

# Avon River (Millendon)

The Avon River contributes the single-largest inflow to the Swan River and has the largest overall catchment of those monitored, only 35 km<sup>2</sup> of which is located on the Swan Coastal Plain (see adjoining map). The remainder of the catchment (approximately 120 000 km<sup>2</sup> in total) extends about 500 km inland, past the Darling Scarp and the goldfield towns of Southern Cross and Lake Grace. Most of the catchment east of the scarp drains internally and does not contribute flow to the monitored portion year-round.

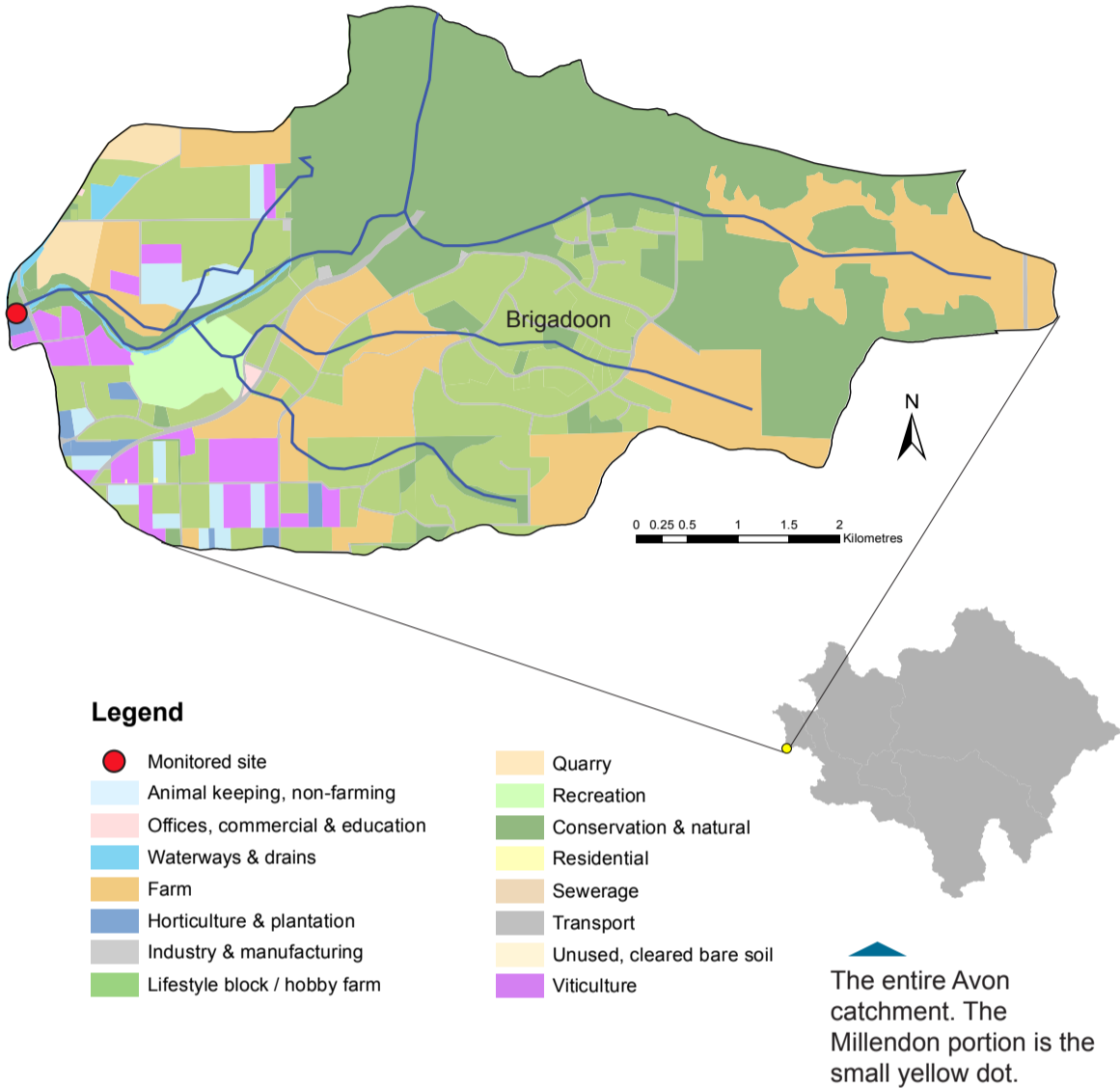
Extensive areas of the catchment have been cleared of the natural dry sclerophyll woodland for agriculture. The replacement of this deep-rooted vegetation by seasonal shallow-rooted crops has reduced evapotranspiration and increased surface water run-off and groundwater recharge. In turn this has increased annual flows by an estimated 80% in the catchment's monitored portion. It does, however, remain an ephemeral system – drying to a series of pools in summer.

Soils in the catchment's monitored portion include red gravels and earths to the east of the Darling Scarp; shallow red and yellow earths as the Avon flows over the scarp; gravelly and sandy Forrestfield and Guildford soils in the foothills; and alluvial red earths adjacent to the river.

Water quality samples are collected fortnightly near the Great Northern Highway to indicate the nutrient contribution from the Avon catchment. Note that the values determined may not represent nutrient concentrations in upstream tributaries. Flow is measured at the Department of Water and Environmental Regulation's gauging station located just downstream of Walyunga National Park.



Sampling site at Great Northern Highway, August, 2012.  
Dominic Heald



## Millendon – facts and figures

Average rainfall (2012–16)	~ 680 mm per year (Perth metro) ~ 283 mm per year (Southern Cross)
Catchment area	120 000 km <sup>2</sup> (total Avon catchment) 35 km <sup>2</sup> (Millendon catchment only)
Per cent cleared area (2005)	53%
River flow	Ephemeral No major water supply dams in catchment
Average annual flow	~ 114 GL per year (2012–16 average)
Main land uses (2005)	Conservation and natural, farming, lifestyle blocks/hobby farms.

## Nutrient Summary: concentrations, estimated loads and targets

Year	Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Annual flow (GL)	616011	107.4	140.2	181.9	246.0	23.8	135.0	35.1	150.1	118.0*	45.3*	222.1*
TN median (mg/L)	SWN5	0.79	0.79	0.80	1.00	0.73	1.10 <sup>#</sup>	0.89	1.15 <sup>#</sup>	0.94	0.87	1.00
TP median (mg/L)	SWN5	0.010	0.013	0.019	0.016	0.018	0.030	0.014	0.015	0.023	0.017	0.026
TN load (t/yr)	SWN5	113.8	153.4	251.0	319.0	20.6	155.4	30.2	169.8	115.7*	44.2*	247.1*
TP load (t/yr)	SWN5	3.07	4.00	7.52	9.37	0.48	4.44	0.70	4.53	2.90*	1.10*	7.09*

TN short term target = 2.0 mg/L

TN long term target = 1.0 mg/L

TP short term target = 0.2 mg/L

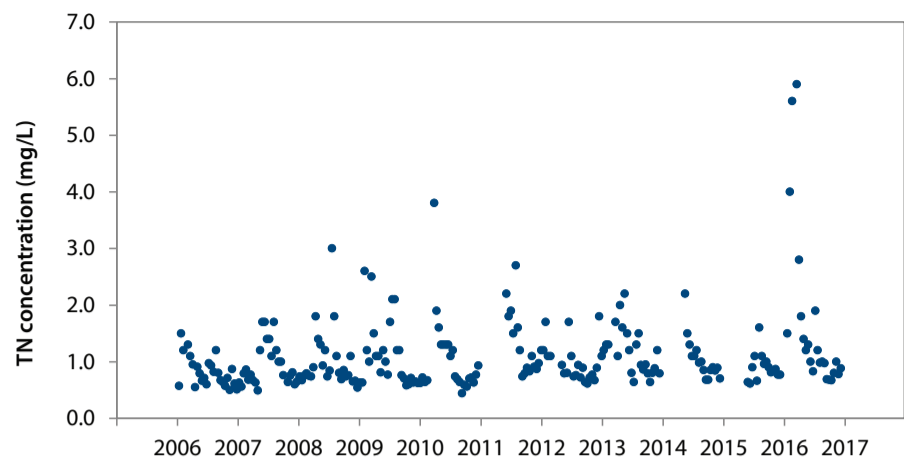
TP long term target = 0.1 mg/L

 insufficient data to test target  failing both short and long-term target  passing short but failing long-term target  passing both short and long-term target

\* Best estimate using available data.    <sup>#</sup> Statistical tests that account for the number of samples and large data variability are used for testing against targets on three years of winter data. Thus the annual median value can be above the target even when the site passes the target (or below the target when the site fails).

# Changes in nutrient concentrations over time in the Avon River

Total nitrogen concentrations over the 2006 to 2016 monitoring period



### Trend

Total nitrogen (TN) concentrations were stable from 2012 to 2016 and no trend was detected over this period. Over the longer-term (2007–16), there was an emerging increasing trend of 0.02 mg/L/yr. TN concentrations have therefore stabilised since the last nutrient report which showed an increasing trend of 0.1 mg/L/yr over the 2007–11 time period. The high concentrations recorded in 2016 coincided with the commencement of flow and was mostly due to dissolved organic nitrogen.

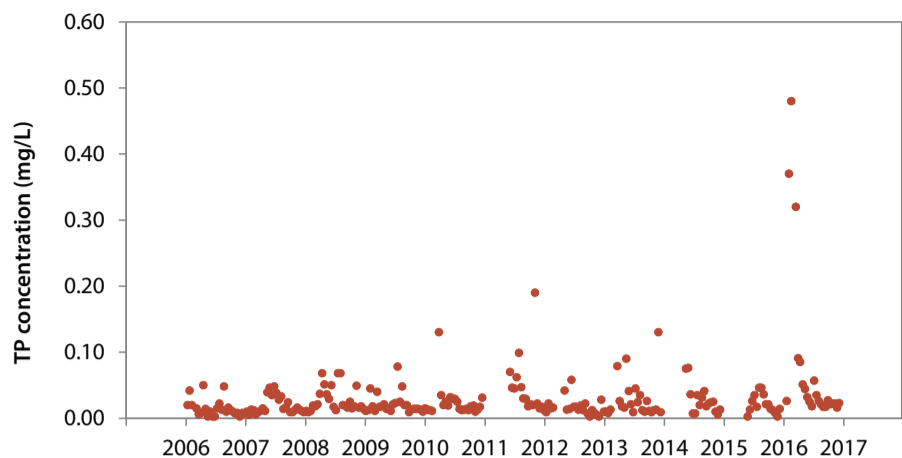
### Target

The Avon River has been passing the short- and long-term TN targets for the reporting period.



Avon River Walyunga National Park, April 2016 Photo: Emma van Looij.

Total phosphorus concentrations over the 2006 to 2016 monitoring period



### Trend

Total phosphorus (TP) concentrations were stable over the reporting period. No trends were detected over the short-

(2012–16) or long-term (2007–16). Similar to the TN concentrations, the high TP concentrations in 2016 coincided with the commencement of flow.

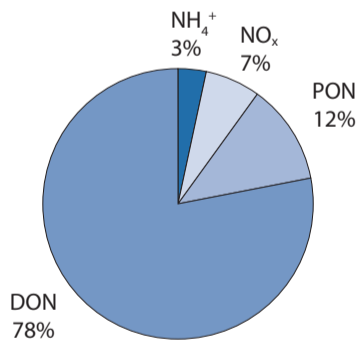
### Target

The Avon River has been passing the short- and long-term TP targets for the reporting period.



## Nutrient fractions and estimated loads in the Avon River

Average composition of nitrogen (N) in the Avon River over the 2012 to 2016 monitoring period



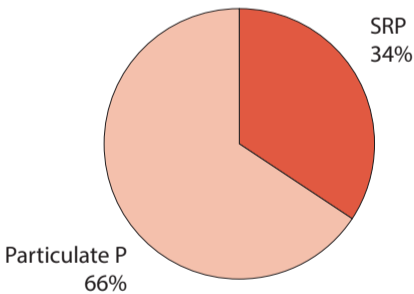
### Nitrogen

Most of the nitrogen (N) was present in the form of dissolved organic N (DON). This largely comprises organic compounds leached from peaty sub-soils and degrading plant and animal matter and is available for uptake by plants, algae and bacteria. Particulate organic N (PON) is composed of plant and animal debris and

needs to be further broken down to become available to plants and algae. The remaining N was present as dissolved inorganic N (DIN, consisting of ammonium –  $\text{NH}_4^+$  and N oxides –  $\text{NO}_x$ ) which is mostly derived from animal waste and fertilisers and is readily available for plant and algal uptake.

Due to the Avon River's large discharge volume, it contributes a substantial TN load to the Swan-Canning estuary even though concentrations are low. In fact, over the five years 2012 to 2016, the average TN load was larger than the other eight subcatchments with flow data combined.

Average composition of phosphorus (P) in the Avon River over the 2012 to 2016 monitoring period



### Phosphorus

About two-thirds of the phosphorus (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 plant and algal uptake, but may become available over time as particles decompose or release bound phosphate. Soluble reactive phosphorus (SRP) is derived from fertilisers and animal waste and is readily available for plant and algal uptake. It made up the remaining P.

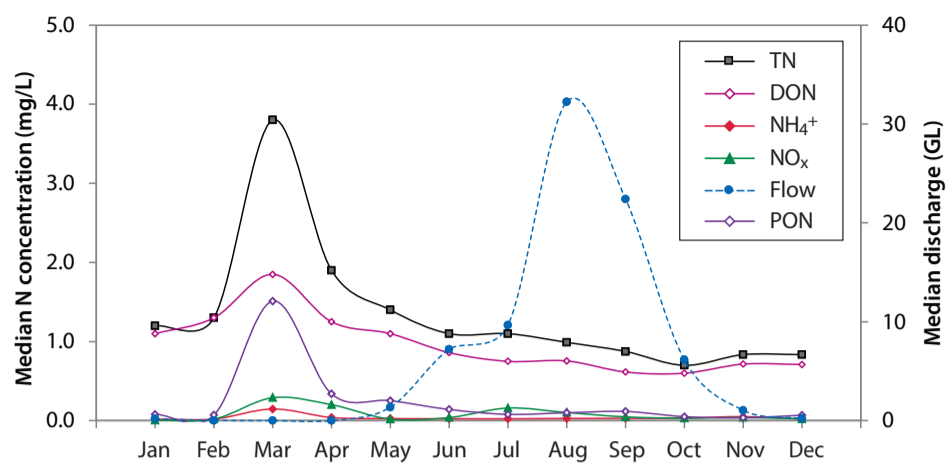
Due to the Avon River's large discharge volume, it contributes a significant TP load to the Swan-Canning estuary even though

concentrations are low. The TP load (2012–16 average) was the second-largest of the nine subcatchments with flow data.



# Seasonal variation in nutrient concentrations in the Avon River

Nitrogen seasonal variation over the 2012 to 2016 monitoring period



## Nitrogen

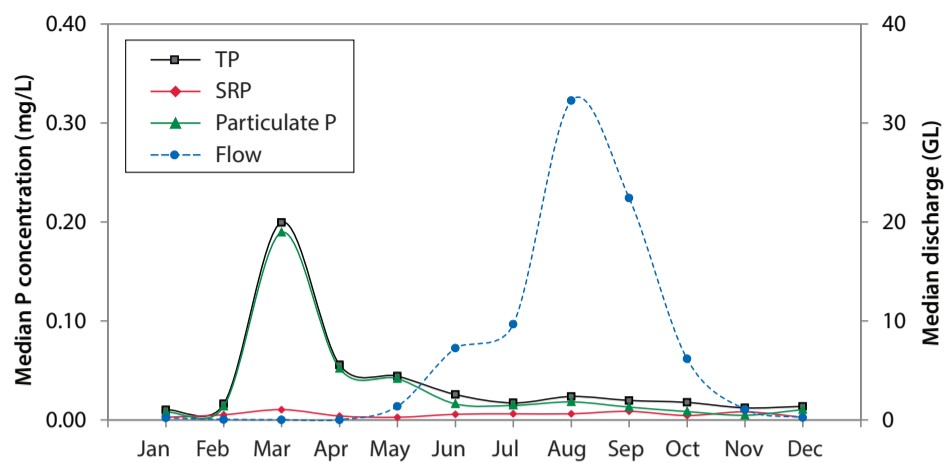
The high N concentrations seen in Jan–Apr including the large peak in March were due to unseasonal flow, especially in 2016. This followed heavy rainfall in many parts of the catchment in January and March of 2016 which flushed N into the river via overland flows. There was evidence of a seasonal pattern in N concentrations for the remainder of the year. NO<sub>x</sub> increased in June and is being carried to the river via sub-surface and

groundwater flows. DON is likely sourced in-stream as well as from plant and animal matter being washed into the river from the surrounding catchment.



Backwater (left) in Walyunga National Park, April 2016. Photo: Emma van Looij.

Phosphorus seasonal variation over the 2012 to 2016 monitoring period



## Phosphorus

As for N, the peak in P concentrations in March can be attributed to unseasonal flow, especially in 2016 where heavy rains in many parts of the catchment

flushed P into the river. P concentrations also exhibited a seasonal pattern, generally being higher during winter when flows are higher. Likely sources of particulate P include surface runoff and bank erosion and scouring. SRP is probably entering the river via groundwater as well as surface and sub-surface runoff.



Photo: Veronica Campagna



Photo: Emma van Looij



Photo: Emma van Looij

**Photographs of Avon River:** (Top left) the Avon River in Toodyay, note the lack of riparian vegetation and erosion along the banks, July 2017. (Bottom left) Syds Rapids in Walyunga National Park, April 2016. (Right) Bells Rapids in January 2017 following heavy summer rainfall.

# Local nutrient reduction strategies for the Avon River

Nutrient reduction strategies being undertaken or recently completed in the catchment include but are not limited to:

- Healthy Soils Healthy Rivers Program delivered by Perth NRM and Wheatbelt NRM, with funding support from the Australian Government and the Department of Biodiversity, Conservation and Attractions (DBCA), provides workshops and individual advice to farmers and horticulturists to help improve farm efficiencies particularly in nutrient management.
- The DBCA and Department of Water and Environmental Regulation removed 5000 m<sup>3</sup> of sediment from Katrine Pool in the Avon River, reducing the sediment load entering the Swan-Canning estuary from the Avon Catchment and supporting the reduction of nutrient concentrations that contribute to algal blooms and poor water quality in the estuary.
- Revegetating 25 hectares of riparian zone on tributaries contributing sediment load to the Avon River (and ultimately the Swan-Canning estuary) with native species to reduce nutrient exports.
- The Wooroloo Brook Land Conservation District Committee (no longer operating) worked for many years on revegetation projects and foreshore restoration activities in the Wooroloo Brook catchment (a tributary of the Avon River).
- Scenario modelling completed as part of the *Avon Basin Hydrological and Nutrient Modelling Report*.



Photo: Emma van Loon

## Avon Basin hydrological and nutrient modelling report

The *Avon Basin Hydrological and Nutrient Modelling Project*, completed in 2015, complements the River Protection Strategy and presents a roadmap for reducing nutrient and sediment inputs into the Swan Canning river system. It uses sophisticated modelling to identify nutrient sources and scenarios to improve water quality.

The Avon Basin modelling project revealed 195 GL of flow, 213 tonnes of N, 5.3 tonnes of P and 6500 tonnes of sediment enter the Swan Canning river system each year from the Avon Catchment.

## Swan Canning water quality improvement plan

The *Swan Canning water quality improvement plan* (SCWQIP) complements the River Protection Strategy (RPS) and presents a roadmap for reducing nutrient inputs into the river systems. It uses sophisticated modelling to identify nutrient sources and provides nutrient reduction targets for each of the subcatchments.

The modelling focused on the coastal catchments and so did not include the Avon River. The Avon contributes a significant proportion of the nutrient loads to the estuary due to its high discharge volumes; hence nutrient modelling of the Avon is currently being undertaken. This will enable a more strategic management approach to nutrient reduction in the catchment and help the DBCA and its partners achieve the nutrient load targets.

SCWQIP load and concentration targets for Millendon

	Max. load (t/yr)	Conc. target (mg/L)	% reduction
TN	2.6	1.00	0%
TP	0.15	0.100	0%

For further information on the RPS and the SCWQIP contact [rivers.info@dbca.wa.gov.au](mailto:rivers.info@dbca.wa.gov.au)

## Summary: Avon River

- The Avon has been passing the short- and long-term nutrient targets since monitoring began in 1987.
- Of the 33 sites sampled, the Avon had the fifth-lowest 2016 median TP concentration.
- The proportion of N present as highly bioavailable DIN is low compared with the other sites sampled.
- Of the nine sites with flow data, the Avon currently contributes the largest average TN load, nearly five times greater than the next site, and the second-largest average TP load.
- There was an emerging increasing long term TN trend detected.