City of **Cockburn**

Yangebup Lake Nutrient Stripping Trial

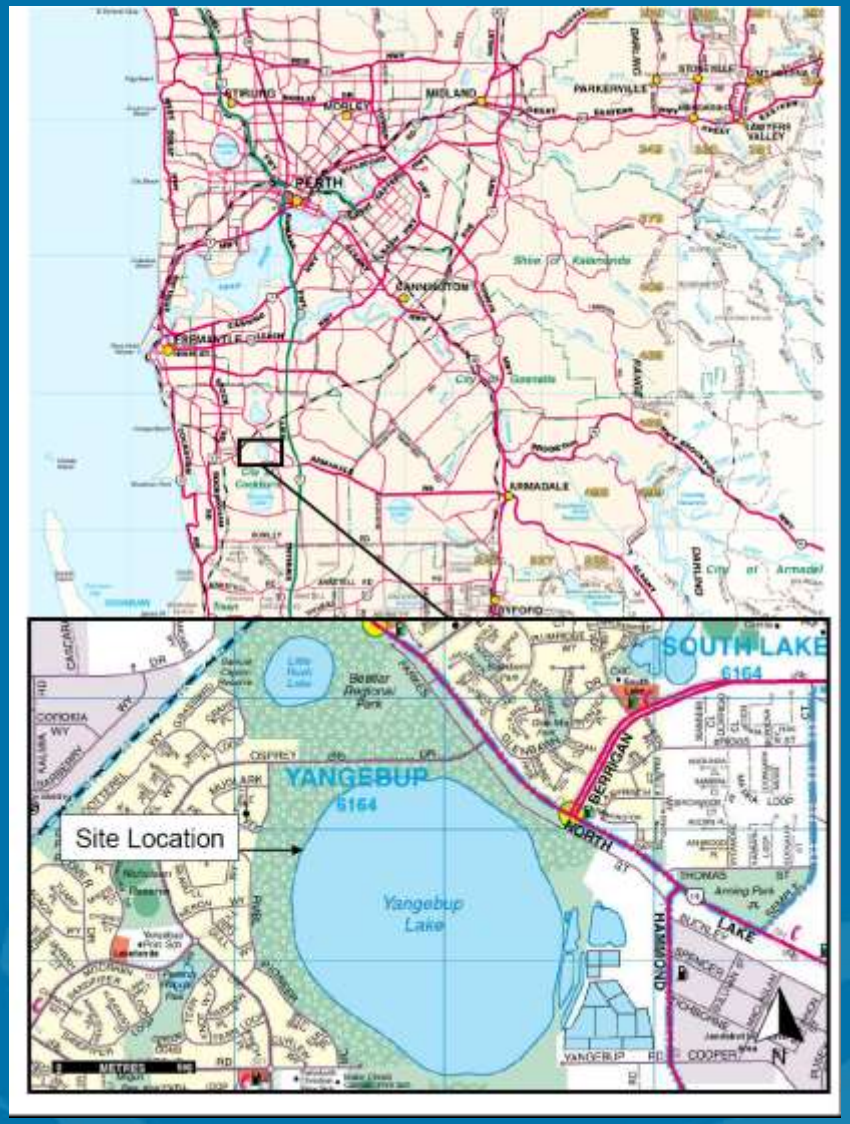
Chris Beaton & Linda Metz

Project Overview

Aim: To address excess nutrients in Yangebup Lake by using solar power to pump nutrient rich water from the lake through a treatment train then allowing the treated water to flow back into the lake.

Funding: City of Cockburn capital works program and NRM grant funding

Location - Yangebup Lake



Location - Yangebup Lake

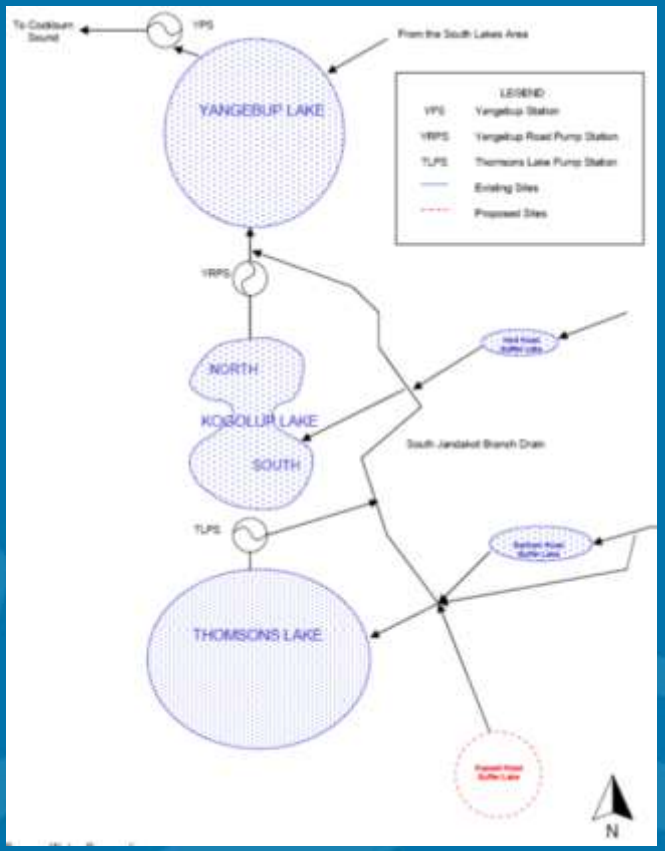
Yangebup Lake

Part of the Eastern chain of the Beeliar Wetlands

68 hectares of open water

Approx. 4 metres deep

Part of 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 Woolscourers

Water levels ranged between 13.4 metres AHD (dry) to 17.8 metres AHD

Yangebup Lake 1953

Yangebup Lake 2000

Nitrogen Balance 2003

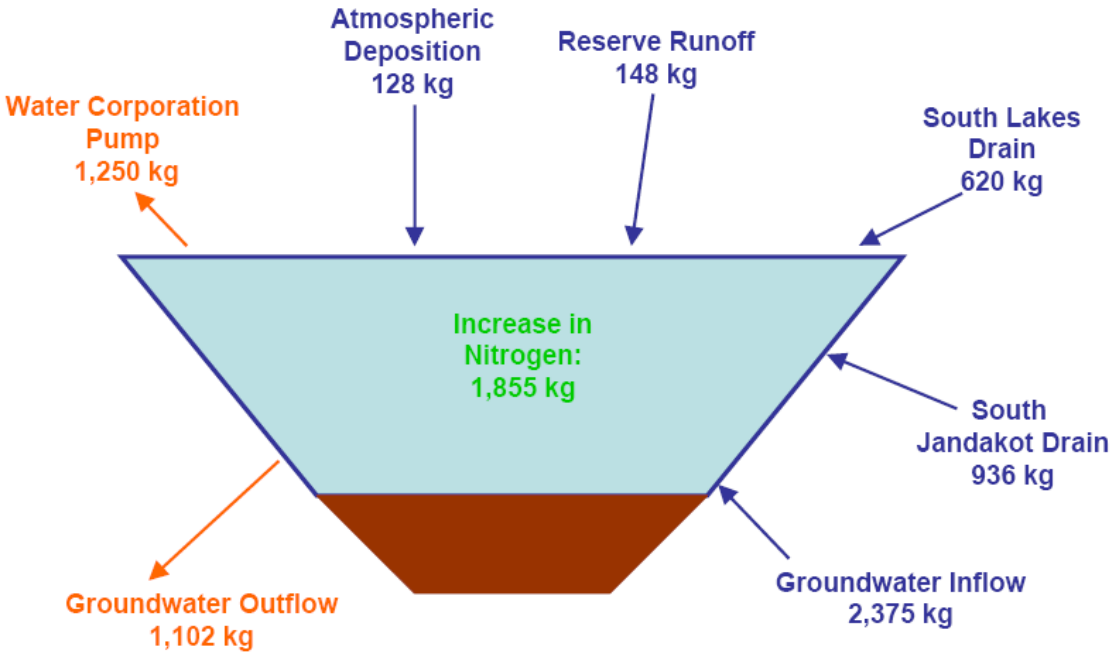


FIGURE 16: 2003 Nitrogen Balance for Yangebup Lake		
CLIENT: City of Cockburn		
DRAWN BY:	CHECKED BY: KL	JOB NUMBER: 05.150
DATE:	REPORT ISSUE:	

Phosphorus Balance 2003

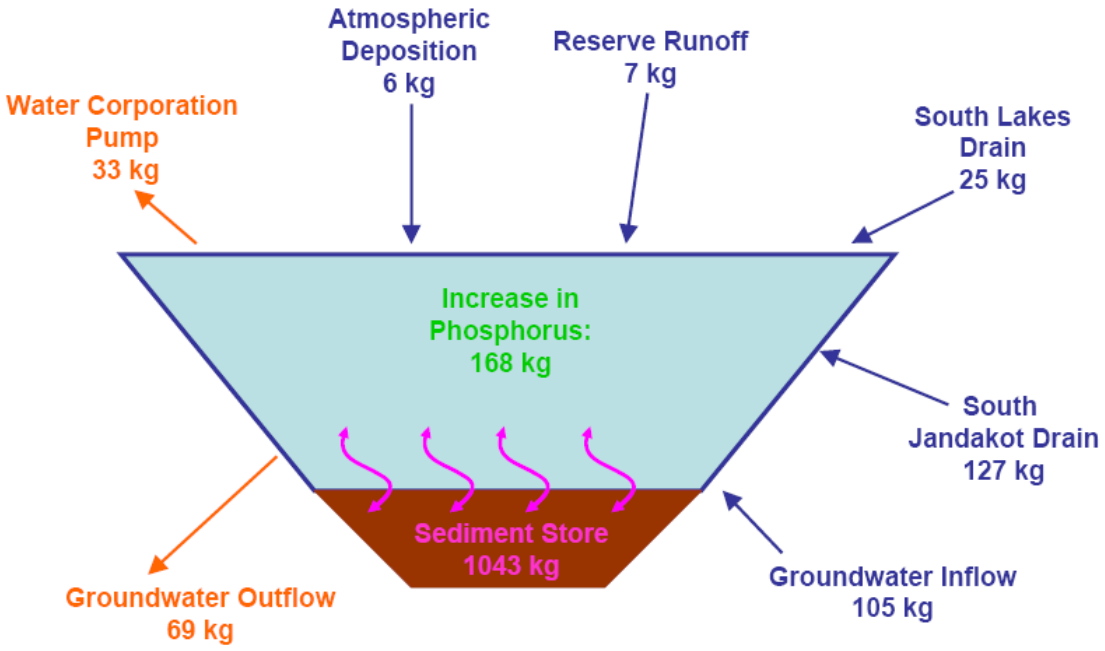


FIGURE 17: 2003 Phosphorus Balance for Yangebup Lake

CLIENT: City of Cockburn		
DRAWN BY:	CHECKED BY: KL	JOB NUMBER: 05.150
DATE:	REPORT ISSUE:	

Total P & Total N

Key to Water States	Mean TP (µg/L)	Mean TN (µg/L)
Oligotrophic	<8	<660
Mesotrophic	8-26	660-750
Eutrophic	26-84	750-1880
Hypertrophic	>84	>1880

Source Env Aust Report

Total P & Total N

Yangebup Lake				
Year	Summer Levels		Winter Levels	
	TP (µg/L)	TN (µg/L)	TP (µg/L)	TN (µg/L)
1995	249	5330	161	3257
1996	134	4096	184	4061
1997	136	4538	131	3902
1998	110	4962	79	4295
1999	116	5595	87	4527
2000	88	5062	107	4703
2001	85	4766	227	4500
2002	108	3918	479	6367
2003	140	4008	178	4640
2004	116	4100	129	4900
2005	122	5836	110	4620

Source: ENV Aust Report

Studies have revealed

Arsenic contained within sediment

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.

Management responses needed to address issues

Yangebup Lake Today

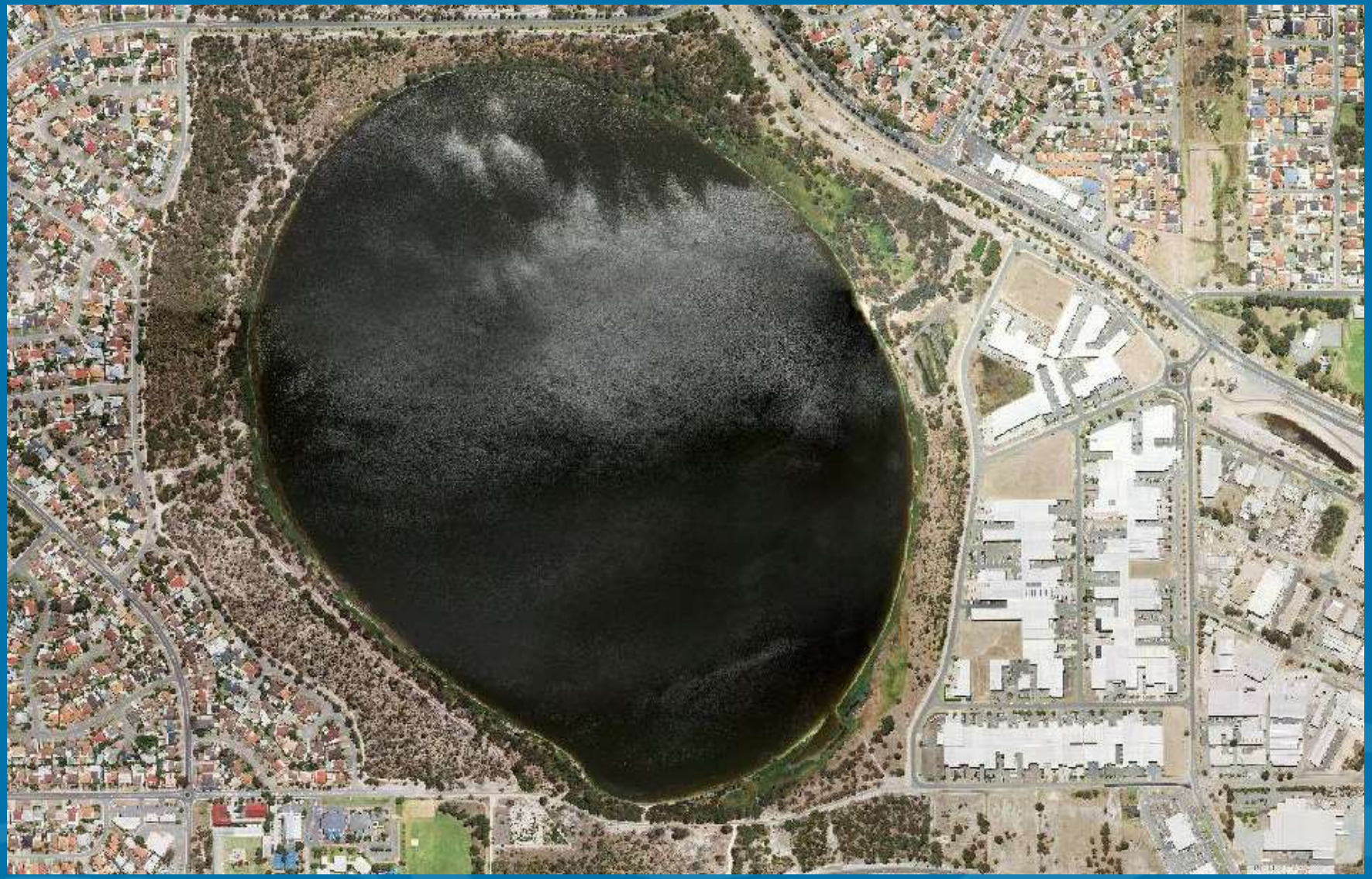
Surrounding reserve managed by City of Cockburn

Water body ~~managed~~ owned by WAPC

Degraded condition due to past development – farming, clearing, woolscourers, residential development.

Remains nutrient enriched

Yangebup Lake 2016

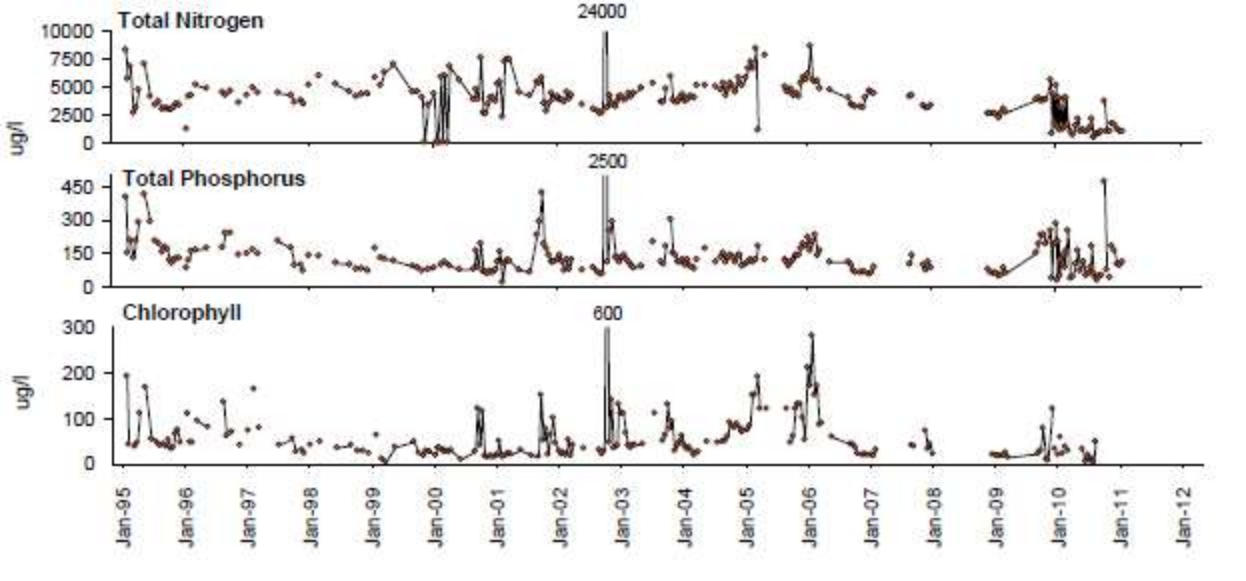


Source: COC GIS

Actions to address nutrients to date

- On-going revegetation - 20 years +.
- Conversion of 2 drains to living streams.
- Installation of GPT on South Lake Drain
- Community education on the impacts of excess nutrient use.

Progress being made



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

- Ecological Macroinvertebrate Report 2015

Nutrient Stripping Basin

In response to the still elevated nutrient levels a novel approach was developed.

Bio-rentention basins or nutrient stripping treatment trains have been used successfully elsewhere to treat storm water generally using storm water run off from storm events.

Solar powered nutrient stripping??

This basin designed in conjunction with David Wills and Associates.

Nutrient Stripping Basin

Benefits:
Additional vegetation to strip nutrients, provide shade and habitat & vegetation provides barrier for midge.

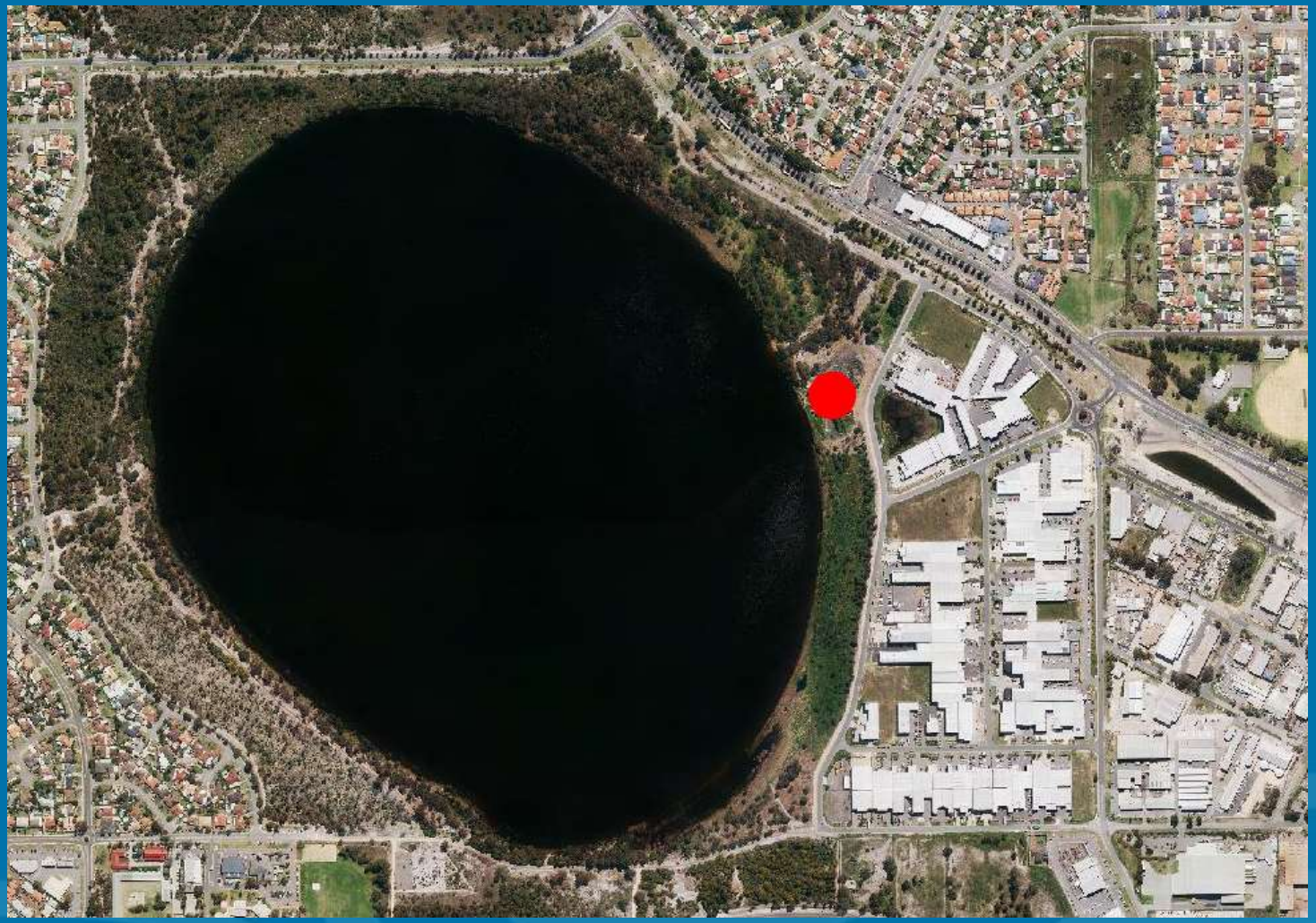
Solar pump to take water from lake minimal ongoing cost.

Nutrient Stripping Basin Pump

Submersible Pump

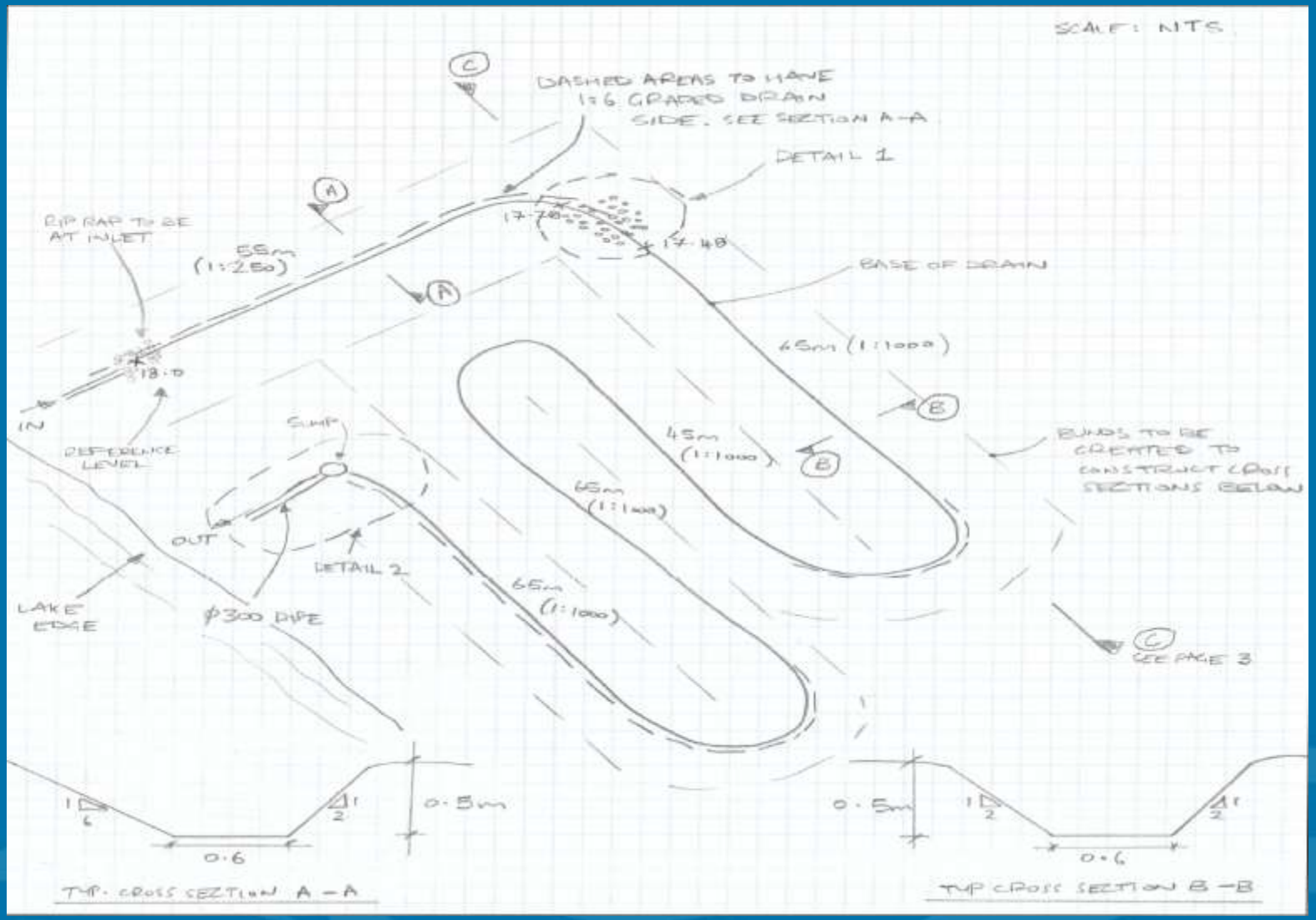
- Peak Capacity 200L/m
- 150mm pipe at inlet
- 300mm pipe at outlet into basin
- Pump located on pontoon 80m from shore

Location of Basin



Location of Basin

Design (David Wills and Assoc.)



Works commence

Site prior to works

Works underway

Works underway

Excavation

Riffles

Works underway

Outlet grate

Inlet from lake

Outlet from grate to lake

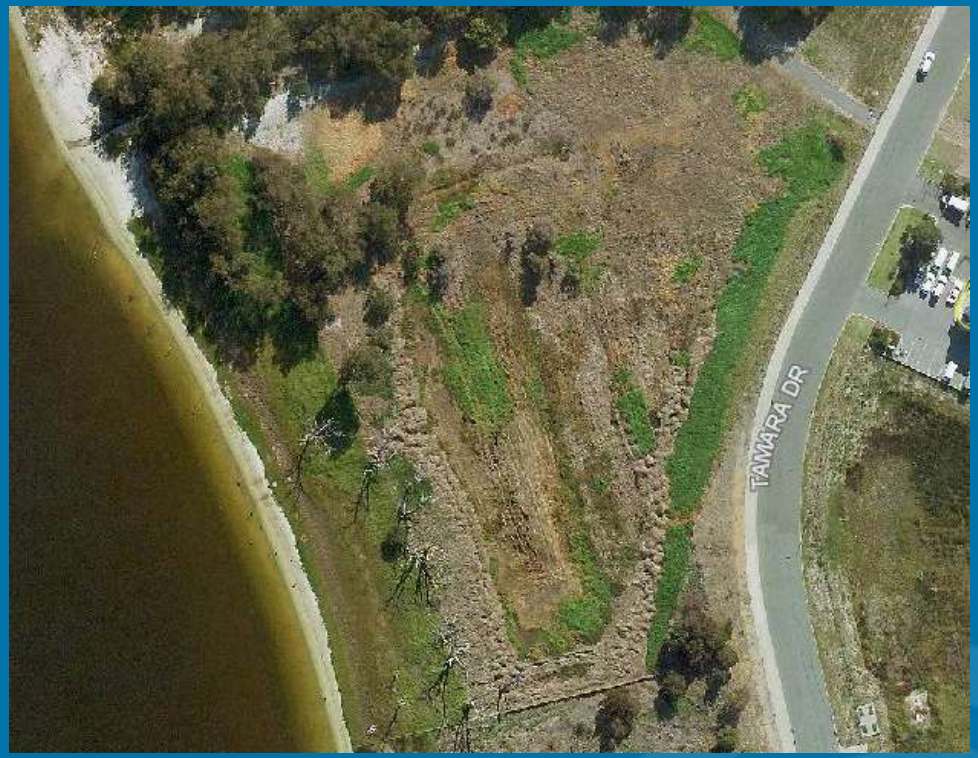
Works underway

Planting

Making progress

End point

Before and After Aerial



May 2015

July 2015

Nutrient Stripping Construction

Works undertaken:

- Autumn Macroinvertebrate sampling and water quality analysis
- Weed control to remove Kikuyu
- Excavation of site -10,000 cubic metres of soil 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

Problems Encountered to Date

Problems:

- Very Strong Growth (including weeds) - Nutrients possibly in soil or groundwater.
- Floating pump – moving closer to shore due to wind and wave action.
- Pipes floating and visible – potential for vandalism
- Pump stopped pumping due to clogging.

Problems Encountered to Date

Problems continued:

Results of water quality parameters vary considerably

Groundwater inflow – possibly impacting basin.

Good but bad.

Overall cost to date: $150,000

Problems Encountered to Date

SAMPLE CODE	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
File		16010601	16010601	16010601		16011101,1202		16011302		16010601
Inflow	6/01/2016	9.2	6.6	5	160	3	5	99	3100	208
Outflow	6/01/2016	7.9	12.7	12	690	4	29	120	3900	230
Inflow	20/01/2016	8.3	6.2	72	690	2	110	400	5400	231
Outflow		8.0	7.5	16	380	3	14	58	3300	226
inflow	03.02.16	9.2	7.4	2	48	4	6	68	2500	228
outflow		8.3	5.6	16	8	<2	23	170	3300	232
inflow	17/02/2016	8.3	5.0	<2	59	11	<2	140	2900	238
outflow	18/02/2016	8.3	6.6	<2	8	<2	3	80	2600	230
Inflow	2/03/2016	9.0	5.1	<2	6	<2	2	110	2600	236
Outflow	2/03/2016	8.2	6.3	<2	6	<2	3	230	3500	238
Inflow	11/03/2016	8.9	4.9	<2	6	<2	<2	53	2400	244
Outflow	11/03/2016	8.6	7.4	<2	7	3	<2	530	6800	268
Inflow	30/03/2016	8.8	4.8	<2	5	<2	<2	53	2600	256
Outflow	30/03/2016	8.1	6.5	<2	38	3	2	76	2800	260
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

Future

Ongoing monitoring and maintenance:

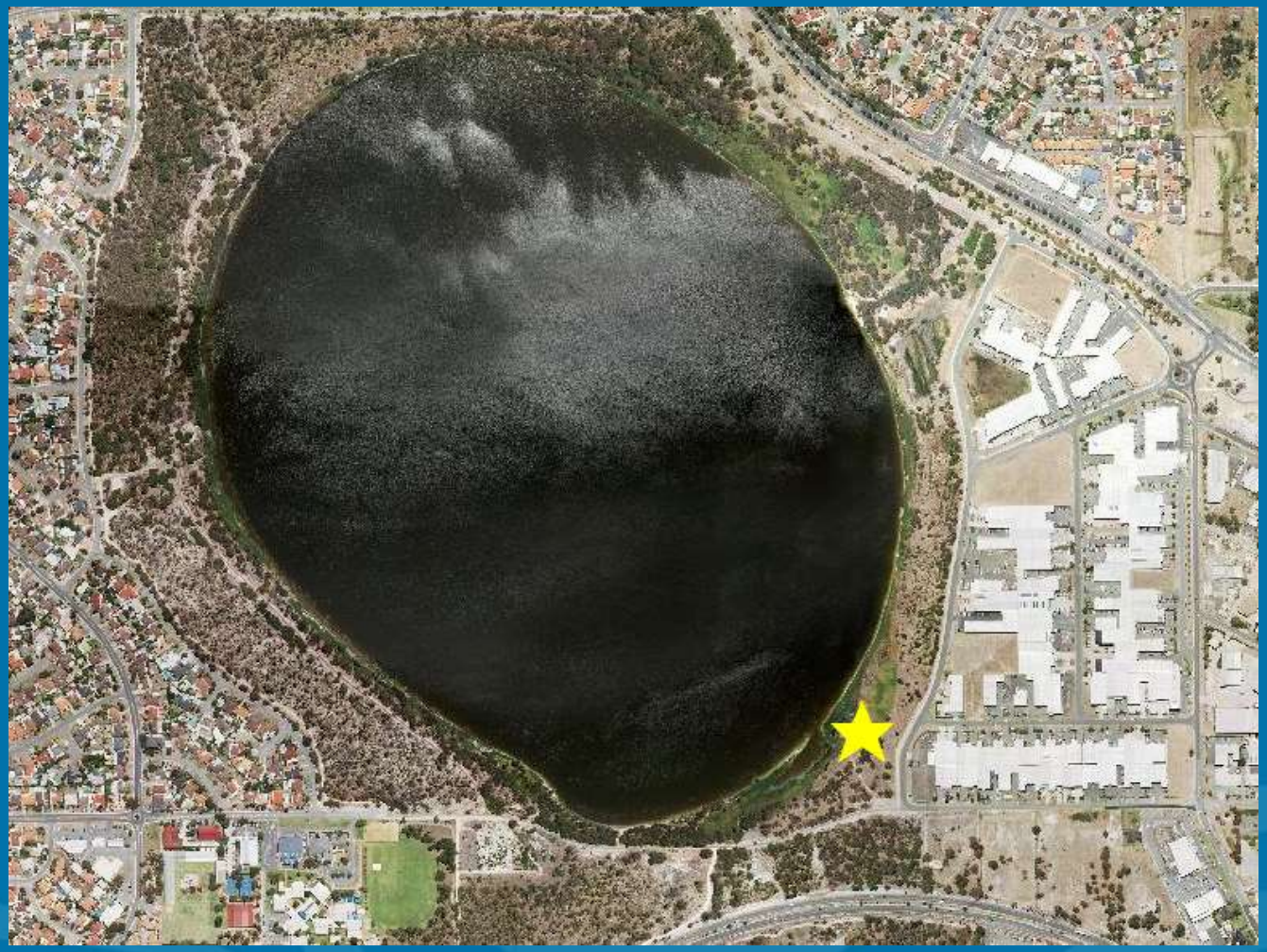
- Continued water quality monitoring
- A further macroinvertebrate survey and report in spring and annually thereafter.
- Ongoing weed control & maintenance
- Infill planting where necessary
- Possibly harvesting of sedges

Future works

Future works:

- Possibly intercept and divert ground water.
- Installation of additional pumps to allow more water to be treated.
- Construction of another nutrient stripping basins on other side of lake (Other sites may be less effected by groundwater inflow).

Next site



Long Term Outcomes

- Yangebup Lake is important fauna refuge in a drying climate - enhanced habitat values across reserve.
- Focus on continued improvement in water quality to reduce algae & midge
- Initiative possibly used in other locations to treat water quality issues.

Progress

September 2015

December 2015

February 2016

May 2016

Progress

September 2015

December 2015

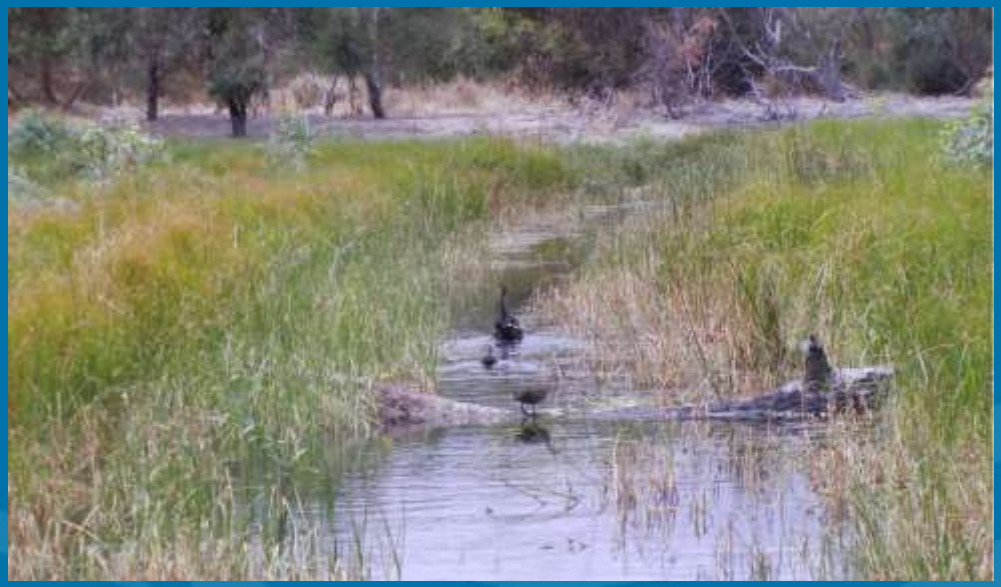
February 2016

May 2016

Progress

September 2015

December 2015



February 2016

Solar array

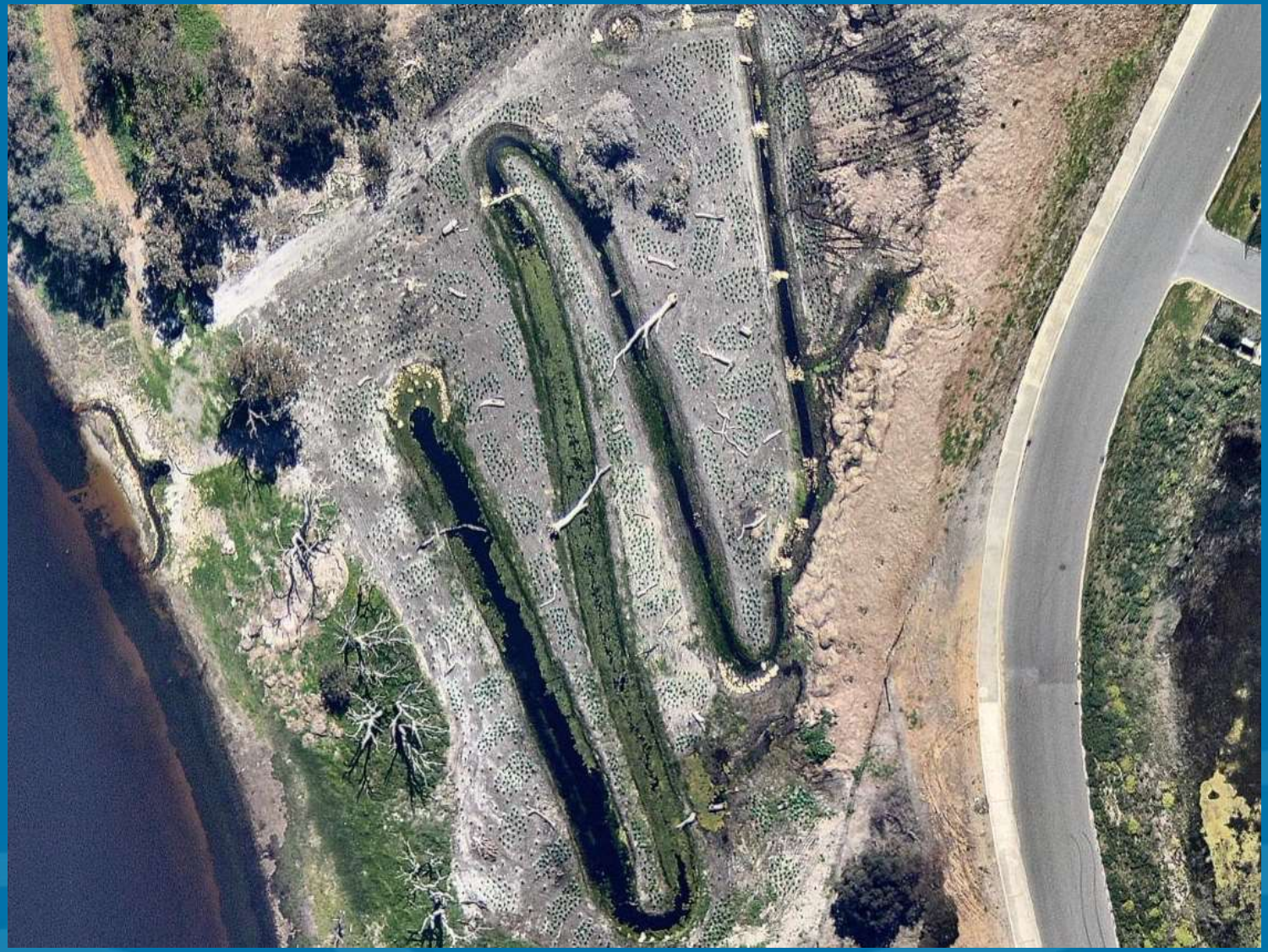
Water Flowing into Lake Dec 2015

Water Flowing into Lake Feb 2016

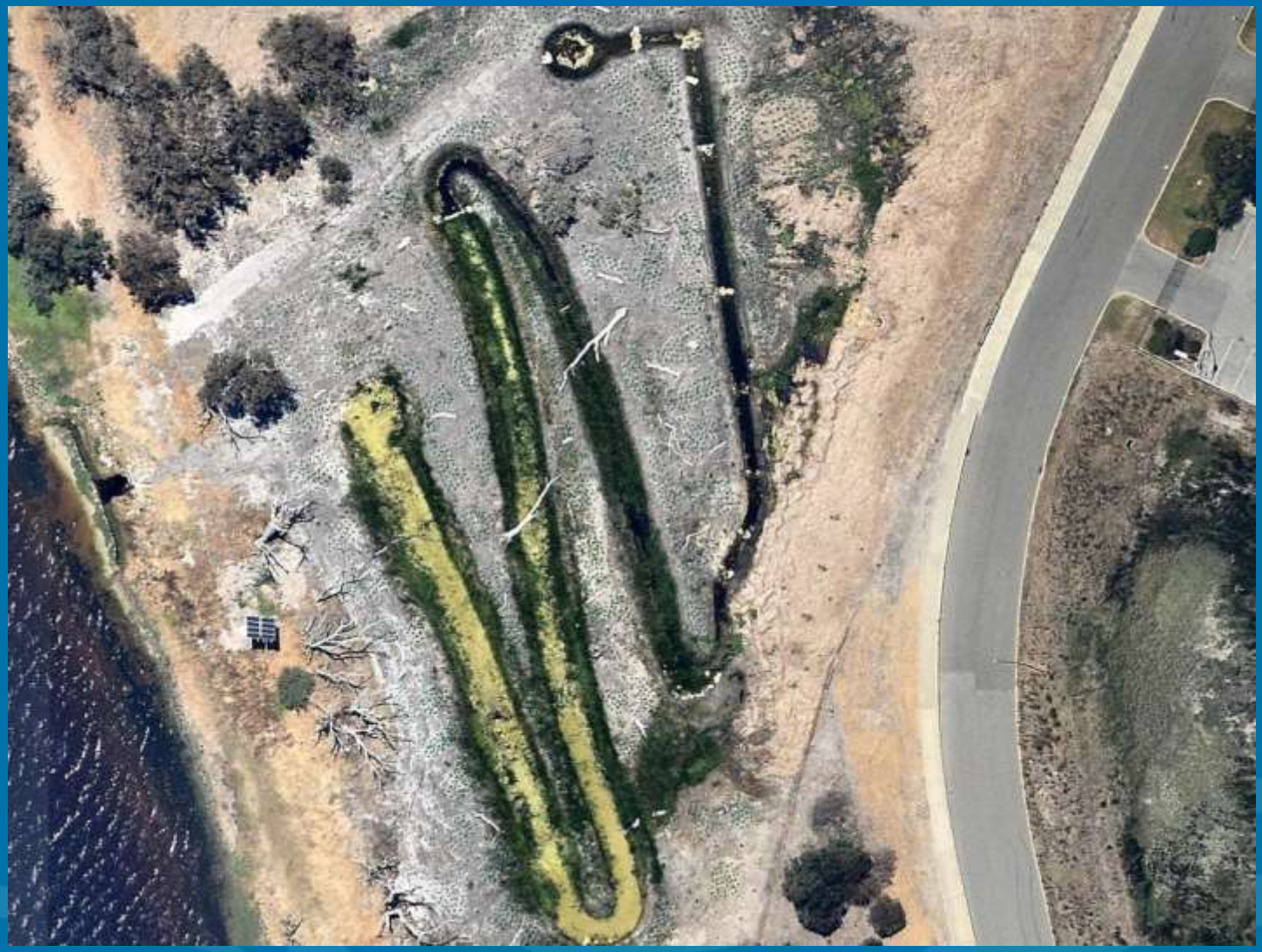
Water Flowing into Lake May 2016

July 2015

September 2015



November 2015



January 2016

May 2016

Progress

Entry to basin June 2015

Entry to basin Jan 2016

Entry to basin May 2016

Thank You