Salty Lagoon Post Closure Monitoring

Project Management and Ecosystem Health Report February 2020



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Table of Contents

Introduction	1
Guiding Values	
	1
odology	2
Discrete Sampling	2
Fixed Point Photo Monitoring	2
Aquatic Weed Monitoring	2
Erosion Monitoring	3
Permanent Water Quality Monitoring Stations	3
lts	6
Water Quality Samples	6
Permanent Water Quality Monitoring Stations	6
Aquatic Weed Monitoring	10
Erosion Monitoring Stations	10
ission	11
Water Quality	11
Other Observations	12
Adaptive Management – Risk Evaluation	13
Points	14
	Discrete Sampling Fixed Point Photo Monitoring Aquatic Weed Monitoring Erosion Monitoring Permanent Water Quality Monitoring Stations Its Water Quality Samples Permanent Water Quality Monitoring Stations Aquatic Weed Monitoring Erosion Monitoring Erosion Monitoring Erosion Monitoring Erosion Monitoring Stations Ission Water Quality Other Observations Adaptive Management – Risk Evaluation

Illustration 2.1	Water Quality and Erosion Monitoring Site Locations	. 5
Illustration 3.1	Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1 January 2020 to	
	29 February 2019	. 8
Illustration 3.2	Salty Creek Rainfall and Water Quality Monitoring Station Data 1 January 2020 to 2	9
	February 2020	. 9
Illustration 4.1	Erosion progression at all sites, plotted against monthly rainfall totals	12

Tables

<u>Table 2.1</u>	Locations of Water Quality Sample Sites in Salty Lagoon and Salty Creek (WGS84) 2
<u>Table 2.2</u>	Type and Locations (WGS84) of Erosion Monitoring Sites
<u>Table 2.3</u>	YSI Sonde Status on 3 March 2020 4
<u>Table 3.1</u>	Results of Discrete Samples Collected 4 March 20207
Table 3.2	Erosion Monitoring Results from 4 March 2020 10



GeoLINK environment of design Salty Lagoon Project Management & Ecosystem Health Report, February 2020 1731-1324

i

1. Introduction

1.1 Introduction

This document comprises the fourth bi-monthly monitoring report for year 8 of Salty Lagoon Post-Closure monitoring year's 6-10 program (GeoLINK 2017a). 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 January 2020 until 29 February 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 fourth bi-monthly site visit for year 8 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 4 March 2020. Water quality samples were collected between the hours of 7:30 am and 11:00 am on that day. A low tide of 0.66 metres was forecast for 10.54 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 S3. The specific locations of all sites sampled are presented in **Table 2.1** and **Illustration 2.1**. They are the same sites previously used for the MPPC (GeoLINK 2017a).

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

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

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 for the 2019 – 2020 summer period was completed on-foot and from a canoe during the site visit on 22 January 2020. Aquatic weed monitoring for the 2020 autumn period will be undertaken in May 2020.

AQUATIC SCIENCE AND MANAGEMENT



Salty Lagoon Project Management & Ecosystem Health Report, February 2020 1731-1324

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 2.1**.

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.

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		
ER6	Impact	542121	6783272		

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

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.

HOBO U20 water level loggers were installed in the water at each PWQMS and a third HOBO 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 3 March 2020 and replaced by a serviced and calibrated set.

The status of the two deployed YSI EXO3 sondes on 3 March 2020 is displayed in Table 2.3.



Sonde	SN17F104100	SN 17H104488	Spare Probes
pH	EXO pH	EXO pH	EXO pH
(cap life	17H105048	17H105047	17H105049
expectancy 18	Manufactured 08/2017	Manufactured 08/2017	Manufactured 08/2017
months)	New cap 03/2019	New cap 05/2019	New cap 03/2019
Temp/ cond	EXO Wiped CT	EXO Wiped CT	EXO Wiped CT
(life expectancy	17F103252	17F102047	17F102685
7-10 years)	Manufactured 06/2017	Manufactured 06/2017	Manufactured 06/2017
DO	EXO Optical DO	EXO Optical DO	EXO Optical DO
(cap life	17H103495	17H103493	17H103494
expectancy 18	Manufactured 08/2017	Manufactured 08/2017	Manufactured 08/2017
months)	New cap 03/2019	New cap 05/2019	New cap 03/2019
Turbidity	YSI EXO Turbidity	YSI EXO Turbidity	YSI EXO Turbidity
(life expectancy	17H101468	17H101465	17H103513
7-10 years)	Manufactured 08/2017	Manufactured 08/2017	Manufactured 08/2017
Wiper	YSI Exo Wiper 17G101952	YSI Exo Wiper 17G101954 New wiper brush installed 03/2020	No Spare Wiper
Status	Serviced probes installed in Salty Lagoon 4/03/2020 Sonde repaired under warranty 04/2019 New batteries installed 22/01/2020	Serviced probes installed in Salty Creek 07/11/2019 New Batteries installed 04/03/2020	Awaiting service and calibration.
Notes	 180 days estimated	 218 days estimated	 Probes Removed
	battery life	battery life	from Salty Lagoon
	 Memory cleared – 50045.3 days logging available 	 Memory cleared – 50045.3 days logging available 	4/03/2020

Table 2.3 YSI Sonde Status on 3 March 2020

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).







200

Water Quality and Erosion Monitoring Site Locations

Salty Lagoon Project Management & Ecosystem Health Report, February 2020 1731-1297

3. Results

3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 4 March 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 4 March 2020

	Salty Lagoon						Salt	y Creek			
Parameter	Guiding Value	S1	S1 (1m)	S2	S3	S3 (1m)	S3 (QA)*	S4	Guiding Value	S5	S5 (1m)
Blue Green Algae ID (cells/mL)	0	Nil	ns	Nil	Nil	ns	Nil	Nil	0	Nil	-
Nitrite Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	ns	<0.010	<0.010	0.01	<0.010	-
Nitrate Nitrogen (mg/L)	0.01	<0.010	ns	<0.010	<0.010	ns	<0.010	<0.010	0.01	<0.010	-
Oxidized Nitrogen (mg/L)	-	<0.010	ns	<0.010	<0.010	ns	<0.010	<0.010	-	<0.010	-
Ammonia Nitrogen (mg/L)	0.05	1.07	ns	<0.010	0.99	ns	0.99	<0.010	0.11	0.024	-
Total Kjeldahl Nitrogen (mg/L)	1.6	3.2	ns	2.2	3.16	ns	3.16	1.57	1.63	1.84	-
Total Nitrogen (mg/L)	1.6	3.2	ns	2.2	3.16	ns	3.16	1.57	1.63	1.84	-
Total Phosphorus(mg/L)	0.14	0.34	ns	0.3	0.31	ns	0.32	0.03	0.04	0.05	-
Orthophosphate (mg/L)	0.11	0.25	ns	0.23	0.23	ns	0.23	<0.010	0.01	<0.010	-
Chlorophyll-a (µg/L)	5	30	ns	2	12	ns	18	7	3	<1	-
Enterococcus (CFU/100mL)	170	160	ns	610	255	ns	200	30	40	35	-
Faecal Coliforms (CFU/100mL)	135	2	ns	48	1	ns	6	2	150	58	-
Temp (°C)	25.9	26.67	26.57	24.9	26.4	26.24	ns	25.2	13.1 - 28.8	26.85	-
рН	6.9	6.66	6.57	6.19	6.54	6.49	ns	5.21	4.3 - 6.8	4.18	-
ORP (mV)	-	89	69	153	155	123	ns	202	-	301	-
Cond (mS/cm)	8.0	2.71	2.7	0.707	2.67	2.71	ns	1.55	0.3 - 21.5	0.927	-
Turbidity (NTU)	13	5.7	6.3	2.9	5.1	7.7	ns	2.3	11	1.9	-
DO (mg/L)	4.09	2.54	2.66	0.87	3.11	2.8	ns	1.77	5.52	4.11	-
DO (% sat)	-	32.4	33.9	10.7	39.5	35.5	ns	21.9	-	52.3	-
TDS (mg/L)	-	1.74	1.73	0.452	1.71	1.73	ns	0.993	-	0.593	-
Sal (ppt)	-	1.4	1.4	0.3	1.4	1.4	ns	0.8	-	0.5	-
Depth (m)	-	Surface	0.5	Surface	Surface	0.5	Surface	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

TNTC = too numerous to count



Salty Lagoon Project Management & Ecosystem Health Report, February 2020 1731-1324



Illustration 3.1 Salty Lagoon Rainfall and Water Quality Monitoring Station Data 1 January 2020 to 29 February 2019



Salty Lagoon Project Management & Ecosystem Health Report, February 2020
1731-1324



Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 1 January 2020 to 29 February 2020



Salty Lagoon Project Management & Ecosystem Health Report, February 2020 1731-1324

3.3 Aquatic Weed Monitoring

No significant aquatic weeds were identified during the aquatic weed survey on 22 January 2020 and there were no weeds noted during the site inspection on 4 March 2020.

3.4 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2**. There was a significant advance of the head cuts at the three impact stations in relation to the previous measurements on 22 January 2020, marking the first notable change in the head cut position since October 2018. The head cut has advanced at least 25 m towards Salty Lagoon since the monitoring began in July 2017.

Station	Control/ Impact	Distance 25 July 2017 (m)	Distance 4 March 2020 (m)	Cut Movement (m)
ER1	Control	7.55	7.40	0.15
ER2	Control	10.20	8.90	1.30
ER3	Control	9.95	9.80	0.15
ER4	Impact	8.35	-3.65	12.00
ER5	Impact	12.35	-12.65	25.00
ER6	Impact	10.40	6.20	4.20

Table 3.2 Erosion Monitoring Results from 4 March 2020



4. Discussion

4.1 Water Quality

Total rainfall for this reporting period was above average, falling in two very large events, a large event and several small to moderate events. The conductivity and level data from the Salty Creek PWQMS indicate that the entrance to Salty Creek remained closed from the beginning of the reporting period until it opened on 10 February 2020 when the water level in Salty Creek and Salty Lagoon reached 2.39 mAHD. The water in Salty Creek drained very rapidly and the water level reduced by more than 1.5 m in less than 15 hours. The water levels in Salty Creek fluctuated tidally for the remained of the reporting period, the effect of the tide diminishing towards the end of the reporting period. At the time of the site inspection on 4 March 2020, the entrance to Salty Creek was still open and flowing (Plates 4.1 and 4.2). The water level in Salty Lagoon also fluctuated significantly during this monitoring period. The levels in Salty Lagoon were very low at the beginning of the reporting period and increased in response to rainfall until a peak of 2.41 mAHD was reached prior to Salty Creek opening and draining. The water levels in Salty Lagoon then stabilised at approximately 1.9 mAHD, at which point the two waterways become hydrologically separated. Aside from the response to rainfall, daily water level fluctuations of more than 5 cm were measured in Salty Lagoon and Salty Creek on the hottest days when water temperatures were fluctuating by as much as 10 °C. It is likely that the dark tannin staining and large surface area to depth ratio of the water contributes to these fluctuations through expansion and contraction but also that they may reflect groundwater fluctuations in response to evapotranspiration.

The conductivity measured at the Salty Lagoon and Salty Creek PWQMS decreased significantly over the course of the monitoring period, indicating that dilution by rainfall runoff was a major factor driving water quality. At the time of the site inspection on 4 March 2020 the water in Salty Lagoon and Salty Creek was brackish, although tidal movements were delivering salt water upstream in Salty Creek. The conductivity measurements collected on 4 March 2020 complied with guiding values at all sites.

Erosion monitoring indicated that the head cut advanced significantly during this reporting period and the movements were the largest individual changes recorded since monitoring began. There was a small measured advance of the head cuts at two of the three control sites (**Illustration 4.1**). The erosion resulted from heavy, sustained flow from Salty Lagoon to Salty Creek. The head cut is now approximately 20 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, historically, led to fish kill will be restored.

The DO concentrations in discrete samples collected on 4 March 2020 were below the guiding values at all sites. While low DO concentrations are naturally prevalent at the sites to the west of Salty Lagoon (sites S2 and S4) they are less frequent in the open water of Salty Lagoon and Salty Creek. The data from the Salty Creek and Salty Lagoon PWQMS indicate that low DO concentrations had occurred at both stations (at the bottom of the water column) following rainfall events and persisted until the end of the monitoring period. The data from the Salty Lagoon PWQMS showed some indications of diurnal DO fluctuations returning at the end of the monitoring period. Historically, low DO concentrations have frequently occurred following changes in the salinity of the water in Salty Lagoon and Salty Creek (from fresh to salt or *vice versa*), when microalgal processes are interrupted. The low DO concentrations recorded during this reporting period and on 4 March 2020 are likely to be a result of this process.



Salty Lagoon Project Management & Ecosystem Health Report, February 2020 11 1731-1324

AQUATIC SCIENCE AND MANAGEMENT

Many of the nutrient concentrations from samples collected on 4 March 2020 did not comply with guiding values. The exceptions were the nitrate and nitrite concentrations from all sites, ammonia concentrations from S2, S4 and S5 and the orthophosphate concentrations from S4 and S5. The TN and TP concentrations from most sites were very high. While nutrient concentrations in Salty Lagoon typically decrease after rainfall, the intensity and duration of the rainfall events during this reporting period appear to have delivered higher than normal nutrient loads. Based on the available information it is unlikely that the higher than normal nutrient concentrations resulted from the treated sewerage disposal, but further monitoring will provide a clearer picture of any emerging trends. Chlorophyll-a concentrations did not comply with guiding values at S1, S3 or S4. At S1 and S3 they indicated an algal bloom of moderate proportions and at S2 an algal bloom of small proportions. There were no blue-green algae detected in any samples.

Several other results did not comply with guiding values, including

- The pH measurements from S5, where resulting from low pH rainfall runoff from the catchment.
- The temperature measurements from S1 and S3. This is a combination of seasonality and the colour of the water.
- The enterococcus concentration at S2 and S3, probably related to bird use of the area and/or rainfall runoff.





4.2 Other Observations

The entrance to Salty Creek was open on 4 March 2020. The entrance opened approximately 200 m to the south of the last observed opening. A large number and wide variety of birds were observed incidentally during the site inspection including Pacific Black Duck, Pelican, Black Swan, Dusky Moorhen, Pied Cormorant and Little Black Cormorant. Large fish were observed on several occasions.





Plate 4.1 The open entrance to Salty Creek on 4 March 2020



Plate 4.2 The open entrance to Salty Creek on 4 March 2020



Plate 4.3 Fixed point photo from ER4 on 4 March 2020



Plate 4.4 Fixed point photo from ER4 on 22 January 2020

4.3 Adaptive Management – Risk Evaluation

Due to the recent progression of the head cut between Salty Lagoon and Salty Creek, the risk of a channel forming between the two water bodies has heightened. Should the channel eventuate, the system would return to a more dynamic ecosystem and potentially conditions that historically led to fish kills. In accordance with the project *Environmental Response Protocol* (GeoLINK 2017b), the risk rating for the Salty Lagoon Response Protocol is uncertain. Adaptive management site visits are recommended for periods of potential head cut progression, with the following triggers:

- >50 mm of rainfall with 24 hrs.
- >200 mm of rainfall within a week.
- Other high risk events, for example >100 mm of rainfall within 72 hours, significant storm surge, atypically large tides, etc. Due consideration would be given to rainfall intensity and volume, and the Salty Creek entrance status when known as appropriate.



AQUATIC SCIENCE AND MANAGEMENT

5. Key Points

- 1. Water levels rose sharply in Salty Lagoon and Salty Creek during this reporting period in response to very heavy rainfall conditions throughout February. The entrance to Salty Creek opened on 10 February 2020 and water levels reduced quickly.
- 2. A large number of results did not comply with the guiding values.
- 3. Nutrient concentrations very high at most sites and chlorophyll-a concentrations indicated algal blooms at some sites, It is thought that the very heavy rainfall conditions delivered nutrients to the system at higher than normal rates.
- 4. The erosive headcut to the east of the old channel between Salty Lagoon and Salty Creek advanced approximately 15 m towards Salty Lagoon during this reporting period. There is a significant possibility that the eroding channel will break into Salty Lagoon during the next heavy rainfall, or if moderate rainfall conditions persist for an extended period.
- 5. The risk rating for the Salty Lagoon Response Protocol is uncertain, due to the potential for the erosive channel to break into Salty Lagoon. <u>Heavy rainfall may lead to a high risk rating and require a site inspection in the coming months</u>.



Plate 5.1 Fixed point photo from ER5 on 4 March 2020



Plate 5.2 Fixed point photo from ER5 on 22 January 2020



Salty Lagoon Project Management & Ecosystem Health Report, February 2020 14 1731-1324

References

Bureau of Meteorology (2020). http://www.bom.gov.au/. Accessed 25/03/2020.

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

GeoLINK (2017b). Environmental Response Protocol – October 2017, Salty Lagoon Monitoring: Post Closure of Artificial Channel. 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.



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