

Salty Lagoon

Post Closure Monitoring

Project Management and Ecosystem Health Report

October 2020



AQUATIC SCIENCE AND MANAGEMENT

PO Box 119
Lennox Head NSW 2478
T 02 6687 7666

PO Box 1446
Coffs Harbour NSW 2450
T 02 6651 7666

info@geolink.net.au

Prepared for: Richmond Valley Council
© GeoLINK, 2020

<i>UPR</i>	<i>Description</i>	<i>Date Issued</i>	<i>Issued By</i>
1731-1321	First issue	23/11/2020	David Andrighetto



Table of Contents

1.	Introduction	1
1.1	Introduction	1
1.2	Guiding Values	1
2.	Methodology	2
2.1	Discrete Sampling	2
2.2	Fixed Point Photo Monitoring	2
2.3	Aquatic Weed Monitoring	2
2.4	Erosion Monitoring	3
2.5	Permanent Water Quality Monitoring Stations	3
3.	Results	6
3.1	Water Quality Samples	6
3.2	Permanent Water Quality Monitoring Stations	6
3.3	Aquatic Weed Monitoring	10
3.4	Erosion Monitoring Stations	10
4.	Discussion	11
4.1	Water Quality	11
4.2	Other Observations	12
5.	Key Points	13

Illustrations

Illustration 2.1	Battery life in the EXO Sondes during this reporting period plotted against battery life from the Salty Creek PWQMD from July 2020 to August 2020	4
Illustration 2.2	Water Quality and Erosion Monitoring Site Locations	5
Illustration 3.1	Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1 September 2020 to 31 October 2020.....	8
Illustration 3.2	Salty Creek Rainfall and Water Quality Monitoring Station Data 1 September 2020 to 31 October 2020.....	9
Illustration 3.3	Erosion Progression Plotted against Monthly Rainfall since July 2017	10

Plates

Plate 4.1	The closed entrance to Salty Creek on 2 November 2020	12
Plate 4.2	Streaked Arrowgrass, commonly associated with saline environments, was observed for the first time in Salty Lagoon	12



Tables

<u>Table 2.1</u>	<u>Locations of Water Quality Sample Sites in Salty Lagoon and Salty Creek (WGS84)</u>	<u>2</u>
<u>Table 2.2</u>	<u>Type and Locations (WGS84) of Erosion Monitoring Sites</u>	<u>3</u>
<u>Table 2.3</u>	<u>YSI Sonde Status on 2 November 2020.....</u>	<u>4</u>
<u>Table 3.1</u>	<u>Results of Discrete Samples Collected 2 November 2020.....</u>	<u>7</u>
<u>Table 3.2</u>	<u>Erosion Monitoring Results from 2 November 2020.....</u>	<u>10</u>



1. Introduction

1.1 Introduction

This document comprises the second bi-monthly monitoring report for year 9 of Salty Lagoon Post-Closure monitoring year's 6-10 program (GeoLINK 2017). The monitoring program is as described in *Final Evaluation Report – Salty Lagoon Monitoring: Pre-Post Closure of Artificial Channel – Project Finalisation Report*, which forms an extension of the monitoring undertaken as part of the *Salty Lagoon Ecosystem Recovery Monitoring Program; Pre-Post Closure of Artificial Channel* (MPPC) (Hydrosphere Consulting 2010).

This report is for the monitoring period 1 September 2020 until 31 October 2020.

1.2 Guiding Values

Guiding values were developed for Salty Lagoon and Salty Creek as part of the MPPC program (GeoLINK 2012) to assist with the contextualisation of monthly water monitoring results, rather than as a measure of the health of the waterway. These values are used as part of the current post-closure monitoring and provide a yardstick around which the adaptive management of Salty Lagoon can be discussed.



2. Methodology

2.1 Discrete Sampling

This was the second bi-monthly site visit for year 9 post-closure monitoring at Salty Lagoon. It included routine maintenance of permanent water quality monitoring stations and discrete water quality sampling. The site visit was undertaken on 2 November 2020. Water quality samples were collected between the hours of 7:00 am and 12:30 pm on that day. A high tide of 1.69 metres was forecast for 9.58 am.

Discrete water quality samples were taken from surface water (approximately 0.2 metre depth) at four sites in Salty Lagoon and a single site (S5) in Salty Creek. An additional quality assurance (QA) replicate sample was collected at S2. The specific locations of all sites sampled are presented in **Table 2.1** and **Illustration 2.2**. They are the same sites previously used for the MPPC (GeoLINK 2017).

Table 2.1 Locations of Water Quality Sample Sites in Salty Lagoon and Salty Creek (WGS84)

Site	S 1	S 2	S 3	S 4	S 5
Eastings	0542064	0541799	0542037	0541738	0542187
Northings	6782801	6782669	6783013	6783033	6783665
Site Description	Lagoon monitoring station	SE of Drainage Channel	NE area of lagoon	NW area of lagoon	Creek monitoring station

Physico-chemical water quality parameters were measured with a calibrated HORIBA U-52 hand held water quality meter. Samples were collected from the surface, and at depth intervals of one metre where water levels allowed.

Samples were collected in jars for analysis of chemical and biological parameters at the Coffs Harbour Laboratory (CHL). Sterile jars were used for collection of samples for bacteriological analysis and brown glass jars were used for collection of samples for analysis of chlorophyll-a and blue green algal (BGA) content. Samples were placed upon ice in an esky and delivered to CHL on the same day.

2.2 Fixed Point Photo Monitoring

In addition to water quality samples, photos were taken showing the environment to the north, east, south and west of each water quality sample site. An additional photo monitoring site is located on the in-filled artificial channel.

2.3 Aquatic Weed Monitoring

Aquatic weed monitoring occurs three times each year; once in each of the summer, autumn and spring seasons. Maps of the monitoring meander and detailed data are provided in the annual reports. Aquatic weed monitoring was undertaken during the site inspection on 2 November 2020. The next aquatic weed monitoring is scheduled for early January 2021.

2.4 Erosion Monitoring

A series of stations have been set up around the active head cut to the east of the infilled channel and some nearby control sites to assess the progression of erosion between Salty Lagoon and Salty Creek. The specific locations of all sites sampled are presented in **Table 2.2** and **Illustration 2.2**.

The stations were set up in July 2017 at the head cut (Stations 4, 5 and 6), with control sites at points where lateral tributaries from Salty Creek lead towards Salty Lagoon (Stations 1, 2 and 3). At each site the monitoring involves a fixed-point photo and a measurement from a fixed peg to the nearest point of the head cut. In March 2020 site ER5 had to be extended because the fixed peg was overtaken by the erosion. A new site, ER5A was created but allows erosion progression to be measured from the same initial reference point as ER5.

Table 2.2 Type and Locations (WGS84) of Erosion Monitoring Sites

Site	Control/ Impact	Peg Location	
		Easting	Northing
ER1	Control	541961	6783356
ER2	Control	541934	6783355
ER3	Control	541978	6783342
ER4	Impact	542112	6783277
ER5	Impact	542129	6783262
ER5A	Impact	542128	6783245
ER6	Impact	542121	6783272

2.5 Permanent Water Quality Monitoring Stations

There are two permanent water quality monitoring stations (PWQMS) in place with YSI EXO3 series water quality sondes measuring temperature, pH, conductivity, turbidity and dissolved oxygen (DO) concentrations at 30-minute intervals. One PWQMS is located in Salty Lagoon at S1 and one in Salty Creek at S5. The data from these sites is downloaded at bi-monthly intervals for reporting purposes.

HOB0 U20 water level loggers were installed in the water at each PWQMS and a third HOB0 was installed above the water at S1 to collect barometric pressure data for offsetting atmospheric variability.

The temperature, pH, conductivity, turbidity and DO sensors on the EXO3 sonde installed at the Salty Lagoon PWQMS were removed on 2 November 2020 and replaced by a serviced and calibrated set. In addition, the pH probe at the Salty Creek PWQMS was replaced on 21 September 2020 after it was found to be malfunctioning.

At the time of the site visit on 2 November 2020 the batteries on both sondes were completely discharged, despite new batteries having been installed on 1 September 2020 as per protocol. The only explanation for this is a change of battery brand. A routine battery life of 4 months was normal with the previous brand but the batteries installed on 1 September 2020 only lasted 25 to 28 days (**Illustration 2.1**). A third alternative brand of battery was installed on 2 November 2020 and all future batteries will be the initial brand used.



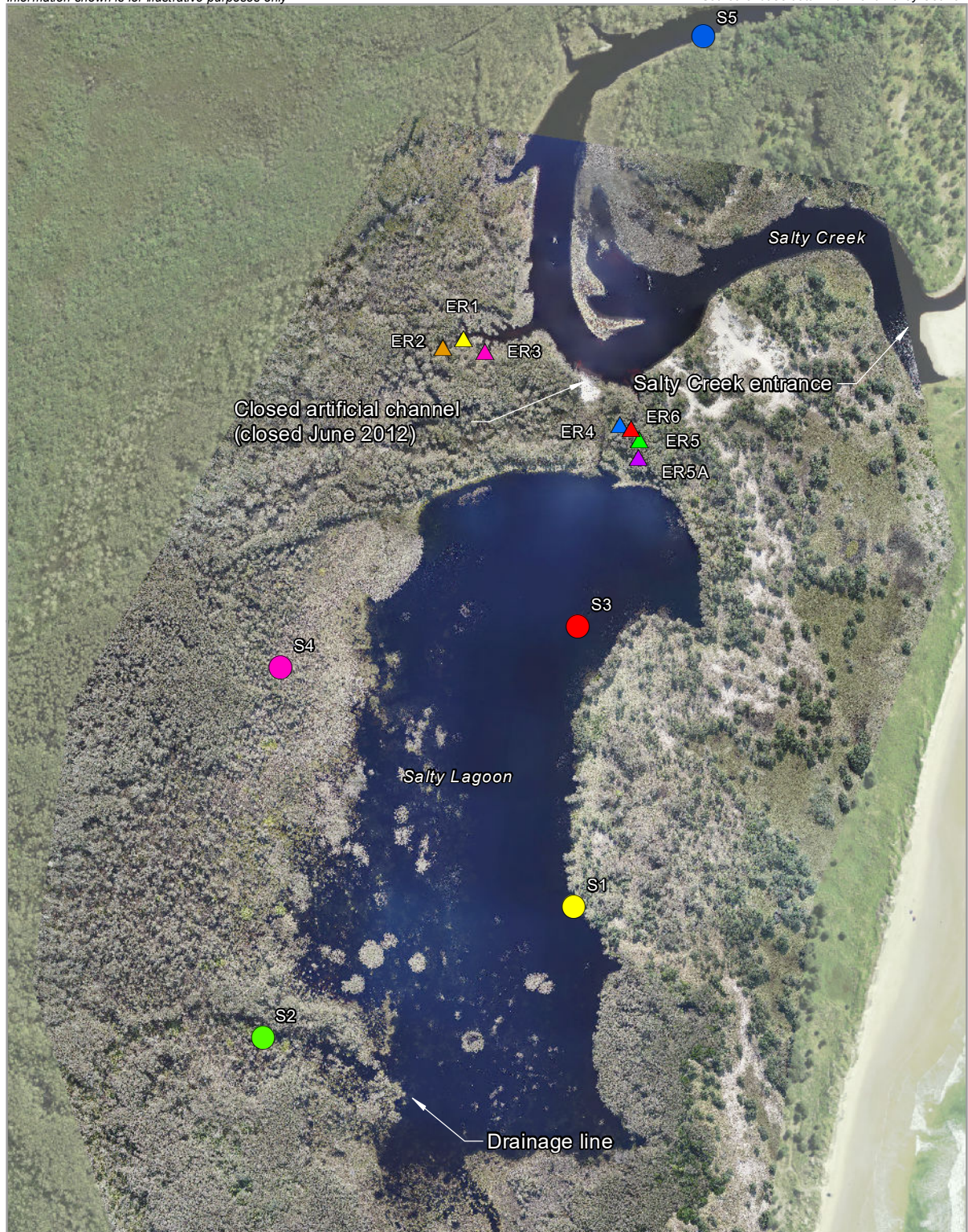
Illustration 2.1 Battery life in the EXO Sondes during this reporting period plotted against battery life from the Salty Creek PWQMD from July 2020 to August 2020

The status of the two deployed YSI EXO3 sondes on 2 November 2020 is displayed in **Table 2.3**.

Table 2.3 YSI Sonde Status on 2 November 2020

Sonde	SN17F104100	SN 17H104488	Spare Probes
pH (cap life expectancy 18 months)	EXO pH 17H105048 Manufactured 08/2017 New cap 10/2020	EXO pH 17H105049 Manufactured 08/2017 New cap 09/2020	EXO pH 17H105047 Manufactured 08/2017 New cap 03/2019
Temp/ cond (life expectancy 7-10 years)	EXO Wiped CT 17F102685 Manufactured 06/2017	EXO Wiped CT 17F103252 Manufactured 06/2017	EXO Wiped CT 17F102047 Manufactured 06/2017
DO (cap life expectancy 24 months)	EXO Optical DO 17H103494 Manufactured 08/2017 New cap 03/2019	EXO Optical DO 17H103495 Manufactured 08/2017 New cap 03/2019	EXO Optical DO 17H103493 Manufactured 08/2017 New cap 05/2019
Turbidity (life expectancy 7-10 years)	YSI EXO Turbidity 17H103513 Manufactured 08/2017	YSI EXO Turbidity 17H101468 Manufactured 08/2017	YSI EXO Turbidity 17H101465 Manufactured 08/2017
Wiper	YSI Exo Wiper 17G101952 New wiper brush installed 07/2020	YSI Exo Wiper 17G101954 New wiper brush installed 03/2020	No Spare Wiper
Status	<ul style="list-style-type: none"> - Serviced probes installed in Salty Lagoon 2/11/2020 - New batteries installed 2/11/2020 	<ul style="list-style-type: none"> - Serviced probes installed in Salty Creek 1/09/2020 - pH probe installed 21/09/2020 - New Batteries installed 2/11/2020 	<ul style="list-style-type: none"> - Awaiting service and calibration. - Probes Removed from Salty Lagoon 2/11/2020
Notes	<ul style="list-style-type: none"> - 218 days estimated battery life - Memory cleared – 50045.3 days logging available 	<ul style="list-style-type: none"> - 218 days estimated battery life - Memory cleared – 50045.3 days logging available 	<ul style="list-style-type: none"> - pH probe needs new cap

Climate information was sourced from the Evans Head bombing range weather station on the Bureau of Meteorology website (BOM 2020). Evans Head Sewage Treatment Plant (STP) facility routine sampling information was provided by Richmond Valley Council (RVC).



LEGEND

Water Quality Site

- S1
- S2
- S3
- S4
- S5

Erosion Monitoring Site

- ▲ ER1
- ▲ ER2
- ▲ ER3
- ▲ ER4
- ▲ ER5
- ▲ ER5A
- ▲ ER6

0 120

Location of Water Quality and Erosion Monitoring Sites





3. Results

3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 2 November 2020 are reported in **Table 3.1**.

3.2 Permanent Water Quality Monitoring Stations

The data collected at the PWQMS, and rainfall data correlating to the reporting period are presented in **Illustration 3.1** and **Illustration 3.2**.



Table 3.1 Results of Discrete Samples Collected 2 November 2020

Parameter	Salty Lagoon								Salty Creek	
	Guiding Value	S1	S1 (1m)	S2	S2 (QA)*	S3	S3 (1m)	S4	Guiding Value	S5
Blue Green Algae ID (cells/mL)	0	4000	ns	nil	<100	2000	ns	<100	0	<100
Nitrite Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.01	<0.010
Nitrate Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	0.01	<0.010
Oxidized Nitrogen (mg/L)	-	<0.010	ns	<0.010	<0.010	<0.010	ns	<0.010	-	<0.010
Ammonia Nitrogen (mg/L)	0.05	<0.010	ns	0.03	0.03	<0.010	ns	0.038	0.11	0.033
Total Kjeldahl Nitrogen (mg/L)	1.6	2.1	ns	1.54	1.53	2.14	ns	2.4	1.63	0.9
Total Nitrogen (mg/L)	1.6	2.1	ns	1.54	1.53	2.14	ns	2.4	1.63	0.9
Total Phosphorus(mg/L)	0.14	0.16	ns	0.2	0.22	0.16	ns	0.03	0.04	<0.03
Orthophosphate (mg/L)	0.11	0.03	ns	0.16	0.13	0.028	ns	<0.010	0.01	<0.010
Chlorophyll-a (µg/L)	5	25	ns	7	6	22	ns	48	3	5
Enterococcus (CFU/100mL)	170	60	ns	35	30	<5	ns	5	40	<5
Faecal Coliforms (CFU/100mL)	135	195	ns	25	10	25	ns	<5	150	<5
Temp (°C)	25.9	23.27	22.95	21.55	ns	23.91	23.68	19.54	13.1 - 28.8	24.64
pH	6.9	6.76	6.77	6.53	ns	6.79	6.78	5.7	4.3 - 6.8	6.72
ORP (mV)	-	209	209	175	ns	220	196	76	-	190
Cond (mS/cm)	8.0	2.01	2.01	1.24	ns	2.02	2.02	4.21	0.3 - 21.5	25.2
Turbidity (NTU)	13	16.1	18.9	2.7	ns	19.9	20	3.4	11	4
DO (mg/L)	4.09	5.48	5.58	0.94	ns	6.52	6.26	0.14	5.52	5.41
DO (% sat)	-	66	66.8	11	ns	79.4	76	1.5	-	72.3
TDS (mg/L)	-	1.29	1.29	0.795	ns	1.29	1.29	2.69	-	15.6
Sal (ppt)	-	1	1	0.6	ns	1	1	2.2	-	15.3
Depth (m)	-	Surface	1	Surface	Surface	Surface	1	Surface	-	Surface

Note: * = randomly selected quality assurance sample.

red text = not compliant with MPPC guiding values (see GeoLINK 2012).

levels below detection limits will be incorporated into databases as 0 for the purpose of statistical analyses

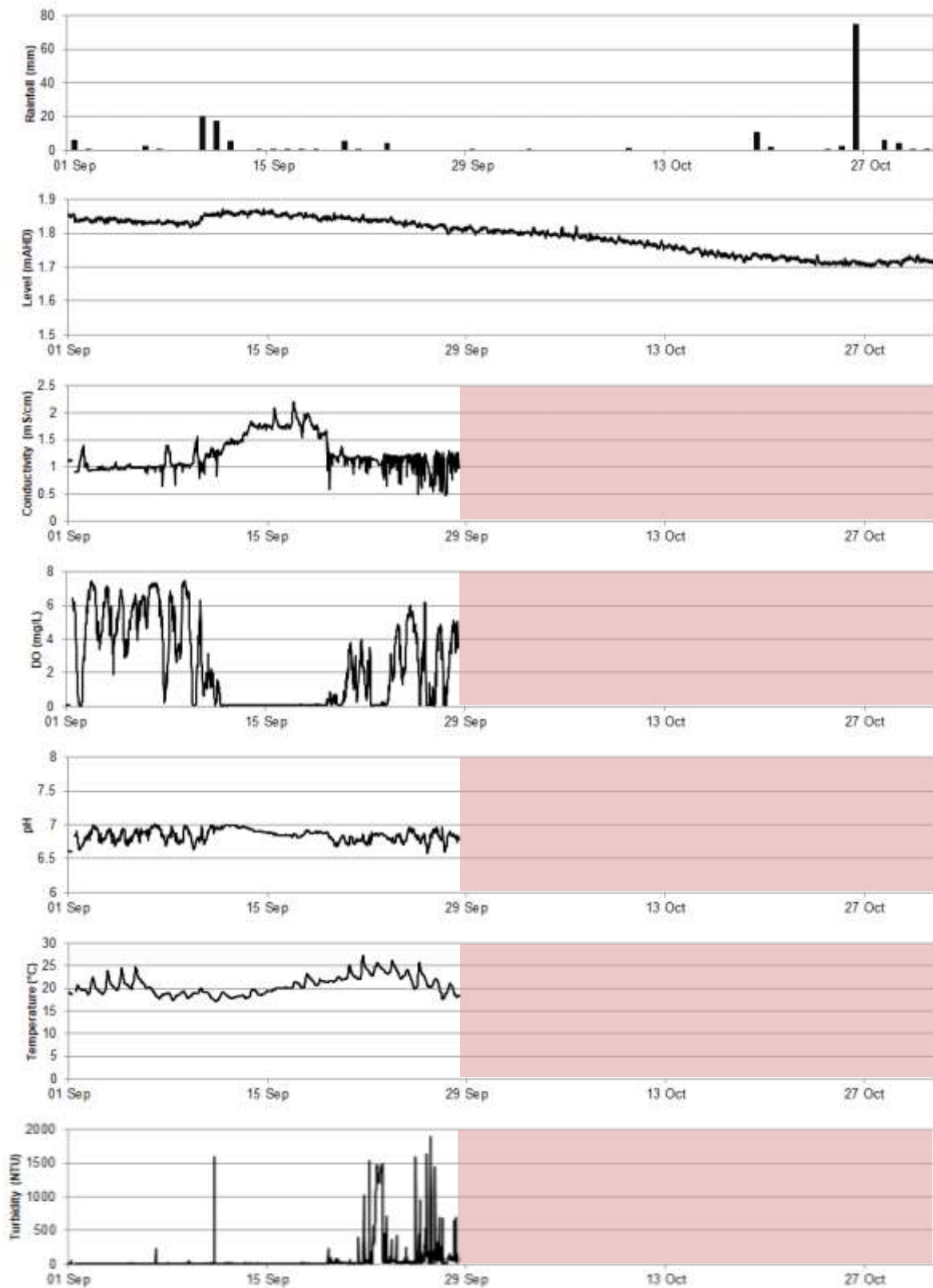


Illustration 3.1 Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1
September 2020 to 31 October 2020

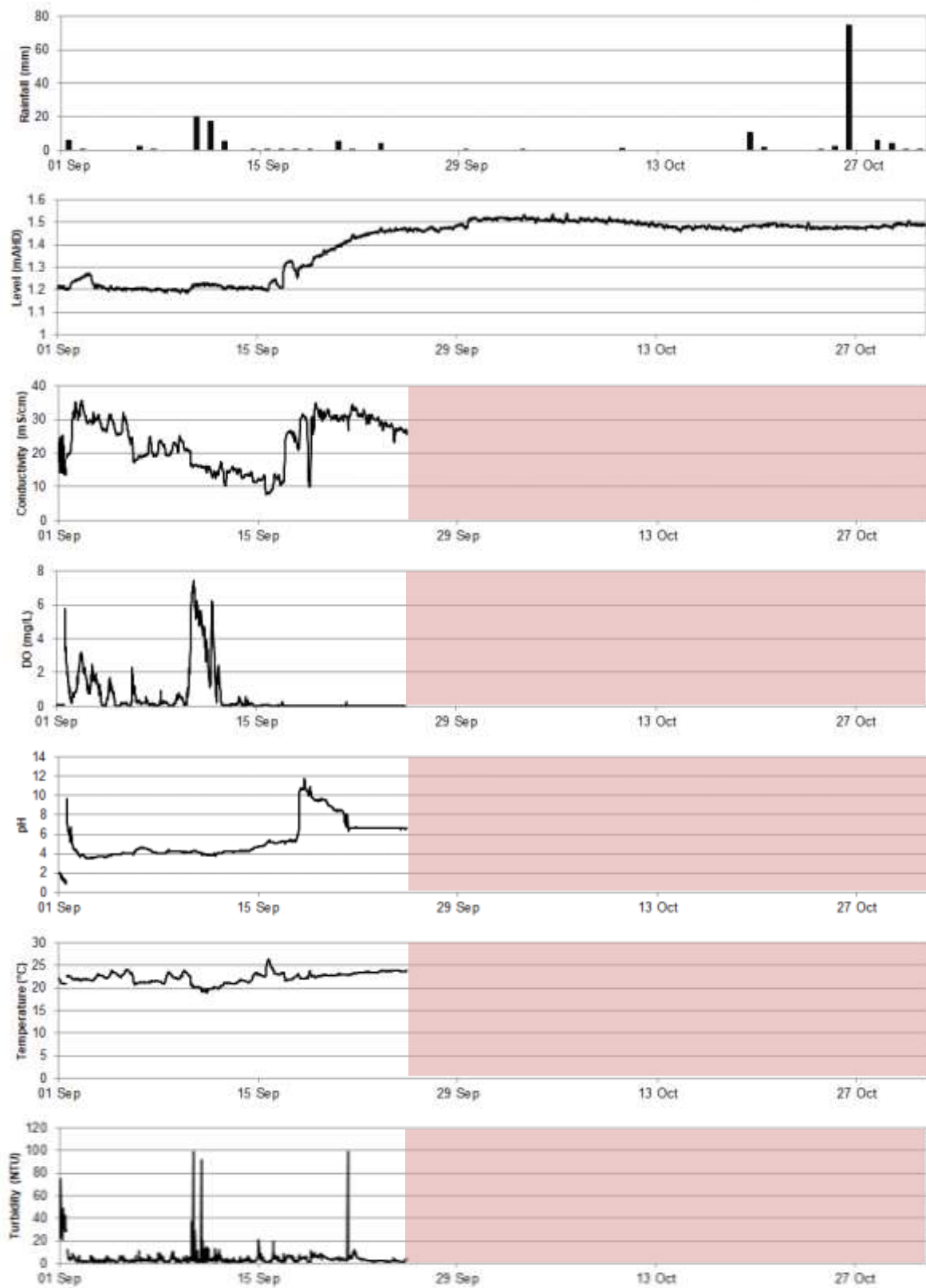


Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 1
September 2020 to 31 October 2020

3.3 Aquatic Weed Monitoring

No significant aquatic weeds were identified during the aquatic weed survey on 2 November 2020.

3.4 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2** and **Illustration 3.3**. There was no advance of the head cuts at any of the three impact stations in relation to the previous measurements on 1 September 2020. The head cut has advanced at least 27 m towards Salty Lagoon since the monitoring began in July 2017.

Table 3.2 Erosion Monitoring Results from 2 November 2020

Station	Control/ Impact	Distance 25 July 2017 (m)	Distance 2 November 2020 (m)	Cut Movement (m)
ER1	Control	7.55	7.35	0.20
ER2	Control	10.20	8.90	1.30
ER3	Control	9.95	9.90	0.05
ER4	Impact	8.35	-5.25	13.60
ER5	Impact	12.35	-15.55	27.90
ER6	Impact	10.40	6.15	4.25

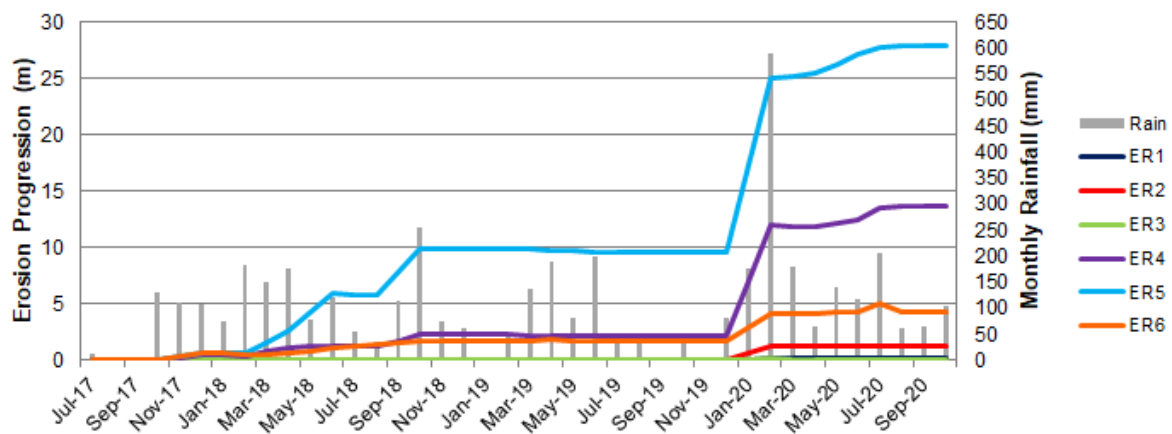


Illustration 3.3 Erosion Progression Plotted against Monthly Rainfall since July 2017



4. Discussion

4.1 Water Quality

The logged water quality data for this reporting period was impacted by technical problems. The pH probe on the Salty Creek logger was replaced on 21 September 2020 after anomalous results were noted during the previous site inspection. The batteries in both probes failed on 25 and 28 September 2020 although new batteries (of a reputable brand) had been installed on 1 September 2020.


Total rainfall for this reporting period comprised of several small to moderate events and one heavy event on 26 October 2020. The heavy rainfall on 26 October 2020 resulted in an adaptive management site inspection. No environmental incident was noted.

The conductivity and level data from the Salty Creek PWQMS indicate that the entrance to Salty Creek was constricted from the beginning of the monitoring period and that catchment inflow was the key influence on water levels although there were minor seawater ingress events on 1 and 16 September. At the time of the site inspection on 2 November 2020, the entrance to Salty Creek was closed (**Plate 4.1**). The water level in Salty Lagoon reduced throughout this monitoring period, initially as water flowed out into Salty Creek and later as a result of evaporation. Heavy rainfall on 26 October 2020 had little influence on the water level in Salty Lagoon.

The conductivity measured at the Salty Lagoon PWQMS remained relatively constant during this reporting period, remaining within the range of typical fresh to brackish conditions. There was a small increase in conductivity, which together with other parameters indicates that the water column in Salty Lagoon was stratified for a period of approximately 8 days following moderate rainfall between 9 and 11 September 2020. The conductivity measurements at the Salty Creek PWQMS fluctuated in response to seawater ingress and rainfall events. At the time of the site inspection on 2 November 2020 the water in Salty Lagoon was well mixed and brackish, indicating that further evaporation had occurred. The water in Salty Creek was also well mixed and the conductivity measurements were approximately 50% those of seawater. The conductivity measurements collected on 2 November 2020 complied with guiding values at all sites except S5, where they slightly exceeded them.

Erosion monitoring indicated that the head cut did not advance during this reporting period. The level information indicates that runoff from Salty Lagoon into Salty Creek was low and did not persist for the entire monitoring period. There was no advance of the head cuts at the control sites. The head cut is approximately 14 m from the current banks of Salty Lagoon. If it reaches Salty Lagoon, the channel formed is highly likely to increase in size when tidal movements occur and some of the conditions that previously led to fish kills will be restored. Such a scenario could have an impact on future planning for the disposal of treated wastewater.

The DO concentrations in discrete samples collected on 2 November 2020 were below the guiding values at the two westernmost sites in Salty Lagoon and at the Salty Creek site. The DO concentrations measured at the open water sites in Salty Lagoon were healthy. Low DO concentrations are naturally prevalent at the sites to the west of Salty Lagoon (sites S2 and S4). The available data from the Salty Lagoon PWQMS indicates that the DO concentrations in Salty Lagoon during this reporting period fluctuated in response to daily patterns with the exception of a short period where the water column was stratified and DO concentrations at the bottom of the water column (where the sonde is located) remained low. The available data from the Salty Creek PWQMS indicate that low DO concentrations persisted at the bottom of the water column for almost the entire



monitoring period and healthy DO concentrations were only measured when mixing occurred in response to the largest rainfall event.

Several nutrient concentrations from samples collected on 2 November 2020 did not comply with guiding values. These included TN concentrations from S1, S3 and S4 and TP and orthophosphate concentrations from S1, S2 and S3. It is likely that evaporation was the key factor leading to increased nutrient concentrations. Chlorophyll-a concentrations in all samples did not comply with guiding values, and indicated algal blooms of moderate to large proportions in samples from S1, S3 and S4. Blue-green algae were recorded from all five sites for the second consecutive time, in high concentrations from S1 and S3. The blue green algae detected were from the genera *Pseudanabaena* (S1 and S3) and *Synechococcus* (other sites). *Pseudanabaena* common in freshwater environments. *Synechococcus* is a primarily marine genus with some freshwater species. Neither genera form toxic blooms (Entwistle *et al.* 1997).

All other results complied with guiding values with the exception of the faecal coliform concentration from S1 and the turbidity measurements from S1 and S3. The faecal coliform concentration at S1 was probably associated with waterbird use of the area and the turbidity measurements are likely to have been a result of the algal bloom described above.

4.2 Other Observations

The entrance to Salty Creek was closed on 2 November 2020. A variety of birds were observed incidentally during the site inspection including Pacific Black Duck, Pelican, Pied Cormorant, Little Black Cormorant, Great Egret, Whimbrel, Masked Lapwing, Little Tern, White bellied Sea Eagle, Brahminy Kite and Swamp Harrier.



Plate 4.1 The closed entrance to Salty Creek on 2 November 2020



Plate 4.2 Streaked Arrowgrass, commonly associated with saline environments, was observed for the first time in Salty Lagoon



5. Key Points

1. Significant data loss occurred as a result of poor battery performance.
2. Water levels reduced in Salty Lagoon throughout the current monitoring period. Water levels in and Salty Creek were variable in response to rainfall conditions and seawater ingress.
3. A moderate number of results did not comply with the guiding values.
4. Nutrient and chlorophyll-a concentrations increased and did not comply with guiding values in many samples.
5. Blue-green algae were detected for the second consecutive month. Concentrations at S1 and S3 were relatively high. The blue-green algae detected were not from genera that cause toxic blooms.
6. The erosive headcut to the east of the old channel between Salty Lagoon and Salty Creek did not advance during this reporting period. However, there is a continued risk that the eroding channel will break into Salty Lagoon during the next heavy rainfall, or if moderate rainfall conditions persist for an extended period.
7. The risk rating for the Salty Lagoon Response Protocol is 'uncertain', due to the potential for the erosive channel to break into Salty Lagoon. Heavy rainfall may lead to a 'high' risk rating and require site a site inspection in the coming months. An adaptive management site inspection was undertaken in response to heavy rainfall on 26 October 2020. No environmental incident was recorded.



References

Bureau of Meteorology (2020). <http://www.bom.gov.au/>. Accessed 17/11/2020.

Entwistle, T., Sonneman, J. and Lewis, S. (1997) *Freshwater Algae in Australia*.

GeoLINK (2012). *Salty Lagoon Monitoring: Pre-Post Closure of Artificial Channel – Project Management and Ecosystem Health Monthly Report – September 2012*. Report to Richmond Valley Council.

GeoLINK (2017). *Final Evaluation Report - Salty Lagoon Monitoring: Pre-Post Closure of Artificial Channel – Project Finalisation Report*. Report to Richmond Valley Council.

Hydrosphere (2010). *Salty Lagoon Monitoring Program Pre/Post Closure of the Artificial Channel*. Unpublished report to Richmond Valley Council. Hydrosphere Consulting, Ballina.



Copyright and Usage

©GeoLINK, 2020

This document, including associated illustrations and drawings, was prepared for the exclusive use of Richmond Valley Council. It is not to be used for any other purpose or by any other person, corporation or organisation without the prior consent of GeoLINK. GeoLINK accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

This document, including associated illustrations and drawings, may not be reproduced, stored, or transmitted in any form without the prior consent of GeoLINK. This includes extracts of texts or parts of illustrations and drawings.