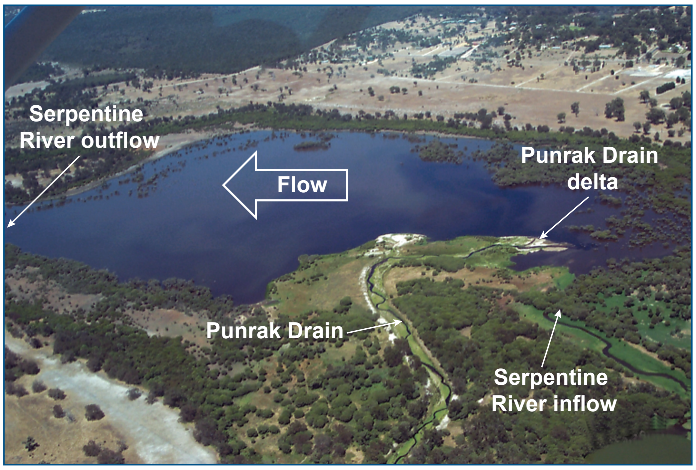
Dirk Brook – Punrak Drain

Dirk Brook begins on the Darling Plateau, before flowing onto the Swan Coastal Plain, where it is joined by Myara Brook. To the north, Karnet Brook also flows from the plateau, becoming Karnet Drain before its confluence with Dirk Brook. It is at this point the modified drainage system is re-named Punrak Drain.

Punrak Drain flows into Lake Amarillo, one of the Serpentine Lakes. It is responsible for contributing large amounts of nutrients, especially nitrogen, to the Serpentine River and Lakes and depositing sediment at the drain's outflow – widening the delta.



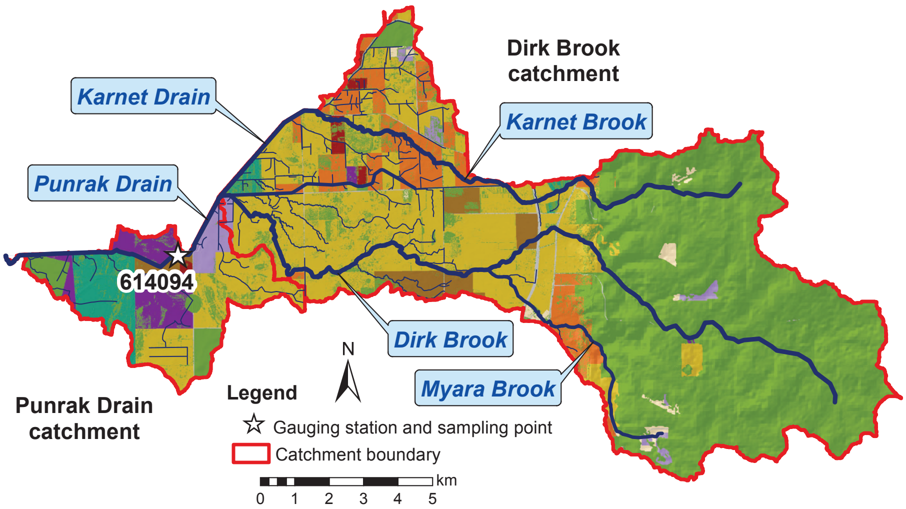
Punrak Drain flows year-round during wet years but ceases to flow from around December to May in dry years. Much of the Punrak Drain catchment is subject to seasonal inundation (52%).

To the east of the Darling Scarp the catchment remains relatively undisturbed. To the west, the land has been cleared, mostly for agriculture (e.g. stock grazing), as well as more intensive land uses (e.g. piggeries and turf farms). The soils in the greater catchment vary, however the Punrak Drain catchment consists entirely of sandy and clayey swamps and leached sands and has a high or very high risk of phosphorus leaching to waterways.

Land use classification (2006)		Area (km^2)	Area (%)
Animal keeping – non-farming (horses)		8.9	6.6
Cattle for beef (predominantly)		37	28
Cattle for dairy		3.5	2.6
Conservation and natural		70	53
Horticulture		2.4	1.8
Industry, manufacturing and transport		1.3	1.0
Intensive animal use		0.87	0.65
Lifestyle block		1.0	0.75
Mixed grazing		4.1	3.1
Plantation		3.9	2.9
Residential		<0.01	<0.01
Total		**134**	**100**

Since 2006, water quality has been monitored near the bottom of the catchment at the gauging station at Yangedi Swamp (614094). Before this, samples were collected approximately 600 m upstream near the Punrak Road Bridge.

Flow has been measured at the gauging station since 1995. Initially this was undertaken by the Water Corporation however in 2005 the Department of Water assumed responsibility. There was a period of approximately two years when flow was not measured (2004 to 2005).



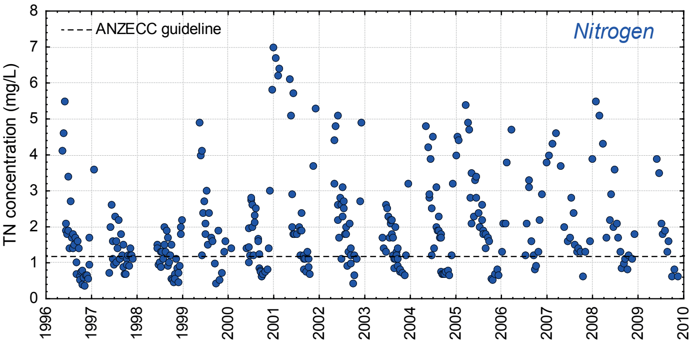
Nutrient summary: median concentrations, loads and status classification at 614094

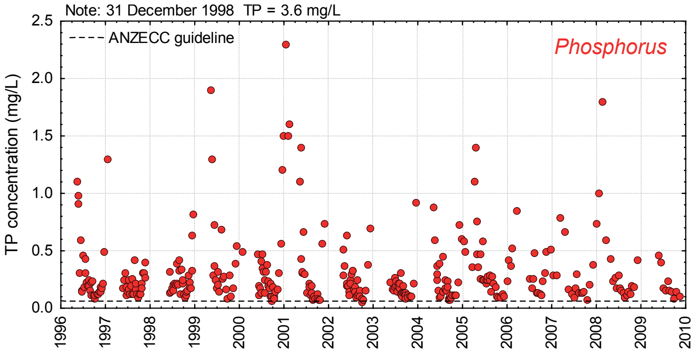
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Annual flow (GL)	28	16	15	23	21	4.3	15	42			4.1*	15	15	18
TN median (mg/L)	1.4	1.2	1.1	1.75	1.4	1.9	2.1	1.4	1.9	2.2	2.1	1.7	2.0	1.7
TP median (mg/L)	0.19	0.19	0.21	0.29	0.19	0.20	0.19	0.15	0.17	0.26	0.26	0.17	0.23	0.15
TN load (t/year)	57	31	28	46	43	7.3	29	88			10*	35	30	40
TP load (t/year)	7.1	3.8	3.5	5.8	5.5	0.88	3.4	11			1.3*	3.7	3.6	4.6

Status classification: Low, Moderate, High, Very high

Status reported for three-year period end (i.e. 1996–98 reported in 1998) TN = total nitrogen TP = total phosphorus * best estimate using available data

Total nitrogen (TN) and total phosphorus (TP) concentrations (1996–2009)





TN concentration:

The annual percentage of TN samples that exceeded the ANZECC[1] guideline for lowland rivers (1.2 mg/L) ranged between 39% (1997) and 94% (2007).

Between 1996 and 2004, 58% of samples exceeded the guideline. This value increased to 79% for the period between 2005 and 2009.

TN trend:

Trend analysis was undertaken using data from 2005 to 2009 inclusive.

Once the data were adjusted for flow and seasonality, an emerging increasing trend (0.28 mg/L/year) was detected.

TP concentration:

Between 1996 and 2009, all but one sample (2002) exceeded the ANZECC[1] guideline for lowland rivers (0.065 mg/L).

Also 9% of TP samples exceeded 0.65 mg/L, 10 times the guideline. With the exception of 2009 each year had at least one sample greater than 0.65 mg/L.

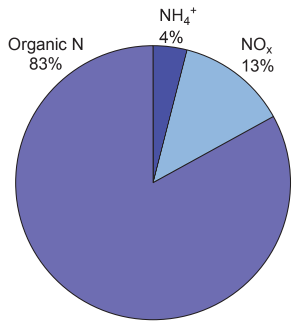
The annual percentage of samples that exceeded 0.65 mg/L ranged between 3% in 2000, 2002 and 2003 to 29% in 2001.

TP trend:

Trend analysis was undertaken using data from 2005 to 2009 inclusive.

Once the data were adjusted for flow and seasonality, an emerging increasing trend (0.052 mg/L/year) was detected.

Nutrient fractions (2005–09)



Nitrogen:

Most of the nitrogen (N) was organic in nature. Organic N consists of both dissolved organic and particulate nitrogen. 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).

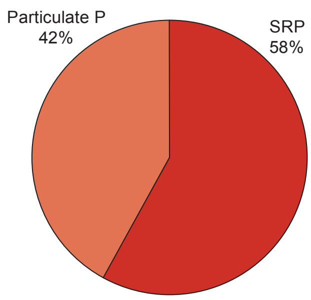
DIN is also derived from animal wastes and fertilisers but is readily available to plants and algae.

Of the five catchments that drain into the Serpentine River, Dirk Brook – Punrak Drain had the highest proportion of DIN (17%).

Phosphorus:

Over half 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.

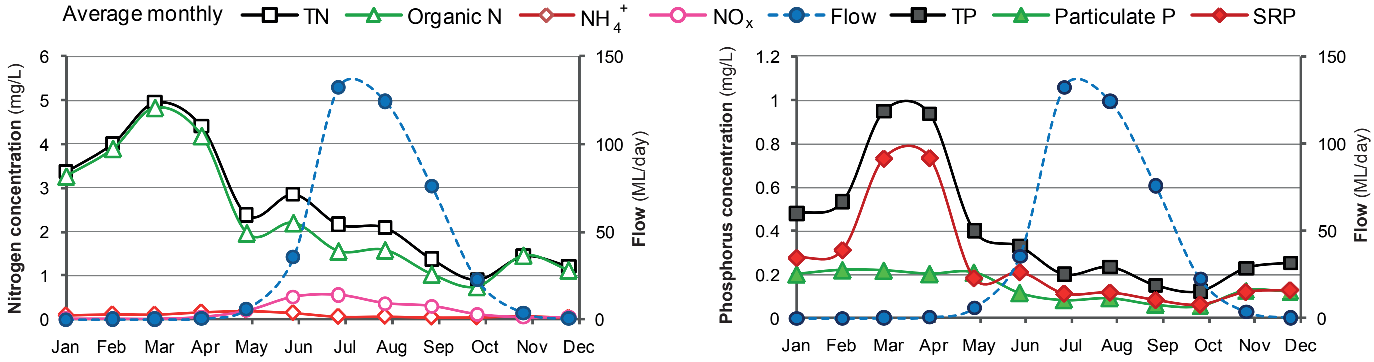


Particulate P is not readily available for uptake by plants and algae, but may become available over time as particles decompose or release bound phosphate.

Dirk Brook – Punrak Drain was one of four sites within the Peel-Harvey catchment that had more than half of the phosphorus present as SRP. Of the four, two others flow to the Serpentine River (Gull Road and Nambeelup Brook) while Meredith Drain flows to the Harvey River at the south of the Peel-Harvey catchment.

Punrak Drain, downstream of 614094 – May 2008

Seasonal variation in nutrient concentrations and riverine flow (2005–09)



Nitrogen:

TN and organic N concentrations were greatest during low flows. The high concentrations during the summer were possibly caused by decaying plant matter, or from nutrient-rich groundwater seepage.

Increased winter flows diluted the organic N however average monthly NO_x concentrations increased, possibly due to excess fertilisers and animal wastes being flushed into the system.

Average monthly concentrations of TN exceeded ANZECC[1] guidelines throughout the year (with the exception of October).

ANZECC[1] guideline concentrations were also exceeded in summer by average monthly NH_4^+ concentrations and in winter by average NO_x concentrations.

Phosphorus:

TP concentrations were greatest between January and April when flow was at its lowest.

Average monthly SRP concentrations were greater than particulate P concentrations with the exception of May and November. During March and April SRP was elevated, possibly due to nutrient-rich groundwater seepage.

All average monthly TP and SRP concentrations exceeded ANZECC[1] guideline values.

	ANZECC 2000[1]	Months exceeded
TN	1.2 mg/L	Nov – Sept
NH_4^+	0.08 mg/L	Jan – Jun, Nov
NO_x	0.15 mg/L	May – Sept
TP	0.065 mg/L	All
SRP	0.04 mg/L	All

Catchment remediation[2]

Many nutrient reduction measures have been undertaken in the Dirk Brook catchment. In 2001 an artificial wetland was constructed and riffles and meanders were also installed in waterways. Revegetation and stock exclusion took place during subsequent years. The aim was to reduce nutrient concentrations and sediment loads, while enhancing the system's ecological values by slowing the flows, increasing oxygen concentrations and providing habitat.

The effect of individual interventions on nutrient concentrations could not be assessed due to insufficient data. Similarly, ecological monitoring was not undertaken after these activities so their effectiveness in improving stream health could not be determined.

No improvement in nutrient concentrations at the bottom of the catchment was observed. This is not surprising given the extent of the remediation works in contrast to the size of the entire catchment, as well as land use intensification.

Artificial wetland entrance – 2001
Punrak Drain, upstream of 614094

Meander and riffle – 2001
Un-named drain, north of Karnet Brook

Plant growth

In recent years Punrak Drain has become choked with grass and weeds despite ongoing efforts to remove them.

Clear – December 2005
Punrak Drain, 614094

Choked – January 2010

Fish deaths

In February 2002 approximately 100 cobbler died in Punrak Drain. The cobbler, which were either migrating upstream or living in the drain, had become trapped in small, stagnant, isolated pools.

It was determined that water had been diverted from the drain into the artificial wetland constructed upstream, reducing downstream flow and causing the drain to become a series of pools. Action was taken to ensure that environmental flows are considered when diverting water from the drain to prevent this from happening again.

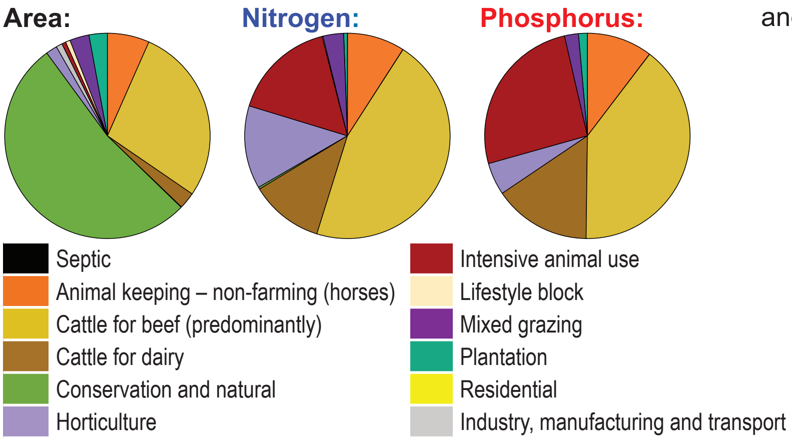
Modelled results (1997–2007)[3]

This page reports results from the Streamflow Quality Affecting Rivers and Estuaries (SQUARE) model. It estimated flow, nitrogen and phosphorus loads at the outlets of the 13 subcatchments of the Peel-Harvey estuary.

Nutrient sources

There were five main sources of nutrient load in the Dirk Brook – Punrak Drain catchment: ‘cattle for beef’, ‘intensive animal use’, ‘horticulture’, ‘cattle for dairy’ and ‘horse properties’.

‘Intensive animal use’ consists of two piggeries, two poultry farms and one dairy. While they only occupied 0.6% of the catchment area, they were responsible for 16% of the nitrogen and 26% of the phosphorus load.



Annual exports to Peel Inlet

The Dirk Brook – Punrak Drain catchment is 1.6% of the area that drains to the Peel Inlet. On average it contributed to the Peel Inlet:

- 4% of the flow (18 GL/year)
- 7% of the nitrogen load (51 tonnes/year)
- 8% of the phosphorus load (5.6 tonnes/year).

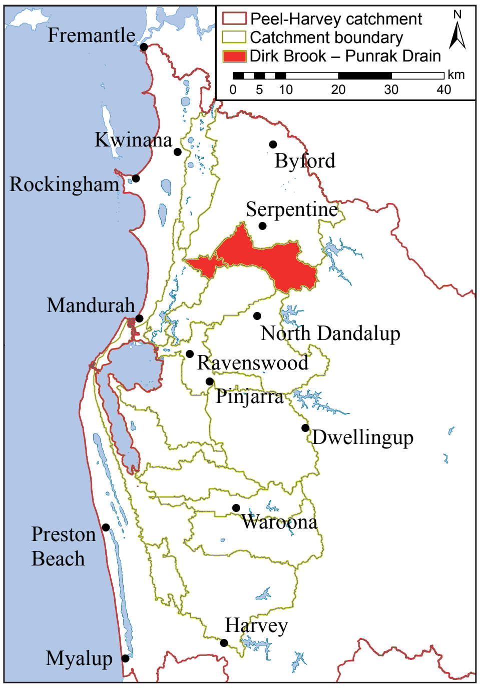
Remediation priority

The SQUARE-modelled data indicated that based on nutrient loads per cleared area (kg/ha/year):

- Punrak Drain catchment requires high-priority nitrogen and phosphorus remediation action
- Dirk Brook catchment requires high-priority nitrogen and medium-priority phosphorus remediation action.

Dirk Brook – Punrak Drain had the greatest nitrogen load per cleared area of all the catchments draining to the Peel-Harvey estuary

How Dirk Brook – Punrak Drain fits within the Peel-Harvey catchment: location and statistics



Catchment draining to estuary	Area (km²)	Flow (GL)	TN load (tonnes/ year)	TN load per cleared area (kg/ha)	TP load (tonnes/ year)	TP load per cleared area (kg/ha)
Peel Main Drain	120	11	26	3.0	4.5	0.52
Upper Serpentine	502	55	106	3.8	21	0.75
Dirk Brook – Punrak Drain	**134**	**18**	**51**	**7.5**	**5.6**	**0.82**
Nambeelup	143	19	44	3.6	10.5	0.86
Lower Serpentine	94	6.2	9.7	1.6	2.9	0.49
Mandurah	24	3.0	7.9	5.0	1.3	0.84
Upper Murray	6 752	286	204	0.51	4.9	0.01
Lower Murray, mid Murray and Dandalup	638	74	198	6.4	4.9	0.16
Coolup (Peel)	151	23	42	3.2	15	1.2
Subtotal Peel Inlet	**8 558**	**496**	**701**	**1.4**	**73**	**0.14**
Coolup (Harvey)	113	16	26	3.3	14	1.8
Mayfield Drain	119	19	33	3.1	7.1	0.67
Harvey	710	142	259	6.9	39	1.0
Meredith Drain	56	11	16	4.3	8.3	2.2
Subtotal Harvey Estuary	**998**	**188**	**334**	**5.6**	**69**	**1.2**
Total Peel-Harvey estuary	**9 556**	**684**	**1 035**	**1.8**	**142**	**0.25**

References

1 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.

2 Cousins, MD 2010, *Water quality of Dirk Brook, Western Australia – status and trends 2000 – 2006*, Water Science Technical Series, Report no. 27, Department of Water, Western Australia – draft.

3 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.

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