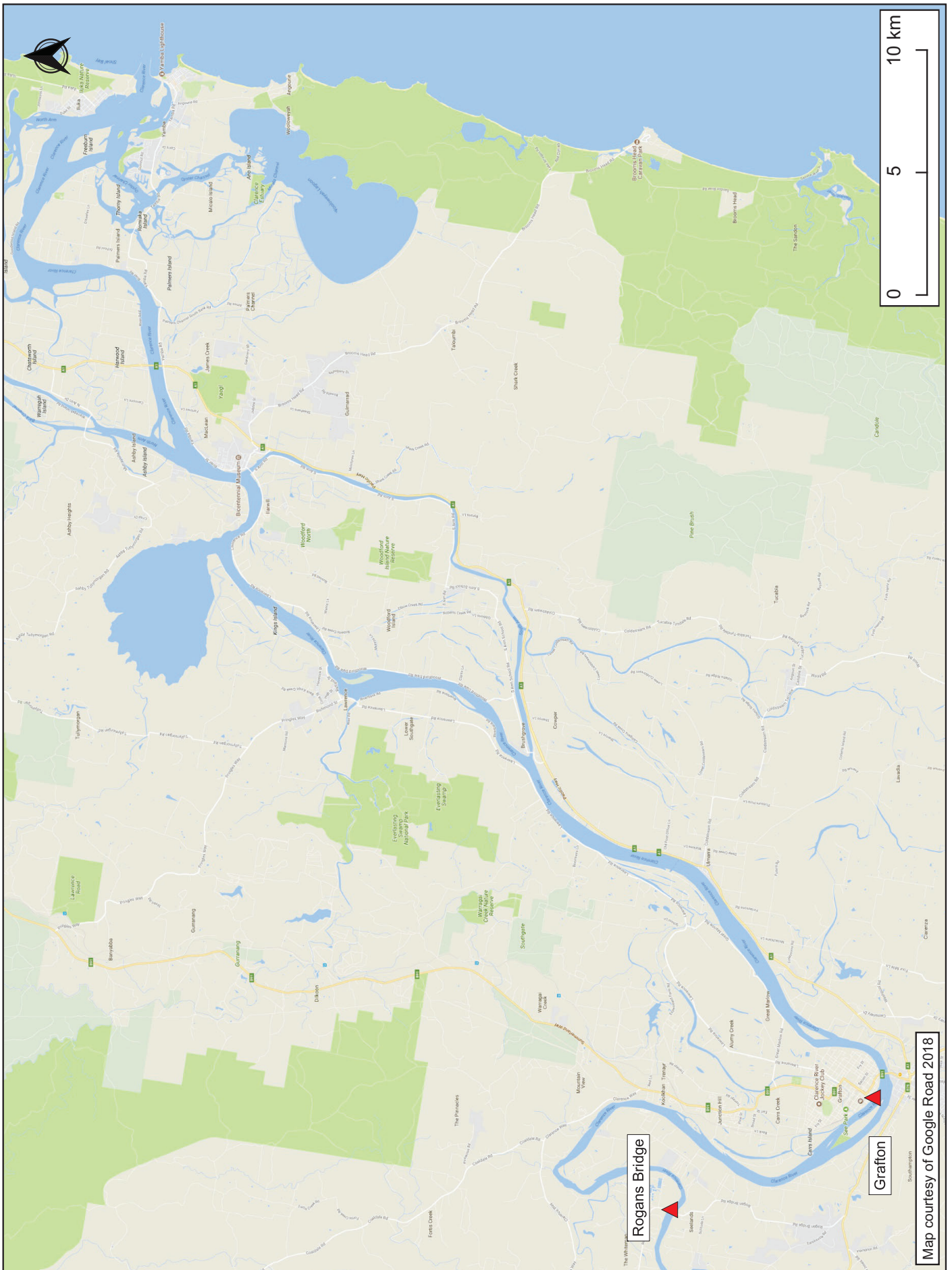
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Figure

4

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STATION LOCATIONS
CLARENCE RIVER REGION

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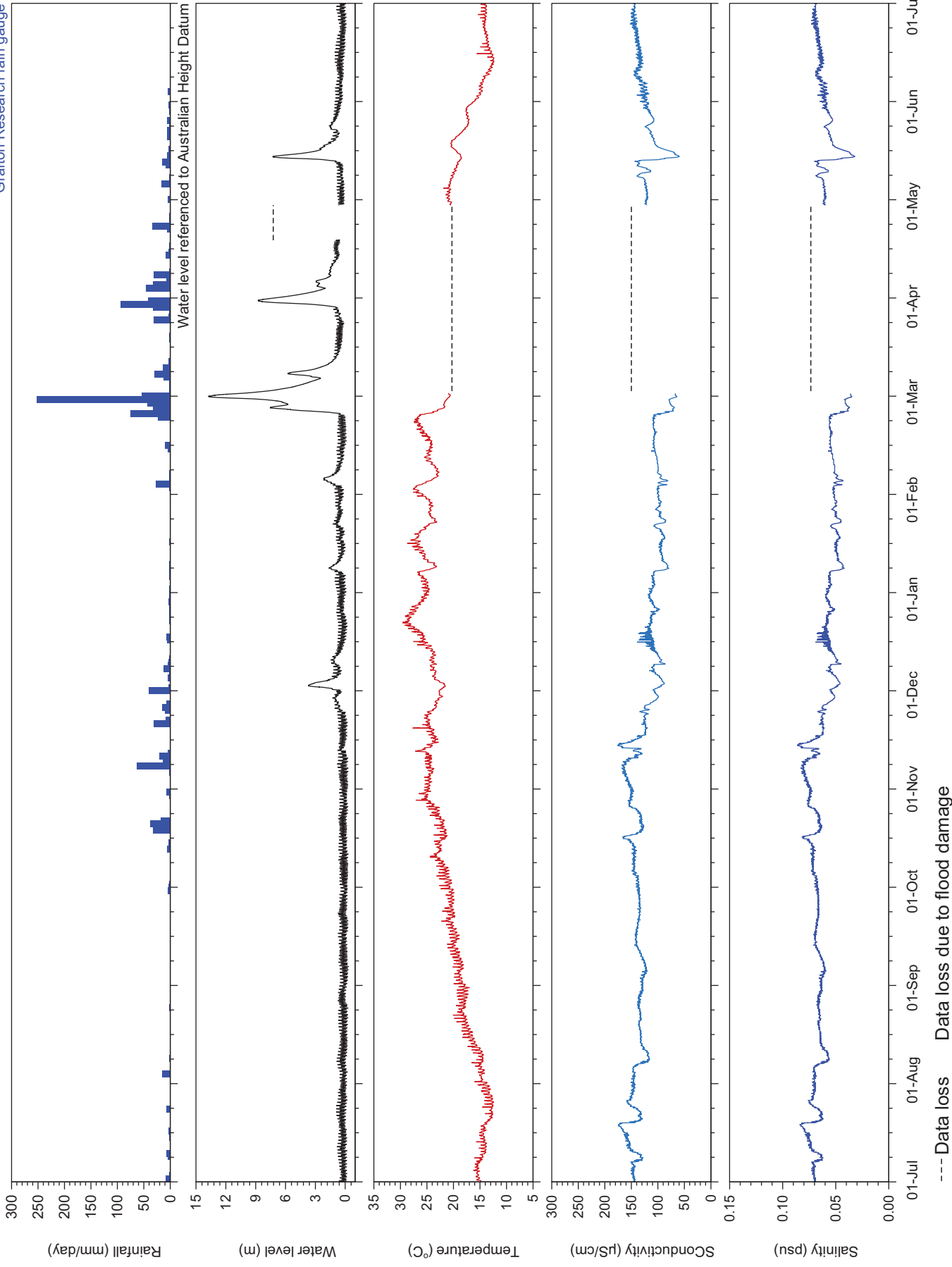
Figure

5

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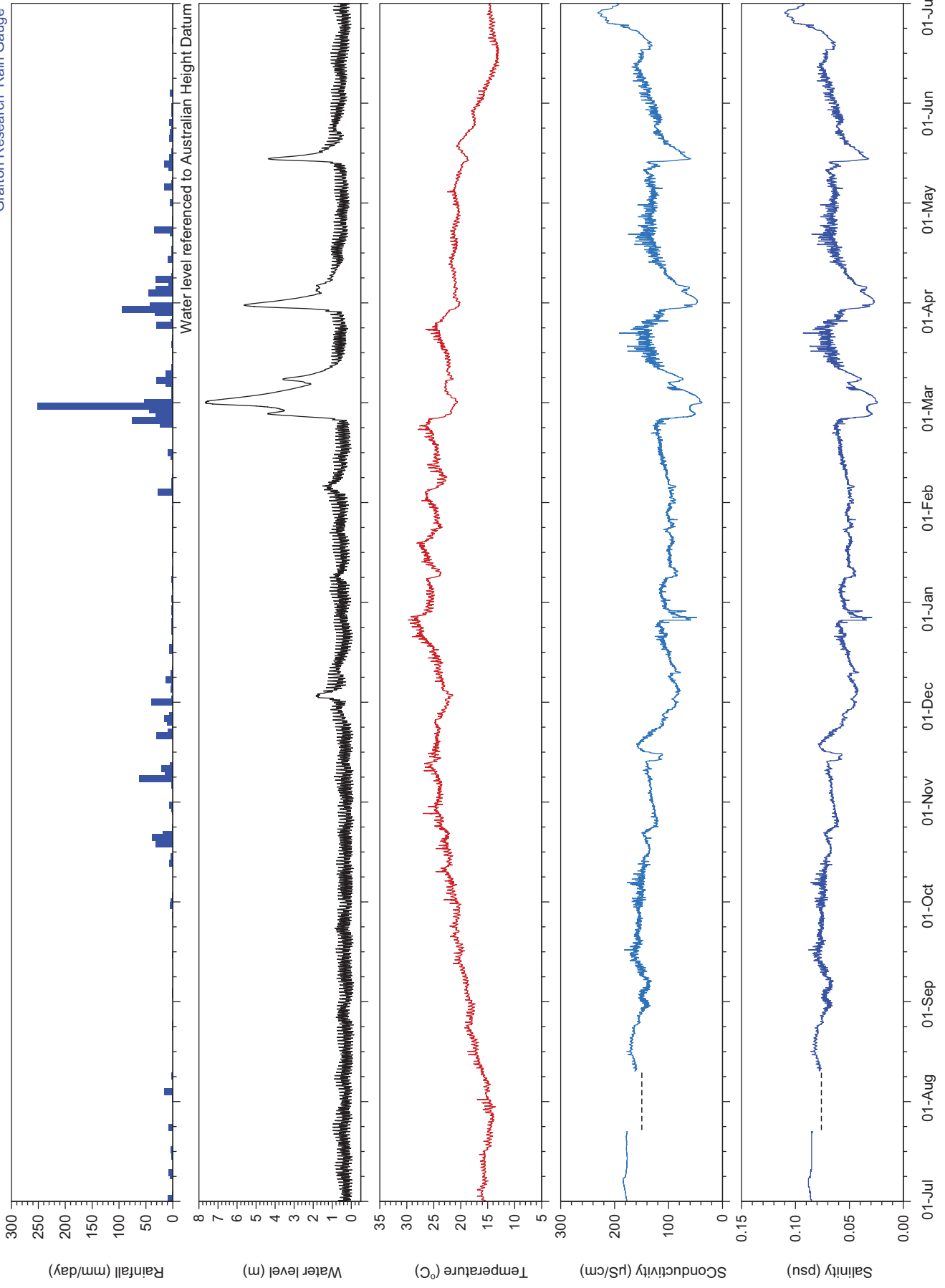
Map courtesy of Google Road 2018

Grafton Research rain gauge

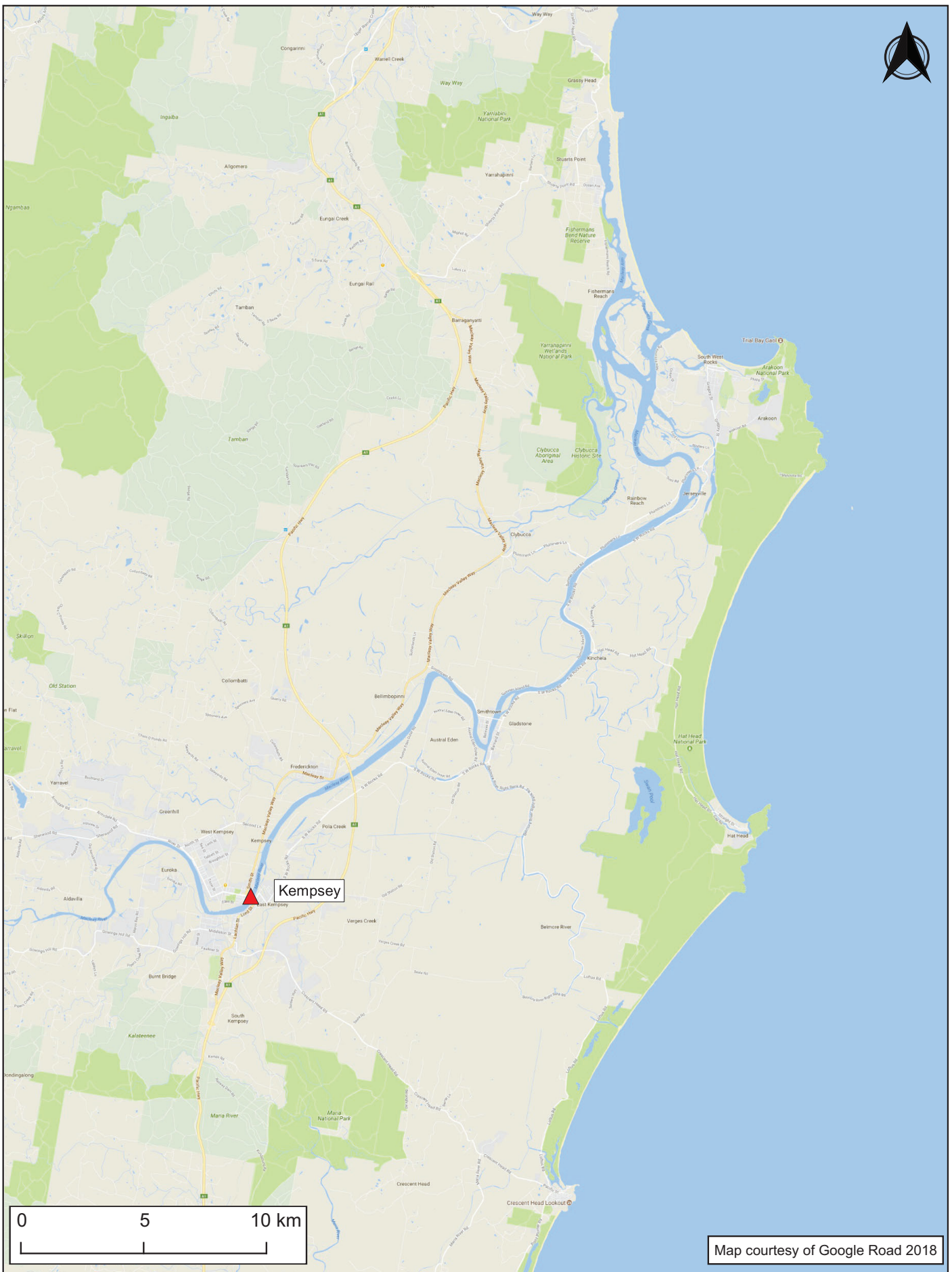


WATER LEVEL AND WATER QUALITY DATA
2021–2022
ROGANS BRIDGE

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Figure
6
DRAWING 2910-06.cdr



WATER LEVEL AND WATER QUALITY DATA
2021–2022
GRAFTON



STATION LOCATIONS MACLEAY RIVER REGION

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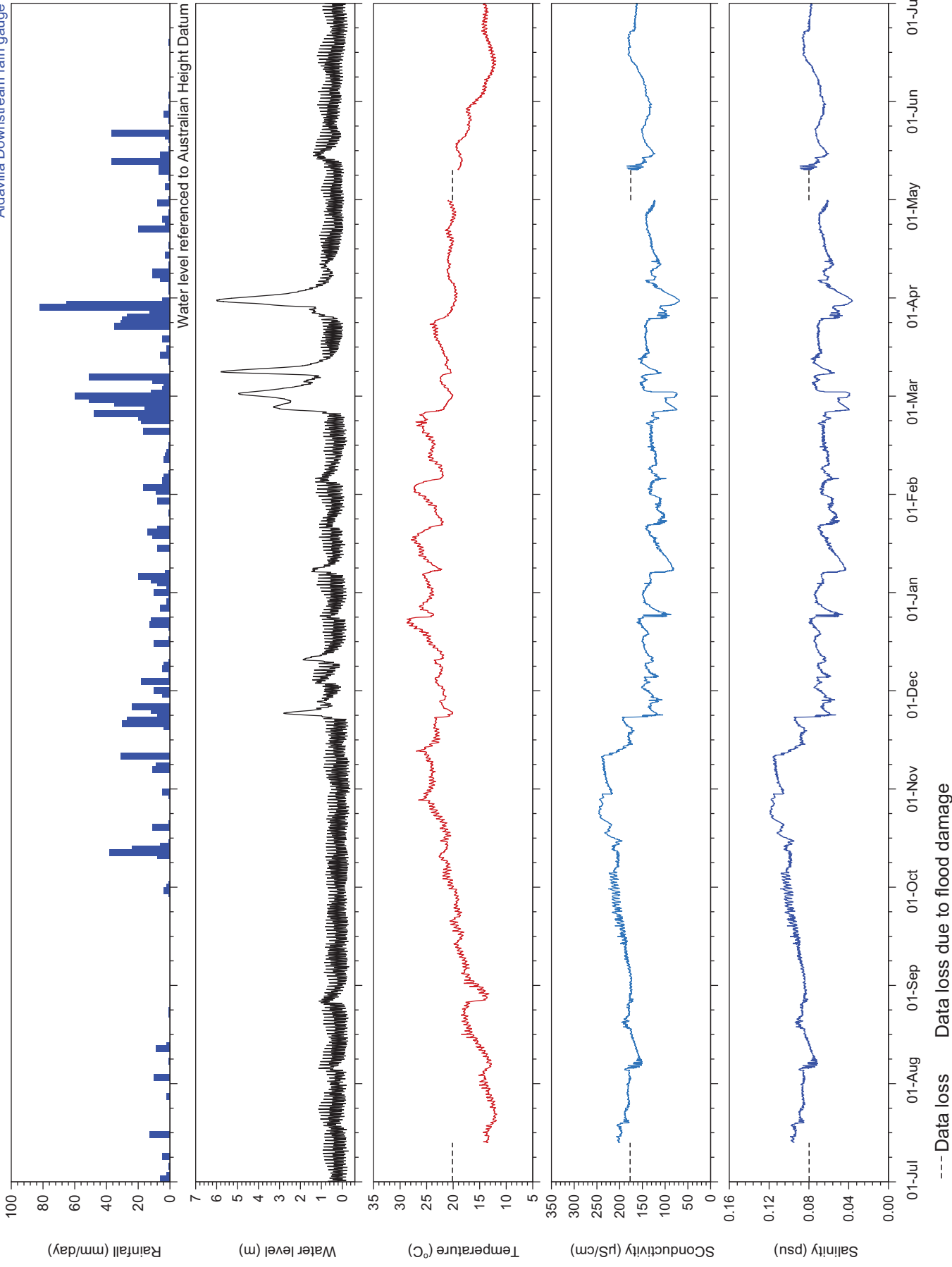
Report MHL2910

Figure

8

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Aldavilla Downstream rain gauge



--- Data loss Data loss due to flood damage



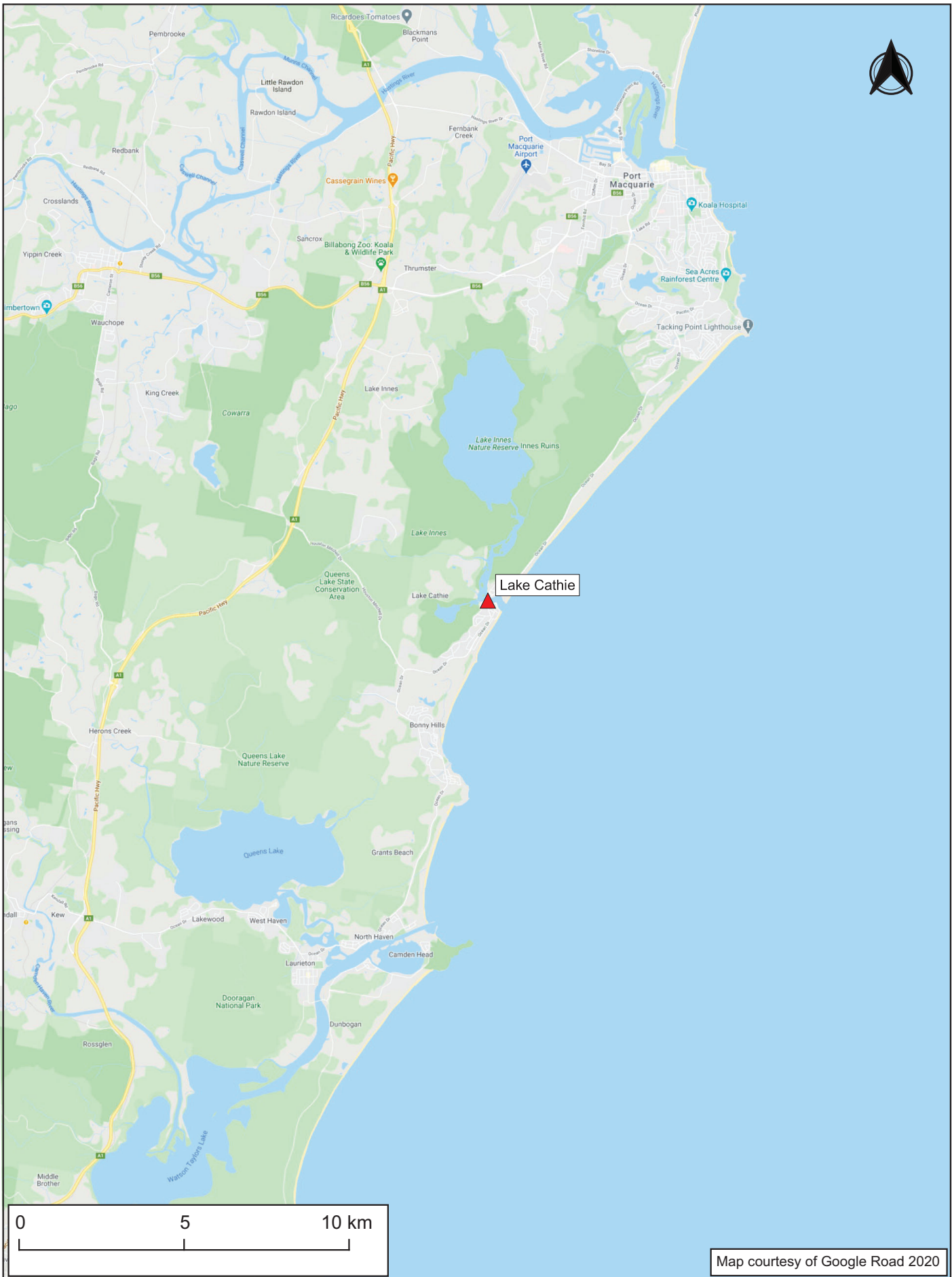
WATER LEVEL AND WATER QUALITY DATA 2021–2022 KEMPSEY

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Figure
9

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**STATION LOCATIONS
LAKE CATHIE**

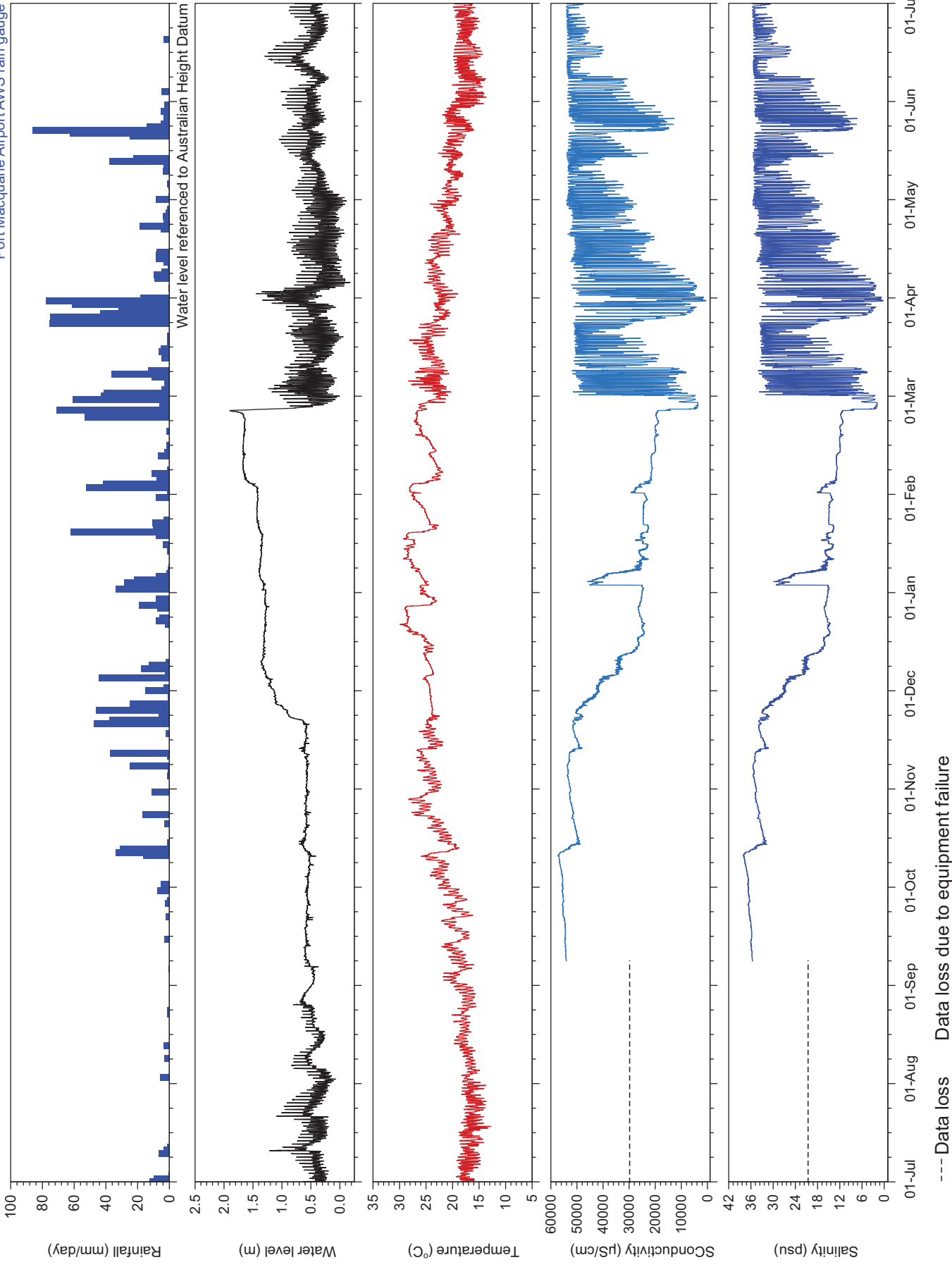
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Figure
10

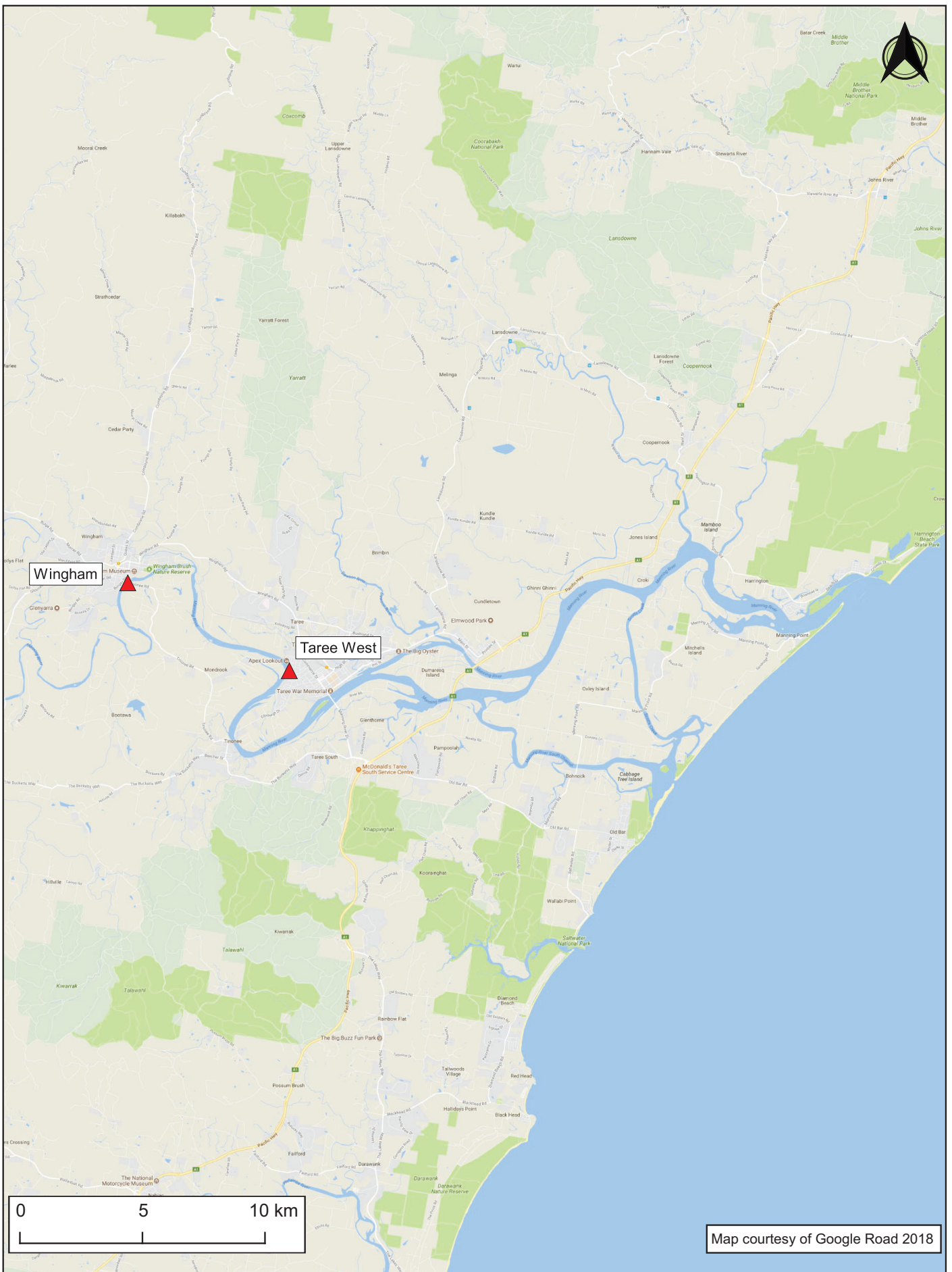
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Port Macquarie Airport AWS rain gauge



WATER LEVEL AND WATER QUALITY DATA
2021-2022
LAKE CATHIE

Manly
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Figure
11
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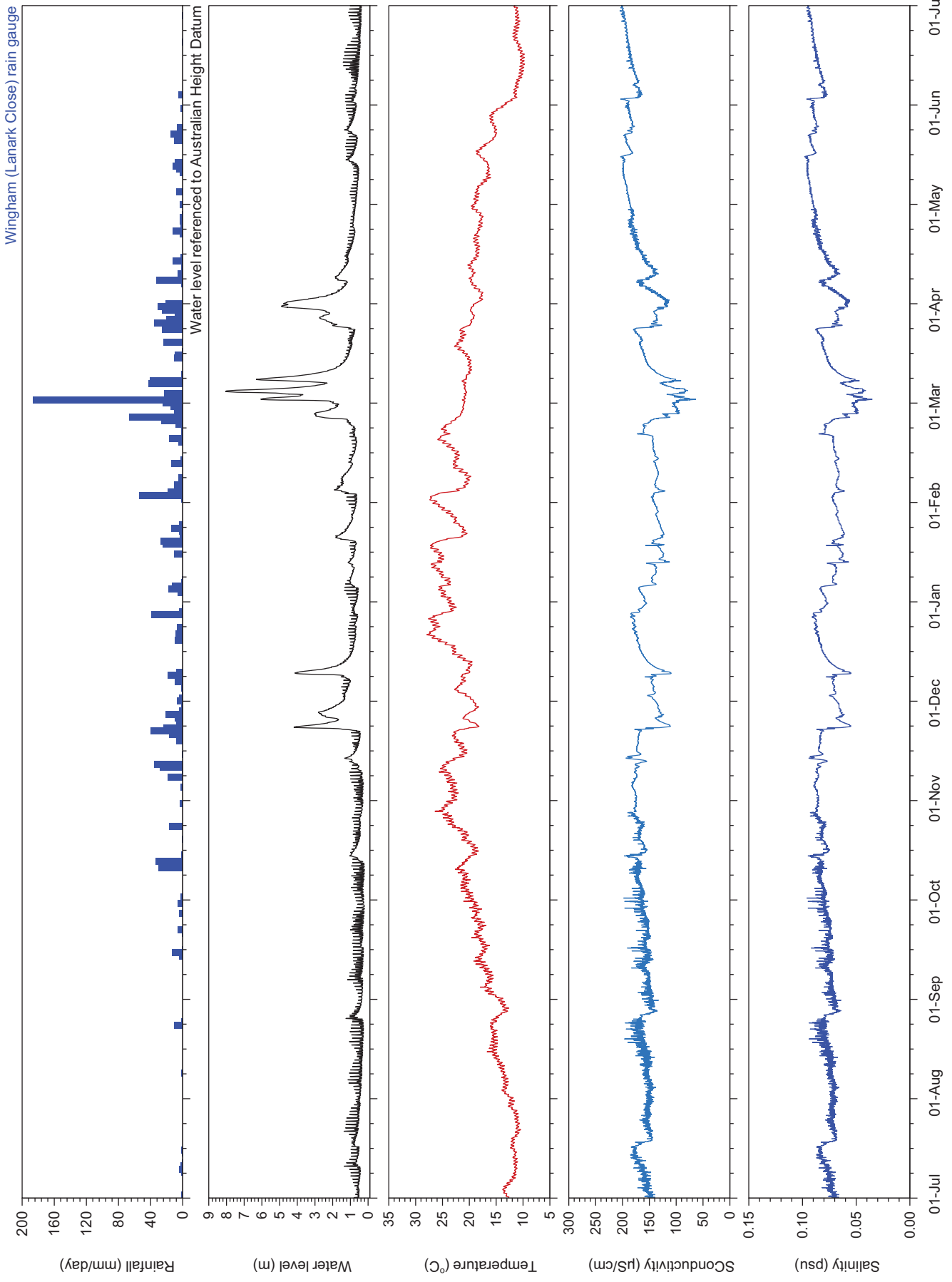
**STATION LOCATIONS
MANNING RIVER REGION**

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Figure
12

DRAWING 2910-12.cdr



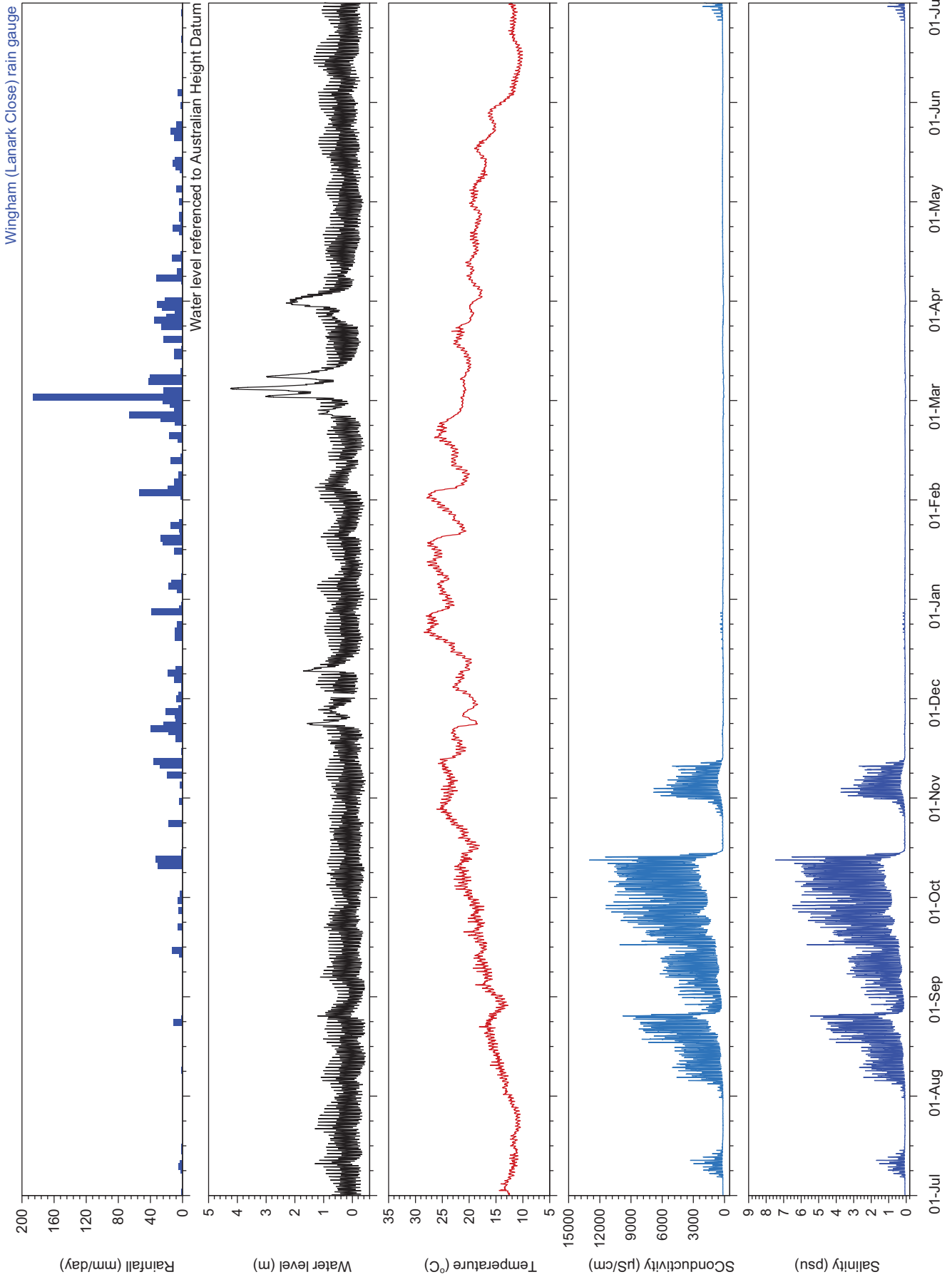
WATER LEVEL AND WATER QUALITY DATA
2021–2022
WINGHAM

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
13

DRAWING 2910-13.cdr



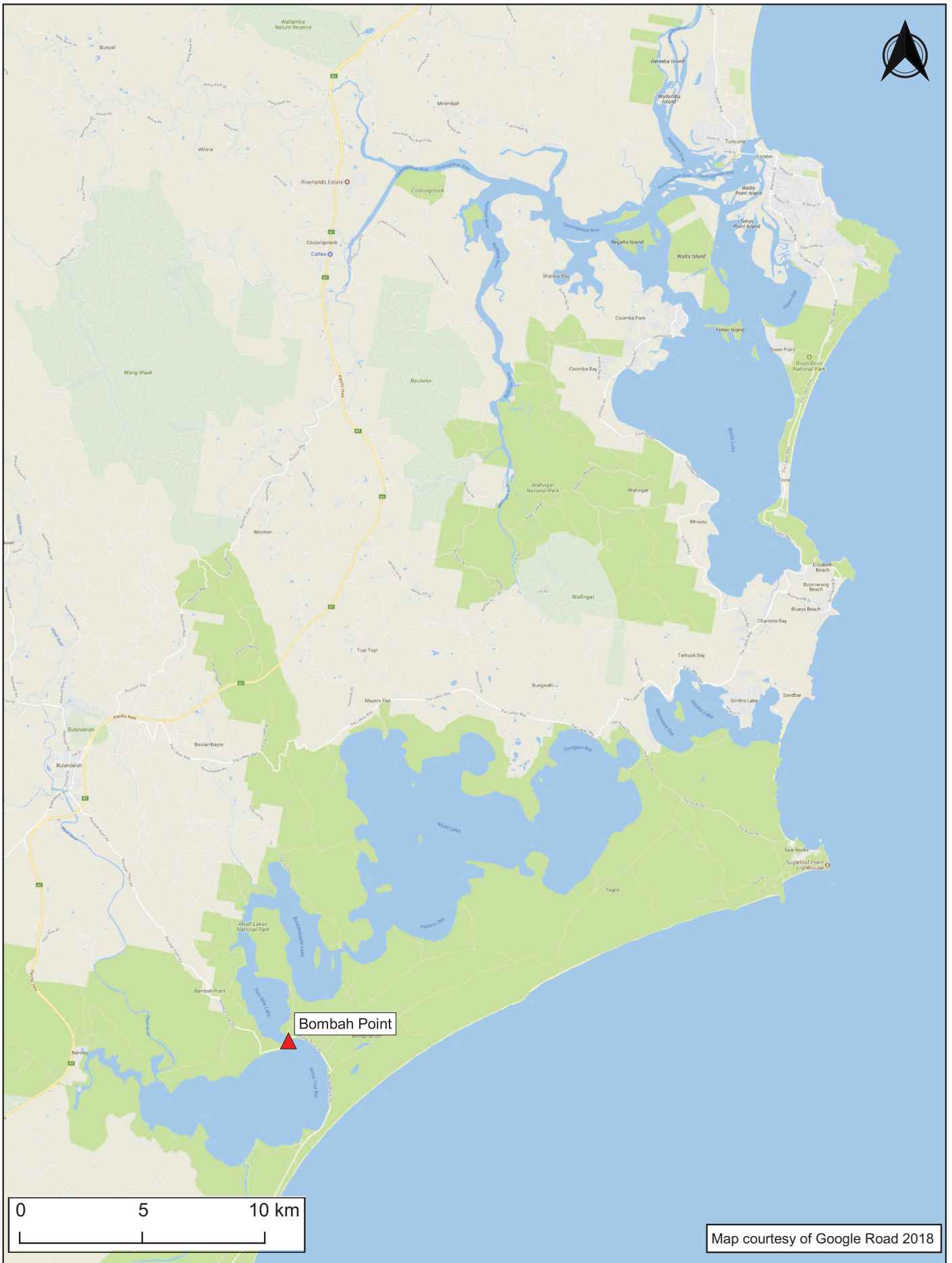
WATER LEVEL AND WATER QUALITY DATA
2021-2022
TAREE WEST

Manly
Hydraulics
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Report MHL2910

Figure
14

DRAWING 2910-14.cdr



Map courtesy of Google Road 2018



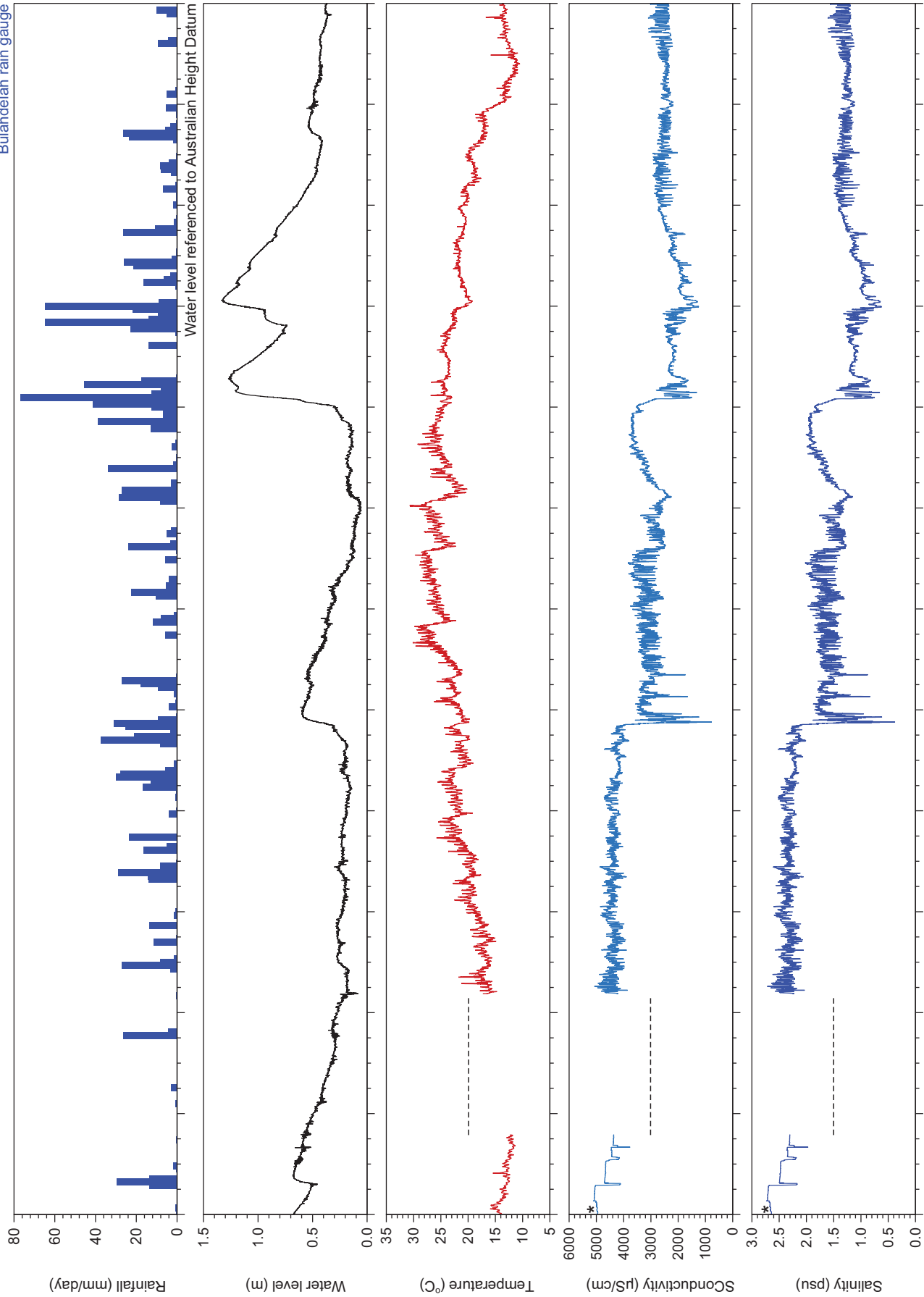
STATION LOCATIONS GREAT LAKES REGION

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Report MHL2910

Figure
15

DRAWING 2910-15.cdr



Bulahdelah rain gauge

Water level referenced to Australian Height Datum

80
60
40
20
0
1.5
1.0
0.5
0.0
35
30
25
20
15
10
5
6000
5000
4000
3000
2000
1000
0
3.0
2.5
2.0
1.5
1.0
0.5
0.0

Rainfall (mm/day) Water level (m) Temperature (°C) Conductivity (µS/cm) Salinity (psu)

01-Jul 01-Aug 01-Sep 01-Oct 01-Nov 01-Dec 01-Jan 01-Feb 01-Mar 01-Apr 01-May 01-Jun 01-Jul

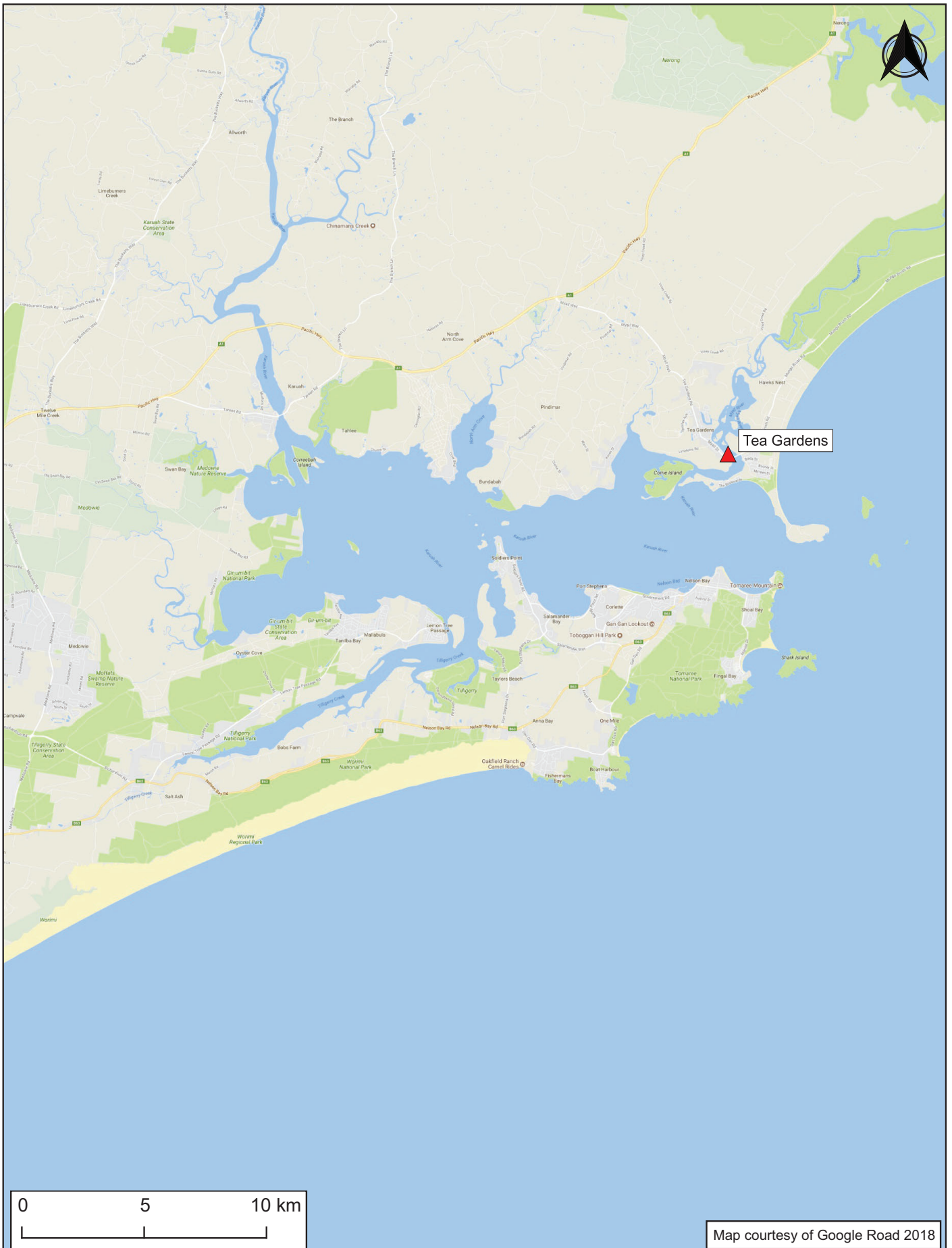
*Standalone water quality sensor was deployed on the bank away from the original station for safe access. The trace indicates a less dynamic saline influence at this monitoring point.

--- Data loss from 25 July 2021 when water entered the battery compartment.



WATER LEVEL AND WATER QUALITY DATA
2021–2022
BOMBAH POINT

Manly
Hydraulics
Laboratory
Report MHL2910
Figure
16
DRAWING 2910-16.cdr



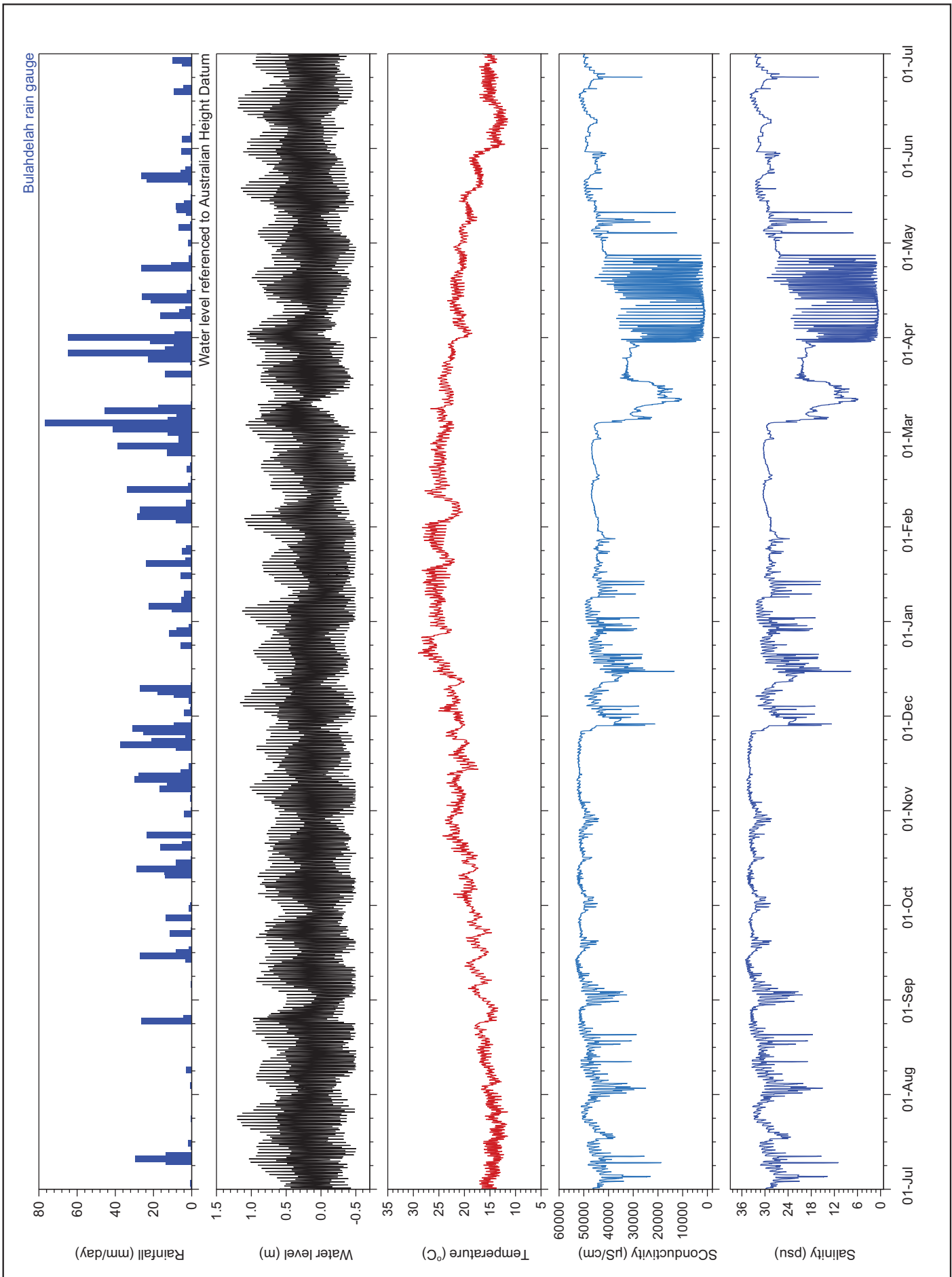
STATION LOCATIONS
PORT STEPHENS REGION

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
17

DRAWING 2910-17.cdr



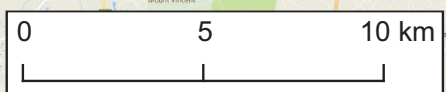
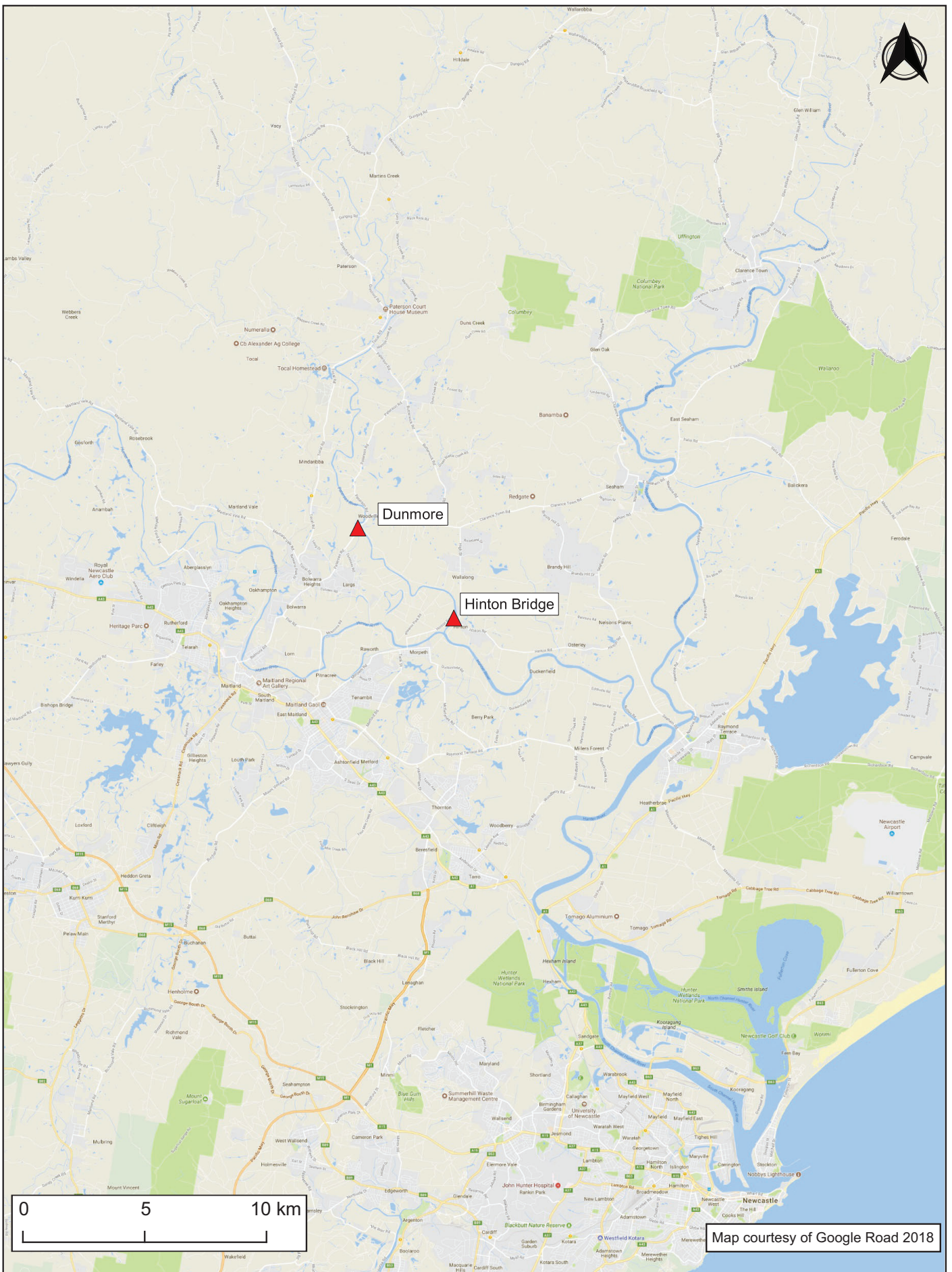
WATER LEVEL AND WATER QUALITY DATA
2021–2022
TEA GARDENS

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
18

DRAWING 2910-18.cdr

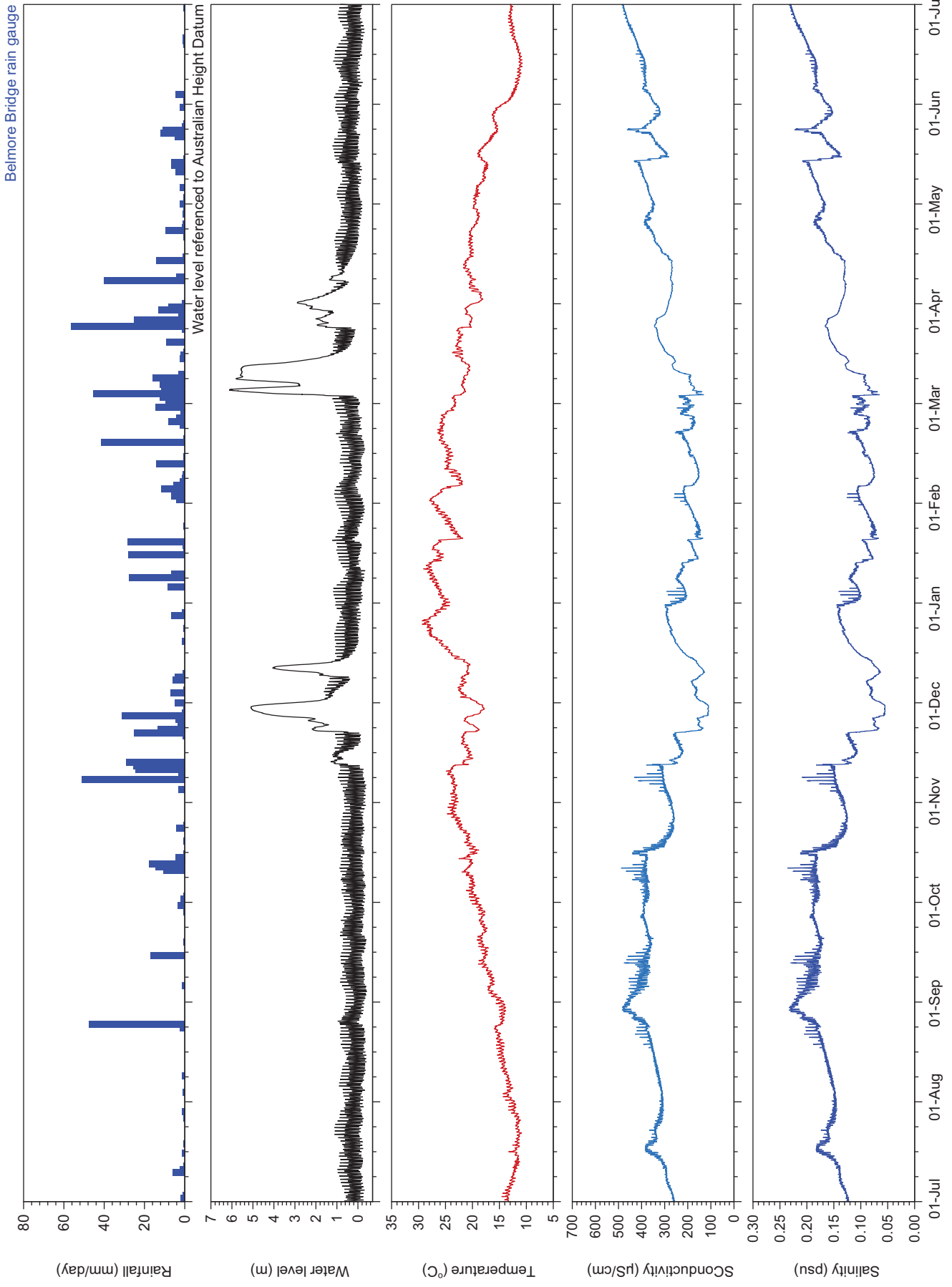


Map courtesy of Google Road 2018



STATION LOCATIONS PATERSON RIVER REGION

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Report MHL2910
Figure
19
DRAWING 2910-19.cdr

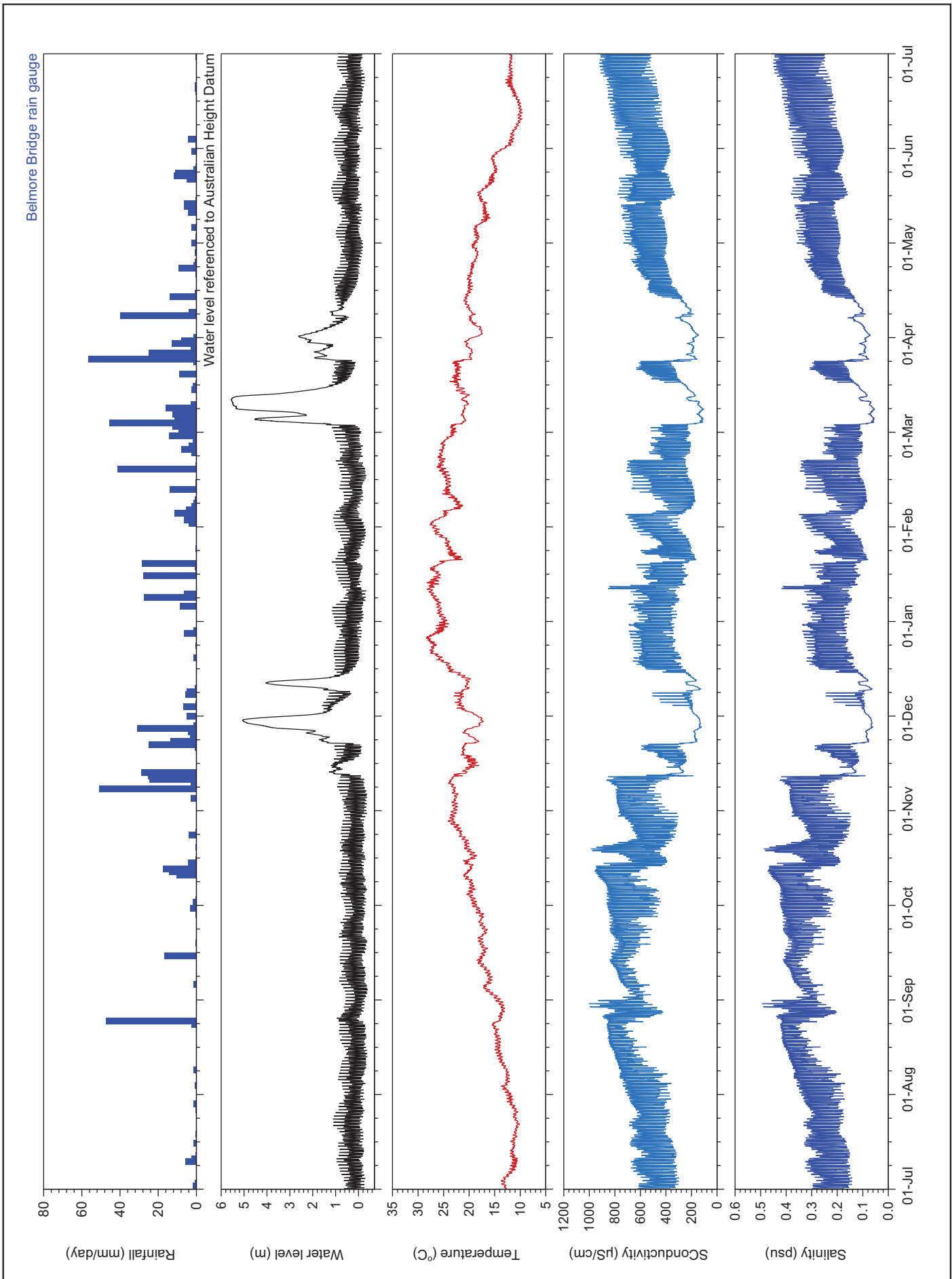


WATER LEVEL AND WATER QUALITY DATA
2021–2022
DUNMORE

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
20



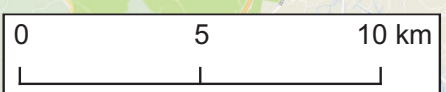
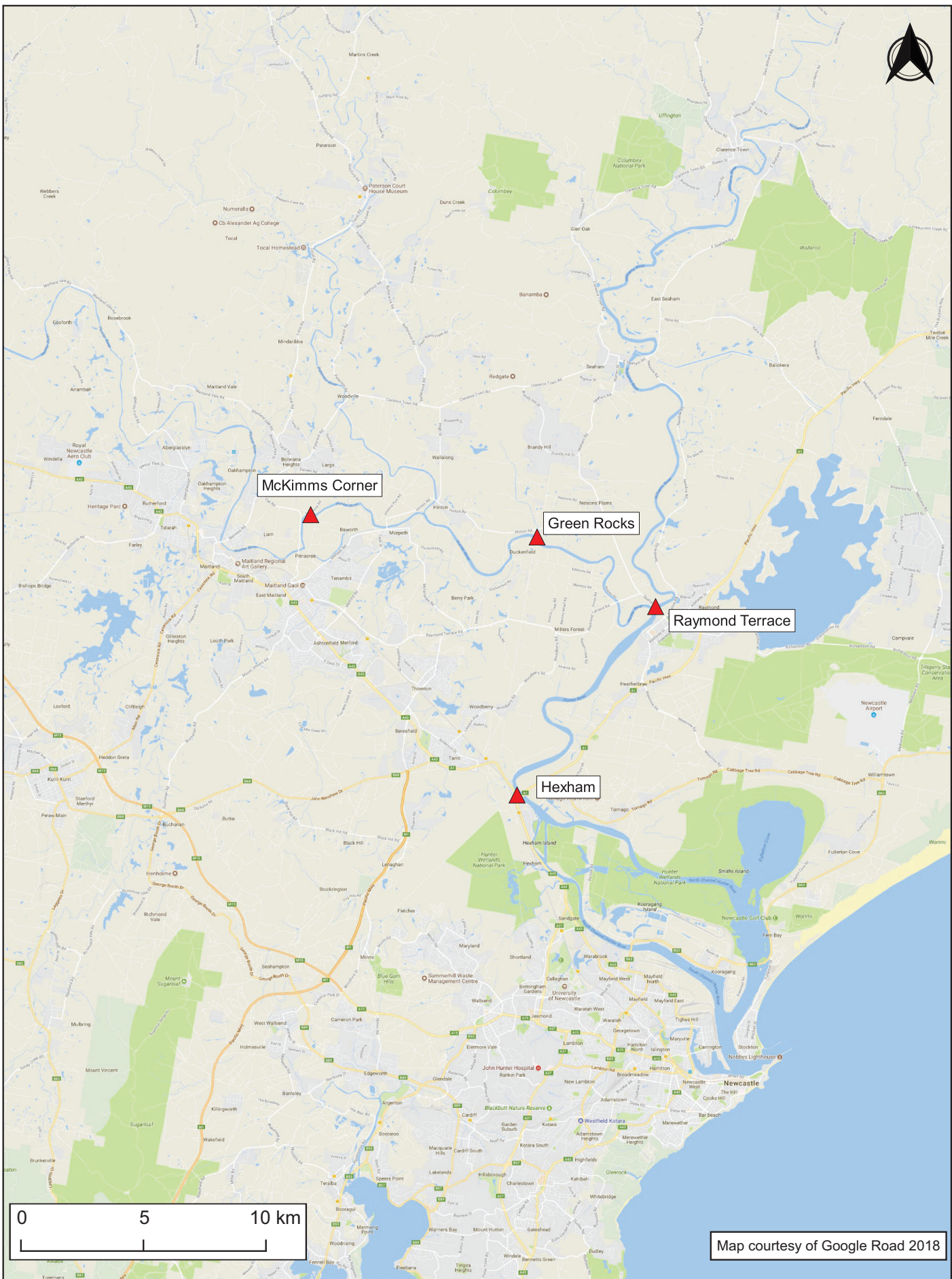
WATER LEVEL AND WATER QUALITY DATA
2021–2022
HINTON BRIDGE

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
21

DRAWING 2910-21.cdr

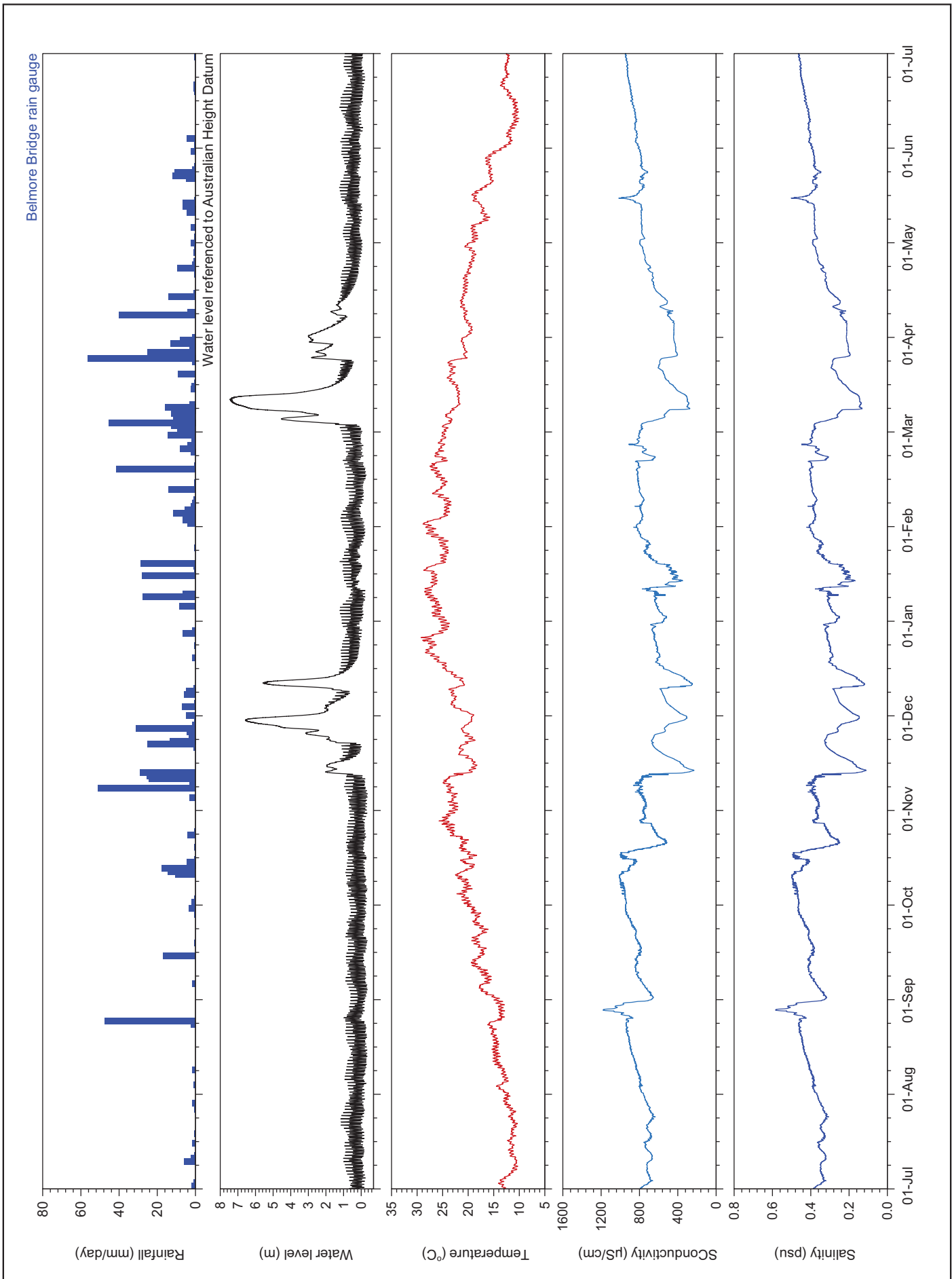


Map courtesy of Google Road 2018



STATION LOCATIONS HUNTER RIVER REGION

**Manly
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Laboratory**
Report MHL2910
Figure
22
DRAWING 2910-22.cdr



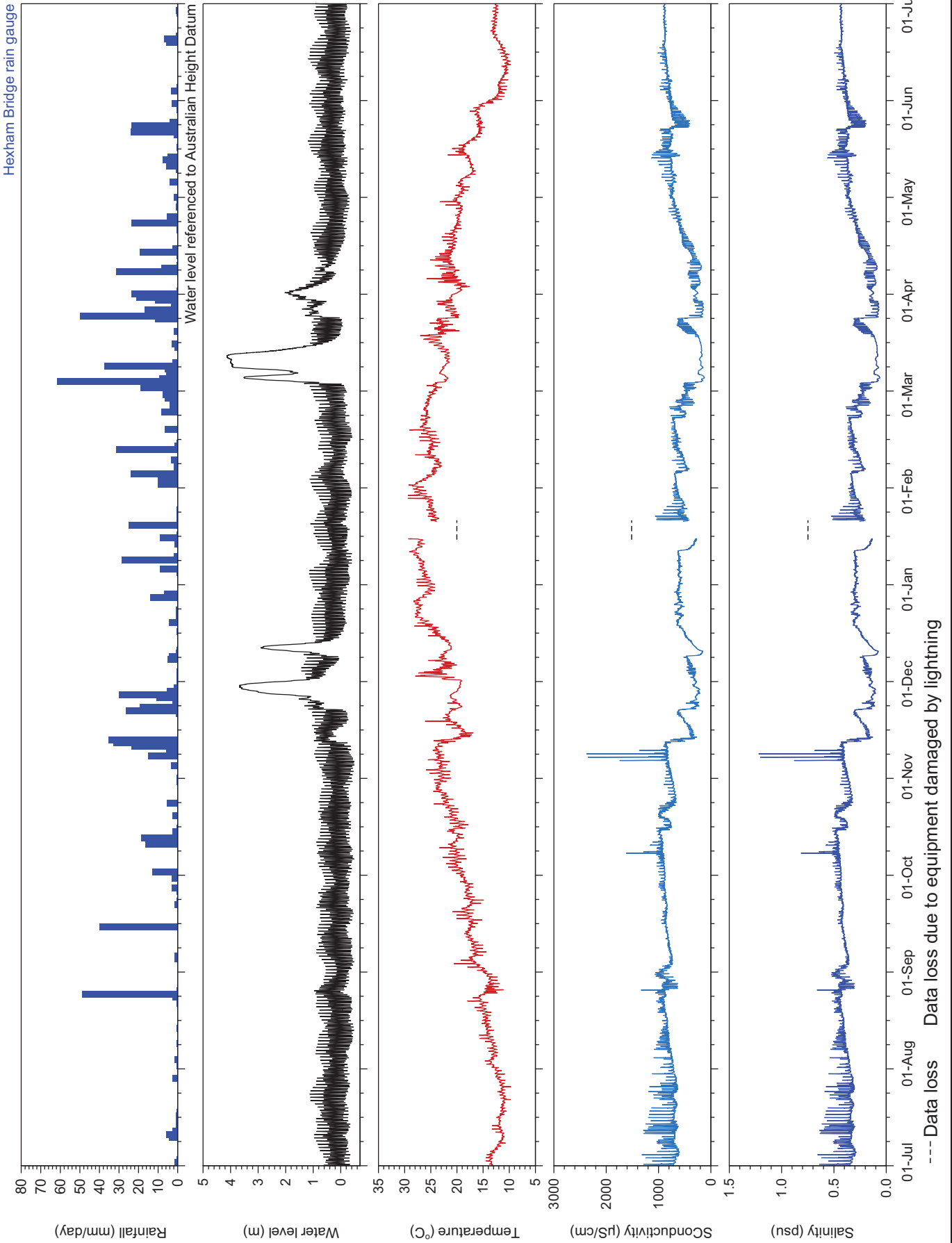
WATER LEVEL AND WATER QUALITY DATA
2021–2022
McKIMMS CORNER

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
23

DRAWING 2910-23.cdr



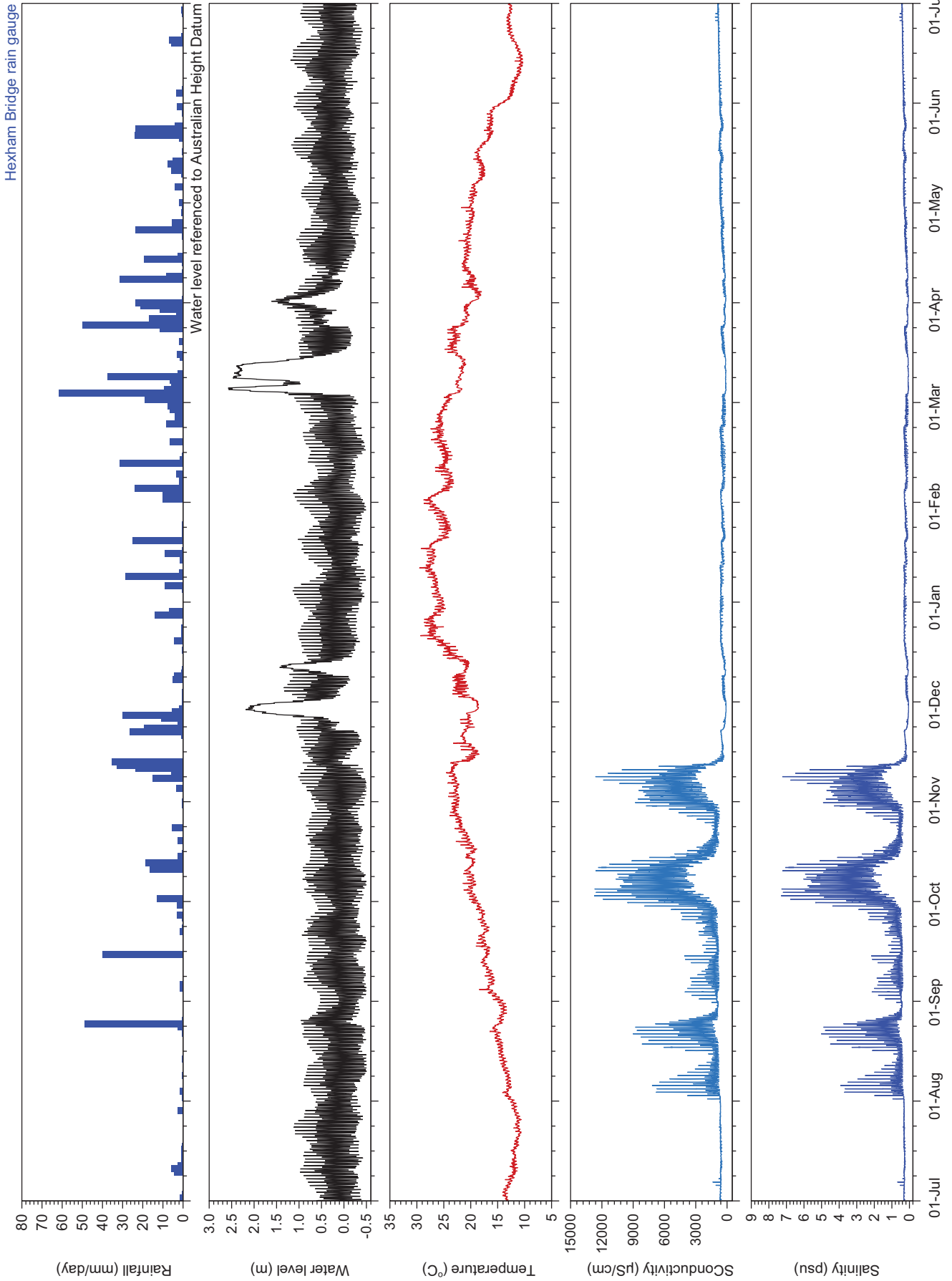
WATER LEVEL AND WATER QUALITY DATA
2021–2022
GREEN ROCKS

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
24

DRAWING 2910-24.cdr



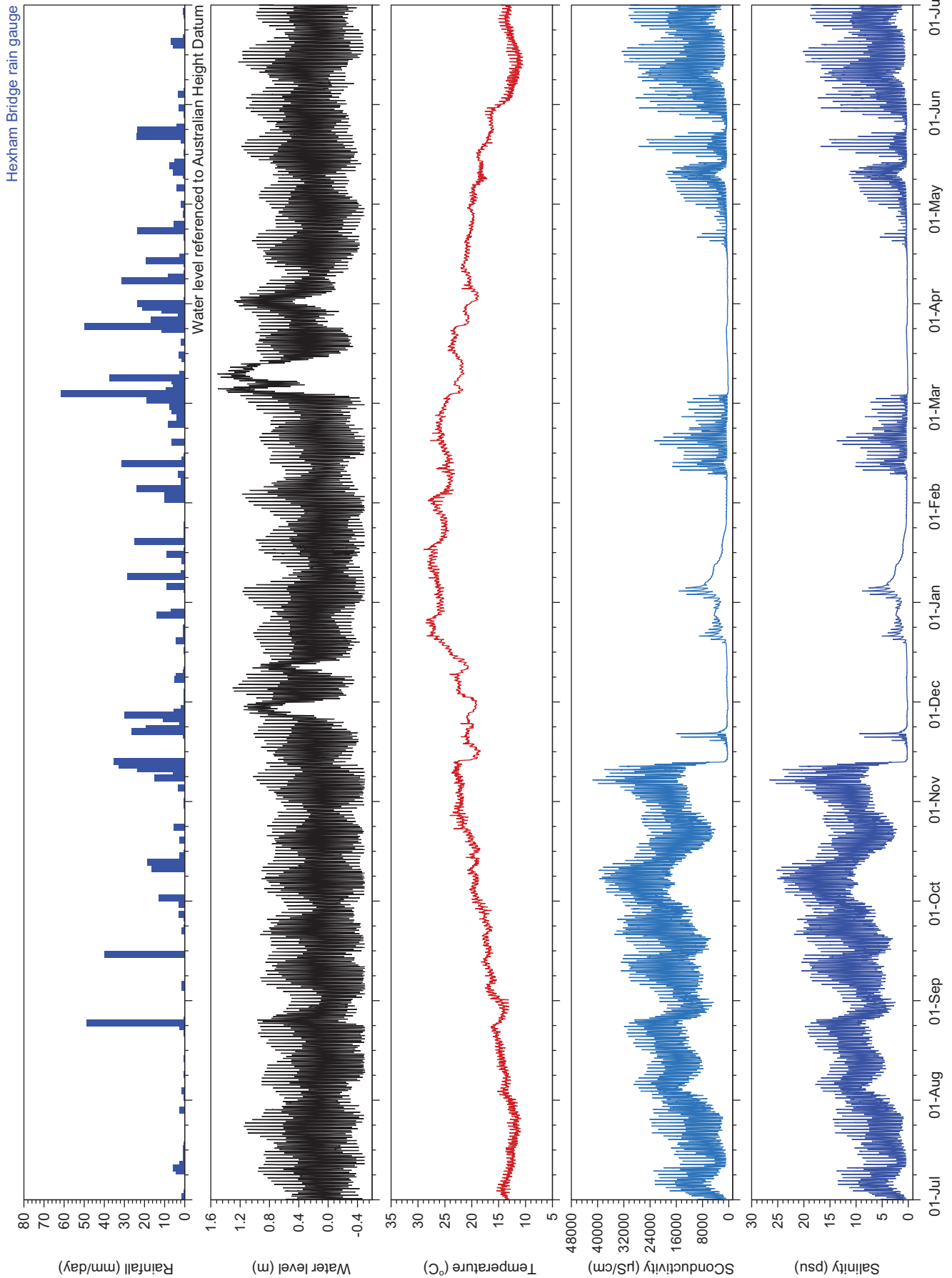
WATER LEVEL AND WATER QUALITY DATA
2021–2022
RAYMOND TERRACE

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
25

DRAWING 2910-25.cdr



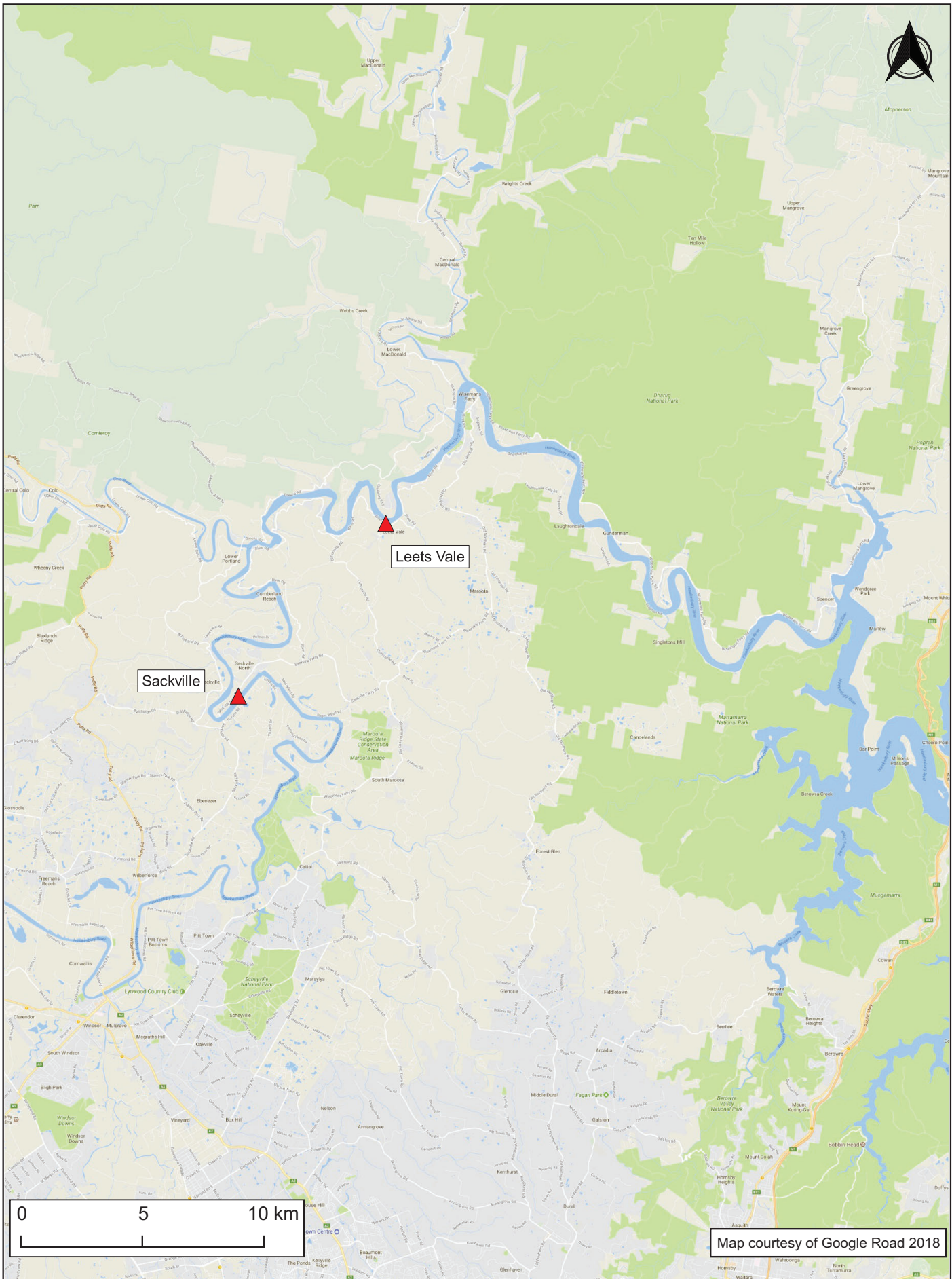
WATER LEVEL AND WATER QUALITY DATA
2021–2022
HEXHAM BRIDGE

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
26

DRAWING 2910-26.cdr



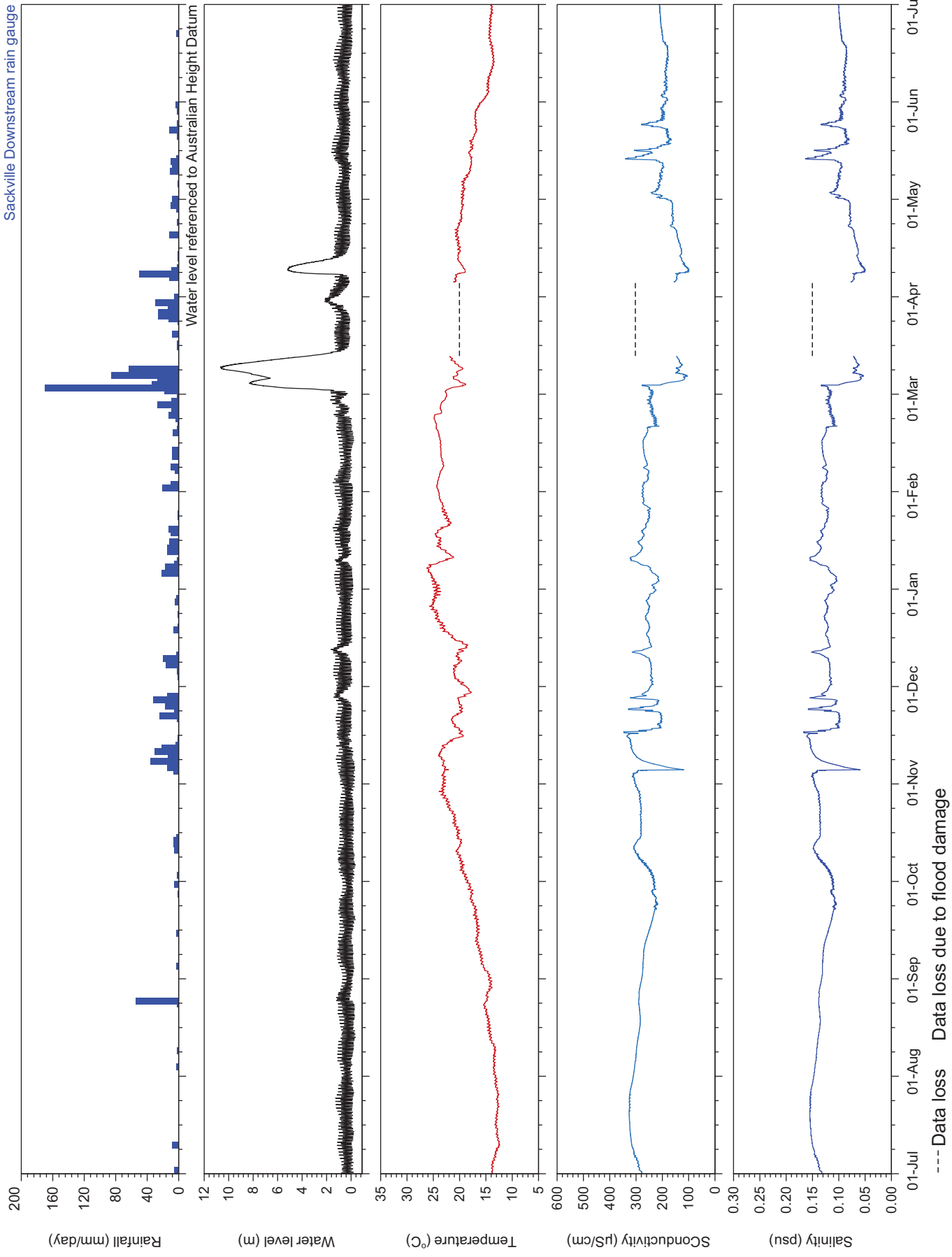
**STATION LOCATIONS
HAWKESBURY RIVER REGION**

**Manly
Hydraulics
Laboratory**

Report MHL2910

Figure
27

DRAWING 2910-27.cdr

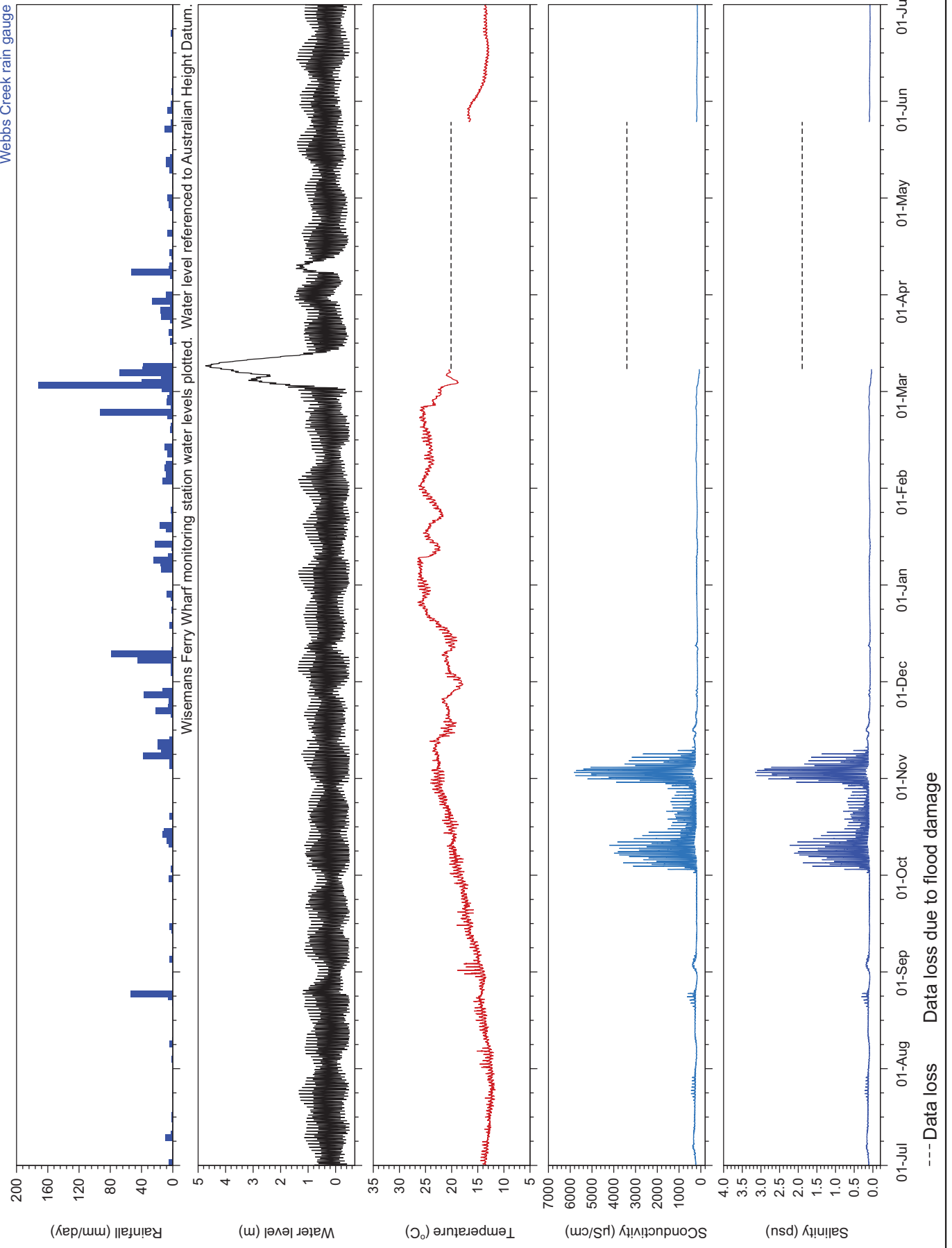


WATER LEVEL AND WATER QUALITY DATA
 2021–2022
 SACKVILLE

Manly
 Hydraulics
 Laboratory

Report MHL2910

Figure
 28



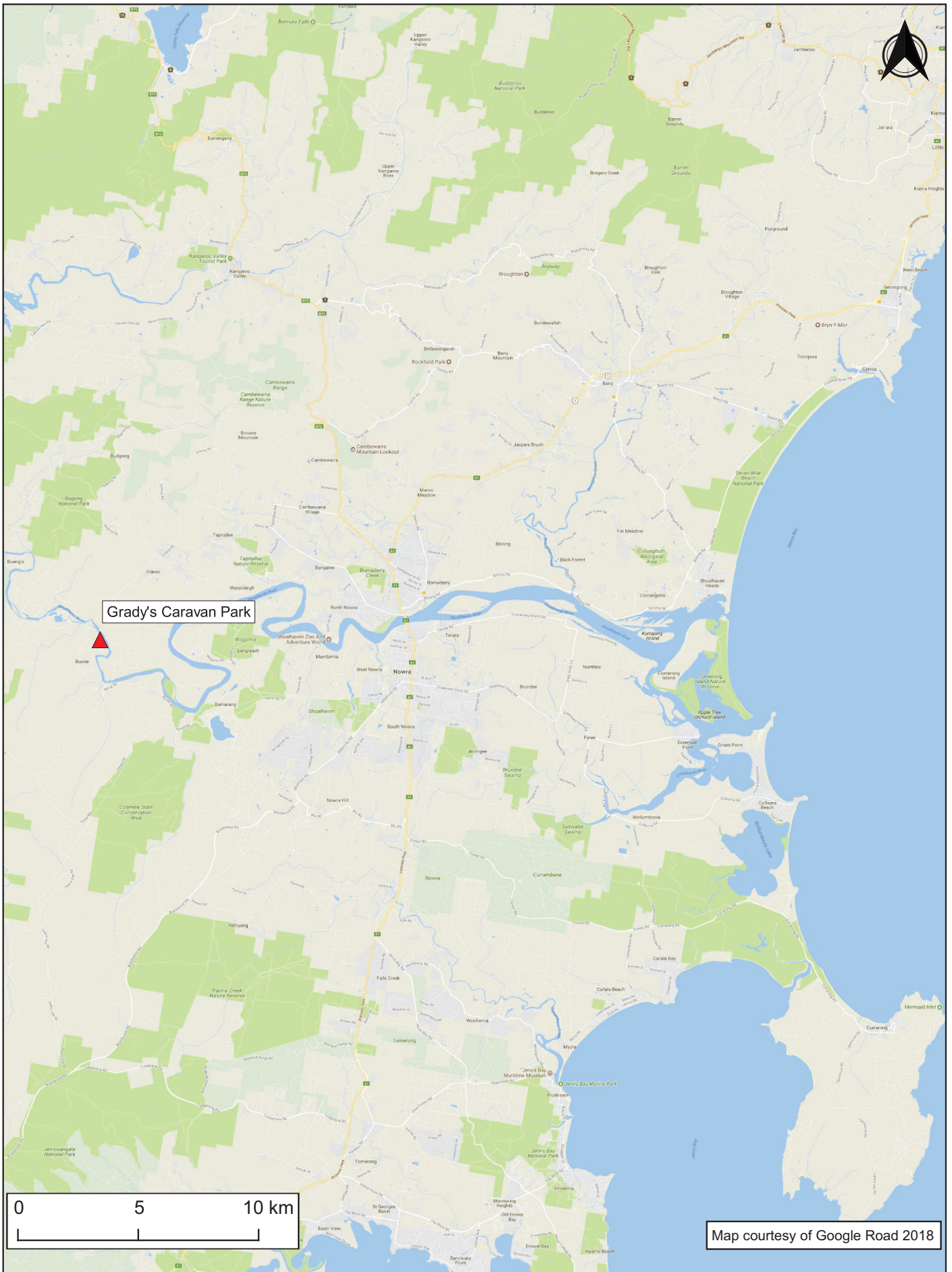
WATER LEVEL AND WATER QUALITY DATA
2021–2022
LEETS VALE

Manly
Hydraulics
Laboratory

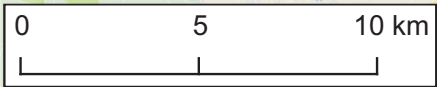
Report MHL2910

Figure
29

DRAWING 2910-29.cdr



Grady's Caravan Park



Map courtesy of Google Road 2018



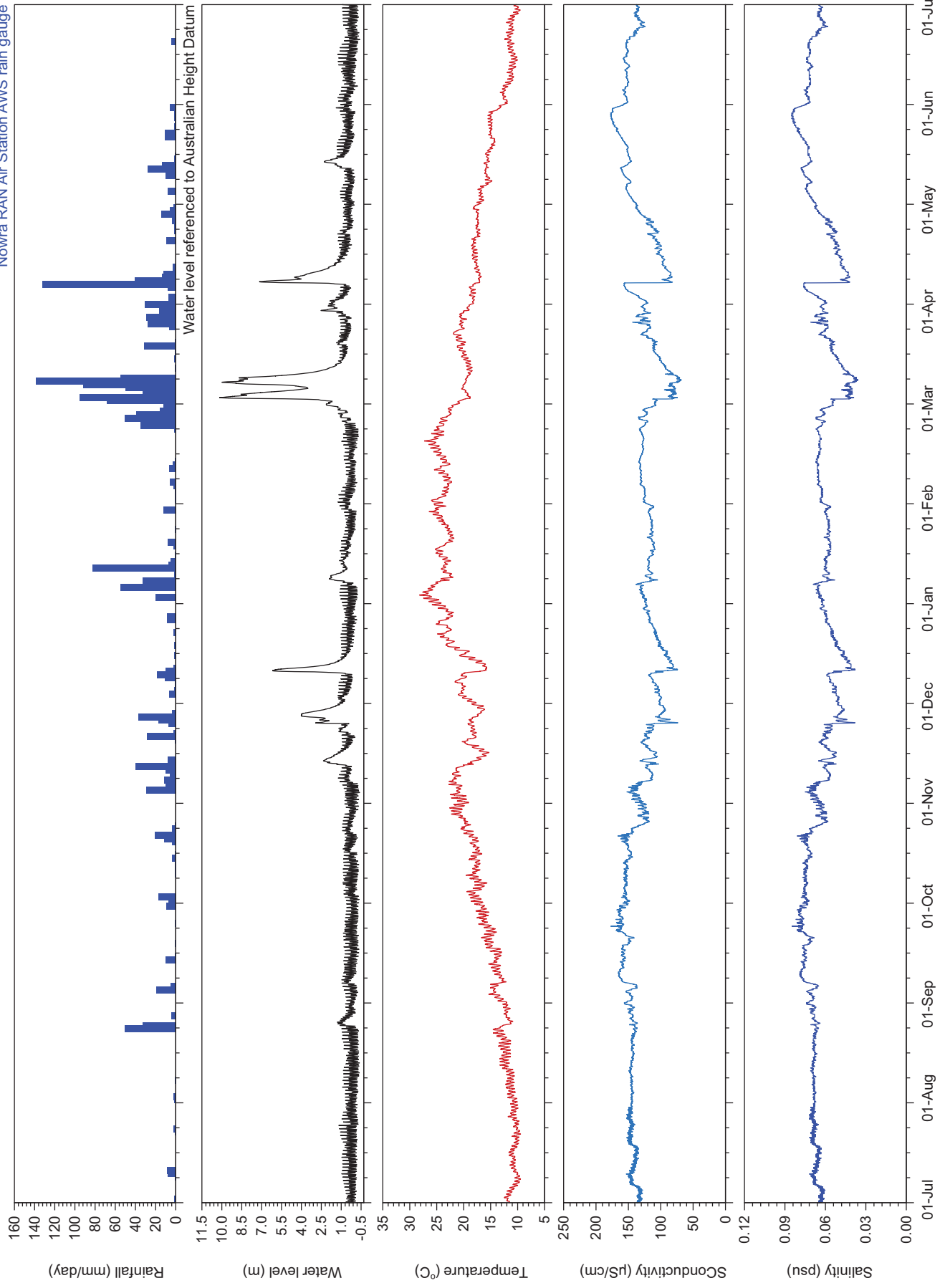
STATION LOCATIONS
SHOALHAVEN RIVER REGION

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
30

DRAWING 2910-30.cdr

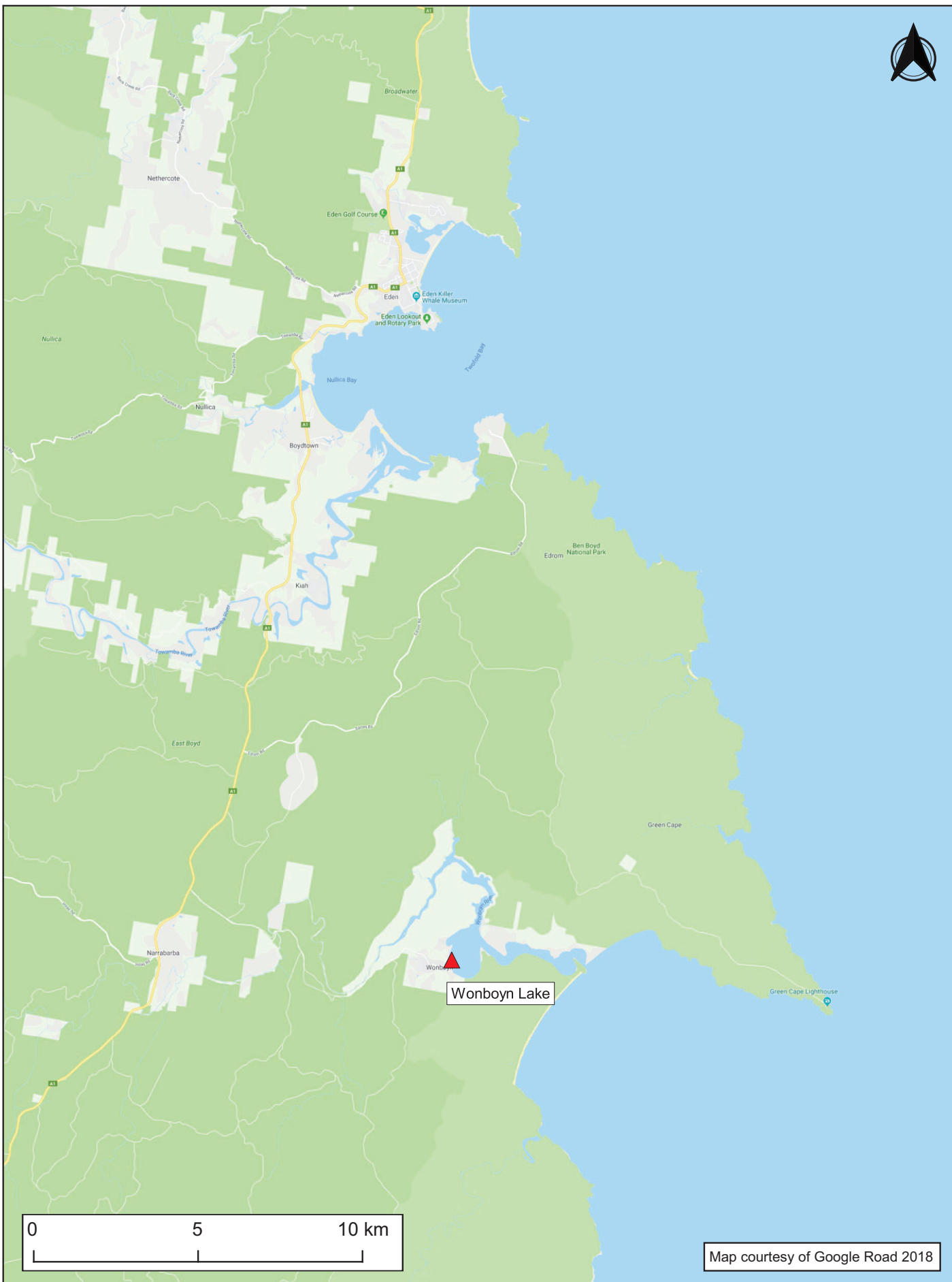


WATER LEVEL AND WATER QUALITY DATA
2021–2022
GRADY'S CARAVAN PARK

Manly
Hydraulics
Laboratory

Report MHL2910

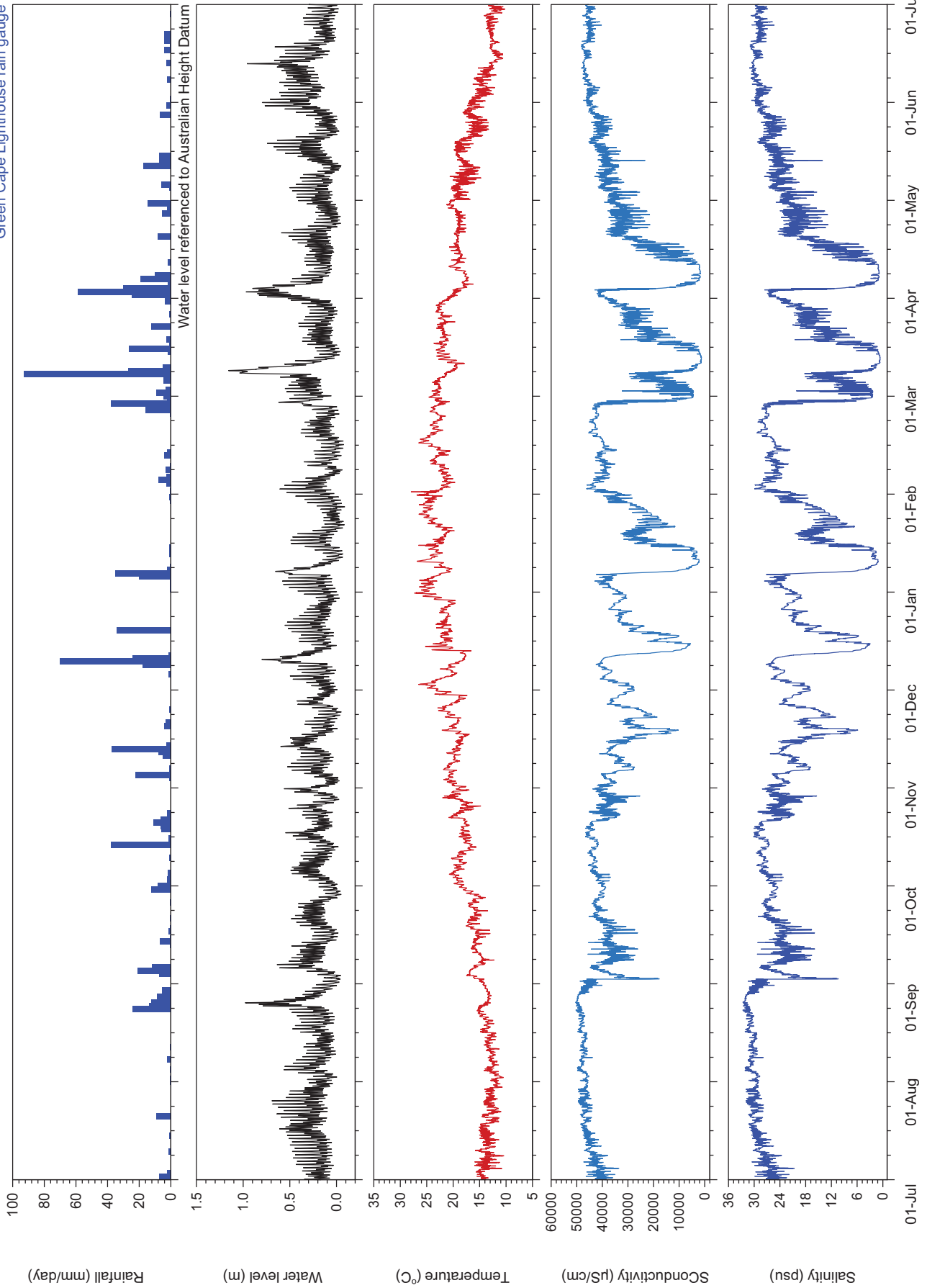
Figure
31



STATION LOCATIONS
WONBOYN LAKE

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Laboratory**
Report MHL2910
Figure
32
DRAWING 2910-32.cdr

Green Cape Lighthouse rain gauge



WATER LEVEL AND WATER QUALITY DATA
2021–2022
WONBOYIN LAKE

Manly
Hydraulics
Laboratory

Report MHL2910

Figure
33

DRAWING 2910-33.cdr

Appendix A Digitised continuous data

Please note that water quality data might not be continuous between a station's tabled start and end dates.

Table A1 Data on line

Station long name	Station name	Station number	Start date	End date	Water quality data collected	Additional MHL report number reference
Brunswick River at Mullumbimby	Mullumbimby	202402	08-Apr-98	18-Mar-99	COND, DO, pH, SAL, TEMP, TUR	1000
Richmond River at Coraki	Coraki	203403	20-Sep-94	ongoing	COND, DO, pH, SAL, TEMP, TUR	749
Richmond River at Oakland Road	Oakland Road	203470	06-Mar-12	ongoing	COND, SAL, TEMP	
Tuombil Canal at Tuombil Highway Bridge	Tuombil Highway Bridge	203411	21-Aug-97	29-Aug-98	COND, DO, pH, SAL, TEMP	961
Rocky Mouth Creek at Rocky Mouth Creek	Rocky Mouth Creek	203432	06-Sep-94	21-Aug-96	COND, DO, pH, SAL, TEMP, TUR	794
Tuombil Canal at Tuombil Floodgate	Tuombil Floodgate	203434	09-Sep-94	29-Sep-95	COND, DO, ORP, pH, SAL, TEMP	961
Richmond River at Bungawalbin	Bungawalbin	203450	09-Sep-94	28-Aug-13	COND, DO, ORP, pH, SAL, TEMP	
Lennox Head at Lake Ainsworth	Lake Ainsworth	203455	15-Nov-95	ongoing	COND, DO, pH, SAL, TEMP	851
Clarence River at Grafton	Grafton	204400	02-Mar-99	ongoing	COND, DO, pH, SAL, TEMP, TUR	1065
Clarence River at Rogans Bridge	Rogans Bridge	204413	09-Mar-99	ongoing	COND, DO, pH, SAL, TEMP, TUR	1065
Clarence River at Mylneford	Mylneford	204460	21-May-10	29-Jan-13	COND, SAL, TEMP	
Nambucca River at Macksville	Macksville	205416	17-Feb-99	22-Feb-00	COND, DO, pH, SAL, TEMP, TUR	1050
Coffs Creek at Coffs Creek Highway Bridge	Coffs Creek Highway Bridge	205439	14-Dec-92	23-Nov-96	TEMP	
Bonville Creek at Bonville	Bonville	205480	08-Aug-97	15-Feb-99	COND, DO, pH, SAL, TEMP, TUR	985
Borirgala Creek at Borirgala Creek	Borirgala Creek	206450	06-Apr-01	26-Sep-01	COND, DO, pH, SAL, TEMP, TUR	1151
Macleay River at South West Rocks	South West Rocks	206456	01-Mar-96	01-Mar-99	pH	986
Macleay River at Euroka Upstream	Euroka Upstream	206458	07-Dec-09	17-Jun-11	COND, SAL, TEMP	
Macleay River at Kempsey	Kempsey	206402	09-Feb-10	ongoing	COND, SAL, TEMP	

Station long name	Station name	Station number	Start date	End date	Water quality data collected	Additional MHL report number reference
Maria River at Green Valley	Green Valley	207406	30-Sep-94	01-Nov-95	COND, DO, ORP, pH, SAL, TEMP	760
Lake Cathie at Lake Cathie	Lake Cathie	207441	18-Aug-93	ongoing	COND, DO, ORP, pH, SAL, TEMP	
Manning River at Wingham	Wingham	208400	08-Dec-09	ongoing	COND, SAL, TEMP	
Manning River at Taree	Taree	208410	16-Feb-10	30-Oct-13	COND, SAL, TEMP	
Manning River at Taree West	Taree West	208420	30-Apr-10	ongoing	COND, SAL, TEMP	
Myall River at Bombah Point	Bombah Point	209475	09-Jul-96	ongoing	COND, SAL, TEMP	906
Myall River at Tea Gardens	Tea Gardens	209480	20-Oct-09	ongoing	COND, SAL, TEMP	
Paterson River at Dunmore	Dunmore	210409	15-Oct-09	ongoing	COND, SAL, TEMP	
Paterson River at Hinton Bridge	Hinton Bridge	210410	03-Dec-93	ongoing	COND, SAL, TEMP	750
Wallis Creek at Wallis Creek Upstream	Wallis Creek Upstream	210428	21-Sep-95	01-Oct-98	COND, DO, pH, SAL, TEMP	965
Hunter River at Green Rocks	Green Rocks	210432	03-Dec-93	ongoing	COND, SAL, TEMP	750
Hunter River at Hexham Bridge	Hexham Bridge	210448	17-Dec-93	ongoing	COND, SAL, TEMP	750
Hunter River at Fullerton Cove Salinity Buoy	Fullerton Cove Salinity Buoy	210149	21-Jun-13	01-Jul-16	COND, SAL, TEMP	
Williams River at Raymond Terrace	Raymond Terrace	210452	15-Oct-09	ongoing	COND, SAL, TEMP	
Hunter River at McKimms Corner	McKimms Corner	210455	08-Oct-09	ongoing	COND, SAL, TEMP	
Hunter River at Belmore Bridge	Belmore Bridge	210458	01-Dec-93	02-Jun-95	COND, TEMP	750
Nepean River at Castlereagh	Castlereagh	212404	21-Feb-95	01-Jul-98	COND, DO, pH, SAL, TEMP, TUR	
Hawkesbury River at Sackville	Sackville	212406	01-Jul-94	ongoing	COND, DO, pH, SAL, TEMP, TUR	
Hawkesbury River at Colo Junction	Colo Junction	212407	07-Nov-09	05-Jul-13	COND, SAL, TEMP	
Hawkesbury River at Ebenezer	Ebenezer	212427	01-Jul-94	01-Jul-98	COND, DO, pH, SAL, TEMP, TUR	

Station long name	Station name	Station number	Start date	End date	Water quality data collected	Additional MHL report number reference
Hawkesbury at Wisemans Ferry Wharf	Wisemans Ferry Wharf	212460	10-Jun-10	19-Jul-13	COND, SAL, TEMP	
Hawkesbury at Leets Vale	Leets Vale	212461	22-Jun-10	ongoing	COND, SAL, TEMP	
Shoalhaven at Grady's Caravan Park	Grady's Caravan Park	215430	06-Oct-10	ongoing	COND, SAL, TEMP	
Wollumboola Lake at Wollumboola	Wollumboola	215454	01-Feb-99	19-Jun-01	COND, DO, pH, SAL, TEMP, TUR	1145
Crookhaven River at Crookhaven Heads	Crookhaven Heads	215408	06-Mar-95	07-Apr-95	COND, DO, pH, SAL, TEMP	
Currarong Creek at Currarong Creek	Currarong Creek	216405	04-Mar-96	02-Mar-97	COND, DO, pH, SAL, TEMP	858
Swan Lake at Swan Lake	Swan Lake	216425	02-Feb-99	02-Feb-00	COND, DO, pH, SAL, TEMP, TUR	
Clyde River at Nelligen	Nelligen	216453	17-Sep-96	17-Sep-97	COND, DO, pH, SAL, TEMP	889
Tomaga at George Bass Drive	George Bass Drive	216455	28-Aug-96	27-Aug-97	COND, DO, pH, SAL, TEMP	890
Tuross River at Coila Lake	Coila Lake	218405	06-Oct-94	12-Nov-96	COND, DO, pH, SAL, TEMP	848
Wagonga River at Barlows Bay	Barlows Bay	218415	02-Sep-96	27-Aug-97	COND, DO, pH, SAL, TEMP, TUR	888
Wallaga Lake at Regatta Point	Regatta Point	219405	06-Mar-95	07-Apr-95	COND, DO, pH, SAL, TEMP	
Bega River at Bega	Bega	219410	24-Feb-10	21-May-13	COND, SAL, TEMP	
Back Lagoon at Back Lagoon	Back Lagoon	219415	25-Sep-97	24-Sep-98	COND, DO, pH, SAL, TEMP, TUR	963
Lake Curalo at Lake Curalo	Lake Curalo	220420	09-Mar-96	09-Mar-98	COND, DO, pH, SAL, TEMP, TUR	920
Wonboyn River at Agnew Wharf	Agnew Wharf	220425	20-Aug-97	20-Aug-98	COND, DO, pH, SAL, TEMP, TUR	964
Wonboyn Lake at Hemingway Creek	Wonboyn Lake	220452	25-Oct-18	ongoing	COND, SAL, TEMP	
Bartletts Creek at Bartletts Creek	Bartletts Creek	201454	06-Jun-95	19-Mar-96	COND, DO, pH, SAL, TEMP	780
Leddays Creek at Leddays Creek	Leddays Creek	201452	02-Jun-95	31-Jul-96	COND, DO, pH, SAL, TEMP	780
Officer Drain at Officer Drain (near Ritchies Creek)	Officer Drain	201453	02-Jun-95	21-Mar-96	COND, DO, pH, SAL, TEMP	780

Station long name	Station name	Station number	Start date	End date	Water quality data collected	Additional MHL report number reference
McLeods Drain at McLeods Drain (near Stotts Creek)	McLeods Drain	201436	21-Mar-96	31-Jul-96	COND, DO, pH, SAL, TEMP	780
McLeods Drain Offshoot at McLeods Drain Offshoot	McLeods Drain Offshoot	201436U	21-Mar-96	31-Sep-96	COND, DO, pH, SAL, TEMP	780
Cudgen Lake Site A	Cudgen Lake	202479	13-Oct-93	15-Oct-93	COND, SAL, TEMP	674
Cudgen Creek at Cudgen Lake West	Cudgen Lake West	202416W	08-Oct-93	05-Nov-93	COND, DO, ORP, pH, SAL, TEMP	674
Cudgen Creek at Cudgen Creek	Cudgen Creek	202419	15-Dec-92	05-Nov-93	COND, DO, ORP, pH, SAL, TEMP	674
Simpsons Creek at Belongil Creek	Belongil Creek	202423	06-Dec-94	17-Dec-96	COND, DO, ORP, pH, SAL, TEMP, TUR	
Richmond River at Shaws Bay	Shaws Bay	203490	11-Mar-99	12-Apr-00	COND, DO, pH, SAL, TEMP, TUR	755, 849
Marshalls Creek at Capricornia Canal	Capricornia Canal	202420	24-Mar-97	31-Mar-98	COND, DO, pH, SAL, TEMP, TUR	1051
Marshalls Creek at New Brighton	New Brighton	202421	17-Mar-97	01-Apr-98	COND, DO, pH, SAL, TEMP, TUR	1000
Brunswick River at Pacific Highway Bridge	Pacific Highway Bridge	202422	18-Mar-97	18-Mar-99	COND, DO, pH, SAL, TEMP, TUR	1000
Simpsons Creek at Simpsons Creek	Simpsons Creek	202424	03-Apr-98	18-Mar-99	COND, DO, pH, SAL, TEMP, TUR	1000
Tuckean Broadwater at Tuckean	Tuckean	203477	30-Oct-95	29-Oct-96	COND, DO, pH, SAL, TEMP, TUR	850
Richmond River at Empire Vale Creek	Empire Vale Creek	203489	08-May-98	12-Oct-99	COND, DO, pH, SAL, TEMP, TUR	1032
Roberts Creek at Roberts Creek	Roberts Creek	204491	20-May-94	24-May-96	COND, DO, pH, SAL, TEMP, TUR	784
Clarence River at Tarrent Bridge	Tarrent Bridge	204415	04-Mar-99	11-Apr-00	COND, DO, pH, SAL, TEMP, TUR	1065
Andersons Inlet at Middle Island MM1	Middle Island MM1	206471	06-Apr-01	15-Dec-06	COND, DO, pH, SAL, TEMP, TUR	986
Andersons Inlet at Middle Island MM2	Middle Island MM2	206471	19-Mar-96	03-Feb-99	COND, DO, ORP, pH, SAL, TEMP	986
Andersons Inlet at Double Island	Double Island	206473	19-Mar-96	03-Feb-99	COND, DO, ORP, pH, SAL, TEMP	986

Station long name	Station name	Station number	Start date	End date	Water quality data collected	Additional MHL report number reference
Macleay River at Andersons Inlet	Andersons Inlet	206470	06-Apr-01	27-Sep-01	COND, DO, pH, SAL, TEMP, TUR	1151
Maria River at Connection Creek	Connection Creek	207429	22-Sep-94	26-Oct-95	COND, DO, ORP, pH, SAL, TEMP	760
Hastings River at Lake Innes	Lake Innes	207442	19-Aug-93	07-Sep-94	COND, DO, ORP, pH, SAL, TEMP	760
Scotts Creek at Scotts Creek	Scotts Creek	208423	20-Oct-98	22-Oct-99	COND, DO, pH, SAL, TEMP, TUR	1029
Wallis Lake at Peach Tree Point	Peach Tree Point	209448	30-Jul-97	09-Mar-99	COND, DO, pH, SAL, TEMP, TUR	987
Wallis Lake at Wallamba Broadwater	Wallamba Broadwater	209449	30-Jul-97	25-Aug-98	COND, DO, pH, SAL, TEMP, TUR	987
Wallis Lake at Booti Island	Booti Island	209447	31-Jul-97	25-Aug-98	COND, DO, pH, SAL, TEMP, TUR	987
Wallis Lake at Darawakh Swamp	Darawakh Swamp	209405	26-Aug-98	08-Mar-99	COND, DO, pH, SAL, TEMP, TUR	987
Smiths Lake at Pacific Palms	Pacific Palms	209466	04-May-95	16-May-96	COND, DO, ORP, pH, SAL, TEMP	771
Myall Lake at Mayers Point	Mayers Point	209445	10-Jul-96	04-Mar-98	COND, DO, pH, SAL, TEMP	906
Myall River at Monkey Jacket	Monkey Jacket	209446	09-Jul-96	04-Mar-98	COND, DO, pH, SAL, TEMP	906
Lake Wollumboola at Wollumboola	Wollumboola	215454	01-Feb-99	19-Jun-01	COND, DO, pH, SAL, TEMP, TUR	1145
Tuross Lake at Trunketabella Bridge	Trunketabella Bridge	218412	04-May-94	11-Mar-98	COND, DO, ORP, pH, SAL, TEMP	921
Wallaga Lake at Meads Bay	Meads Bay	219407	03-Feb-99	10-Feb-00	COND, DO, pH, SAL, TEMP, TUR	1048
Hexham Swamp at Ironbark Creek Downstream	Ironbark Creek Downstream	210437D	01-May-98	15-Nov-16	COND, DO, pH, SAL, TEMP, TUR	
Hexham Swamp at Ironbark Creek Upstream	Ironbark Creek Upstream	210437U	09-Aug-02	27-Oct-04	COND, DO, pH, SAL, TEMP, TUR	
Hexham Swamp at Morris Jetty	Morris Jetty	210484	07-Aug-02	30-Jun-09	COND, DO, pH, SAL, TEMP, TUR	
Hunter River at Fishery Creek	Fishery Creek	210485	08-Aug-02	07-Mar-03	COND, DO, pH, SAL, TEMP, TUR	
Hunter River at Fishery Creek 2	Fishery Creek 2	210485D	11-Jun-03	29-Aug-03	COND, DO, pH, SAL, TEMP, TUR	

Station long name	Station name	Station number	Start date	End date	Water quality data collected	Additional MHL report number reference
Hexham Swamp at Shortland Wetland Centre	Shortland Wetland Centre	210483	10-Mar-99	04-Jul-00	COND, DO, pH, SAL, TEMP, TUR	1058
Lake Macquarie at Swansea Channel Site 4	Swansea Channel Site 4	211482	15-Apr-96	10-May-96	COND, DO, pH, SAL, TEMP	770
Lake Macquarie at Swansea Channel Site 5	Swansea Channel Site 5	211487	15-Apr-96	10-May-96	COND, DO, pH, SAL, TEMP	770
Berowra Creek at Oaky Point Site 2	Oaky Point Site 2	2124121	26-May-95	29-Nov-95	COND, DO, pH, SAL, TEMP	745
Narrabeen Lagoon at Narrabeen Bridge	Narrabeen Bridge	213422	23-Feb-96	15-Nov-05	COND, DO, pH, SAL, TEMP, TUR	
Shoalhaven River at Wharf Road	Wharf Road	215425	06-Mar-95	07-Apr-95	COND, DO, pH, SAL, TEMP	
Clyde River at Mays Wharf WQ (Site 9)	Mays Wharf WQ (Site 9)	216478	25-Sep-96	08-Oct-96	COND, pH, SAL, TEMP	792
Clyde River at Currowan Site 16A	Currowan Site 16A	216481	24-Sep-96	27-Sep-96	COND, SAL, TEMP	
Clyde River at Currowan Site 16B	Currowan Site 16B	216494	24-Sep-96	27-Sep-96	COND, SAL, TEMP	
Clyde River at Currowan Site 16C	Currowan Site 16C	216495	24-Sep-96	27-Sep-96	COND, SAL, TEMP	
Wonboyn River of Wonboyn Lake	Wonboyn River	220480	21-Aug-97	06-Sep-98	COND, DO, pH, SAL, TEMP, TUR	

Key:

COND = Conductivity
DO = Dissolved Oxygen
ORP = Oxidation-reduction potential
pH = Potential of Hydrogen
SAL = Salinity
TEMP = Temperature
TUR = Turbidity

Appendix B Other publications of interest

Data reports

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), 2474 (15–16), 2573 (16–17), 2617 (17–18), 2692 (18–19), 2769 (19–20), 2855 (20–21), 2906 (21–22).

MHL annual ocean tide levels and coastal air pressure 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), 2475 (15–16), 2574 (16–17), 2618 (17–18), 2693 (18–19), 2770 (19–20), 2856 (20–21), 2907 (21–22).

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), 2476 (15–16), 2575 (16–17), 2619 (17–18), 2694 (18–19), 2771 (19–20), 2857 (20–21), 2908 (21–22).

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), 2477 (15–16), 2576 (16–17), 2620 (17–18), 2695 (18–19), 2772 (19–20), 2858 (20–21), 2909 (21–22).

MHL estuary and river water quality summaries available:

MHL Report Nos. 2161 (11–12), 2222 (12–13), 2295 (13–14), 2387 (14–15), 2478 (15–16), 2577 (16–17), 2621 (17–18), 2696 (18–19), 2773 (19–20), 2859 (20–21), 2910 (21–22).

Salinity profiling

NSW Public Works 2010, *Bellinger and Kalang Rivers Data Collection July 2008–September 2009*, Manly Hydraulics Laboratory, Report No. 1951.

NSW Public Works 2012, *NSW Estuaries Salinity Data Compilation*, Manly Hydraulics Laboratory, Report No. 1812.



110B King Street

Manly Vale NSW 2093