NSW GOVERNMENT

Manly Hydraulics Laboratory

NSW COASTAL RAINFALL ANNUAL SUMMARY
2019–2020

Report MHL2771
November 2020

Prepared for:

NSW Department of Planning, Industry and Environment
Climate Change and Sustainability Division

Cover Photograph: Toukley rainfall station, Macquarie-Tuggerah Lakes region

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Foreword

Manly Hydraulics Laboratory (MHL) is a business unit within the Water Group of the NSW Department of Planning, Industry and Environment. The NSW rainfall database has been developed to support a number of programs associated with coastal, floodplain and estuary management for the Climate Change and Sustainability Division of NSW Department of Planning, Industry and Environment. The monitoring service is available to local government and other organisations, both in Australia and overseas.

This annual summary presents the results of rainfall monitoring obtained by the automatic rainfall recording stations along the coastal estuaries and rivers of New South Wales over the period 1 July 2019 to 30 June 2020, and catalogues data collected in NSW by MHL.

This summary has been prepared to provide ready access to MHL's rainfall database and its data analysis capabilities.

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Executive summary

The NSW coastal rainfall annual summary 2019–2020 presents the results of rainfall monitoring obtained by the automatic rainfall recording stations along the coastal estuaries and rivers of New South Wales over the period 1 July 2019 to 30 June 2020.

During this period, the overall data capture across the network, for data processed to within ±10% of calibration, was 99.2%.

This report contains:

- a brief description of the coastal rainfall monitoring program
- guidelines on how to use this report
- information on how to access the database
- a review of significant program developments and rainfall events in 2019–2020
- a list of all stations for which MHL collected rainfall data in 2019–2020 (**Table 5.1**)
- the annual data summaries for each station
- **Appendix A**, which details the rainfall data available
- **Appendix B**, outlining some of the data analysis suites and presentation formats available
- **Appendix C**, a list of publications which may be of interest.

Contents

TABLES

1. Rainfall monitoring program

This report presents the thirty-fourth year of NSW coastal rainfall data collected by Manly Hydraulics Laboratory (MHL). The network of automatic recorders and the associated analysis routines enable efficient delivery of near real time rainfall data from stations across NSW. Extracts from the historical database of rainfall data can also be made available on request (refer to **Appendix A**).

The present program is based on a network of automatic rainfall recording stations installed at various coastal sites (see Section 5 **Station Location Maps**). The network consists of 73 permanent stations funded by the NSW Department of Planning, Industry and Environment, Climate Change and Sustainability Division (CCSD). The network supplements the coverage provided by the Bureau of Meteorology, other agencies and local government rainfall networks. The system utilises 0.2 mm, 0.5 mm and 1.0 mm tipping buckets and data loggers, as shown in **Figure 1**.

Rainfall data is transferred to MHL's databases, located in the NSW Government Data Centre, using a variety of telemetry techniques including internet protocols (IP), landline telephone, cellular networks and event-reporting radio telemetry system (ERTS). The incoming raw data is then made available in near real time to external users to view online. During 2019–2020, MHL completed the second year of a two-year data transfer/telemetry modernisation effort across the CCSD coastal and flood data network to replace legacy systems. During the year, 100% of the monitoring network was upgraded from the legacy data transfer system to the high frequency cloud-based system, refer to **Figure 2** for a schematic.

Data is stored in a database and subject to a quality assurance process which involves several control steps to maintain data quality as well as assignment of data quality codes. Computer programs are used to further format and analyse data.

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

2. How to use this report

This report aims to streamline access to MHL's services and to the rainfall 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. A list of rainfall station data collected and stored online is included in **Appendix A**.

Once a choice has been made for the period of information required, data and services can be obtained in a variety of formats, according to their intended use. All data presented in this report are in Australian Eastern Standard Time (AEST). Allowance for daylight saving time needs to be made by the user of the data if required.

Appendix B provides examples of data analysis and presentation formats available from MHL. Available rainfall products include:

Tabulated output

- daily totals
- intensity/duration tables
- time of tips of rain gauge or short period fixed time step data.

Graphical plots

- hourly, daily, monthly and yearly hyetographs (a graphical representation of rainfall distribution over a period of time)
- intensity-frequency-duration curves.

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 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**.

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

4. Significant events and developments

Significant events and developments which have influenced rainfall data monitoring during the 2019–2020 reporting period are detailed in **Table 4.1** below. The stations which were upgraded to cloud data transfer/hosting and high frequency transfer system during 2019–2020 are shown in **Table 4.1**. The upgrade enables the station to communicate with a new high availability cloud-based database environment and telemetry system to deliver near real time data and at the same time offers greater reliability, speed and auditability by utilising high availability computing services.

Table 4.1 Rainfall station upgrades 2019–2020

Station name	Date	Issue			Comments
		Data quality/ capture	WHS	Cloud data transfer/ hosting	
Cudgera	Jun-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Main Arm	Jun-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Huonbrook	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Myocum	Jun-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Lake Ainsworth	Mar-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Wooli Sportsground	Jun-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Newports Creek	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Middle Boambee	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
North Bonville	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Kooroowi Sharabel	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Stuarts Island Downstream	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Utungun	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Aldavilla Downstream	May-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Green Valley	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Telegraph Point	May-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.

Station name	Date	Issue			Comments
		Data quality/ capture	WHS	Cloud data transfer/ hosting	
Logans Crossing	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Nabiac	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Tuncurry Downstream	Jul-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Pacific Palms Wharf	Aug-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Tarbuck Bay	Aug-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Bulahdelah	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Gostwyck	Dec-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded logger and solar panel.
Seaham	Dec-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded logger.
Belmore Bridge	Oct-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Hexham Bridge	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Barnsley	Feb-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel. Replaced cabinet.
Martinsville	Jan-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Mandalong	Jan-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Wyee	Jan-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Whitemans Ridge	Feb-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Kulnura	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Toukley	Dec-19	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded solar panel.
Hamlyn Terrace	Feb-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Mardi Dam	Jan-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Sterland	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Kangy Angy	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.

Station name	Date	Issue			Comments
		Data quality/ capture	WHS	Cloud data transfer/ hosting	
Berkeley Vale	Jan-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.
Bateau Bay	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Strickland	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Narara	Jul-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Mount Elliot	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Wyoming	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Kincumber	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Webbs Creek	Oct-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Colo Junction	Oct-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Sackville Downstream	Oct-19	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded solar panel
Curl Curl	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Kelso Creek	Jun-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Rixons Pass	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Russell Vale	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger
Mount Pleasant	Aug-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Mount Kembla	Aug-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Dombarton Loop	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Wongawilli	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Port Kembla	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Darkes Road	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Cleveland Road	Jan-20	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger and solar panel.

Station name	Date	Issue			Comments
		Data quality/ capture	WHS	Cloud data transfer/ hosting	
Huntley Colliery	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Upper Calderwood	Oct-19	✓		✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded solar panel.
Little Lake Entrance	Sep-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Nurrewin	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Clover Hill	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
North Macquarie	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Yellow Rock Road	Jan-20			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer. Upgraded to new logger.
Barlows Bay	Sep-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.
Regatta Point	Sep-19			✓	Station upgraded to cloud data transfer/hosting and high frequency transfer.

In the 2019–2020 fiscal year, the maximum recorded rainfall intensities for 11 durations between 5 minutes and 72 hours occurred at three different stations across the CCSD rainfall network (**Table 4.2**). To determine the significance of a rainfall event, the intensities are compared against the Annual Exceedance Probability (AEP), where the AEP is the probability of an event occurring in any one year at a particular duration. An event with a 1% AEP (or the 100-year rainfall) is an event that has a 1% chance of being equalled or exceeded in any one year.

A summary of rainfall events for each month during 2019–2020 on the NSW east coast is provided in **Table 4.3**. 100 mm of rain falling in a 24-hour period is adopted to define a significant rain event.

The maximum recorded rainfall for durations of 5 minutes to 72 hours at each station for 2019–2020 is presented in **Table 4.4**.

Table 4.2 Maximum recorded intensities for all stations

Duration	Station	Date	Rainfall (mm)	Rainfall (mm/hr)	AEP (%)
5min	Mount George	16/10/2019	19.0	228.0	5
10min	Mount George	16/10/2019	28.0	168.0	5
20min	Kooroowi Sharabel	17/02/2020	39.5	118.5	10
30min	Kooroowi Sharabel	17/02/2020	49.0	98.0	10
60min	Bulahdelah	16/01/2020	75.0	75.0	5
3hrs	Nurrewin	09/02/2020	116.5	38.8	5
6hrs	Nurrewin	09/02/2020	197.0	32.8	5
12hrs	Nurrewin	09/02/2020	330.0	27.5	2
24hrs	Nurrewin	09/02/2020	472.5	19.7	2
48hrs	Nurrewin	10/02/2020	578.5	12.1	5
72hrs	Nurrewin	10/02/2020	706.5	9.8	1

Table 4.3 2019–2020 Summary of rainfall events

Month	Summary of rainfall events
July 2019	No events exceeding 100 mm in 24 hours.
August 2019	Daily rainfall exceeding 100 mm in 24 hours occurred at 13 stations in the Macquarie-Tuggerah Lakes region.
September 2019	No events exceeding 100 mm in 24 hours.
October 2019	No events exceeding 100 mm in 24 hours.
November 2019	No events exceeding 100 mm in 24 hours.
December 2019	No events exceeding 100 mm in 24 hours.
January 2020	Daily rainfall exceeding 100 mm in 24 hours occurred at four stations in the Tweed River region, one station in the Richmond River region, eight stations in the Bellinger River region, one station in the Nambucca River region and one station in the Karuah River region.
February 2020	Daily rainfall exceeding 100 mm in 24 hours occurred at four stations in the Tweed River region, one station in the Richmond River region, eight stations in the Bellinger River region, one station in the Nambucca River region, two stations in the Camden Haven River region, five stations in the Karuah River region, two stations in the Hunter River region, 18 station in the Macquarie-Tuggerah Lakes region, three stations in the Hawkesbury River region, two stations in the Sydney Coastal region, and 15 stations in Wollongong Coastal region.
March 2020	No events exceeding 100 mm in 24 hours.
April 2020	No events exceeding 100 mm in 24 hours.
May 2020	No events exceeding 100 mm in 24 hours.
June 2020	No events exceeding 100 mm in 24 hours.

Table 4.4 2019–2020 Maximum recorded rainfall (mm)

Station	Duration											Total yearly rainfall
	5 min	10 min	20 min	30 min	60 min	3 hrs	6 hrs	12 hrs	24 hrs	48 hrs	72 hrs	
Cudgera	19/01/2020 10.0	19/01/2020 18.5	18/01/2020 34.0	18/01/2020 49.0	18/01/2020 67.0	18/01/2020 102.0	08/02/2020 141.0	09/02/2020 186.0	09/02/2020 253.5	10/02/2020 310.5	09/02/2020 419.0	1741.0
Main Arm	26/09/2019 9.0	26/09/2019 17.0	18/01/2020 23.5	18/01/2020 28.0	18/01/2020 40.5	18/01/2020 72.0	18/01/2020 98.5	18/01/2020 133.0	13/02/2020 212.5	13/02/2020 243.5	13/02/2020 282.0	1515.0
Huonbrook	27/09/2019 8.0	27/09/2019 15.5	27/09/2019 20.0	10/02/2020 23.5	10/02/2020 35.0	18/01/2020 64.5	18/01/2020 97.0	18/01/2020 132.5	13/02/2020 212.5	14/02/2020 251.0	13/02/2020 304.5	1508.5
Myocum	11/02/2020 11.5	11/02/2020 19.0	26/02/2020 28.5	26/02/2020 32.0	24/06/2020 41.0	24/06/2020 76.5	13/02/2020 98.0	06/02/2020 149.0	07/02/2020 226.0	08/02/2020 251.5	09/02/2020 348.0	1578.5
Lake Ainsworth[1]	01/12/2019 7.5	26/02/2020 15.0	26/02/2020 26.5	26/02/2020 31.5	24/02/2020 38.0	24/02/2020 48.5	07/02/2020 68.5	07/02/2020 101.5	07/02/2020 163.0	08/02/2020 224.5	09/02/2020 324.5	1355.5
Wooli Sportsground	13/02/2020 13.0	13/02/2020 23.0	13/02/2020 33.5	13/02/2020 39.5	06/02/2020 51.0	13/02/2020 96.0	13/02/2020 183.0	13/02/2020 224.0	13/02/2020 243.5	13/02/2020 282.5	13/02/2020 304.0	1620.0
Perry Drive	08/02/2020 8.5	11/02/2020 13.0	11/02/2020 21.5	11/02/2020 26.0	11/02/2020 43.0	11/02/2020 56.0	11/02/2020 76.0	06/02/2020 109.0	09/02/2020 158.0	13/02/2020 187.0	09/02/2020 240.0	1531.5
Shephards Lane	11/02/2020 8.5	11/02/2020 16.0	11/02/2020 24.0	11/02/2020 34.5	11/02/2020 58.5	11/02/2020 90.0	11/02/2020 116.5	06/02/2020 135.0	09/02/2020 155.5	13/02/2020 211.5	09/02/2020 283.5	1570.5
Red Hill	03/04/2020 14.0	03/04/2020 23.0	03/04/2020 26.0	11/02/2020 29.5	11/02/2020 54.0	11/02/2020 80.0	11/02/2020 108.5	06/02/2020 135.5	07/02/2020 150.0	13/02/2020 207.0	09/02/2020 279.5	1552.5
Newports Creek[1]	12/12/2019 8.0	03/04/2020 14.0	03/04/2020 23.0	03/04/2020 24.5	11/02/2020 37.0	11/02/2020 68.5	11/02/2020 95.0	06/02/2020 132.0	07/02/2020 156.5	08/02/2020 166.5	09/02/2020 276.0	1340.0
Middle Boambee	26/09/2019 15.0	17/02/2020 20.0	17/02/2020 31.0	17/02/2020 41.0	17/02/2020 54.5	06/02/2020 68.5	06/02/2020 110.0	06/02/2020 164.5	07/02/2020 188.0	07/02/2020 194.5	09/02/2020 308.0	1709.5
North Bonville	11/02/2020 11.5	11/02/2020 19.5	11/02/2020 28.0	11/02/2020 32.0	11/02/2020 42.5	06/02/2020 75.5	06/02/2020 118.0	06/02/2020 179.0	07/02/2020 210.5	07/02/2020 219.5	09/02/2020 315.5	1727.0
Kooroowi Sharabel	26/09/2019 14.0	17/02/2020 23.5	17/02/2020 39.5	17/02/2020 49.0	17/02/2020 62.0	06/02/2020 72.5	06/02/2020 118.0	07/02/2020 179.0	07/02/2020 231.5	08/02/2020 241.5	09/02/2020 317.0	1522.5
Stuarts Island Downstream	17/02/2020 8.5	17/02/2020 16.5	08/02/2020 22.0	08/02/2020 27.5	08/02/2020 32.5	09/02/2020 54.5	09/02/2020 64.5	09/02/2020 82.5	19/01/2020 140.0	10/02/2020 155.5	09/02/2020 178.5	1285.0
Utungun[1]	12/12/2019 6.0	12/12/2019 7.0	10/06/2020 11.0	10/06/2020 13.0	10/06/2020 19.5	10/06/2020 37.0	10/06/2020 54.5	10/06/2020 78.5	11/06/2020 95.5	11/06/2020 101.5	19/01/2020 110.0	460.5
Aldavilla Downstream	07/02/2020 11.0	07/02/2020 16.0	07/02/2020 20.0	16/01/2020 24.0	16/01/2020 30.0	11/02/2020 42.0	11/02/2020 53.0	18/01/2020 53.0	09/02/2020 82.0	09/02/2020 91.0	09/02/2020 139.5	841.0

Station	Duration											Total yearly rainfall
	5 min	10 min	20 min	30 min	60 min	3 hrs	6 hrs	12 hrs	24 hrs	48 hrs	72 hrs	
Green Valley[1]	27/04/2020 7.0	27/04/2020 12.5	11/02/2020 16.5	11/02/2020 20.0	09/02/2020 26.5	06/02/2020 52.0	06/02/2020 64.0	06/02/2020 78.5	07/02/2020 97.0	08/02/2020 104.0	09/02/2020 179.5	1019.0
Telegraph Point	16/01/2020 7.5	16/01/2020 15.0	16/01/2020 24.5	16/01/2020 30.0	16/01/2020 44.5	16/01/2020 57.0	16/01/2020 61.5	09/02/2020 70.0	09/02/2020 97.5	09/02/2020 103.5	09/02/2020 171.5	1015.5
Logans Crossing	17/09/2019 8.5	08/02/2020 13.5	08/02/2020 21.0	27/04/2020 29.5	27/04/2020 37.5	27/04/2020 50.5	09/02/2020 74.5	09/02/2020 130.0	09/02/2020 188.0	09/02/2020 222.0	09/02/2020 297.5	1294.5
Mount George[1]	16/10/2019 19.0	16/10/2019 28.0	16/10/2019 38.5	16/10/2019 41.5	16/10/2019 42.5	08/02/2020 64.5	09/02/2020 104.0	09/02/2020 146.5	09/02/2020 181.0	09/02/2020 213.0	09/02/2020 250.0	1054.5
Nabiac	23/01/2020 11.0	23/01/2020 17.0	23/01/2020 22.5	23/01/2020 25.5	23/01/2020 27.0	09/02/2020 56.0	09/02/2020 82.5	09/02/2020 112.0	09/02/2020 146.0	09/02/2020 185.5	09/02/2020 241.0	945.5
Tuncurry Downstream	30/04/2020 9.0	30/04/2020 12.0	30/04/2020 15.5	28/03/2020 15.5	09/02/2020 21.0	09/02/2020 47.0	09/02/2020 81.5	09/02/2020 106.0	09/02/2020 143.5	09/02/2020 183.0	09/02/2020 242.5	913.0
Pacific Palms Wharf	07/02/2020 8.0	26/05/2020 15.5	07/02/2020 22.5	07/02/2020 29.5	07/02/2020 52.5	07/02/2020 87.5	07/02/2020 105.0	09/02/2020 148.0	08/02/2020 216.5	09/02/2020 366.0	09/02/2020 435.0	1310.0
Tarbuck Bay	09/02/2020 9.0	09/02/2020 18.0	09/02/2020 30.0	09/02/2020 39.0	09/02/2020 61.5	09/02/2020 90.5	09/02/2020 114.0	09/02/2020 163.5	08/02/2020 221.0	08/02/2020 390.5	08/02/2020 513.5	1439.0
Bulahdelah	16/01/2020 10.5	16/01/2020 19.5	16/01/2020 33.5	16/01/2020 45.0	16/01/2020 75.0	16/01/2020 84.0	09/02/2020 89.5	09/02/2020 105.0	09/02/2020 139.5	09/02/2020 206.0	09/02/2020 283.0	972.0
Gostwyck	19/02/2020 7.0	19/02/2020 12.0	19/02/2020 17.0	19/02/2020 18.5	09/02/2020 24.0	09/02/2020 48.0	09/02/2020 62.5	09/02/2020 83.0	09/02/2020 108.0	09/02/2020 113.0	09/02/2020 138.0	682.0
Seaham	19/02/2020 11.5	19/02/2020 19.5	19/02/2020 29.5	19/02/2020 31.5	26/01/2020 34.0	09/02/2020 43.5	09/02/2020 56.0	09/02/2020 84.0	09/02/2020 111.5	10/02/2020 123.0	09/02/2020 151.0	773.5
Belmore Bridge	28/01/2020 5.0	28/01/2020 6.5	19/02/2020 9.5	19/02/2020 10.5	09/02/2020 16.5	09/02/2020 35.5	09/02/2020 45.0	09/02/2020 59.0	09/02/2020 79.5	09/02/2020 90.0	09/02/2020 119.5	598.0
Hexham Bridge	16/01/2020 10.0	16/01/2020 18.5	16/01/2020 25.5	16/01/2020 30.5	16/01/2020 41.5	16/01/2020 42.0	16/01/2020 42.0	09/02/2020 47.0	31/08/2019 56.0	10/02/2020 74.5	09/02/2020 93.5	681.5
Barnsley	26/02/2020 9.5	20/02/2020 16.5	20/02/2020 20.5	08/04/2020 26.5	08/04/2020 26.5	09/02/2020 40.5	09/02/2020 53.0	09/02/2020 74.5	09/02/2020 87.0	31/08/2019 114.5	09/02/2020 148.5	846.5
Martinsville[1]	02/02/2020 7.0	02/02/2020 10.0	26/01/2020 15.0	26/01/2020 18.0	26/01/2020 23.0	09/02/2020 47.0	09/02/2020 76.0	09/02/2020 112.5	09/02/2020 140.0	09/02/2020 193.0	09/02/2020 286.0	933.5
Mandalong	18/02/2020 6.5	17/02/2020 10.5	18/02/2020 15.0	18/02/2020 18.5	18/02/2020 32.5	09/02/2020 54.0	09/02/2020 83.5	09/02/2020 114.0	09/02/2020 135.5	09/02/2020 205.0	09/02/2020 297.5	1119.5
Wyee	18/02/2020 8.5	18/02/2020 12.0	18/02/2020 18.0	17/01/2020 22.5	17/01/2020 32.0	09/02/2020 47.5	09/02/2020 81.0	09/02/2020 111.5	07/02/2020 132.0	09/02/2020 178.0	09/02/2020 291.5	1174.5

Station	Duration											Total yearly rainfall
	5 min	10 min	20 min	30 min	60 min	3 hrs	6 hrs	12 hrs	24 hrs	48 hrs	72 hrs	
Whitemans Ridge	18/02/2020 6.0	18/02/2020 12.0	18/02/2020 20.0	18/02/2020 23.5	17/01/2020 32.0	09/02/2020 65.5	09/02/2020 105.0	09/02/2020 148.5	07/02/2020 189.5	09/02/2020 288.5	09/02/2020 429.0	1208.5
Yarramalong	18/02/2020 6.0	25/03/2020 10.0	09/02/2020 15.0	09/02/2020 19.0	09/02/2020 32.0	09/02/2020 68.5	09/02/2020 106.0	09/02/2020 151.0	09/02/2020 195.5	09/02/2020 304.0	09/02/2020 435.0	1142.5
Kulnura	09/04/2020 6.5	09/04/2020 10.0	09/02/2020 13.0	09/02/2020 16.5	09/02/2020 28.0	09/02/2020 60.5	09/02/2020 93.5	09/02/2020 138.0	09/02/2020 187.5	09/02/2020 281.5	09/02/2020 402.0	1119.5
Toukley[1]	30/08/2019 5.0	30/08/2019 9.0	30/08/2019 12.0	30/08/2019 14.5	30/08/2019 23.5	30/08/2019 34.0	30/08/2019 45.0	31/08/2019 59.5	31/08/2019 79.5	31/08/2019 115.5	31/08/2019 120.0	655.5
Hamlyn Terrace	18/02/2020 6.0	25/06/2020 11.0	18/02/2020 17.0	07/02/2020 23.0	07/02/2020 37.0	07/02/2020 59.0	07/02/2020 92.0	07/02/2020 137.0	07/02/2020 179.0	09/02/2020 229.5	09/02/2020 358.0	1236.5
Mardi Dam[1]	25/09/2019 8.5	25/09/2019 16.0	25/09/2019 20.5	25/09/2019 20.5	07/02/2020 33.5	07/02/2020 60.5	07/02/2020 118.5	07/02/2020 165.0	07/02/2020 205.0	09/02/2020 268.5	09/02/2020 386.5	1179.0
Sterland	25/03/2020 7.5	25/03/2020 9.5	17/01/2020 13.5	17/01/2020 17.0	07/02/2020 28.0	07/02/2020 64.0	07/02/2020 106.5	07/02/2020 152.0	08/02/2020 209.5	09/02/2020 336.5	09/02/2020 461.0	1350.5
Kangy Angy	25/03/2020 8.5	25/03/2020 14.0	25/03/2020 16.0	07/02/2020 17.5	07/02/2020 29.0	07/02/2020 62.0	07/02/2020 112.0	07/02/2020 157.5	08/02/2020 188.5	09/02/2020 275.0	09/02/2020 407.5	1395.5
Berkeley Vale[1]	18/02/2020 7.5	18/02/2020 12.5	08/04/2020 17.5	08/04/2020 22.5	07/02/2020 31.0	07/02/2020 61.5	07/02/2020 101.0	07/02/2020 146.5	08/02/2020 185.5	08/02/2020 275.0	09/02/2020 340.0	1641.0
Bateau Bay	18/02/2020 8.5	18/02/2020 16.0	18/02/2020 18.0	18/02/2020 18.5	07/02/2020 31.0	08/02/2020 54.5	07/02/2020 80.5	07/02/2020 123.0	08/02/2020 165.5	08/02/2020 216.0	09/02/2020 328.5	1446.5
Lisarow	09/02/2020 5.5	09/02/2020 10.0	09/02/2020 18.5	09/02/2020 19.5	07/02/2020 29.0	07/02/2020 71.0	07/02/2020 122.5	07/02/2020 163.0	08/02/2020 205.5	09/02/2020 301.0	09/02/2020 450.0	1413.5
Strickland	30/08/2019 6.5	30/08/2019 9.0	09/02/2020 14.5	30/08/2019 18.5	30/08/2019 27.5	07/02/2020 59.0	07/02/2020 98.5	09/02/2020 148.5	09/02/2020 202.5	09/02/2020 295.5	09/02/2020 445.5	1355.0
Narara	18/02/2020 7.0	18/02/2020 13.5	18/02/2020 14.0	17/01/2020 17.5	17/01/2020 27.5	07/02/2020 64.0	07/02/2020 100.0	07/02/2020 137.5	09/02/2020 181.5	09/02/2020 266.0	09/02/2020 408.0	1395.5
Mount Elliot	07/02/2020 6.0	05/03/2020 9.5	07/02/2020 14.5	07/02/2020 21.5	07/02/2020 40.0	07/02/2020 84.5	07/02/2020 139.5	07/02/2020 189.5	08/02/2020 379.0	08/02/2020 298.5	09/02/2020 444.0	1641.0
Wyoming	08/01/2020 9.0	08/01/2020 15.0	08/01/2020 19.0	08/01/2020 26.5	08/01/2020 38.0	07/02/2020 72.5	07/02/2020 111.5	07/02/2020 147.0	08/02/2020 176.0	09/02/2020 265.0	09/02/2020 400.5	1446.5
Kincumber	04/07/2019 6.0	07/02/2020 10.0	07/02/2020 16.5	07/02/2020 20.0	07/02/2020 28.5	07/02/2020 70.0	07/02/2020 106.5	07/02/2020 137.0	10/02/2020 165.5	09/02/2020 218.0	10/02/2020 347.0	1534.5

Station	Duration											Total yearly rainfall
	5 min	10 min	20 min	30 min	60 min	3 hrs	6 hrs	12 hrs	24 hrs	48 hrs	72 hrs	
Webbs Creek	17/02/2020 11.2	17/02/2020 15.0	17/02/2020 15.4	17/02/2020 15.4	08/02/2020 18.4	09/02/2020 35.0	09/02/2020 62.0	09/02/2020 94.0	09/02/2020 118.0	09/02/2020 167.0	09/02/2020 244.0	855.4
Colo Junction	12/02/2020 7.4	12/02/2020 10.0	12/02/2020 12.2	08/02/2020 16.0	08/02/2020 24.2	09/02/2020 40.0	09/02/2020 59.5	09/02/2020 86.0	09/02/2020 107.5	09/02/2020 162.0	09/02/2020 210.0	808.6
Sackville Downstream	27/02/2020 16.4	27/02/2020 21.4	27/02/2020 21.6	27/02/2020 21.6	27/02/2020 21.6	09/02/2020 40.5	09/02/2020 61.0	09/02/2020 88.5	09/02/2020 105.0	09/02/2020 142.0	09/02/2020 193.0	765.4
Curl Curl	01/10/2019 7.0	01/10/2019 13.0	01/10/2019 20.5	01/10/2019 20.5	17/01/2020 23.0	07/02/2020 50.5	09/02/2020 79.5	09/02/2020 141.5	10/02/2020 183.0	09/02/2020 201.5	09/02/2020 326.0	1162.5
Kelso Creek	02/02/2020 5.0	21/05/2020 9.5	21/05/2020 16.5	21/05/2020 18.0	09/02/2020 23.5	09/02/2020 47.0	09/02/2020 87.0	09/02/2020 153.0	10/02/2020 195.5	10/02/2020 262.5	10/02/2020 324.0	906.8
Rixons Pass	16/01/2020 10.5	16/01/2020 16.5	08/02/2020 26.0	08/02/2020 34.0	08/02/2020 51.0	08/02/2020 82.0	08/02/2020 94.5	09/02/2020 128.5	10/02/2020 170.0	10/02/2020 294.5	10/02/2020 359.5	1226.5
Russell Vale	16/01/2020 10.5	08/02/2020 15.5	08/02/2020 24.0	08/02/2020 30.5	08/02/2020 45.0	08/02/2020 75.0	08/02/2020 85.5	08/02/2020 110.0	10/02/2020 142.5	10/02/2020 251.5	10/02/2020 308.0	1075.5
Mount Pleasant	08/02/2020 7.5	08/02/2020 14.0	08/02/2020 23.5	08/02/2020 32.0	08/02/2020 40.0	08/02/2020 64.5	08/02/2020 83.5	09/02/2020 132.5	10/02/2020 192.0	10/02/2020 301.0	10/02/2020 366.0	1261.0
Mount Kembla	12/02/2020 6.5	27/03/2020 10.5	27/03/2020 14.5	18/02/2020 20.0	09/02/2020 27.5	09/02/2020 43.0	09/02/2020 72.0	09/02/2020 128.5	10/02/2020 196.5	10/02/2020 286.5	10/02/2020 358.0	1048.5
Dombarton Loop	08/02/2020 5.5	18/02/2020 11.0	08/02/2020 20.5	09/02/2020 24.0	09/02/2020 45.5	09/02/2020 87.5	09/02/2020 146.0	09/02/2020 253.5	10/02/2020 363.0	10/02/2020 481.0	10/02/2020 557.5	1340.5
Wongawilli[1]	16/01/2020 6.0	16/01/2020 10.0	16/01/2020 14.0	16/01/2020 17.0	16/01/2020 21.0	16/01/2020 22.0	29/08/2019 25.5	30/08/2019 35.0	17/01/2020 39.0	18/09/2019 48.5	19/09/2019 52.0	424.0
Port Kembla	18/02/2020 7.0	18/02/2020 11.5	18/02/2020 19.0	18/02/2020 24.0	10/02/2020 32.0	10/02/2020 55.5	10/02/2020 58.5	10/02/2020 81.5	10/02/2020 147.0	10/02/2020 189.5	10/02/2020 236.0	869.5
Darkes Road	18/02/2020 7.5	18/02/2020 8.5	09/02/2020 13.5	09/02/2020 18.0	09/02/2020 25.5	09/02/2020 39.5	09/02/2020 65.5	09/02/2020 113.5	10/02/2020 165.0	10/02/2020 232.0	10/02/2020 291.0	846.0
Cleveland Road	20/01/2020 5.0	09/02/2020 9.5	09/02/2020 15.5	09/02/2020 19.5	10/02/2020 30.5	09/02/2020 41.0	09/02/2020 68.5	09/02/2020 119.0	10/02/2020 179.5	10/02/2020 242.0	10/02/2020 305.5	852.0
Huntley Colliery	20/01/2020 12.0	20/01/2020 17.0	20/01/2020 20.0	09/02/2020 23.5	09/02/2020 40.5	09/02/2020 67.0	09/02/2020 115.0	09/02/2020 195.0	10/02/2020 279.5	10/02/2020 368.5	10/02/2020 450.5	1125.0
Upper Calderwood	20/01/2020 8.0	20/01/2020 10.0	10/02/2020 14.5	09/02/2020 20.0	09/02/2020 36.0	09/02/2020 60.5	09/02/2020 96.0	09/02/2020 156.5	10/02/2020 236.0	10/02/2020 298.0	10/02/2020 382.5	918.5

Station	Duration											Total yearly rainfall
	5 min	10 min	20 min	30 min	60 min	3 hrs	6 hrs	12 hrs	24 hrs	48 hrs	72 hrs	
Little Lake Entrance	16/01/2020 5.5	16/01/2020 8.5	16/01/2020 10.5	10/02/2020 13.5	10/02/2020 21.5	10/02/2020 37.5	09/02/2020 40.0	10/02/2020 61.0	10/02/2020 109.5	10/02/2020 128.0	10/02/2020 157.0	673.5
Nurrewin	07/02/2020 6.0	09/02/2020 11.5	09/02/2020 21.5	09/02/2020 31.0	09/02/2020 55.0	09/02/2020 116.5	09/02/2020 197.0	09/02/2020 330.0	10/02/2020 472.5	10/02/2020 578.5	10/02/2020 706.5	1378.0
Clover Hill	07/02/2020 6.5	09/02/2020 11.0	09/02/2020 21.0	09/02/2020 29.0	09/02/2020 50.0	09/02/2020 106.0	09/02/2020 167.5	09/02/2020 283.5	10/02/2020 429.0	10/02/2020 541.5	10/02/2020 673.0	1338.5
North Macquarie	07/02/2020 6.0	09/02/2020 11.5	09/02/2020 21.5	09/02/2020 31.0	09/02/2020 55.0	09/02/2020 116.5	09/02/2020 197.0	09/02/2020 330.0	10/02/2020 472.5	10/02/2020 578.5	10/02/2020 706.5	854.5
Yellow Rock Road	10/02/2020 9.5	10/02/2020 12.5	10/02/2020 19.0	10/02/2020 22.5	10/02/2020 41.0	10/02/2020 61.5	09/02/2020 81.5	09/02/2020 146.0	10/02/2020 241.5	10/02/2020 281.5	10/02/2020 349.0	957.0
Lake Conjola Downstream	16/01/2020 5.0	31/03/2020 9.0	08/02/2020 12.0	08/02/2020 16.0	08/02/2020 17.5	21/05/2020 28.0	21/05/2020 39.0	08/02/2020 45.0	10/02/2020 67.0	10/02/2020 110.0	10/02/2020 142.5	713.5
Barlows Bay	20/01/2020 5.0	20/01/2020 9.0	20/01/2020 13.5	20/01/2020 15.0	20/01/2020 15.5	09/02/2020 25.0	09/02/2020 39.5	10/02/2020 53.5	10/02/2020 79.5	11/02/2020 90.5	11/02/2020 106.5	458.5
Regatta Point	07/02/2020 5.0	07/02/2020 5.5	05/03/2020 7.5	05/03/2020 9.0	05/03/2020 14.0	05/03/2020 22.5	04/03/2020 28.5	10/02/2020 45.0	10/02/2020 66.0	05/03/2020 76.0	10/02/2020 85.5	409.5

[1] Some measure of data loss occurred at these stations. See individual plots for further details.
Note – the date listed refers to the time that the recorded total rainfall ends.

4.1 Southern Oscillation Index

The Southern Oscillation Index (SOI) is a calculation of monthly or seasonal shifts in the air pressure between Darwin and Tahiti (source: Bureau of Meteorology). As well as being linked to the temperature of the Pacific Ocean and the strength of Pacific trade winds, the SOI is also associated with rainfall and can be used to predict whether higher or lower than average rainfall may occur in northern and eastern Australia.

A La Niña episode occurs when there are ongoing positive SOI values, and increases the probability of higher than average rainfall in northern and eastern Australia. Sustained negative SOI values have been coined El Niño events, and are associated with a reduction in rainfall over northern and eastern Australia. Even low to moderate El Niño events can lead to severe droughts in Australia. The SOI for the period July 2000 to June 2020 is graphically represented in **Figure 3**.

4.2 Data provision

Rainfall data is provided to the public on behalf of CCSD via the following methods:

- MHL's public internet home pages, providing near real time access to a limited sample of data/email correspondence and File Transfer Protocol (FTP)
- MHL provides CCSD, NSW State Emergency Service (SES) and Bureau of Meteorology (BoM) officers access to near real time environmental data and our 'quality assured' historical database through the CCSD information portal, which is password protected
- NSW SES officers also receive automated notifications from flood warning systems in NSW
- a web-based data request system is available where electronic requests can be submitted via MHL's homepage at http://www.mhl.nsw.gov.au under the data request menu.

During 2019–2020:

- MHL received in excess of 79,000 visitors per month to its website
- MHL served in excess of 147,000 webpage hits per month to customers and to the public
- approximately 1,760,000 webpage hits were recorded from the public (excluding customers) in 2019–2020.

Data access also continues to assist the Bureau of Meteorology, local government authorities, State Emergency Service, NSW Police, WaterNSW, NSW Surf Life Saving Association, universities, the NSW court system, private consultancies, Transport for NSW and Maritime Services and the Natural Resources Commission.

4.3 Data capture performance

Rainfall data presented by MHL is collected, analysed and subjected to a strict quality assurance process in accordance with MHL's internal standards and work instructions. Field verification of the rainfall gauge is performed by delivering a known volume of water in a controlled flow directly into the catch of the rain gauge using a field calibration device. The total number and rate of tips of the tipping bucket and the data recorded on the logger are then compared with the known volume. The percentage difference between the known volume and the recorded tips is used to assign a quality code to the data. Other observations such as blockages in the rain gauge catch and comparison with nearby rainfall stations are also taken into consideration. Refer to **Table 4.5** below for definitions of the various quality codes.

During 2019–2020, the overall data capture across the network, for data with a quality code of 105 or better, was 99.2%. **Table 5.1** Index of figures provides data capture percentages for each rainfall region. Missing or 208 quality coded data can result in gaps in the data record. This can be caused by a range of reasons, such as equipment damage or failure, power failure, or site specific environmental issues.

Automatic recorded rainfall data is recorded to a resolution equal to the size of the tipping bucket (0.2 mm, 0.5 mm or 1.0 mm). Each record or tip of the bucket is triggered when the tipping bucket is filled, which may occur over a period of time.

Table 4.5 MHL data quality code descriptions

Quality code		Rainfall*
5	Records processed to	±3% of calibration
55	Records processed to	±5% of calibration
100	Data from previous MHL database, processed to	±3% of calibration
105	Records processed to	±10% of calibration
208	Records processed to greater than	<-10% or >10% of calibration
150	Uncoded – data not yet quality controlled	Raw data from the instrument with only preliminary quality checks performed
1, 204, 205, 206, 207, 255	Data loss/data missing	

* A quality code is assigned based on infield status verification checks.

5. Rainfall monitoring summary

This section documents locality maps and quality assured rainfall monitoring summaries for each station. **Table 5.1** and **Table 5.2** provide indexes to the figures presented. The rainfall plots shown in Figure 5 to Figure 92 are presented as daily rainfall totals from midnight to midnight.

Table 5.1 Index of figures

	Figure
Typical pluviometer station	1
Data transfer schematic legacy (upper) and high frequency cloud (lower)	2
Southern Oscillation Index, June 2000–June 2020	3

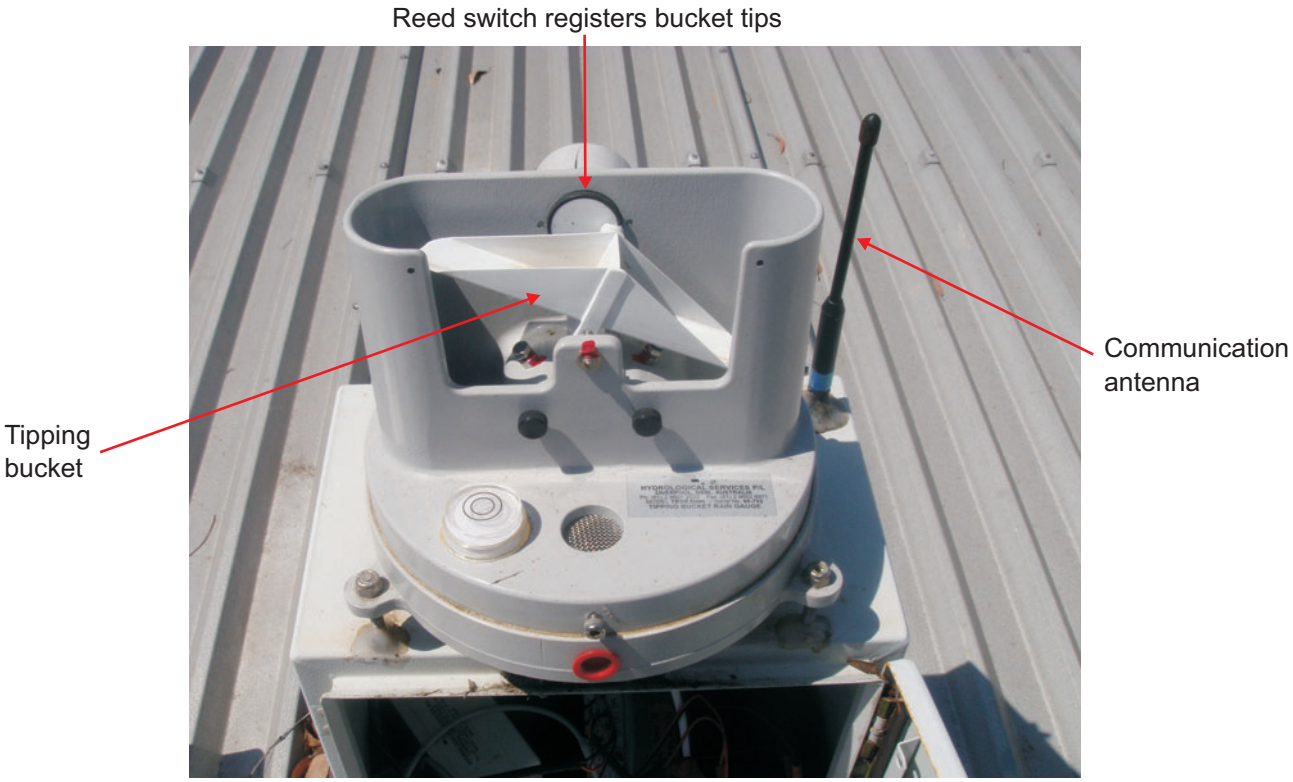
Region	Station short name	Station no.	MGA	Easting	Northing	Capture %	Figure
Station Locality Map	Tweed River and Brunswick River Regions					100.0%	4
Tweed	Cudgera	558046	56	549668	6859164		5
Brunswick	Main Arm	558053	56	542469	6847276		6
Brunswick	Huonbrook	558049	56	537723	6841573		7
Brunswick	Myocum	558036	56	550528	6837390		8
Station Locality Map	Richmond River Region					87.4%	9
Richmond	Lake Ainsworth	203455	56	557863	6816160		10
Station Locality Map	Bellinger River Region (North)					100.0%	11
Bellinger	Wooli Sportsground	559071	56	525712	6696894		12
Station Locality Map	Bellinger River Region (South)					99.5%	13
Bellinger	Perry Drive	559019	56	510142	6650416		14
Bellinger	Shephards Lane	559017	56	508196	6650884		15
Bellinger	Red Hill	559016	56	506635	6649672		16
Bellinger	Newports Creek	559051	56	505893	6646680		17
Bellinger	Middle Boambee	559048	56	504720	6645291		18
Bellinger	North Bonville	559050	56	500593	6641143		19
Bellinger	Kooroowi Sharabel	559008	56	482562	6629162		20
Station Locality Map	Nambucca River Region					90.8%	21
Nambucca	Stuarts Island Downstream	205466	56	499519	6608564		22
Nambucca	Utungun	205414	56	485800	6600344		23
Station Locality Map	Macleay River and Hastings River Regions					98.3%	24
Macleay	Aldavilla Downstream	206459	56	479318	6561231		25
Hastings	Green Valley	207406	56	486416	6540068		26
Hastings	Telegraph Point	207415	56	481082	6534512		27

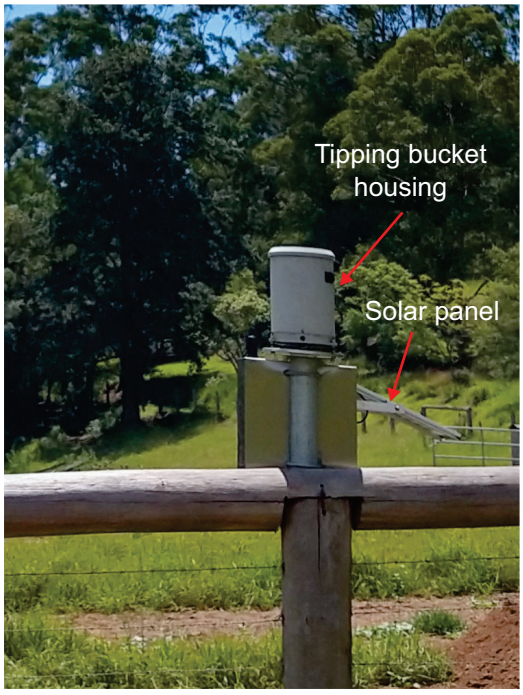
Region	Station short name	Station no.	MGA	Easting	Northing	Capture %	Figure
Station Locality Map	Camden Haven Region					95.9%	**28**
Camden Haven	Logans Crossing	207428	56	470913	6502295		29
Manning	Mount George	208440	56	419229	6472262		30
Station Locality Map	Karuah River Region					100.0%	**31**
Karuah	Nabiac	209404	56	436831	6446432		32
Karuah	Tuncurry Downstream	209401D	56	450368	6441819		33
Karuah	Pacific Palms Wharf	209406	56	455401	6422551		34
Karuah	Tarbuck Bay	209465	56	451548	6417906		35
Karuah	Bulahdelah	209460	56	425442	6413407		36
Station Locality Map	Hunter River Region					100.0%	**37**
Hunter	Gostwyck	210402	56	369088	6396074		38
Hunter	Seaham	210462	56	381105	6385316		39
Hunter	Belmore Bridge	210458	56	364492	6377780		40
Hunter	Hexham Bridge	210448	56	376568	6368156		41
Station Locality Map	Macquarie-Tuggerah Lakes (North) Region					99.6%	**42**
Macquarie-Tuggerah Lakes	Barnsley	561067	56	367906	6355834		43
Macquarie-Tuggerah Lakes	Martinsville	561083	56	351239	6341583		44
Macquarie-Tuggerah Lakes	Mandalong	561081	56	355224	6335165		45
Macquarie-Tuggerah Lakes	Wyee	561097	56	358608	6328268		46
Station Locality Map	Macquarie-Tuggerah Lakes (South), Brisbane Water Regions					99.7%	**47**
Macquarie-Tuggerah Lakes	Whitemans Ridge	561026	56	343653	6324899		48
Macquarie-Tuggerah Lakes	Yarramalong	561137	56	338869	6322377		49
Macquarie-Tuggerah Lakes	Kulnura	561078	56	333796	6321517		50
Macquarie-Tuggerah Lakes	Toukley	211401	56	362599	6318531		51
Macquarie-Tuggerah Lakes	Hamlyn Terrace	561133	56	357399	6319854		52
Macquarie-Tuggerah Lakes	Mardi Dam	561082	56	351038	6314555		53
Macquarie-Tuggerah Lakes	Sterland	567138	56	342433	6315335		54
Macquarie-Tuggerah Lakes	Kangy Angy	561132	56	350168	6310609		55
Macquarie-Tuggerah Lakes	Berkeley Vale	561134	56	353191	6309376		56
Macquarie-Tuggerah Lakes	Bateau Bay	561069	56	358098	6305653		57
Macquarie-Tuggerah Lakes	Lisarow	561079	56	348900	6305317		58
Macquarie-Tuggerah Lakes	Strickland	561136	56	345377	6305541		59
Brisbane Water	Narara	561085	56	344310	6304220		60
Brisbane Water	Mount Elliot	561084	56	350646	6302980		61
Brisbane Water	Wyoming	561098	56	346415	6302026		62
Brisbane Water	Kincumber	561077	56	350387	6294461		63
Station Locality Map	Hawkesbury River Region					100.0%	**64**
Hawkesbury	Webbs Creek	212408	56	312331	6303939		65
Hawkesbury	Colo Junction	212407	56	303223	6298183		66
Hawkesbury	Sackville Downstream	212438	56	302769	6291566		67

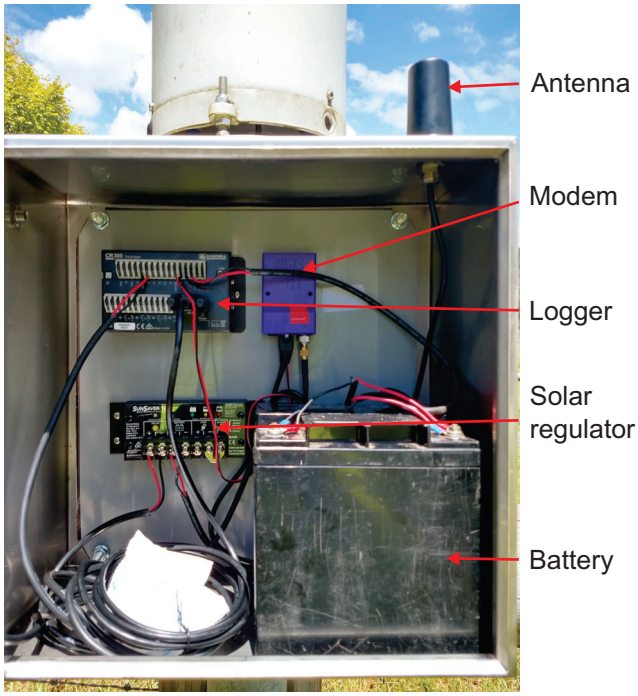
Region	Station short name	Station no.	MGA	Easting	Northing	Capture %	Figure
Station Locality Map	Sydney Coastal Region					100.0%	**68**
Sydney Coastal	Curl Curl	213426	56	342094	6262459		69
Sydney Coastal	Kelso Creek	213430	56	313782	6241020		70
Station Locality Map	Wollongong Coastal Region					99.7%	**71**
Wollongong Coastal	Rixons Pass	568317	56	305281	6196889		72
Wollongong Coastal	Russell Vale	568318	56	306377	6196135		73
Wollongong Coastal	Mount Pleasant	568229	56	303026	6191630		74
Wollongong Coastal	Mount Kembla	568314	56	299550	6186441		75
Wollongong Coastal	Dombarton Loop	568307	56	294719	6185605		76
Wollongong Coastal	Wongawilli	568320	56	293261	6182388		77
Wollongong Coastal	Port Kembla	568316	56	306636	6182719		78
Wollongong Coastal	Darkes Road	568309	56	297450	6182477		79
Wollongong Coastal	Cleveland Road	568308	56	295800	6179726		80
Wollongong Coastal	Huntley Colliery	568311	56	290648	6178905		81
Wollongong Coastal	Upper Calderwood	568319	56	288750	6175160		82
Wollongong Coastal	Little Lake Entrance	214467	56	304250	6173571		83
Wollongong Coastal	Nurrewin	568228	56	284567	6173437		84
Wollongong Coastal	Clover Hill	568310	56	284233	6172392		85
Wollongong Coastal	North Macquarie	568315	56	291440	6171492		86
Wollongong Coastal	Yellow Rock Road	568321	56	292886	6167649		87
Station Locality Map	South Coast (North) Region					100.0%	**88**
South Coast	Lake Conjola Downstream	216420	56	272446	6094316		89
Station Locality Map	South Coast (Mid) Region					100.0%	**90**
South Coast	Barlows Bay	218415	56	239464	5988955		91
South Coast	Regatta Point	219405	56	236881	5971060		92

Table 5.2 Index of Appendix B figures

Sample rainfall data outputs	Figure
Sample daily and monthly rainfall plots	**B1**
Sample Intensity-Frequency-Duration formulated in 1987	**B2**
Sample Intensity-Frequency-Duration formulated in 2019	**B3**
Sample rain gauge tip times	**B4**







NSW GOVERNMENT

TYPICAL PLUVIOMETER STATION

Manly Hydraulics Laboratory

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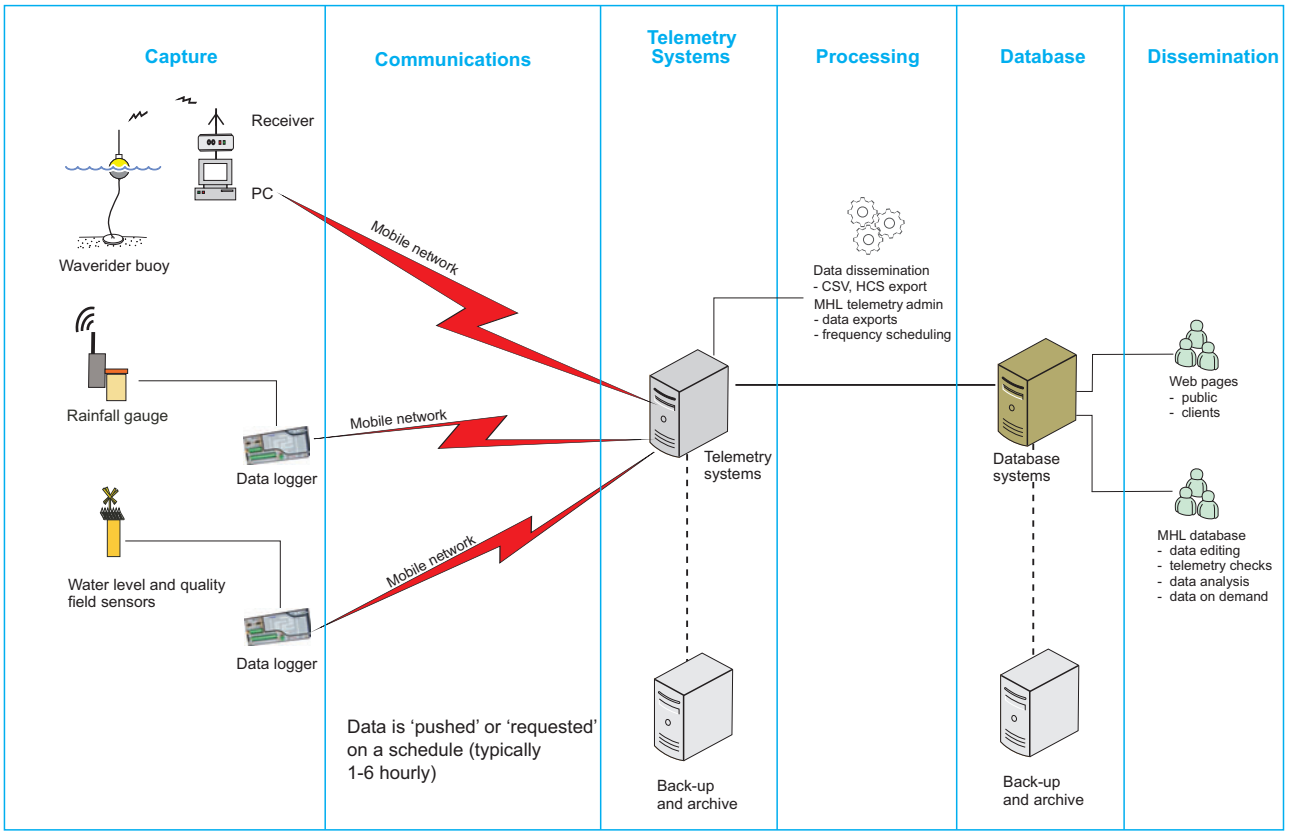
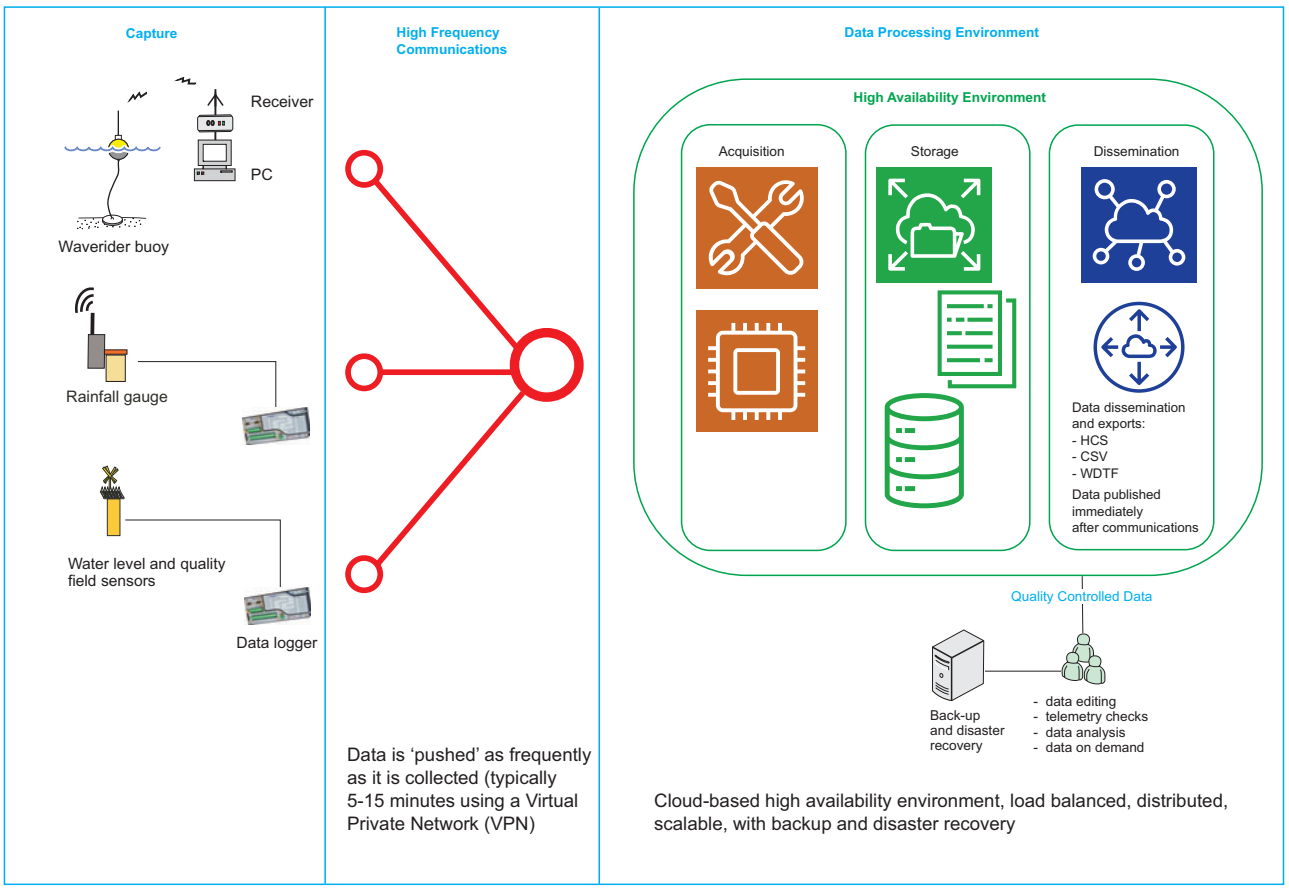
Figure 1

DRAWING 2771-01.cdr





NSW GOVERNMENT

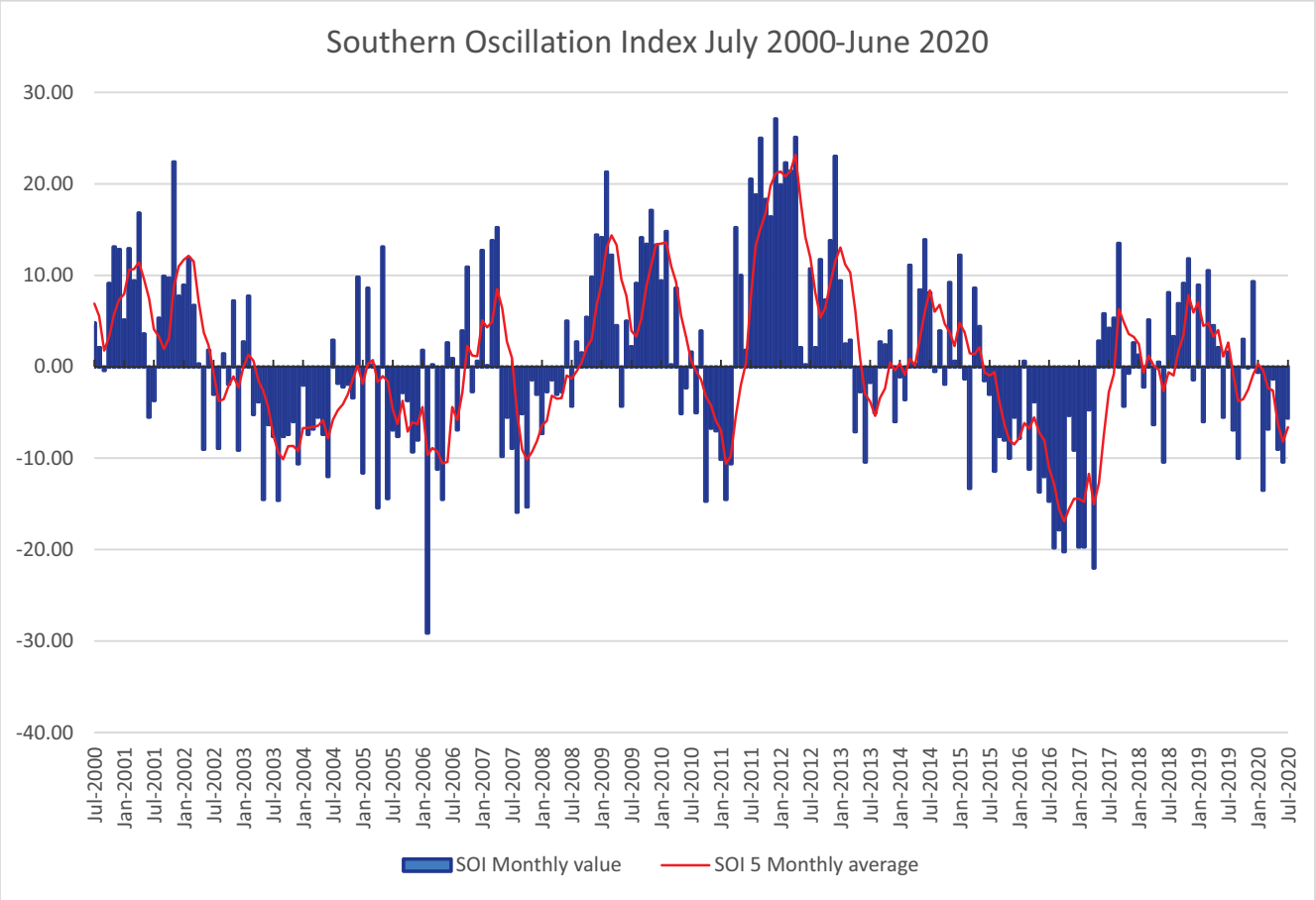
DATA TRANSFER SCHEMATIC
LEGACY (upper) AND HIGH FREQUENCY CLOUD (lower)

Manly Hydraulics Laboratory

Report MHL2771

Figure 2

DRAWING 2771-02.cdr



NSW GOVERNMENT

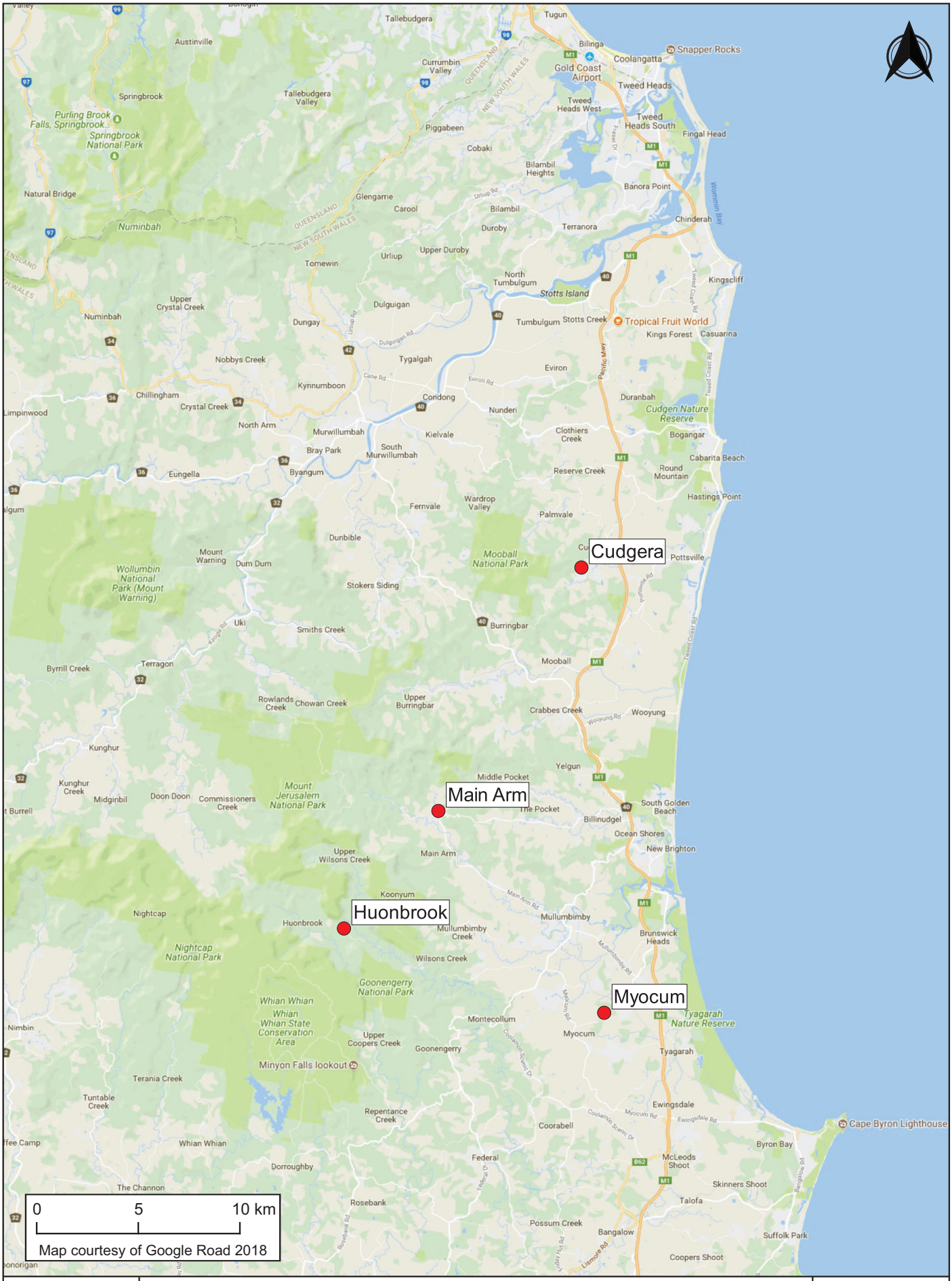
SOUTHERN OSCILLATION INDEX
JULY 2000–JUNE 2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 3

DRAWING 2771-03.cdr



NSW GOVERNMENT

RAINFALL STATION LOCATIONS
TWEED RIVER AND BRUNSWICK RIVER REGIONS

Manly Hydraulics Laboratory

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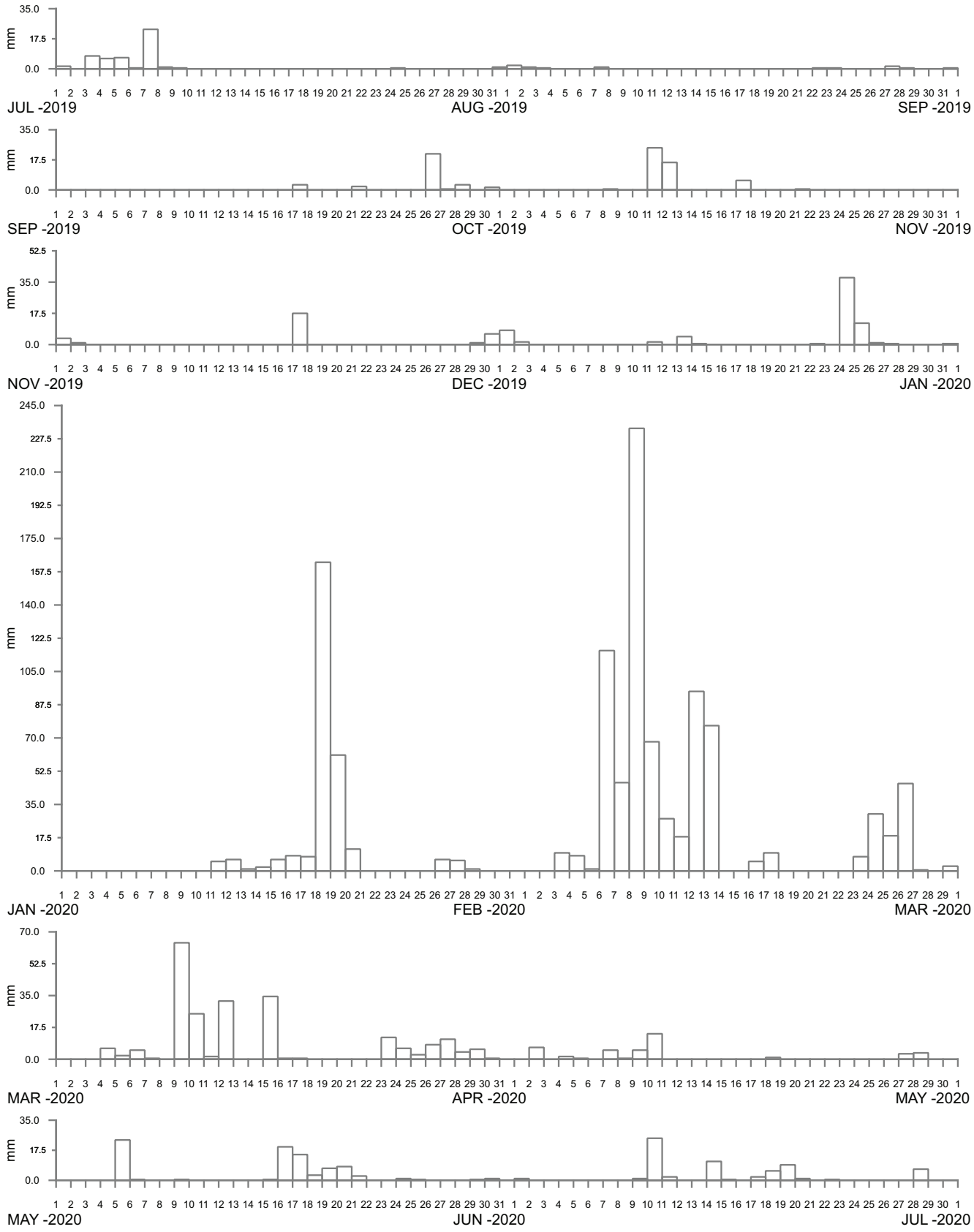
Figure 4

DRAWING 2771-04.cdr



NSW GOVERNMENT

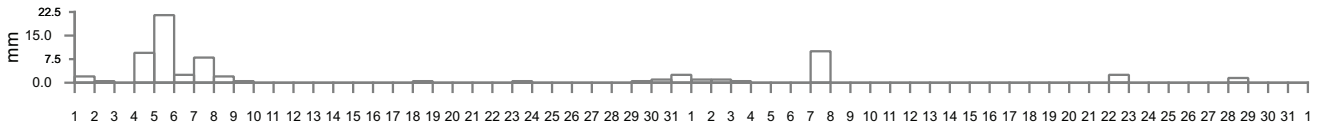
CUDGERA AT CABBAGE GUM ROAD
2019–2020

Manly Hydraulics Laboratory

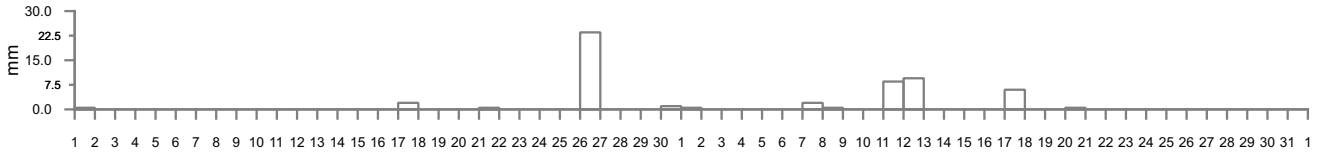
Report MHL2771

Figure 5

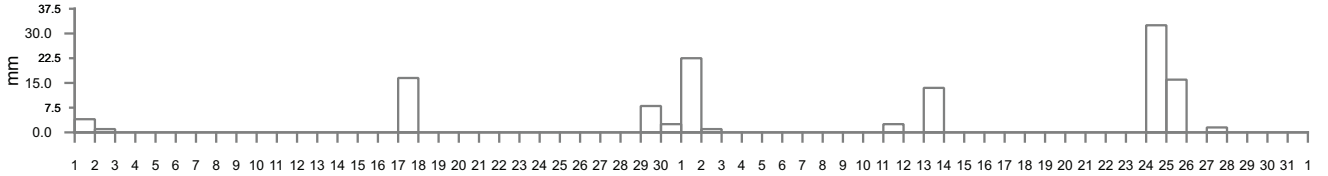
DRAWING 2771-05.cdr



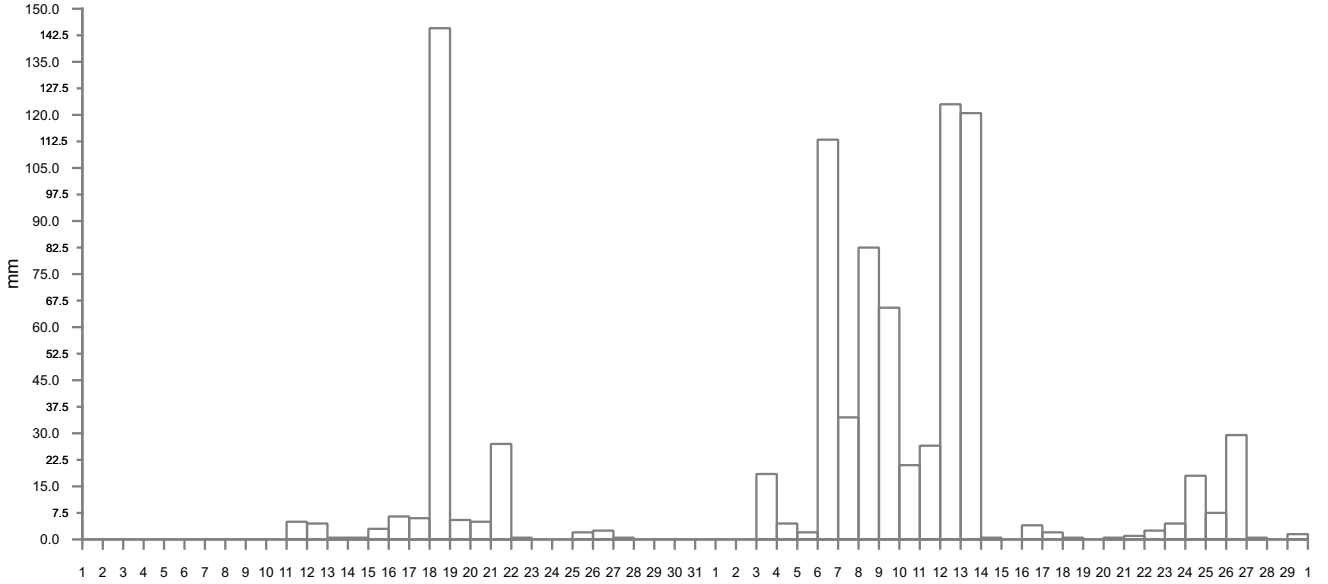
JUL -2019 AUG -2019 SEP -2019



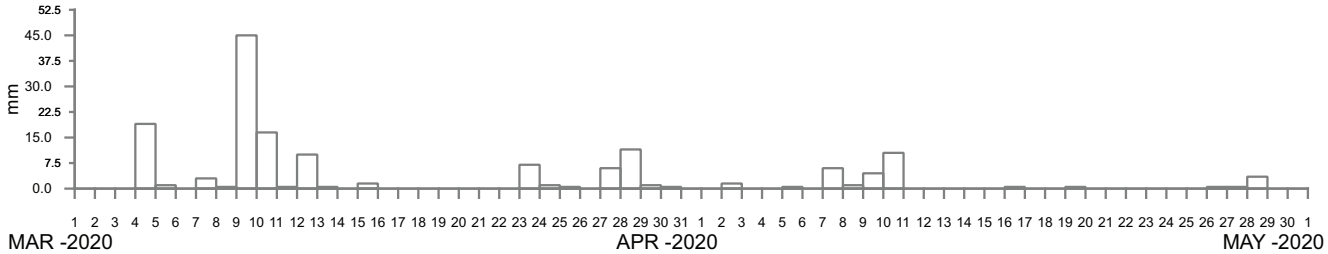
SEP -2019 OCT -2019 NOV -2019



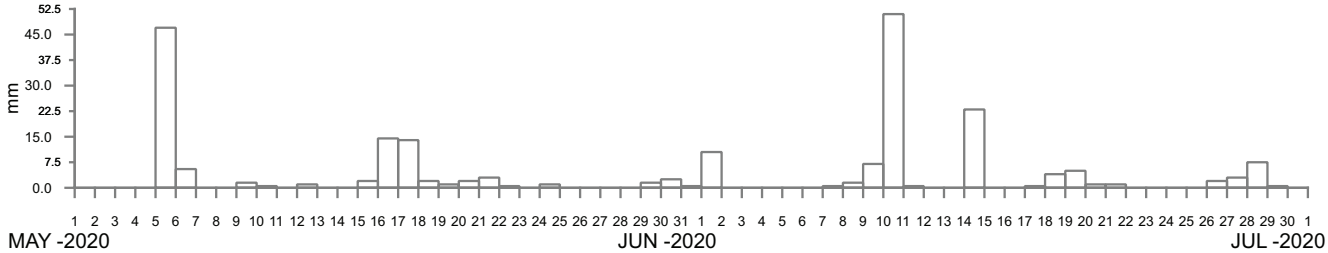
NOV -2019 DEC -2019 JAN -2020



JAN -2020 FEB -2020 MAR -2020



MAR -2020 APR -2020 MAY -2020



MAY -2020 JUN -2020 JUL -2020

---------- DATA LOSS

NSW GOVERNMENT

MAIN ARM AT MAIN ARM ROAD
2019–2020

Manly Hydraulics Laboratory

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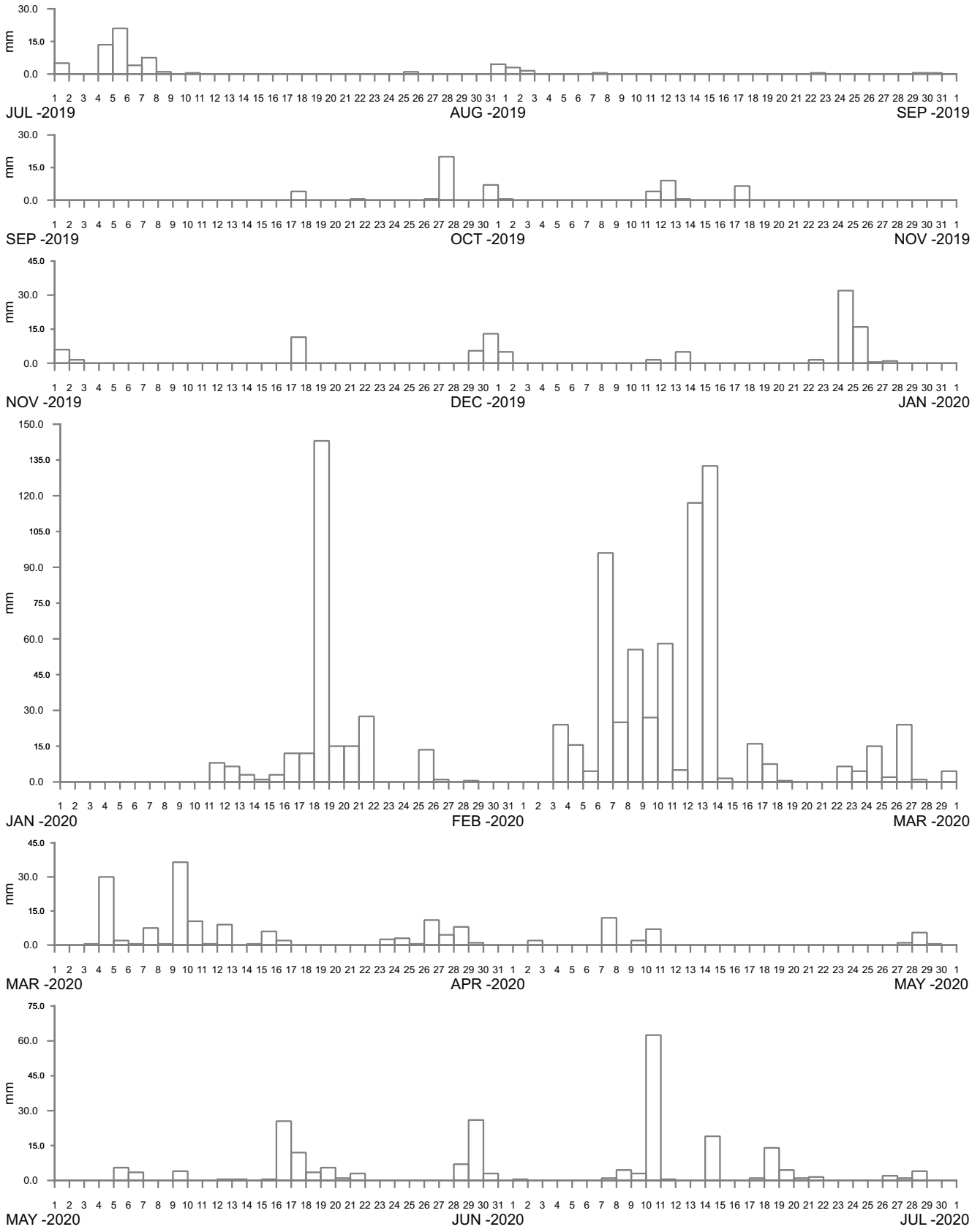
Figure 6

DRAWING 2771-06.cdr



---------- DATA LOSS

NSW GOVERNMENT

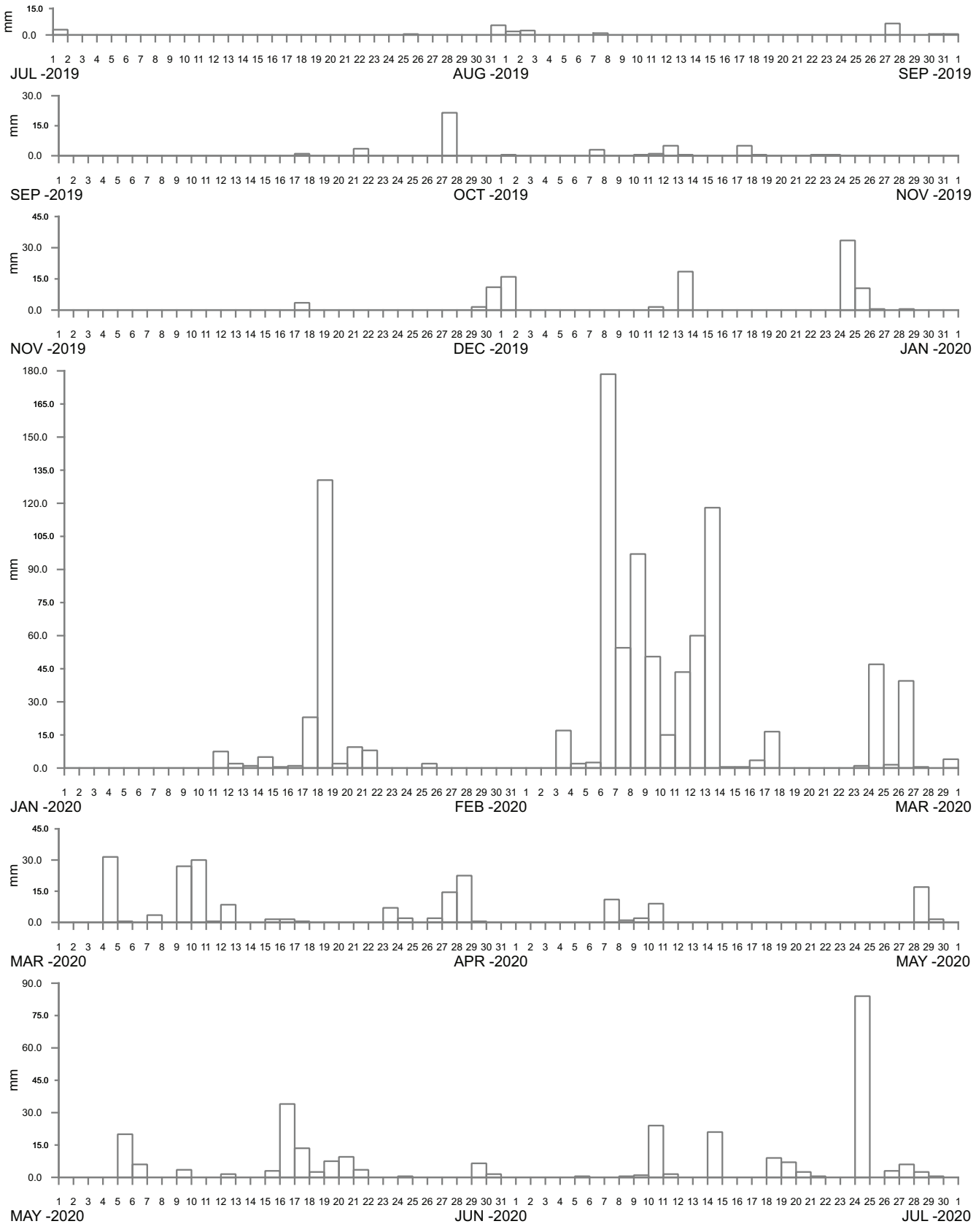
HUONBROOK AT WILSONS CREEK ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 7

DRAWING 2771-07.cdr



NSW GOVERNMENT

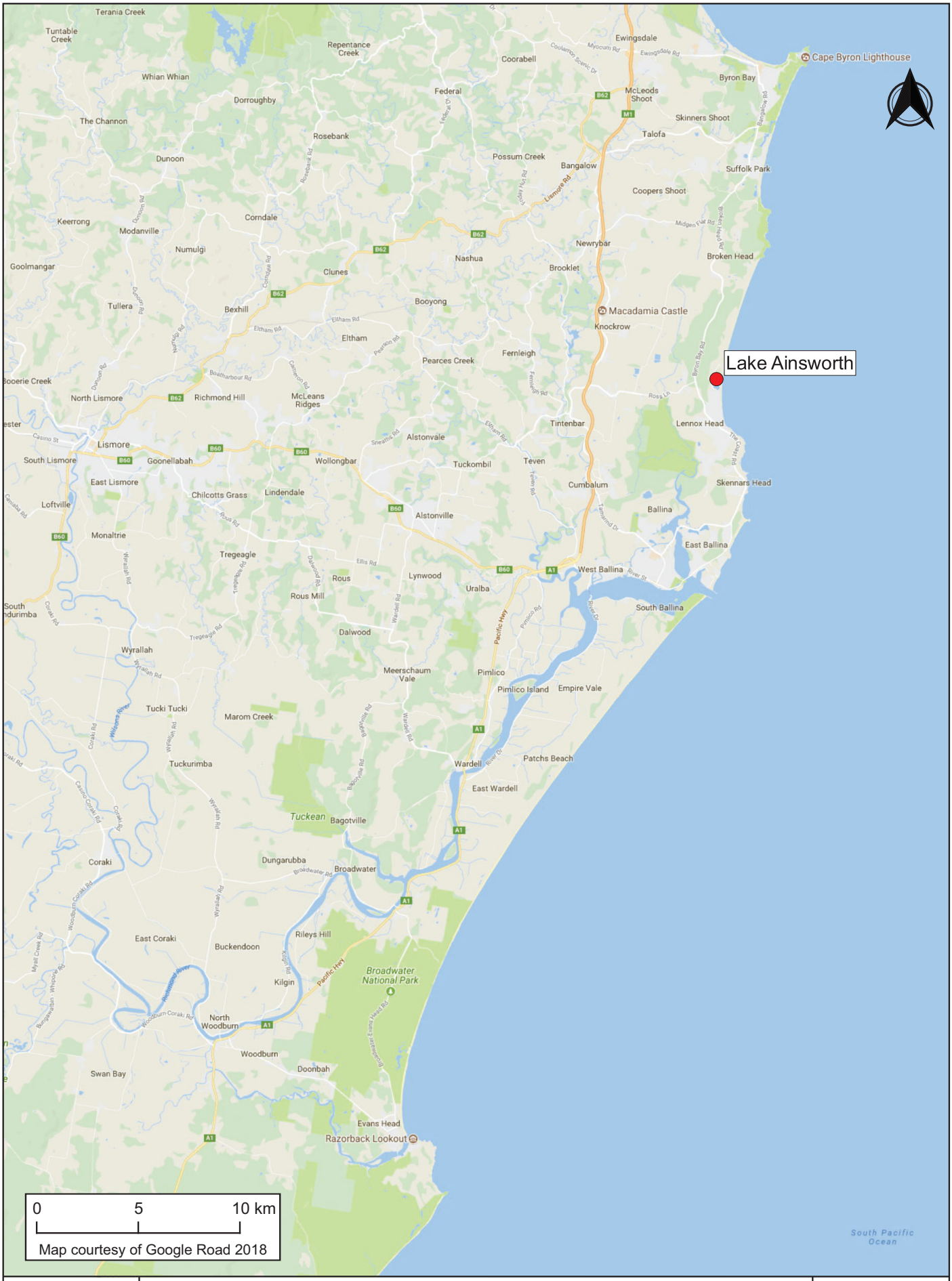
MYOCUM AT KINGSVALE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 8

DRAWING 2771-08.cdr



NSW GOVERNMENT

RAINFALL STATION LOCATIONS
RICHMOND RIVER REGION

Manly Hydraulics Laboratory

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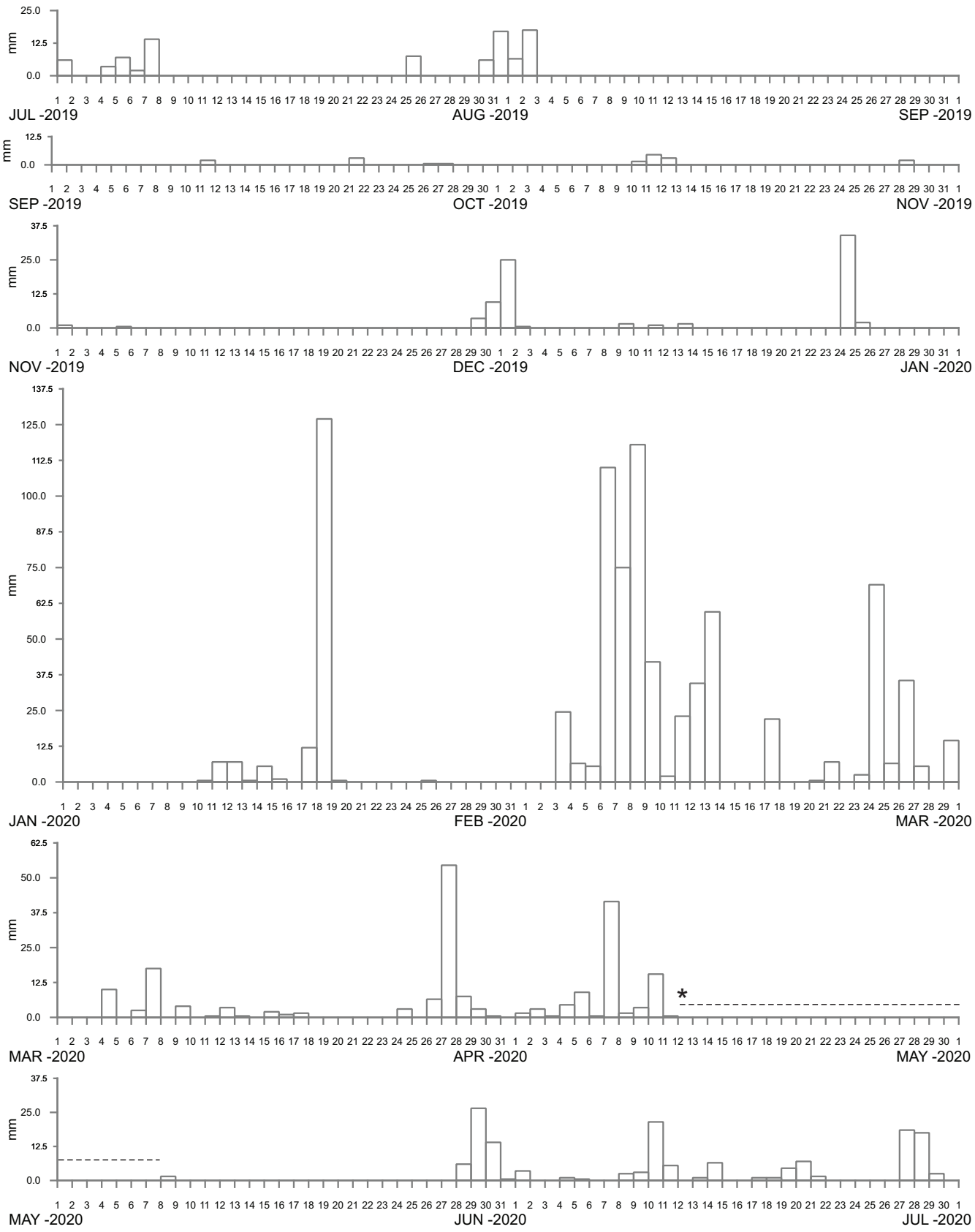
Figure 9

DRAWING 2771-09.cdr



---------- DATA LOSS

*Data loss due to logger error

NSW GOVERNMENT

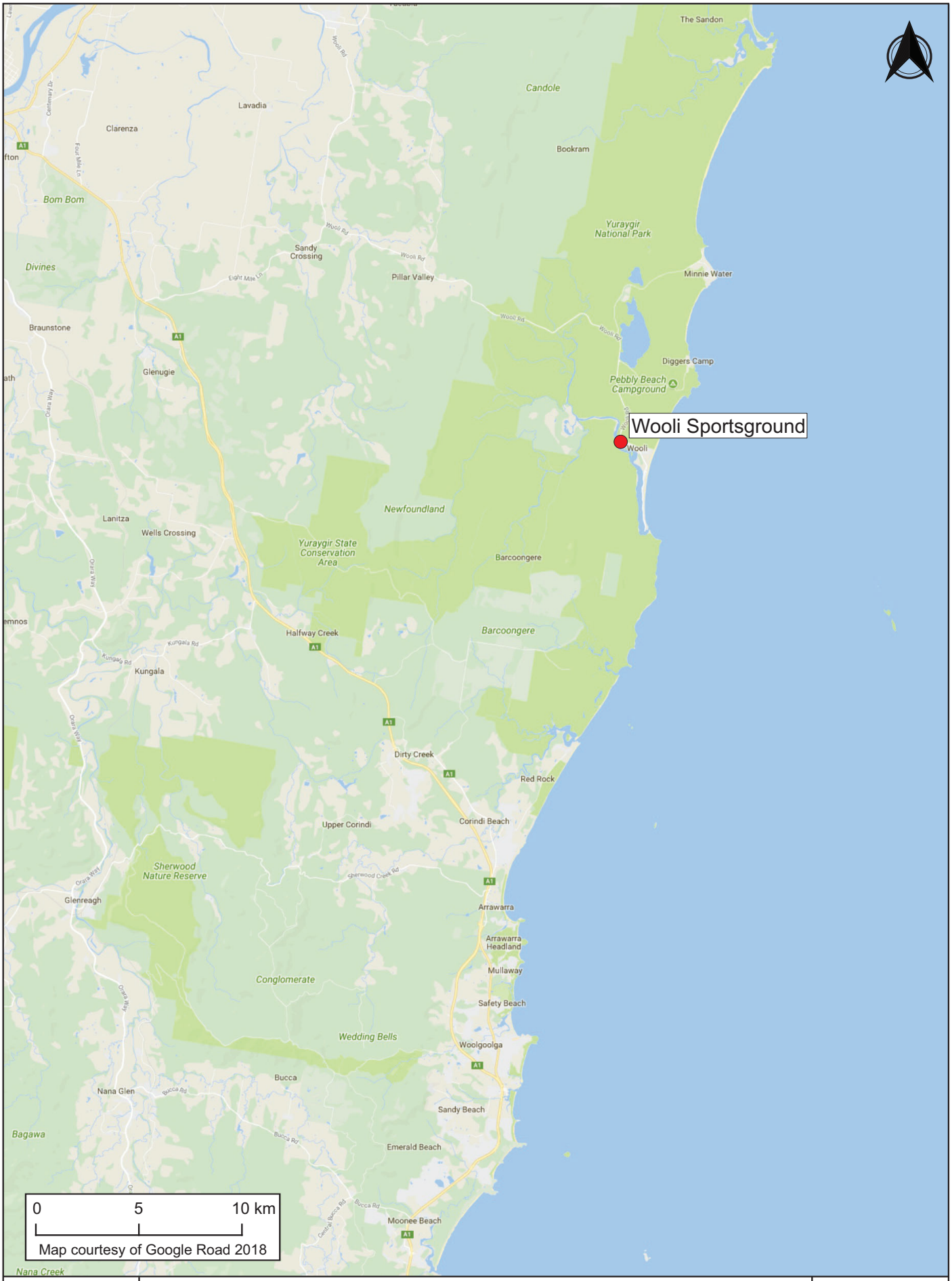
LAKE AINSWORTH AT LENNOX HEAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 10

DRAWING 2771-10.cdr



NSW GOVERNMENT

RAINFALL STATION LOCATIONS
BELLINGER RIVER REGION (NORTH)

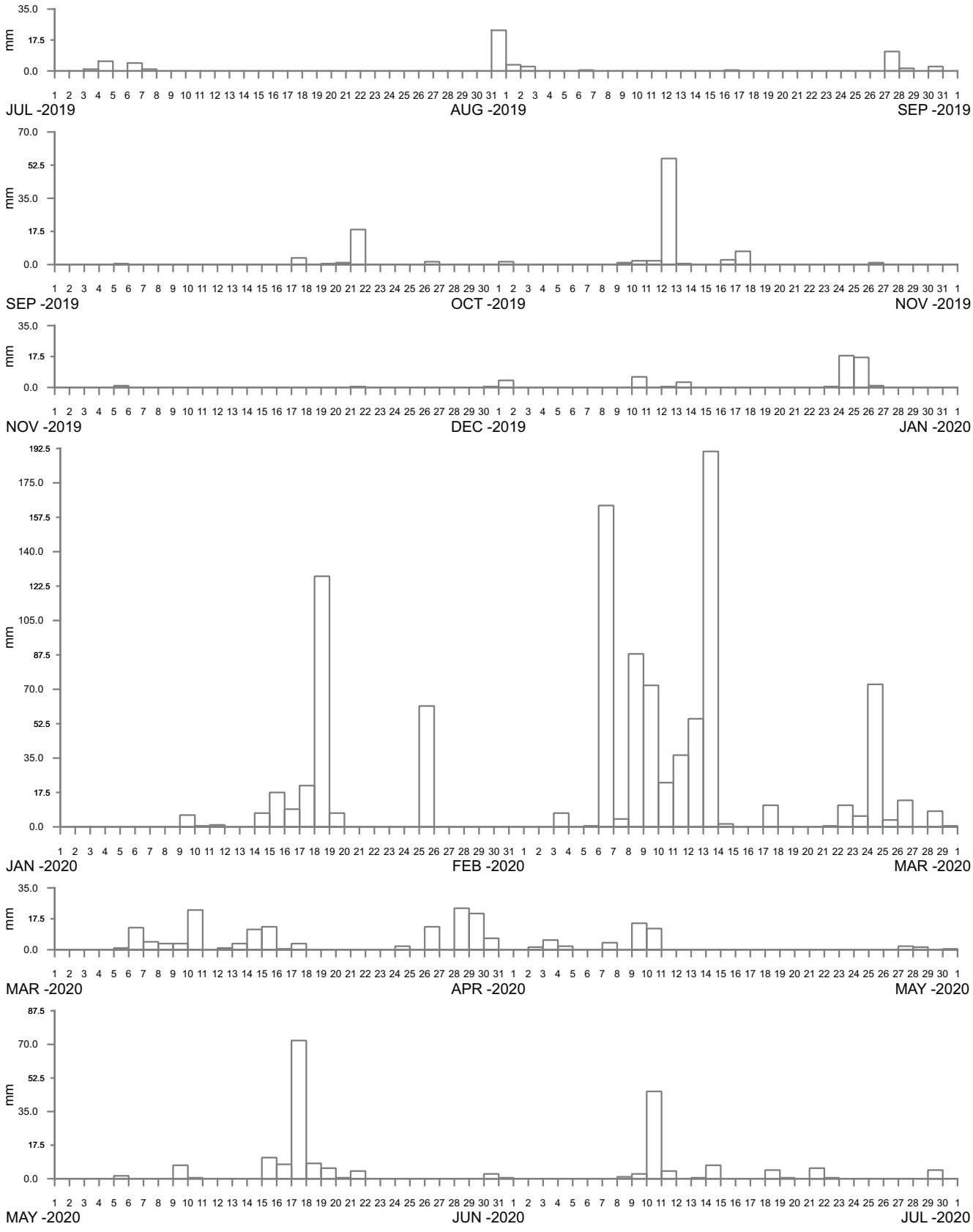
Manly Hydraulics Laboratory

Report MHL2771

Figure

11

DRAWING 2771-11.cdr



NSW GOVERNMENT

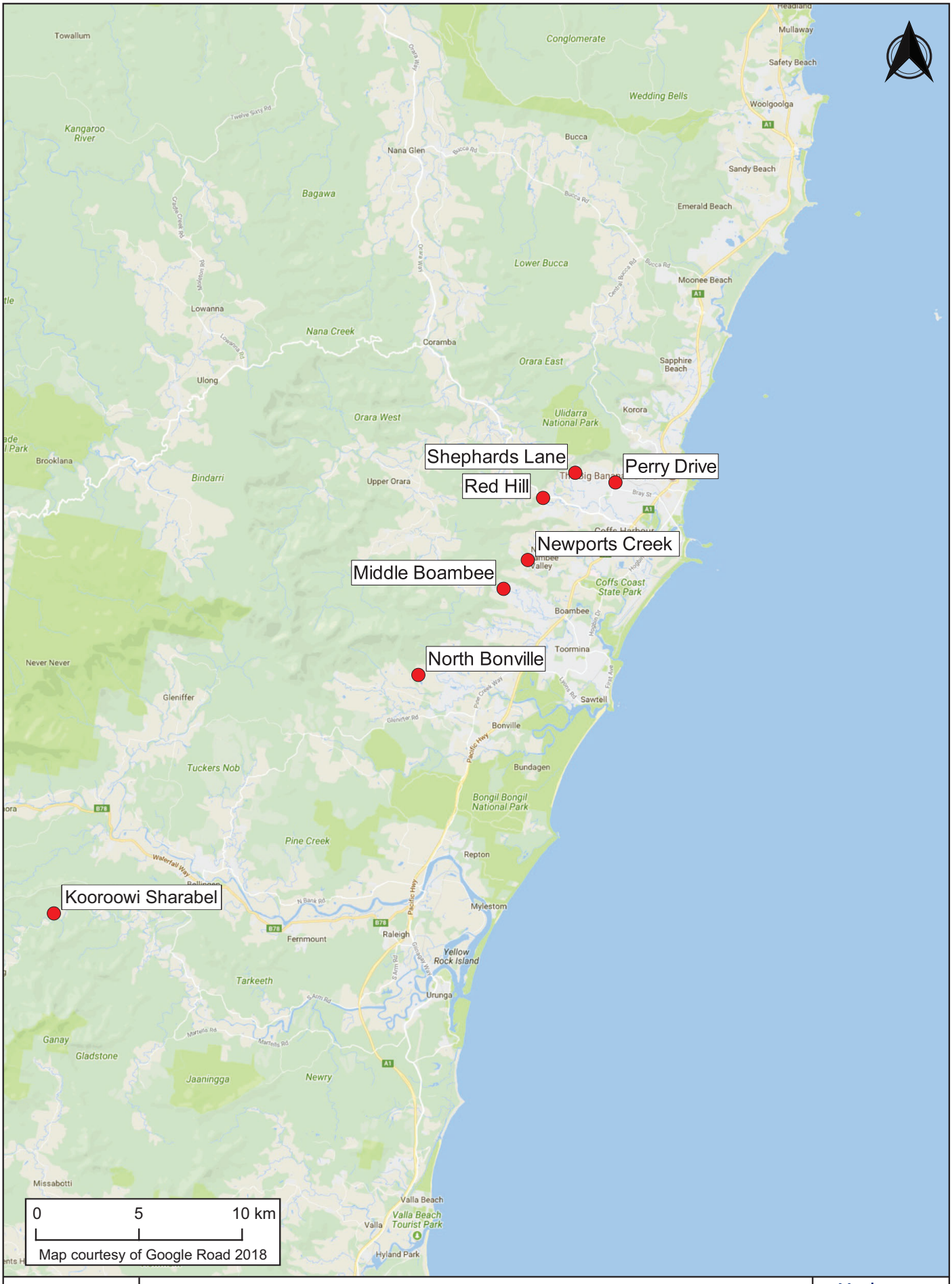
WOOLI SPORTSGROUND AT WOOLI RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 12

DRAWING 2771-12.cdr



NSW GOVERNMENT

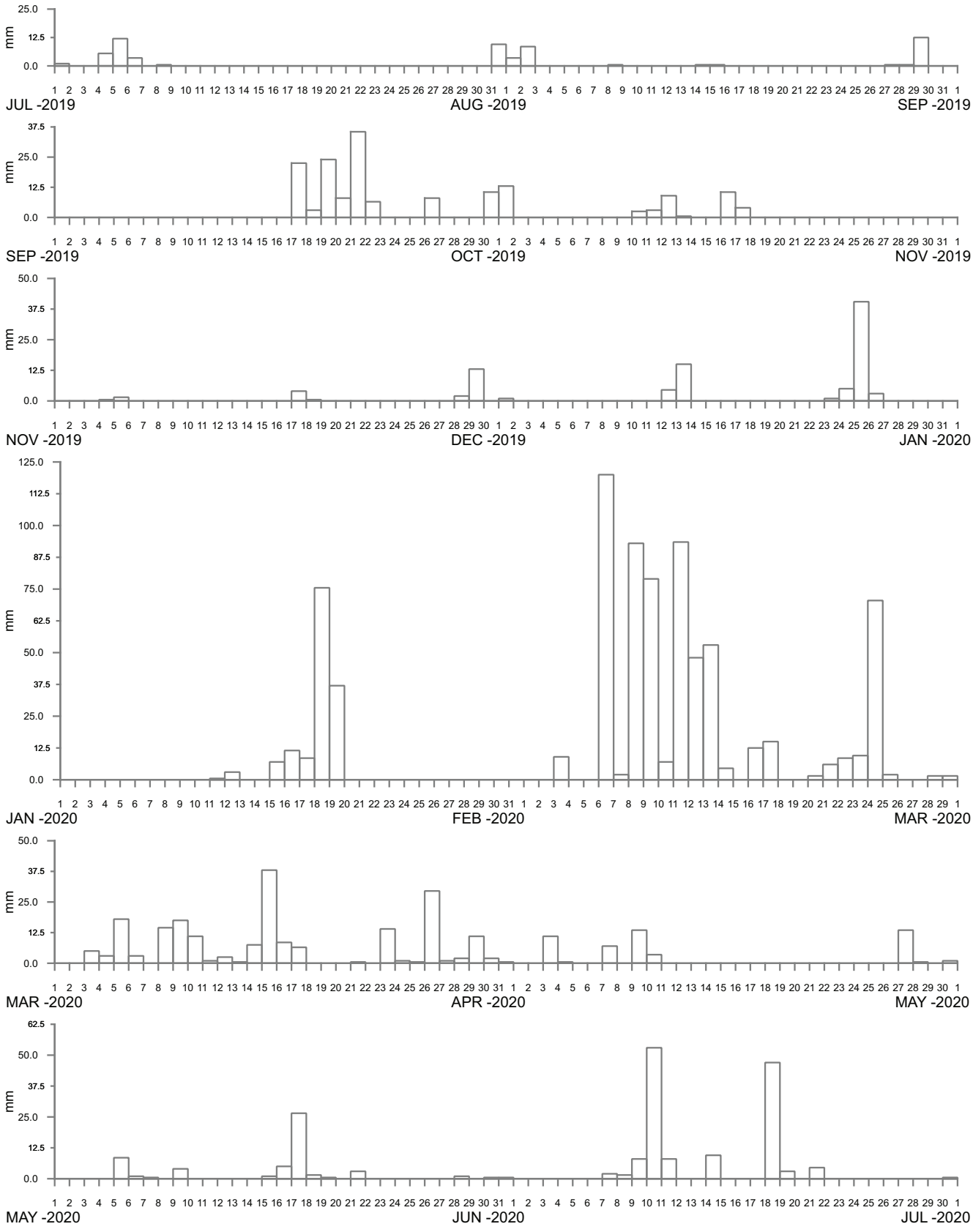
RAINFALL STATION LOCATIONS
BELLINGER RIVER REGION (SOUTH)

Manly Hydraulics Laboratory

Report MHL2771

Figure 13

DRAWING 2771-13.cdr



DATA LOSS

NSW GOVERNMENT

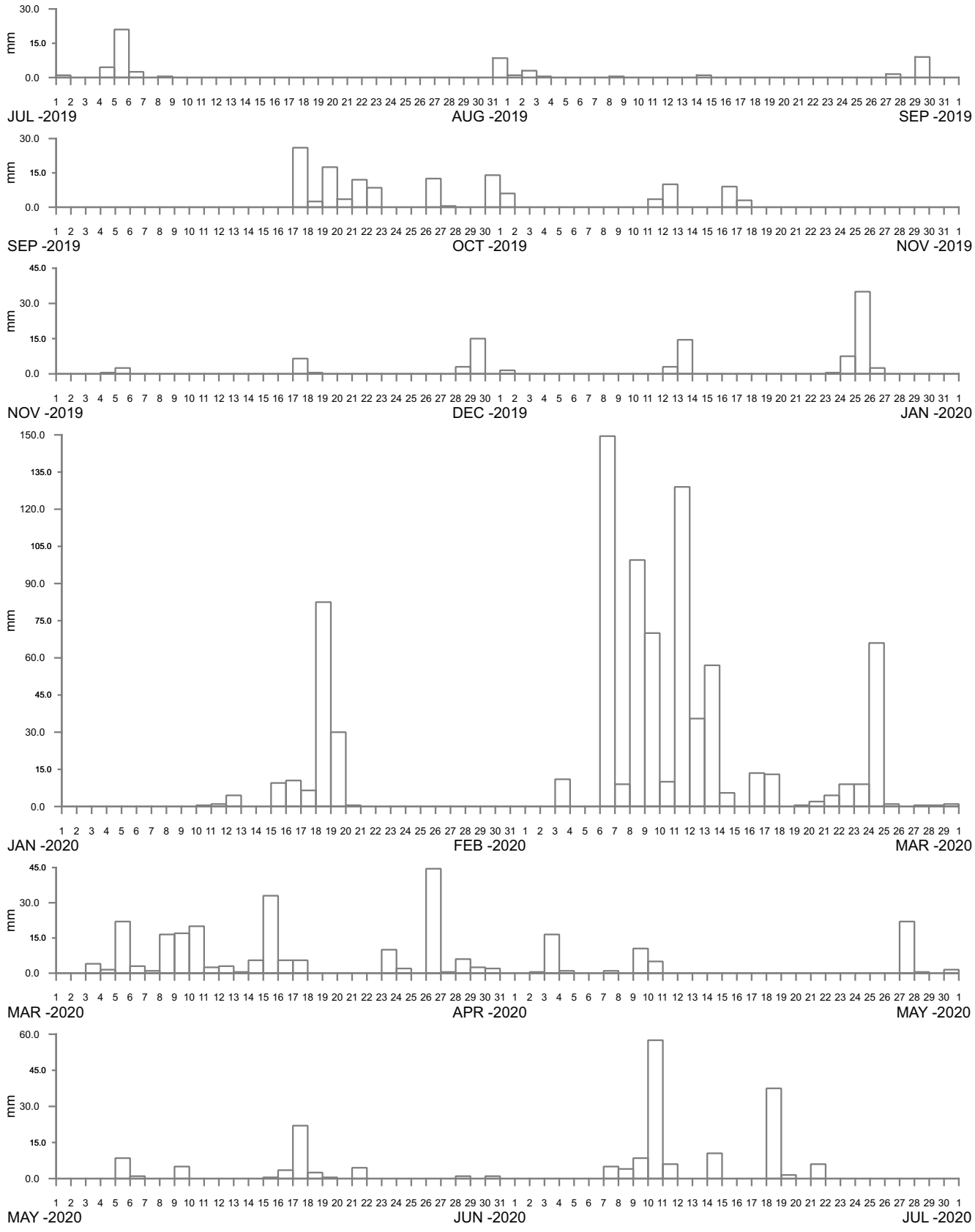
PERRY DRIVE AT COFFS HARBOUR
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 14

DRAWING 2771-14.cdr



DATA LOSS

NSW GOVERNMENT

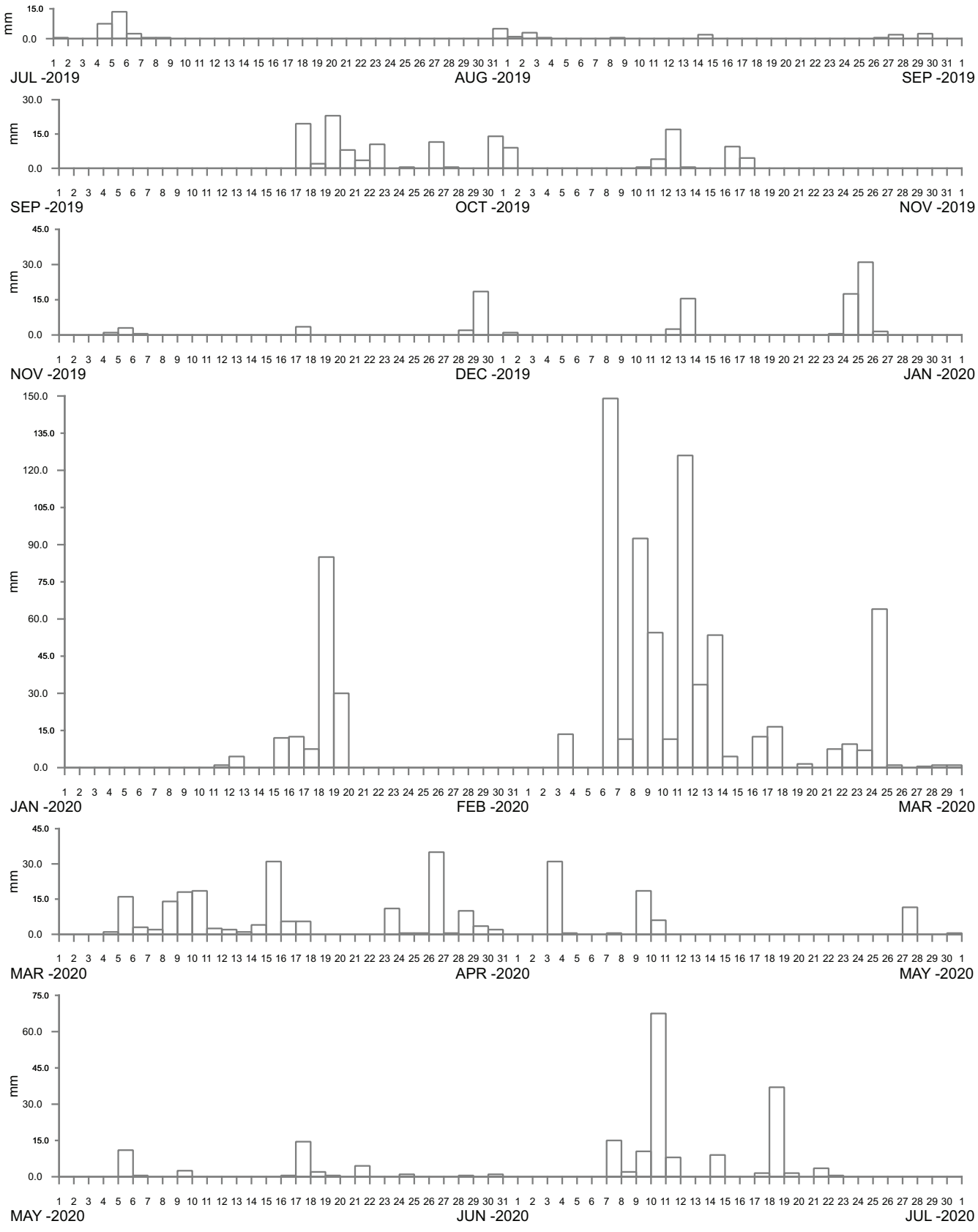
SHEPHARDS LANE AT COFFS HARBOUR
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 15

DRAWING 2771-15.cdr



NSW GOVERNMENT

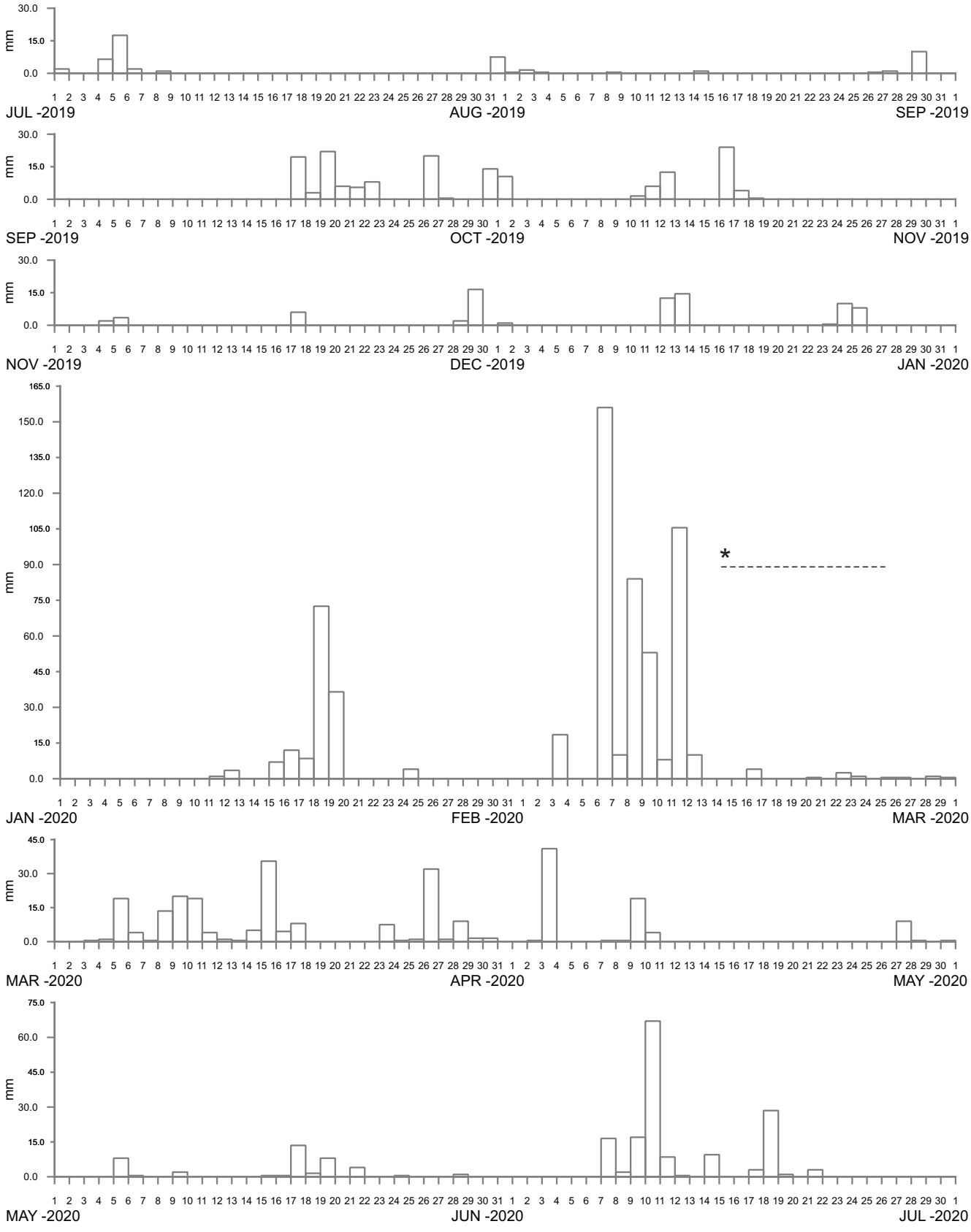
RED HILL AT COFFS HARBOUR
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 16

DRAWING 2771-16.cdr



DATA LOSS

*Data coded as 208 due to a suspected temporary blockage

NSW GOVERNMENT

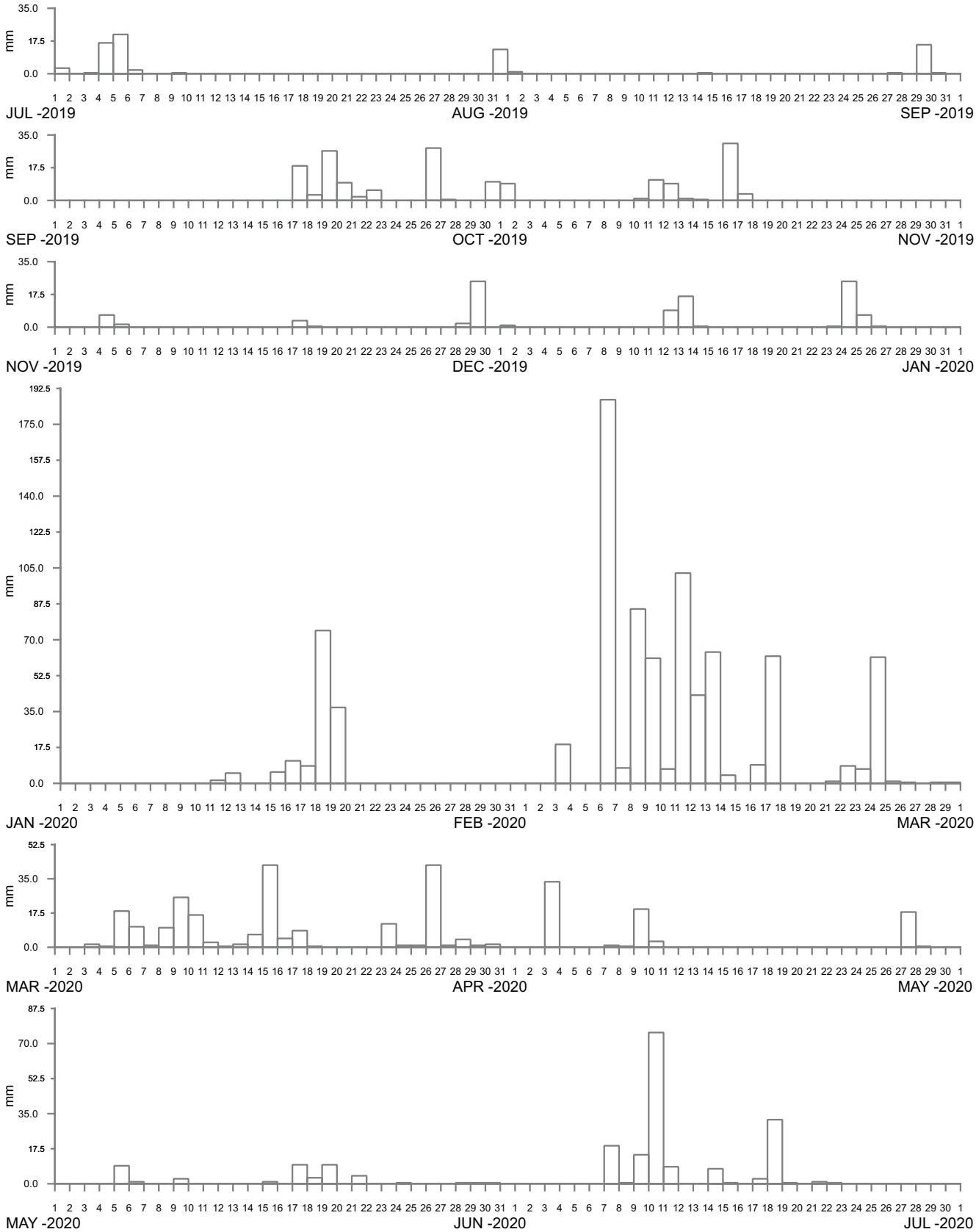
NEWPORTS CREEK AT ENGLANDS ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 17

DRAWING 2771-17.cdr



NSW GOVERNMENT

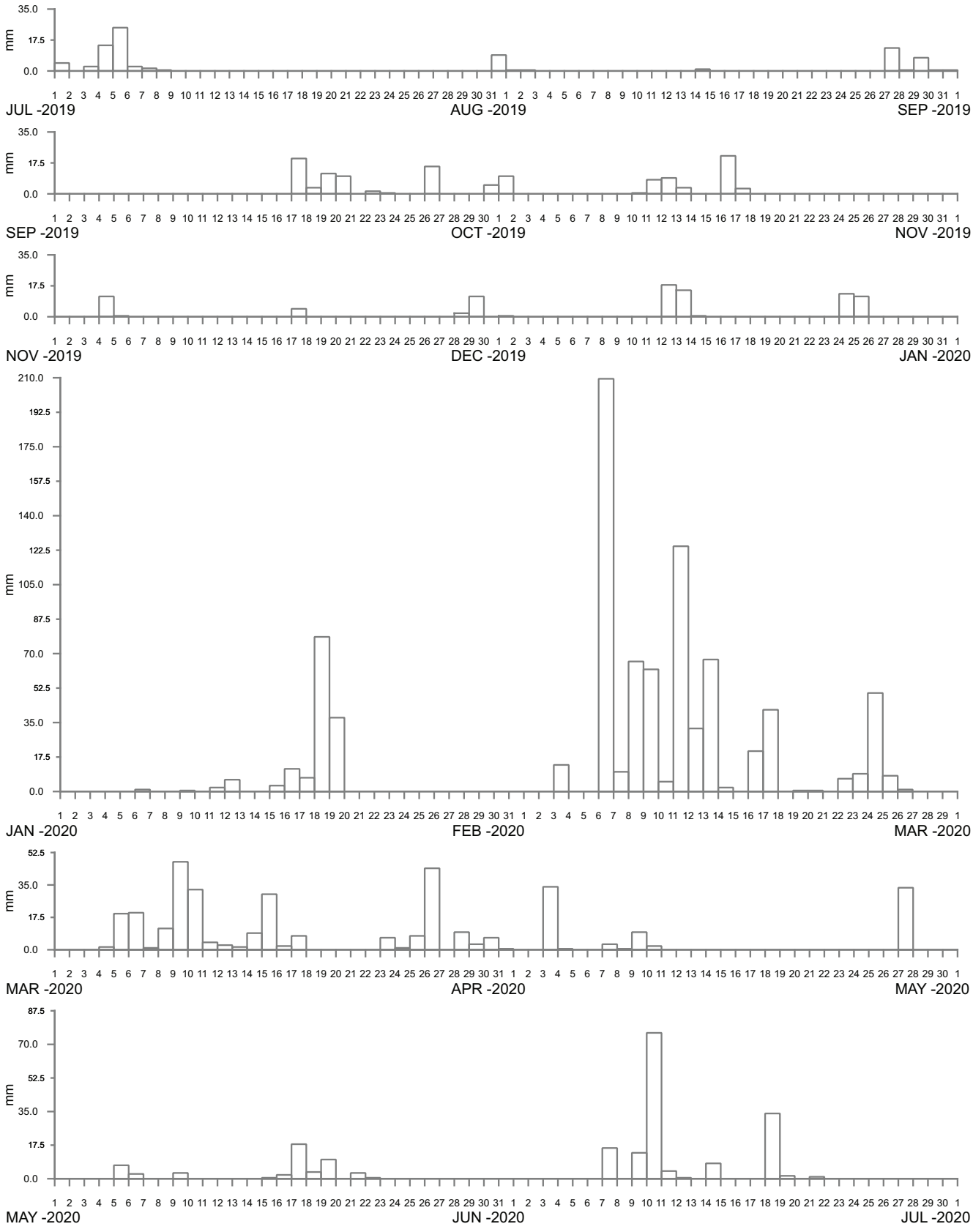
MIDDLE BOAMBEE AT CEDARVALE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 18

DRAWING 2771-18.cdr



NSW GOVERNMENT

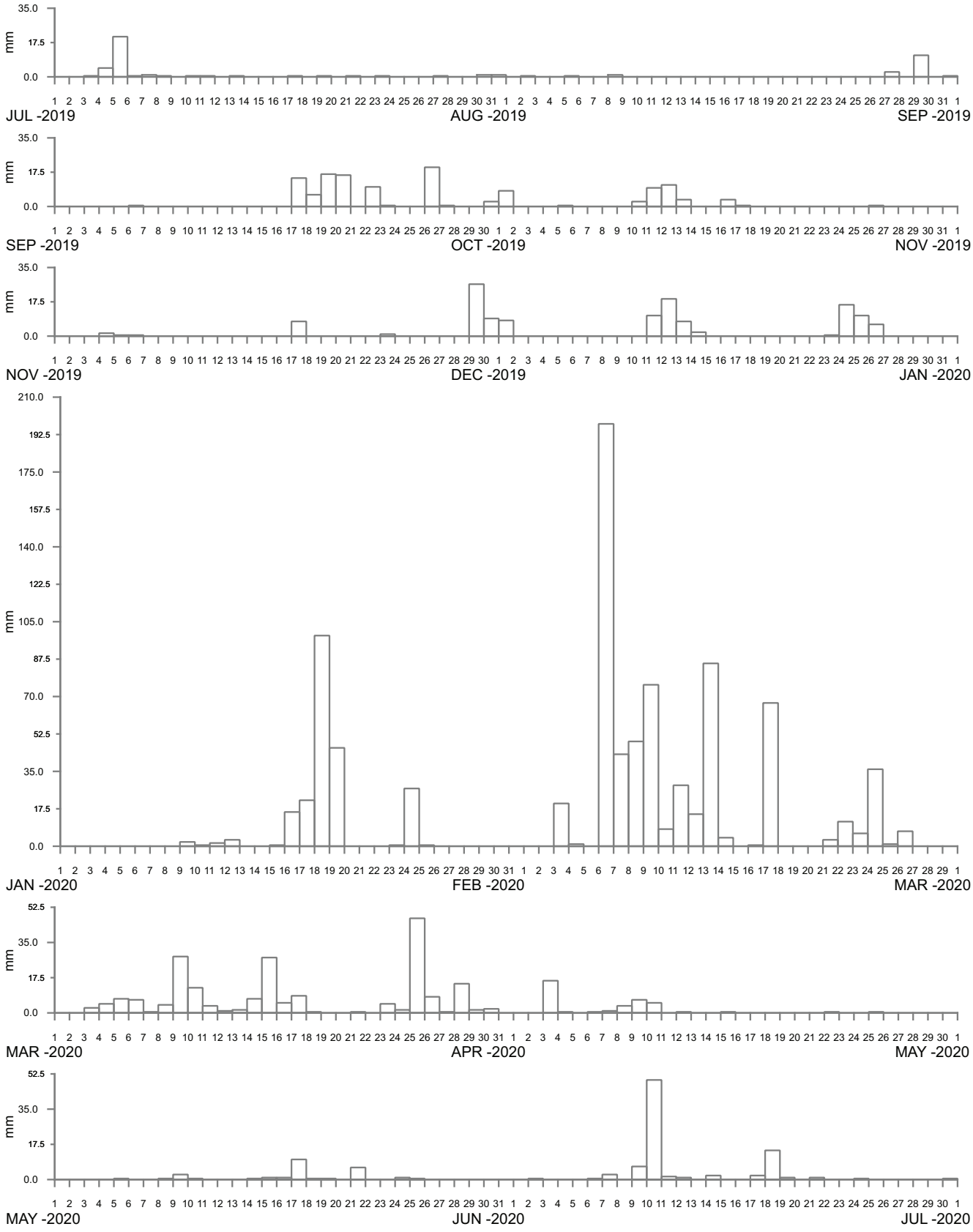
NORTH BONVILLE AT NORTH BONVILLE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 19

DRAWING 2771-19.cdr



NSW GOVERNMENT

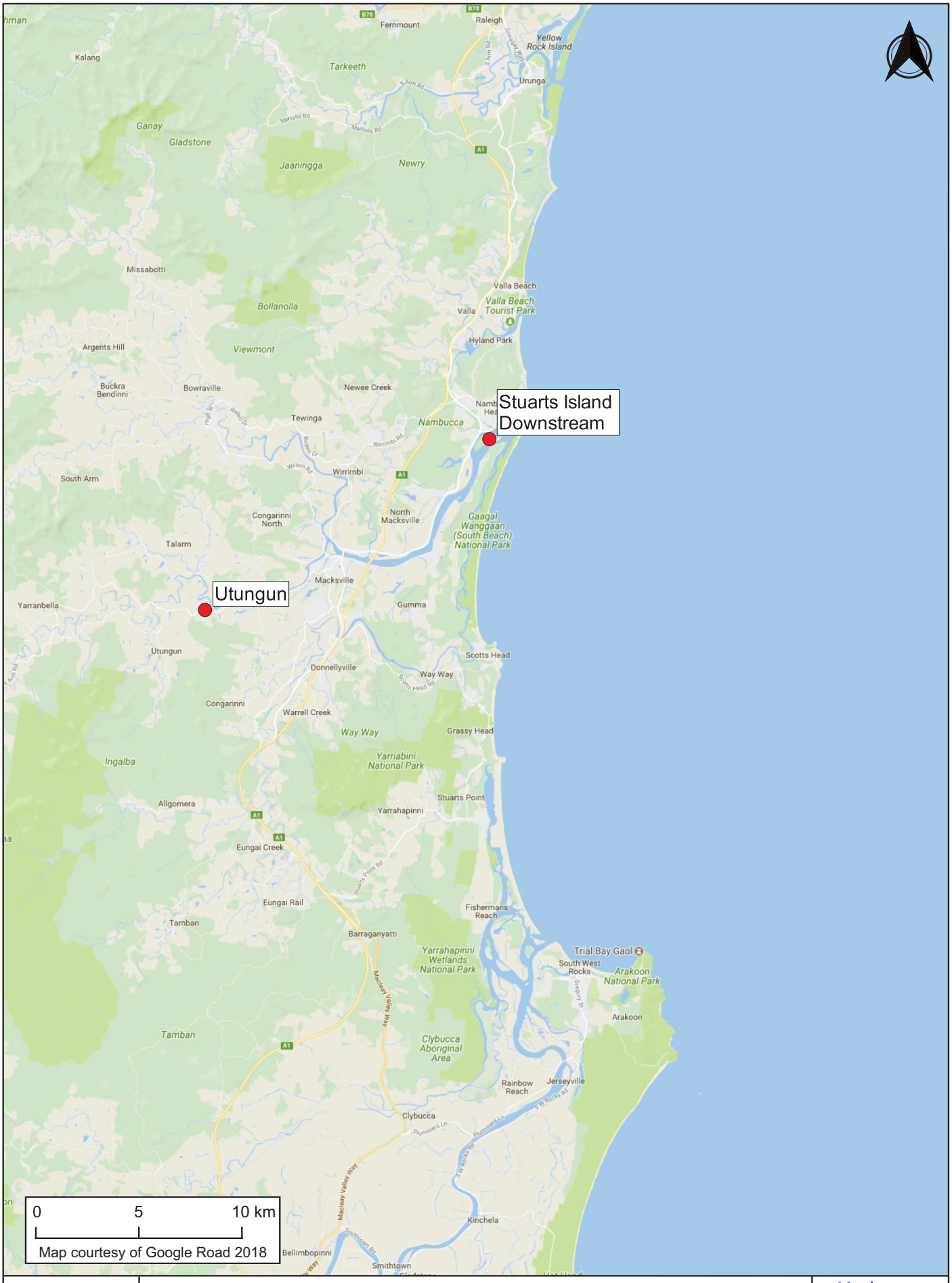
KOOROOWI SHARABEL AT KALANG RIVER 2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 20

DRAWING 2771-20.cdr



NSW GOVERNMENT

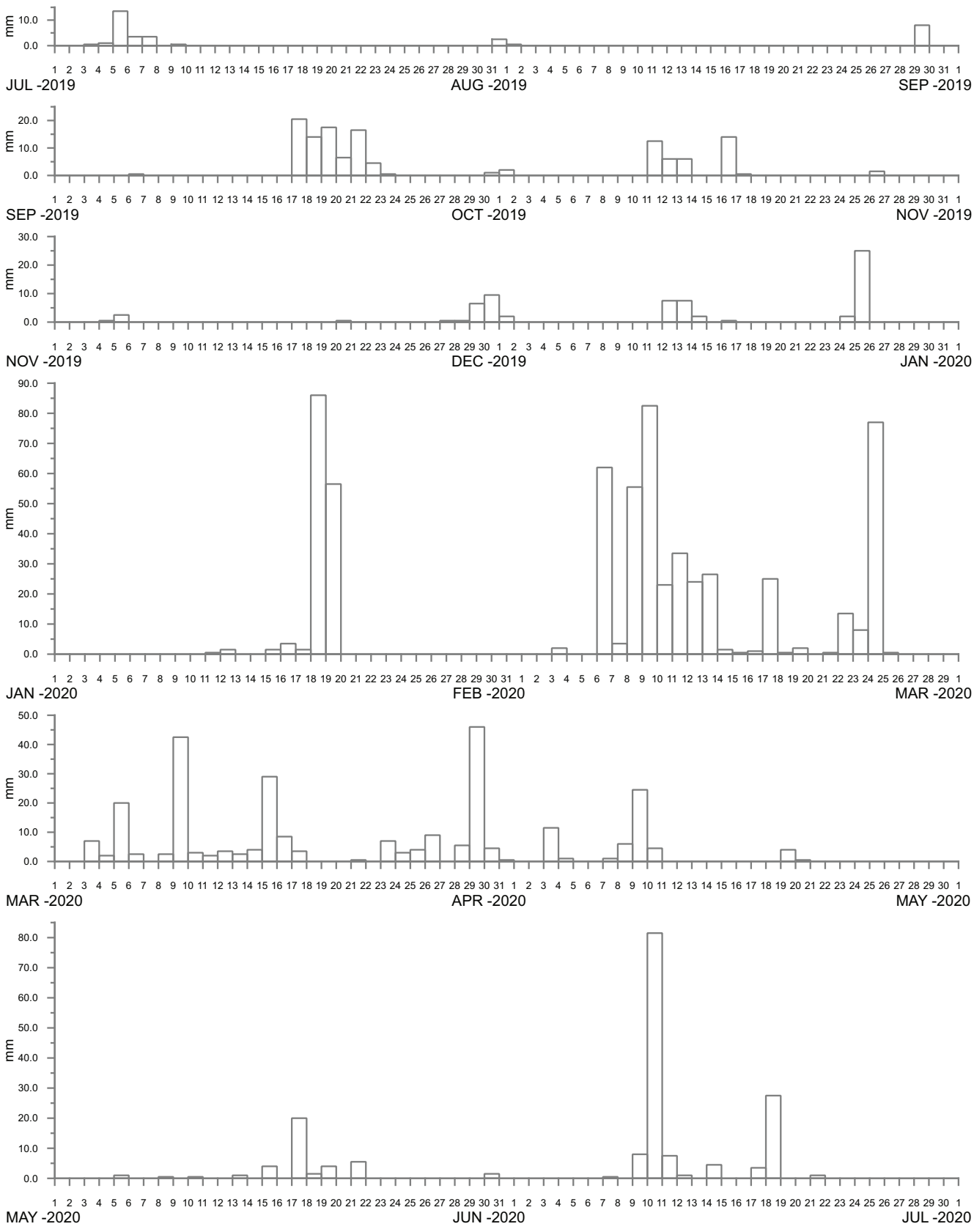
RAINFALL STATION LOCATIONS
NAMBUCCA RIVER REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 21

DRAWING 2771-21.cdr



DATA LOSS

NSW GOVERNMENT

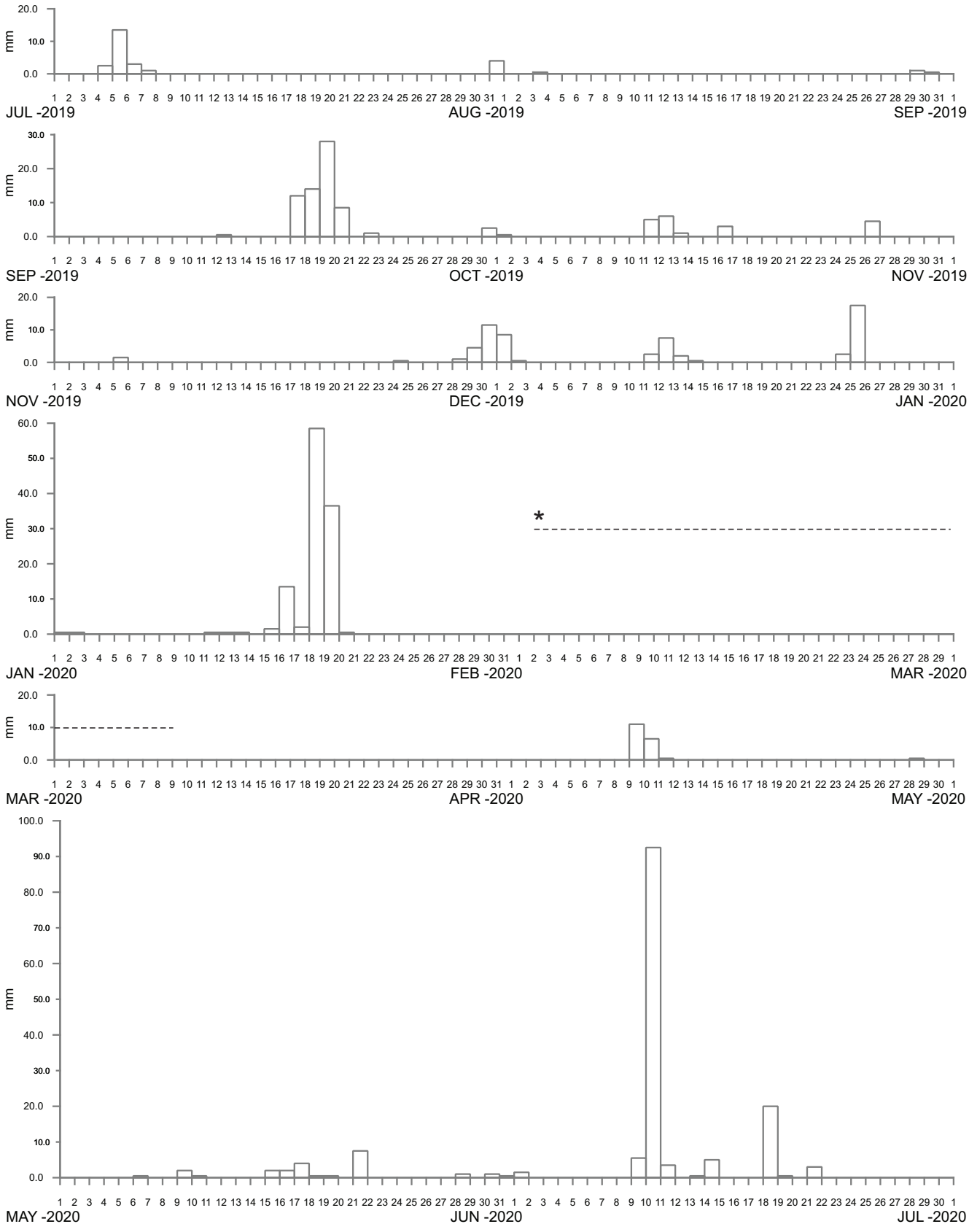
STUARTS ISLAND DOWNSTREAM AT NAMBUCCA HEADS 2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 22

DRAWING 2771-22.cdr



---------- DATA LOSS

*Data loss due to corrosion in wiring

NSW GOVERNMENT

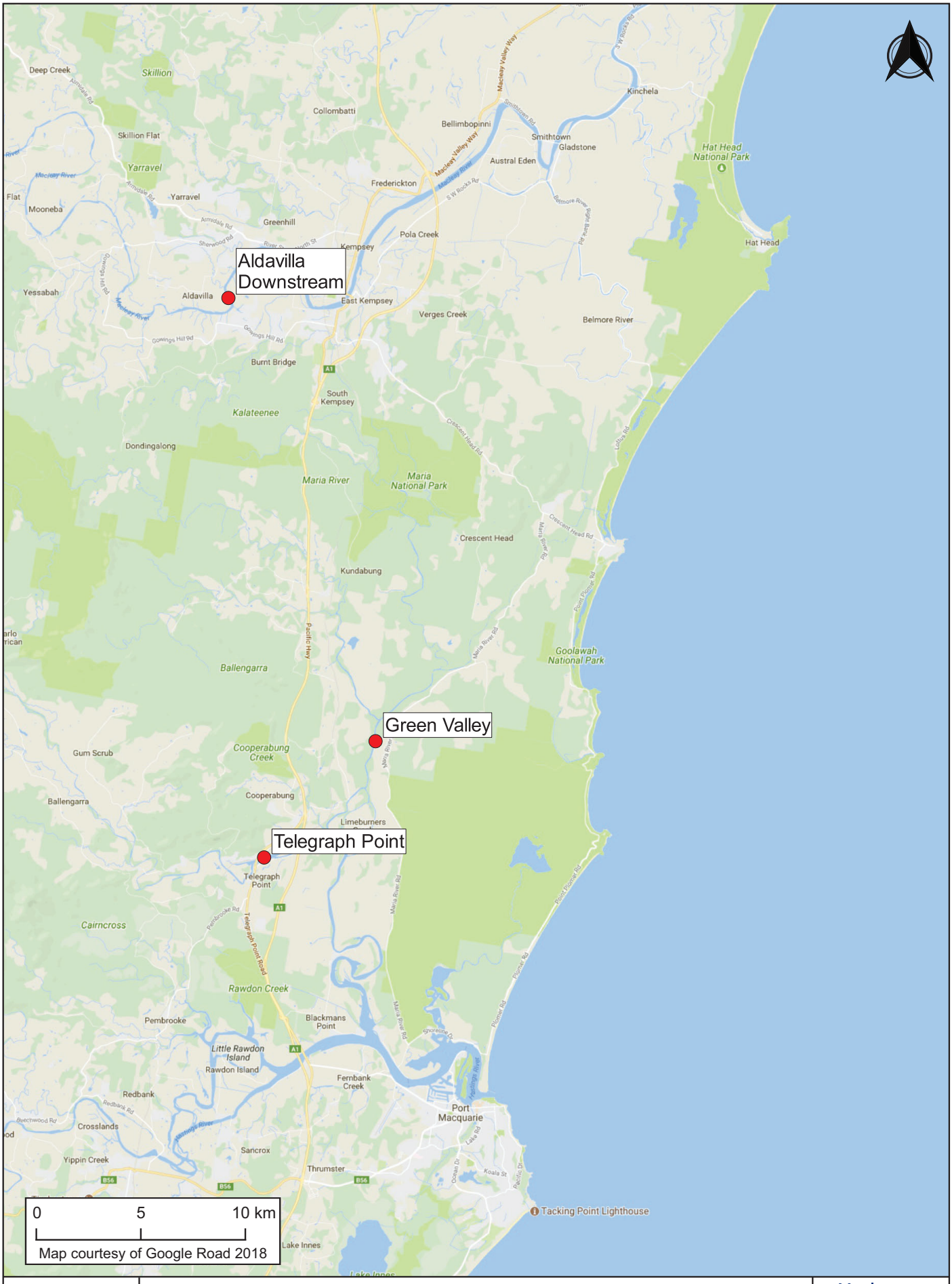
UTUNGUN AT TAYLORS ARM
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 23

DRAWING 2771-23.cdr



NSW GOVERNMENT

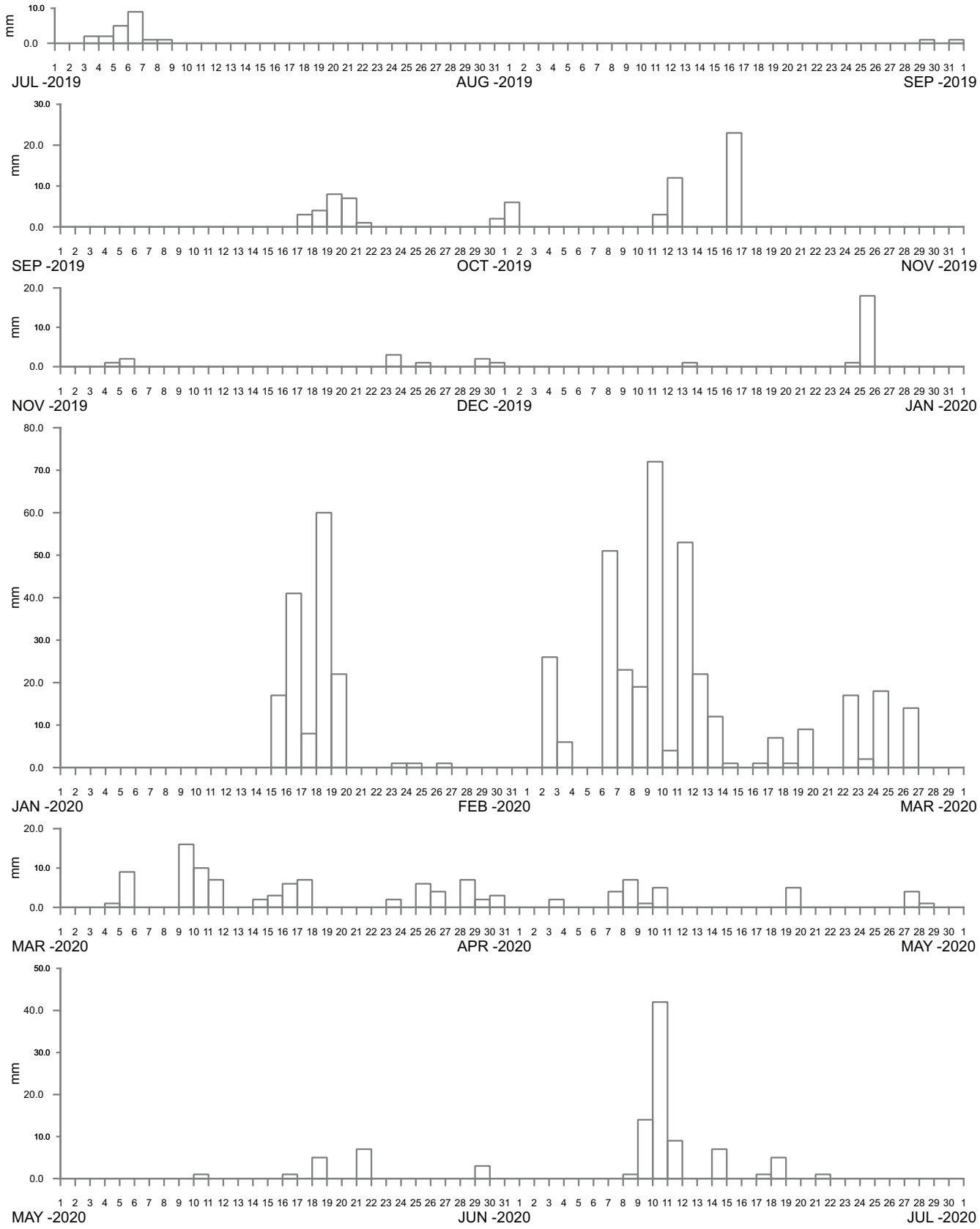
RAINFALL STATION LOCATIONS
MACLEAY RIVER AND HASTINGS RIVER REGIONS

Manly Hydraulics Laboratory

Report MHL2771

Figure 24

DRAWING 2771-24.cdr



---------- DATA LOSS

NSW GOVERNMENT

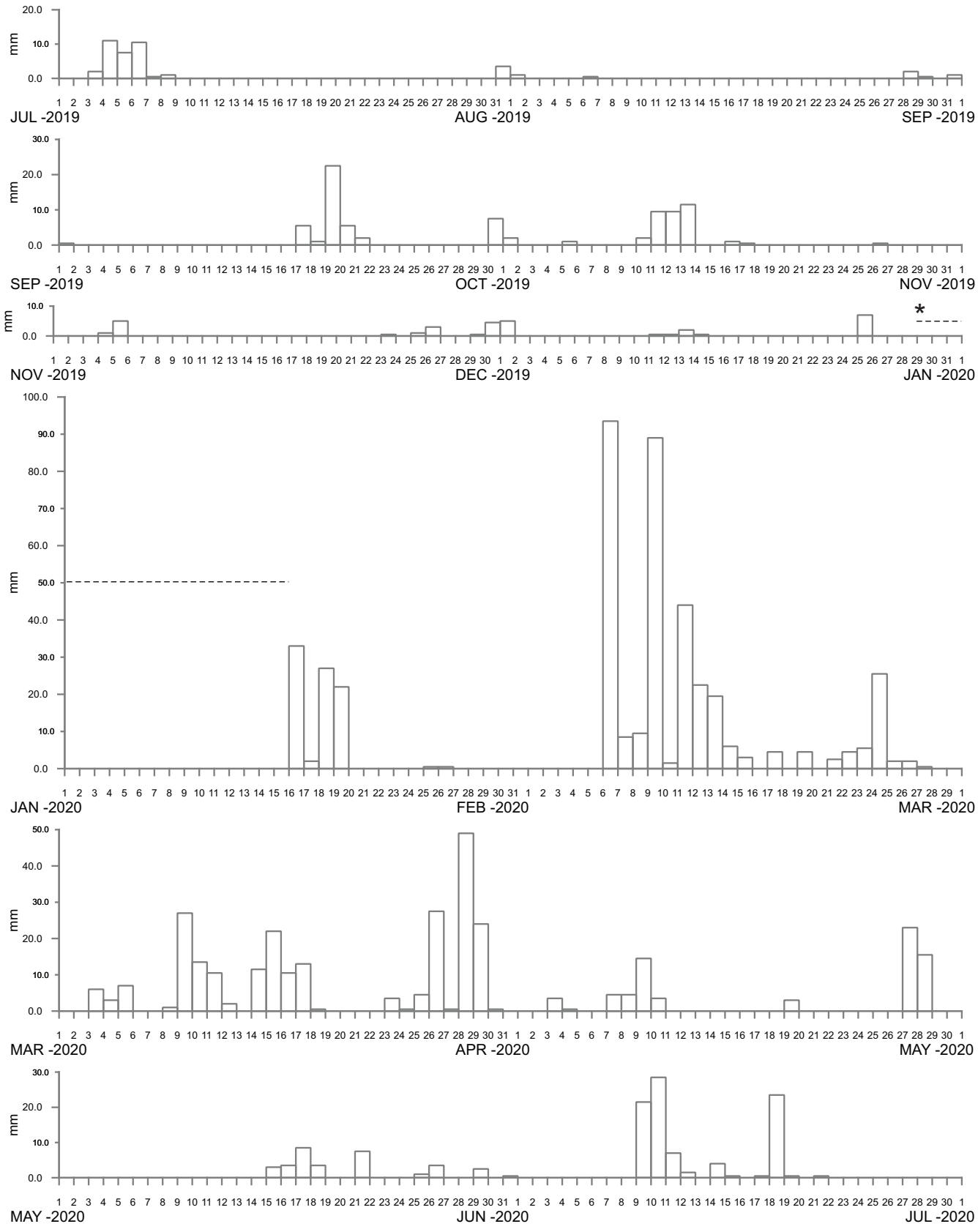
ALDAVILLA DOWNSTREAM AT MACLEAY RIVER 2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 25

DRAWING 2771-25.cdr



---------- DATA LOSS *Data loss due to logger failure

NSW GOVERNMENT

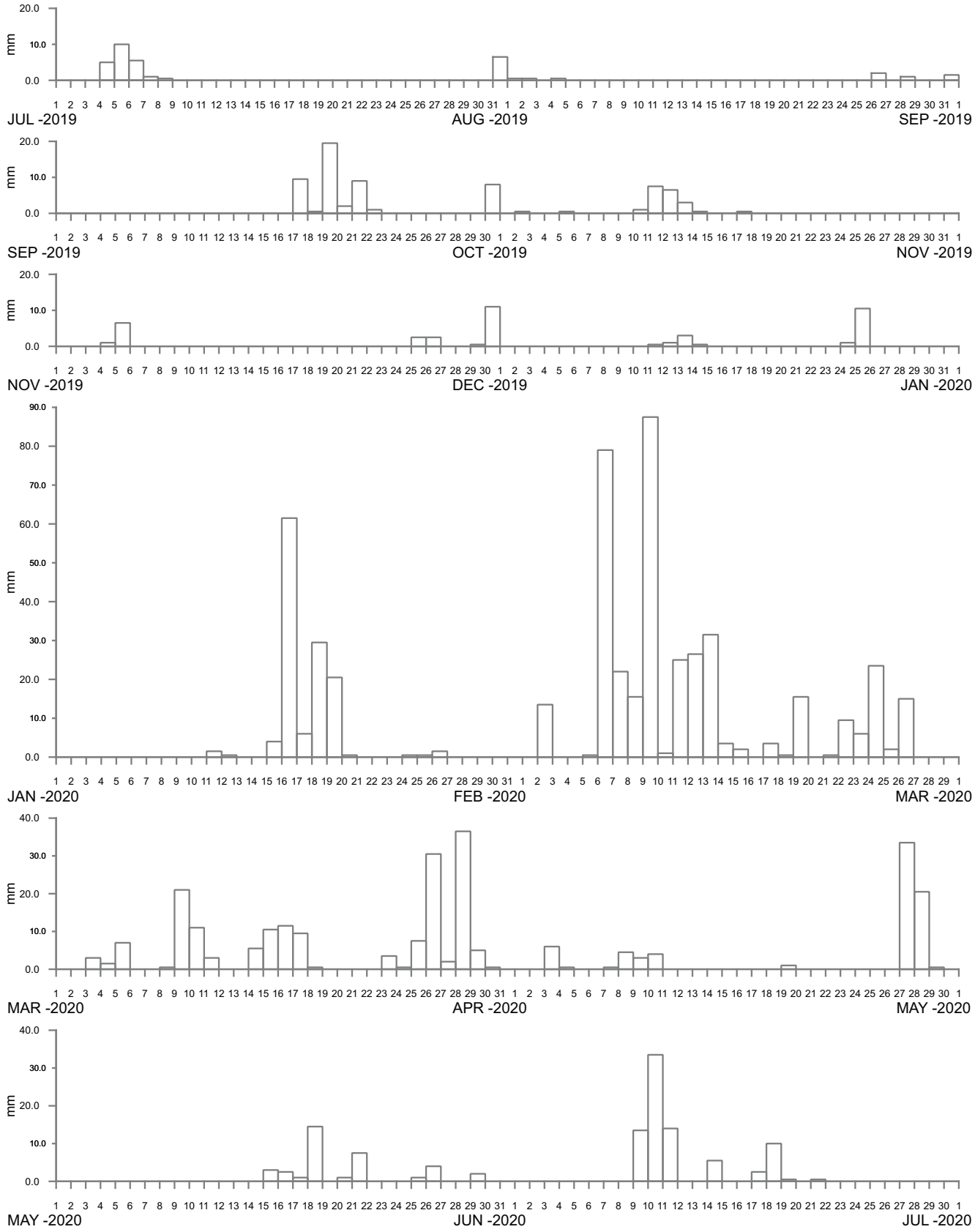
GREEN VALLEY AT MARIA RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 26

DRAWING 2771-26.cdr



NSW GOVERNMENT

TELEGRAPH POINT AT WILSONS RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 27

DRAWING 2771-27.cdr

NSW GOVERNMENT

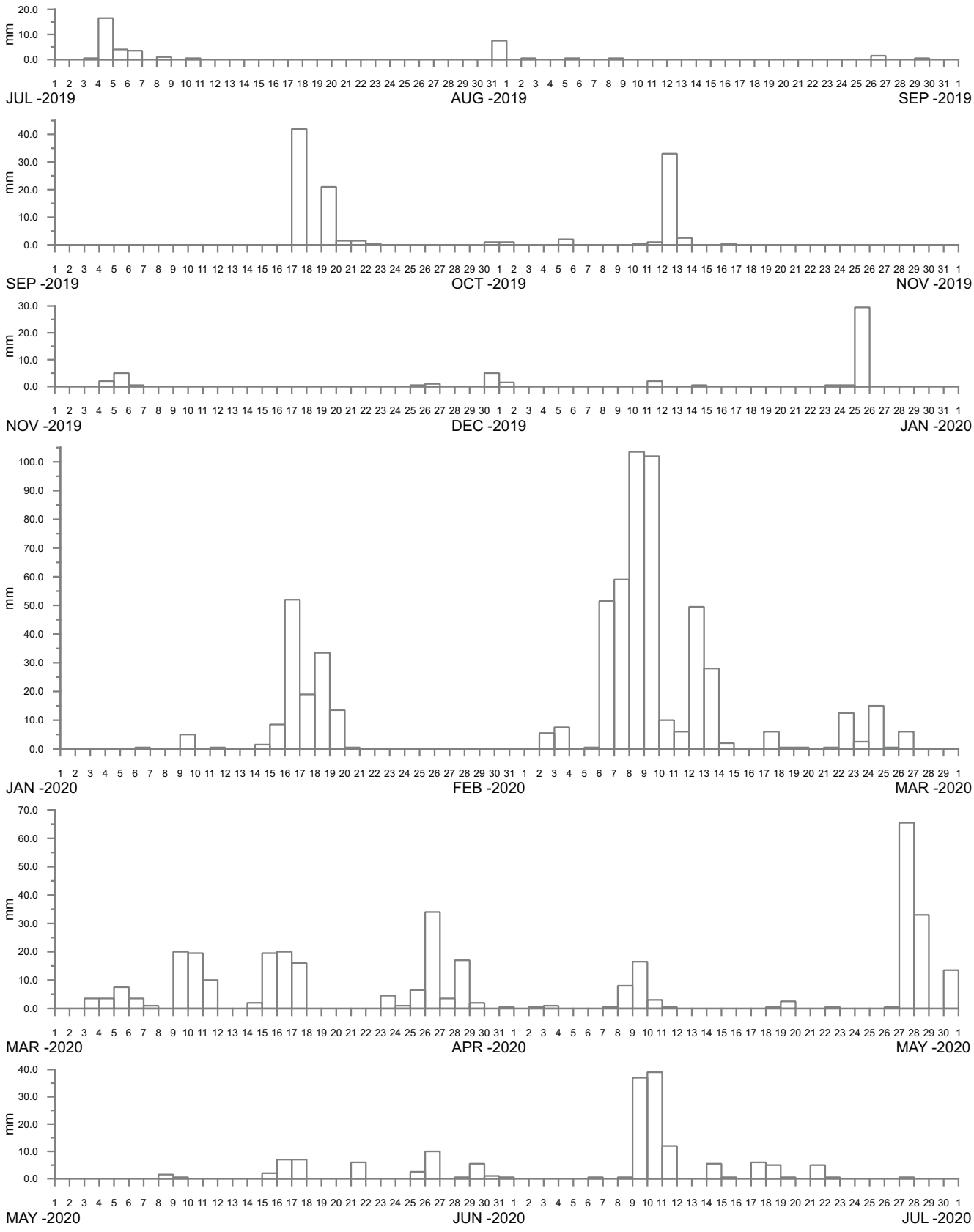
RAINFALL STATION LOCATIONS
CAMDEN HAVEN REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 28

DRAWING 2771-28.cdr



---------- DATA LOSS

NSW GOVERNMENT

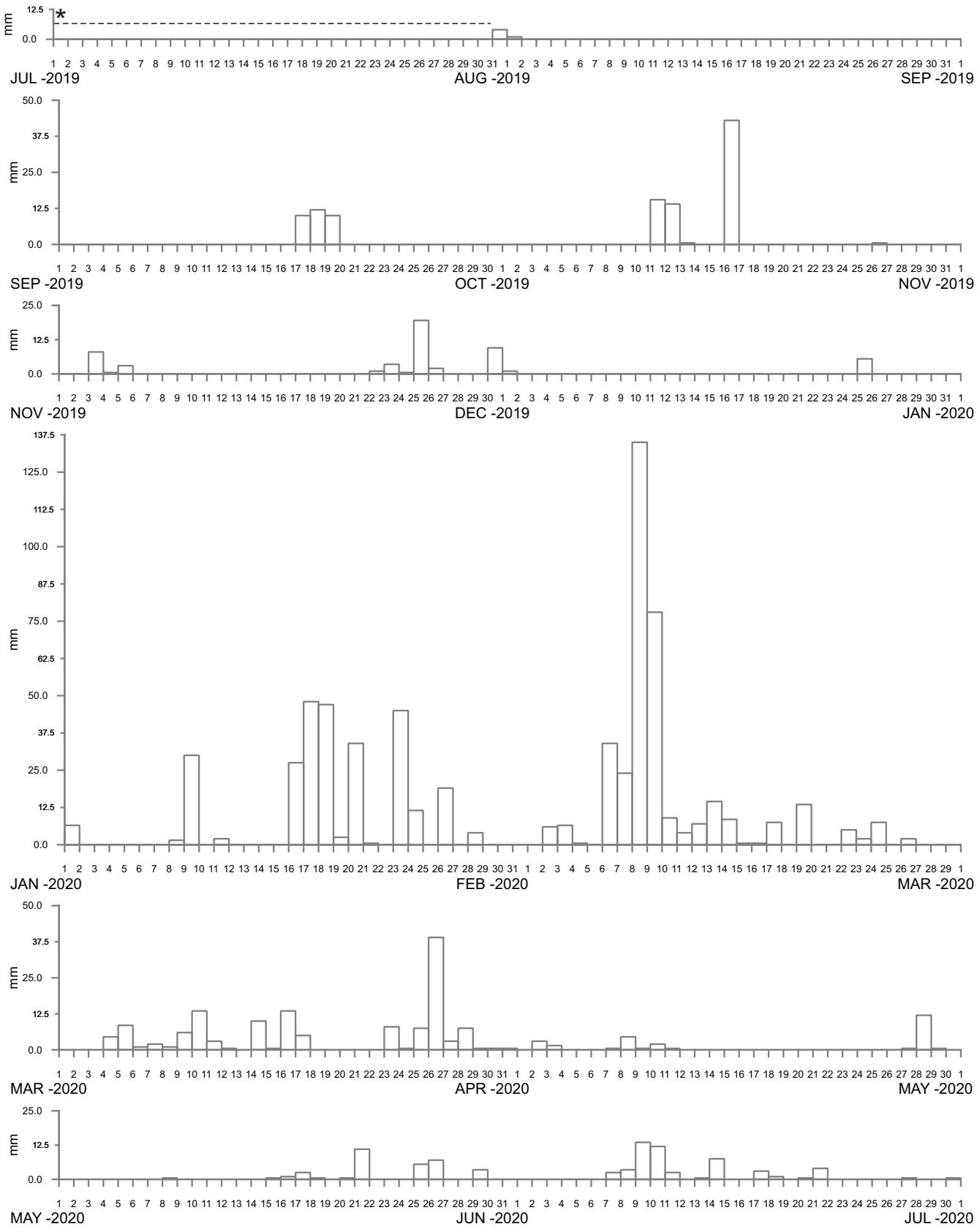
LOGANS CROSSING AT CAMDEN HAVEN
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 29

DRAWING 2771-29.cdr



DATA LOSS *Data loss due to wiring error

NSW GOVERNMENT

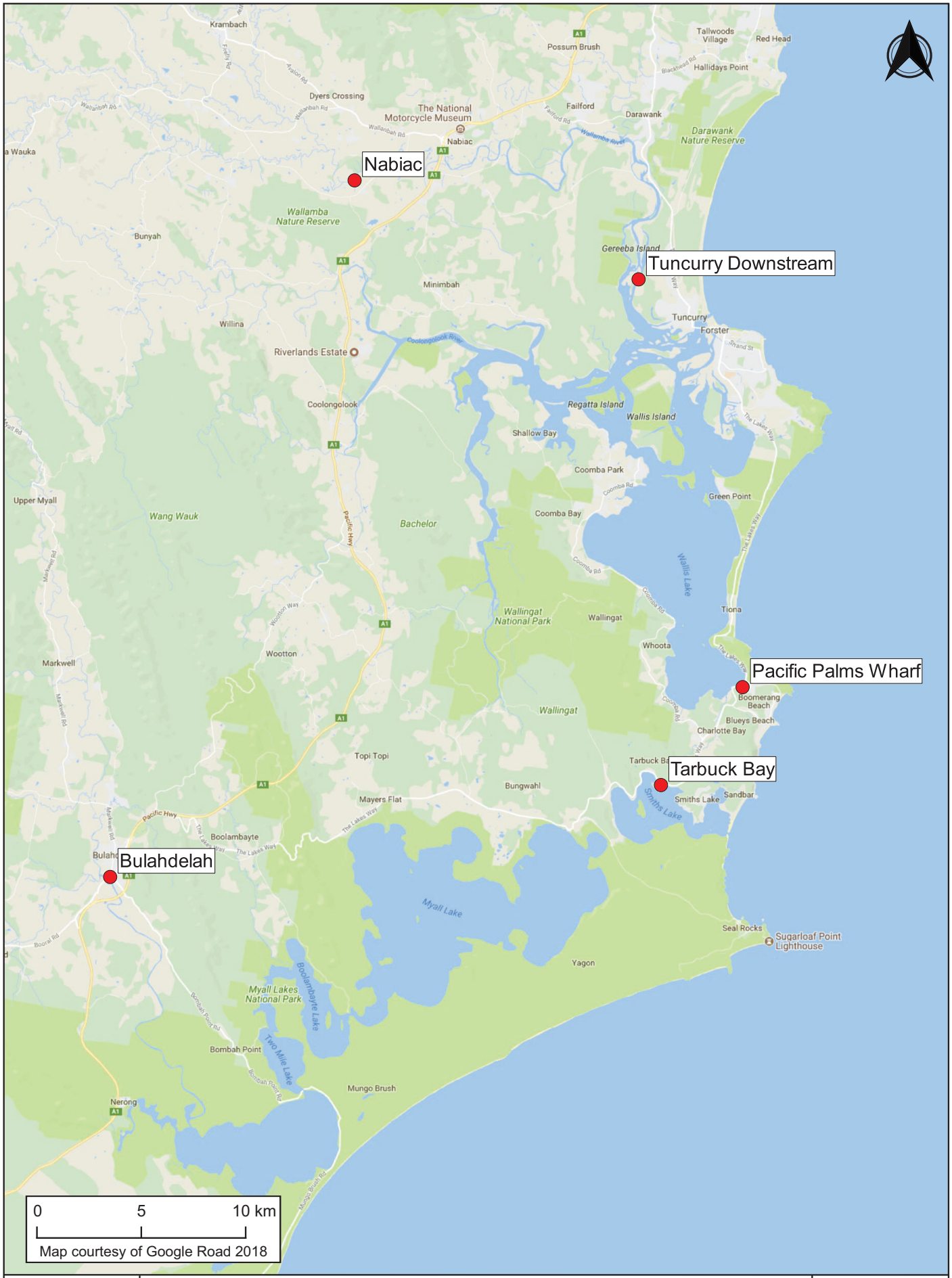
MOUNT GEORGE AT MANNING RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 30

DRAWING 2771-30.cdr



NSW GOVERNMENT

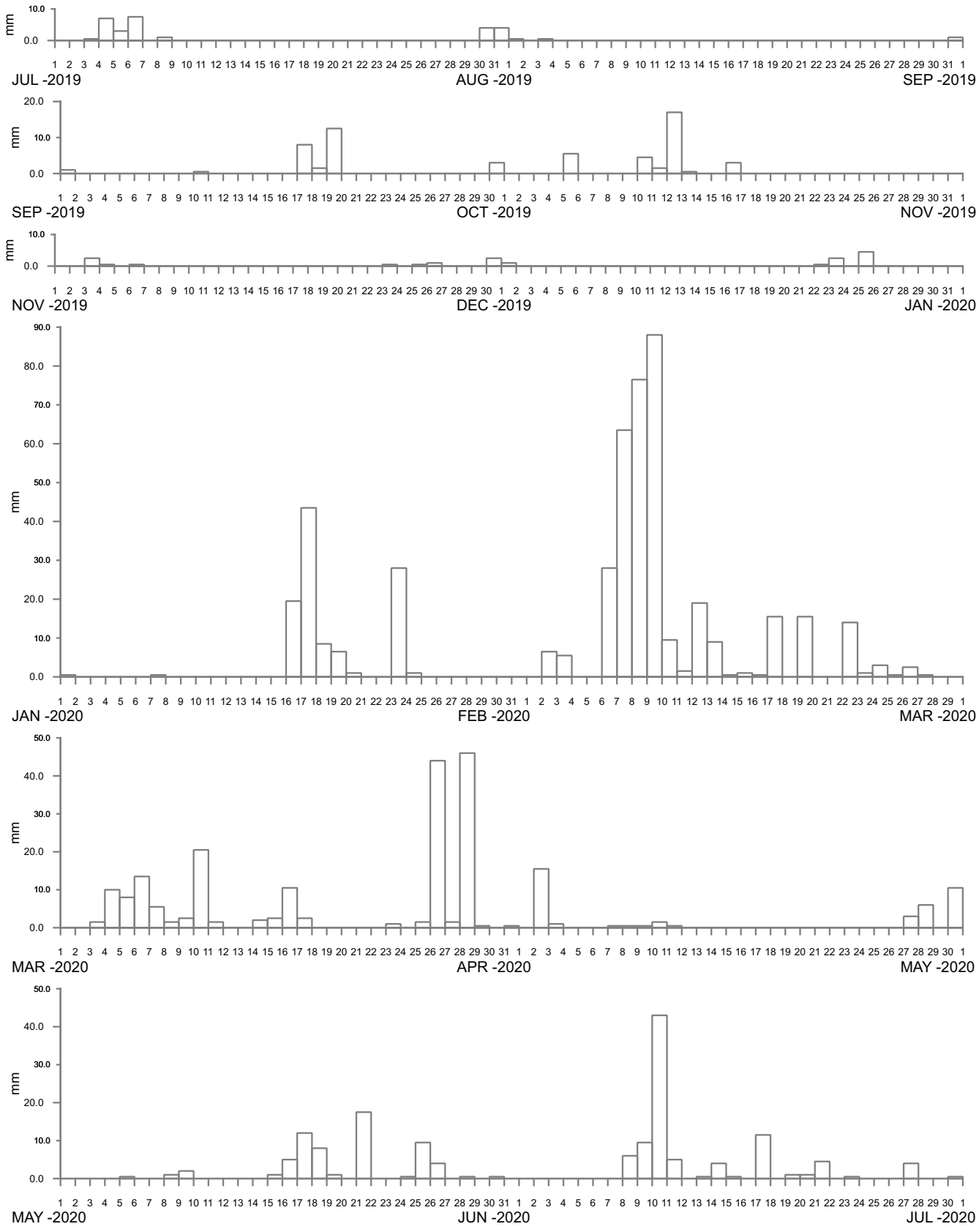
RAINFALL STATION LOCATIONS
KARUAH RIVER REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 31

DRAWING 2771-31.cdr



DATA LOSS

NSW GOVERNMENT

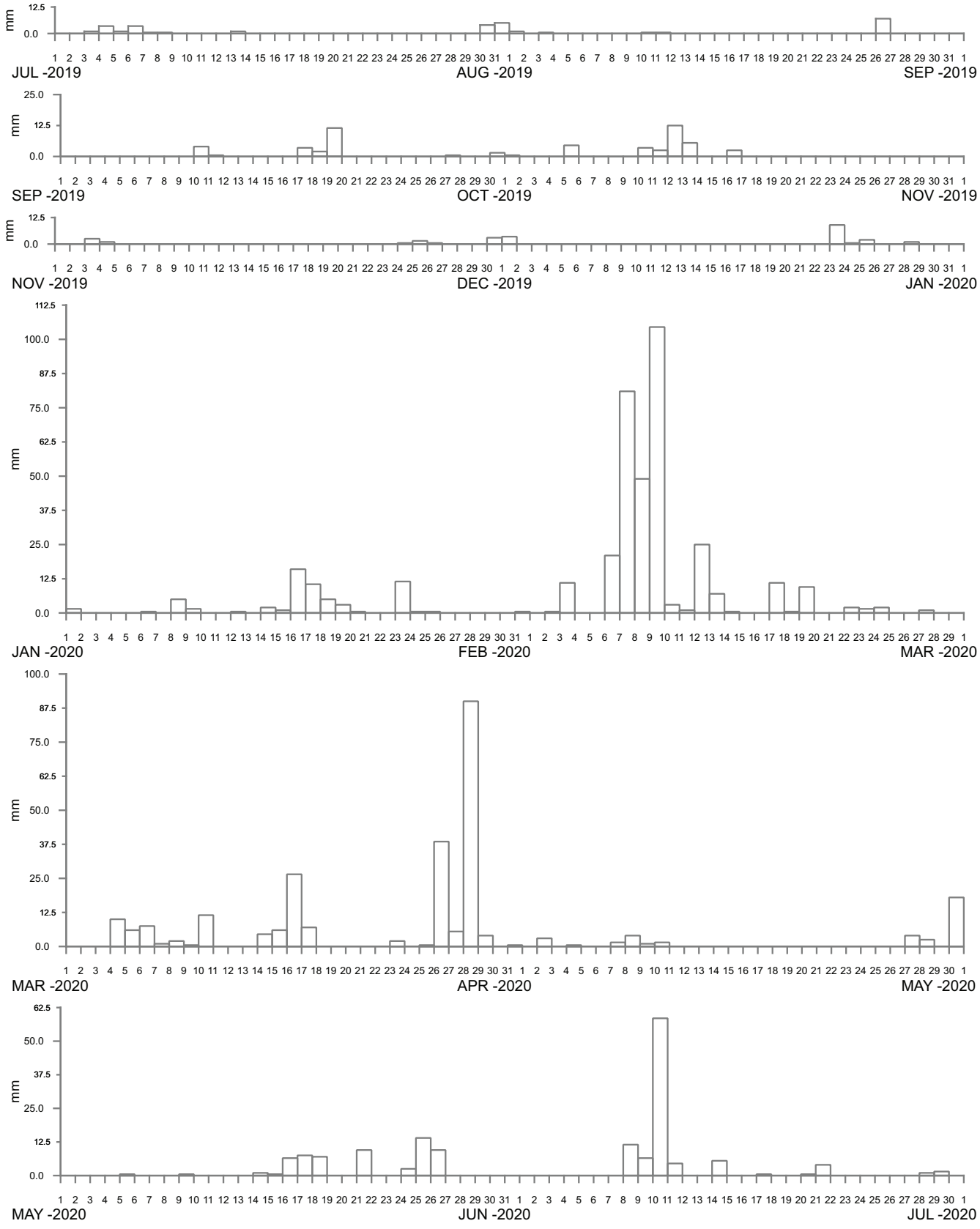
NABIAC AT WALLAMBA RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 32

DRAWING 2771-32.cdr



NSW GOVERNMENT

TUNCURRY DOWNSTREAM AT WALLAMBA RIVER
2019–2020

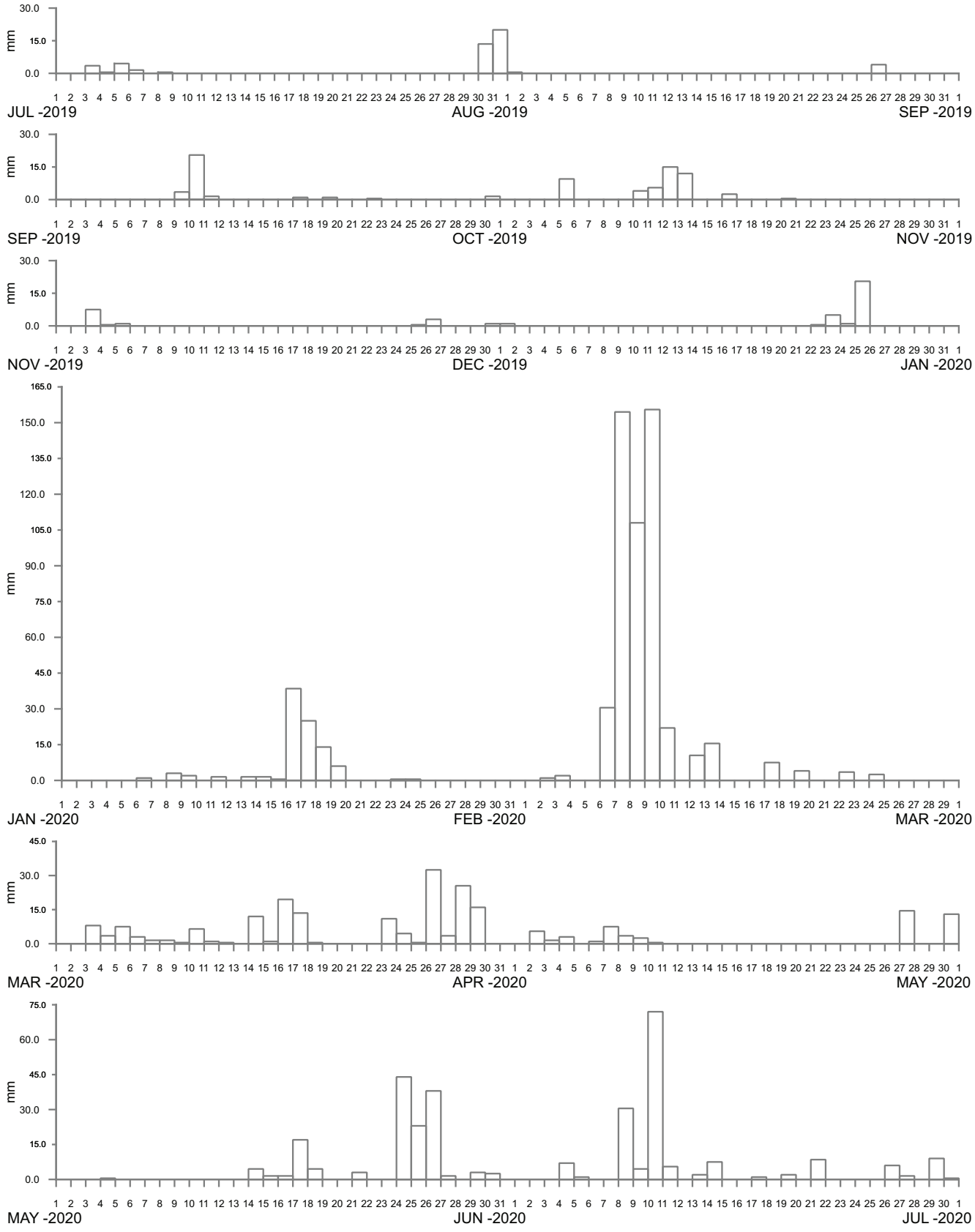
Manly Hydraulics Laboratory

Report MHL2771

Figure

33

DRAWING 2771-33.cdr



DATA LOSS

NSW GOVERNMENT

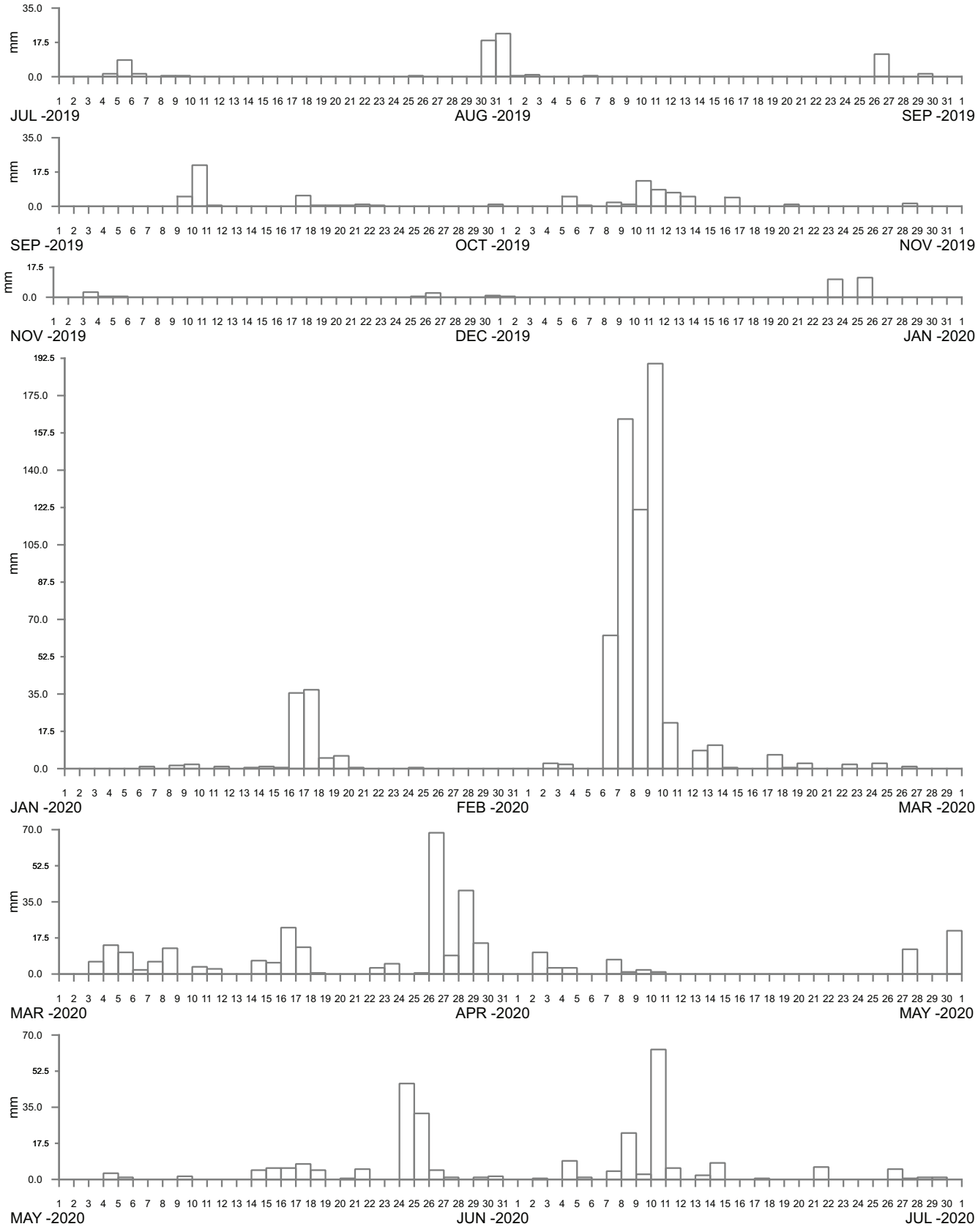
PACIFIC PALMS WHARF AT WALLIS LAKES 2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 34

DRAWING 2771-34.cdr



NSW GOVERNMENT

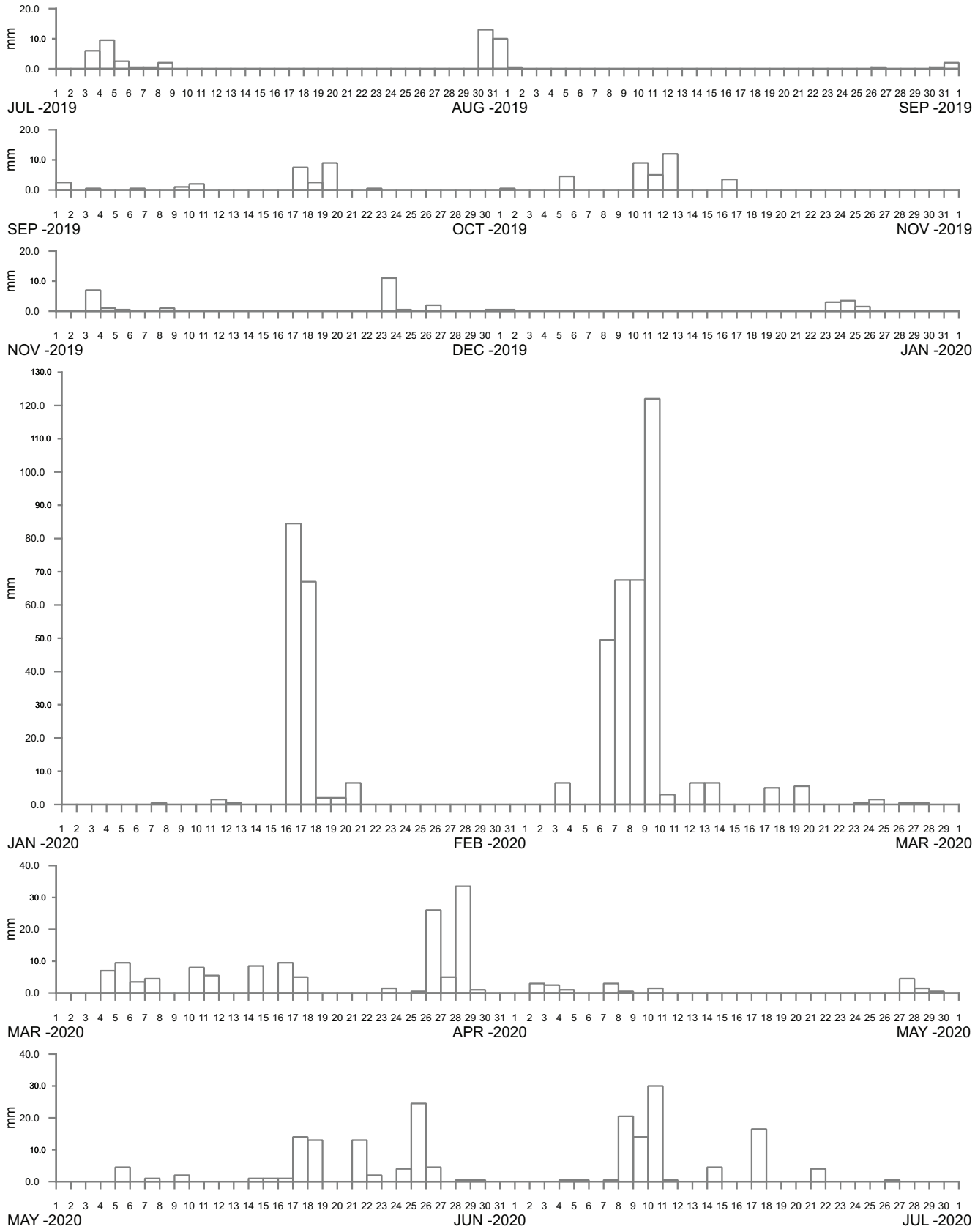
TARBUCK BAY AT SMITHS LAKE
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 35

DRAWING 2771-35.cdr



BULAHDELAH AT MYALL RIVER
2019–2020

Manly Hydraulics Laboratory

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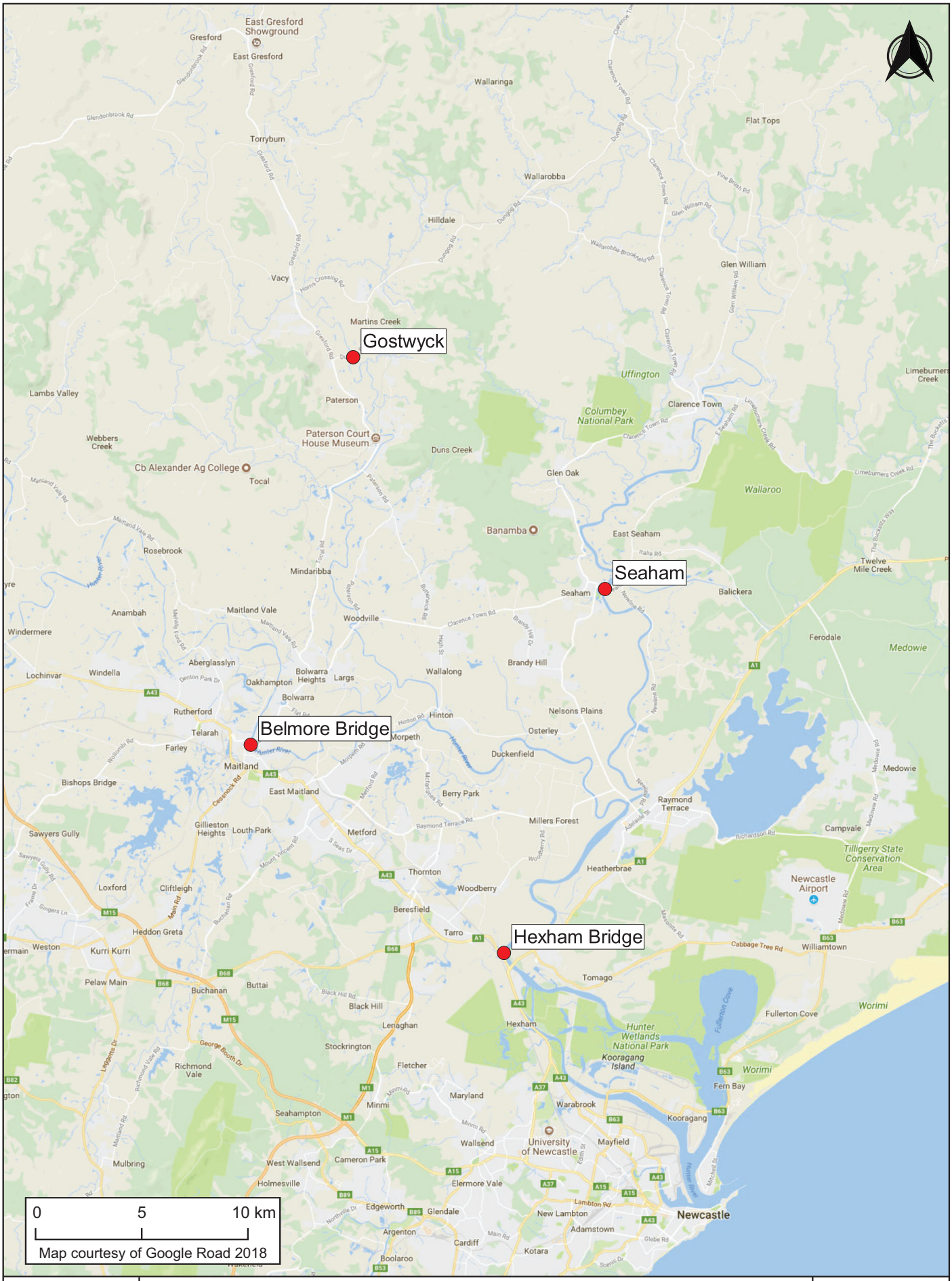
Figure 36

DRAWING 2771-36.cdr



NSW GOVERNMENT

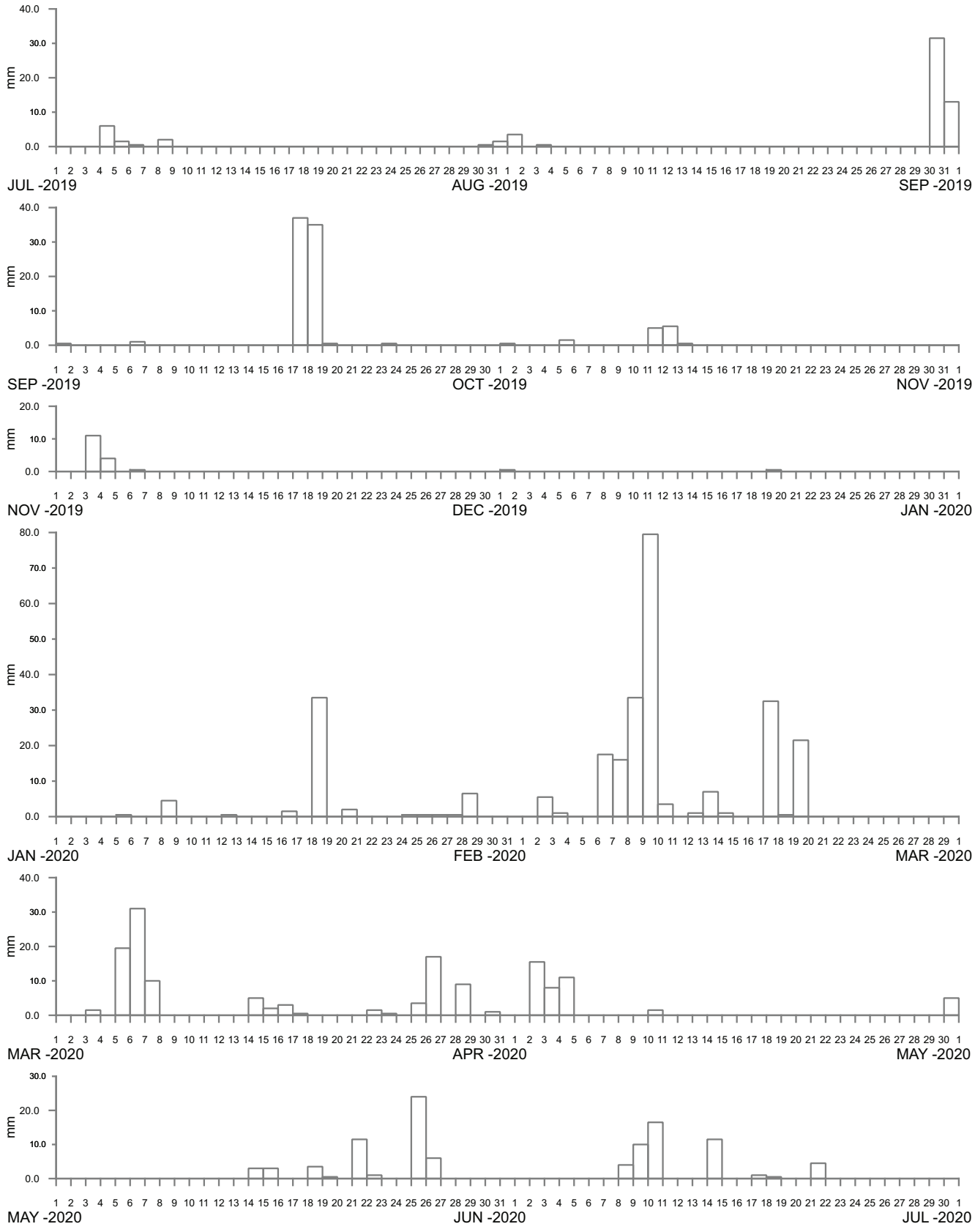
RAINFALL STATION LOCATIONS
HUNTER RIVER REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 37

DRAWING 2771-37.cdr



NSW GOVERNMENT

GOSTWYCK AT PATERSON RIVER
2019–2020

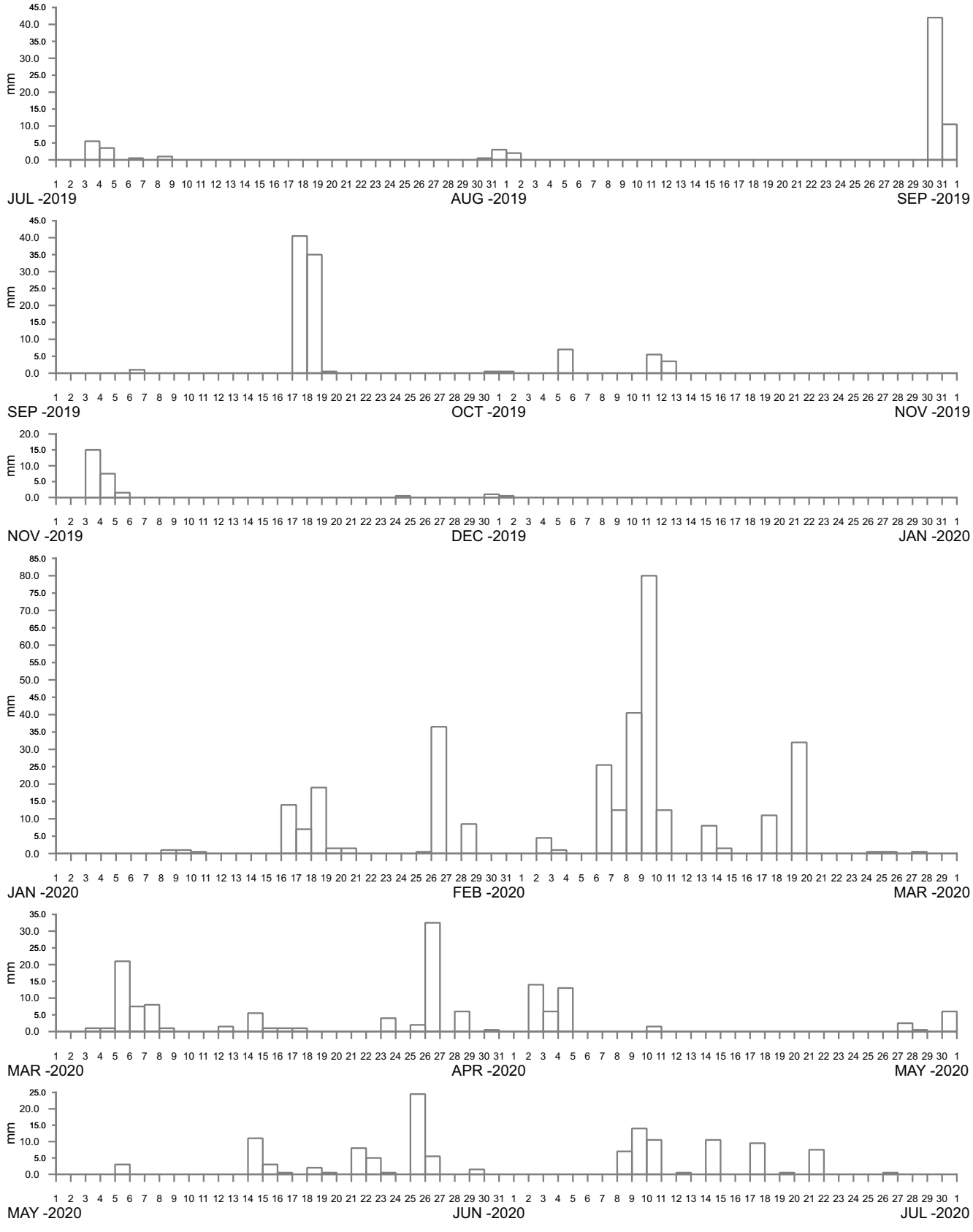
Manly Hydraulics Laboratory

Report MHL2771

Figure

38

DRAWING 2771-38.cdr



DATA LOSS

NSW GOVERNMENT

SEAHAM AT WILLIAMS RIVER
2019–2020

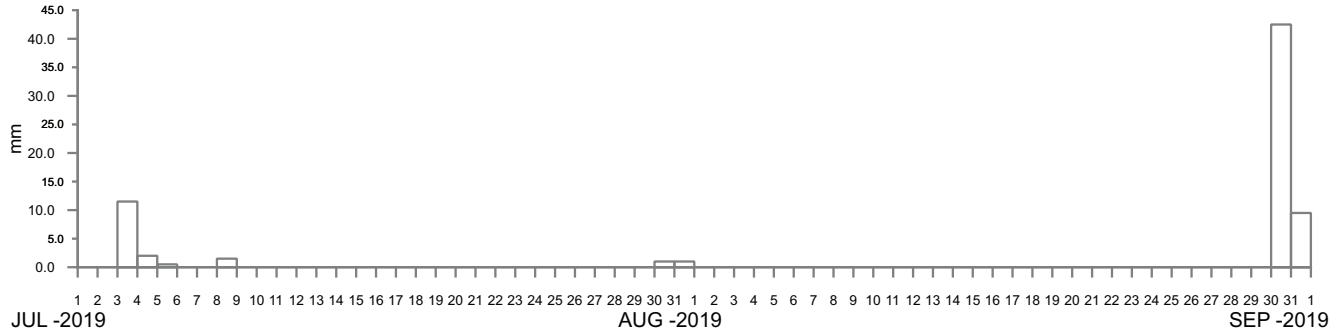
Manly Hydraulics Laboratory

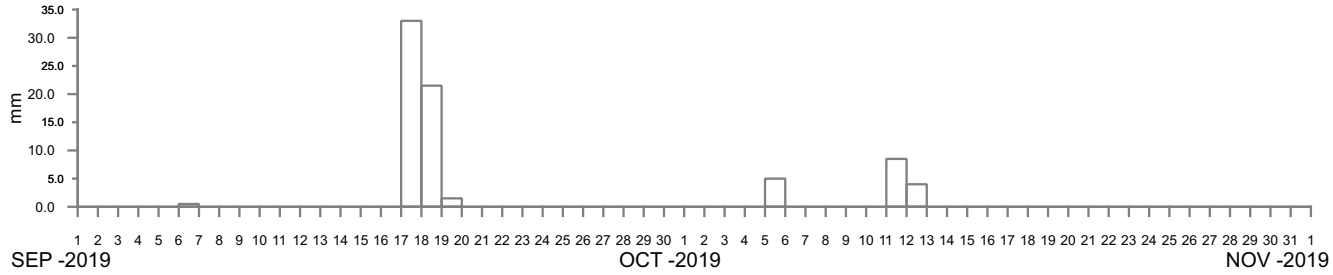
Report MHL2771

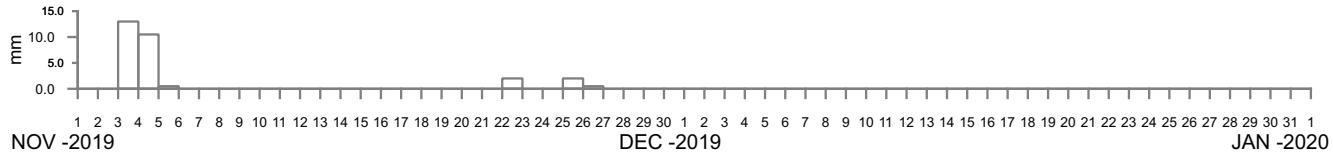
Figure

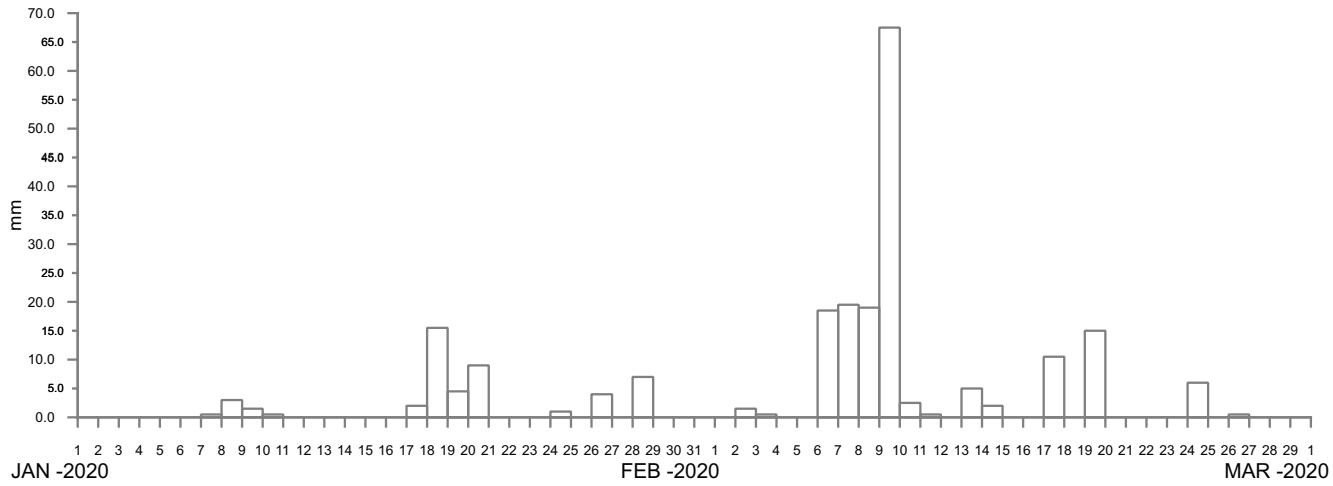
39

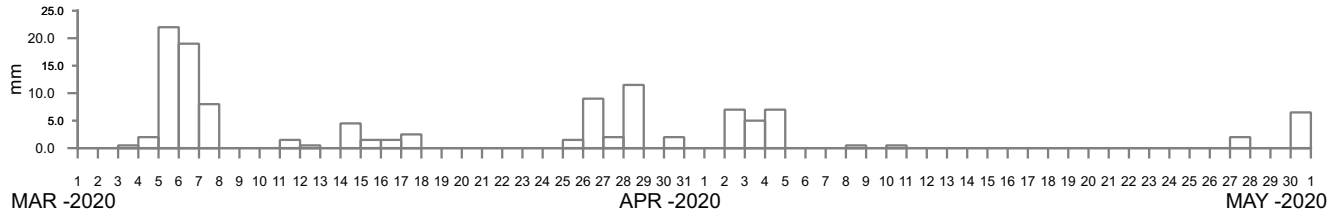
DRAWING 2771-39.cdr

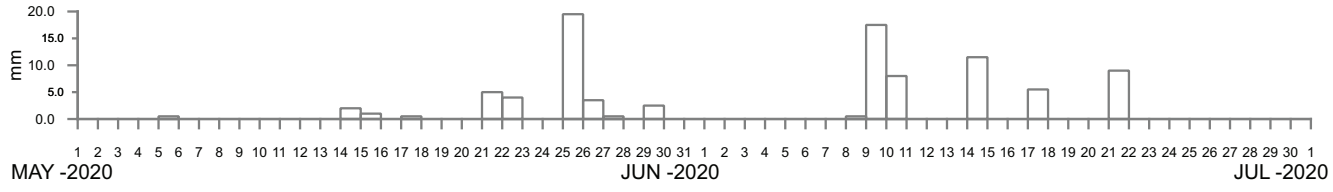












DATA LOSS

NSW GOVERNMENT

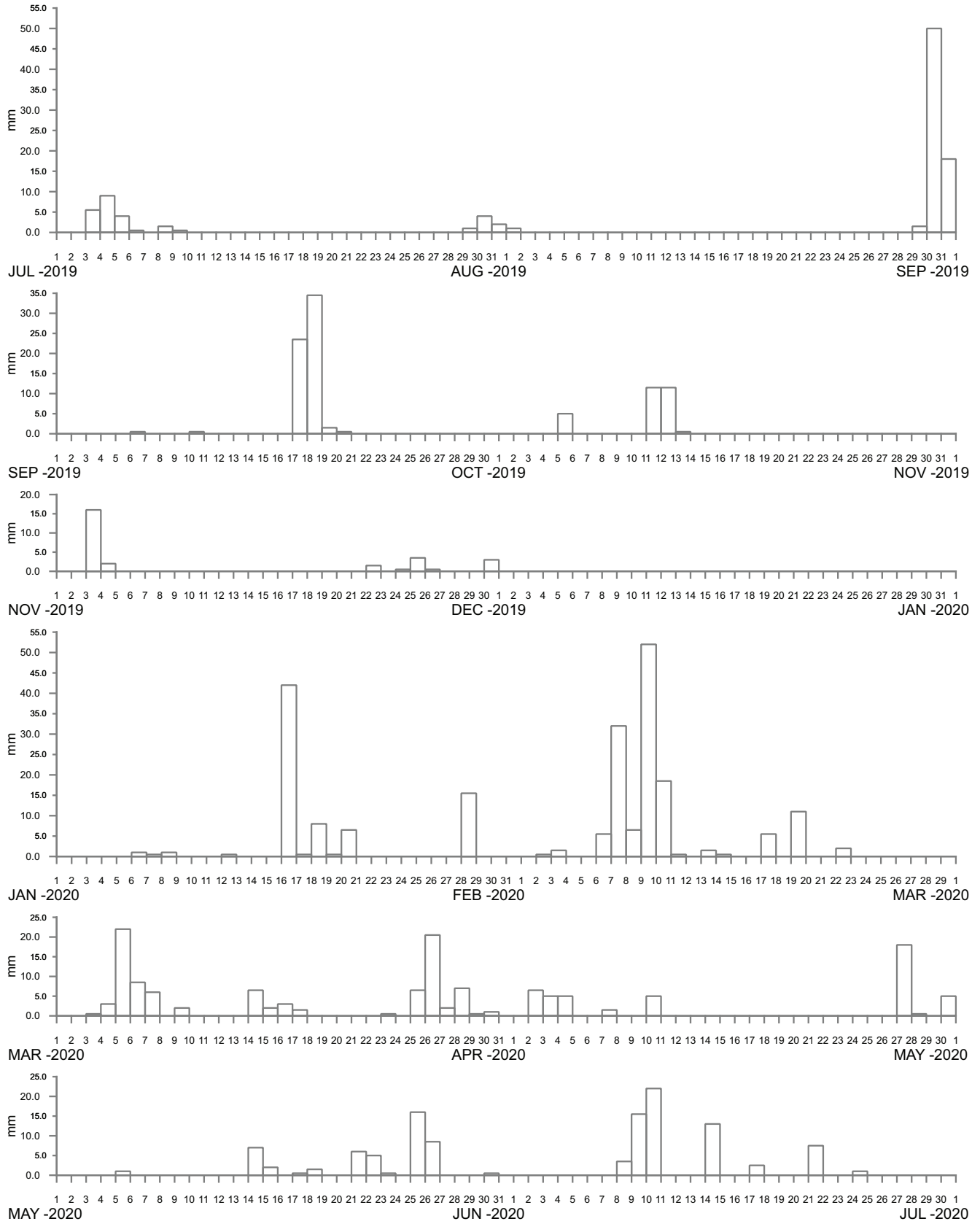
BELMORE BRIDGE AT HUNTER RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 40

DRAWING 2771-40.cdr



DATA LOSS

NSW GOVERNMENT

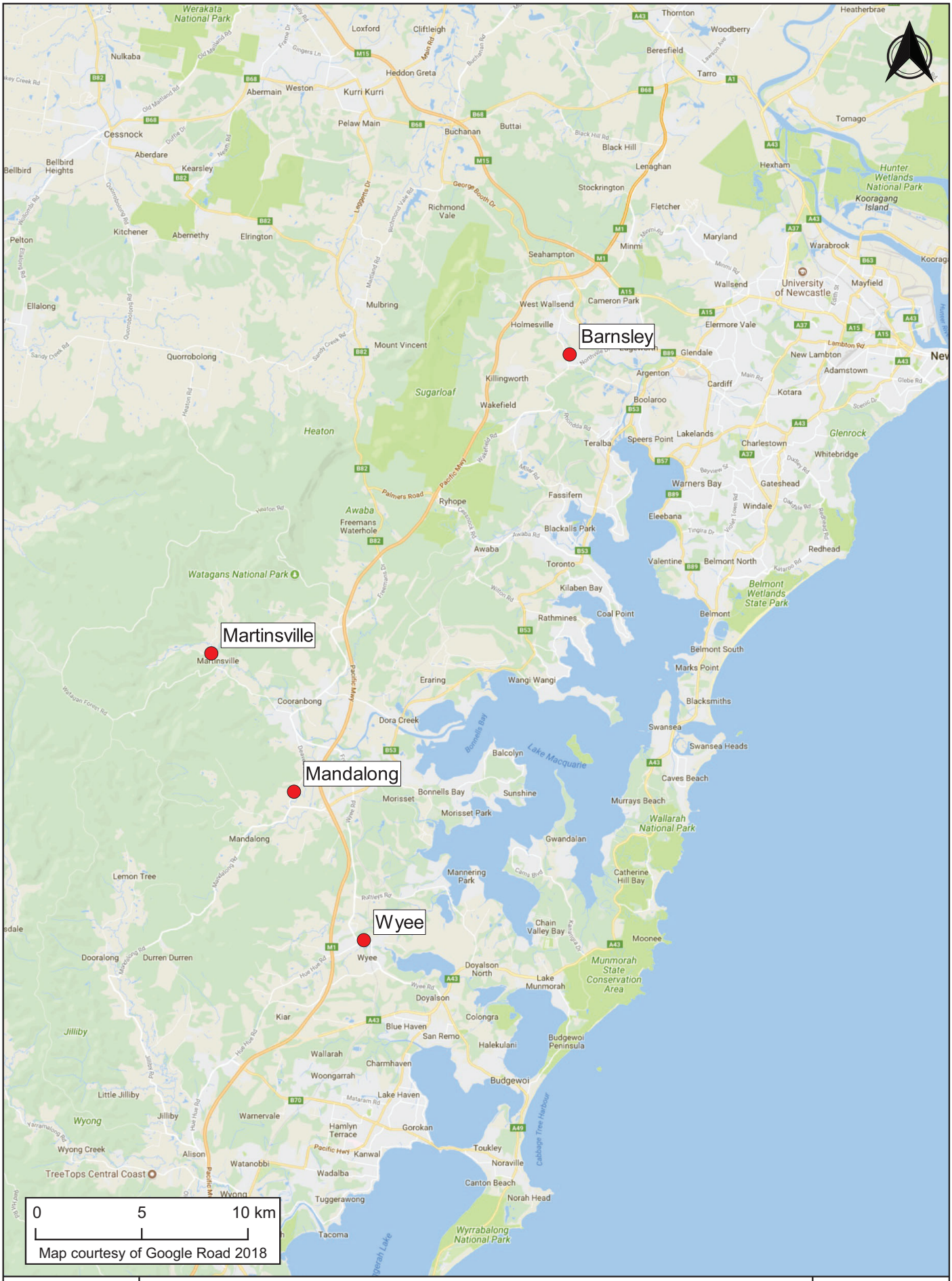
HEXHAM BRIDGE AT HUNTER RIVER
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 41

DRAWING 2771-41.cdr



NSW GOVERNMENT

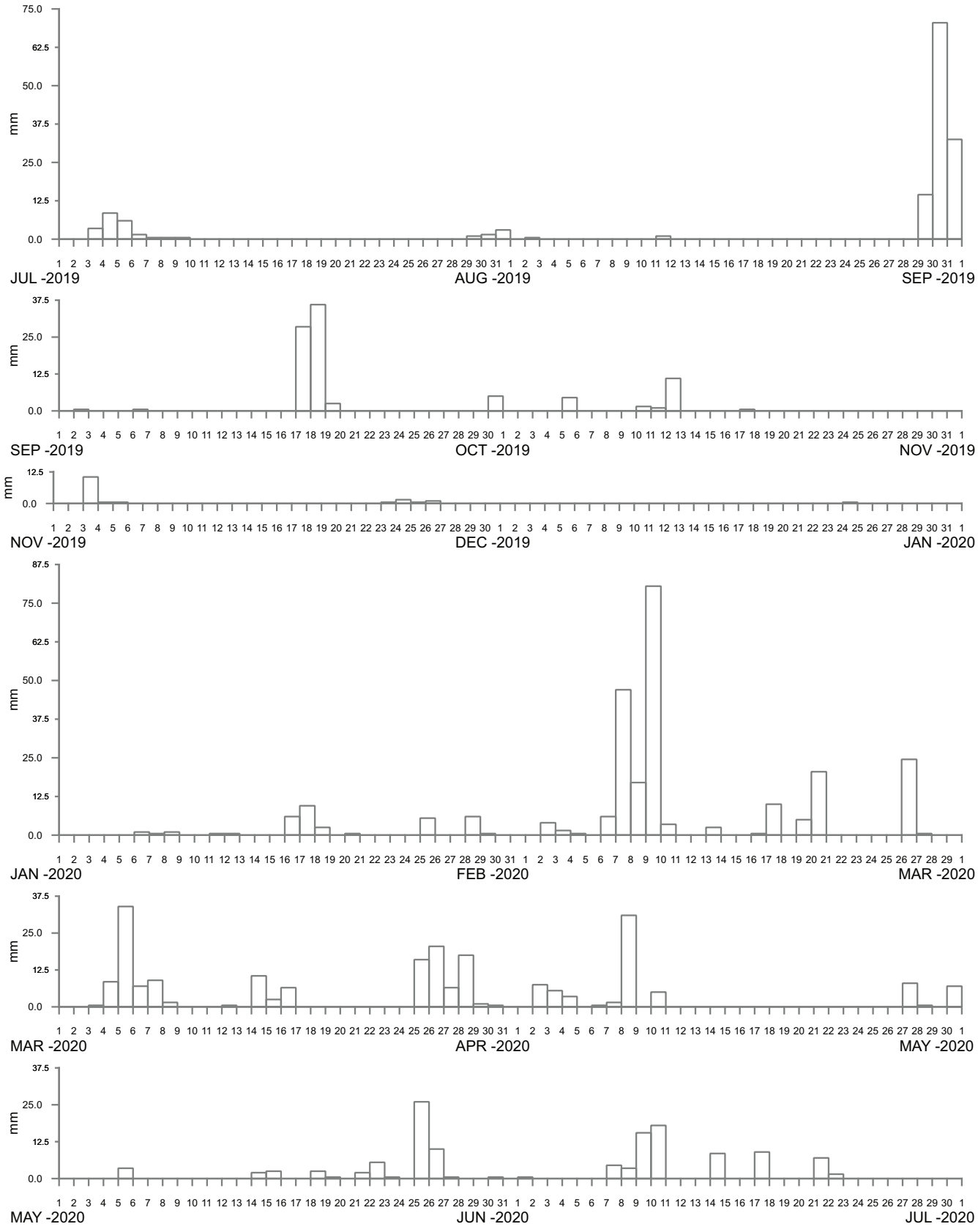
RAINFALL STATION LOCATIONS
MACQUARIE-TUGGERAH LAKES (NORTH) REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 42

DRAWING 2771-42.cdr



DATA LOSS

NSW GOVERNMENT

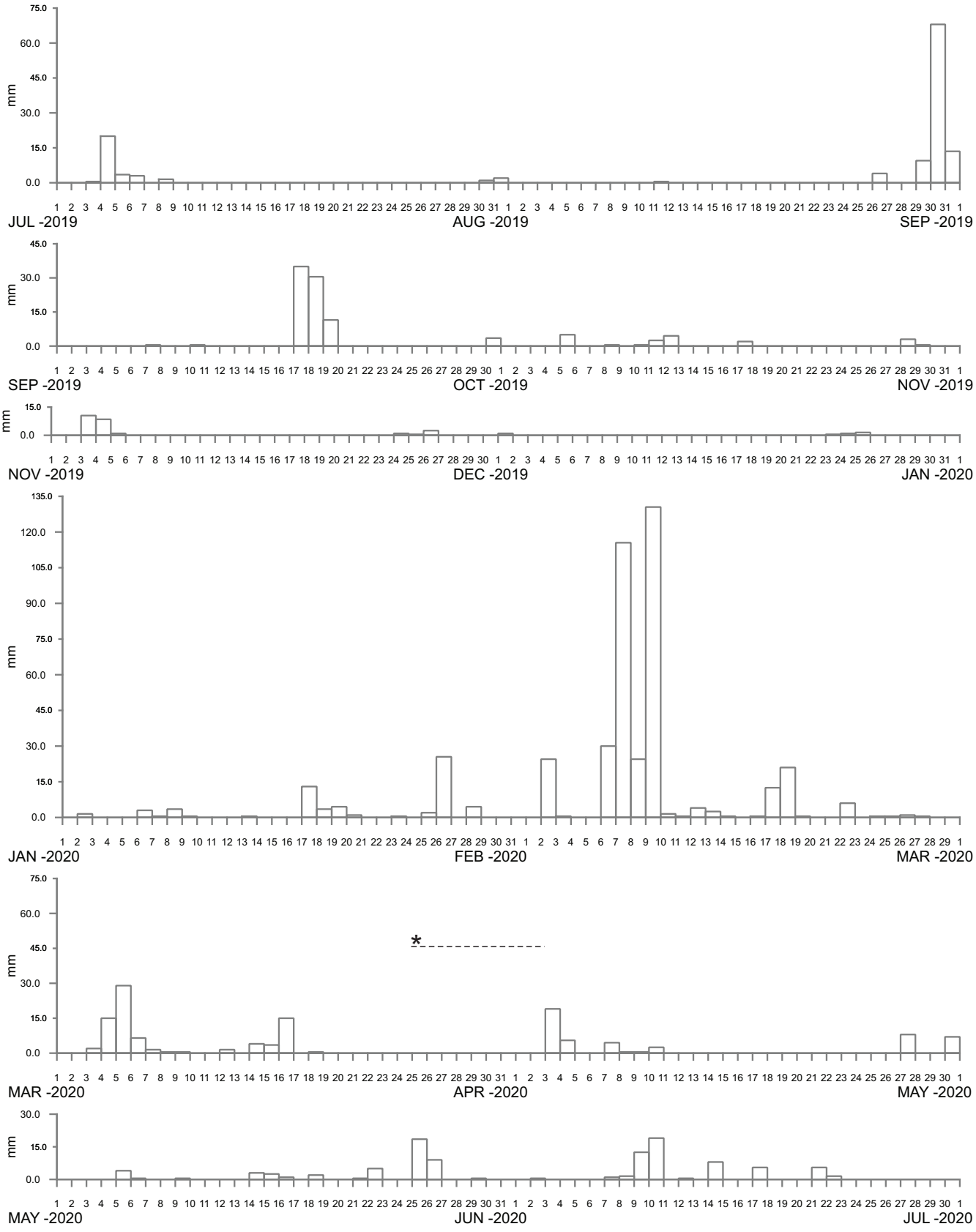
BARNSLEY AT JOHNSON AVENUE
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 43

DRAWING 2771-43.cdr



---------- DATA LOSS *Data loss due to blockage in tipping bucket

NSW GOVERNMENT

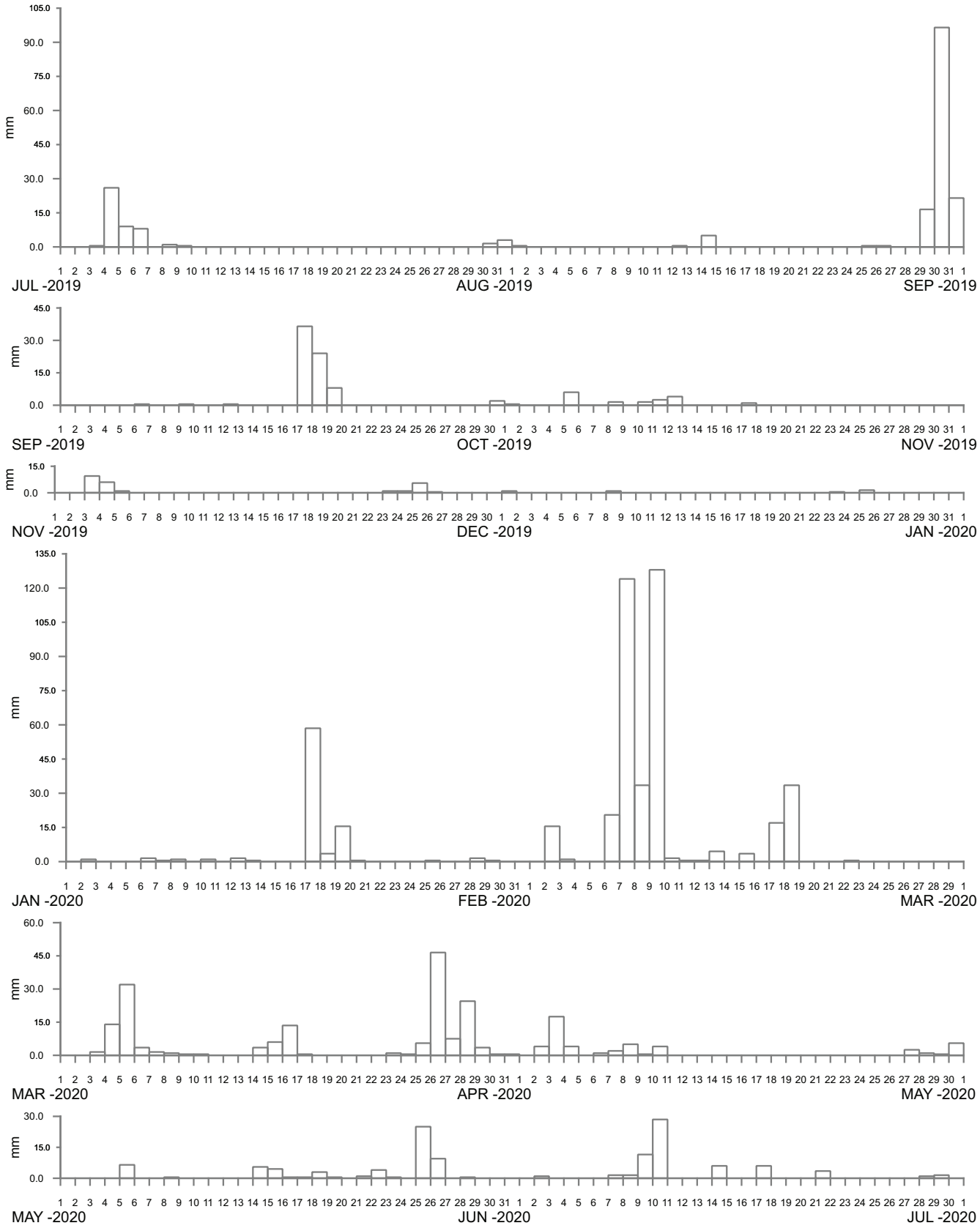
MARTINSVILLE AT MARTINSVILLE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 44

DRAWING 2771-44.cdr



DATA LOSS

NSW GOVERNMENT

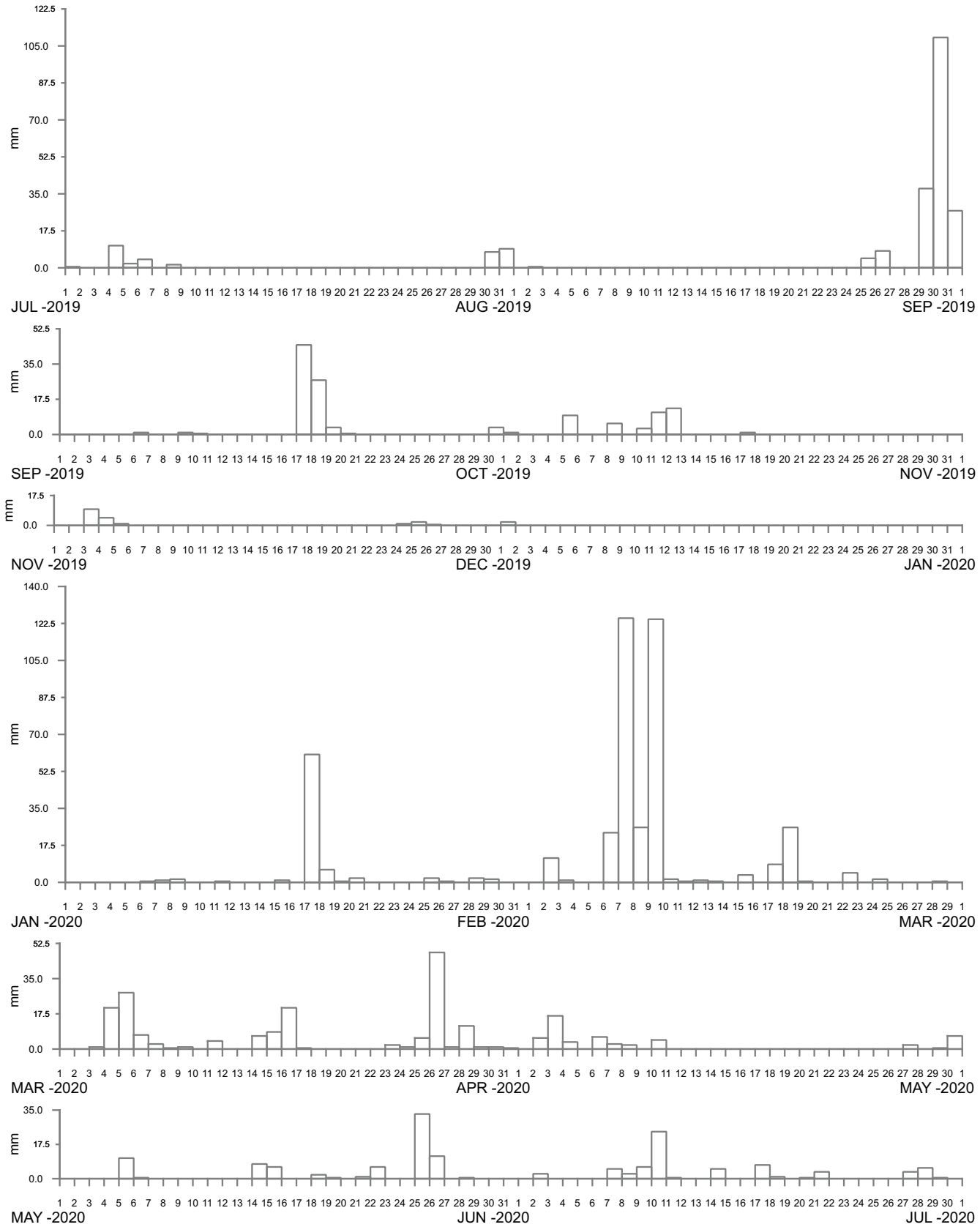
MANDALONG AT DEAVES ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 45

DRAWING 2771-45.cdr



WYEE AT COLLUNGRA STREET
2019–2020

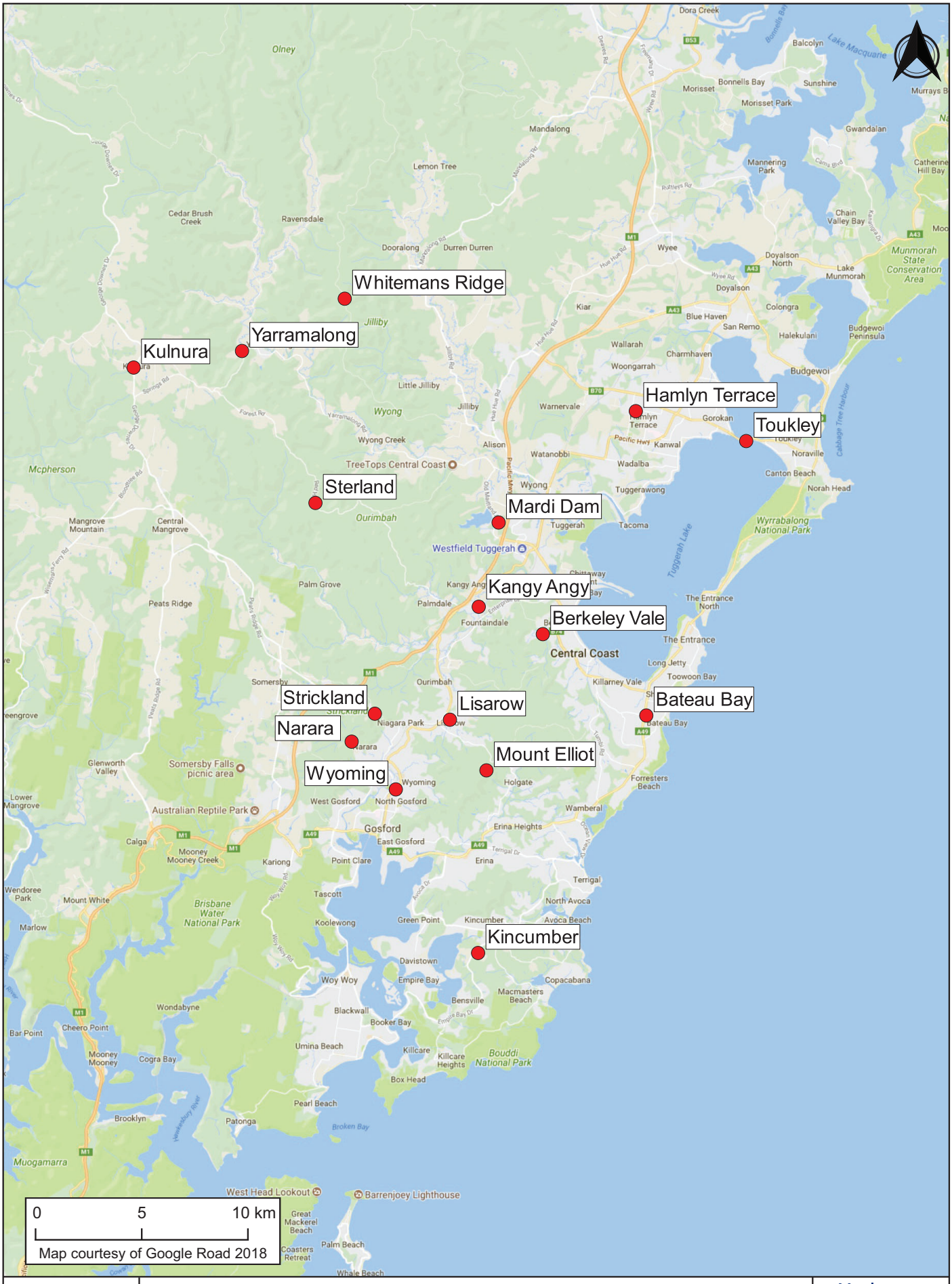
NSW GOVERNMENT

Manly Hydraulics Laboratory

Report MHL2771

Figure 46

DRAWING 2771-46.cdr



NSW GOVERNMENT

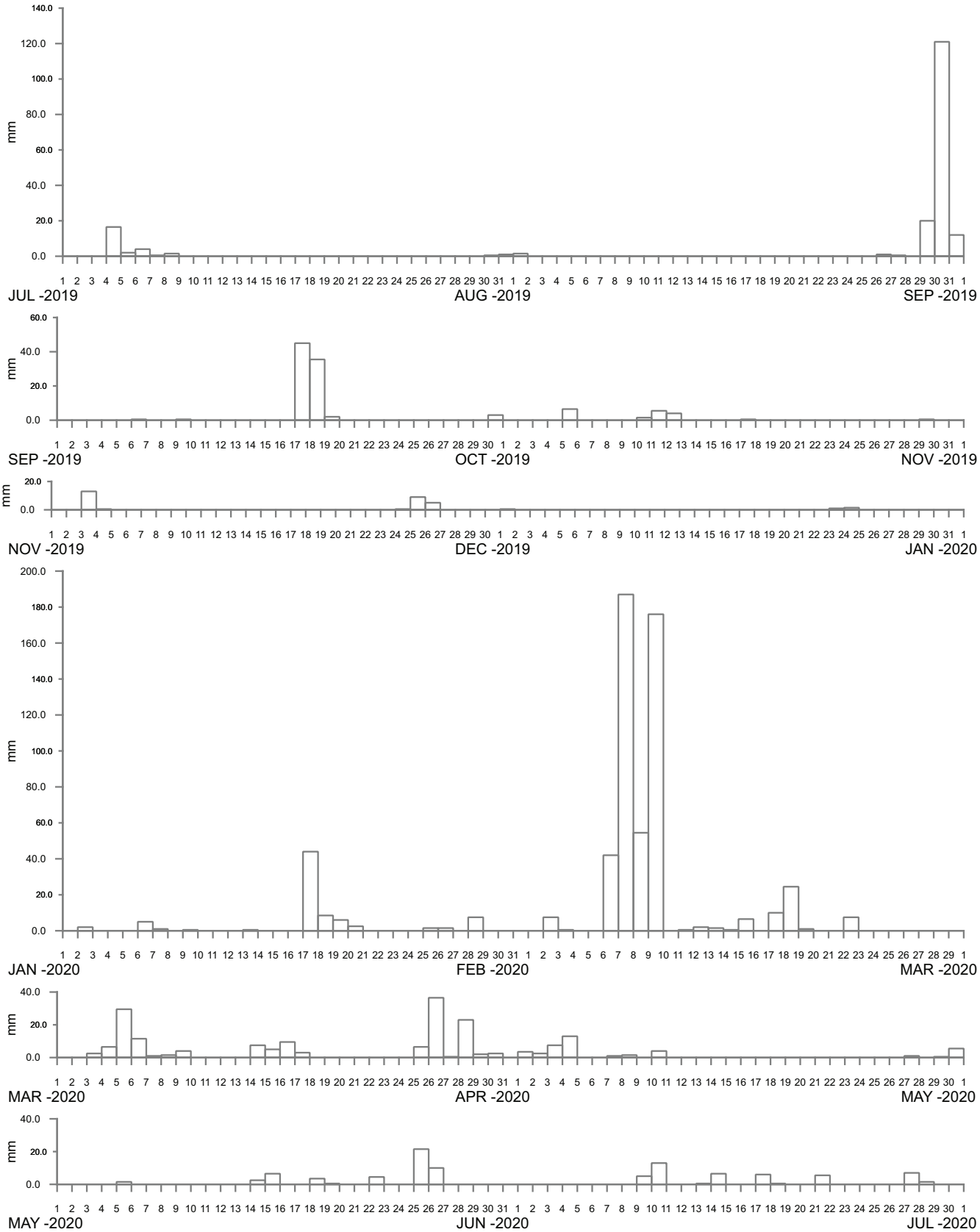
RAINFALL STATION LOCATIONS
MACQUARIE-TUGGERAH LAKES (SOUTH) AND BRISBANE WATER REGIONS

Manly Hydraulics Laboratory

Report MHL2771

Figure 47

DRAWING 2771-47.cdr



DATA LOSS

NSW GOVERNMENT

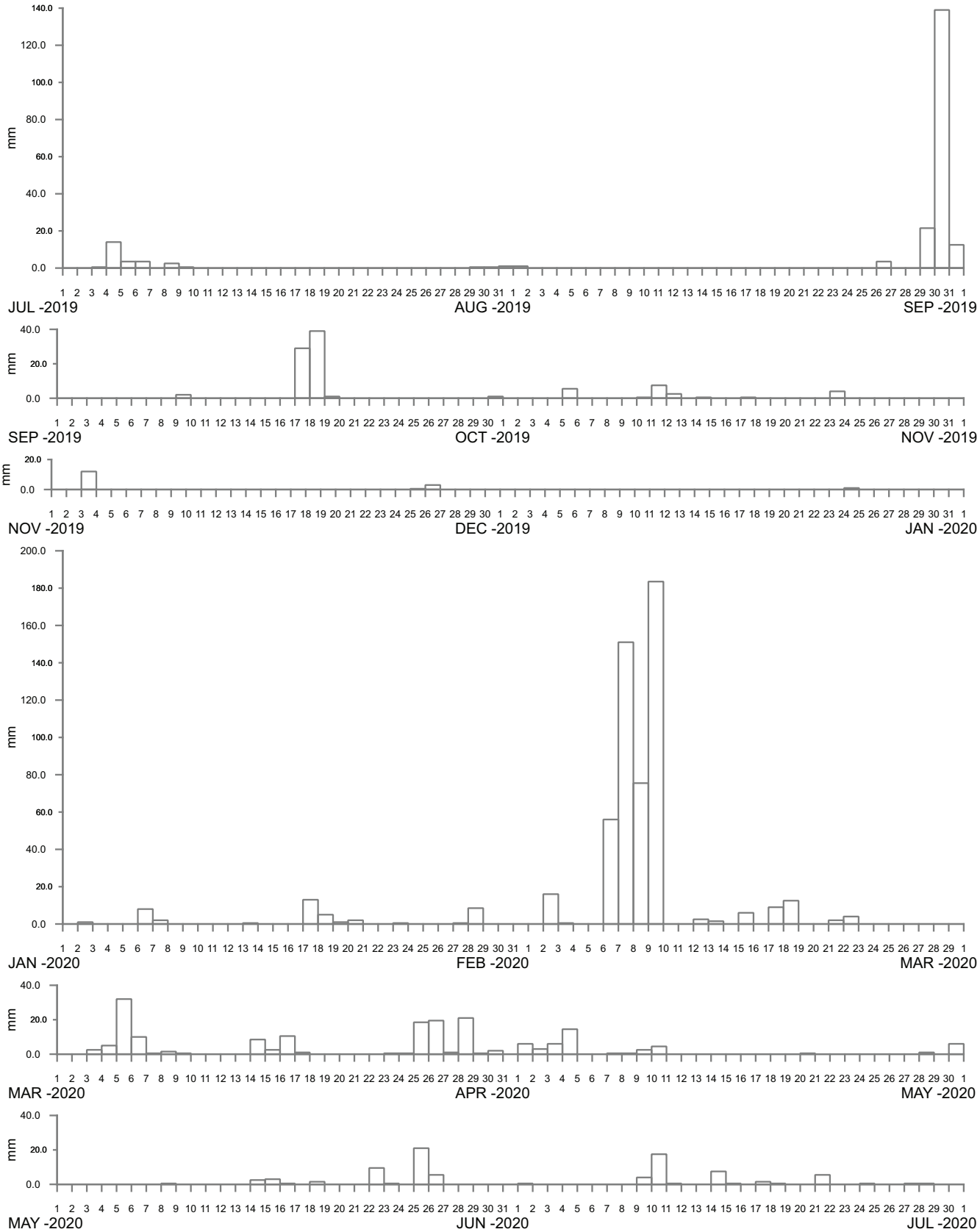
WHITEMANS RIDGE AT WATAGANS FOREST DRIVE
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 48

DRAWING 2771-48.cdr



DATA LOSS

NSW GOVERNMENT

YARRAMALONG AT BUMBLE HILL ROAD
2019–2020

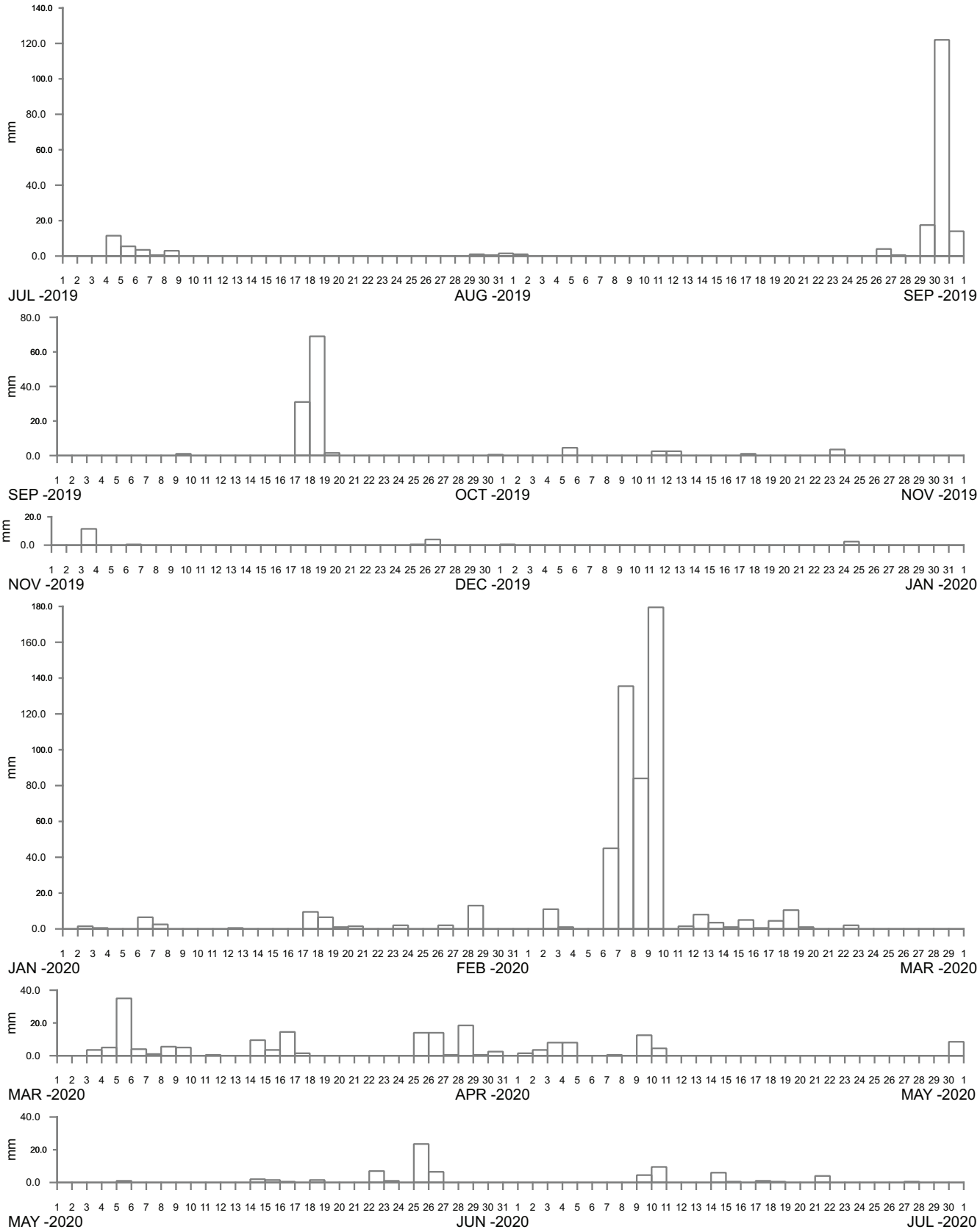
Manly Hydraulics Laboratory

Report MHL2771

Figure

49

DRAWING 2771-49.cdr



DATA LOSS

NSW GOVERNMENT

KULNURA AT GEORGE DOWNS DRIVE
2019–2020

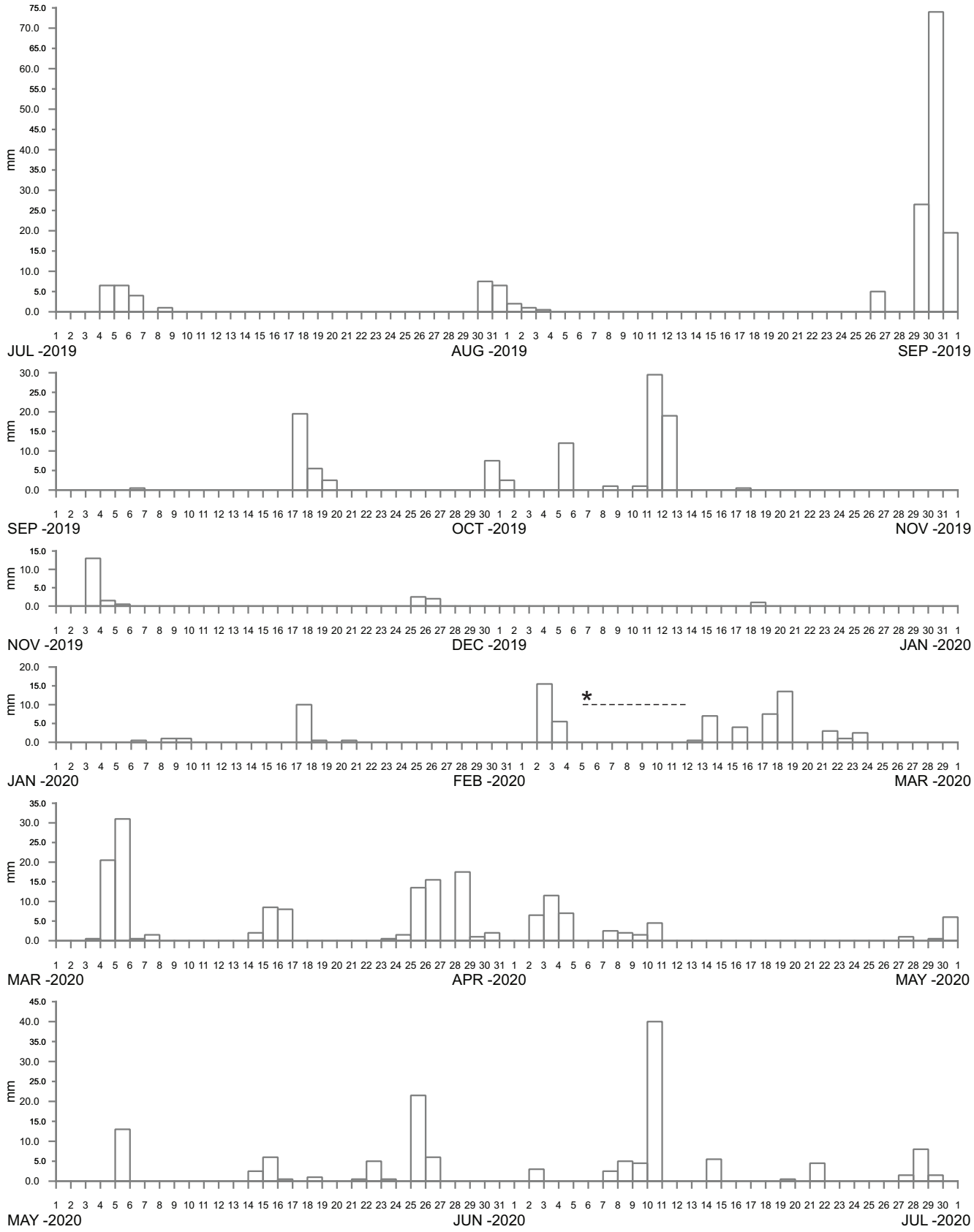
Manly Hydraulics Laboratory

Report MHL2771

Figure

50

DRAWING 2771-50.cdr



---------- DATA LOSS

*Excess rainfall tips removed due to an electrical fault

NSW GOVERNMENT

TOUKLEY AT TUGGERAH LAKE
2019–2020

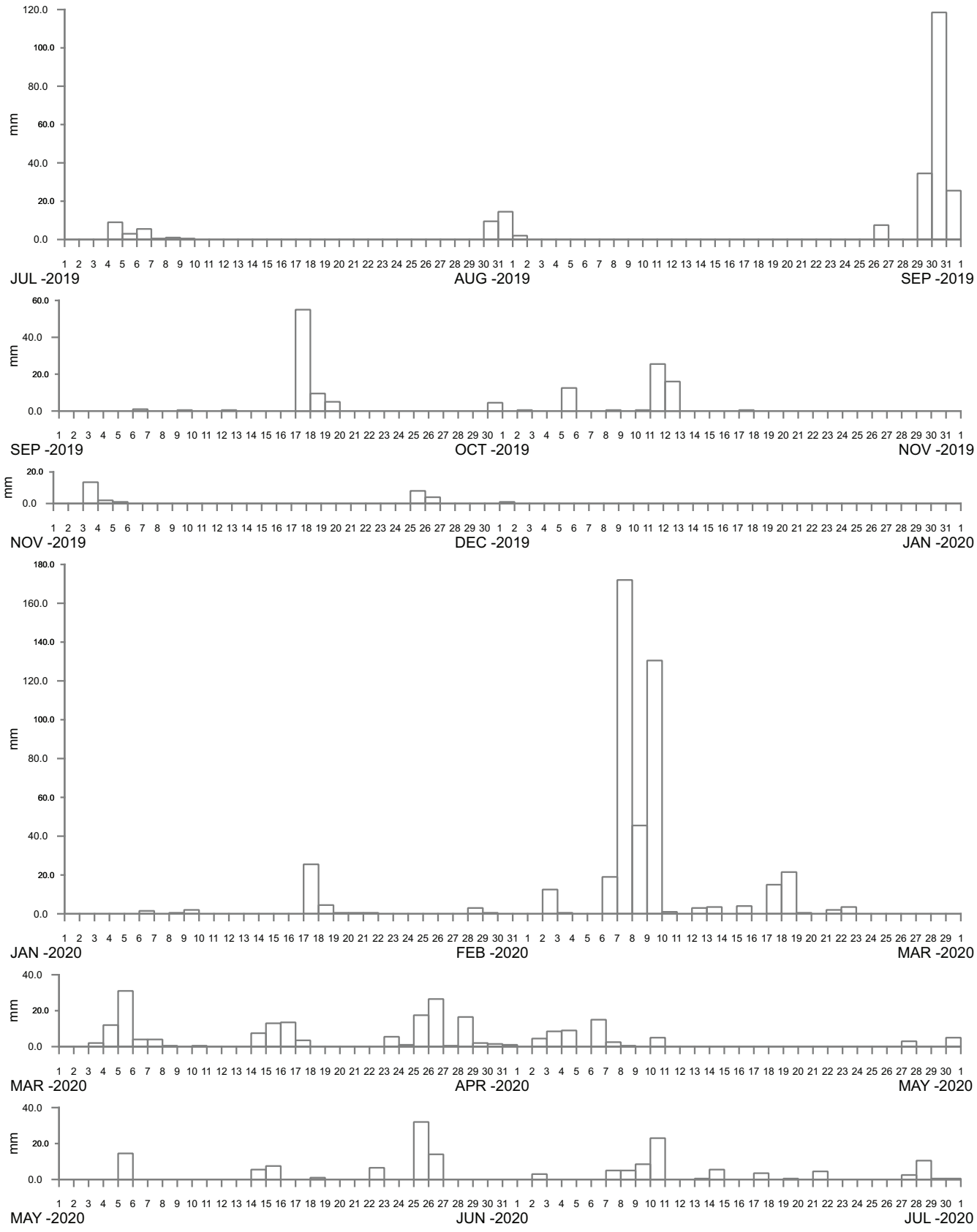
Manly Hydraulics Laboratory

Report MHL2771

Figure

51

DRAWING 2771-51.cdr



DATA LOSS

NSW GOVERNMENT

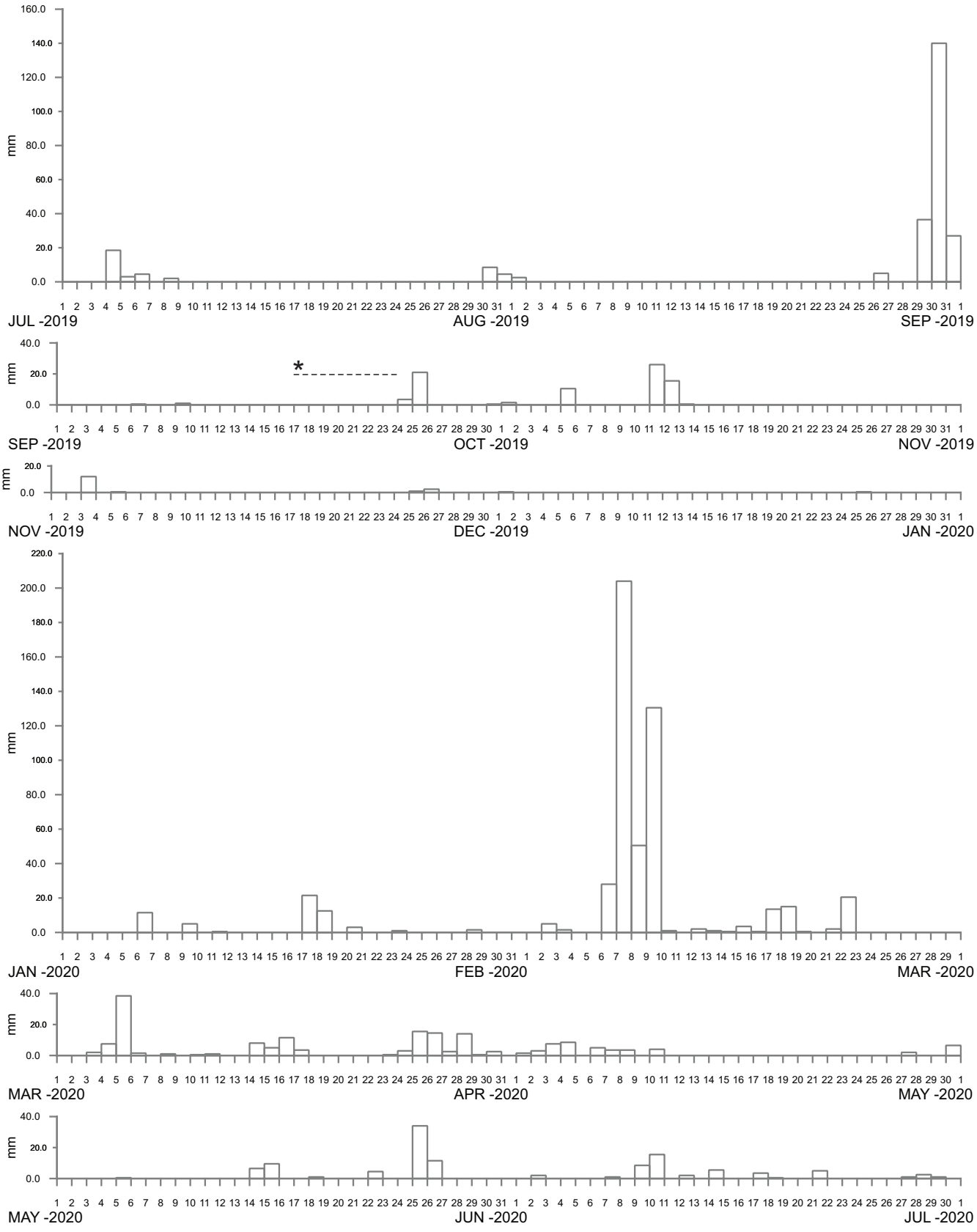
HAMLYN TERRACE AT WARNERVALE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 52

DRAWING 2771-52.cdr



---------- DATA LOSS

*Data loss due to blockage in tipping bucket

NSW GOVERNMENT

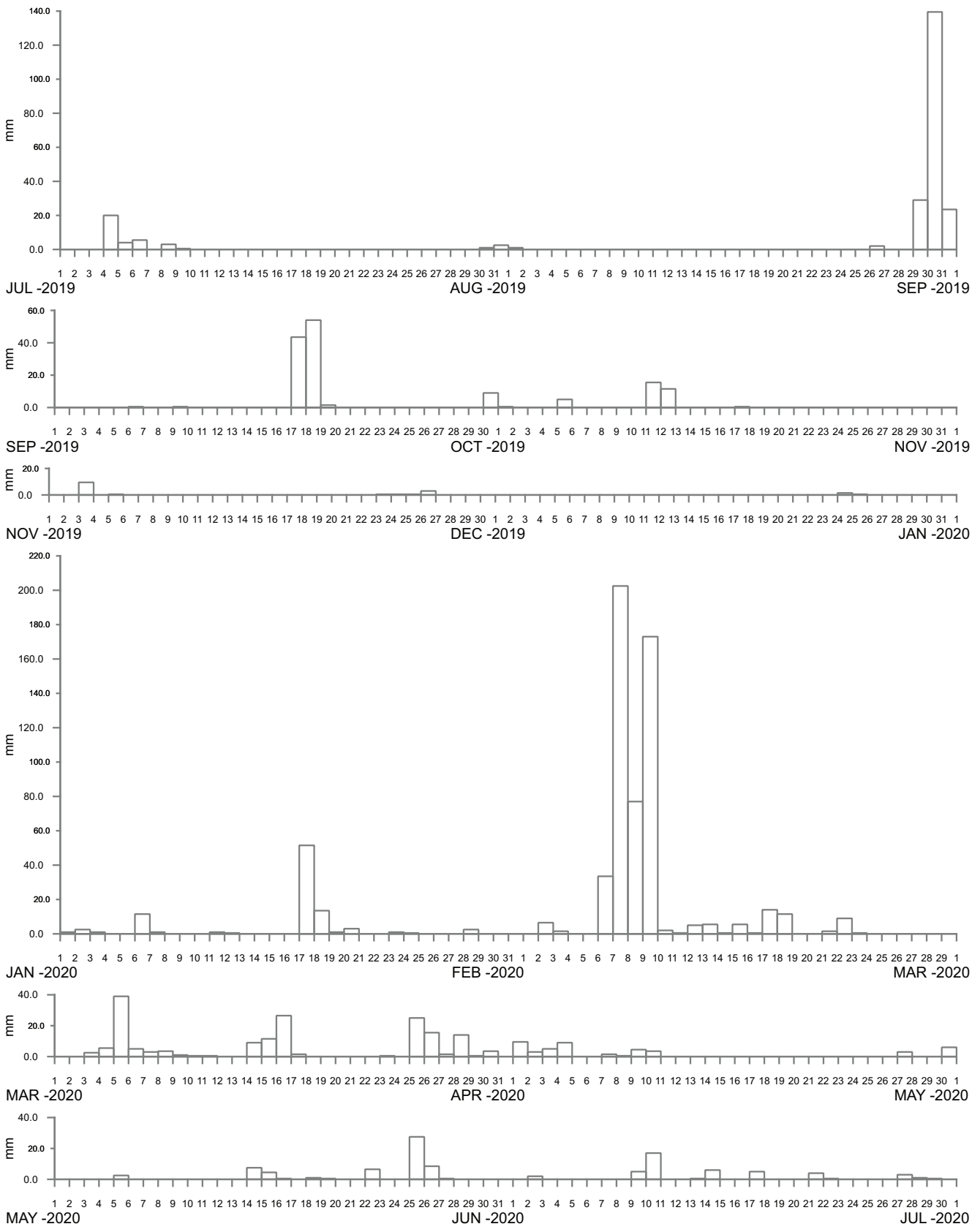
MARDI DAM AT OLD MAITLAND ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 53

DRAWING 2771-53.cdr



DATA LOSS

NSW GOVERNMENT

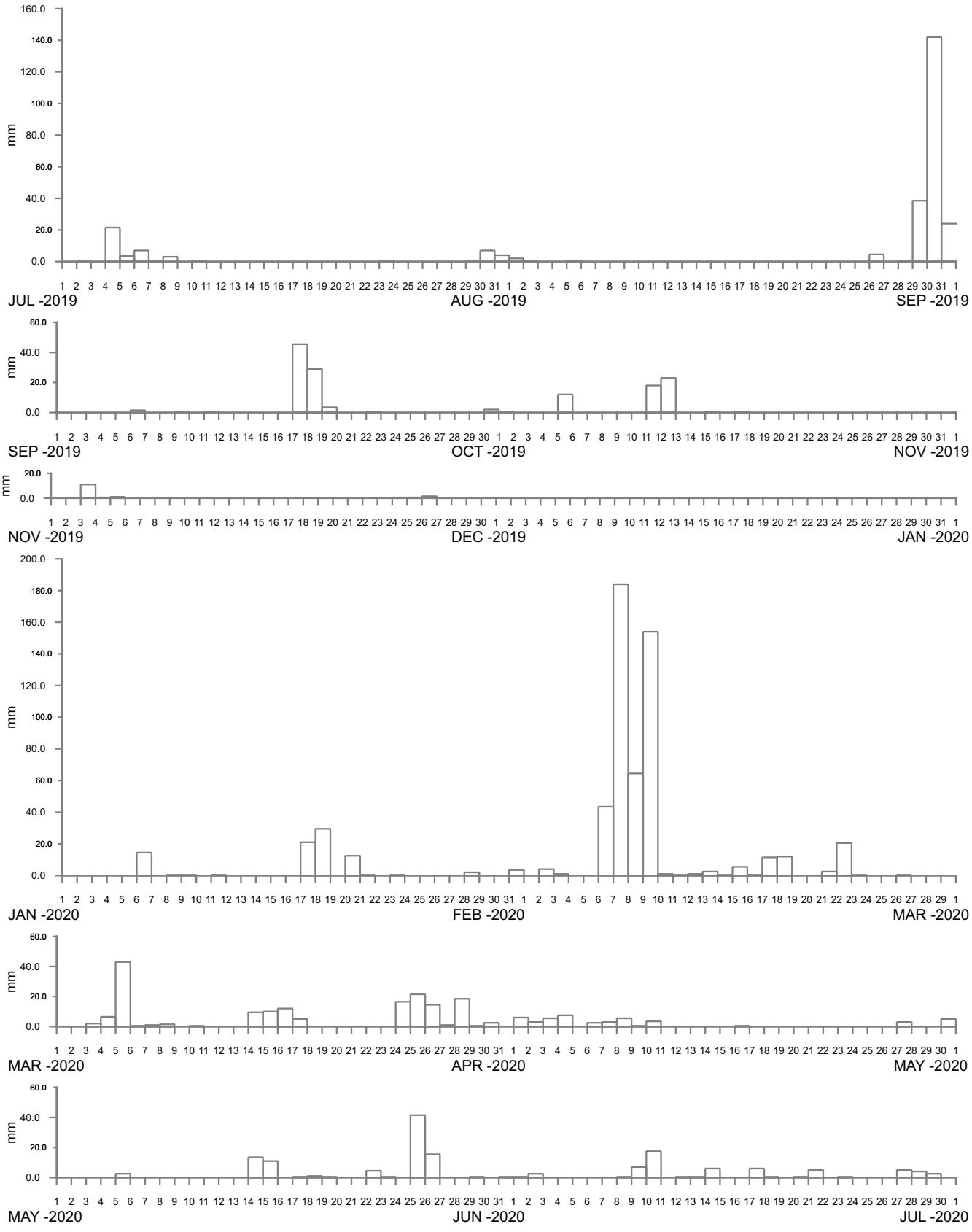
STERLAND AT RED HILL FOREST ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 54

DRAWING 2771-54.cdr



NSW GOVERNMENT

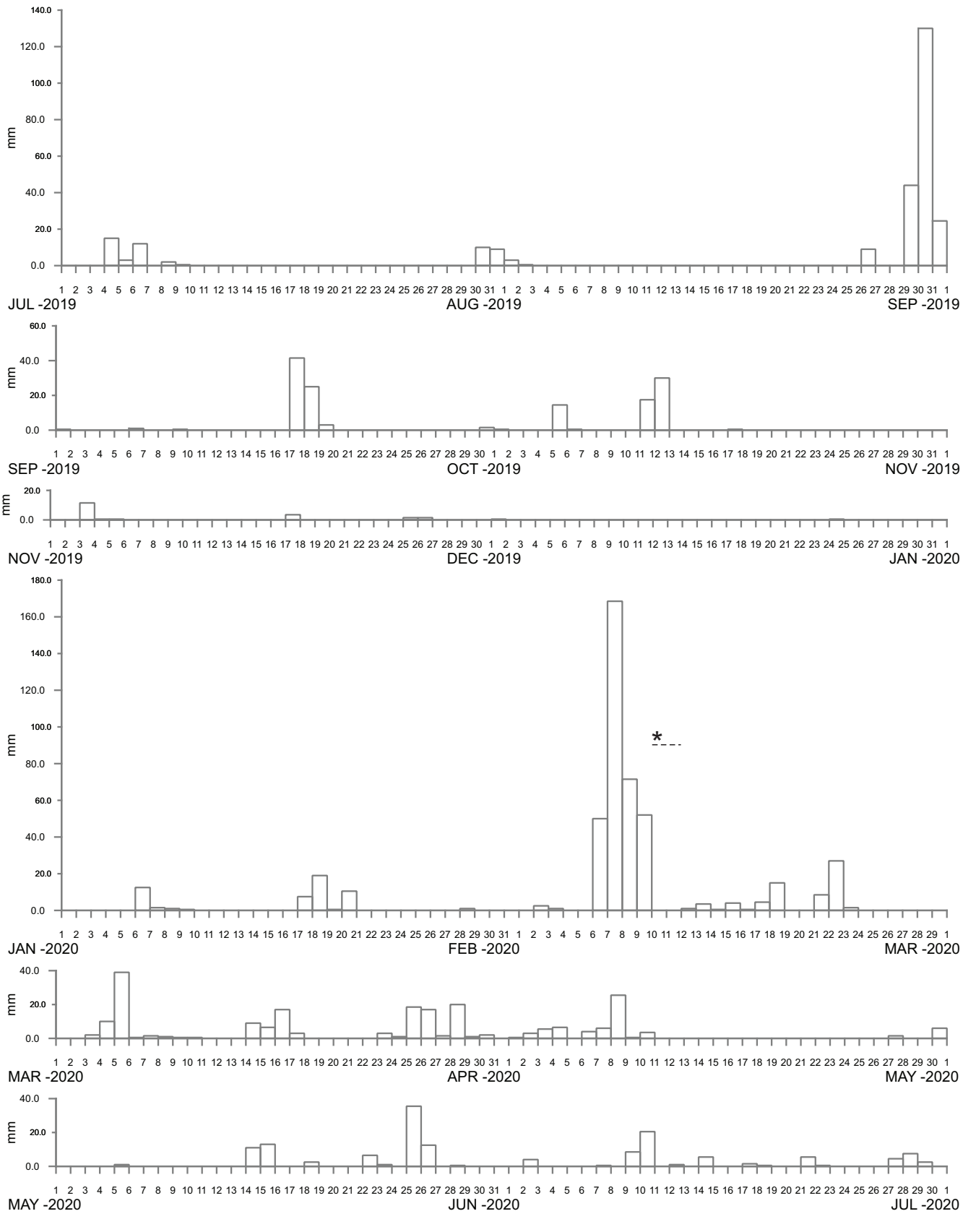
KANGY ANGY AT ORCHARD ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 55

DRAWING 2771-55.cdr



DATA LOSS

*Excess rainfall tips removed due to an electrical fault

NSW GOVERNMENT

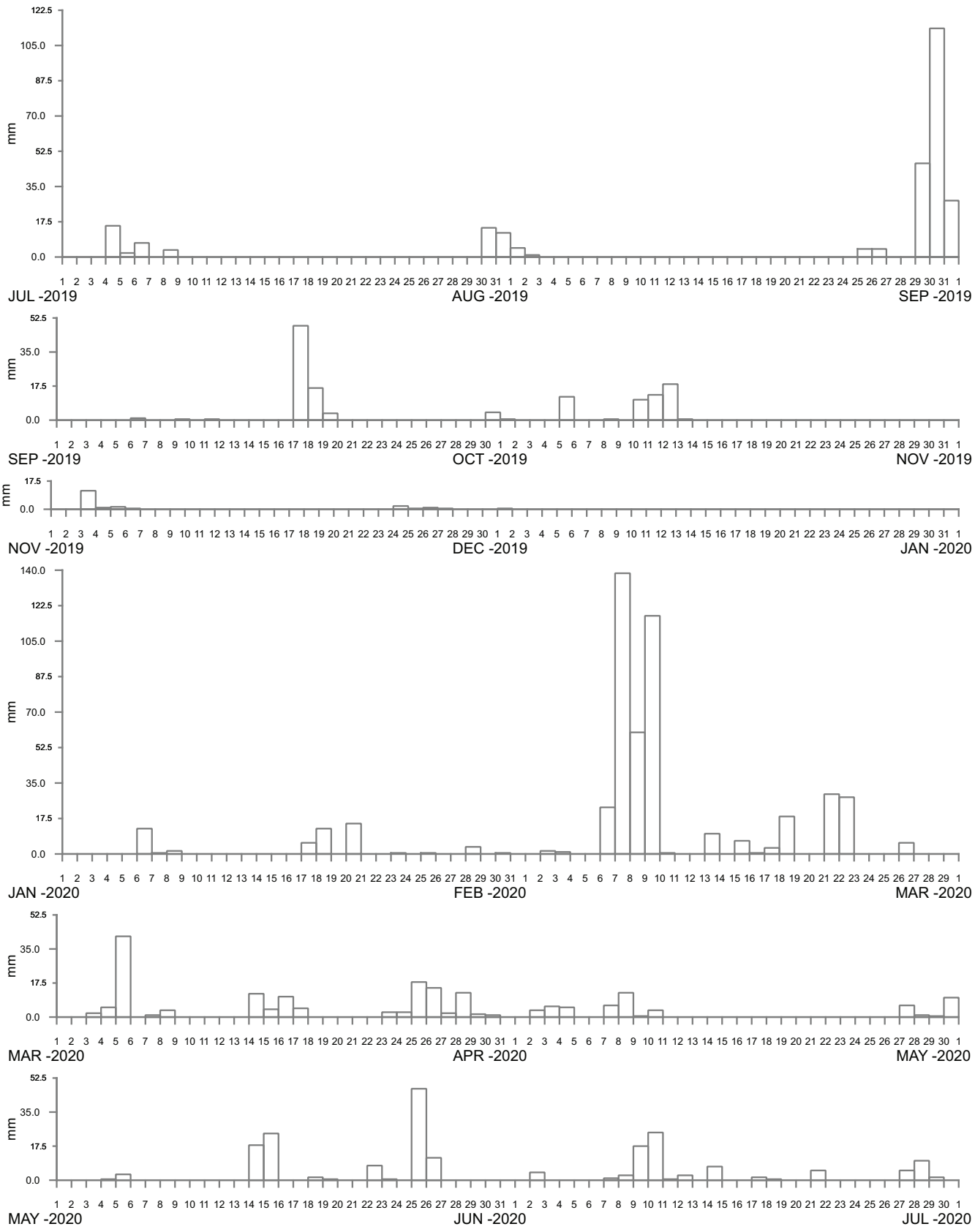
BERKELEY VALE AT BERKELEY VALE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 56

DRAWING 2771-56.cdr



DATA LOSS

NSW GOVERNMENT

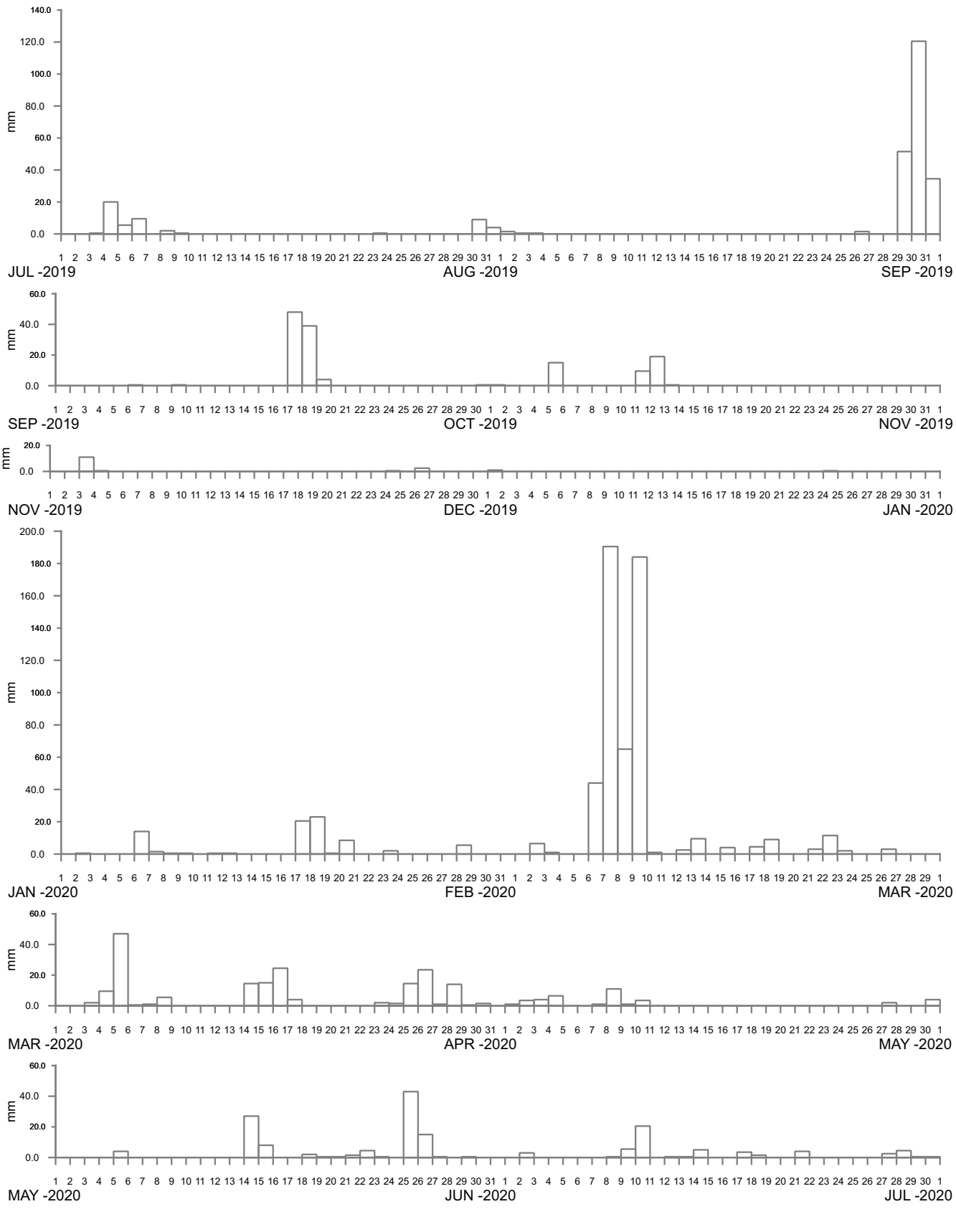
BATEAU BAY AT SEWAGE TREATMENT WORKS 2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 57

DRAWING 2771-57.cdr



DATA LOSS

NSW GOVERNMENT

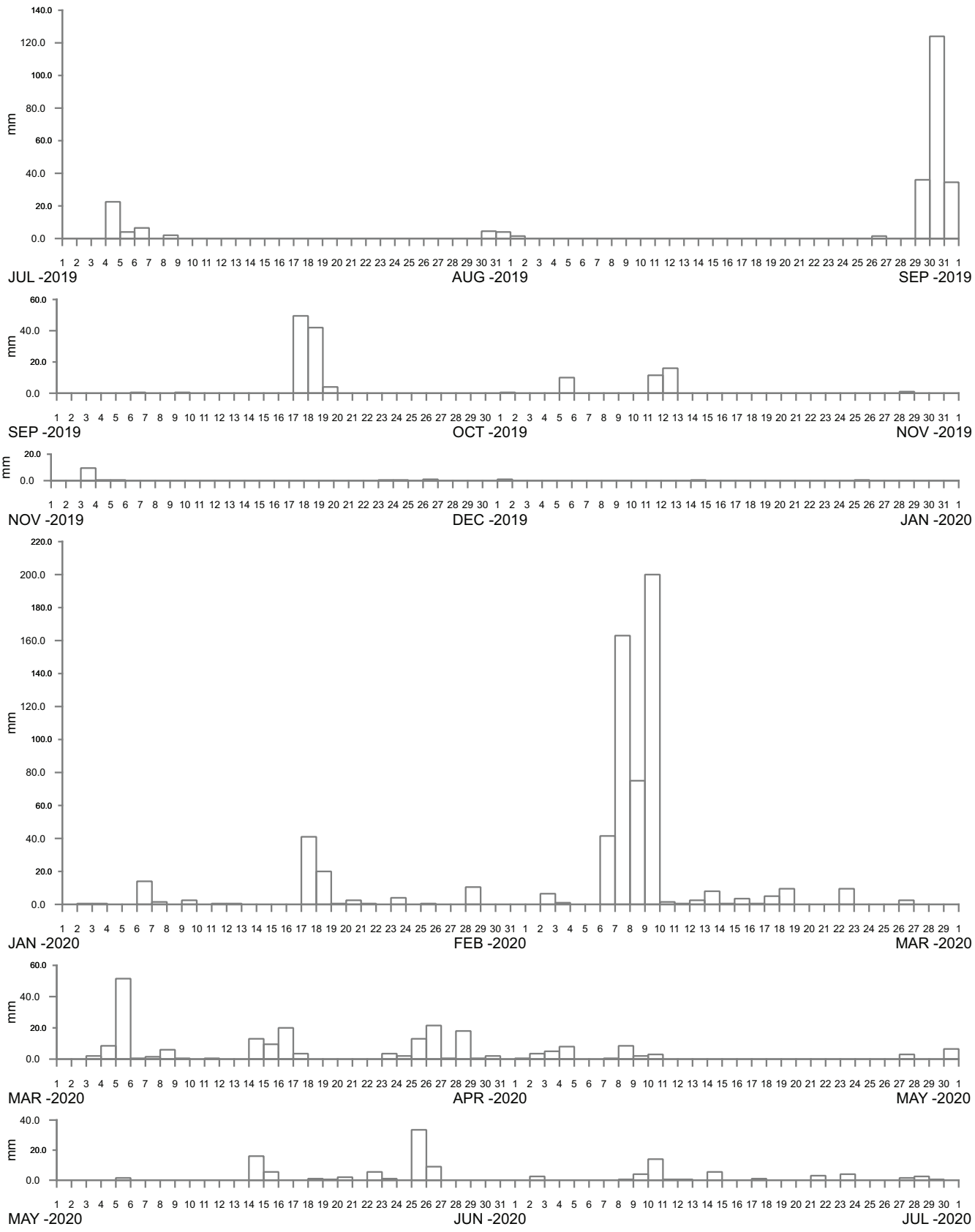
LISAROW AT FAGANS ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 58

DRAWING 2771-58.cdr



NSW GOVERNMENT

STRICKLAND AT MANGROVE ROAD
2019–2020

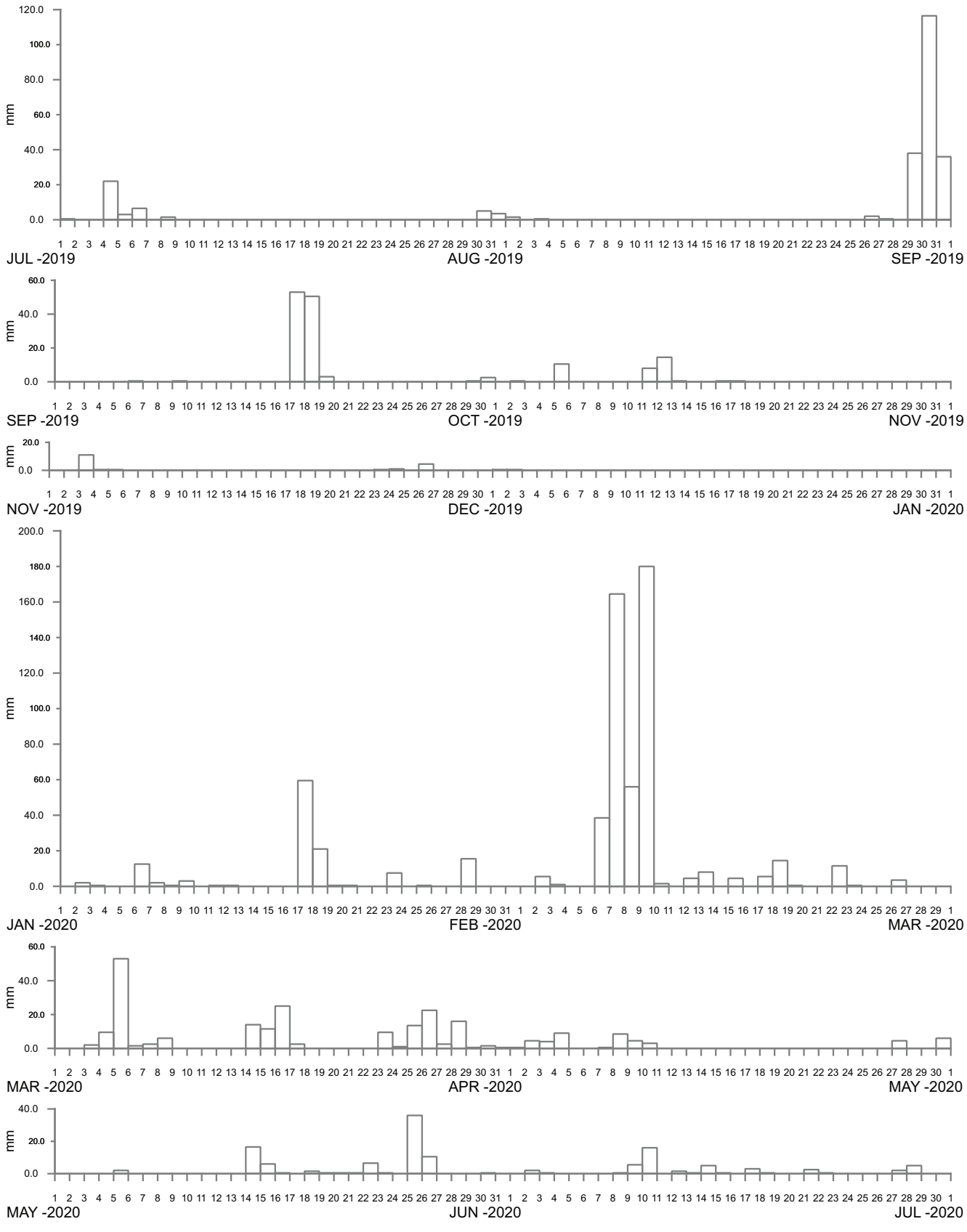
Manly Hydraulics Laboratory

Report MHL2771

Figure

59

DRAWING 2771-59.cdr



DATA LOSS

NSW GOVERNMENT

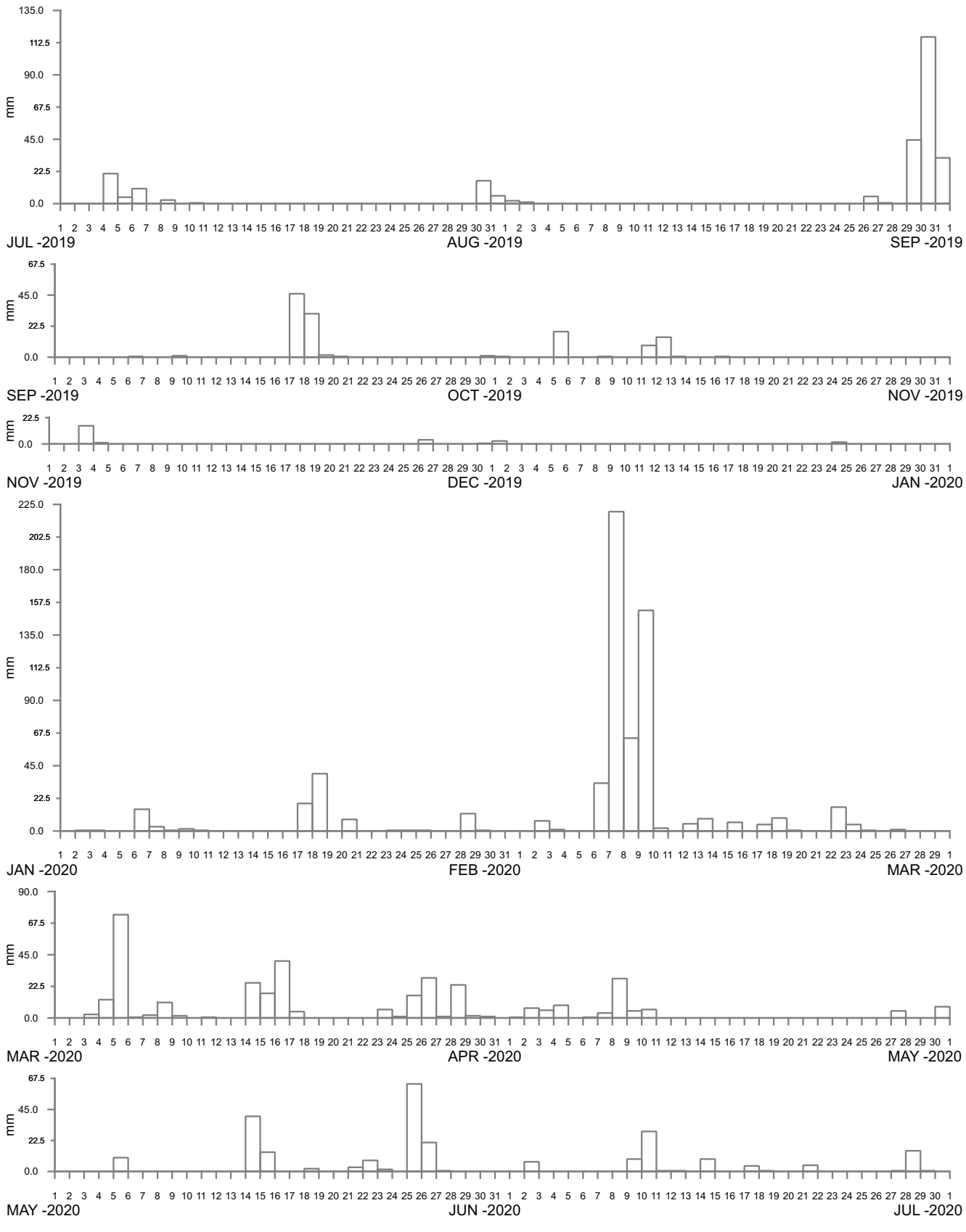
NARARA AT RESEARCH ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 60

DRAWING 2771-60.cdr



DATA LOSS

NSW GOVERNMENT

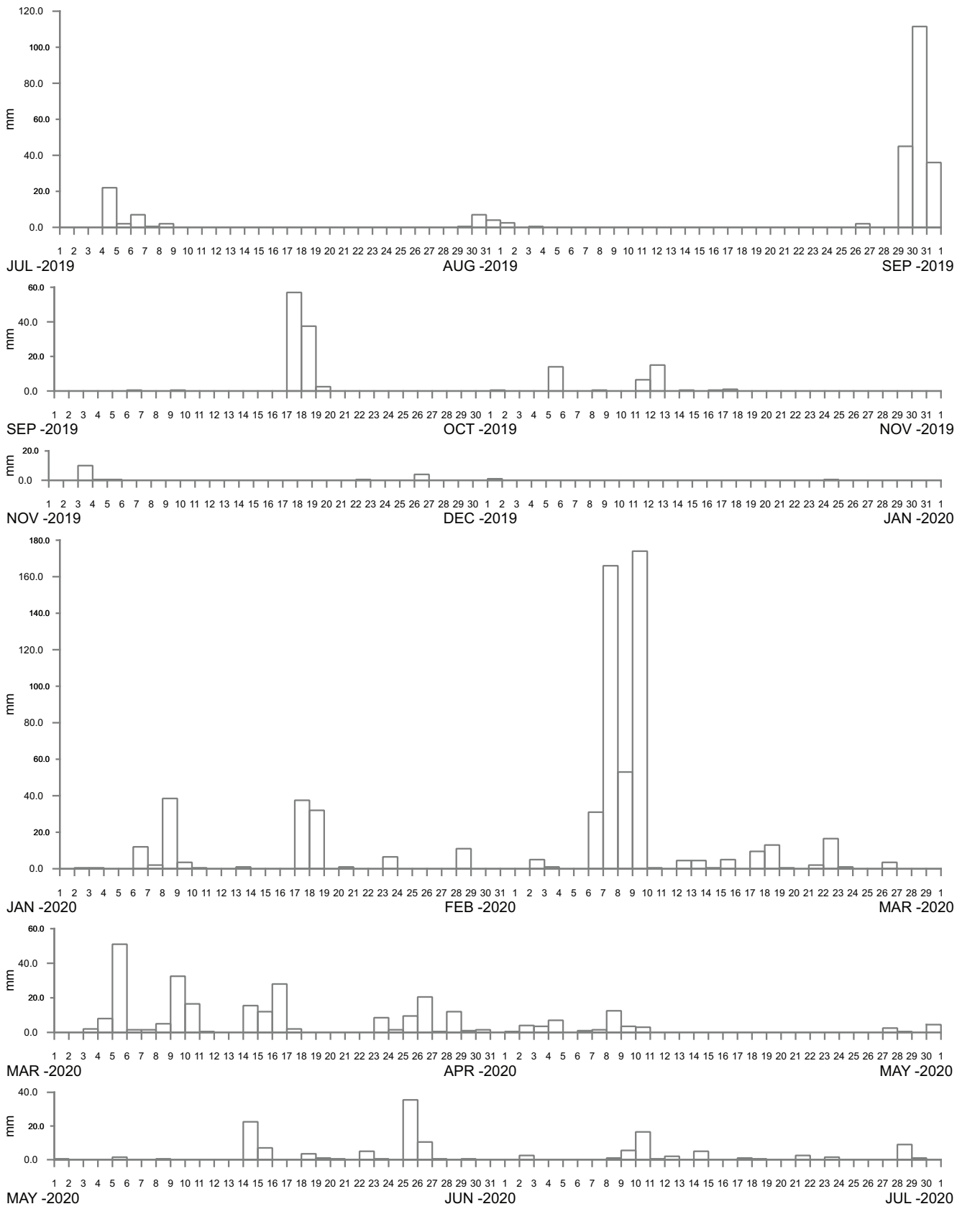
MOUNT ELLIOT AT TOOMEYS ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 61

DRAWING 2771-61.cdr



DATA LOSS

NSW GOVERNMENT

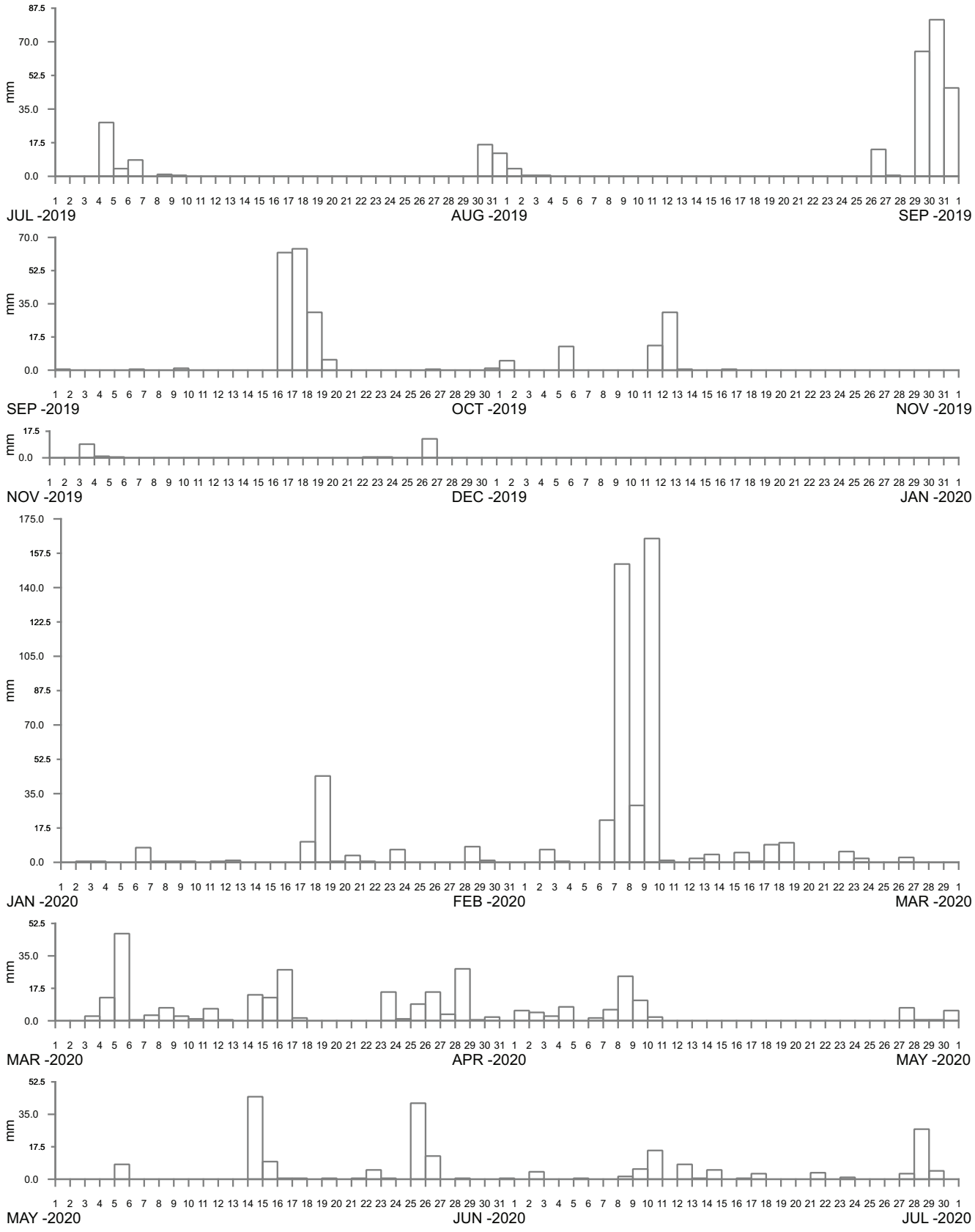
WYOMING AT LAYCOCK STREET
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 62

DRAWING 2771-62.cdr



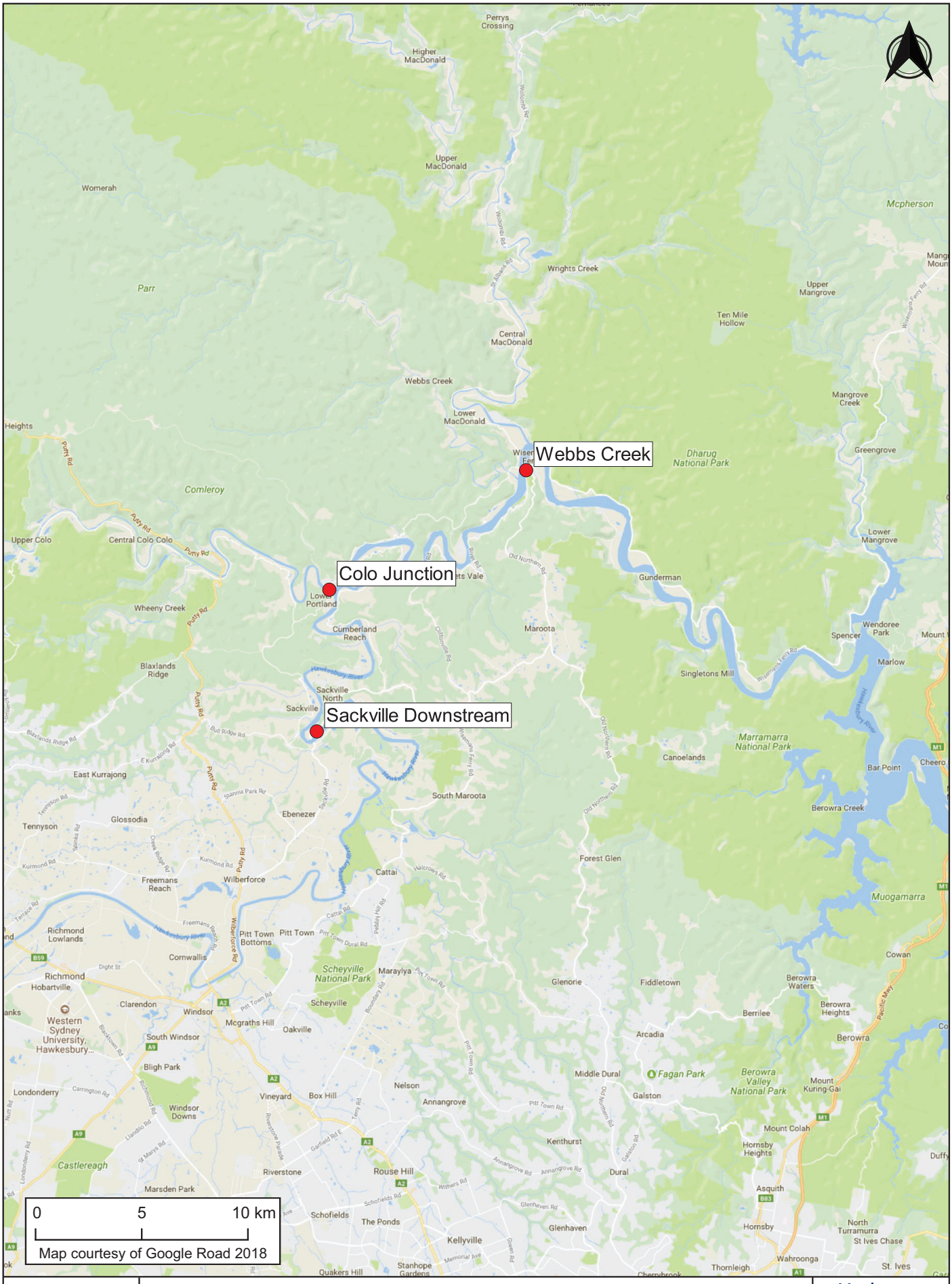
KINCUMBER AT DOYLE STREET
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 63

DRAWING 2771-63.cdr



NSW GOVERNMENT

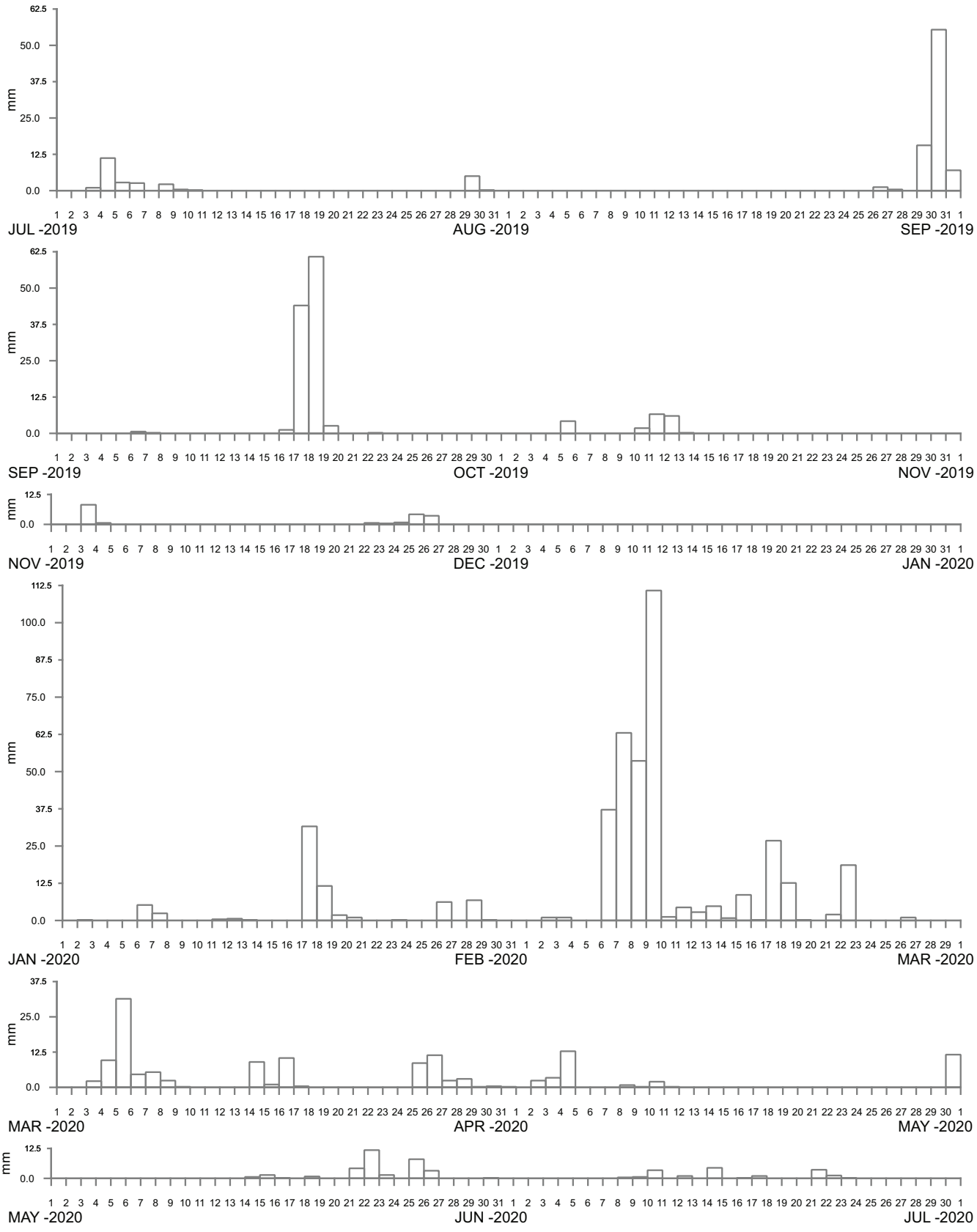
RAINFALL STATION LOCATIONS
HAWKESBURY RIVER REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 64

DRAWING 2771-64.cdr



DATA LOSS

NSW GOVERNMENT

WEBBS CREEK AT HAWKESBURY RIVER
2019–2020

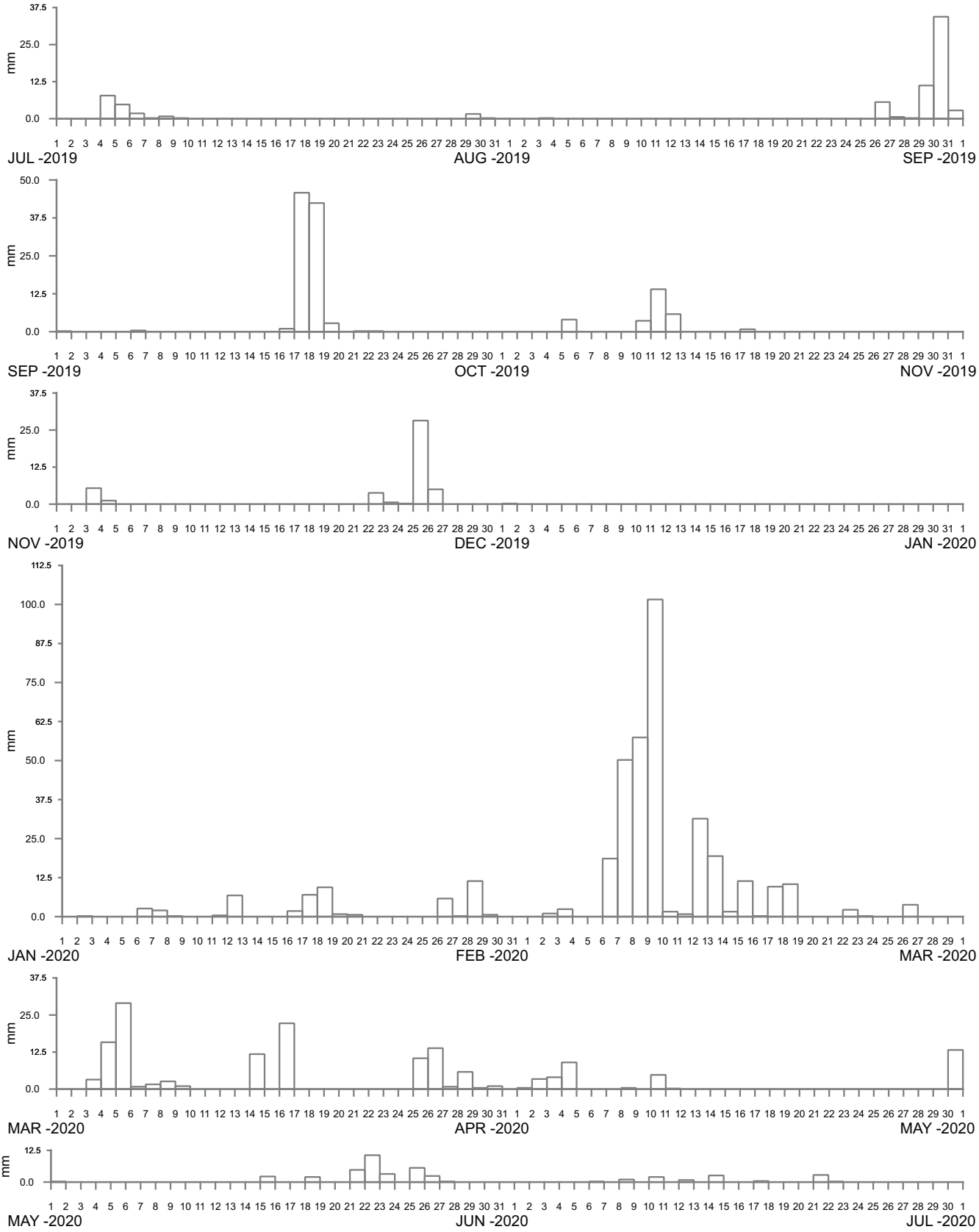
Manly Hydraulics Laboratory

Report MHL2771

Figure

65

DRAWING 2771-65.cdr



NSW GOVERNMENT

COLO JUNCTION AT HAWKESBURY RIVER
2019–2020

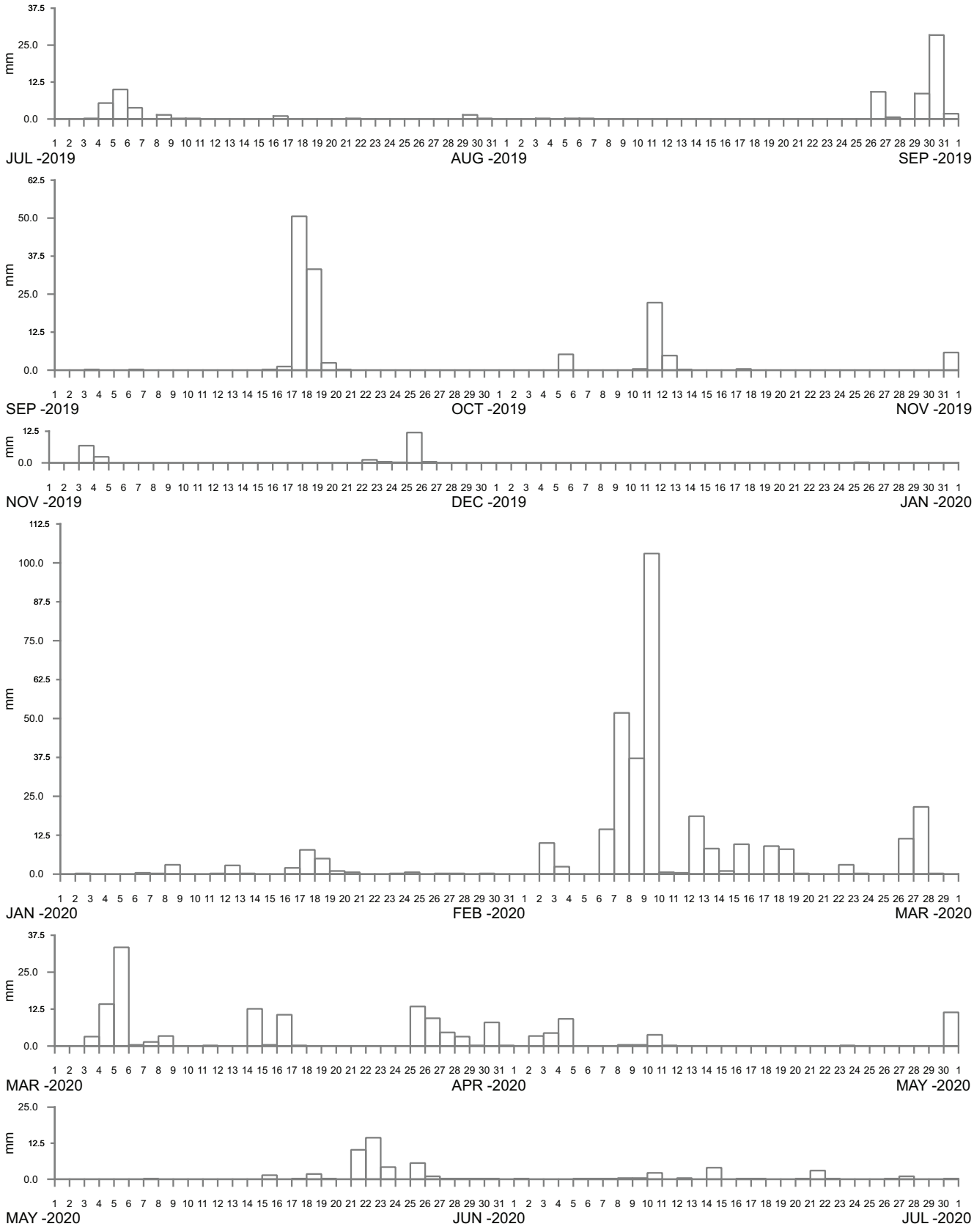
Manly Hydraulics Laboratory

Report MHL2771

Figure

66

DRAWING 2771-66.cdr



NSW GOVERNMENT

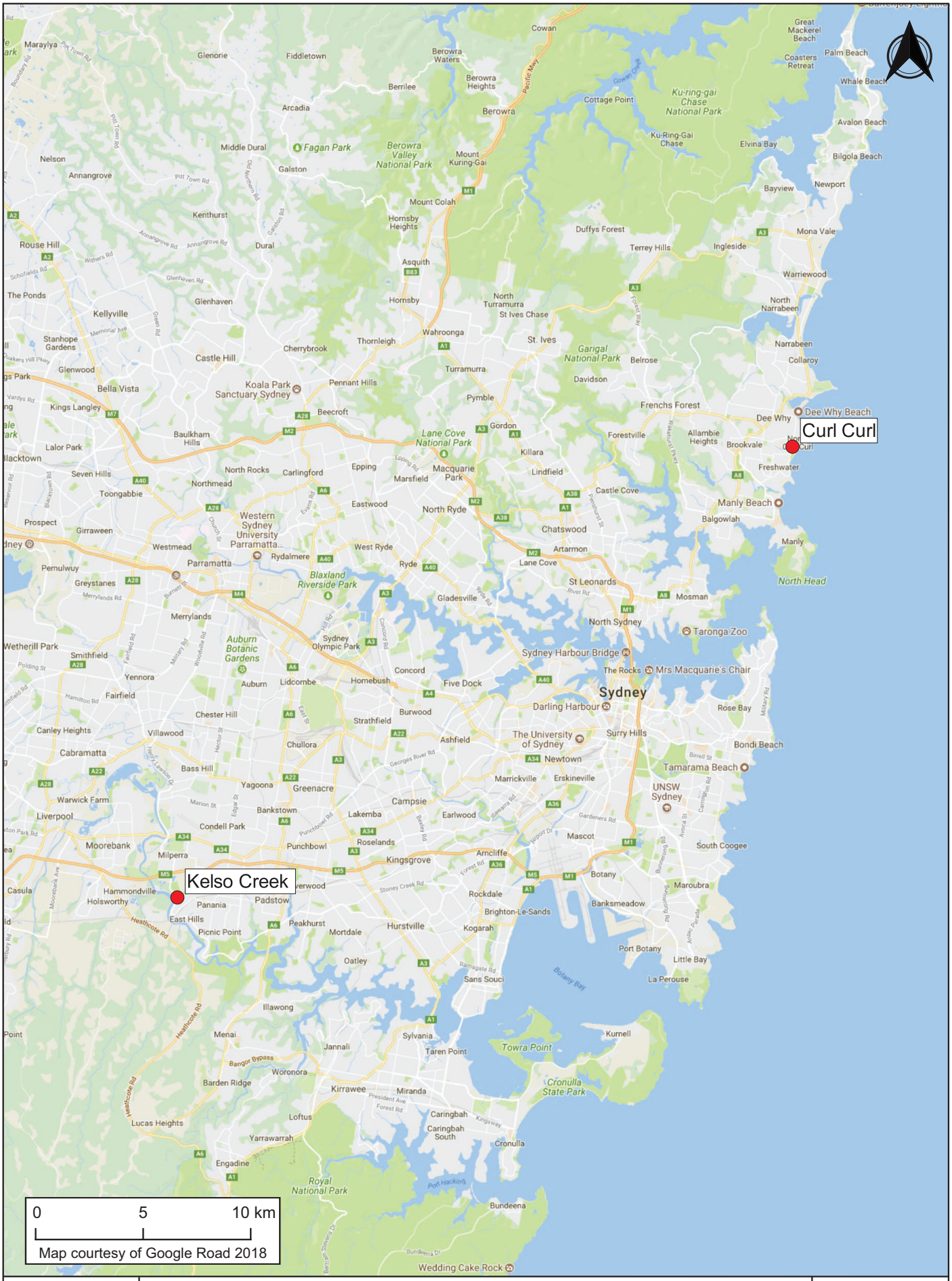
SACKVILLE DOWNSTREAM AT HAWKESBURY RIVER 2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 67

DRAWING 2771-67.cdr



NSW GOVERNMENT

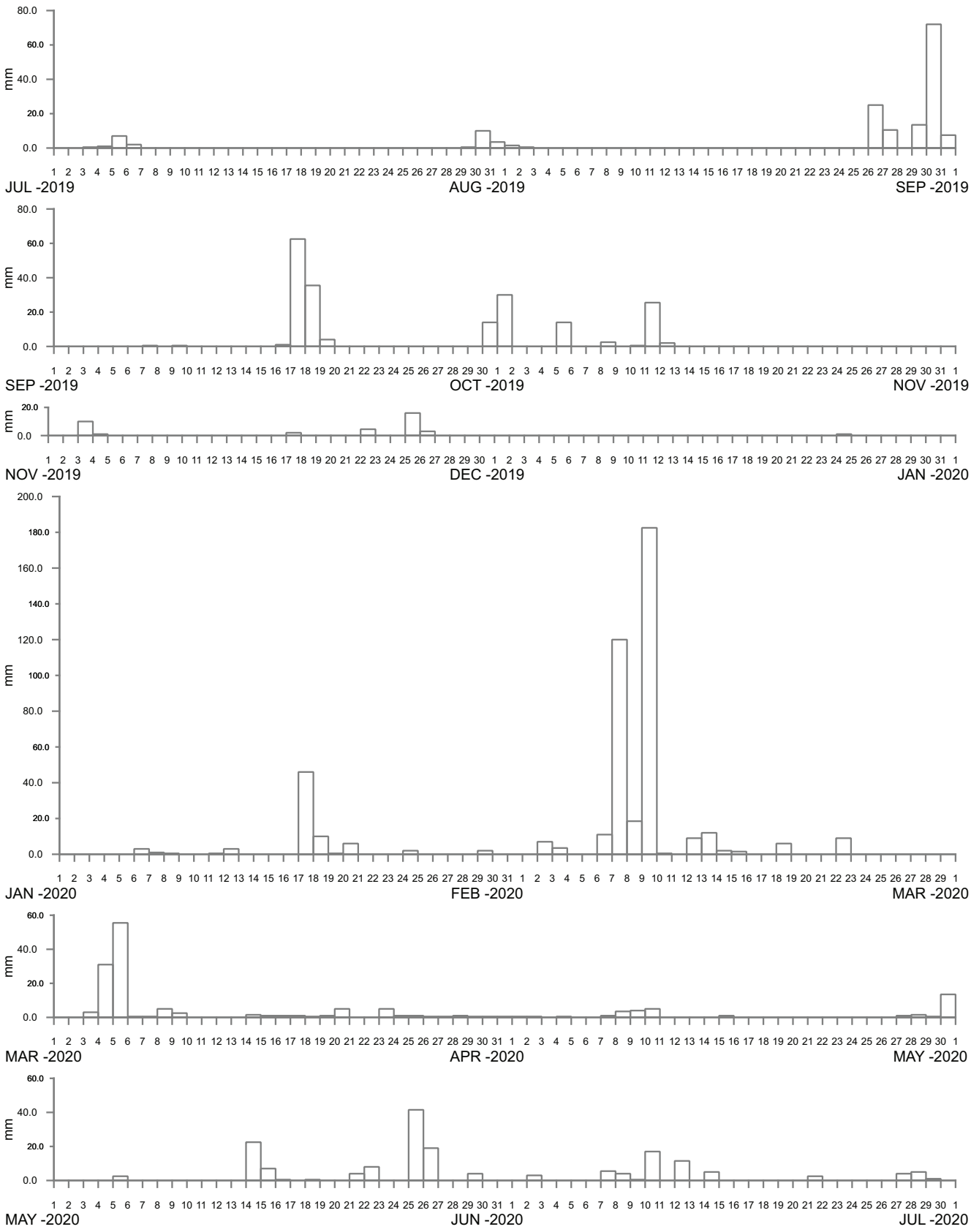
RAINFALL STATION LOCATIONS
SYDNEY COASTAL REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 68

DRAWING 2771-68.cdr



DATA LOSS

NSW GOVERNMENT

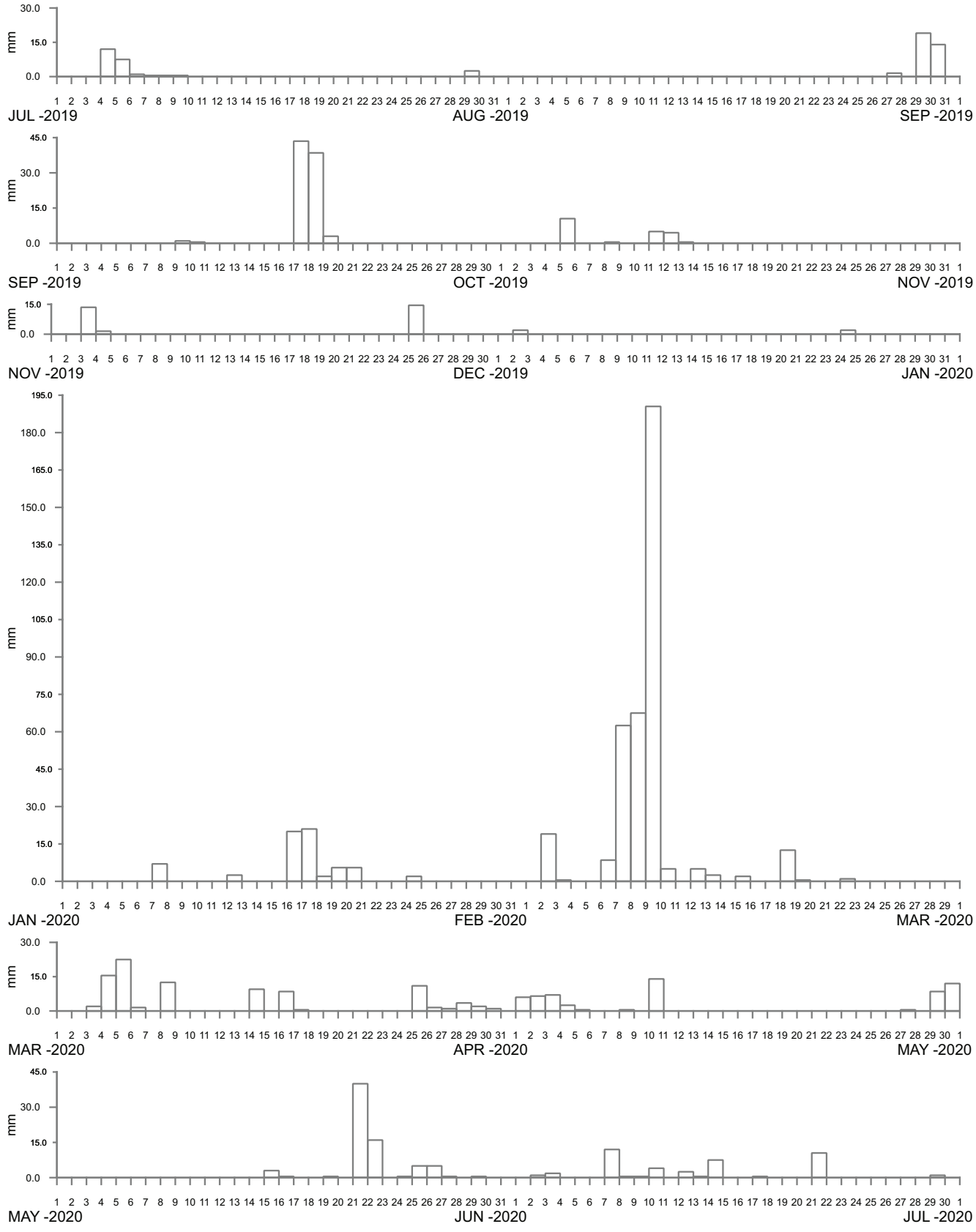
CURL CURL AT CURL CURL LAGOON
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 69

DRAWING 2771-69.cdr



DATA LOSS

NSW GOVERNMENT

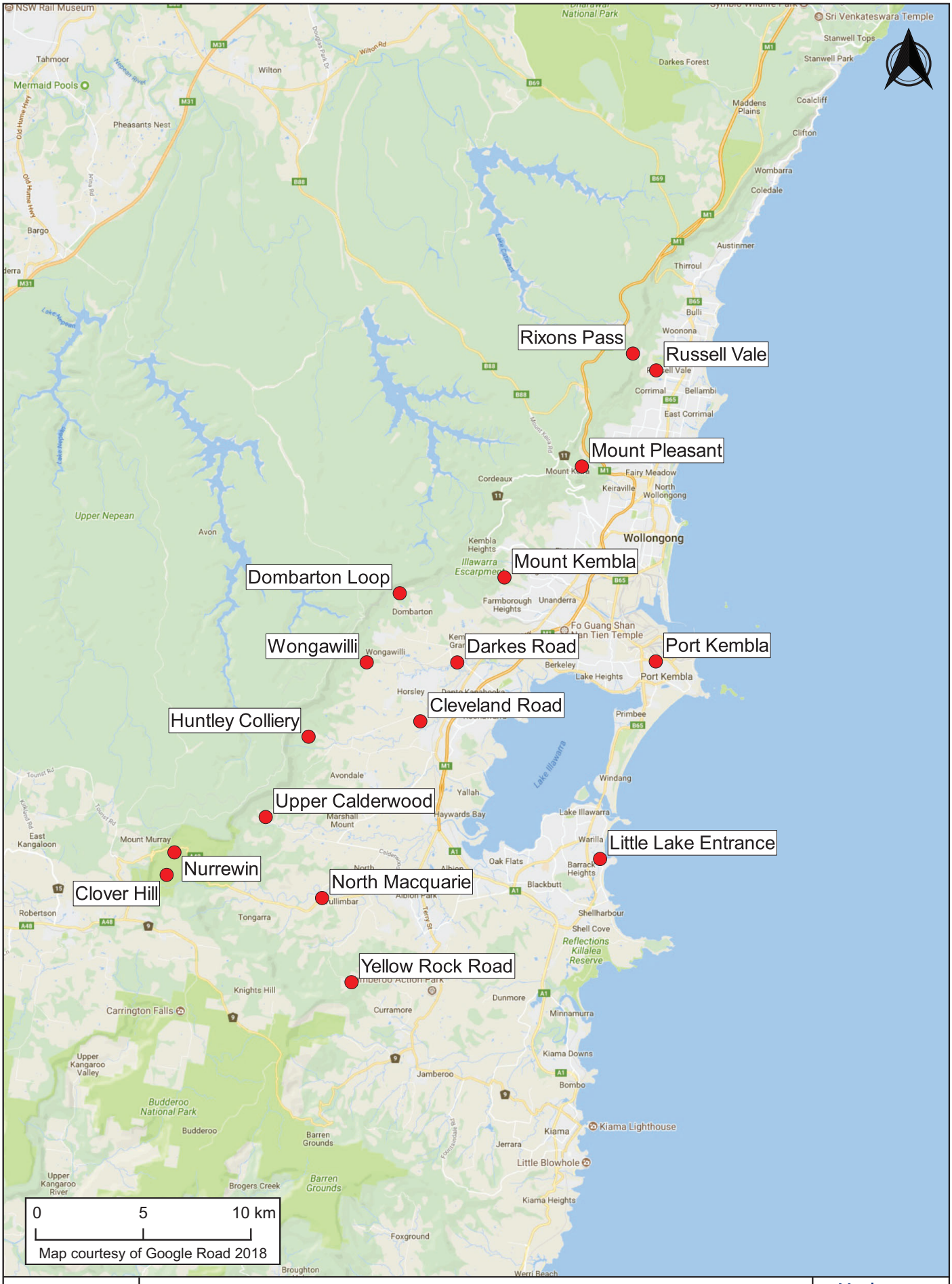
KELSO CREEK AT KELSO CREEK
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 70

DRAWING 2771-70.cdr



NSW GOVERNMENT

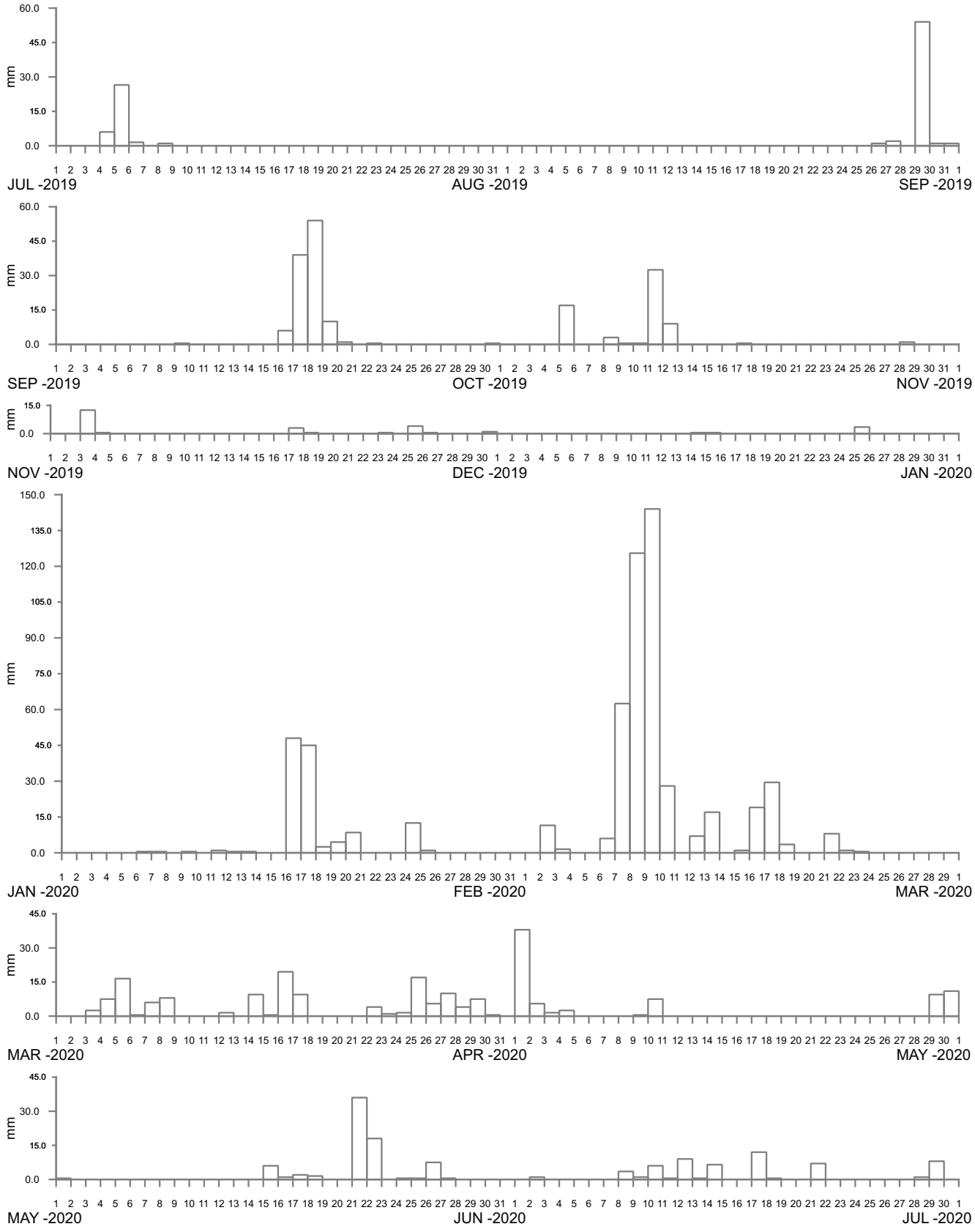
RAINFALL STATION LOCATIONS
WOLLONGONG COASTAL REGION

Manly Hydraulics Laboratory

Report MHL2771

Figure 71

DRAWING 2771-71.cdr



DATA LOSS

NSW GOVERNMENT

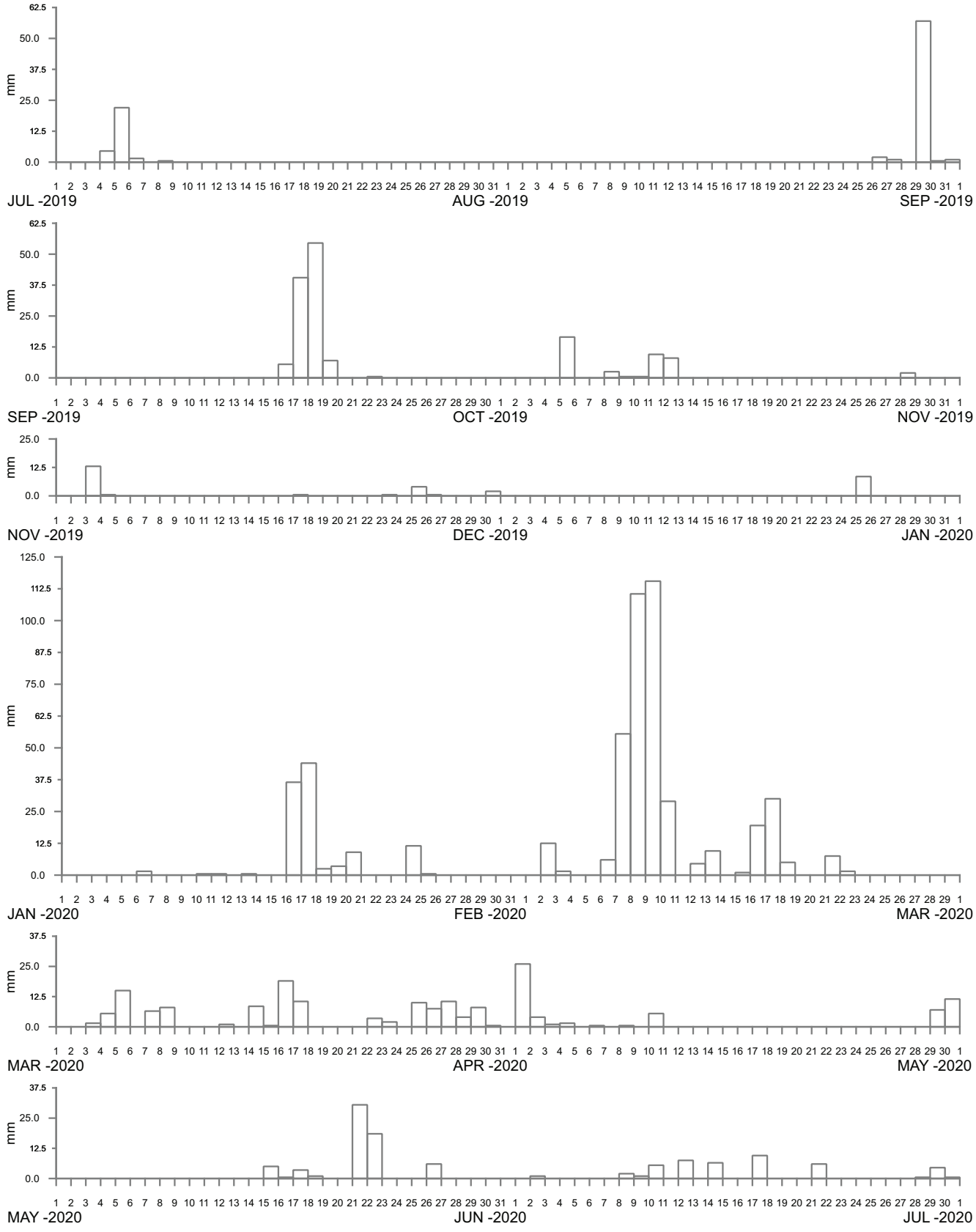
RIXONS PASS AT RIXONS PASS ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 72

DRAWING 2771-72.cdr



DATA LOSS

NSW GOVERNMENT

RUSSELL VALE AT WHITING CRESCENT
2019–2020

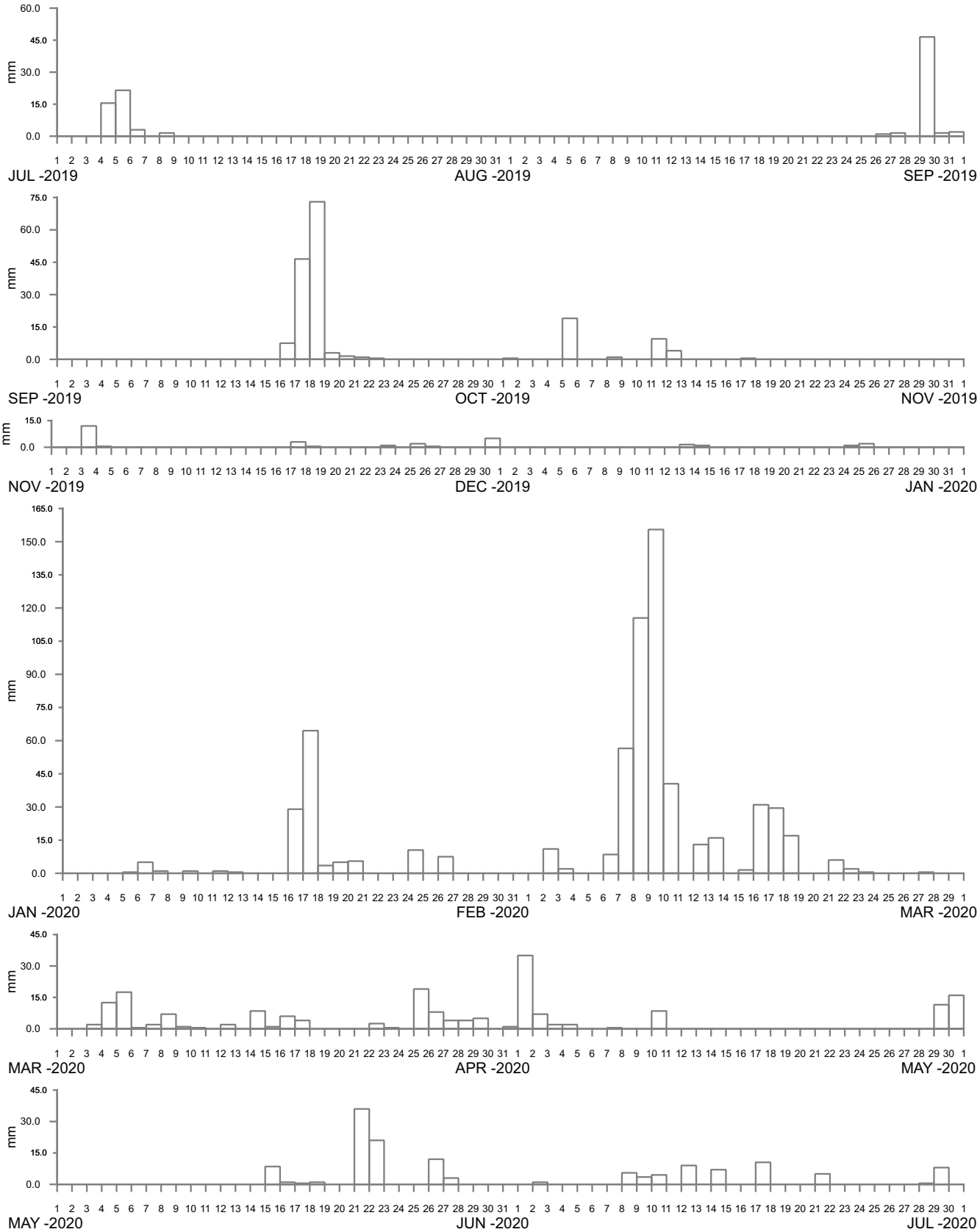
Manly Hydraulics Laboratory

Report MHL2771

Figure

73

DRAWING 2771-73.cdr



DATA LOSS

NSW GOVERNMENT

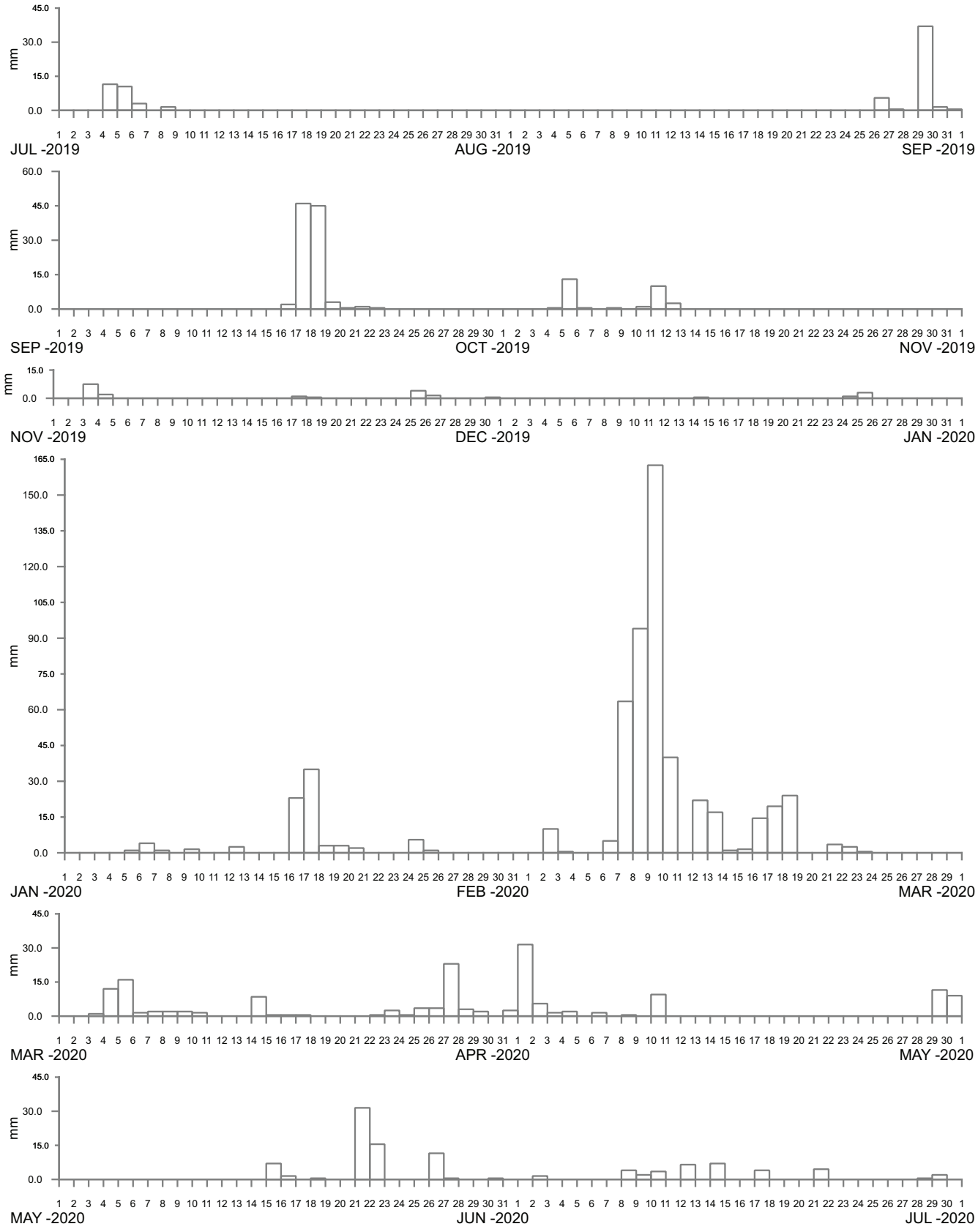
MOUNT PLEASANT AT PARRISH AVENUE
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 74

DRAWING 2771-74.cdr



DATA LOSS

NSW GOVERNMENT

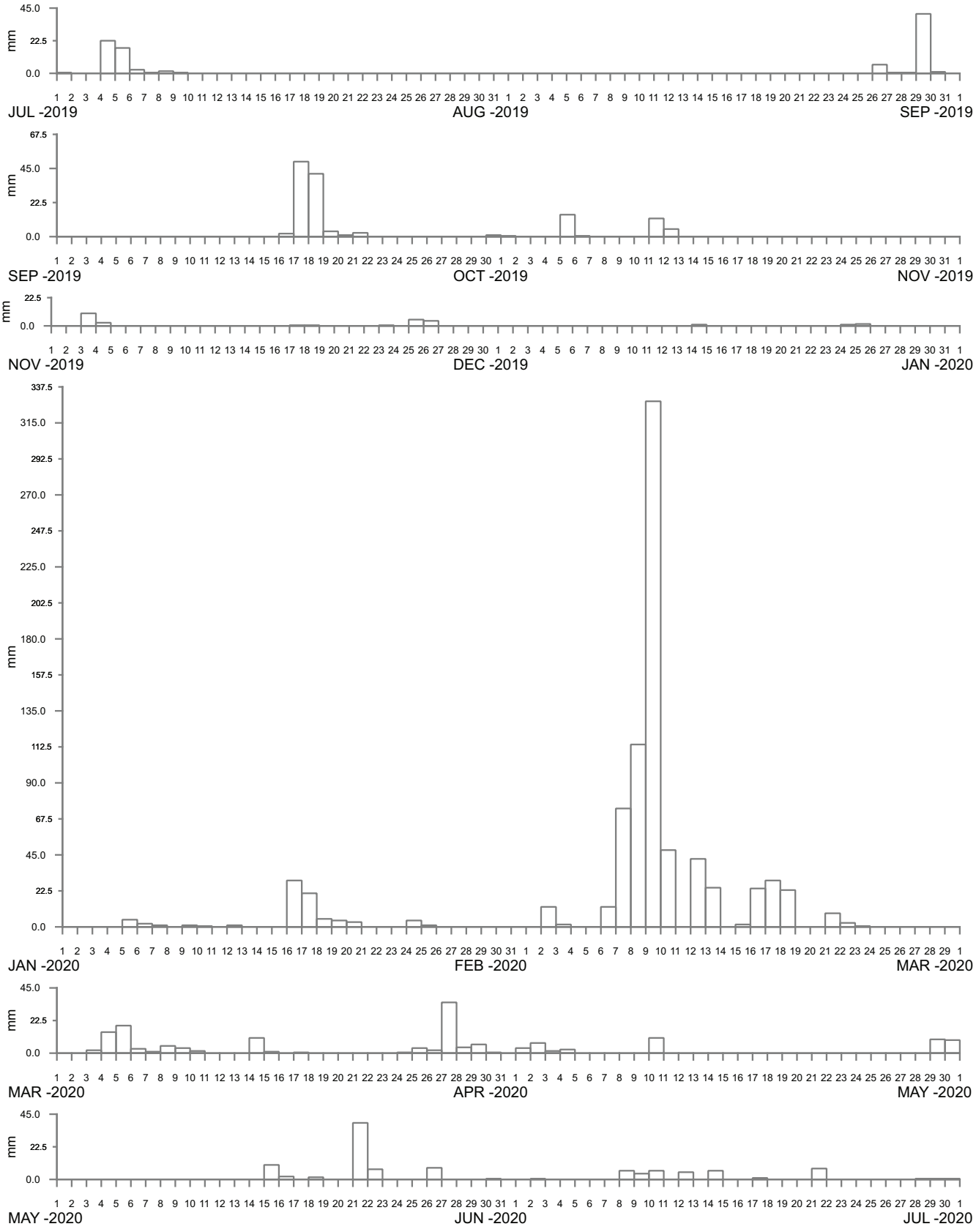
MOUNT KEMBLA AT STAFF ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 75

DRAWING 2771-75.cdr



NSW GOVERNMENT

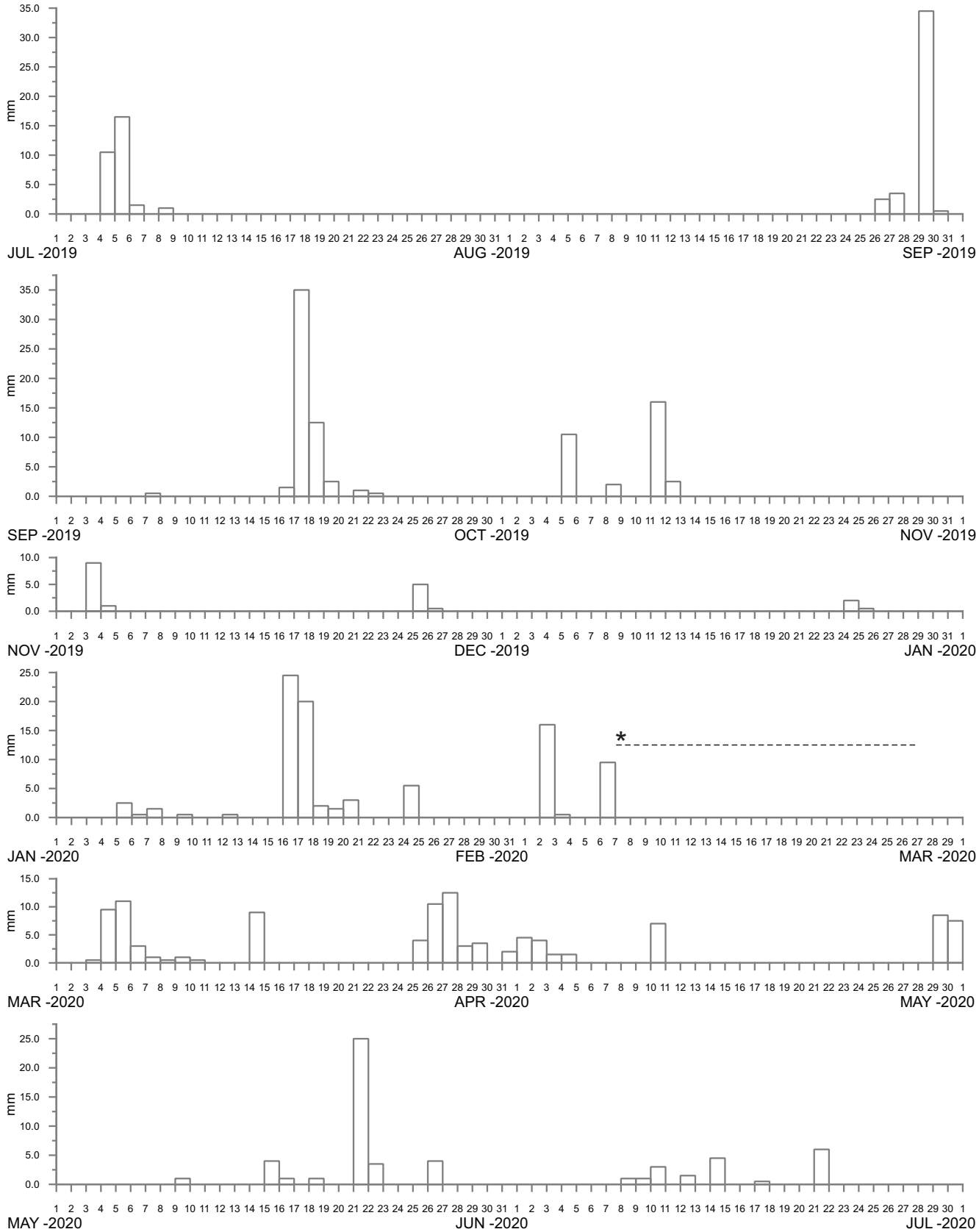
DOMBARTON LOOP AT PAYNES ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 76

DRAWING 2771-76.cdr



---------- DATA LOSS *Data loss due to logger failure

NSW GOVERNMENT

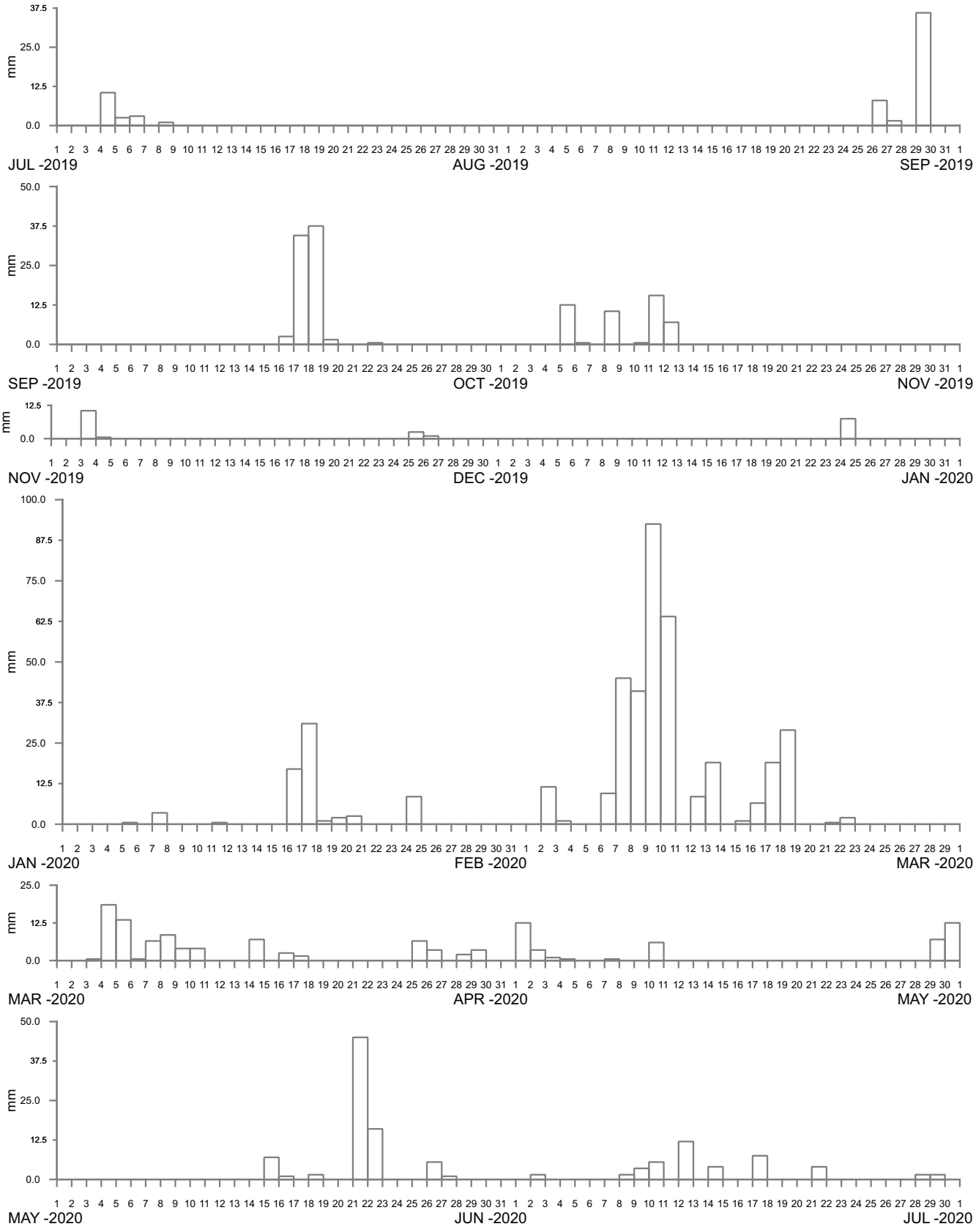
WONGAWILLI AT JERSEY FARM ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 77

DRAWING 2771-77.cdr



NSW GOVERNMENT

PORT KEMBLA AT FIVE ISLANDS ROAD
2019–2020

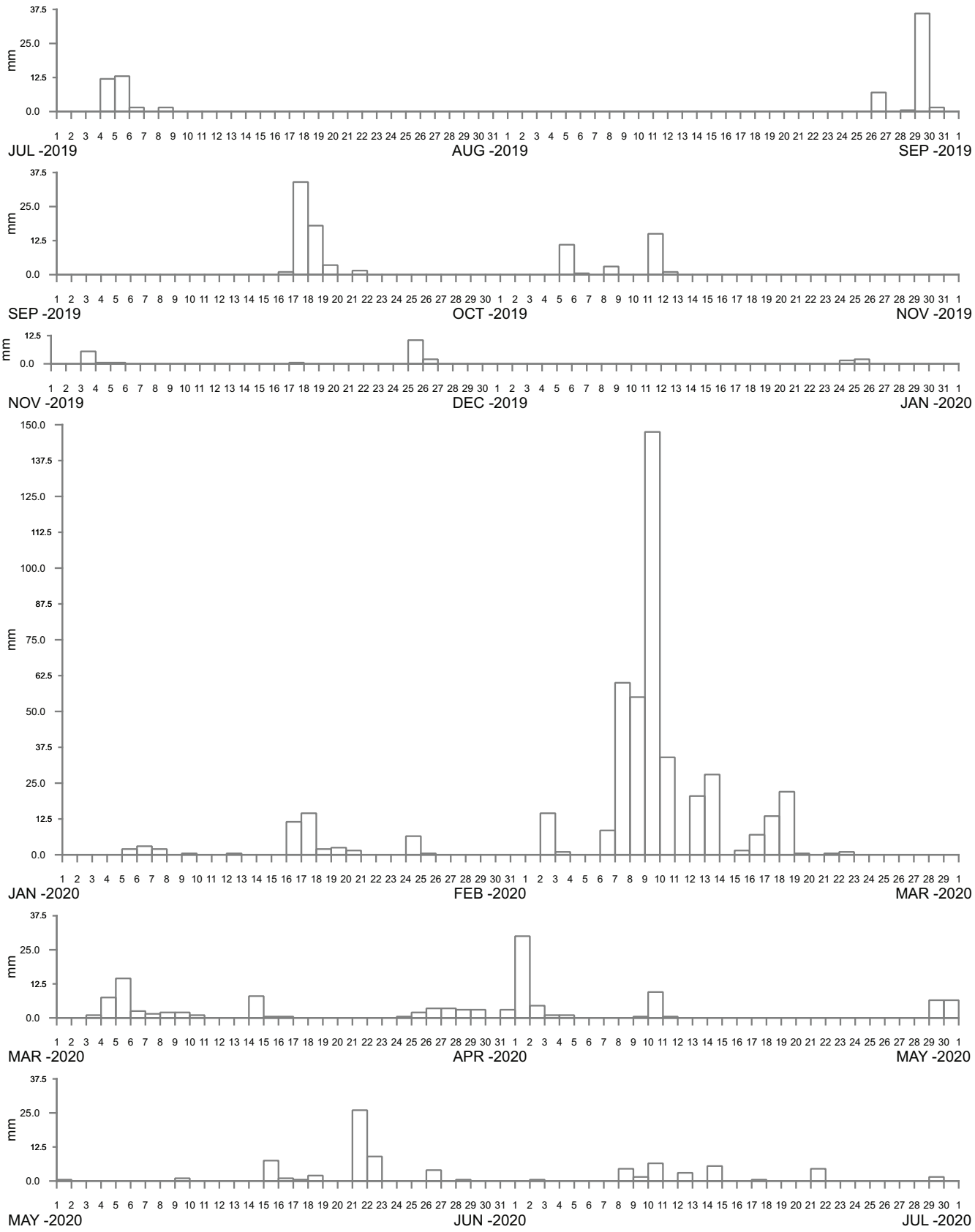
Manly Hydraulics Laboratory

Report MHL2771

Figure

78

DRAWING 2771-78.cdr



NSW GOVERNMENT

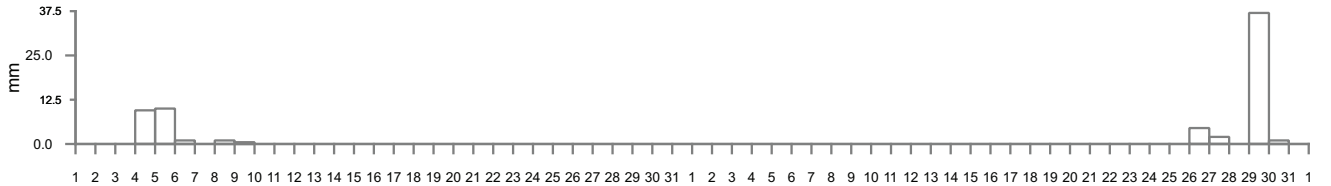
DARKES ROAD AT DAPTO
2019–2020

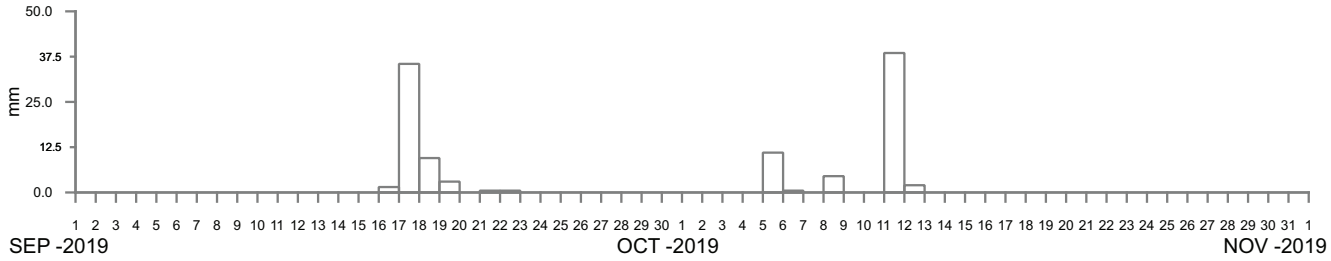
Manly Hydraulics Laboratory

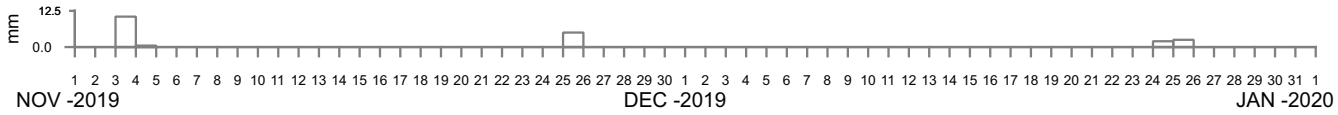
Report MHL2771

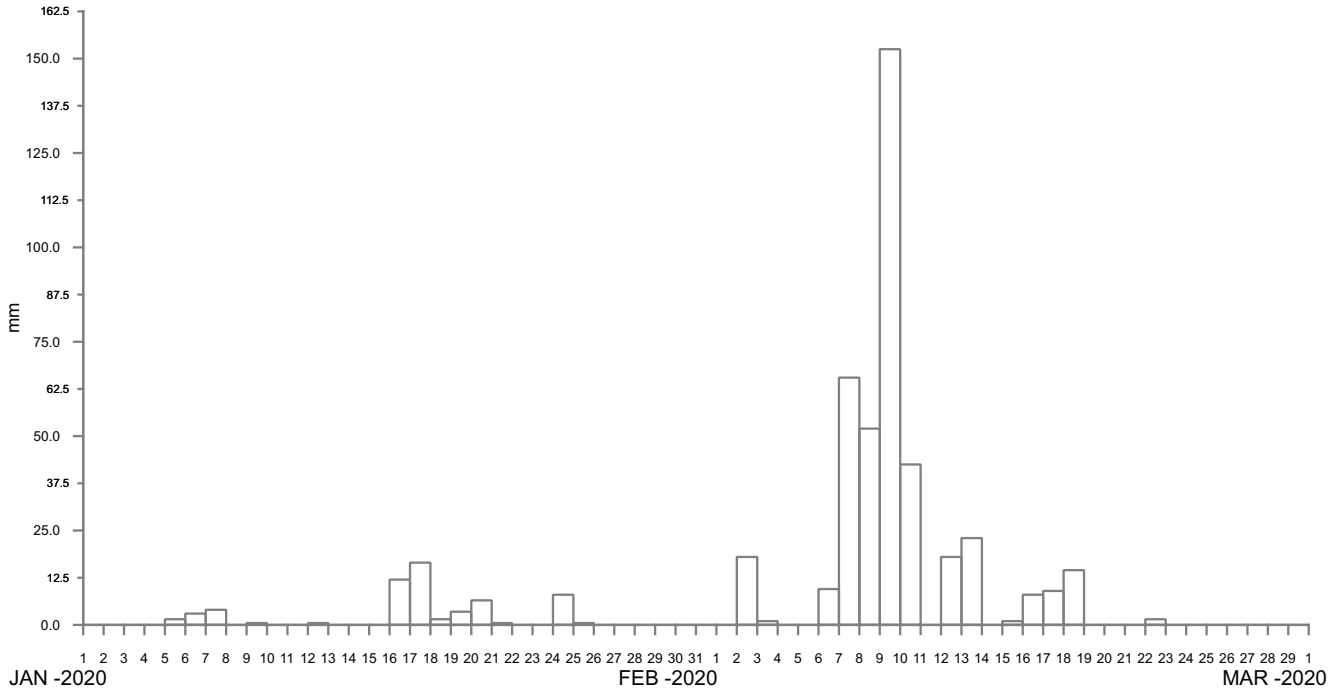
Figure 79

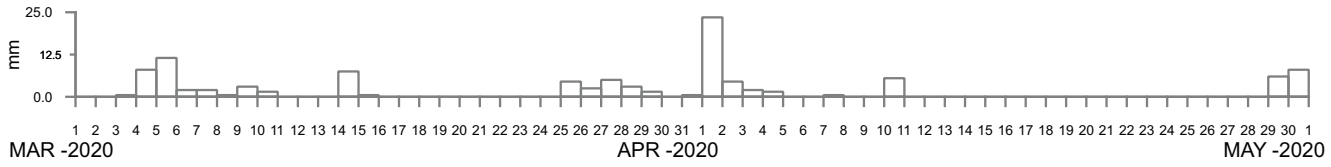
DRAWING 2771-79.cdr

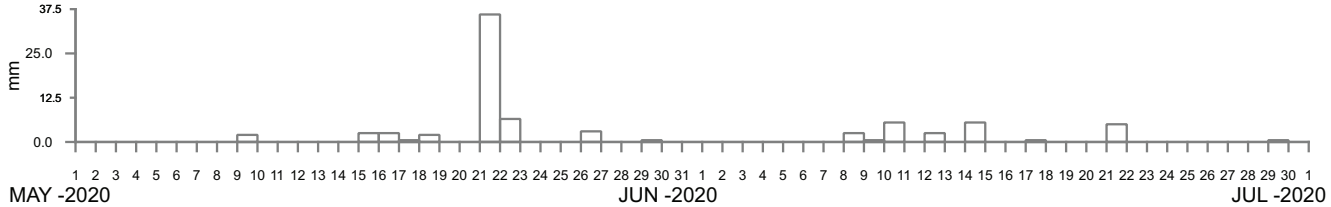












---------- DATA LOSS

NSW GOVERNMENT

CLEVELAND ROAD AT CLEVELAND ROAD
2019–2020

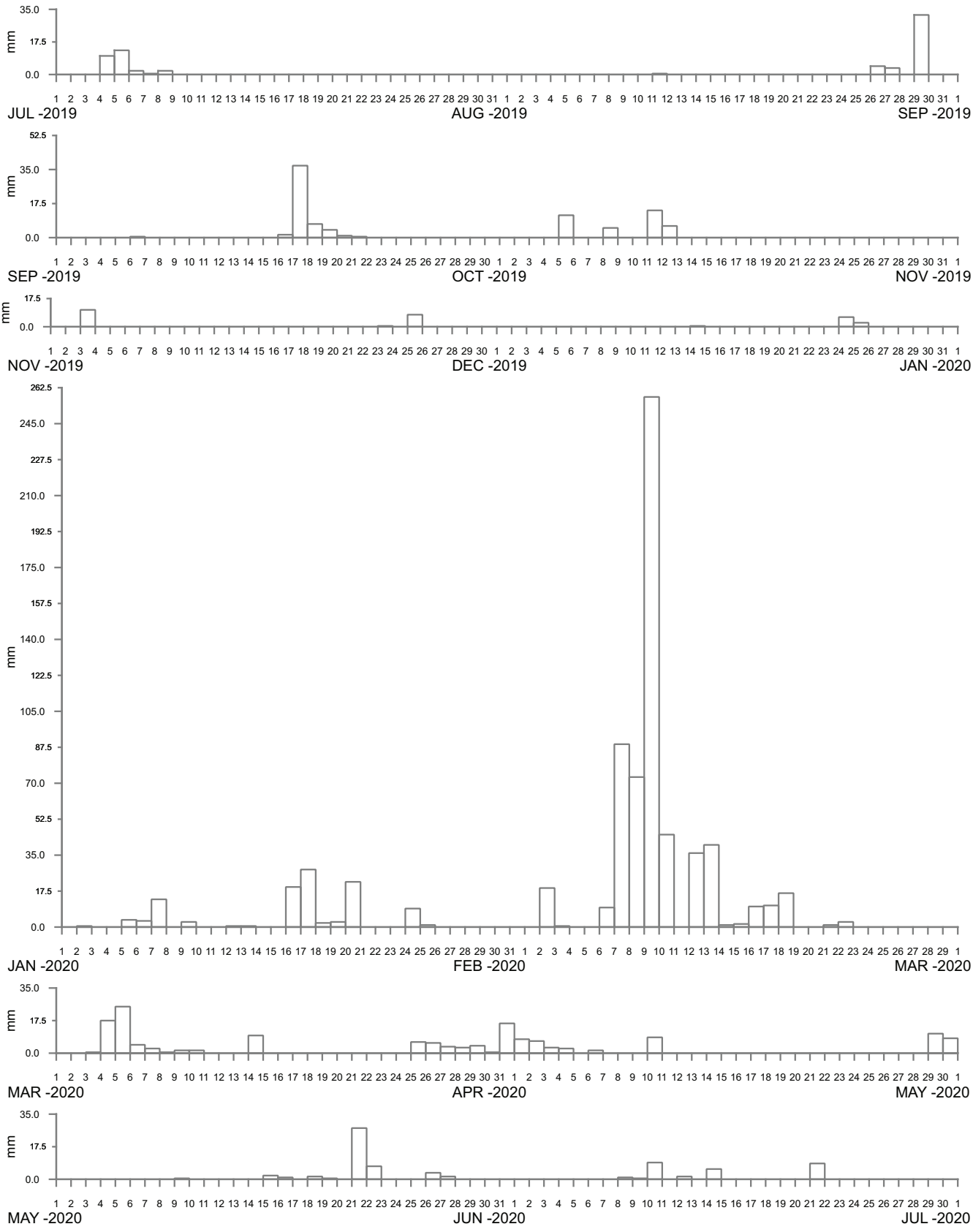
Manly Hydraulics Laboratory

Report MHL2771

Figure

80

DRAWING 2771-80.cdr



DATA LOSS

NSW GOVERNMENT

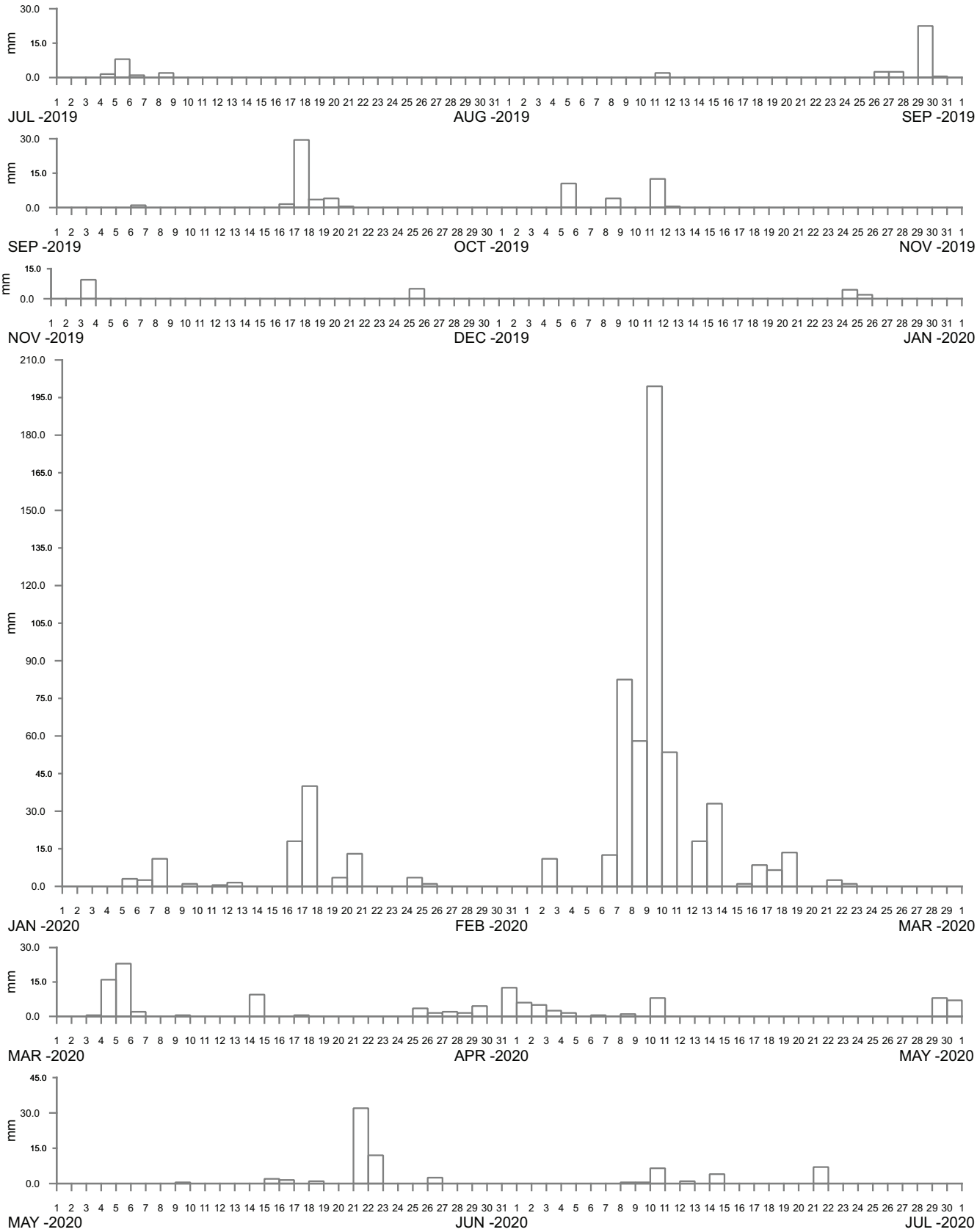
HUNTLEY COLLIERY AT AVONDALE ROAD
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 81

DRAWING 2771-81.cdr



DATA LOSS

NSW GOVERNMENT

UPPER CALDERWOOD AT CALDERWOOD ROAD 2019–2020

Manly Hydraulics Laboratory

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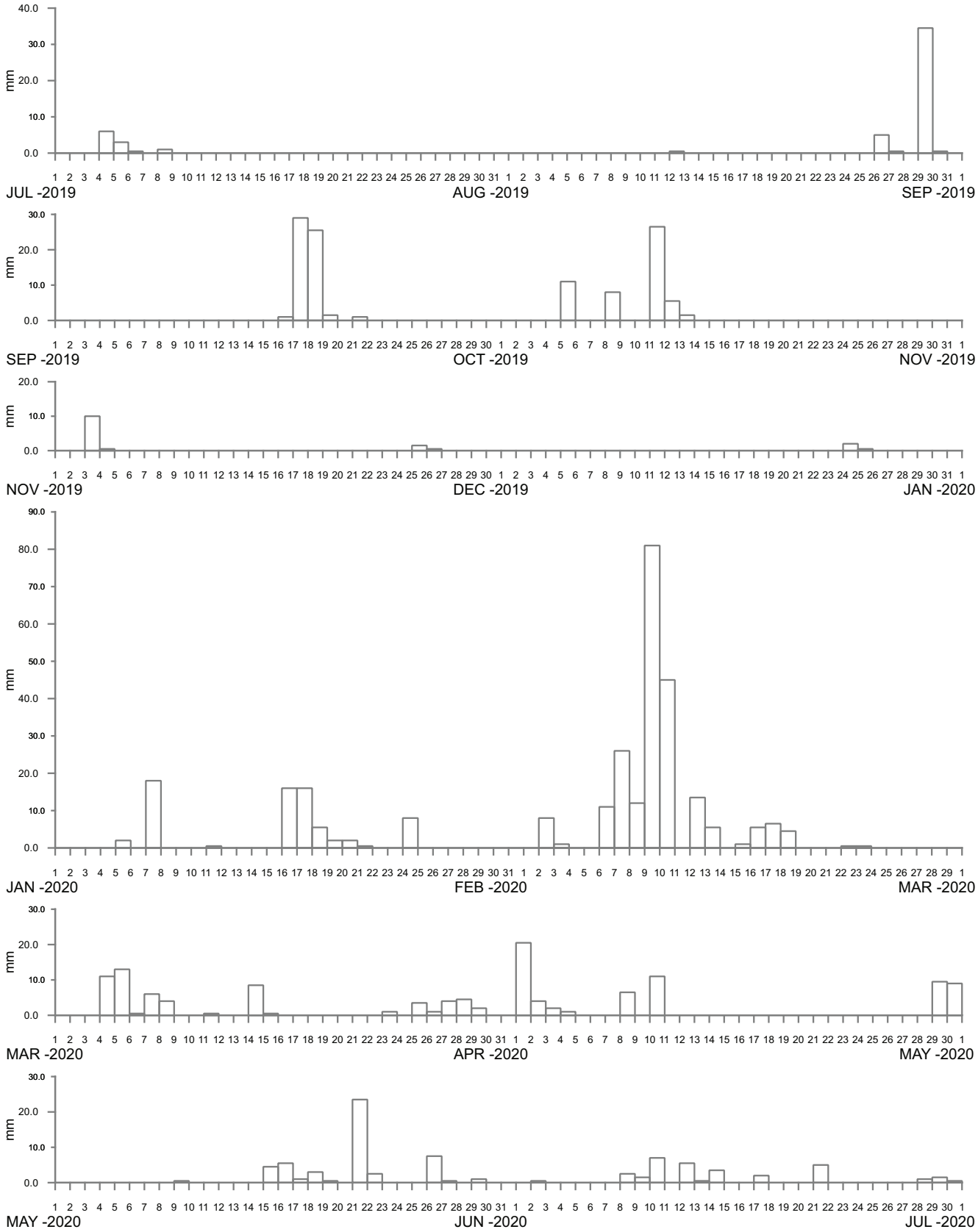
Figure 82

DRAWING 2771-82.cdr



DATA LOSS

NSW GOVERNMENT

LITTLE LAKE ENTRANCE AT LITTLE LAKE
2019–2020

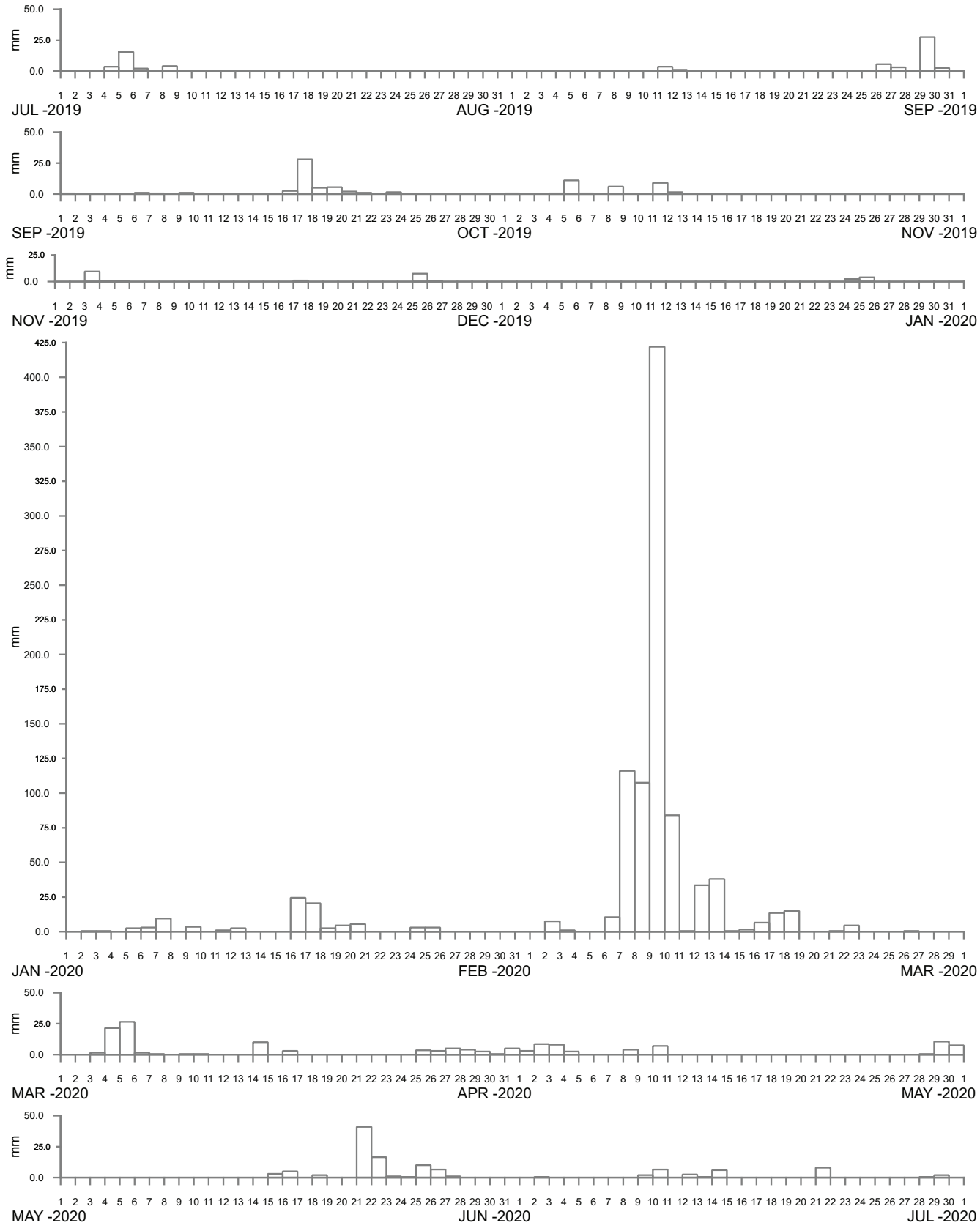
Manly Hydraulics Laboratory

Report MHL2771

Figure

83

DRAWING 2771-83.cdr



DATA LOSS

NSW GOVERNMENT

NURREWIN AT ILLAWARRA HIGHWAY
2019–2020

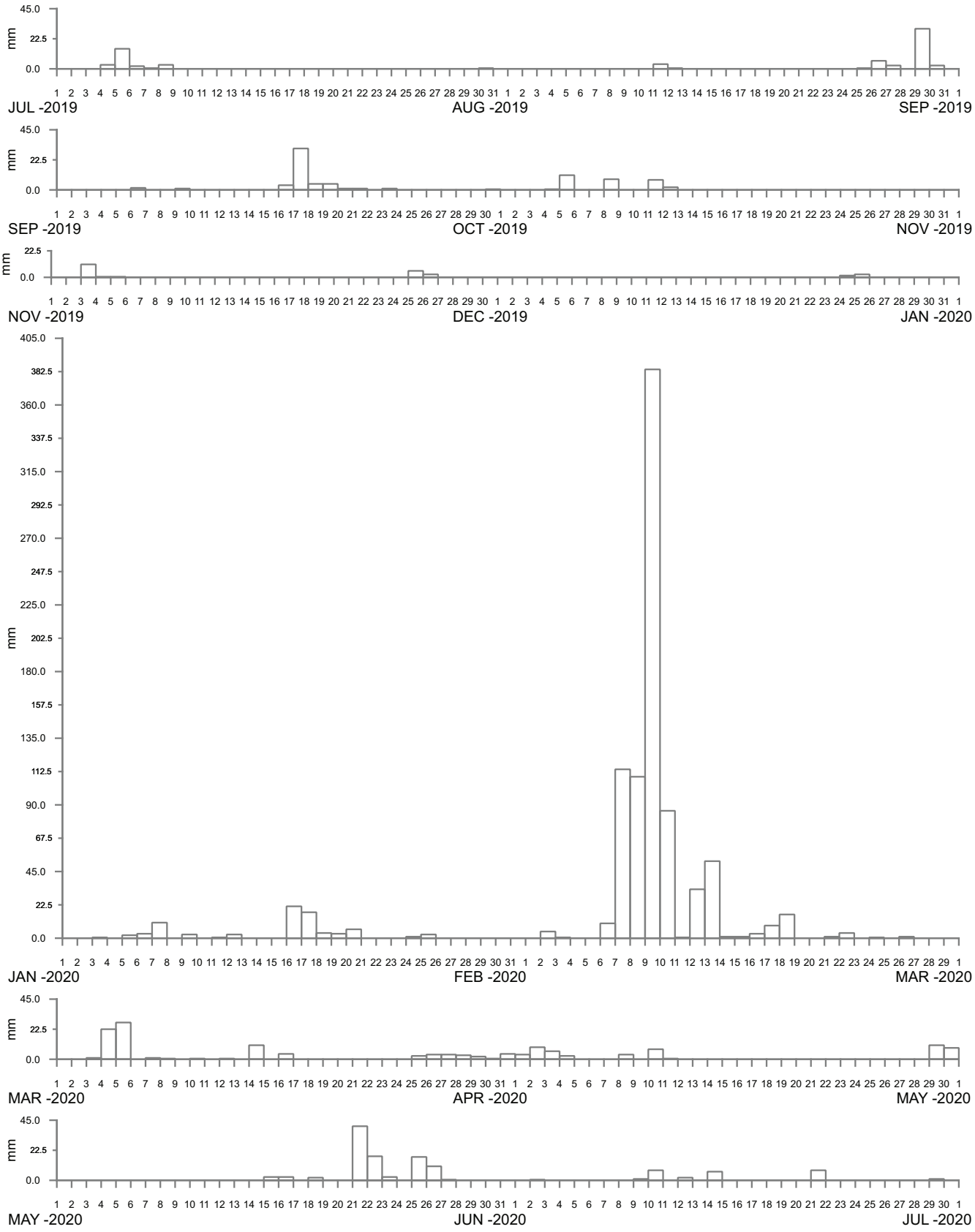
Manly Hydraulics Laboratory

Report MHL2771

Figure

84

DRAWING 2771-84.cdr



NSW GOVERNMENT

CLOVER HILL AT CLOVER HILL ROAD
2019–2020

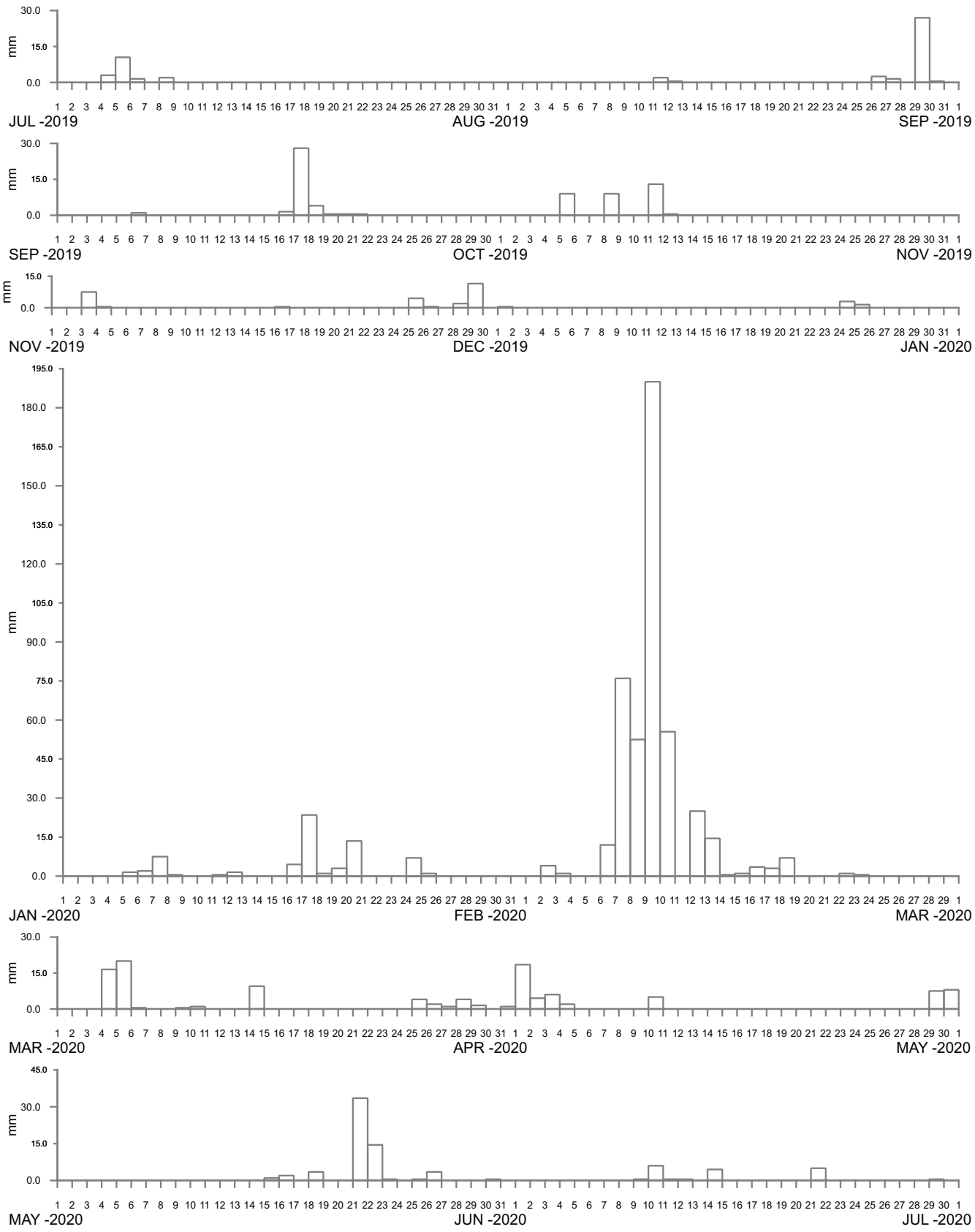
Manly Hydraulics Laboratory

Report MHL2771

Figure

85

DRAWING 2771-85.cdr



DATA LOSS

NSW GOVERNMENT

NORTH MACQUARIE AT NORTH MACQUARIE ROAD 2019–2020

Manly Hydraulics Laboratory

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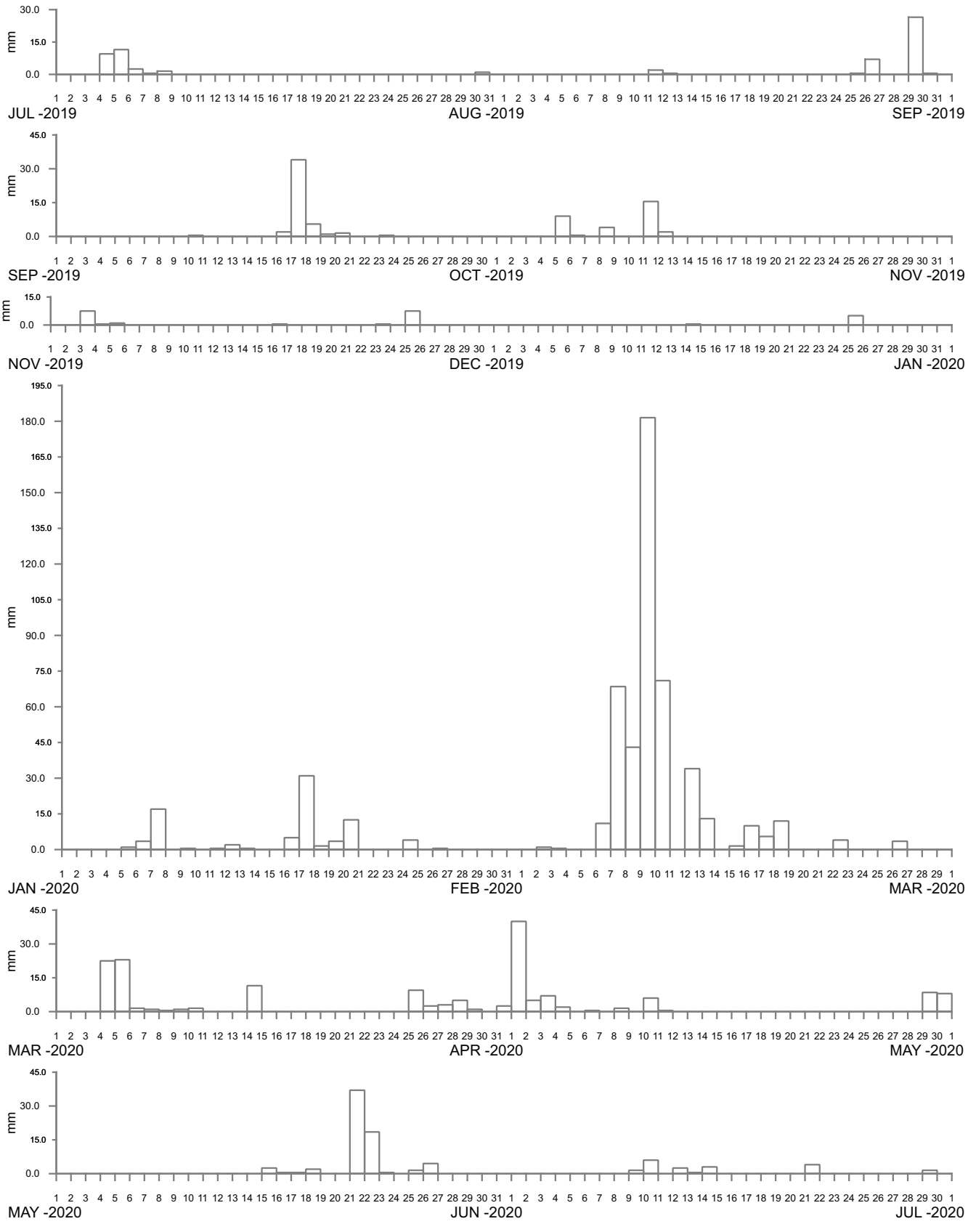
Figure 86

DRAWING 2771-86.cdr



DATA LOSS

NSW GOVERNMENT

YELLOW ROCK ROAD AT YELLOW ROCK ROAD
2019–2020

Manly Hydraulics Laboratory

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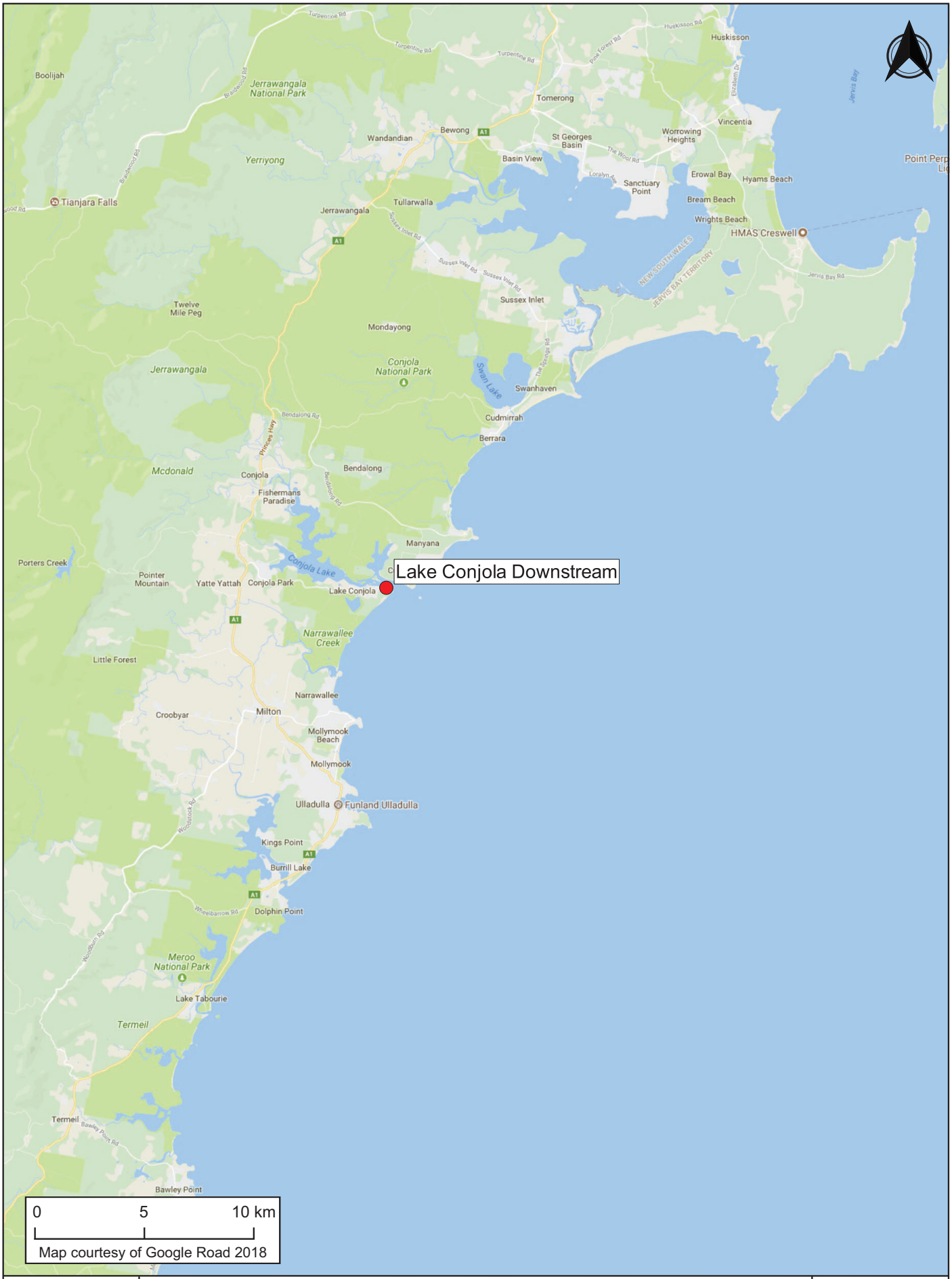
Figure 87

DRAWING 2771-87.cdr



NSW GOVERNMENT

RAINFALL STATION LOCATIONS
SOUTH COAST (NORTH) REGION

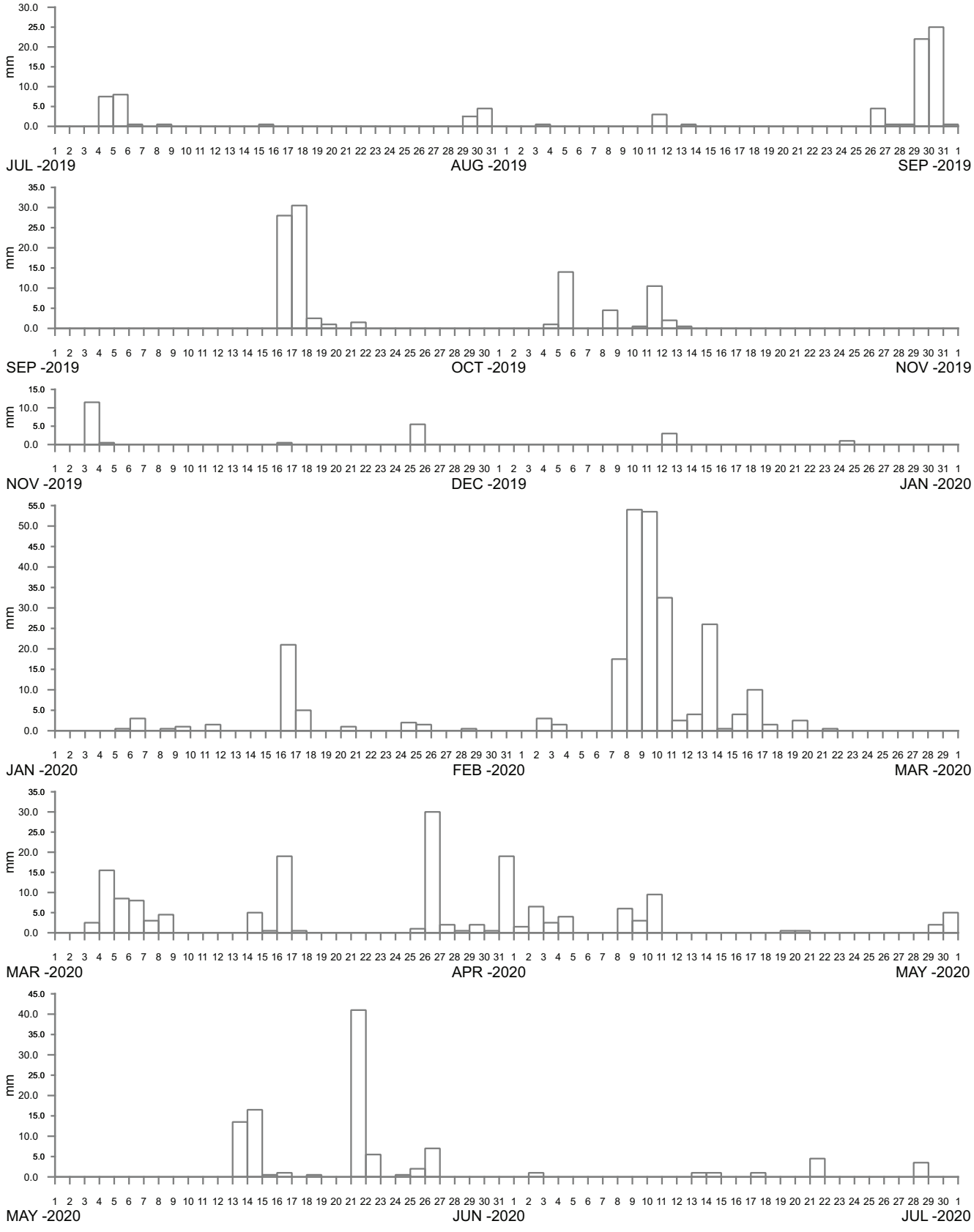
Manly Hydraulics Laboratory

Report MHL2771

Figure

88

DRAWING 2771-88.cdr



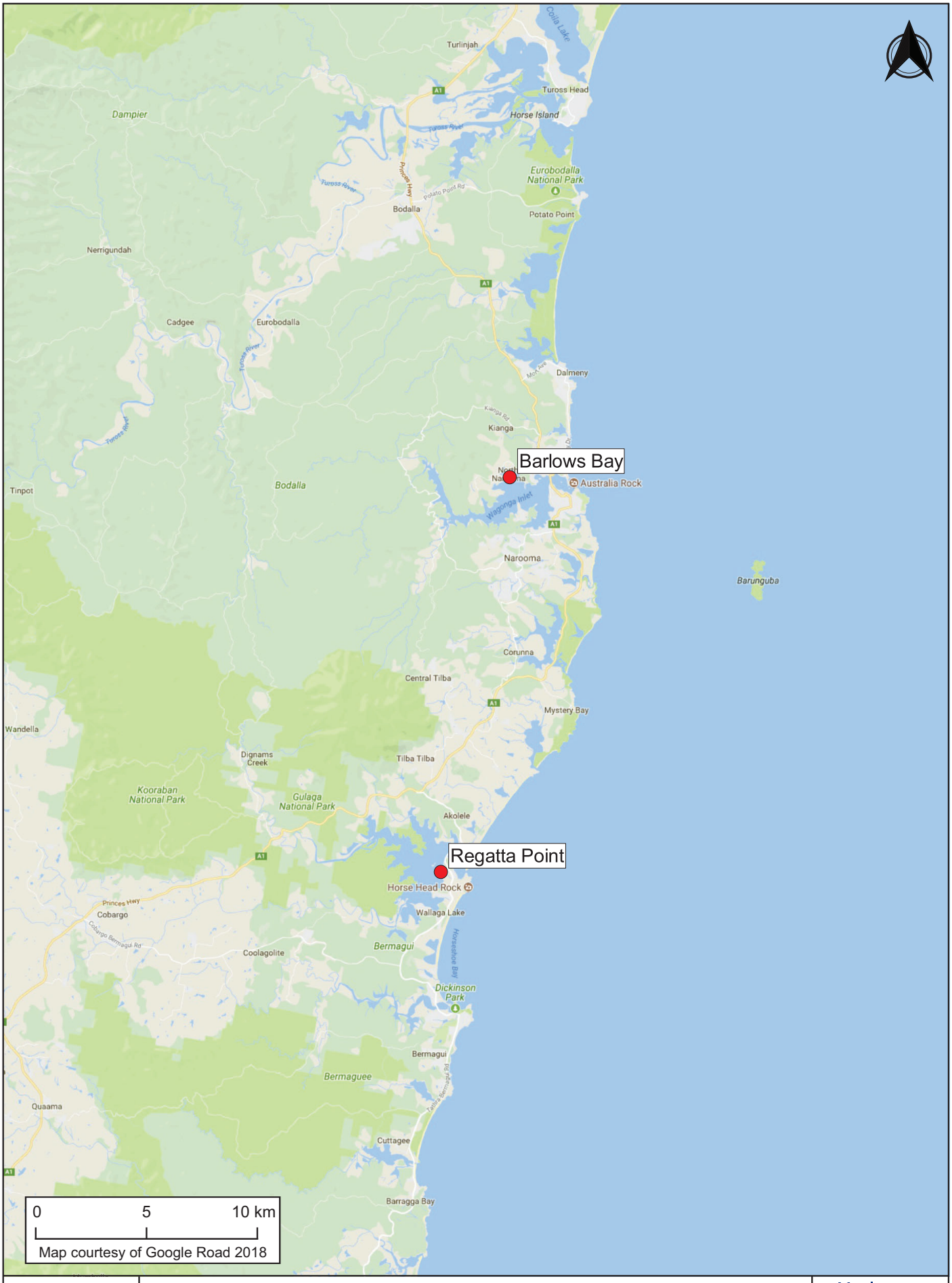
LAKE CONJOLA DOWNSTREAM AT CONJOLA LAKE
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 89

DRAWING 2771-89.cdr



NSW GOVERNMENT

RAINFALL STATION LOCATIONS
SOUTH COAST (MID) REGION

Manly Hydraulics Laboratory

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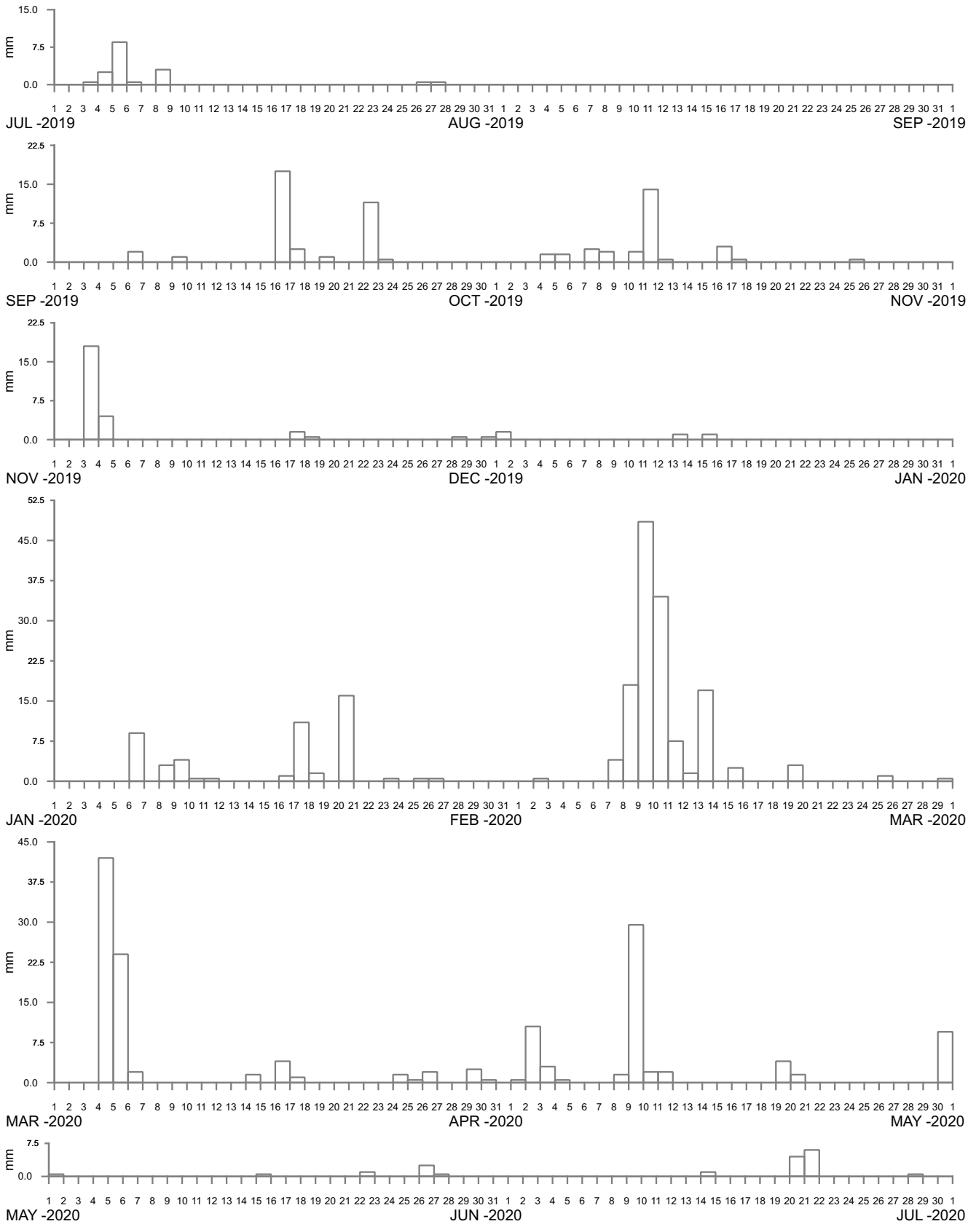
Figure

90

DRAWING 2771-90.cdr



DATA LOSS

NSW GOVERNMENT

BARLOWS BAY AT WAGONGA INLET
2019–2020

Manly Hydraulics Laboratory

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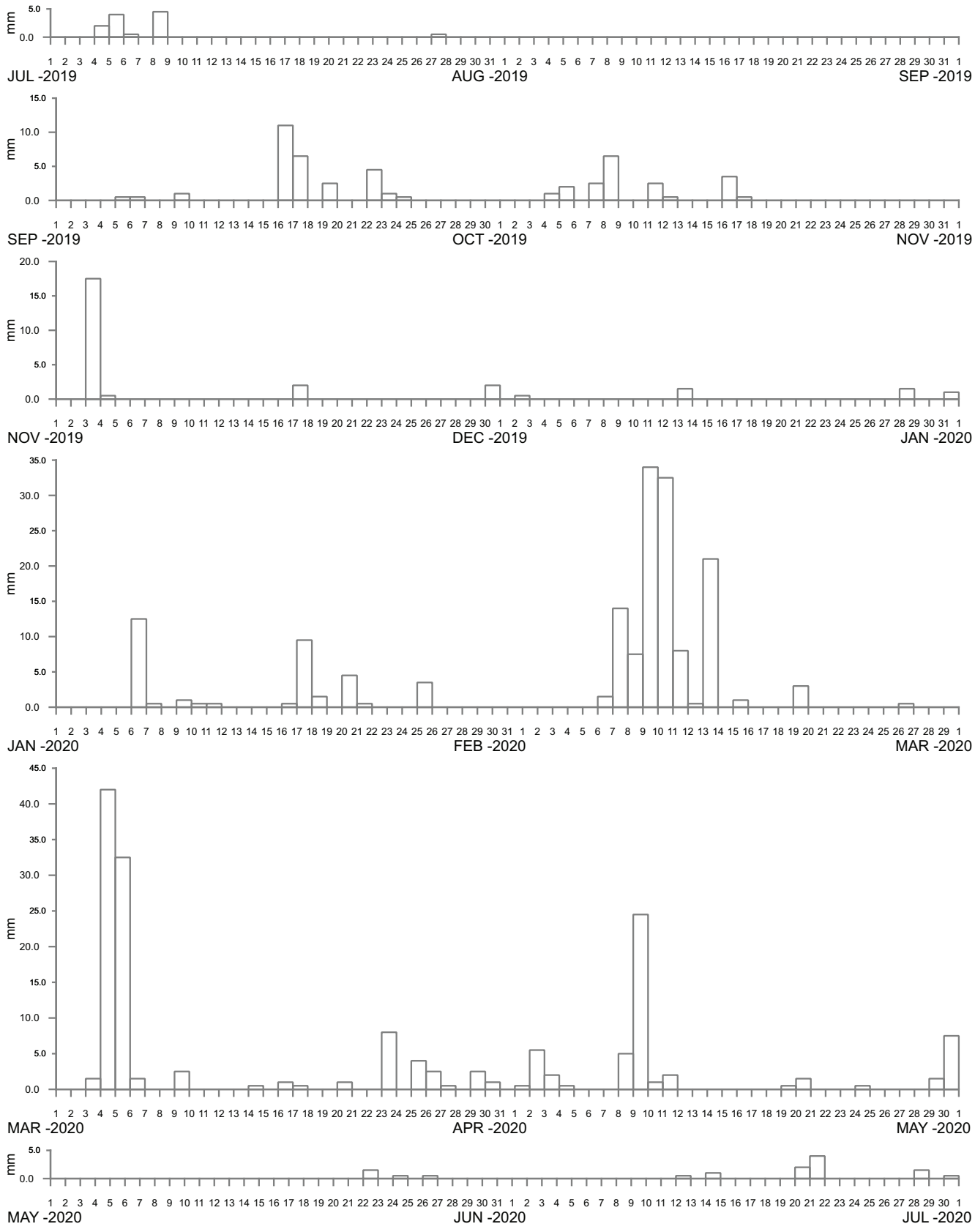
Figure 91

DRAWING 2771-91.cdr



DATA LOSS

NSW GOVERNMENT

REGATTA POINT AT WALLAGA LAKE
2019–2020

Manly Hydraulics Laboratory

Report MHL2771

Figure 92

DRAWING 2771-92.cdr

Appendix A Station data online

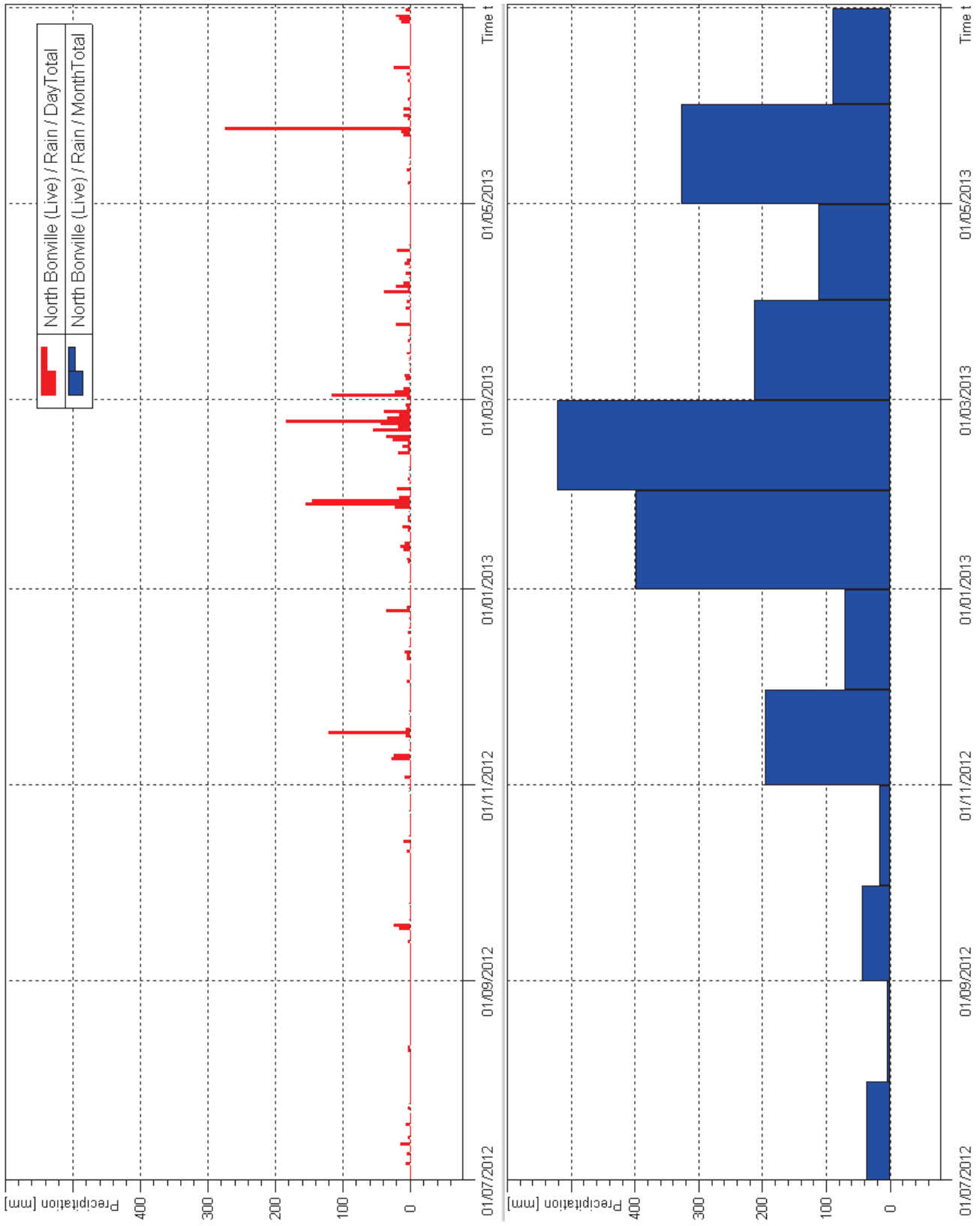
Table A1 Station data online

Region	Station	Period of data
Tweed	Cudgera	Aug 1983–ongoing
Brunswick	Main Arm	Sep 1983–ongoing
Brunswick	Huonbrook	May 1986–ongoing
Brunswick	Myocum	Feb 1986–ongoing
Richmond	Lake Ainsworth	Oct 1994–ongoing
Richmond	Empire Vale	May 1998–Jul 2000
Richmond	Wollongbar	Jul 1992–Jul 1994
Clarence	Yamba	Apr 2002–ongoing
Clarence	Wyndora	Jan 1990–Jun 1991
Clarence	Roberts Creek	May 1994–Jun 1996
Clarence	Shannon Creek	Nov 2000–May 2008
Bellinger	Wooli Caravan Park	Jun 1997–Apr 2012
Bellinger	Wooli Sportsground	Apr 2012–ongoing
Bellinger	Perry Drive	Dec 1998–ongoing
Bellinger	Shephards Lane	Dec 1998–ongoing
Bellinger	Red Hill	Nov 1998–ongoing
Bellinger	Newports Creek	Dec 1990–ongoing
Bellinger	Middle Boambee	Dec 1990–ongoing
Bellinger	South Boambee	Apr 1991–April 2015
Bellinger	North Bonville	Dec 1990–ongoing
Bellinger	Gleniffer	Aug 1993–Feb 2007
Bellinger	Bellinger Council	Apr 1993–Jun 2001
Bellinger	Kooroowi	May 1991–Jun 2012
Bellinger	Kooroowi Sharabel	Jun 2012–ongoing
Bellinger	Thora	Feb 1993–ongoing
Nambucca	Bowraville	Jun 1993–Oct 2001
Nambucca	Stuarts Island Downstream	Oct 1998–ongoing
Nambucca	Utungun	Nov 1991–ongoing
Macleay	Euroka Upstream	Jul 1990–June 2011
Macleay	Aldavilla Downstream	Dec 2011–ongoing
Maria	Green Valley	Sep 1994–ongoing
Hastings	Telegraph Point	Nov 1990–ongoing
Hastings	Lake Cathie	Aug 1993–Jun 2001
Hastings	Ellenborough	Jun 1991–Sep 1999
Camden Haven	Logans Crossing	Dec 1989–ongoing
Manning	Mount George	Mar 1991–ongoing
Karuah	Nabiac	Jun 1983–ongoing
Karuah	Tuncurry	Aug 2002– Feb 2018
Karuah	Tuncurry Downstream	Jun 2016-ongoing
Karuah	Tiona	Jun 2002–Sep 2015
Karuah	Pacific Palms Wharf	Oct 2013–ongoing
Karuah	Tarbuck Bay	May 1996–ongoing
Karuah	Bulahdelah	Aug 1996–ongoing
Hunter	Gostwyck	Oct 1999–ongoing
Hunter	Seaham	Sep 1999–ongoing

Region	Station	Period of data
Hunter	Hexham Bridge	May 1998–ongoing
Hunter	Belmore Bridge	Sep 1995–ongoing
Hunter	Cardiff	Mar 1991–Dec 1995
Macquarie-Tuggerah Lakes	Barnsley	Jan 1988–ongoing
Macquarie-Tuggerah Lakes	Fassifern	Jan 1992–Dec 1997
Macquarie-Tuggerah Lakes	Dora Creek	May 1992–Jul 1999
Macquarie-Tuggerah Lakes	Martinsville	Mar 1988–ongoing
Macquarie-Tuggerah Lakes	Mandalong	Dec 1988–ongoing
Macquarie-Tuggerah Lakes	Wyee	May 1992–ongoing
Macquarie-Tuggerah Lakes	Whitemans Ridge	Apr 1989–ongoing
Macquarie-Tuggerah Lakes	Yarramalong	Nov 1988–ongoing
Macquarie-Tuggerah Lakes	Kulnura	Jun 1989–ongoing
Macquarie-Tuggerah Lakes	Toukley	Feb 1985–ongoing
Macquarie-Tuggerah Lakes	Warnervale	Jan 1986–Apr 2010
Macquarie-Tuggerah lakes	Hamlyn Terrace	Mar 2010–ongoing
Macquarie-Tuggerah Lakes	Wyong Weir Upstream	Jan 1986–Apr 2008
Macquarie-Tuggerah Lakes	Wyong	Jan 1986–Apr 1991
Macquarie-Tuggerah Lakes	Kangy Angy	Aug 2010–ongoing
Macquarie-Tuggerah Lakes	Chittaway	Dec 1989–Aug 2010
Macquarie-Tuggerah Lakes	Berkeley Vale	Jun 1988–ongoing
Macquarie-Tuggerah Lakes	Mardi Dam	Oct 1988–ongoing
Macquarie-Tuggerah Lakes	Sterland	Apr 1989–ongoing
Macquarie-Tuggerah Lakes	Long Jetty	Sept 1992–Sept 1998
Macquarie-Tuggerah Lakes	Bateau Bay	Jan 1980–ongoing
Macquarie-Tuggerah Lakes	Lisarow	Apr 1989–ongoing
Brisbane Water	Strickland	Dec 1985–ongoing
Brisbane Water	Narara	Apr 1989–ongoing
Brisbane Water	Mount Elliot	Dec 1985–ongoing
Brisbane Water	Wyoming	Oct 1988–ongoing
Brisbane Water	Kincumber	May 1987–ongoing
Hawkesbury	Webbs Creek	Jul 1999–ongoing
Hawkesbury	Colo Junction	Jul 1999–ongoing
Hawkesbury	Sackville Downstream	Jun 1999–ongoing
Hawkesbury	Woy Woy	Jul 1991–Jul 1996
Hawkesbury	Brooklyn	Apr 1991–Dec 1995
Hawkesbury	Cowan	Jun 1991–Dec 1995
Hawkesbury	Penrith	Dec 1994–Jan 1995
Hawkesbury	Narellan Creek	Jan 1994–Sep 1996
Hawkesbury	Camden Life Centre	Mar 1994–Sep 1996
Hawkesbury	Mt Annan School	Feb 1994–Sep 1996
Blue Mountains	Mount Boyce	Nov 1992–Feb 1995
Blue Mountains	Clarence	Nov 1992–Feb 1995
Blue Mountains	Zig Zag	Nov 1992–Feb 1995
Sydney Coastal	Kuringai	Jan 1991–Sep 1996
Sydney Coastal	Wahroonga	Nov 1990–Dec 1995
Sydney Coastal	Beecroft	Sep 1992–Jul 1996
Sydney Coastal	Avalon	Jun 1994–ongoing
Sydney Coastal	Mona Vale	Jun 1994–ongoing
Sydney Coastal	Narrabeen Creek	May 1998–Sep 2010
Sydney Coastal	Middle Creek	Apr 1995–ongoing

Region	Station	Period of data
Sydney Coastal	Cromer	Mar 1994–ongoing
Sydney Coastal	Belrose	May 1994–ongoing
Sydney Coastal	Allambie	Jun 1999–ongoing
Sydney Coastal	Balgowlah	Aug 1999–Jul 2005
Sydney Coastal	Curl Curl	Feb 2014–ongoing
Sydney Coastal	North Manly	May 1995–ongoing
Sydney Coastal	Manly Dam	Nov 1995–ongoing
Sydney Coastal	Chatswood	Sep 1992–Jul 1996
Sydney Coastal	Denistone	Jan 1990–Jun 1996
Sydney Coastal	M4 Motorway	Jun 1993–Dec 1995
Sydney Coastal	Homebush Bay	Feb 1993–Mar 1994
Sydney Coastal	Kelso Creek	Nov 1996–ongoing
Wollongong Coastal	Bulli Pass	Jan 1983–Oct 1998
Wollongong Coastal	Rixons Pass	Jun 1985–ongoing
Wollongong Coastal	Russell Vale	Jul 1982–ongoing
Wollongong Coastal	Corrimal Colliery	Jun 1985–Dec 1993
Wollongong Coastal	Mount Pleasant	Jun 1997–ongoing
Wollongong Coastal	Mount Nebo	Nov 1982–Feb 1997
Wollongong Coastal	Mount Kembla	Jun 1985–ongoing
Wollongong Coastal	Dombarton Loop	Jun 1985–ongoing
Wollongong Coastal	Wongawilli	Jan 1983–ongoing
Wollongong Coastal	Port Kembla BHP	Jan 1993–ongoing
Wollongong Coastal	Port Kembla	Sep 1982–ongoing
Wollongong Coastal	Darkes Road	Feb 1994–ongoing
Wollongong Coastal	Cleveland Road	Jun 1985–ongoing
Wollongong Coastal	Huntley Colliery	Jan 1983–ongoing
Wollongong Coastal	Calderwood	Jan 1983–Jun 1985
Wollongong Coastal	Upper Calderwood	Jun 1985–ongoing
Wollongong Coastal	Little Lake	May 1992–Oct 2014
Wollongong Coastal	Little Lake Entrance	May 2014–ongoing
Wollongong Coastal	Airport	Jun 1991–Mar 1995
Wollongong Coastal	North Macquarie	Jul 1985–ongoing
Wollongong Coastal	Clover Hill	Dec 1985–ongoing
Wollongong Coastal	Nurrewin	Jan 2006–ongoing
Wollongong Coastal	Yellow Rock Road	Jan 1983–ongoing
Wollongong Coastal	Balgownie	Jul 1982–Jun 1987
Wollongong Coastal	Woonona	Jul 1982–Jun 1985
South Coast	Lake Wollumboola	Feb 1999–Oct 2000
South Coast	Lake Conjola Downstream	Jul 2016–ongoing
South Coast	Lake Conjola	Jan 1999–Jul 2017
South Coast	Barlows Bay (Narooma)	Jul 1999–ongoing
South Coast	Regatta Point	Jan 1999–ongoing
South Coast	Merimbula Wharf	Aug 1997–Sep 2001
South Coast	Agnew Wharf	Aug 1997–Jun 2000

Appendix B Sample rainfall data outputs



NSW GOVERNMENT

SAMPLE DAILY AND MONTHLY RAINFALL PLOTS

Manly Hydraulics Laboratory

Report MHL2771

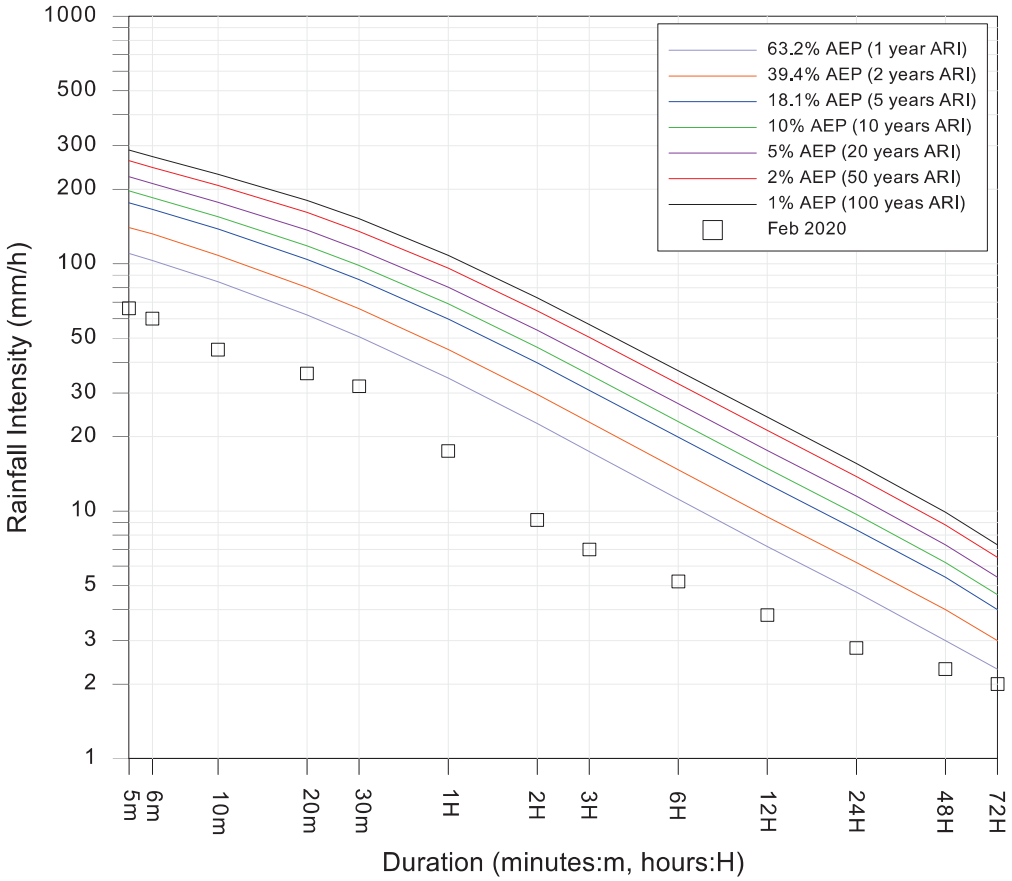
Figure

B1

DRAWING 2771-B1.cdr

Site Owner: CCSD
Latitude: -35.2692 Longitude:150.5

AEP = Annual Exceedance Probability
ARI = Average Recurrence Interval



Duration (minutes:m) (hours:H)	Rainfall Intensity (mm/hr)	Time/Date
5m	66	05:12 08 Feb 2020
6m	60	05:12 08 Feb 2020
10m	45	05:32 08 Feb 2020
20m	36	05:29 08 Feb 2020
30m	32	05:37 08 Feb 2020
1H	17.5	06:06 08 Feb 2020
2H	9.2	06:01 08 Feb 2020
3H	7	05:42 08 Feb 2020
6H	5.2	06:15 08 Feb 2020
12H	3.8	13:17 08 Feb 2020
24H	2.8	04:28 10 Feb 2020
48H	2.3	05:06 10 Feb 2020
72H	2	16:47 10 Feb 2020

Reference: Australian Rainfall and Runoff (1987)

Australian Rainfall and Runoff (Institute of Engineers Australia 1987) states:
Use of the terms 'recurrence interval' and 'return period' has been criticised as leading to confusion in the minds of some decision-makers and members of the public. Although the terms are simple superficially, they are sometimes misinterpreted as implying that the associated magnitude is only exceeded at regular intervals, and that they are referring to the elapsed time to the next exceedance.

The use of the term 'Average Recurrence Interval' (ARI) can lead to confusion. It is preferable, therefore, to express the rarity of a rainfall event in terms of Annual Exceedance Probability (AEP). For example, 'a rainfall total of 60mm falling in 3 hours at Cudgera has a 0.010 (i.e. 1%) probability of being equalled or exceeded in any one year' can be easier to understand than the equivalent statement of 'rainfall total of 60mm in 3 hours has an ARI of 100 years'.

Adapted from: http://www.bom.gov.au/water/designRainfalls/ifd/glossary.shtml

NSW GOVERNMENT

SAMPLE INTENSITY-FREQUENCY-DURATION FORMULATED IN 1987

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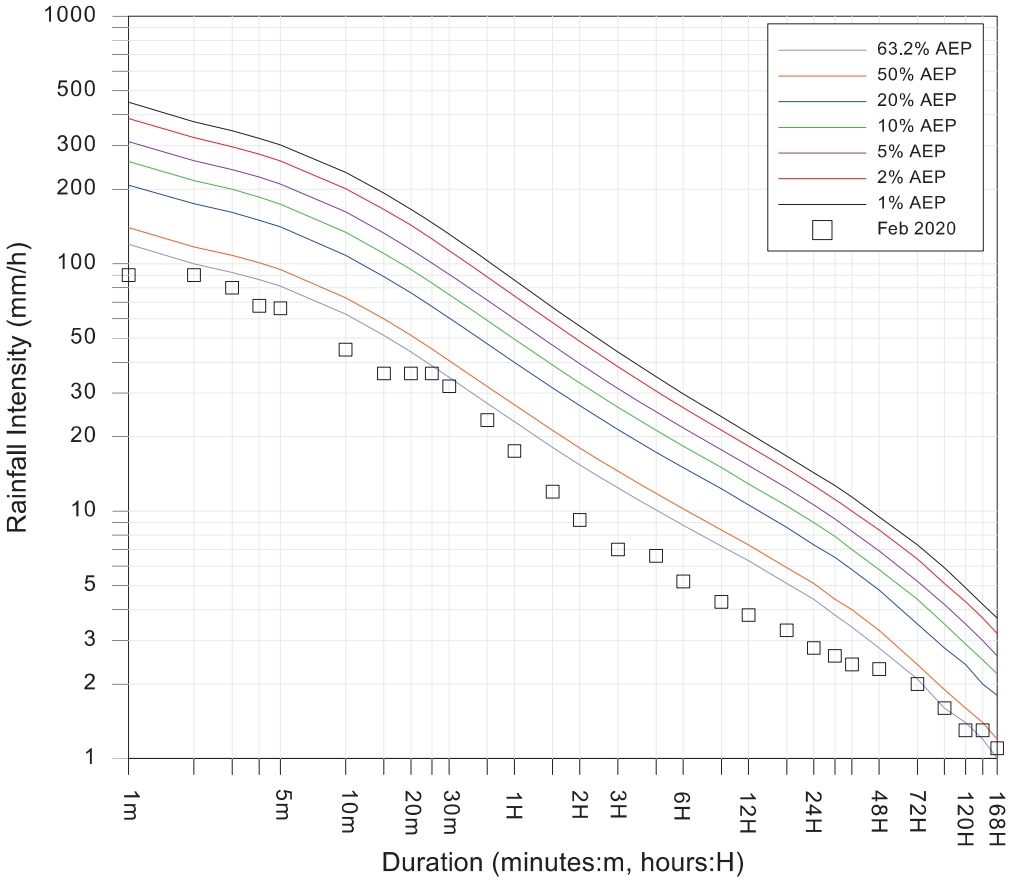
Figure B2

DRAWING 2771-B2.cdr

Site Owner: CCSD
Latitude: -35.2692 Longitude:150.5

AEP = Annual Exceedance Probability



Duration (minutes:m) (hours:H)	Rainfall Intensity (mm/hr)	Time/Date
1m	90	05:24 08 Feb 2020
2m	90	05:11 08 Feb 2020
3m	80	05:12 08 Feb 2020
4m	67.5	05:12 08 Feb 2020
5m	66	05:12 08 Feb 2020
10m	45	05:32 08 Feb 2020
15m	36	05:37 08 Feb 2020
20m	36	05:29 08 Feb 2020
25m	36	05:31 08 Feb 2020
30m	32	05:37 08 Feb 2020
45m	23.3	05:51 08 Feb 2020
1H	17.5	06:06 08 Feb 2020
1.5H	12	05:52 08 Feb 2020
2H	9.2	06:01 08 Feb 2020
3H	7	05:42 08 Feb 2020
5H	6.6	05:47 08 Feb 2020
6H	5.2	06:15 08 Feb 2020
9H	4.3	21:08 09 Feb 2020
12H	3.8	13:17 08 Feb 2020
18H	3.3	05:12 10 Feb 2020
24H	2.8	04:28 10 Feb 2020
30H	2.6	14:11 10 Feb 2020
36H	2.4	15:43 10 Feb 2020
48H	2.3	05:06 10 Feb 2020
72H	2	16:47 10 Feb 2020
96H	1.6	03:12 11 Feb 2020
120H	1.3	03:12 12 Feb 2020
144H	1.3	08:47 13 Feb 2020
168H	1.1	03:12 14 Feb 2020

Reference: Australian Rainfall and Runoff (2019)

The probability terminology used for the 2019 design rainfalls is consistent with the probability terminology for the new edtion of Australian Rainfall and Runoff (ARR2019). Further details on the new probability terminology can be found in Book 1; Chapter 2; Section 2.2 Terminology of ARR2019 http://arr.ga.gov.au/arr-guideline.The main terms used to describe design rainfalls are:
- *Exceedances per year (EY):* the number of times an event is likely to occur or be exceeded within any given year.
- *Annual exceedance probability (AEP):* the probability or likelihood of an event occurring or being exceeded within any given year, usually expressed as a percentage.
For further information refer to BoM frequently asked questions: http://www.bom.gov.au/water/designRainfalls/ifd/ifd-faq.shtml

NSW GOVERNMENT

SAMPLE INTENSITY-FREQUENCY-DURATION FORMULATED IN 2019

Manly Hydraulics Laboratory

Report MHL2771

Figure B3

DRAWING 2771-B3.cdr

Station Name	North Bonville (Live)
Station Number	559050
MGA Easting (m zone 56)	500592.91
MGA Northing (m zone 56)	6641143.16

Date	Time	Value [mm]	State of value
26/01/2013	2:35:17	0.5	5 (Very Good)
26/01/2013	2:40:12	0.5	5 (Very Good)
26/01/2013	4:04:04	0.5	5 (Very Good)
26/01/2013	4:04:53	0.5	5 (Very Good)
26/01/2013	4:07:48	0.5	5 (Very Good)
26/01/2013	5:56:18	0.5	5 (Very Good)
26/01/2013	5:57:42	0.5	5 (Very Good)
26/01/2013	5:59:16	0.5	5 (Very Good)
26/01/2013	6:00:32	0.5	5 (Very Good)
26/01/2013	6:01:22	0.5	5 (Very Good)
26/01/2013	6:02:22	0.5	5 (Very Good)
26/01/2013	12:20:33	0.5	5 (Very Good)
26/01/2013	12:20:51	0.5	5 (Very Good)
26/01/2013	12:21:32	0.5	5 (Very Good)
26/01/2013	12:22:02	0.5	5 (Very Good)
26/01/2013	12:22:42	0.5	5 (Very Good)
26/01/2013	12:23:49	0.5	5 (Very Good)
26/01/2013	12:24:37	0.5	5 (Very Good)
26/01/2013	12:25:42	0.5	5 (Very Good)
26/01/2013	12:35:17	0.5	5 (Very Good)
26/01/2013	19:16:58	0.5	5 (Very Good)
26/01/2013	19:49:01	0.5	5 (Very Good)
26/01/2013	19:51:13	0.5	5 (Very Good)
26/01/2013	21:12:07	0.5	5 (Very Good)
26/01/2013	21:55:36	0.5	5 (Very Good)
26/01/2013	22:01:34	0.5	5 (Very Good)
26/01/2013	22:05:28	0.5	5 (Very Good)
26/01/2013	22:10:31	0.5	5 (Very Good)
26/01/2013	22:12:16	0.5	5 (Very Good)
26/01/2013	22:13:47	0.5	5 (Very Good)
26/01/2013	22:15:34	0.5	5 (Very Good)
26/01/2013	22:17:57	0.5	5 (Very Good)

Appendix C Publications of interest

Data Reports

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).

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).

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), 2475 (15–16), 2574 (16–17), 2618 (17–18), 2693 (18–19).

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).

Flood Reports

MHL Flood Reports:

- *New South Wales North Coast Flood Summary June 2005*, MHL Report No. 1426
- *Marshalls Creek Flood Event 30 June 2005,* MHL Report No. 1435
- *New South Wales North Coast January 2006 Flood Summary*, MHL Report No. 1469
- *New South Wales North Coast March 2006 Flood Summary*, MHL Report No. 1482
- *New South Wales Central Coast June 2007 Flood Summary*, MHL Report No. 1754
- *New South Wales Hunter Valley, Wallamba River and Myall River June 2007 Flood Summary*, MHL Report No. 1755

- *New South Wales Hawkesbury and Nepean June 2007 Flood Summary*, MHL Report No. 1756
- *New South Wales Tweed River January 2008 Flood Summary*, MHL Report No. 1801
- *New South Wales Richmond River January 2008 Flood Summary*, MHL Report No. 1802
- *New South Wales Clarence River January 2008 Flood Summary*, MHL Report No. 1803
- *New South Wales Coffs Harbour and Bellinger River Region January 2008 Flood Summary*, MHL Report No. 1804
- *New South Wales Coffs Harbour, Bellinger River and Nambucca River Regions February 2009 Flood Summary*, MHL Report No. 1908
- *New South Wales Coffs Harbour and Bellinger River Regions April 2009 Flood Summary*, MHL Report No. 1913
- *NSW Northern Rivers May 2009 Flood Report*, MHL Report No. 1965
- *NSW North Coast Flood Summary January–March 2013*, MHL Report No. 2202
- *NSW Hunter and Central Coast Flood Summary April–May 2015,* MHL Report No. 2364
- *NSW South Coast Flood Summary August 2015,* MHL Report No. 2397
- *NSW North Coast Flood Summary March 2017*, MHL Report No. 2535
- *NSW Coastal Flood Summary February 2020,* MHL Report No. 2752

Other references

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia,

Bureau of Meteorology, *Climate Glossary – Southern Oscillation Index*, retrieved on 04 October 2010 from http://www.bom.gov.au/climate/glossary/soi.shtml

The Institution of Engineers, Australia 1987, '*Australian Rainfall and Runoff: A Guide to Flood Estimation'*, Institute of Engineers, Australia

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