### Salty Lagoon Post Closure Monitoring

Project Management and Ecosystem Health Report October 2017



#### AQUATIC SCIENCE AND MANAGEMENT

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Prepared for: Richmond Valley Council © GeoLINK, 2018

| UPR       | Description  | Date Issued | Issued By         |
|-----------|--------------|-------------|-------------------|
| 1731-1285 | First issue  | 21/12/2017  | David Andrighetto |
| 1731-1295 | Second issue | 09/01/2018  | David Andrighetto |
| 1731-1298 | Third issue  | 10/01/2018  | David Andrighetto |

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## 1. Introduction

#### 1.1 Introduction

The following report provides an introduction to the Salty Lagoon Post-Closure monitoring years 6-10 (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 22 June 2017 until 25 October 2017.

### 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 first of the bi-monthly site visits for post-closure monitoring at Salty Lagoon. It included installation of new permanent water quality monitoring equipment and discrete water quality sampling. The site visit was undertaken on 25 October 2017. Water quality samples were collected between the hours of 9:00 am and 1:00 pm on that day. A high tide of 1.55 metres was forecast for 12.24 pm.

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 2017).

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

| Table 2.1 | Locations of Water | Quality Sam | ole Sites in Salty | y Lagoon and Salt | v 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 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 | <b>Type and Locations</b> | (WGS84) of Erosio | n Monitoring Sites |
|-----------|---------------------------|-------------------|--------------------|
|           |                           | · · · ·           |                    |

#### 2.4 Permanent Water Quality Monitoring Stations

There are two permanent water quality monitoring stations (PWQMS) in place for the duration of the MPPC, measuring temperature, pH, conductivity, turbidity and dissolved oxygen (DO) concentrations at 30 minute intervals. One Permanent Water Quality Monitoring Station (PWQMS) is located in Salty Lagoon at S1 and one in Salty Creek at S5. The data from these sites will be downloaded at bimonthly intervals for reporting purposes.

Water level will be measured at 30 minute intervals by HOBO U20 water level loggers at each PWQMS. The raw data will be offset by barometric pressure data collected by a third HOBO located on-site.

New YSI EXO3 series sondes were installed at sites S1 and S5 and the old YSI 6 series sondes removed. The YSI EXO3 series sondes were installed in the old sleeves at both sites. At S1 the existing infrastructure was in serviceable condition but at S5 new stainless steel stirrups were installed to replace the degraded existing ones.

The temperature, pH, conductivity, turbidity and DO sensors on the EXO3 sondes will be replaced every four months by a set of serviced and calibrated probes. The EXO3 sondes will be left in place for the duration of monitoring because the probes can be replaced in the field.

The status of the two YSI EXO3 sondes on 25 October 2017 is displayed in Table 2.3.



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| Sonde                   | SN17F104100   | SN 17H104488  | Spare Probes  |
|-------------------------|---|---|---|
| pH                      | EXO pH  | EXO pH  | YSI EXO pH  |
| (cap life expectancy 18 | 17H105048   | 17H105049   | 17H105047   |
| months)                 | Manufactured 08/2017  | Manufactured 08/2017  | Manufactured 08/2017  |
| Temp/ cond              | EXO Wiped CT  | EXO Wiped CT  | EXO Wiped CT  |
| (life expectancy 7-10   | 17F103252   | 17F102685   | 17F102047   |
| years)                  | Manufactured 06/2017  | Manufactured 06/2017  | Manufactured 06/2017  |
| DO                      | EXO Optical DO  | EXO Optical DO  | EXO Optical DO  |
| (cap life expectancy 18 | 17H103495   | 17H103494   | 17H103493   |
| months)                 | Manufactured 08/2017  | Manufactured 08/2017  | Manufactured 08/2017  |
| Turbidity               | YSI EXO Turbidity   | YSI EXO Turbidity   | YSI EXO Turbidity   |
| (life expectancy 7-10   | 17H101468   | 17H103513   | 17H101465   |
| years)                  | Manufactured 08/2017  | Manufactured 08/2017  | Manufactured 08/2017  |
| Wiper                   | YSI Exo Wiper<br>17G101952  | YSI Exo Wiper<br>17G101954  | No Spare wiper  |
| Status                  | Probes installed in<br>Salty Lagoon<br>25/10/2017   | Probes installed in<br>Salty Lagoon<br>25/10/2017   | Probes yet to be deployed   |
| Notes                   | <ul> <li>First deployment.</li> <li>Probes manufacture calibrated</li> <li>Estimated sonde battery life 217.9 days</li> <li>Memory 50149.4 days logging.</li> </ul> | <ul> <li>First deployment.</li> <li>Probes manufacture calibrated</li> <li>Estimated sonde battery life 217.8 days</li> <li>Memory 50149.4 days logging.</li> </ul> | <ul> <li>Serviced 10/2013</li> <li>Turbidity quad seal<br/>replaced 10/2013</li> <li>New pH probe<br/>09/2015</li> <li>New temp/cond<br/>probe 06/2016</li> </ul> |

#### Table 2.3 YSI sonde Status on 25 October 2017

Climate information was sourced from the Evans Head bombing range weather station on the Bureau of Meteorology website (BoM 2017). Evans Head Sewage Treatment Plant (STP) facility routine sampling information was provided by RVC.







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### Water Quality and Erosion Monitoring Site Locations

# 3. Results

### 3.1 Water Quality Samples

Results of the water quality monitoring undertaken on 25 October 2017 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 same period, are presented in **Illustration 3.1** and **Illustration 3.2**. The PWQMS data presented is the last data collected from the old YSI 6 series sondes before they were removed. Only the level and conductivity data is presented; the DO, pH and turbidity data was unreliable due to the period that the equipment had remained in place without servicing.



#### Results of Discrete Samples Collected 25 October 2017 Table 3.1

|                                   |                  |         |         | Salty Lag | ioon    |             |         |         | Salty Creek      |         |
|-----------------------------------|------------------|---------|---------|-----------|---------|-------------|---------|---------|------------------|---------|
| Parameter                         | Guiding<br>Value | S1      | S1 (1m) | S2        | S3      | S3*<br>(QA) | S3 (1m) | S4      | Guiding<br>Value | S5      |
| Blue Green Algae ID<br>(cells/mL) | 0                | Nil     | ns      | Nil       | Nil     | Nil         | ns      | Nil     | 0                | Nil     |
| Nitrite Nitrogen (mg/L)           | 0.01             | <0.01   | ns      | <0.01     | <0.01   | <0.01       | ns      | <0.01   | 0.01             | <0.01   |
| Nitrate Nitrogen (mg/L)           | 0.01             | <0.01   | ns      | <0.01     | <0.01   | <0.01       | ns      | <0.01   | 0.01             | <0.01   |
| Oxidized Nitrogen (mg/L)          | -                | <0.01   | ns      | <0.01     | <0.01   | <0.01       | ns      | <0.01   | -                | <0.01   |
| Ammonia Nitrogen (mg/L)           | 0.05             | 0.016   | ns      | <0.01     | 0.015   | 0.016       | ns      | <0.01   | 0.11             | <0.01   |
| Total Kjeldahl Nitrogen (mg/L)    | 1.6              | 1.42    | ns      | 1.71      | 1.41    | 1.42        | ns      | 1.87    | 1.63             | 1.83    |
| Total Nitrogen (mg/L)             | 1.6              | 1.42    | ns      | 1.71      | 1.41    | 1.42        | ns      | 1.87    | 1.63             | 1.83    |
| Total Phosphorus(mg/L)            | 0.14             | 0.03    | ns      | 0.1       | 0.04    | 0.04        | ns      | 0.03    | 0.04             | <0.03   |
| Orthophosphate (mg/L)             | 0.11             | 0.01    | ns      | 0.05      | <0.01   | 0.01        | ns      | <0.01   | 0.01             | <0.01   |
| Chlorophyll-a (µg/L)              | 5                | <1      | ns      | 4         | <1      | <1          | ns      | <1      | 3                | <1      |
| Enterococcus (CFU/100mL)          | 170              | 25      | ns      | 55        | 0       | 10          | ns      | 50      | 40               | 15      |
| Faecal Coliforms<br>(CFU/100mL)   | 135              | 10      | ns      | 162       | 6       | 10          | ns      | 432     | 150              | 82      |
| Temp (°C)                         | 25.9             | 22.5    | 22.58   | 23.68     | 22.16   | ns          | 21.81   | 21.91   | 13.1 - 28.8      | 18.98   |
| рН                                | 6.9              | 6.92    | 6.81    | 6.41      | 6.87    | ns          | 6.77    | 5.27    | 4.3 - 6.8        | 6.03    |
| ORP (mV)                          |                  | 150     | 161     | 160       | 188     | ns          | 180     | 64      |                  | -39     |
| Cond (mS/cm)                      | 8.0              | 9.09    | 9.16    | 7.66      | 8.99    | ns          | 9.07    | 3.88    | 0.3 - 21.5       | 0.256   |
| Turbidity (NTU)                   | 13               | 2.9     | 1       | 0         | 0.7     | ns          | 0.7     | 9.4     | 11               | 6.6     |
| DO (mg/L)                         | 4.09             | 5.92    | 5.25    | 2.76      | 7.6     | ns          | 7.48    | 2.49    | 5.52             | 6.88    |
| DO (% sat)                        | -                | 72      | 64      | 34.1      | 91.8    | ns          | 89.8    | 29.4    | -                | 76.4    |
| TDS (mg/L)                        | -                | 5.72    | 5.77    | 4.83      | 5.66    | ns          | 5.72    | 2.48    | -                | 0.166   |
| Sal (ppt)                         | -                | 5.1     | 5.1     | 4.2       | 5       | ns          | 5.1     | 2       | -                | 0.1     |
| Depth (m)                         | -                | Surface | 1m      | Surface   | Surface | Surface     | 1m      | Surface | -                | Surface |

\* = randomly selected quality assurance sample. Note:

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



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## Illustration 3.2 Salty Creek Rainfall and Water Quality Monitoring Station Data 22 June 2017 to 25 October 2017



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### 3.3 Erosion Monitoring Stations

The data collected at the erosion monitoring stations is presented in **Table 3.2**. There was little or no advancement noted at any stations.

| Static | on Peg Location            | Distance 25 July 2017<br>(m) | Distance 25 October<br>2017 (m) | Cut Movement<br>(m) |
|--------|----------------------------|------------------------------|---------------------------------|---------------------|
| ER1    | 56J 0541961<br>UTM 6783356 | 7.55                         | 7.55                            | 0.00                |
| ER2    | 56J 0541934<br>UTM 6783355 | 10.20                        | 10.20                           | 0.00                |
| ER3    | 56J 0541978<br>UTM 6783342 | 9.95                         | 9.85                            | 0.10                |
| ER4    | 56J 0542112<br>UTM 6783277 | 8.35                         | 8.35                            | 0.00                |
| ER5    | 56J 0542129<br>UTM 6783262 | 12.35                        | 12.35                           | 0.00                |
| ER6    | 56J 0542121<br>UTM 6783272 | 10.40                        | 10.40                           | 0.00                |

Table 3.2 Erosion monitoring results from 25 October 2017



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## 4. Discussion

### 4.1 Water Quality

The remaining water quality data from the Salty Lagoon PWQMS covers the period between 21 June 2017 and 12 September 2017. The remaining data from the Salty Creek PWQMS covers the period between 21 June and 21 August 2017. Most of the data is of questionable quality due to the period of time without servicing the equipment. However, the water level and conductivity data appear to be reliable and have been presented here to provide an indication of the major events between the end of the MPPC and the beginning of post-closure monitoring.

Rainfall between 21 June 2017 and 25 October 2017 was characterised by a long dry period followed by several moderate to heavy rainfall events in October. Water level data from Salty Lagoon indicates that Salty Lagoon remained at high levels for the duration of this period and that water levels increased around 21 August 2017 in response to water flowing in from Salty Creek. The water level in Salty Creek fluctuated regularly in the interim period in response to tidal movements and seawater ingress. The final data points available from the old PWQMS equipment show very high water levels resulting from seawater ingress on 21 August 2017. The water level in Salty Creek increased at that time by over 0.3 metres in response to an unusually large storm surge event that was well documented across the east coast (Brassington 2017). At the time of the site inspection on 25 October 2017 the entrance to Salty Creek was closed (**Plate 5.1**) and water levels in Salty Creek were still very high.

Erosion monitoring did not find any advancements among the cuts resulting from water draining out of Salty Lagoon. The lack of erosion is associated with the high water levels in Salty Creek, restricting hydraulic capacity out of Salty Lagoon. Water levels at the time of the site inspection were so high that the fixed point photos do not show the position of the cuts.

Conductivity measurements from the PWQMS show the impact of seawater ingress on Salty Creek and the impact of saltwater intrusion from Salty Creek into Salty Lagoon. At the time of the site inspection the conductivity measurements in Salty Lagoon were still higher than normal, and exceeded guiding values at S1 and S3. The saltwater penetrated up to S2 and S4 resulting in high conductivity measurements at those sites. The water column was well mixed at the Salty Lagoon sites but distinctly stratified at the Salty Creek site into a freshwater surface layer and a saline layer at the bottom.

The DO concentrations in discrete samples collected on 25 October 2017 were typical at all sites. The DO concentrations complied with guiding values at all sites except the two westernmost sites in Salty Lagoon, which are usually (and naturally) oxygen poor.

All nutrient and chlorophyll-a concentrations complied with guiding values this month with the exception of the TN concentrations from S2, S4 and S5. The chlorophyll-a concentrations complied with guiding values at all sites. There were no blue-green algae detected in any samples.

With the exception of the pH measurement from the S1 and high faecal coliform concentrations from S2 and S4 all other measurements complied with guiding values. The high pH measurement from S1 is likely to have resulted from saltwater ingress. The high faecal coliform concentrations are likely to be associated with rainfall runoff from the days prior to the site inspection.



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#### 4.2 Other Observations

The entrance to Salty Creek was closed on 25 October 2017 (**Plate 5.1**). The headcut located to the east of the in-filled artificial channel was stable from 21 June to 25 October 2017. A variety of birds were observed incidentally during the site inspection including Australasian Grebe, Pacific Black Duck, Pelican, Great Egret, Great Cormorant, Little Black Cormorant and Pied Cormorant.



Plate 4.1 The Headcut to the east of the old channel on 25 October 2017



Plate 4.2 The Headcut to the east of the old channel on 21 June 2017



# 5. Key Points

- 1. Water levels in Salty Lagoon appear to have remained at very high levels in the period between site inspections
- 2. Seawater ingress into Salty Creek and saltwater intrusion from Salty Creek into Salty Lagoon were key events in the interim period.
- 3. Almost all results complied with the guiding values.
- 4. Chlorophyll-a concentrations complied with guiding values at all sites.
- 5. The erosive headcut to the east of the old channel between Salty Lagoon and Salty Creek has not advanced in the interim period.



Plate 5.1 The closed entrance to Salty Creek on 25 October 2017



Plate 5.2 Calm conditions on Salty Creek



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