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Appendix A
Weir Locations – 28 two-metre high weirs

Appendix B
Rainfall – Runoff Volume Graph

Appendix C
Cost Estimate Breakdown
1. **Introduction**

Development around the Torrens Lake including the redeveloped Adelaide Oval, Convention Centre, new hospital and Riverbank Precinct will increase the focus on the lake and its problem with water quality and occasional algal blooms. As part of this activity the Natural Resources Management Board (NRMB) has been tasked with investigating methods of reducing the Blue Green Algae (BGA) blooms in the lake, which occur from time to time during the summer months.

It is believed that significant summer rainfall events produce flows that are high in nutrients and organics, which stimulates the growth of BGA in Torrens Lake. One of the suggested options for reducing the risk of BGA blooms is to improve the quality of the summer storm runoff flowing into the lake by installing a series of detention weirs along the river upstream of the lake.

This document is a report on the high level investigation conducted on this option.

2. **Scope of Works**

2.1 Scope

The objective is to investigate the feasibility of building a series of stormwater detention weirs along the eastern reach of the River Torrens between the Frome Road Bridge and the outskirts of the city boundary, a total distance of 18km. In assessing the feasibility, a high level concept design and cost estimate is to be developed.

The investigation provides estimates of the capacity of the detention weirs and compares this volume to summer storm events in order to determine the size of the summer rainfall event that the detention weirs are able to attenuate.

The NRMB have provided the following information to aid the investigation:

- River Torrens Flood Mitigation Study Report 1981 providing information of river bed levels and water depths for various storm events.

In addition to the above, rainfall data has been sourced from the Australian Bureau of Meteorology and drawings from the Linear Park development were provided by SA Water. The SA Water drawings provided cross sections and contours of the river in a few selected locations.

2.2 Assumptions

The investigation is based on the following assumptions:

1. The changes in river flows are linear along the river between gauging stations.
2. It is assumed that the flows measured at Holbrook Gauging Station give a reasonable representation of the volume of inflow into Torrens Lake.
3. Weirs will be constructed in large gabion rock baskets.
4. The weirs must not compromise the open space benefits of the Linear Park.
5. The cross-sections given on the Linear Park drawings are assumed to be representative of the length of river investigated. Design flood levels have been used to determine water levels upstream and downstream.

2.3 Methodology

The methodology used for the high level concept design is as follows;

1. Cross-sectional drawings of the river were reviewed in order to identify typical sections of the River Torrens.

2. Using the dimensions of the typical sections and average slope of the river bed along various reaches, the maximum weir spillway heights were estimated and detention volumes determined.

3. The slope of the riverbed was used to determine the spacing and number of weirs. Weirs are spaced such that the upstream weir is 50m upstream of the high water level of the downstream weir. For the purposes of this investigation, high water level is assumed to be 100mm above spillway level.

4. River flow data and the total rainfall volumes for storm events (in excess of 5mm/hr intensity) were compared with rainfall data to estimate the size of the rainfall event that could be detained in the weirs.

5. Rainfall runoff volumes were analysed in Excel and a line of best fit added to the graph of rainfall intensity vs. runoff volume to establish the expected volume of runoff for any given storm event. From the 1997-2001 data, 37 rainfall events were analysed which had a mean runoff volume of 326ML. The variation in data was large however, with a standard deviation of 277ML, meaning it is difficult to determine an accurate runoff volume for a rainfall event.

3. Investigation Results

For the purposes of determining the number of weirs and volume detained by each weir, the river has been divided into three typical sections. The lower section is assumed to be rectangular, the middle section trapezoidal and the upper section triangular.

Figure 1 and Table 1 below provide a summary of the three typical sections.

<table>
<thead>
<tr>
<th>Typical Section</th>
<th>Chainage (m)</th>
<th>Shape of channel</th>
<th>Gradient (%)</th>
<th>Water depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Lower)</td>
<td>0 – 5260</td>
<td>Rectangular</td>
<td>0.22</td>
<td>2.0</td>
</tr>
<tr>
<td>2 (Middle)</td>
<td>5260 – 12830</td>
<td>Trapezoidal</td>
<td>0.36</td>
<td>2.0</td>
</tr>
<tr>
<td>3 (Upper)</td>
<td>12830 – 17930</td>
<td>Triangular</td>
<td>0.72</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 1: Summary of river cross-sections & gradients
Based on the above methodology and assumptions the potential weir positions have been located. A total of 28 weirs will be required along the 18km length of river (based on a water depth of 2 metres). The last weir at the downstream end will be located just downstream of the Hackney Road bridge. A layout of the approximate positions can be found in Appendix A.

Using the assumed channel geometry, the cross-sectional area of the weirs for each of the three sections has been calculated, and the storage volume behind each weir determined based on a uniform channel gradient within each section. Table 2 provides a summary of the number of weirs in each river section and the storage provided.

<table>
<thead>
<tr>
<th>Typical section</th>
<th>No. of weirs</th>
<th>Weir spacing (m)</th>
<th>Cross-sectional area of channel (m²)</th>
<th>Storage at each weir (ML)</th>
<th>Total storage (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangular</td>
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<td>1180</td>
<td>38</td>
<td>22.42</td>
<td>90</td>
</tr>
<tr>
<td>Trapezoidal</td>
<td>16</td>
<td>620</td>
<td>23</td>
<td>4.75</td>
<td>76</td>
</tr>
<tr>
<td>Triangular</td>
<td>8</td>
<td>340</td>
<td>14.3</td>
<td>1.62</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>28</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>179</strong></td>
</tr>
</tbody>
</table>

Table 2: Weir storage summary

### 3.1 Weir design

While the function of the weirs is to detain the rainfall runoff for up to ten days, the weirs are to be built in residential areas. Hence the design would need to consider factors such as aesthetics and safety.

For the purposes of this investigation it is proposed that the weirs are constructed from gabion rock baskets (see example in Figure 2), as they provide a number of useful features. This form of construction will over time blend in with the surroundings better than concrete as it can support the growth of vegetation. In addition gabion baskets are permeable, thus allowing the slow release of the detained water; however an assessment of the permeability has not been conducted as part of this investigation.
The disadvantages of using gabion weirs are that they can require more maintenance than a concrete weir, the life of the structure is shorter as it is dependant on the durability of the wire cage, and the porosity of the weir decreases over time. Typically a structural life of 10-15 years can be expected with minimal maintenance, although the life could be extended to 25-30 years with regular maintenance. Alternatively, PVC coated wire mesh could be used to maximise design life.

### 3.2 Weir capacity

The capacity of the weirs is largely a function of the height of the wall. In this regard the sections provided by SA Water and observations suggested that top of the river channel is approximately 2 metres above the river bed level. Levels higher than 2m above the river bed increased the risk of flooding significant parts of Linear Park and in particular footpaths. Whilst a comprehensive investigation of flood risk was not conducted, a visual assessment of plans provided suggests that if water levels exceed 3 metres above river bed level, there would be a risk of flooding Linear Park and footpaths along the river bank.

A comparison of the rainfall data and daily flow volumes at Holbrooks Road GS with the total storage capacity of the 28 2m high weirs suggests there is sufficient capacity in the weirs to store runoff from an 8mm/hr rainfall event, assuming the weirs are empty at the start of the rainfall event. This is shown in more detail in the graph in Appendix B.

If the depth of weir / water was increased to 4 metres (consistent with a 20 year return period event), 16 weirs could be installed which would provide a total storage volume of 450ML. This would be sufficient to store runoff from a 22mm/hr rainfall event; however it is likely that this would cause significant flooding in the Linear Park and erosion problems.

### 3.3 Cost estimate

Based on the proposed gabion rock basket design, the estimated capital cost of construction for the 28 No. two metre high weirs is **$6.8 million** (average $243k per weir).

The cost of providing the 16 No. four metre high weirs would be approximately **$8.4 million**.
The costs are for the supply and installation and include materials, construction, contractor’s overheads, design, project management, supervision fees and a 50% contingency. They do not include costs for community consultations, environmental investigations, obtaining approvals and other impact assessments.

A breakdown of the estimate can be found in Appendix C.

4. Discussion & Recommendations

This investigation provides a high level cost estimate ($6.8 million) of installing a series of porous weirs along the Torrens River upstream and an indicative estimate of the size of rainfall event that the weirs could detain.

While the investigation shows that the scheme could be implemented the results do not provide a clear indication of the suitability and feasibility of this option as a means of reducing the risk of BGA blooms. There are numerous other factors that need further consideration and some of the other factors that need to be investigated would include;

- Community acceptance
- The impact on Linear Park usage during and after storm events
- Changes to the river’s hydraulic performance and potential erosion issues
- Risks, and in particular, the impact on the river’s ability to cope with flood events
- The effectiveness in preventing BGA blooms and value of capturing an 8mm/hr rainfall event
- Environmental impacts, especially the severe impact on fish passage
- Public safety

In conclusion it would be possible to retain a typical 20mm summer storm (and associated highly polluted water) with 16 No. four metre high gabion weirs at a cost in the vicinity of $8.4 million. However, the impacts, maintenance and eventual replacement costs can be expected to be significant.
Appendix A
Weir Locations – 28 two-metre high weirs
Appendix B
Rainfall – Runoff Volume Graph
Appendix C
Cost Estimate Breakdown
## Detention Weirs Costings
### Low Level Weirs

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
<th>Man hours</th>
<th>Rate $/hr</th>
<th>Total</th>
<th>Machine hrs</th>
<th>Rate $/hr</th>
<th>Total</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>Contractor Overheads</td>
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<td>100000</td>
<td>100000</td>
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<tr>
<td>Gabion blocks (per m3)</td>
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<td>260</td>
<td>1231880</td>
<td>4738</td>
<td>70</td>
<td>1579</td>
<td>140</td>
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<tr>
<td>Cofferdam (m2)</td>
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<td>148448</td>
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<td></td>
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<td></td>
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<tr>
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**Total + 50% contingency** 1.5 $6,800,000
### Detention Weirs Costings
#### High Level Weirs

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total</th>
<th>Man hours</th>
<th>Rate</th>
<th>Machine hrs</th>
<th>Rate</th>
<th>Total</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>Contractor Overheads</td>
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<td>100000</td>
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<td>Excavation (weirs) (m3)</td>
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**Design & Management Total** $ 1,043,687

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