Stormwater harvesting storage management to achieve a sustainable landscape at Royal Botanic Gardens Victoria, Melbourne Gardens

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One of the most beautiful botanic garden landscapes in the world!

The Ornamental Lake Storage – A living system

Constructed wetlands at Eastern end of Ornamental Lake

Working Wetlands Project
Wetlands – Ornamental Lake, RBG

Floating treatment wetlands (17 Beds. 1,000m^2)

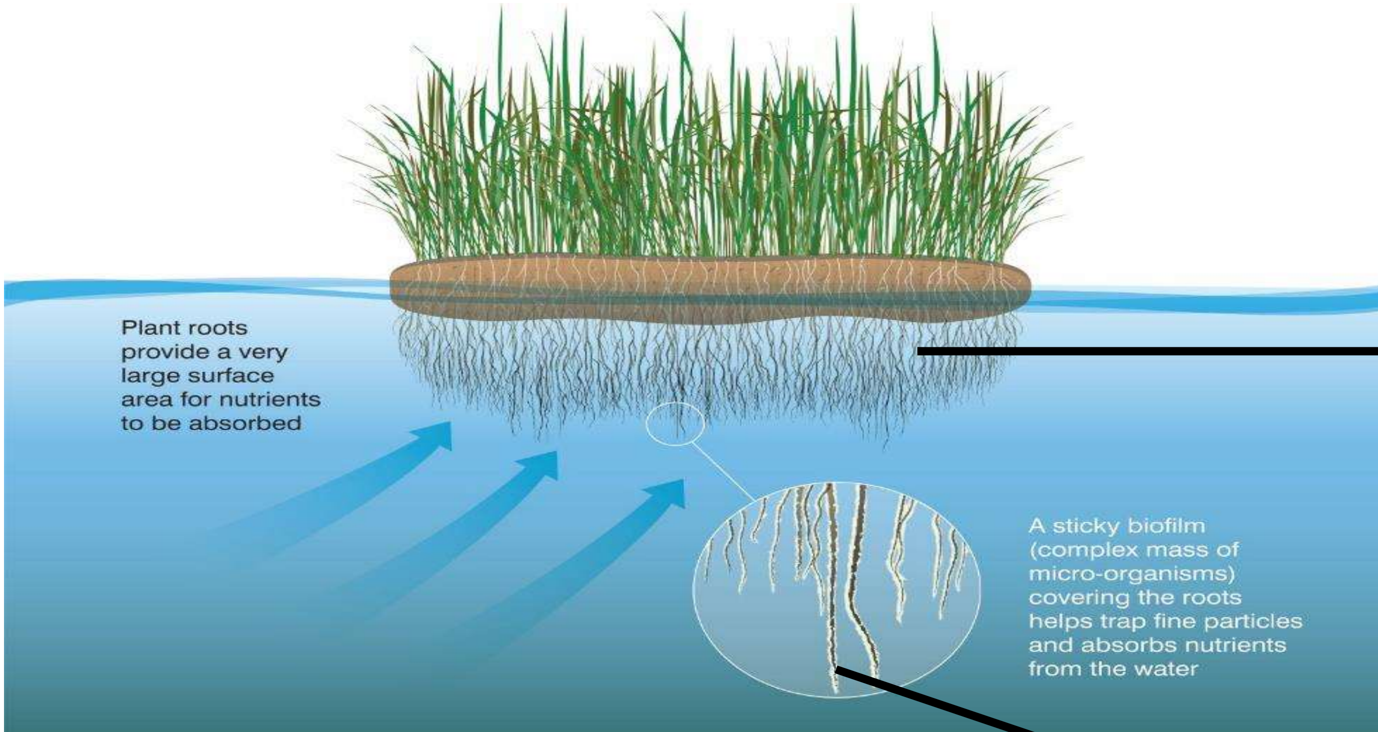
One month after pruning

Working Wetlands Project

Traditional Constructed Wetlands (26 Nov 2011)

A-Gate Wetland

Floating Treatment Wetlands



Challenges for Melbourne Gardens Landscape

- **Adapting to projected climate change**
- **Managing and securing sustainable water supplies**
- **Maintaining the value of a mature heritage landscape through the transition to a new climate**
- **Responding to biosecurity threats**

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Climate change projections – Climate parameters

Group	Parameter	Data Period	Baseline Data	2090 +/-	2090 Result
Temp.	Annual Mean (°C)	1986-2005	15.9	+3.1	19
	Mean Days >35 (°C)	1981-2010	11	+13	24
	Annual Mean Max.(°C)	1986-2005	20.4	+3.3	23.7
Rainfall	Annual Mean (mm)	1986-2005	624	-9%	574
	Winter Mean (mm)	1986-2005	147	-10%	132
	Spring Mean (mm)	1986-2005	180	-19%	146

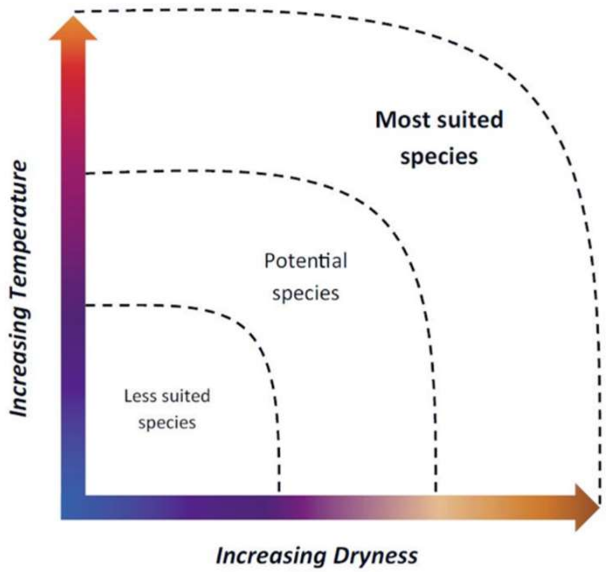
Data sourced and adapted from Australian Bureau of Meteorology, and average values from a high emissions scenario (RCP 8.5) as indicated in projections from Grose M et al. (2015) *Southern Slopes Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports*, eds. Ekström, M. et al., CSIRO and Bureau of Meteorology.

LANDSCAPE SUCCESSION STRATEGY
MELBOURNE GARDENS 2016 - 2036

The *Landscape Succession Strategy* guides the transition from existing plantings to a composition more suited to projected climate and environment conditions of 2090.

Question:
Climate of Melbourne in 2090?

Ans: Dubbo, NSW



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Royal Botanic Gardens Victoria

What is Landscape Succession?

Landscape succession is:

The managed transition of a cultivated landscape from one state currently characterised by an existing palette of living plant collections to another state dominated by taxa more likely to be resilient to Melbourne's projected climate.

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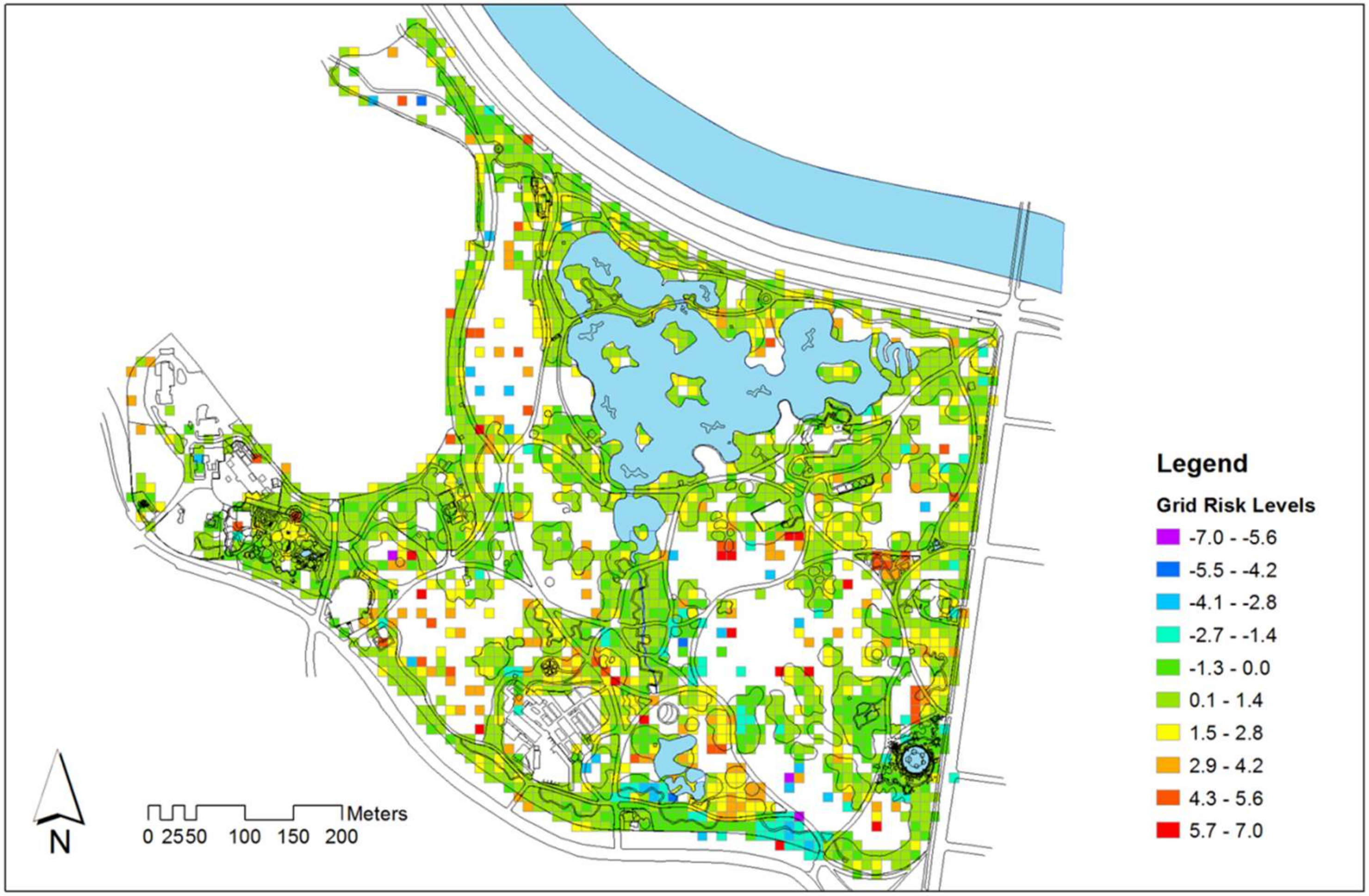
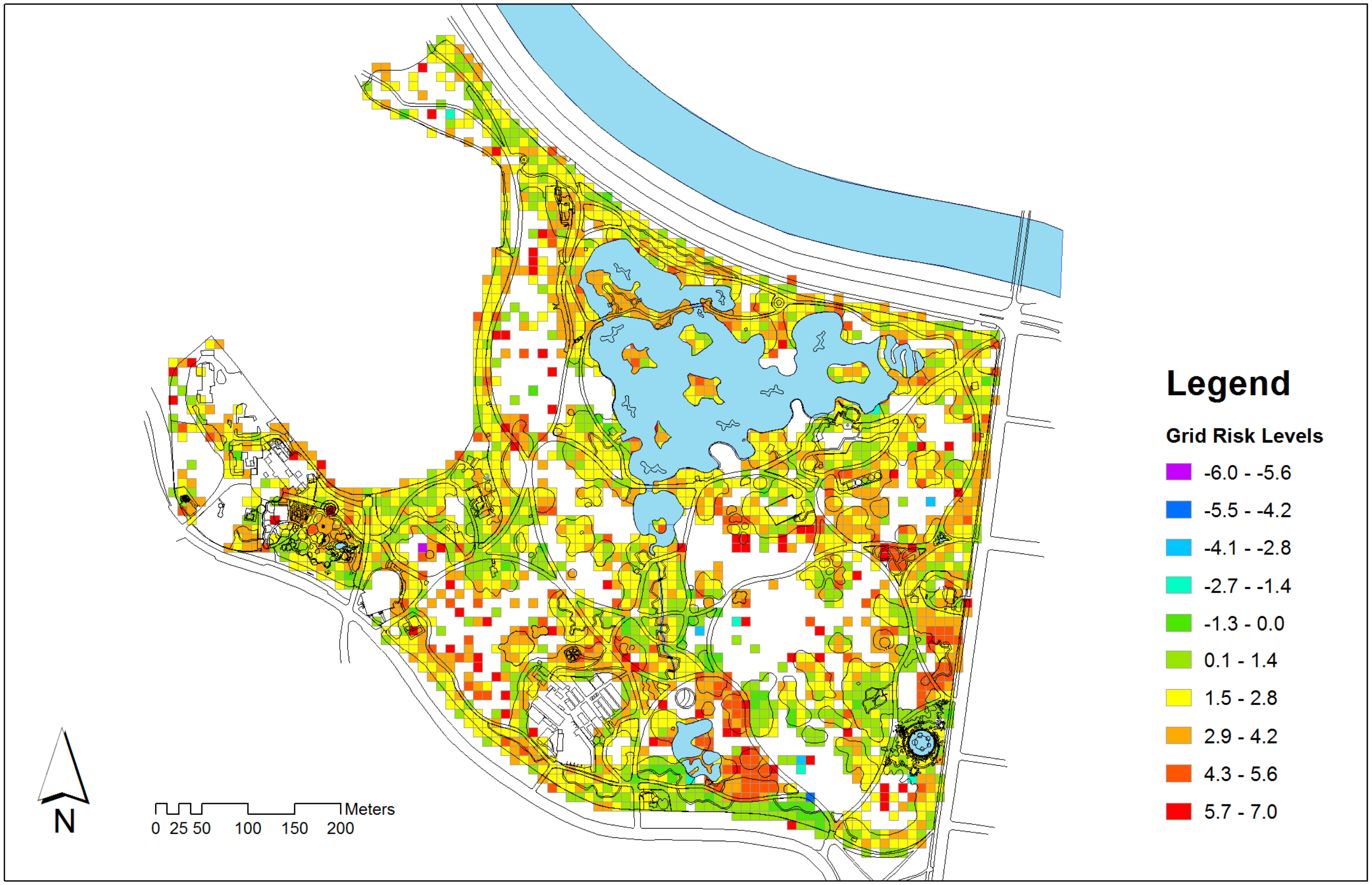
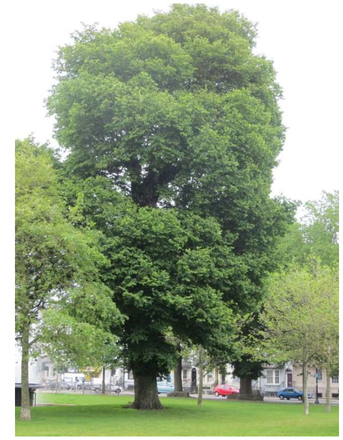
Living Collections under Current Climate Risk Scenario



Living Collections under Extreme Climate Risk Scenario



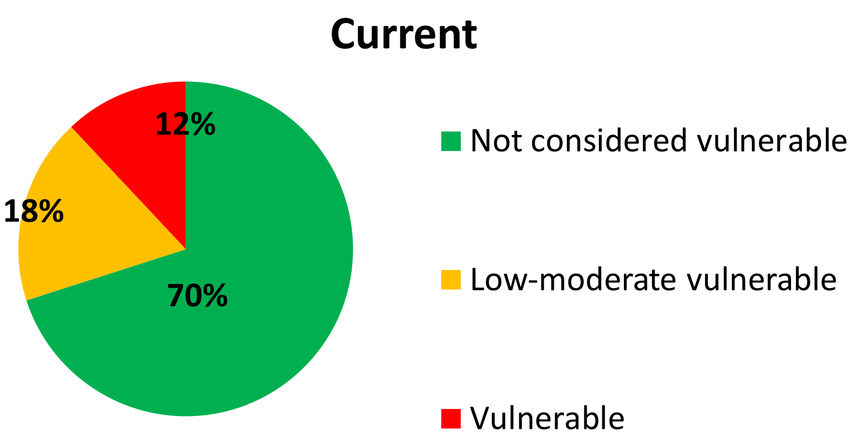


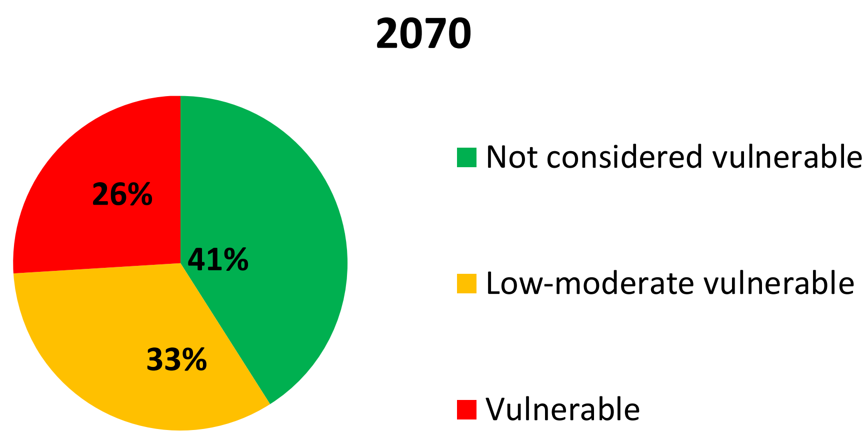
Elm

Silver Birch

Outcomes

Climate Vulnerability Risk Assessment





Data Source: Kendal and Farrar 2017

The RBG Strategy has identified
5 Strategies and Targets

Strategy 1: Actively manage and transition the Melbourne Gardens landscape and plant collection

Strategy 3: Maximise sustainable water availability and use

Target: **By 2020, 100% of landscape irrigation needs are provided by sustainable water sources.**

Ambitious

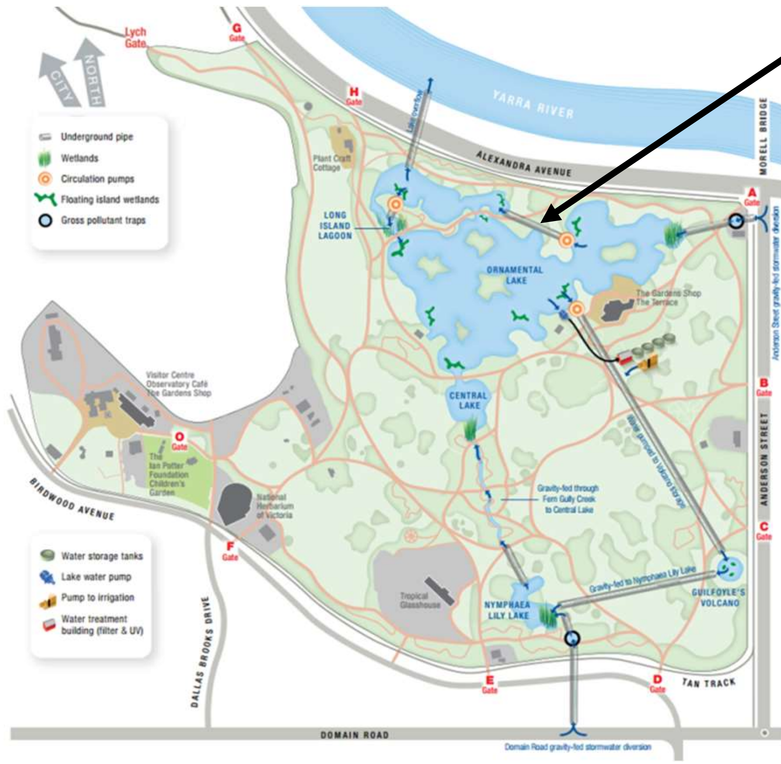
RBG Site Water Cycle Overview

North

CBD

Yarra River

Ornamental Lake



SW

Urban catchments

SW

Urban catchments

Role of Ornamental Lake

a. Amenity
b. Ecological values (Closest 'remnant' freshwater body to CBD)
c. Recreation
d. Water treatment of harvested stormwater
e. Site water management – flood mitigation
f. Modify runoff to discharge – Yarra River
g. Irrigation and water banking storage

Lake Level- Amenity Value
Visitors and Tourists

Risks for the Lake storage

A. Depth of Lake

- **Amenity**

- **Macrophyte health and function**

B. Water quality

- **Nutrients**
- **pH**
- **EC**
- **Toxins**
- **Lack of oxygen**

Need to consider: Physical, Chemical and Biological properties

Potential Water Level Conflict

1. Maximising yield for irrigation (Large drawdown)

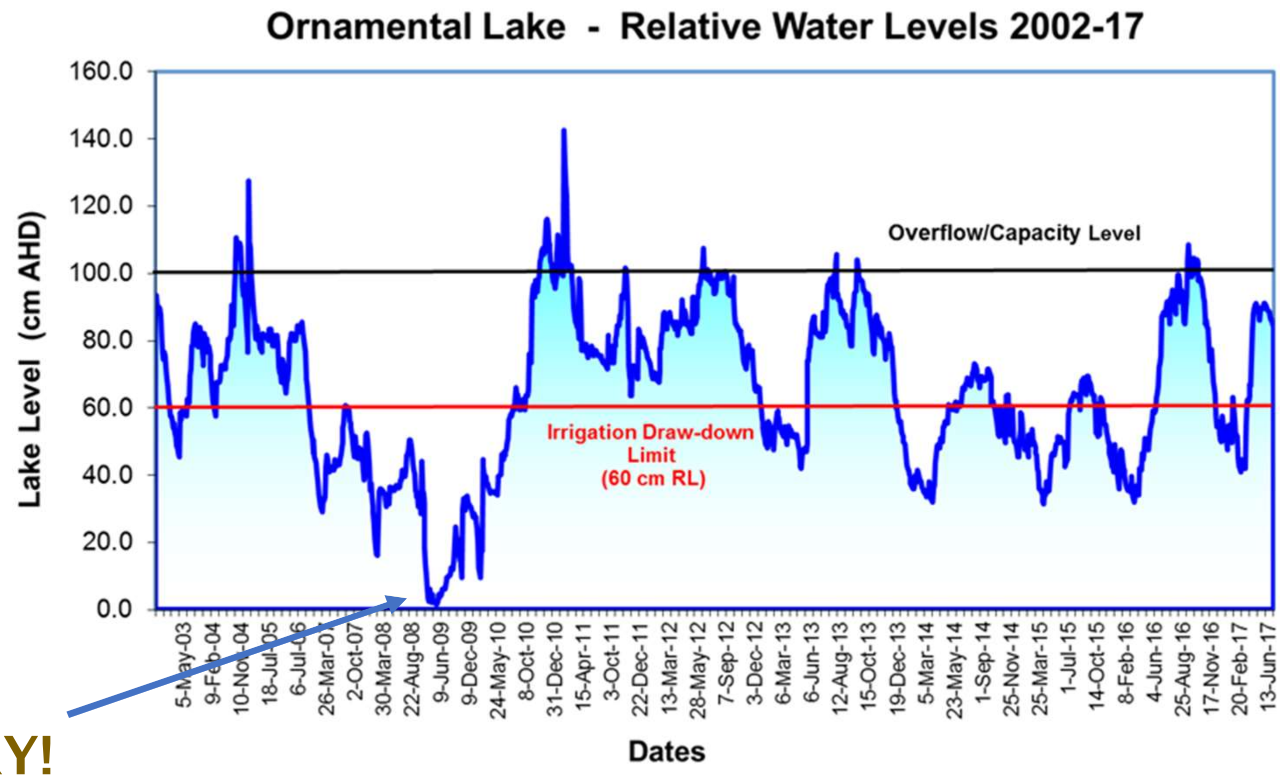
2. Protecting amenity value (Small drawdown allowed)

3. Protecting health of storage/ecosystem

Options:
300 mm Drawdown

500 mm Drawdown

Relative Water Levels 2002-2017



DRY!

Outbreak of *Azolla rubra* (Native, floating water fern)

Clean up cost is huge
– Labour hours (1,900 hrs) and $s

RBGV has now invested in an amphibious harvester. $150 k

Macrophyte management

Oil spill- Local urban catchment
(Analysed as most similar to Emu oil !?, Source?)

Physico-chemical water quality parameters

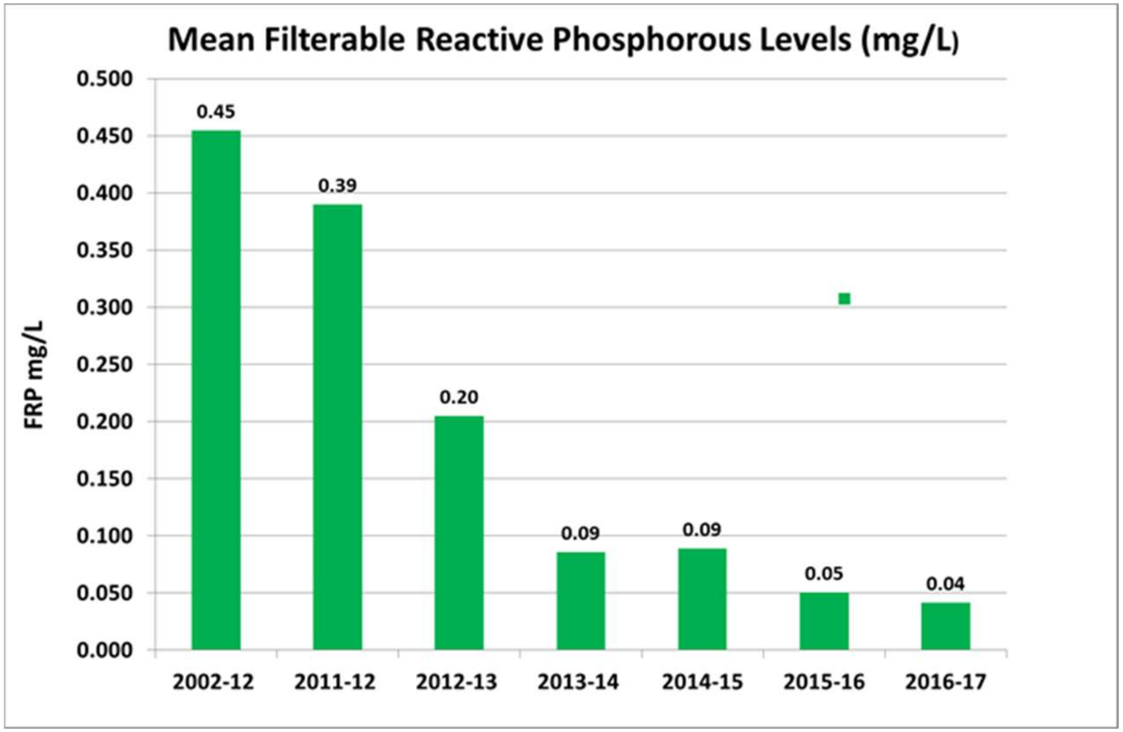
Parameter	Unit	Target Value	2012-17 Mean Values
Bicarbonate	Mean mg/L	<90	117.00
Boron	Mean mg/L	<0.5	0.06
Chloride	Mean mg/L	<40-100	84.00
Copper	Mean mg/L	<0.2	0.01
Calcium	Mean mg/L	>20<100	23.60
Electrical Conductivity (EC)	dS/m	<0.75	0.57
Iron	Mean mg/L	<0.2-0.8	0.60
Magnesium	Mean mg/L	<50	13.80
pH	Mean Unit	6-9	7.53
Sodium	Mean mg/L	<50-100	55.30
Sodium Adsorption Ratio (SAR)	Mean Ratio	<3	2.3
Turbidity	Median NTU	<25	5.0
Zinc	Mean mg/L	<2	0.06

Cyanobacteria (Blue-green algae counts for Ornamental Lake

Period	All Cyanobacteria spp. (Median cells/100 ml)	Dolichospermum spp. (Median cells/ml)	Microcystis spp. (Median cells/ml)
1996-2012	5793	4580	2300
2011-12	4203	5807	29587
2012-13	5879	1975	2643
2013-14	887	3088	119
2014-15	5793	2401	1058
2015-16	233	211	17
2016-17	250	17	52

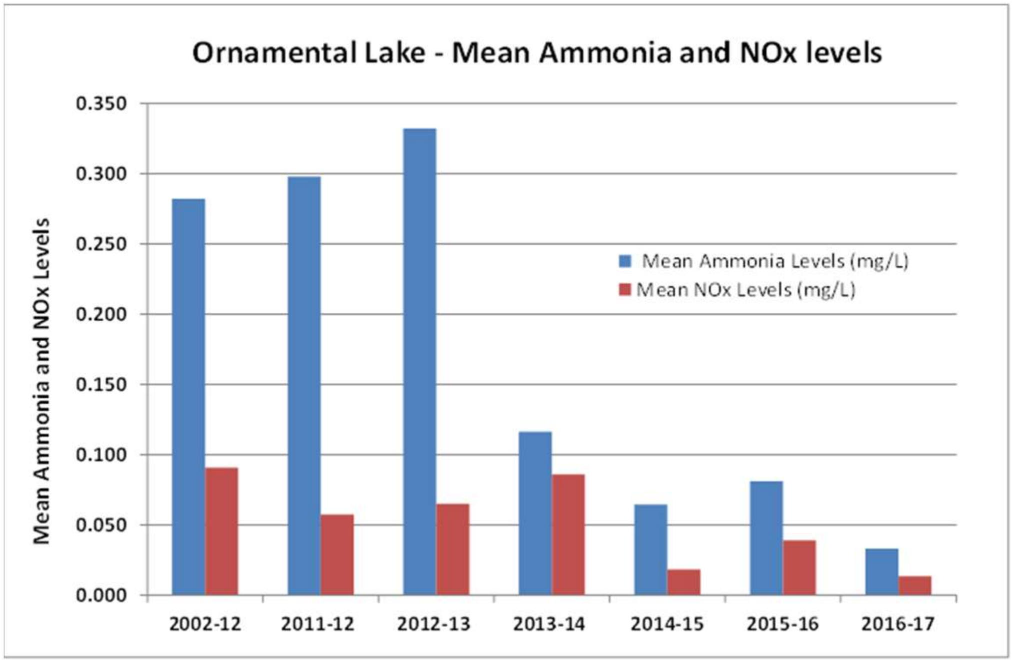
Main cyano. reductions from 2015-2016 – Combination of reducing detention time (recirculation), reduction in nutrient loadings and competition from macrophytes (probably strongest influence).

Phosphorous levels (mg/L)



Compared to 2002-2012 baseline—bioavailable phosphorous levels are 91% less for 2016-17. These are the lowest levels recorded so far.

Mean ammonia and Nox levels

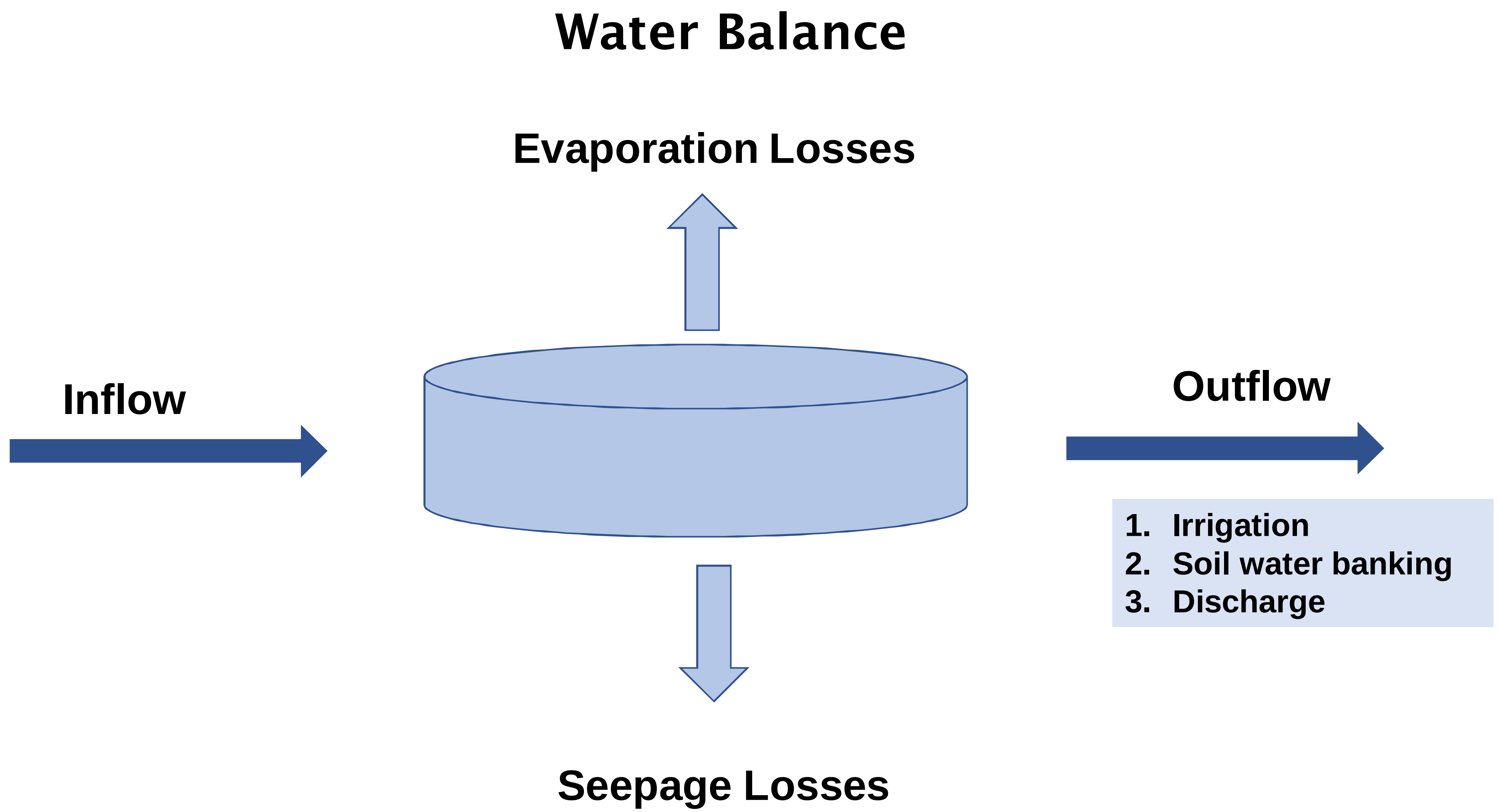


Nutrient reduction a major achievement!

Compared to 2002-2012 baseline—bioavailable nitrogen levels were over 85% less for 2016-17. These are the lowest levels recorded thus far.

Treatment results for E.coli levels in Lake

Period	Pre-treatment Median (CFU/100 ml)	Post-UV treatment Median (CFU/100 ml)	Notes
31/10/12 to 20/02/14	280	2.5	20 samples
31/10/12 to 7/06/17	240	1	35 samples


Water Balance
Evaporation Losses
Inflow
Outflow
1. Irrigation
2. Soil water banking
3. Discharge
Seepage Losses

Modelled Demand and Storage Summary

Item	(ML/Year)	Notes
Total stormwater yield	76	Modelled on assumed climatic conditions for 1999-2008 (528 mm rainfall; 1185 mm pan evaporation)
Evaporation	21	Excludes water use by aquatic plants and marginal vegetation (ET), and seepage losses
Potential Lake overflow	14	If not harvested for Soil Moisture Storage and Recovery (SMSR
Total available for irrigation with no management intervention	41	If SMSR is not applied
Total available for irrigation with storage and demand management	55	Includes Lake overflow as SMSR (banked)

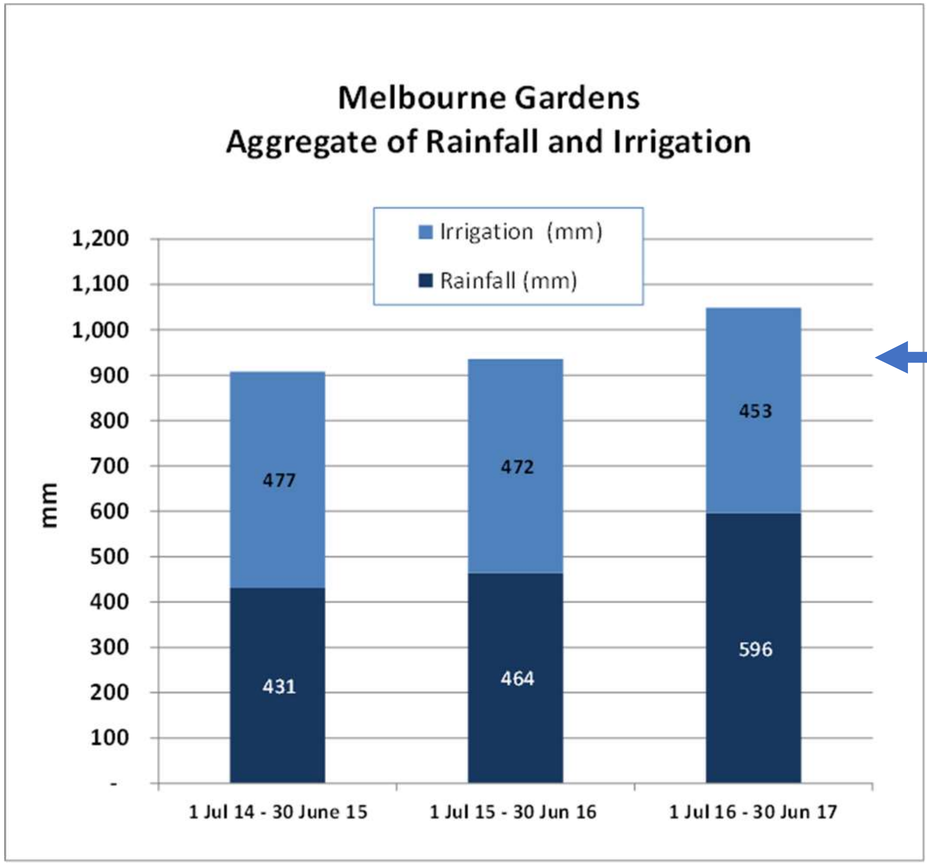
Actual Water Balance Estimation

When annual rainfall is similar to modelled/design baseline, then expected harvest volumes are achieved

Description	Mean 2012-17	2016-17	2015-16	2014-15	2013-14	2012-13
Mean Annual Rainfall (mm)	506	596	464	431	550	490
Ornamental Lake Inflows (ML)	57.4	73.0	49.0	42.2	67.0	56.0
Total Losses (ML)	-53.2	-61.1	-37.8	-50.4	-68.2	-48.4
Irrigation Use (ML)	-32.0	-48.3	-15.0	-31.3	-46.6	-18.6
Evaporation/ Leakage/ Overflow (ML)	-19.7	-12.8	-22.8	-20.1	-13.2	-29.8

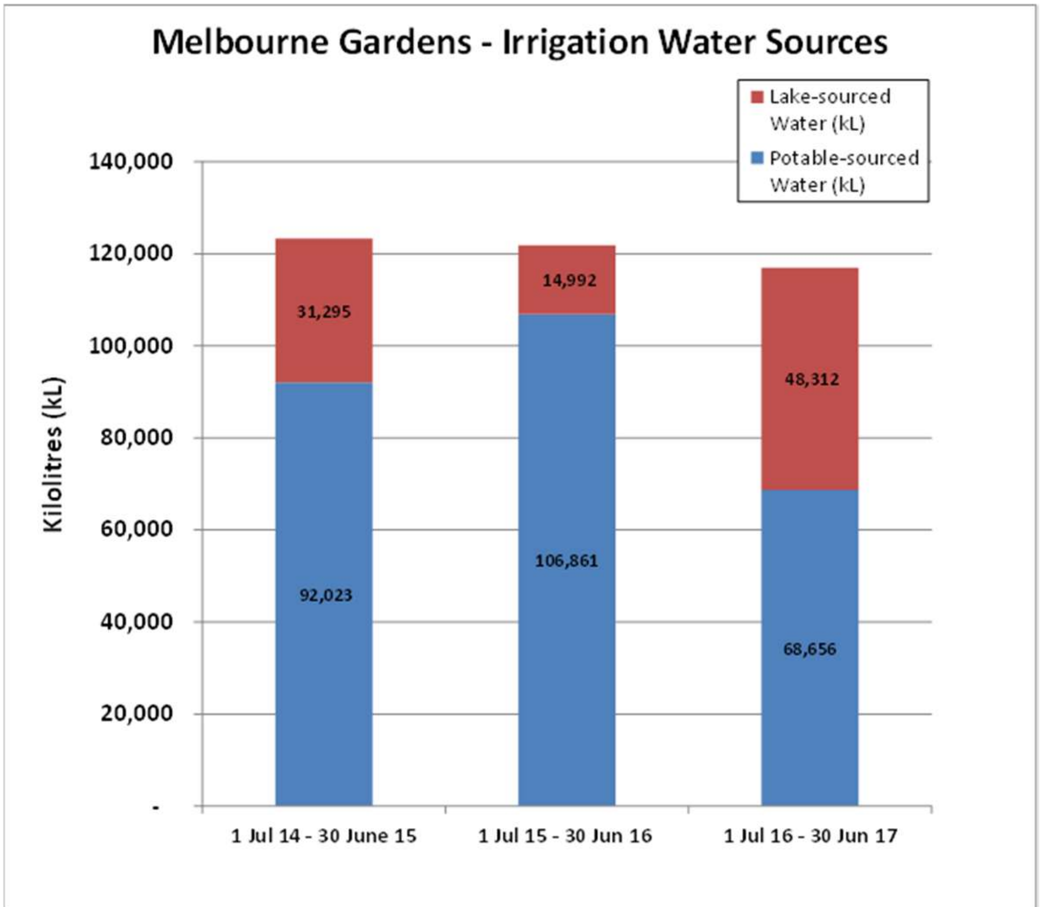
Note: Evaporation losses are likely underestimated , some overflows are not able to be measured

Aggregate of Rainfall and Irrigation



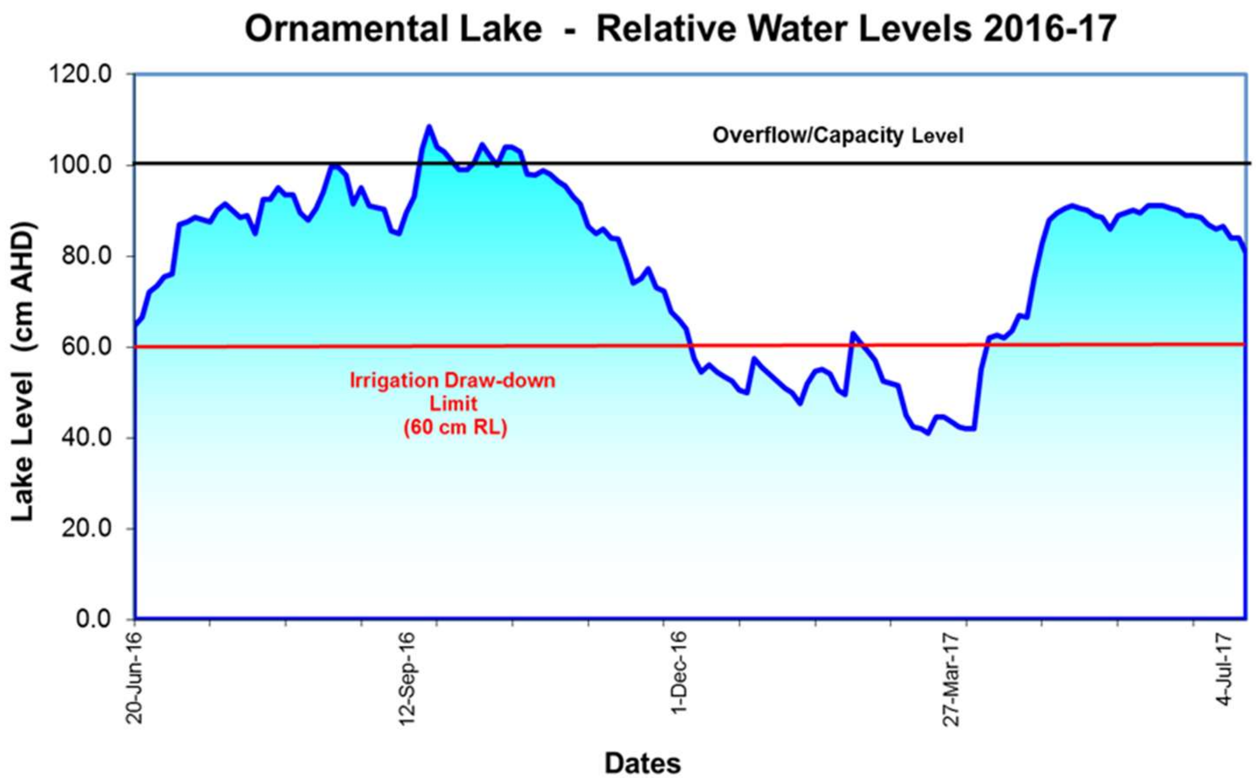
Total water needs of plants

Irrigation Water Source



Mainly potable!

Water banking opportunity - Relative water levels 2016/2017



Water banking - Subsoil Moisture Storage and Recovery

Potential available water storage
= 557 mm or 155 ML over 27.8 Ha

2 Probes to 4 m

4 Probes to 2 m

Research partnership with University Melbourne
and Sentek Technologies

Site water management requires knowing irrigation demand

K_L 0.4

Typical Landscape Coefficients (K_L) used in summer at RBG Melbourne

K_L 0.6-0.7

<K_L 0.3

K_L 0.5

Lake Storage Management Lessons

1. Continual monitoring of Lake level for opportunities to export to soil banking.

2. The Lake and wetlands as a treatment system works.

   Nutrient reductions are evidence of this.

3. Water body/column conditions can favour unwanted macrophyte (Azolla) growth.

   Better understanding of Lake environment conditions and growth habitat of Azolla.

Lake Storage Management Lessons

4. Diligent monitoring of the natural and synthetic systems is essential.

Accurate and reliable Instrumentation/sensing – Quality; Maintenance; Certification; Calibration

5. Urban catchment risks.
Prevention techniques. Who is the responsible authority?

6. Better understanding of storage/lake/stormwater water chemistry – Treatment effectiveness

Lake Management Strategies

1) Maximise beneficial use of harvested water – Minimise discharge to Yarra

2) Use water for irrigation efficiently

3) Maximise soil water banking

4) Achieve effective water treatment

5) Maintain suitable Lake levels for other functional use
E.g. Revenue raising for RBGV through punting activities

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