Dennis

This data report provides a summary of the nutrients at the Dennis sampling site in 2018 as well as historical data from 2004–18. This report was produced as part of the Regional Estuaries Initiative. Downstream of the site, the stream discharges into the Scott River and subsequently the Hardy Inlet. Nutrients (nitrogen and phosphorus) are compounds that are important for plants to grow. Excess nutrients entering waterways from effluent, fertilisers and other sources can fuel algal growth, decrease oxygen levels in water and harm fish and other species. Total suspended solids, pH and salinity data are also presented as they help us better understand the processes occurring in the catchment.

About the catchment

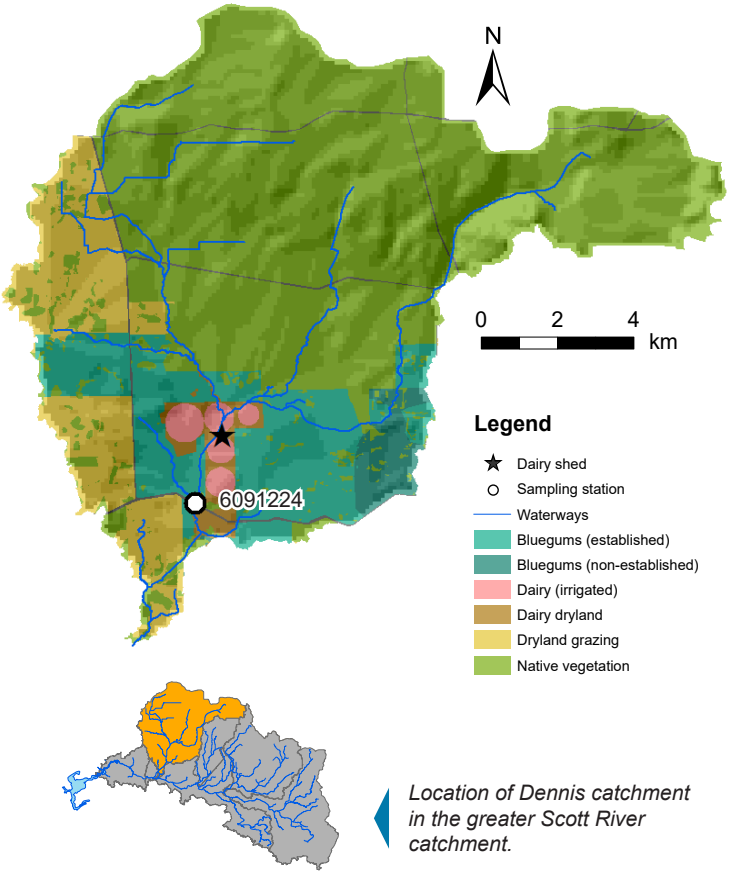
Dennis has a catchment area of about 145 km^2, more than two-thirds of which is covered by native vegetation, mostly in the northern portion of the catchment. Bluegums and dryland grazing are the two dominant land uses and there is one dairy shed in the catchment. Drains have been constructed to help reduce surface water ponding in agricultural land. Much of the fringing vegetation has been lost where the waterways run through farmland.

The Dennis catchment tributary discharges to the Scott River, roughly 2 km upstream of the Brennans Ford gauging station.

Water quality is measured at site 6091224, Coonack Downs, downstream of the culverts where the tributary passes under Governor Broome Road. Just upstream of the sampling site is an irrigated dairy.

Results summary

Nutrient concentrations (total nitrogen and total phosphorus) at the Coonack Downs sampling site in the Dennis catchment were high to very high. The proportion of nitrogen present as ammonia was large, suggesting effluent from the upstream dairy shed is entering the waterway. The lack of fringing vegetation along waterways in farmland areas and the construction of drains to reduce surface water ponding means nutrients can be washed from soils to waterways and are transported downstream quickly rather than being assimilated.



Location of Dennis catchment in the greater Scott River catchment.

Facts and figures

Sampling site code	6091224
Rainfall at Brennans Ford (2018)	850 mm
Catchment area	145 km^2
Per cent cleared area (2009)	33 per cent
River flow	Ephemeral
Main land use (2009)	Native vegetation, bluegum plantations and dryland grazing

Nitrogen over time (2004–18)

Concentrations

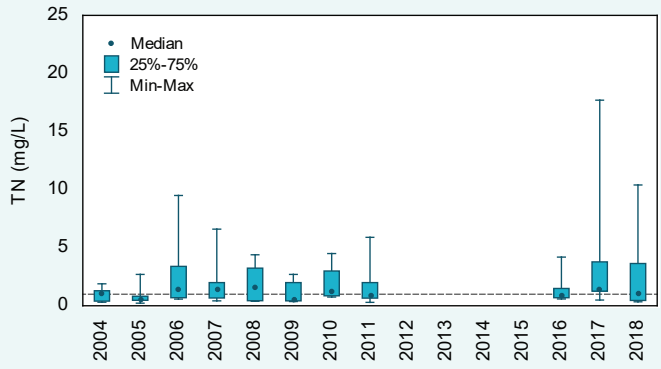
While the median total nitrogen (TN) concentrations were below the water quality improvement plan (WQIP) target for four of the past 15 years, the range in TN concentrations was high, with the maximum TN concentrations well over the target in the past two years.

Concentrations fluctuated over the 2004–18 period, especially the maximum concentrations recorded each year. In 2017, the maximum concentration was 17.7 mg/L, an extremely high concentration for a waterway in the south-west of Western Australia. Land use in the catchment likely contributed to the high TN concentrations recorded, especially the irrigated dairy and dryland beef upstream of the sampling site. It is likely that pulses of nutrients were released from these land uses following periodic fertiliser application or after heavy rain events which flushed nutrients from paddocks and drains.

Trends

As there was a break in regular monitoring between 2012–15, it was not possible to test for trends in TN concentrations at Coonack Downs as a minimum of five years of data are required.

Coonack Down



Total nitrogen concentrations, 2004–18 at site 6091224. The dashed line is the Scott River WQIP target for median TN concentrations.

The water can be quite turbid at the sampling site early in the flow year. This photograph was taken in February.

Nitrogen (2018)

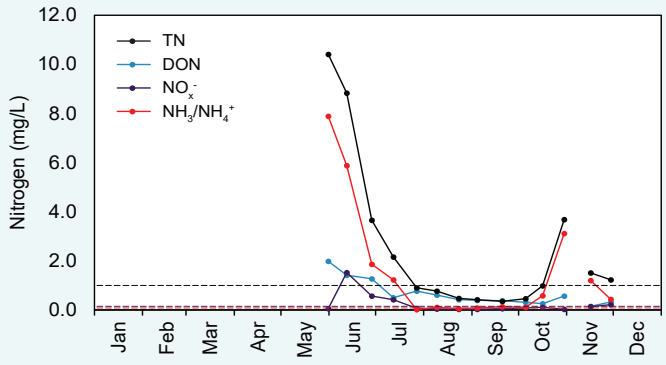
Concentrations

N concentrations varied throughout the year with evidence of a reverse seasonal pattern in TN, ammonia N (NH_3/NH_4^+), dissolved organic nitrogen (DON) and, to a slightly lesser extent, total oxides of nitrogen (NO_x^-). All forms of N were highest in May when flow commenced, before reducing then increasing again in October. From late July to early October, TN was below the WQIP target and NO_x^- was below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value. The very high N concentrations when the waterway started to flow were likely because of a first-flush effect where N was mobilised following heavy rainfall. Much of this N was likely to be the result of mineralisation of organic N in soils and drains over the summer period, and runoff of high-concentration waters from irrigated pasture, which builds up with fertiliser and animal waste over the summer periods. Also, as there was less water present early and late in the flow season, any irrigation returns of dairy effluent would have been diluted less than in the wetter months.

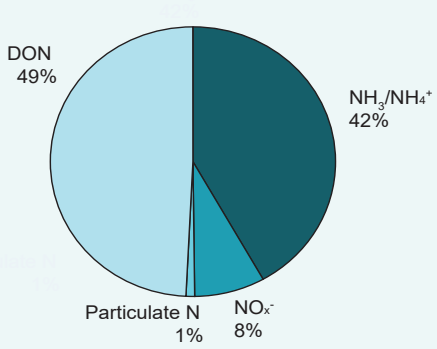
Types of nitrogen

Total N is made up of many different types of N. Coonack Downs had the second highest percentage of N present as NH_3/NH_4^+ of the nine sites sampled in the Scott River catchment (42 per cent). This is a much higher proportion than is found in pristine waterways. This form of N is bioavailable to plants and algae and is used to fuel rapid growth. It is likely the NH_3/NH_4^+ is coming from the dairy farm upstream as it is found in high concentrations in animal waste. The percentage of N present as DON was the second lowest of the Scott River sites. DON consists mainly of degrading plant and animal matter but may also include other forms. The bioavailability of DON varies depending on its form; some are highly bioavailable whereas others, like degrading plant and animal matter, often need to be further broken down.

Coonack Downs



2018 nitrogen concentrations at 6091224. The black dashed line is the Scott River WQIP target for TN, the red and purple lines are the ANZECC trigger values for lowland rivers for NH_3/NH_4^+ and NO_x^-.



2018 average nitrogen fractions at site 6091224.

Cattle with unrestricted access to waterways. They contribute nutrients, destroy fringing vegetation and cause erosion.

Phosphorus over time (2004–18)

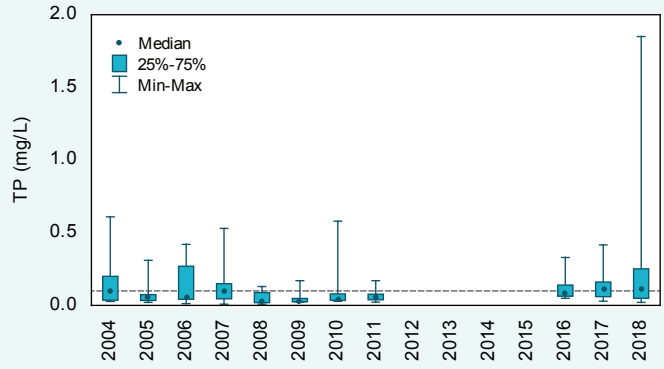
Concentrations

The median total phosphorus (TP) concentration was below the WQIP TP target every year except 2017 and 2018. While concentrations fluctuated over the past 15 years, the maximum concentration in 2018 was much higher than previous years.

Trends

It is possible that TP concentrations are increasing at this site; however, it was not possible to test for trends to verify this because of the break in regular monitoring between 2012–15. A minimum five years of data are needed to be able to test for trends.

Coonack Downs



Total phosphorus concentrations, 2004–18 at site 6091224. The dashed line is the Scott River WQIP target for median TP concentrations.

Much of the natural fringing vegetation has been lost and replaced with weeds along the waterways in the Dennis catchment.

Phosphorus (2018)

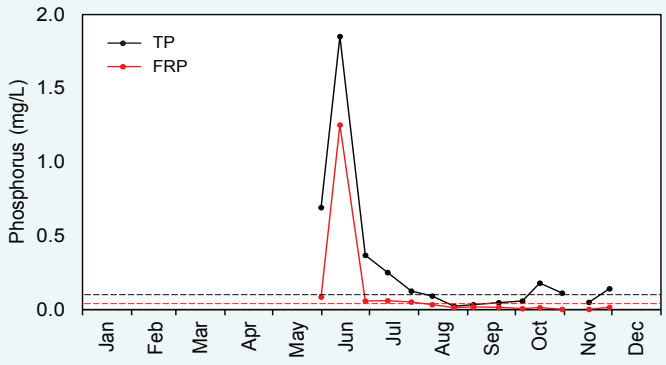
Concentrations

TP and, to a slightly lesser extent, filterable reactive phosphorus (FRP) concentrations showed a reverse seasonal trend, being higher early and late in the flow-year and low in the middle. It is likely the peak in early June was because of a first-flush effect where nutrients that were present in the dry waterway and on the ground surrounding the waterway were flushed into the stream following heavy rainfall. Also, there was less water present early and late in the flow season so any irrigation returns or dairy effluent entering the waterway was not diluted by the lower concentrations from catchment runoff. During the wetter months of August and September, when flow volumes were at their highest, both TP and FRP were below their respective target and trigger value.

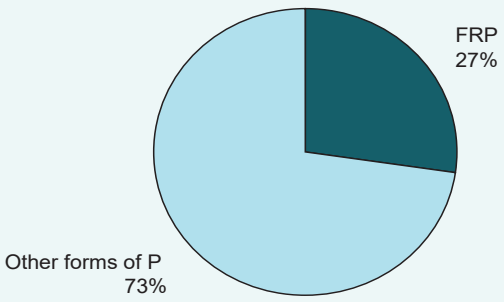
Types of phosphorus

Total P is made up of different types of P. At Coonack Downs, nearly three-quarters of the P was present as either particulate P or dissolved organic P (DOP) or both. Particulate P generally needs to be broken down before becoming bioavailable to algae. The bioavailability of DOP varies and is poorly understood. The remainder of the P was present as FRP which is readily bioavailable, meaning plants and algae can use it to fuel rapid growth. FRP was probably derived from animal waste and fertilisers as well as natural sources.

Coonack Downs



2018 phosphorus concentrations at 6091224. The black dashed line is the Scott River WQIP target for TP, the red is the ANZECC trigger value for lowland rivers for FRP.



2018 average phosphorus fractions at site 6091224.

High water levels in September. The bluegum plantations in the background are one of the dominant land uses in the Dennis catchment.

Total suspended solids over time (2004–18)

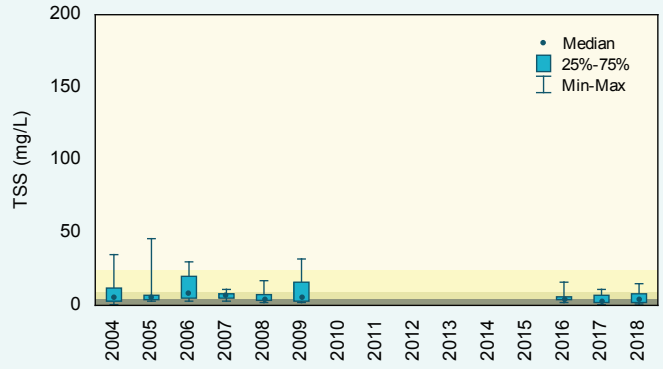
Concentrations

Using the Statewide River Water Quality Assessment (SWRWQA) bands, the median total suspended solids (TSS) concentration at Coonack Downs was classified as low for the past three years (2016–18). Before this, it was classified as moderate for all years except 2008 when it was also low. TSS concentrations have fluctuated slightly over the reporting period; however, there is no clear evidence they are changing over time.

Trends

As there was a break in regular monitoring between 2010–15, it was not possible to test for trends in TSS concentrations at Coonack Downs. A minimum of five years of data are required to test for trends.

Coonack Downs



Total suspended solids concentrations, 2004–18 at site 6091224. The shading refers to the SWRWQA classification bands.

very high high moderate low

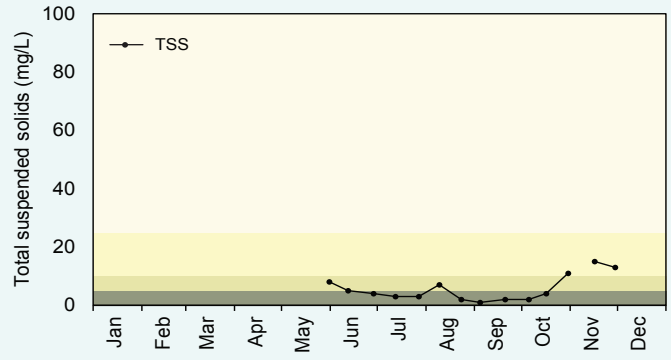
The Coonack Downs sampling site in August. Water levels are typically high at this time of the year.

Total suspended solids (2018)

Concentrations

In 2018, most of the samples collected fell within the low band, with three in each of the moderate and high bands. There was some evidence of a slight reverse seasonal pattern, with concentrations higher in the beginning and end of the flow year (with the exception of the small spike in August). These peaks may be because of irrigation returns or dairy effluent which are not being diluted as much early and late in the flow year when there is less water from other sources present in the stream. It is likely that particulate matter is also coming from in-stream erosion (which is exacerbated by stock accessing the creek) and runoff from upstream land use.

Coonack Downs



2018 total suspended solids concentrations at 6091224. The shading refers to the SWRWQA classification bands.

very high high moderate low

The Coonack Downs sampling site in December. The site has ceased to flow, with only a stagnant pool present. This site dries completely over summer.

pH over time (2004–18)

pH values

pH at Coonack Downs fluctuated over the past 15 years. In all years, except 2015 when it was below the lower trigger value, the median pH has been within the upper and lower ANZECC trigger values.

Trends

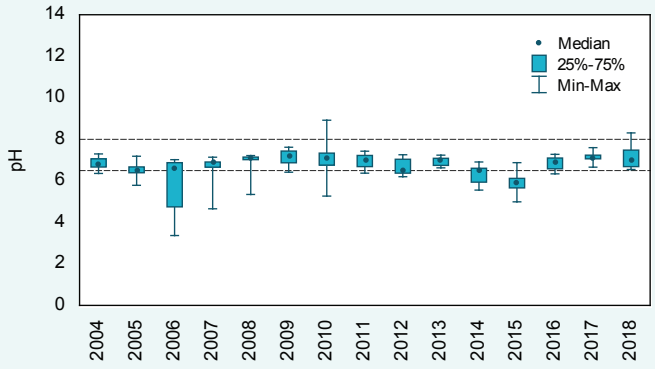
There was a small increasing short-term trend in pH at Coonack Downs (0.3 pH units/year, 2014–18). It is likely this trend is part of the normal fluctuations in pH at this site rather than being because of an actual change in pH. Ongoing monitoring of pH will help determine whether pH is actually increasing. There was no long-term trend present (2009–18).

pH (2018)

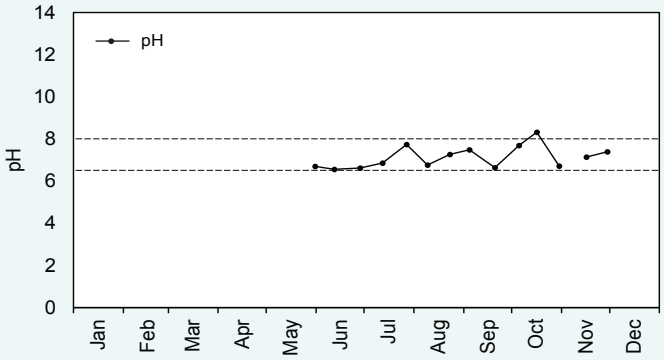
pH values

There was no evidence of a seasonal pattern in pH at Coonack Downs, with values fluctuating throughout the year. Except for one sampling occasion in October, all readings were within the upper and lower ANZECC trigger values.

Coonack Downs



pH levels, 2004–18 at site 6091224. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.



2018 pH levels at 6091224. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

Algae growing in a stagnant pool at the Coonack Downs sampling site in November.

Salinity over time (2004–18)

Concentrations

Salinity fluctuated over the past 15 years at Coonack Downs. Using the SWRWQA classification bands, the median salinity has been fresh over the entire reporting period, though most years had some samples classified as marginal.

Trends

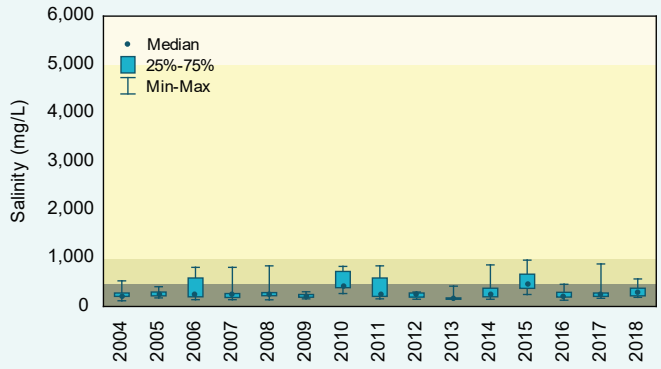
Trend testing showed no short- or long-term trends in salinity concentrations at Coonack Downs (2014–18 and 2009–18 respectively).

Salinity (2018)

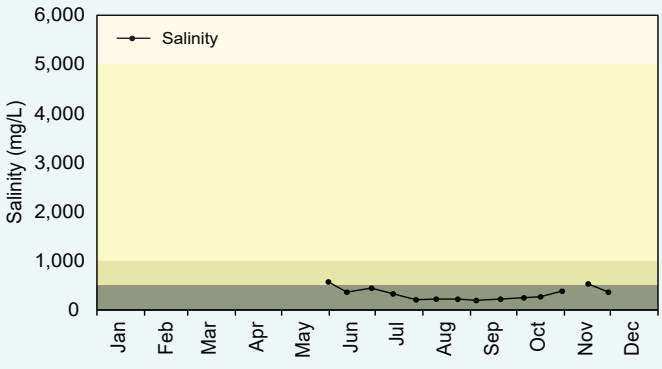
Concentrations

Salinity showed a slight inverse relationship to flow. That is, when flow volumes were higher, salinity levels were lower and vice versa. In 2018, most of the samples fell into the fresh band, with only two classified as marginal. The small peak in May was likely related to either salts left behind by evaporation as the stream dried over summer being dissolved following early rainfall, or irrigation returns and dairy effluent entering the waterway and not being diluted to the same extent as in the middle of the year when water levels are higher. The increase in concentrations later in the year coincided with water in the stream drying up. At this time, more of the water present is groundwater, irrigation returns and dairy effluent and there is also evapoconcentration occurring, which suggests the slightly elevated salinity is because of one (or more) of these sources.

Coonack Downs



Salinity concentrations, 2004–18 at site 6091224. The shading refers to the SWRWQA classification bands.



2018 salinity concentrations at 6091224. The shading refers to the SWRWQA classification bands.

saline brackish marginal fresh

Paperbarks overhanging a waterway in the Dennis catchment. These provide shading as well as a natural carbon source to the waterway.

Background

The Regional Estuaries Initiative is a State Government program to improve the health of waterways and estuaries in the south-west of Western Australia. Healthy Estuaries WA is a Royalties for Regions program launched in 2020 and will build on the work of the Regional Estuaries Initiative. Collecting and reporting water quality data, such as this report, helps build understanding of the whole system. By understanding the whole system, we can direct investment towards the most effective actions in the catchments to protect and restore the health of our waterways.

You can find the latest data on the condition of Hardy Inlet at estuaries.dwer.wa.gov.au/estuary/hardy-inlet/

The Regional Estuaries Initiative partners with the Lower Blackwood Land Conservation District Committee (Lower Blackwood LCDC) to fund best-practice fertilisers, dairy effluent and watercourse management on farms.

- To find out how you can be involved visit estuaries.dwer.wa.gov.au/participate
- To find out more about the Lower Blackwood LCDC go to lowerblackwood.com.au
- To find out more about the health of the rivers in the Hardy Inlet catchment go to rivers.dwer.wa.gov.au/assessments/results

Methods

Total nitrogen and TP concentrations were compared with the Scott River WQIP targets. These targets represent the historical median winter concentration where lyngbya blooms were not observed in the upper Hardy Inlet. They were developed for use at Brennans Ford but have been used at all Scott River sites to allow for comparisons between sites. Where possible, other parameters were compared with the ANZECC trigger values for lowland rivers in south-west Australia. These values provide a value above which there may be a risk of adverse effect. For pH there is both an upper and lower trigger value which represent the acceptable pH range. Where there were no ANZECC trigger values available (for TSS and salinity) the SWRWQA classification bands were used to allow samples and sites to be classified and compared.

Trend testing was carried out using either the Mann or Seasonal Kendall tests as appropriate. Where there were flow data available and there was a flow-concentration relationship, the data were flow-adjusted before trend analysis.

Annual loads were calculated by multiplying daily flow with daily nutrient concentrations and aggregating over the year. Measured daily concentrations were not available as samples were collected fortnightly at best, so daily concentrations were calculated using the locally estimated scatterplot smoothing algorithm (LOESS).

Glossary

Bioavailable: bioavailable nutrients refers to those nutrients which plants and algae can take up from the water and use straight away for growth.

Concentration: the amount of a substance present in the water.

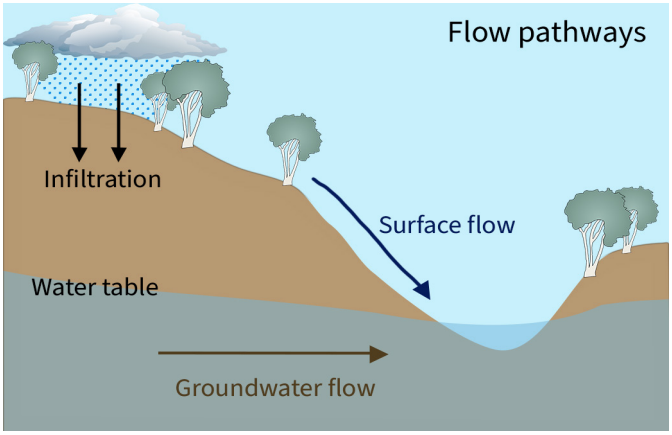
Evapoconcentration: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

Laboratory limit of reporting: this is the lowest concentration (or amount) of an analyte that can be reported by a laboratory.

Load: the total mass of a substance passing a certain point.

Load per unit area: the load at the sampling site divided by the entire catchment area upstream of the sampling site.

The schematic below shows the main flow pathways which may contribute nutrients, particulates and salts to the waterways. Connection between surface water and groundwater depends on the location in the catchment, geology and the time of year.



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