The Water Quality of Darwin River and Manton River Reservoirs, July 1993 to December 1995

Report 30/1996

March 1996

Townsend, S.A. & S. Griffiths
Water Quality Branch
Water Resources Division
Power and Water Authority
Darwin.
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Summary

The concentration of total phosphorus, chlorophyll-a, turbidity and light penetration for Darwin River and Manton River Reservoirs over the period July 1993 to December 1995 is presented and compared to historical data. The water quality of both reservoirs has varied little compared to the period July 1985 - June 1993. Darwin River Reservoir water quality is generally good, with brief periods of high iron concentrations at the surface (0.2-1 mg/L), mostly during the dry-wet transition and wet season mixing. Based on off-take iron and manganese data collected since February 1991, there has been no significant change in the concentration of these elements entering Darwin water supply. Nor has there been major changes in the volume of Botryococcus braunii colonies in off-take waters.

Key Words: surface water quality assessment, Adelaide River basin, Darwin River basin.
1.0 Introduction

The water quality of Darwin River Reservoir (DRR) and Manton River Reservoir (MRR) has been monitored regularly since July 1985. Detailed information about seasonal variation in reservoir water quality, based on data collected between July 1985 to June 1993, has been reported by Townsend & Boland (1987), Boland (1988), Lukatelich et al. (1990) and Townsend (1994).

Since mid-1993, a less intensive water sample monitoring program of the reservoirs has been undertaken. It's objective is to assess long term, inter-annual changes in reservoir water quality rather than seasonal or shorter term water quality. Supplementing this program has been weekly to monthly sample collection at the Darwin River Dam pump station. Additionally, the physical limnology of the reservoirs has been monitored by a thermistor string near the tower of each water body. A report about the potential use of the thermistor strings in reservoir water quality monitoring will be completed towards the end of this year.

This report discusses the water quality of DRR and MRR between June 1993 and December 1995, and compares this with historical data.

2.0 Monitoring Programs

2.1 Darwin River and Manton River Reservoirs

The water quality of the reservoirs have been assessed three times every year since mid-1993. Water quality surveys are conducted during periods of characteristic reservoir thermal stratification or mixis. These periods are:

1. the wet-dry transition period when the reservoirs are usually stratified,
2. towards the end of the dry season when the reservoirs are fully mixed, and
3. during the dry-wet transition when stratification is most stable.

An integrated sample equivalent to the depth of the epilimnion (10 m in DRR and 4 m in MRR) was collected during each survey.
Water samples were analysed for:

1. total phosphorus, the most likely nutrient limiting the amount of algae.
2. chlorophyll-a, an algal photosynthetic pigment and index of algal biomass.
3. turbidity, a measure of the scattering of light and an index of the amount of suspended material.

On each sample date, a vertical profile of reservoir light, temperature, dissolved oxygen, pH and conductivity was also taken. Light penetration in each reservoir is expressed in this report as the depth to which 1% of the incident light penetrates (the euphotic zone); the deeper the light penetration, the greater the water clarity. A surface algal trawl was also conducted during each water quality survey. (Profile data is not presented in this report but is stored on the Water Resources Division database).

2.2 Darwin River Dam Pump Station

Since February 1991, water samples have been collected, mostly at weekly intervals, for total iron and manganese analysis at Darwin River Dam, between the pump station and the chlorination point. Monthly samples have also been examined for Botryococcus braunii. Initially, the number of Botryococcus colonies were counted, however this was found to be inadequate because it took no account of colony size. Since September 1994, the volume of Botryococcus colonies, expressed as a concentration (cm$^3$/L), has been determined.

3.0 Reservoir Water Quality

3.1 Darwin River Reservoir

The water quality of DRR is generally good. Figure 1 summarises the reservoirs water quality between mid-1993 and December 1995. Concentrations of phosphorus are low in the reservoir; consequently algal biomass, as measured by chlorophyll-a, is also low. Chlorophyll-a concentrations ranged from 1 to 6 µg/L. This varied from the range of concentrations for the years 1985-1991, when most values (80%) were between 2.0 and 5.8 µg/L and the median (middle ranked value) was 3.5 µg/L (Townsend 1994). Compared to MRR (7.5 µg/L) and Copperfield Creek Dam (10 µg/L; Townsend 1995), the concentrations of chlorophyll-a in DRR are relatively low.
Turbidity and light penetration in DRR between mid-1993 and December 1995 varied little compared to historical data. Since mid-1993, light penetration has averaged 8.2 m and turbidity 1.25 NTU, similar to the median for the years July 1985 - June 1993 when the euphotic zone averaged 9.7 m and turbidity 1.2 NTU.

Total phosphorus concentrations in DRR were low (average 0.005 mg/L; Fig. 1), indeed sometimes they are below the level of analytical detection (0.001 mg/L). At such low concentrations the accuracy of phosphorus determination is ± 0.005 mg/L, accounting for a large proportion of sample variability.

Algal trawls of Darwin River Reservoir surface waters showed Botryococcus braunii, dinoflagelates and desmids were the most dominant algae.

Since mid-1993, there has been no pronounced change in reservoir water quality. Furthermore, compared to the period July 1985 and June 1993, the water quality of the reservoir has remained much the same.

3.2 Darwin River Dam Pump Station

Concentrations of total iron and manganese are presented in Figure 2, and the distribution of sample concentrations summarised in Table 1. The median concentrations of iron and manganese were, respectively, 0.07 and 0.014 mg/L. However, as can be seen in Figure 2 and Table 1, iron and manganese concentrations range over 2 orders of magnitude, with about 10% of samples with concentrations exceeding 0.20 mg/L Fe and 0.036 mg/L Mn.

High iron concentrations in the surface waters of DRR are most common during the dry-wet transition when the water body is stratified, with high hypolimnetic (the bottom layer) concentrations of iron (Townsend 1994). High concentrations near the surface also occur during wet season mixing when hypolimnetic waters are mixed through the water column. The effect of stratification on DRR water quality is reported in detail elsewhere (see Townsend, 1994). There has been no significant change in the concentration of iron or manganese entering Darwin Water Supply since February 1991, based on the Darwin River Dam pump station data (Fig. 2).
Botryococcus volumes tend to be highest towards the end of the dry season, before significant wet season inflow. The concentration of Botryococcus ranged between 0.2 - 1.2 cm\(^3\)/L. Overall, though, there has been no major changes in the concentration of Botryococcus colonies in off-take waters since September 1994.

### 3.3 Manton River Reservoir

Manton River Reservoir is primarily a recreation water body, though in emergencies it could be used to supply potable water. The water quality of MRR is of much lower quality than DRR. It has higher concentrations of iron and manganese in its surface waters. These average 0.22 mg/L Fe and 0.070 mg/L Mn in MRR compared to DRR averages of 0.05-0.10 mg/L Fe and 0.01-0.05 mg/L Mn. Furthermore, the reservoir has higher total phosphorus concentrations (average 0.008 mg/L) and chlorophyll-a concentrations (average 7.5 µg/L), higher turbidity (average 1.7 NTU) and lower light penetration (average 4.5 m). Oxygen concentrations in MRR are generally lower than in DRR (Townsend & Boland 1987).

The water quality of MRR since July 1993 is presented in Figure 3. Whilst there has been a fair amount of variation between samples, overall the concentration of phosphorus and chlorophyll-a, turbidity and light attenuation is much the same as long term average values. The algae of the reservoir is dominated by dinoflagellates, *Botryococcus braunii*, *Trachelomonas* spp., desmids and other Chlorophyta.

### 4.0 References


Table 1 The distribution of total iron and manganese concentrations, expressed as percentile values, at Darwin River Dam pump station (Feb 1991 - Jan 1996).

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Total Iron (mg/L)</th>
<th>Total Manganese (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.012</td>
<td>0.0004</td>
</tr>
<tr>
<td>5</td>
<td>0.020</td>
<td>0.0023</td>
</tr>
<tr>
<td>10</td>
<td>0.032</td>
<td>0.0042</td>
</tr>
<tr>
<td>25</td>
<td>0.050</td>
<td>0.0083</td>
</tr>
<tr>
<td>50</td>
<td>0.070</td>
<td>0.014</td>
</tr>
<tr>
<td>75</td>
<td>0.275</td>
<td>0.023</td>
</tr>
<tr>
<td>90</td>
<td>0.20</td>
<td>0.036</td>
</tr>
<tr>
<td>95</td>
<td>0.33</td>
<td>0.050</td>
</tr>
<tr>
<td>100</td>
<td>0.90</td>
<td>0.098</td>
</tr>
</tbody>
</table>

Explanatory note: To determine the percentile value (or rank), concentrations are ranked from lowest to highest, and assigned a ranking as a percentage. The table should be read as follows: 5% of samples contained less than 0.020 mg/L Fe and 0.0023 mg/L Mn; 10% of samples contained less than 0.032 mg/L Fe and 0.0042 mg/L Mn and so forth. The minimum and maximum concentrations are equal to the 0 and 100 percentile values respectively.
Figure 1. Darwin River Reservoir water quality, July 1993 - December 1995.

(a) Total Phosphorus
(b) Euphotic Depth
(c) Chlorophyll-a
(d) Turbidity
(e) Reservoir Water Level
Figure 2. Water quality at Darwin River Reservoir pump station, January 1991 to January 1996.

Figure 3. Hlation River Reservoir Water Quality.