

Quiet Lakes Water Quality Management Plan

Jason Sonneman & Georgie Wettenhall
DesignFlow





Please note:

These slides are provided as a reference for Quiet Lakes residents who attended presentations at Melbourne Water on 21st and 23rd July 2011.

They should not be read or interpreted as a stand alone document. Please refer to 'The Quiet Lakes Water Quality Management Plan' for a full explanation of the water quality improvement strategies presented herein.



Context

Objective:

- Sustainable management of blue green algae
- Review strategies for improving water quality
- Assess ecological impacts of potential strategies
- Recommend range of strategies to be implemented

Lake health issues

Algal biomass:

- Regular algal blooms
- Occur throughout year
- Blue-green algae

Water plants:

- Low water plant cover
- Water plants abundant prior 2000



Lake health issues:

Lake water quality:

- Brackish
- Slightly alkaline
- Chlorophyll-a - high
- Dissolved oxygen – med-high
- Phosphorus – low
- Inorganic nitrogen – low
- Organic nitrogen – high
- Turbidity <15 NTU

- Overall quality - reasonably good in comparison to other urban lakes.



Previous initiatives

- Water plant planting
- Sediment sampling
- Water column profiling
- Daphnia released into Lake Legana
- Groundwater sampling
- Continuous pumping of groundwater
- Estuary perch introduced to Lake Legana
- Active barriers trialled
- Aeration and pumping system installed in Lake Legana



Strategies considered

- Vegetation restoration
- Mixing
- Lake salinity
- Nutrient reduction
- Groundwater flushing
- Carp removal and fish stocking

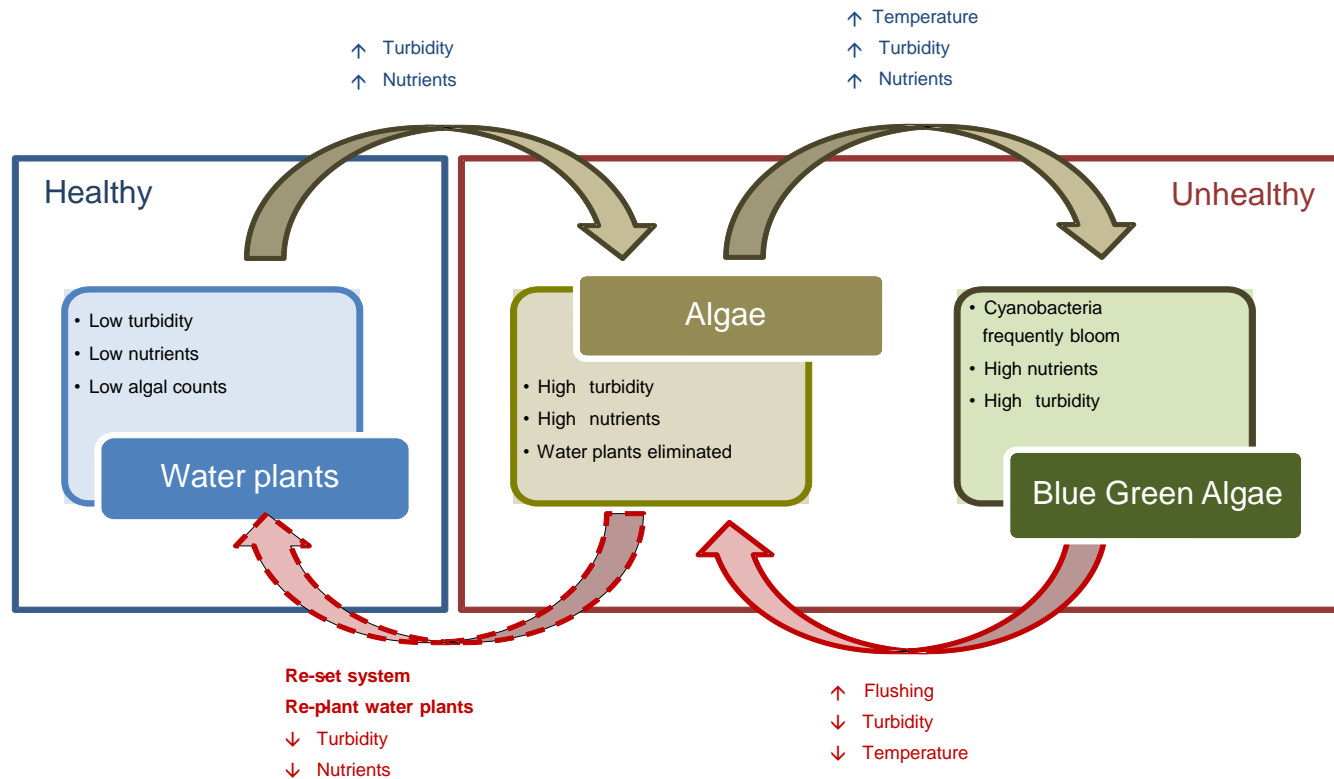
- Floating water plant beds
- Hypolimnetic withdrawal
- Ultrasonication

Vegetation restoration

Waterplants stabilise lakes by helping to maintain low turbidity and providing competition for nutrient resources thereby reducing algal growth.



Vegetation restoration

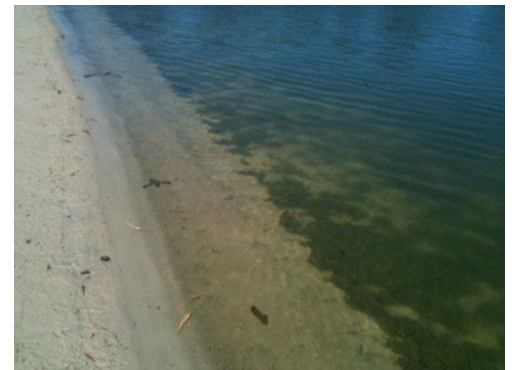


Alternative states model for shallow lakes

Vegetation restoration

Considerations:

- Water levels may need to be lowered to facilitate successful establishment of the vegetation.
- Planting zones.
- Impact on uses of the lake system.
- Addressing potential public safety risks.
- Occasional harvesting may be required.
- May compromise current carp removal methods.





Vegetation restoration

Recommendations:

- At least 50% of each lake bottom area is ultimately colonised by submerged water plants.
- Trial range of species suitable for brackish conditions.
- The conditions for harvesting water plants should be clearly established.
- Retrieval of sand minimised.
- Consider establishing emergent water plants.

Mixing - SolarBee

Increased mixing of the water column and aeration of the sediments:

- reduce potential phosphorus release
 - encourages increased release of nitrogen to the atmosphere
-
- Trial using SolarBee unit in Lake Illawong (commenced 2011)
 - Installation in Lakes Legana and Carramar if trial successful

Mixing - SolarBee

- Does not obstruct lake uses.
- Initial trial cost effective.
- Sustainable solution.



Mixing - SolarBee

Recommendations:

- Monitor water column stability to confirm whether stratification occurs.
- Monitor to evaluate whether the presence of the SolarBee:
 - promotes mixing and prevent lake stratification
 - reduces algal biomass
- Effectiveness of SolarBee units assessed for a minimum of 12 months:

Lake salinity

Current lake salinity detrimental to maintenance of diverse submerged water plant community

- Lake salinity has varied between 8,000-12,000 $\mu\text{S}/\text{cm}$ over the past 10 years.
- Desirable to maintain lake salinity below 6,000 $\mu\text{S}/\text{cm}$.

Potential sources of water:

- Groundwater
- Stormwater diversion

Lake salinity

Groundwater:

- Salinity = 7,000 uS/cm
- High ammonia nitrogen (bioavailable form)

High nitrogen load – likely to contribute to increased algal growth.

- Option not deemed suitable

Lake salinity

Stormwater diversion:

- Diverting low flows from the Gladesville Boulevard pump station.
- Additional source - potentially available from catchment to the south-east of Lake Carramar.

The pollutant load associated with the stormwater runoff would necessitate that all stormwater is treated prior to entering the lake system.



Lake salinity

If salinity management required:

- Feasibility study to assess the potential for managing lake salinity levels by diverting additional stormwater to the lake system.
- Develop salinity model for the lake system - may require the establishment and monitoring of shallow groundwater bores around the lake system.

Nutrient reduction

- Soluble nutrients are required by algae and water plants for growth.
- A reduction in nutrient loads discharged to or within the lake system will help to prevent algal growth.

Potential sources of nutrient inputs into the Quiet Lakes:

- Stormwater inflows – residential runoff and stormwater surcharges.
- Groundwater pumped - Gladesville Boulevard bore.
- Nutrients released from lake sediments.

Sediment removal

- A potential nutrient store - available for release to the overlying water.
- Average depth of the accumulated sediments is 0.1-0.3 m.
- Water level within each lake be drawn down and sediments dried out before removal.





Sediment removal

Advantages:

- Remove majority of nutrient store.
- Reduce release of nutrients into the water column.
- Drying of the lake system - enable carp to be removed.
- Opportunity to modify the deeper sections of the lakes which are hydraulically inefficient or prone to stratification.



Sediment removal

Disadvantages:

- Expensive – disposal costs.
- Decomposition of organic matter present within the sediments - odours.
- Impacts on aquatic organisms.
- Re-accumulation of the sediments over time.



Stormwater treatment

A reduction in the nutrient loads entering the Quiet Lakes will reduce the pool of nutrients within the water column that are available for algal growth.

Treatment options:

- Bioretention and/or wetlands
- Wetlands retrofitted within the existing lake system
- Bioretention cells around the lake perimeter and local streetscapes.



Stormwater treatment

Issues to consider:

- Substantial modifications to the drainage system required (upgrading the capacity of the existing pipes, provision of new drainage infrastructure).
- Treatment wetlands will reduce the area within each lake for beneficial uses and impact amenity.
- Some bioretention systems may need to be built within the lake system, resulting in the loss of shore frontage and amenity for some residential properties.



Stormwater treatment

Recommendations:

- Due to infrastructure constraints it is difficult to treat existing inflows prior to entering the lake system.
- Treating stormwater inflows should only be considered if all other strategies fail.

Groundwater flushing

It is possible to use groundwater to dilute and flush algal biomass from the lake system by establishing a constant base flow.

- Lake residence time of less than 15 days required for flushing to control blue green algal growth.
- Required flow rate between 9-18 ML/day (minimum volume required 3000 ML/year).
- Current lake residence time approximately 3.5 years.

Groundwater flushing

Not recommended as:

- Insufficient groundwater capacity to achieve the desired lake residence time of 15 days.
- Introduce high nitrogen load to the lake system.
- Some ammonia removed via denitrification but unlikely that sufficient nitrogen load would be removed to mitigate the increased risk of algal growth within the lake system.
- Likely to increase algal growth if the flushing rate is insufficient.
- Discharge high nitrogen loads into Port Phillip Bay.



Carp removal and fish stocking

- Constant grazing and physical disturbance
- Reduce water plant cover and remobilise nutrients.
- Removal of carp pressure - encourage expansion of the water plants and provide more favourable conditions for propagule germination and growth.

Carp removal and fish stocking

- Trial carp removal using specialised electro-fishing boat developed to work in brackish-estuarine conditions.
- Expected to be more efficient and quicker than conventional nets - all sizes of carp removed.
- Permanent fish traps - designed and installed.
- Fish stocking - species adapted to brackish conditions

Floating water plant beds

- Alternative option if water plants cannot be established on the base of the lakes.
- Function by removing nutrients from the water column.
- Floating water plant beds placed within each lake – minimum cover of 30-40%.
- Individual racks containing a range of plant species.
- Permanently tethered within the lake.
- Two or three water plant 'islands' within each lake.



Floating water plant beds

Advantages:

- Shading
- Natural solution
- Unlikely to be impacted by carp
- Flexibility in locating beds
- Could be integrated with other lake features



Floating water plant beds

Disadvantages:

- Detract from the aesthetic amenity of the lake system.
- Require ongoing maintenance.
- Potential safety issues.
- May increase the overall number of waterbirds utilising the lake system.
- Potentially reduce wind forced mixing and increase risk of stratification.



Further information

Quiet Lakes Water Quality Management Plan (2011)