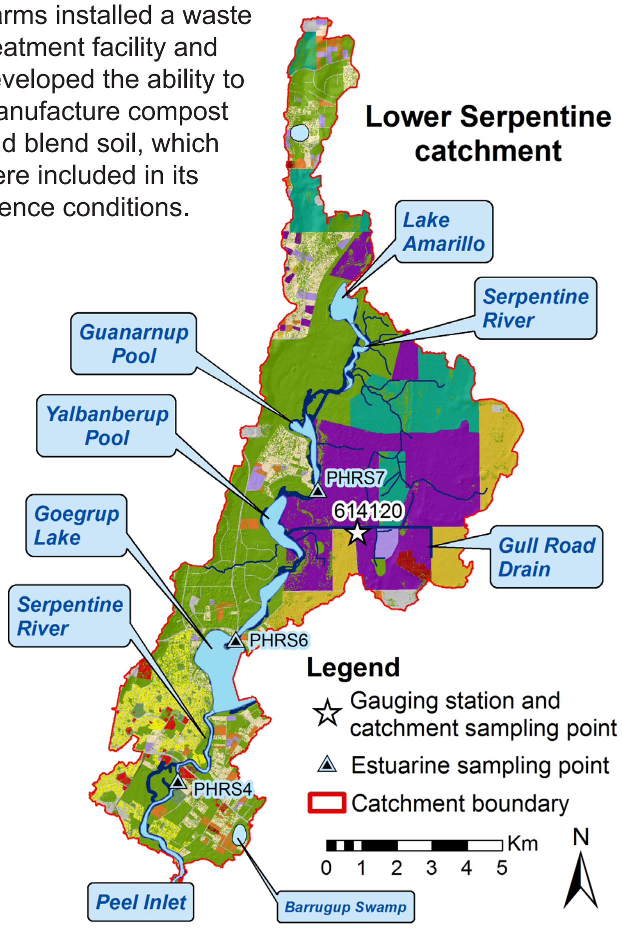
Lower Serpentine River - Gull Road Drain

The lower Serpentine catchment drains to the Serpentine River and lakes between Lake Amarillo and the Peel Inlet.

The lower Serpentine River is tidal so it was not monitored as part of the catchment program. Water quality was monitored at a sampling point in Gull Road Drain (614120), which flows from the east to Yalbanberup Pool. Flow was measured at the Gull Road Drain gauging station between March 2005 and April 2008. The drain stops flowing between December and May in most years.

This site's nutrient concentrations have been of concern for many years and are attributed to Wandalup Farms' (piggery) treatment ponds overflow in the past. In December 2003, in an effort to reduce the impact of the the piggery on the receiving environment Wandalup Farms installed a waste treatment facility and developed the ability to manufacture compost and blend soil, which were included in its licence conditions.



Most of the lower Serpentine catchment is situated on dunes with leached sands and nearly 90% of the catchment has a moderate to very high risk of phosphorus leaching to waterways.

West of the Serpentine River and south of Goegrup Lake, much of the catchment has been urbanised, yet large areas of natural vegetation remain. To the river's east, north of Goegrup Lake, the land has been cleared – mostly for agriculture such as stock grazing, plantations and horticulture. Most of this area is subject to inundation (67%).

Between 2003 and 2006 the area used for 'horticulture' reduced by two-thirds, while land dedicated to 'plantations' nearly doubled. The lower Serpentine catchment is one of the smallest subcatchments in the Peel-Harvey catchment, but in 2006 it had the largest area and percentage area dedicated to 'mixed grazing'.

Land use classification (2006)[1]		Area	
		(km^2)	(%)
Animal keeping – non-farming (horses)		1.8	1.9
Cattle for beef (predominantly)		6.1	6.5
Conservation and natural		42	44
Horticulture		1.7	1.8
Industry, manufacturing and transport		4.8	5.1
Intensive animal use		0.52	0.55
Lifestyle block		5.6	5.9
Mixed grazing		18	19
Offices, commercial and education		0.66	0.70
Plantation		9.5	10
Recreation		0.44	0.46
Residential		3.6	3.8
Viticulture		0.01	0.01
Total		**94**	**100**

In 2014 Gull Road Drain had the highest median TN and TP concentrations of the 13 sites sampled in the Peel-Harvey catchment.

It was also the only site to have a decreasing TP trend (2010–14).

Nutrient summary: median concentrations, loads and status classification at 614120

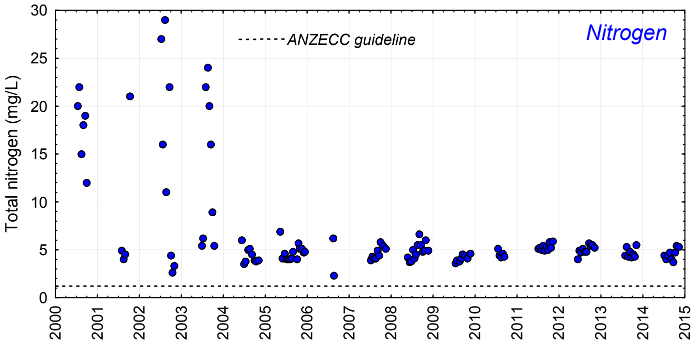
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Annual flow (GL)	-	-	-	-	0.87*	0.03	0.31	-	-	-	-	-	-	-
TN median (mg/L)	4.7	14	12	3.9	4.7	4.3	4.4	4.9	4.1	4.4	5.2	5.0	4.5	4.4
TP median (mg/L)	1.6	3.4	4.4	2.3	2.1	4.8	1.6	1.5	1.1	1.3	1.4	1.1	0.77	0.93
TN load (t/yr)	-	-	-	-	4.1*	0.15	1.4	-	-	-	-	-	-	-
TP load (t/yr)	-	-	-	-	2.0*	0.07	0.64	-	-	-	-	-	-	-

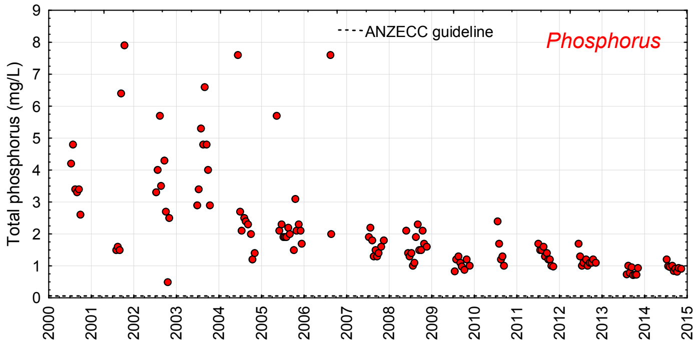
Status classification[2] Low Moderate High Very high

Status reported for three-year period end (i.e. 2012–14 reported in 2014)
TN = total nitrogen TP = total phosphorus

* Best estimate using available data
(- not applicable)

Total nitrogen (TN) and total phosphorus (TP) concentrations (2010–14) at 614120





TN concentration:

Between 2001 and 2014 all TN concentrations exceeded the ANZECC[3] guideline for lowland rivers (1.2 mg/L) and 47% of samples also exceeded 4.8 mg/L, four times the guideline.

After 2003 nitrogen concentrations reduced – reflecting the end of surface water discharge from Wandalup Farms.

Despite this, the percentage of samples exceeding 4.8 mg/L increased from 35% (2005–09) to 51% (2010–14).

TN trend:

Trend analysis[2] used data from 2010 to 2014 inclusive.

No trend was detected.

TP concentration:

Between 2001 and 2014, all TP samples exceeded the ANZECC[3] guideline for lowland rivers (0.065 mg/L) and 59% of samples also exceeded 1.3 mg/L, 20 times the guideline.

The percentage of samples that exceeded 1.3 mg/L decreased from 72% (2005–09) to 21% (2010–14). Despite this all samples (except one in 2002) still exceeded 0.65 mg/L (10 times the ANZECC[3] guideline).

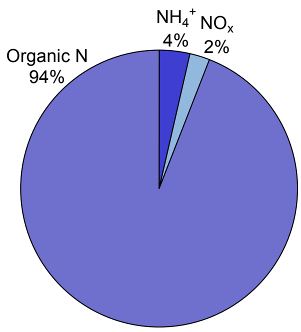
TP trend:

Trend analysis[2] used data from 2010 to 2014 inclusive.

A decreasing trend (0.17 mg/L/year) was detected.

Before construction of the weir on Gull Road Drain (downstream view February 2005)

Nutrient fractions (2010–14) at 614120



Nitrogen:

Most of the nitrogen (N) present was organic in nature. Organic N consists of both dissolved organic and particulate N. It is derived from degrading plant and animal matter and fertilisers. It often needs to be further broken down before it can be used by plants and algae.

The remaining N was dissolved inorganic N (DIN) such as ammonium (NH_4^+) and N oxides (NO_x).

DIN is also derived from animal wastes and fertilisers but is readily available to plants and algae.

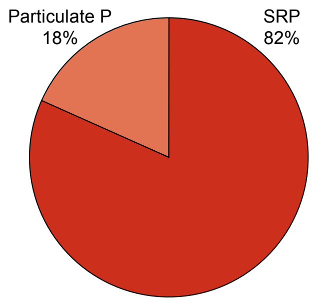
Gull Road Drain had the highest percentage of organic N of the routine sites sampled in the Peel-Harvey catchment. This was likely due to animal-dominated land use adjacent to Gull Road Drain (mixed grazing, piggery and cattle).

Upstream view of Gull Road Drain – June 2005

Phosphorus:

Most of the phosphorus (P) was present as soluble reactive phosphorus (SRP). SRP is derived from fertilisers and animal wastes and is readily available for uptake by plants and algae.

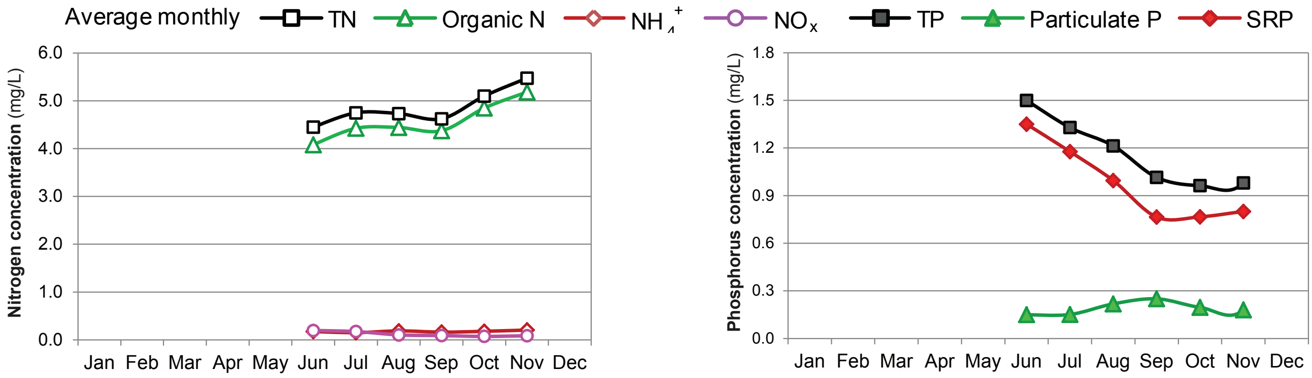
The remaining P was present as particulate P, which consists of sediment-bound forms of P and organic waste materials.



Particulate P is not readily available for uptake by plants and algae, but may become available over time as organic matter decomposes or soil particles release bound P.

Gull Road Drain had the highest percentage of SRP of the sites sampled in the Peel-Harvey catchment. All other sites had 60% or less SRP.

Seasonal variations in nutrient concentrations (2010–14) at 614120



Nitrogen:

Average monthly TN and organic N concentrations increased during the flow period between June and November.

Average monthly NH_4^+ and NO_x concentrations remained fairly constant, with NO_x highest in June when the drain started flowing and NH_4^+ highest in November.

All average monthly concentrations of TN and NH_4^+ exceeded ANZECC[3] guideline values while average monthly NO_x only exceeded guidelines in June and July.

	ANZECC 2000[3]	Months exceeded
TN	1.2 mg/L	All*
NH_4^+	0.08 mg/L	All*
NO_x	0.15 mg/L	Jun–Jul
TP	0.065 mg/L	All*
SRP	0.04 mg/L	All*

*Except Jan–May and Dec as no data. (June had fewer than three samples)

Phosphorus:

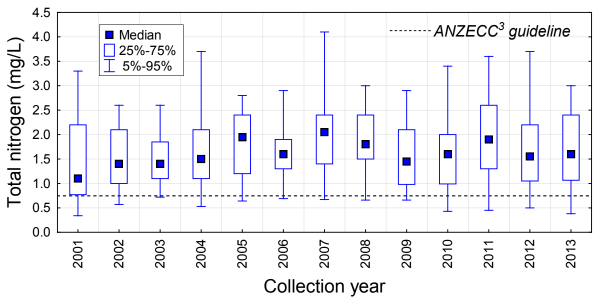
Average monthly TP concentrations were greatest at the start of the flow period.

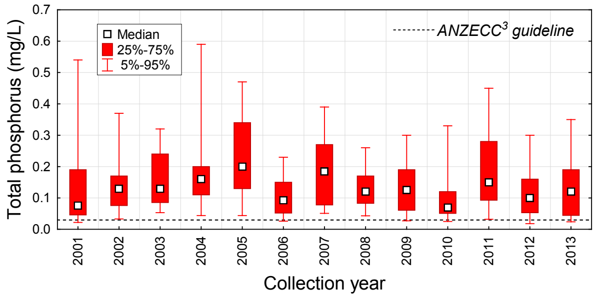
SRP concentrations were much higher than particulate P for most of the year and greatest in June during the first flush. Concentrations decreased until September and then increased slightly before flow ceased in December.

Particulate P increased over winter then decreased slightly before the drain stopped flowing in December. All average monthly TP and SRP concentrations exceeded ANZECC[3] guideline values.

Serpentine River – estuarine water quality

Water quality along the Serpentine River's tidal section was monitored at three sites between 2001 and August 2013. Annual median TN and TP concentrations within the tidal river exceeded ANZECC[3] guidelines for estuarine waters (TN = 0.75 mg/L and TP = 0.03 mg/L).





Most of the nitrogen present was organic, with DIN concentrations increasing during winter. Phosphorus was present mostly as particulate P, with peak concentrations during March and August. SRP concentrations increased substantially in winter.

Fish deaths

Ten instances of dead fish in the lower Serpentine River were reported between 2001 and 2014. Most of the deaths occurred in either February or March (2003, 2004, 2005, 2008, 2012 and 2013). Two were located in Goegrup Lake (December 2006 and November 2008). Most of the incidents were attributed to deoxygenation caused by the collapse and decomposition of algal blooms.

In addition to fish deaths in the Serpentine River, in March 2010 approximately 750 gobies died in Barrugup Swamp located in the south of the catchment. In 2014 between 800 and 1000 mullet died in Black Lake (in the Nambeelup catchment) which feeds into Goegrup Lake and hence the Serpentine River.

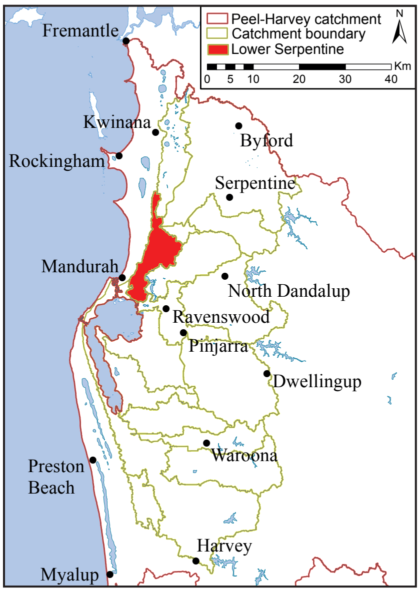
Lyngbya

The toxic blue-green macro-algae Lyngbya bloomed in the Peel-Harvey estuary in 2000 and 2001 and has established itself in the lower Serpentine River. In November 2006 a toxic Lyngbya bloom covered 5 km of the Serpentine River and by the following month covered two-thirds of Goegrup Lake.

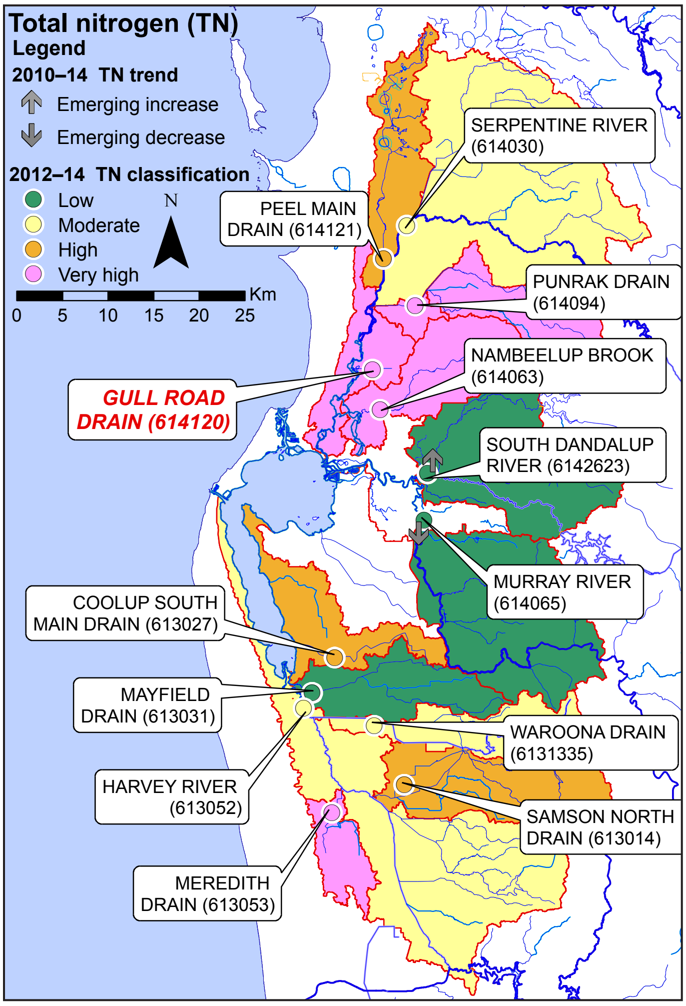
Lyngbya: Serpentine River – November 2006

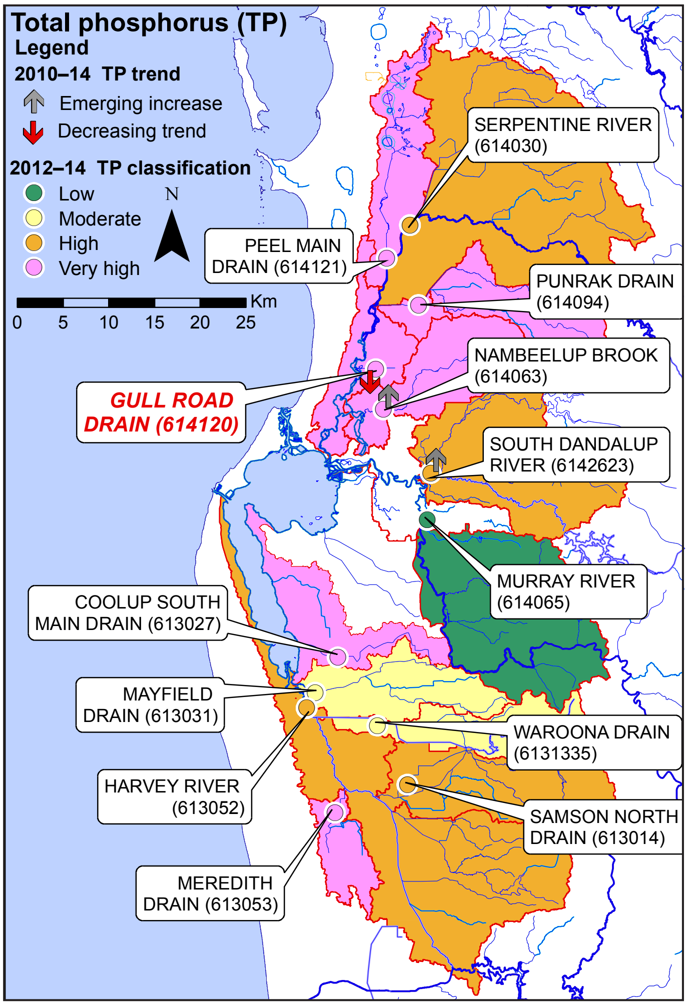
Lyngbya: Goegrup Lake – November 2006

How the lower Serpentine fits within the Peel-Harvey catchment: location and statistics



Catchment	Receiving waterbody	Sample site (AWRC)	Area (km²)	2014 Flow (GL)	2014 TN median (mg/L)	2014 TP median (mg/L)
Peel Main Drain	Serpentine River	614121	120	5.0	1.7	0.19
Upper Serpentine River	Serpentine River	614030	502	28	0.79	0.13
Dirk Brook – Punrak Drain	Serpentine River	614094	134	9.6	1.9	0.21
Nambeelup Brook	Serpentine River	614063	143	9.7	3.7	0.60
Lower Serpentine River - Gull Road Drain	**Peel Inlet**	**614120**	**94**	**-**	**4.4**	**0.93**
South Dandalup River	Murray River	6142623	243	-	1.1	0.11
Mid Murray River	Murray River	614065	293	153	0.57	0.01
Coolup South Main Drain	Harvey Estuary	613027	113	2.1	2.1	0.31
Mayfield Drain	Harvey Estuary	613031	119	15	0.73	0.03
Harvey River	Harvey Estuary	613052	408	98	1.4	0.15
Drakes Brook – Waroona Drain	Harvey River	6131335	107	-	0.99	0.07
Samson North Drain	Harvey River	613014	195	-	1.5	0.18
Meredith Drain	Harvey River	613053	56	-	2.8	0.38





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[1] Kelsey, P, Hall, J, Kretschmer, P, Quinton, B & Shakya, D 2010, *Hydrological and nutrient modelling of the Peel-Harvey catchment*, Water Science Technical Series, Report no. 33, Department of Water, Western Australia.

[2] Department of Water 2015, *Catchment nutrient reports* (methods for the analysis of status classification, loads and trends), <http://www.water.wa.gov.au/water-topics/waterways/assessing-waterway-health/catchment-nutrient-reports>.

[3] ANZECC & ARMCANZ 2000, *Australian guidelines for water quality monitoring and reporting,* National Water Quality Management Strategy, Paper no. 7, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

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