Yangebup Lake Nutrient Stripping Trial

Adam Harris, City of Cockburn

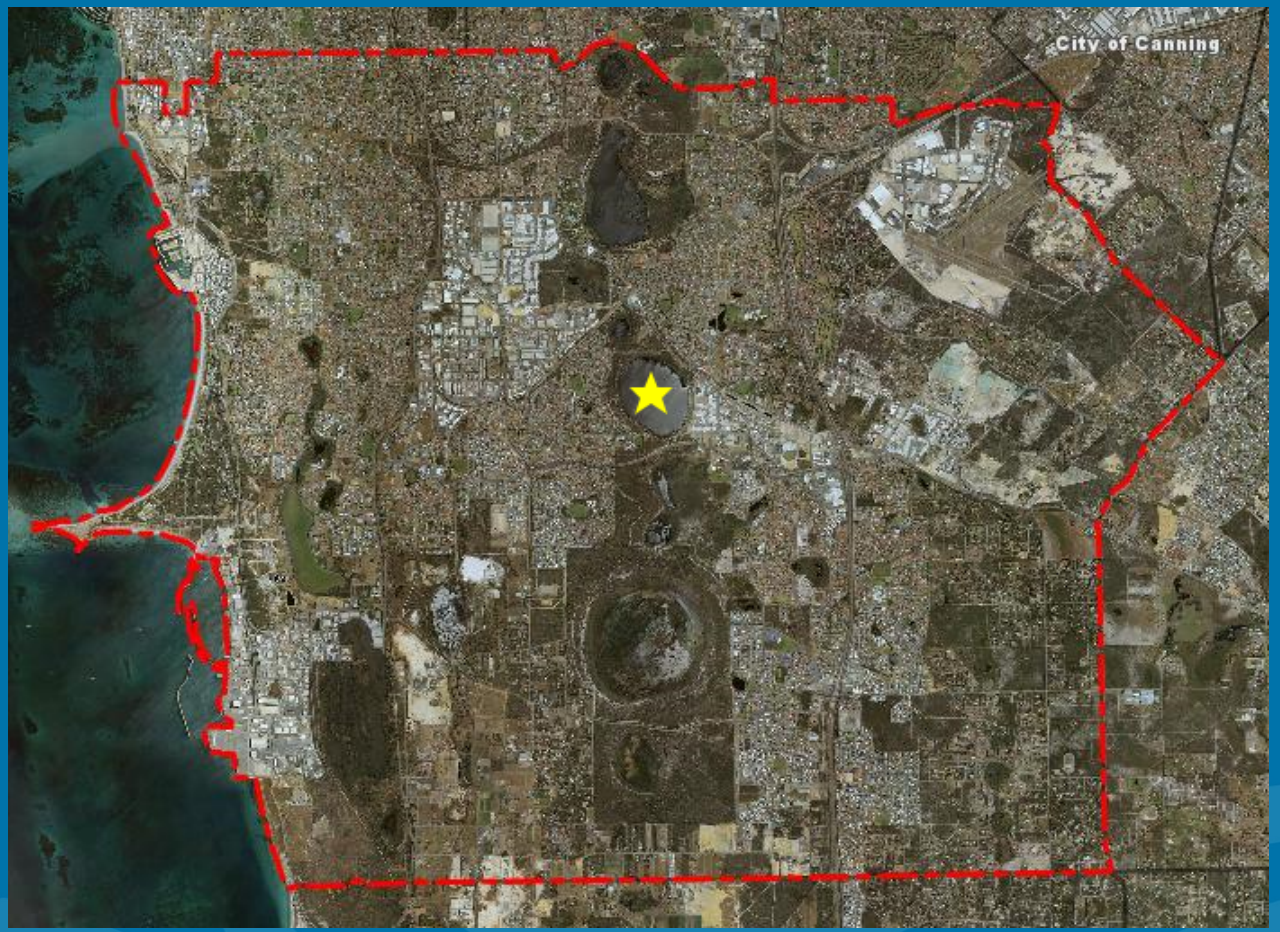
Aim

2 stage project:

1.To assess the effectiveness of using a solar powered pump in conjunction with a traditionally designed nutrient stripping basin to improve the water quality of Yangebup Lake while at the same time enhancing the habitat value of a degraded site

2.Optimising reduction of N and P in the natural system.

Location - Yangebup Lake



Yangebup Lake

- Part of the eastern chain of the Beeliar Wetlands
- 82 hectares of open water
- Approx. 4 metres deep
- Part of South Jandakot Drainage Scheme

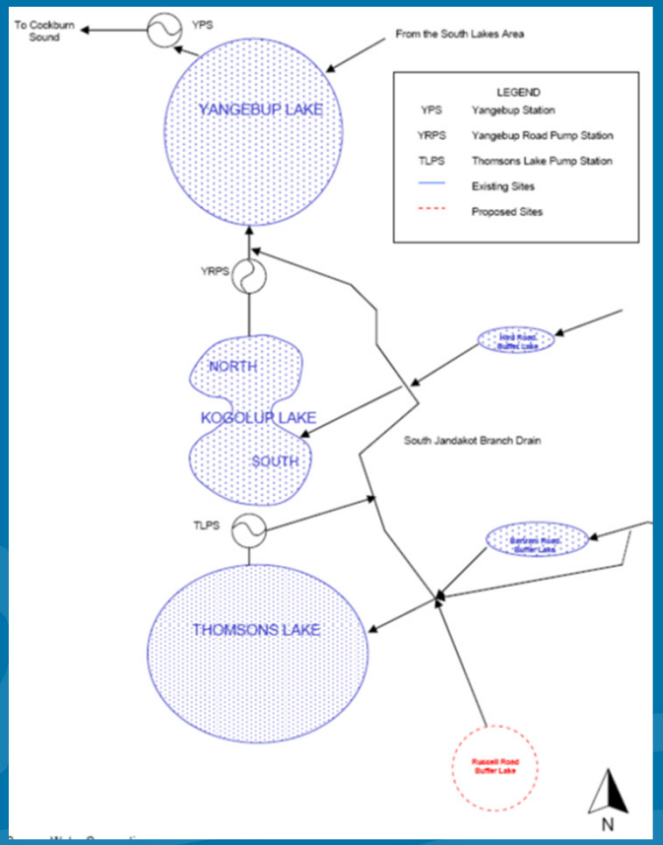


Fig 1. Schematic diagram South Jandakot Drainage Scheme

Yangebup Lake prior to 1960's

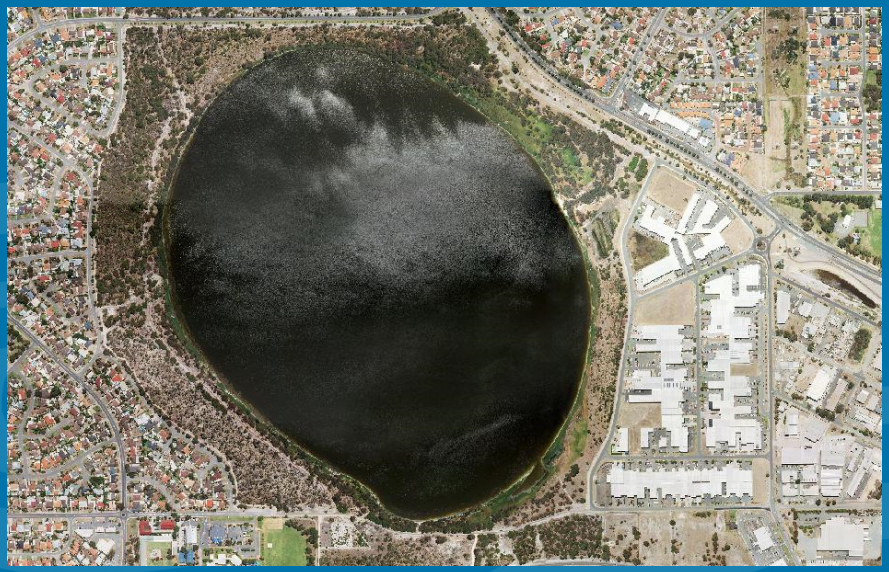
- Regularly dried out
- Much of the surface covered in rushes
  – *Typha domingensis*
- Rushes declined due to influx of saline waters from Wool scourers
- Water levels ranged between 13.4 metres AHD (dry) to 17.8 metres AHD

1953

2000

Yangebup Lake - Today

- City of Cockburn manages the surrounding reserve.
- WAPC responsible for management of the waterbody.
- Poor water quality due to past land uses – farming, clearing, wool scourers, residential development.
- Continues to receive stormwater



Source: COC GIS

Site conditions

- Arsenic contained within sediment (ENV 2003)
- Hypertrophic wetland
- Phosphorus is limiting nutrient to algal growth.
- Two largest additions of nutrients to the lake are from groundwater and storm water drains.
- Higher concentrations of nutrients in incoming surface water and reduced pumping to ocean have lead to net increase in nutrients leading to algae blooms and **high numbers of nuisance midge.**
- Management responses needed to address issues (**midge**)

Nitrogen Balance 2003

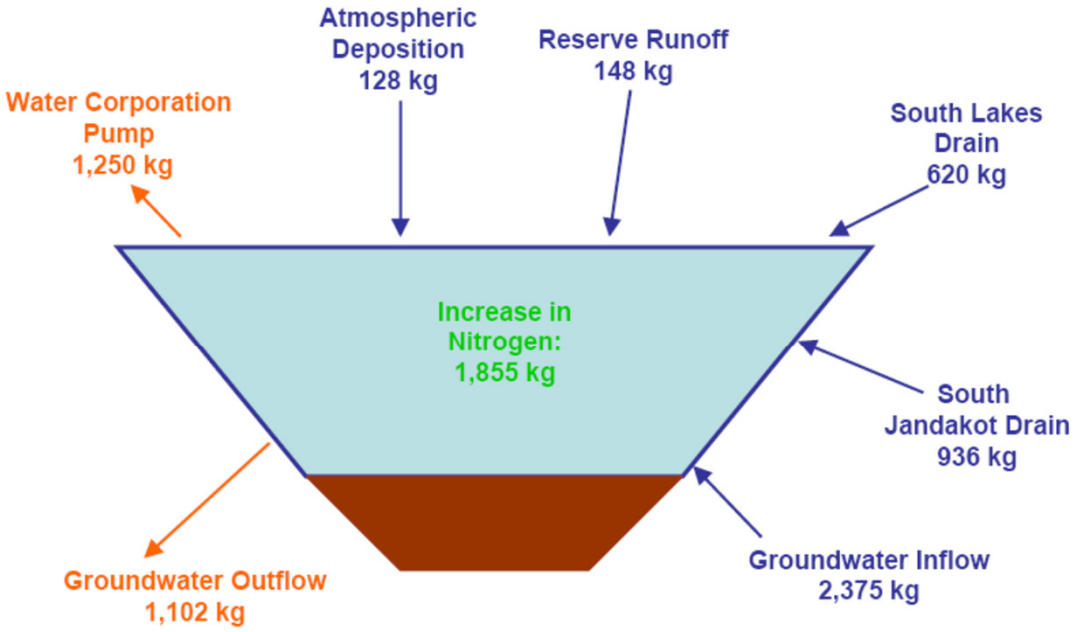


FIGURE 16: 2003 Nitrogen Balance for Yangebup Lake

CLIENT: City of Cockburn

DRAWN BY:	CHECKED BY: KL	JOB NUMBER: 05.150
DATE:	REPORT ISSUE:	

Phosphorus Balance 2003

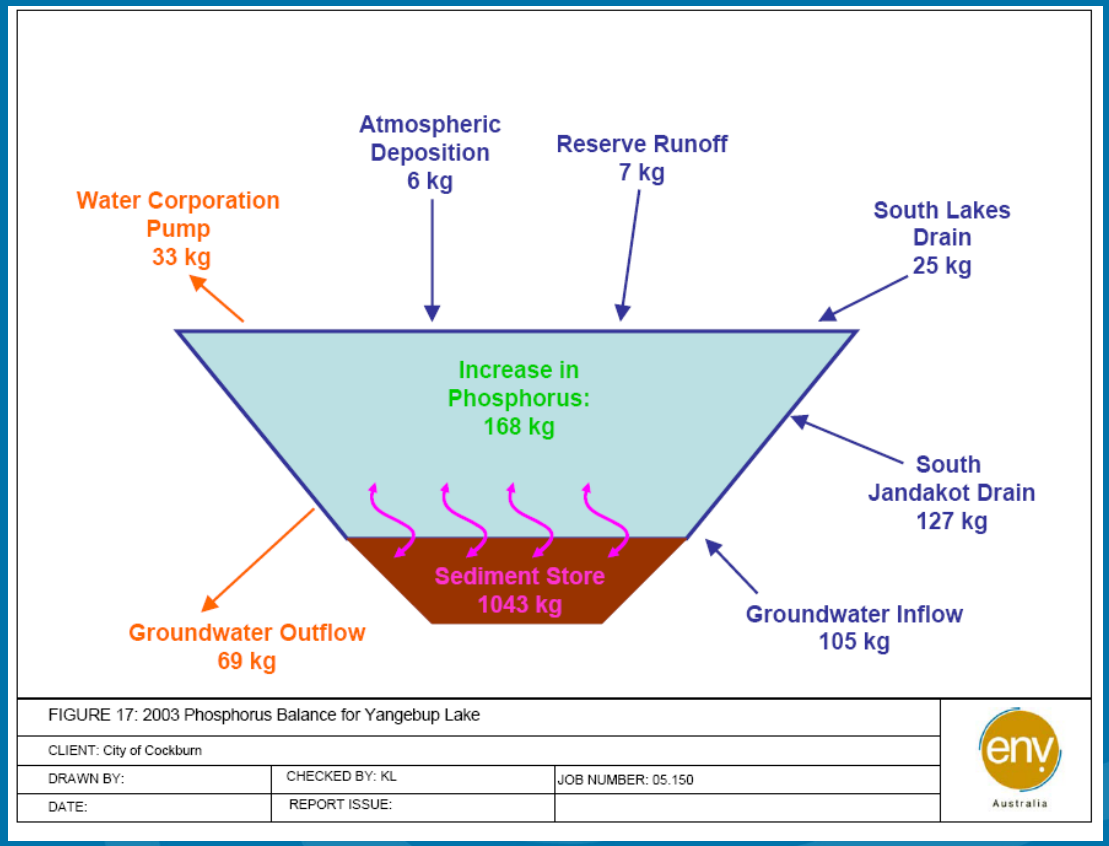
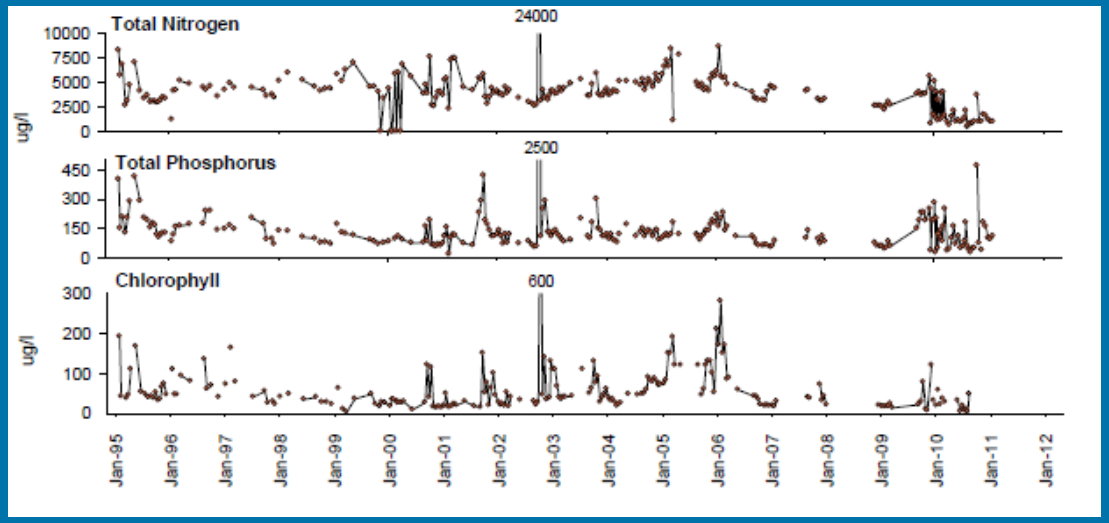


FIGURE 17: 2003 Phosphorus Balance for Yangebup Lake

CLIENT: City of Cockburn

DRAWN BY:	CHECKED BY: KL	JOB NUMBER: 05.150
DATE:	REPORT ISSUE:	

Progress



Source: Wyse and Lund 2012

Since 2009 Total N and P values have been trending down indicating that efforts focused on reducing nutrients have had a positive impact. Midge larvae densities and adult swarms have also been decreasing.

Current Status

Nitrogen and Phosphorous values are still exceeding recommended range (but better). Twenty macroinvertebrate families from 14 orders were collected during the most recent monitoring at Yangebup Lake (this is relatively high).

Parameter	Site				Mean
	YAN_1	YAN_2	YAN_3	YAN_4	
Alkalinity (mg/L)	281	291	281	284	284
Colour (TCU)	56	54	54	56	55
Nitrate (mg/L)	0.17	0.17	0.12	0.12	0.15
Nitrite (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrogen, ammonia (mg/L)	0.13	0.22	0.16	0.17	0.17
Total Nitrogen (TN) (mg/L)	2.5	2.5	2.6	2.8	2.6
Phosphorous, soluble reactive (SRP) (mg/L)	0.01	0.02	0.01	0.01	0.01
Total Phosphorous (mg/L)	0.042	0.030	0.16	0.060	0.073
Turbidity (NTU)	3.6	1.4	1.6	2.5	2.3

* Cells shaded red indicate outside ANZECC recommended range, cells shaded green indicate within ANZECC recommended range

Source: Ecological Macroinvertebrate Report 2015

Nutrient Stripping Basin

- In response to the still elevated nutrient levels a novel approach was developed.
- Nutrient stripping treatment trains have been used successfully elsewhere to treat storm water generally using storm water run off from storm events.
- Hypothesis: Can we use solar power to circulate water from within the wetland through a nutrient stripping basin to reduce the nutrients in the wetland?

Solar Powered Nutrient Stripping Basin

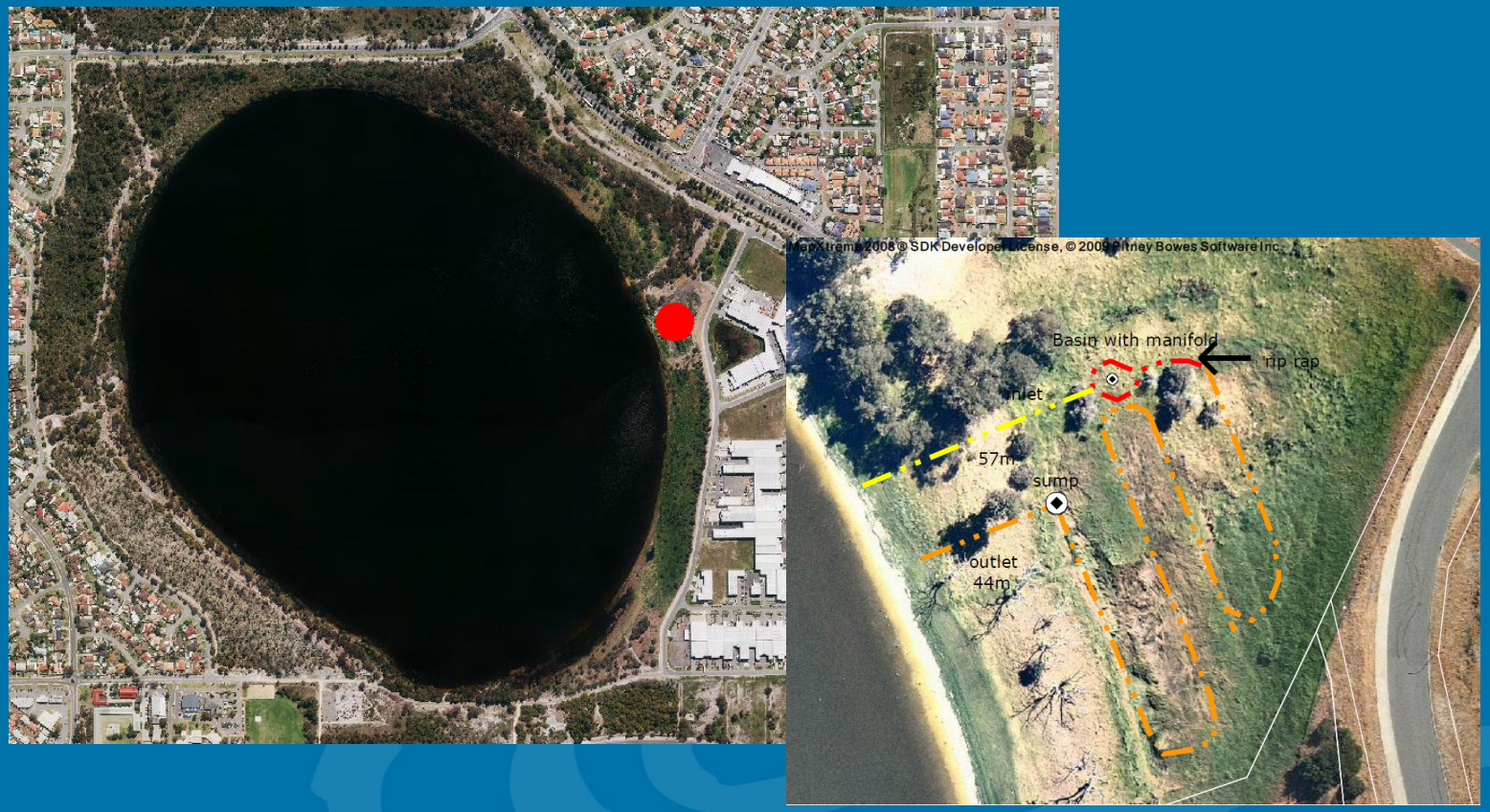
City of Cockburn
wetlands to waves

Benefits:

- Allows us to treat water already in the wetland.
- Additional vegetation to strip nutrients, provide shade and habitat & vegetation provides barrier for midge.
- Using solar power minimises ongoing costs.

8 x 170watt solar panels on 5m pole

Location of Basin



Nutrient Stripping Construction

Works undertaken:

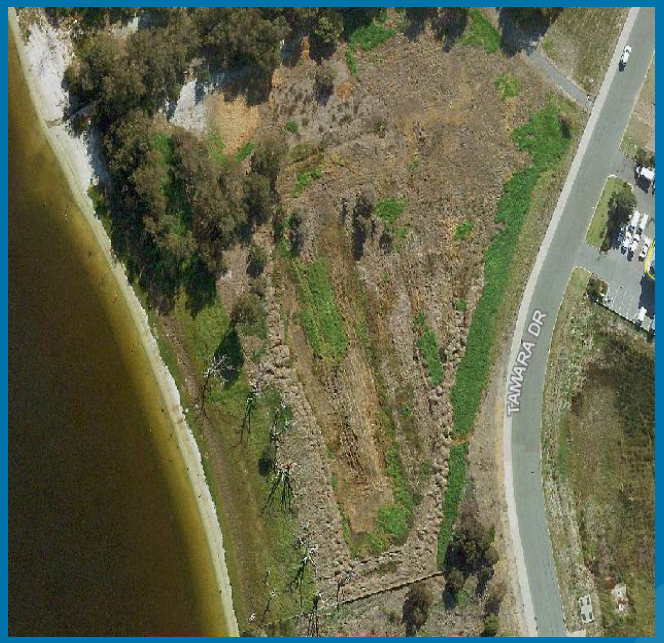
- Autumn 2015 - Macroinvertebrate sampling and water quality analysis
- Weed control to remove Kikuyu
- Excavation of site -10,000 cubic metres of soil and organic material brought into site
- Logs and riffles placed
- 19,000 sedges, trees and shrubs installed
- 3 community planting events
- Funding received from State NRM Office Community Grants Program ($26,000)
- Installation of footing, pole and solar array
- Installation of submersible pump

Construction/Works

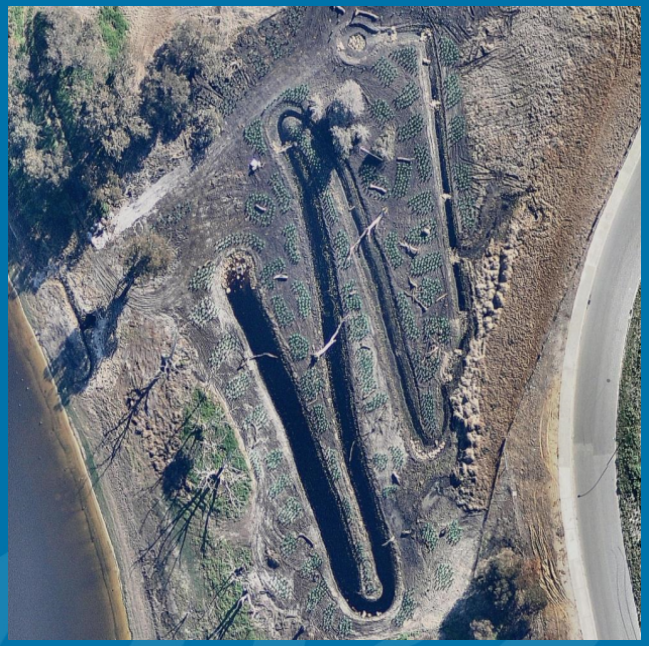
Local species for habitat

Before and After

May 2015

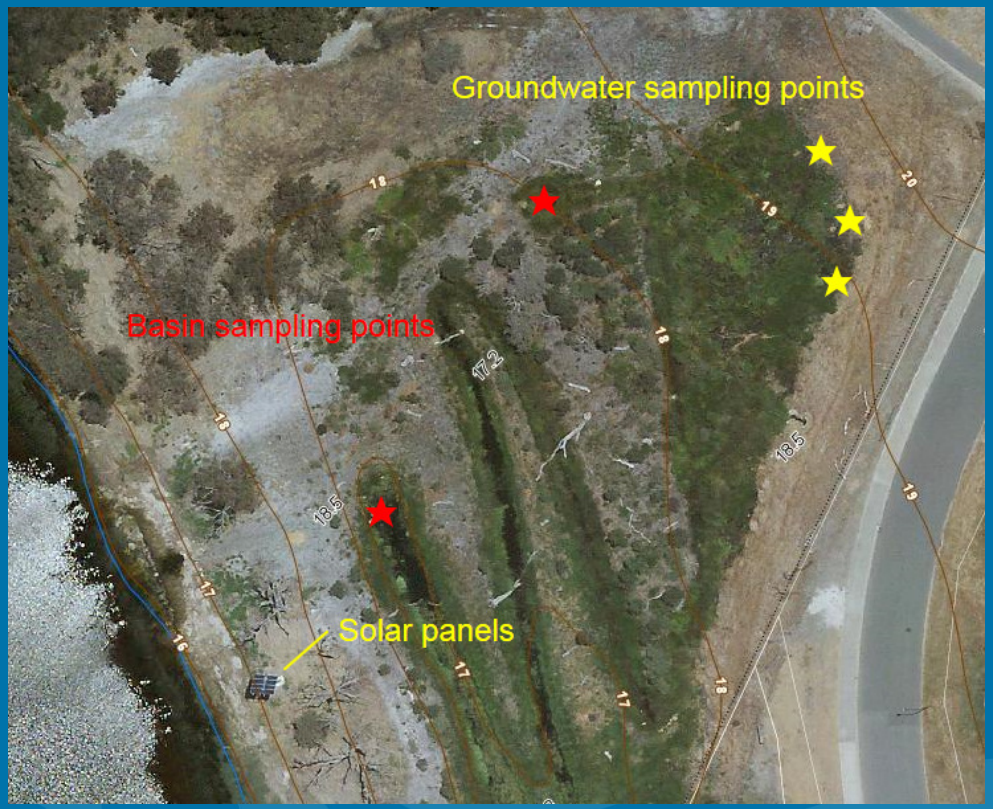


July 2015



Feb 2017

Water Quality Monitoring



Water Quality Results

City of Cockburn
wetlands to waves

METHOD	Sampling	9100	5040	2200	2000	4100	2100-2200	4700	2700	2320B
SAMPLE	Date	pH	COLOUR	NO2	AMMONIA	ORTHO-P	NO3	TOTAL-P	TOTAL-N	Total Alkalinity
			GILVIN 440nm	µg.N/L	µg.N/L	µg.P/L	µg.N/L	µg.P/L	µg.N/L	mg CaCO3/L
Reporting Limit			<0.1	<2	<3	<2	<2	<5	<50	<2
Inflow	6/04/2016	8.8	4.6	<2	5	2	2	53	2700	264
Outflow	6/04/2016	8.1	6.2	<2	69	3	4	53	2600	267
Inflow:	4/05/2016	8.5	4.3	8	85	2	130	80	3200	269
Outflow:	4/05/2016	8.2	8.0	12	180	2	29	69	3000	279
Inflow	8/06/2016	8.8	4.5	<2	3	<2	<2	58	2500	234
Outflow	8/06/2016	7.9	18.4	200	310	4	2800	86	7600	309
Inflow	3/08/2016	No flow								
Outflow	3/08/2016	No flow								
Inflow	7/09/2016	8.2	7.4	16	180	4	53	82	2500	199
Outflow	7/09/2019	7.7	17.4	110	500	4	1200	60	3900	258
Outflow	3/08/2016	8.1	31.2	260	410	7	5200	60	9100	371
Inflow	7/09/2016	8.2	7.4	16	180	4	53	82	2500	199
Outflow	7/09/2016	7.7	17.4	110	500	4	1200	60	3900	258
										236
Inflow	13/10/2016	8.2	8.6	45	170	19	120	57	1900	
Outflow	13/10/2016	7.6	14.4	31	570	14	100	84	2500	
Inflow	9/12/2016	9.0	7.0	2	5	3	6	66	2000	207
Outflow	9/12/2016	7.9	9.3	3	47	5	4	64	2200	221
Inflow	16/12/2016	9.2	6.8	<2	7	3	3	63	2000	207
Outflow	16/12/2016	8.0	9.4	<2	16	3	4	78	2100	221

Water Quality Results

METHOD	Sampling	9100	5040	2200	2000	4100	2100-2200	4700	2700	2320B
SAMPLE	Date	pH	COLOUR	NO2	AMMONIA	ORTHO-P	NO3	TOTAL-P	TOTAL-N	Total Alkalinity
			GILVIN 440nm	µg.N/L	µg.N/L	µg.P/L	µg.N/L	µg.P/L	µg.N/L	mg CaCO3/L
Reporting Limit			<0.1	<2	<3	<2	<2	<5	<50	<2
Groundwater										
Groundwater 1	01/02/2017	7.29	9.6	24	570	280	4500	2500	30000	261
Groundwater 2	01/02/2017	7.28	7.4	6	510	140	1100	1800	13000	273
Groundwater 3	01/02/2017	7.30	7.0	3	520	220	420	3400	17000	324

Incoming groundwater impacting the treatment train

Challenges

- Prolific plant growth (including weeds) - likely due to availability of additional nutrients in soil or groundwater.
- Floating pump – moving closer to shore due to wind and wave action.
- Solar panels, controller and pipes visible – potential for vandalism/theft
- Pump stopped operating due to clogging.
- Over 14-month water quality monitoring, it was found that there was no reduction in phosphorus level from the nutrient stripping basin.
- Groundwater interception contributing nutrients.
- Exporting N & P into wetland but treating groundwater.

Studies revealed……

Murdoch University study confirmed that most of the phosphorus in Yangebup Lake is not present as soluble orthophosphate but as particulate phosphorous. Total phosphorus was found to be dominated by particulate phosphorus (~86%).

This makes the removal of phosphorus in a nutrient stripping basin at Yangebup Lake difficult as particulate phosphorous is not readily available for biomass uptake or chemical adsorption/precipitation.

Requires physical sedimentation.

Within this particulate phosphorus, 87% has a particle size smaller than 25 µm. This in part may explain why no significant phosphorus removal is observed in the Yangebup Lake Nutrient Stripping Basin

Future works- Stage 2

Installation of additional pumps to allow more water to be treated.

Construction of another nutrient stripping basins (Other sites may be less effected by groundwater inflow).

Optimal design for effective P removal involves slow sand filtration-vertical flow constructed wetland.

Possible harvesting of wetland vegetation to remove Nitrogen

Pilot scale trials may be required to determine appropriate grain size, depth of sand column, flow rate, etc

Long Term Outcomes

- Yangebup Lake is important fauna refuge in a drying climate - enhanced habitat values across reserve.

- Continued improvement in water quality to reduce algae & midge
- On-going monitoring to inform efficacy of different approaches to improve water quality.

- Initiative possibly used in other locations to treat water quality issues.

Thank You

adamh@cockburn.wa.gov.au