



Gulungul Creek monitoring data 2017-2018

The Supervising Scientist water chemistry monitoring program has been developed using continuous monitoring of physico-chemical parameters coupled with automatic event-based collection of water samples. Chemistry samples are collected when an electrical conductivity (EC) trigger is reached, indicating the potential for high contaminants to be present in the creek, and during routine quality assurance sampling. No event-based samples were collected this season due to the continuing low electrical conductivity.

Details regarding the development and operation of the monitoring program can be found in the [Surface water chemistry monitoring protocol to assess impacts from Ranger Mine](#).

The charts below compare measurements of key chemical indicators, collected during the **2017-18** wet season, to the [Water Quality Objectives \(WQOs\)](#) for Gulungul Creek. The WQOs present a hierarchical set of trigger values for each indicator, enabling a tiered approach to the oversight and management of water quality in Gulungul Creek.

Focus Trigger Value - Values that are higher than the Focus level but lower than the Action level will result in a watching brief. A watching brief involves precautionary ongoing data assessment to verify whether or not a trend away from background is occurring, possibly including further sampling if required.

Action Trigger Value - Values that are higher than the Action level but lower than the Guideline/Limit will result in a data assessment. Where assessment of the data shows the value represents a trend away from background, the company must undertake:

- An investigation into the cause of the exceedance; and
- Correction of the cause, if it is deemed to be mining-related.

The Focus and Action Trigger Values are used by the company to manage surface water quality during mine activities. These are not displayed on the plots below.

Guideline Trigger Value - The company shall treat values in excess of the Guideline the same as a Limit exceedance except:

- When there is a corresponding increase at the upstream (background) site; and
- For the Mn limit when the flow is less than one cumec.

When one or more of the above exceptions occurs, a Guideline exceedance will be treated the same as an Action exceedance.



Limit Trigger Value - Values that are higher than the Limit will result in a full investigation, including:

- Determining the cause(s) of the exceedance;
- Collecting further samples and data; and
- Undertaking immediate correction of the cause, if it is deemed to be mining-related.

The Guideline and/or Limit Values are used to monitor compliance and ensure the protection of the downstream environment.

Flow was recorded in Gulungul Creek for 166 days over the 2017-18 wet season. Flow commenced on 3 January 2018 and ceased on 18 June 2018. Rainfall for the start of the 2017-2018 wet season, as recorded at Jabiru Airport, was above average. Falls in January were nearly double the average for that month. The last rainfall recorded for the season at Jabiru Airport (BOM station 014198) was on 20 April 2018. Water quality monitoring data collected by the SSB showed that all Water Quality Objectives were met in Gulungul Creek for the 2017-18 wet season, indicating that operations at Ranger mine have not resulted in harm to downstream environments.

Chemical Indicators

- Conductivity in Gulungul Creek
- Magnesium in Gulungul Creek
- Uranium in Gulungul Creek
- Manganese in Gulungul Creek
- Turbidity in Gulungul Creek
- Radium-226 in Gulungul Creek

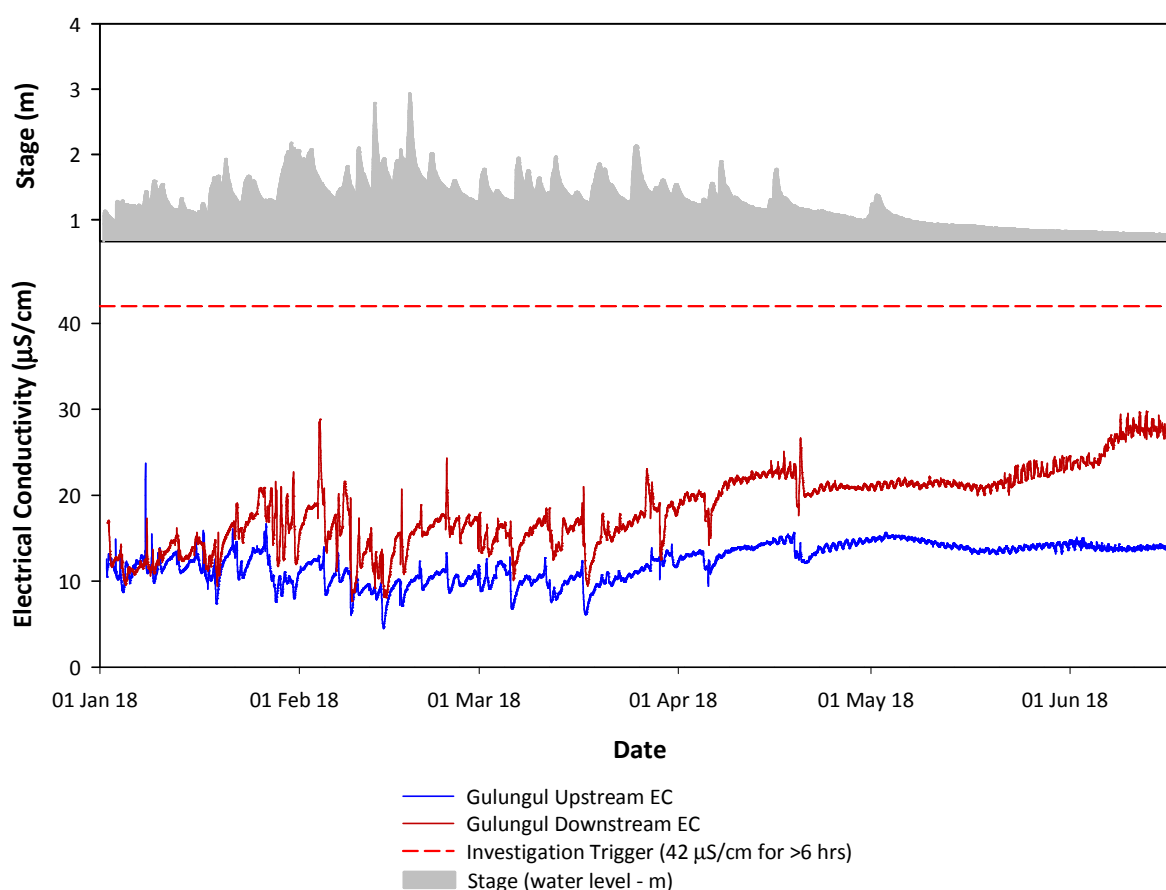
Conductivity in Gulungul Creek

A set of Electrical Conductivity (EC) Trigger Values have been derived to indicate when magnesium (Mg) concentrations might be approaching levels that exceed the Mg Trigger Values. The EC Trigger Values have been derived using the long-term EC-Mg relationship for Magela Creek. An additional *Investigation Trigger* was derived for EC which prompts an assessment of estimated Mg concentrations using the long-term Mg/EC relationship, or an event-specific relationship. The EC *Investigation Trigger* applies if conductivity exceeds 42 $\mu\text{S}/\text{cm}$ for more than 6 hours to prevent unnecessary action for short duration (< 6 hours) pulses that go above 42 $\mu\text{S}/\text{cm}$ but do not approach the Mg Guideline value.



Throughout the 2017-18 wet season, the conductivity in Gulungul Creek remained well below the Investigation Trigger value. The slightly higher EC recorded at the downstream monitoring location can be attributed to the flushing of solutes from the shallow aquifer system to the west and south of the active mine site. ERA actively manage water quality in the Gulungul catchment, which has enabled water quality objectives in Gulungul Creek to be maintained for the 2017-18 wet season.

A gradual increase in EC during recessional flows is indicative of higher solute groundwater continuing to express into the surface water system once rainfall has ceased. This is a similar pattern to that seen in previous years.



Gulungul Creek continuous conductivity monitoring data for the 2017-18 wet season.

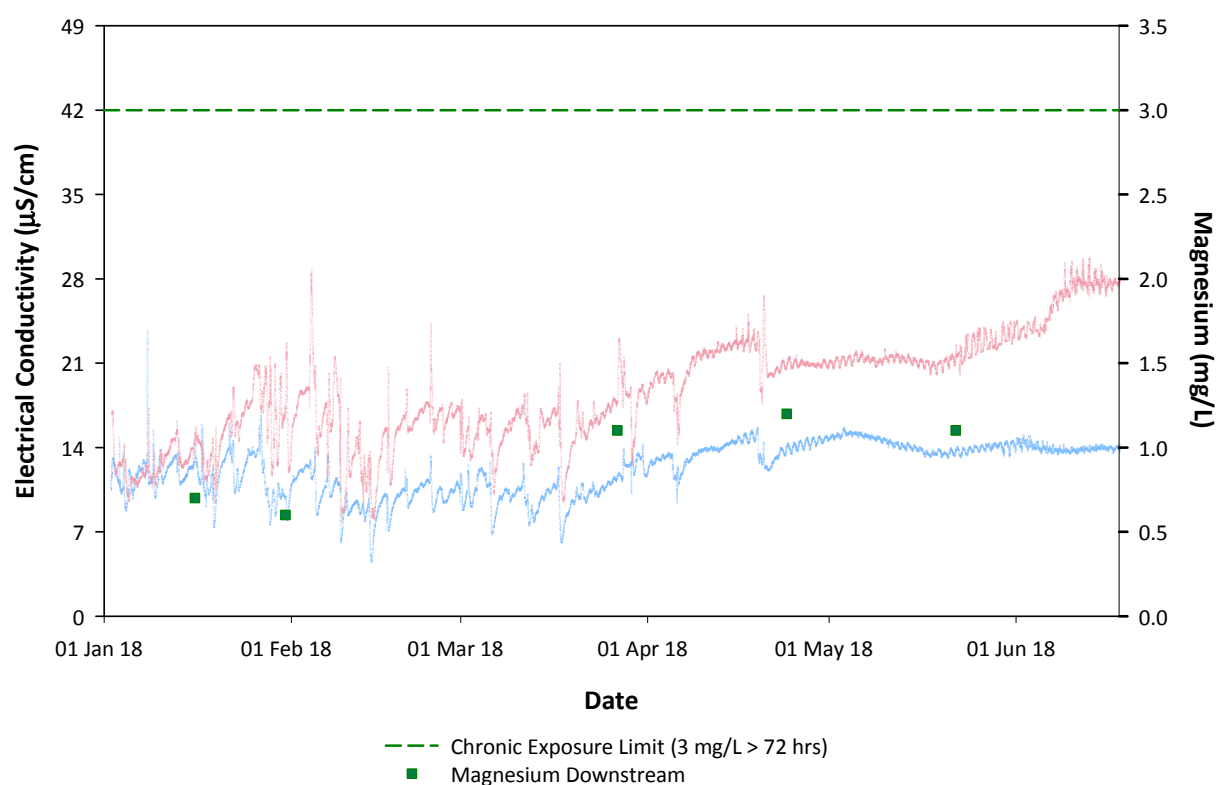
Magnesium in Gulungul Creek

The magnesium (Mg) *Chronic Exposure Limit* of 3 mg/L has been derived using local ecotoxicological data and applies to exposures greater than 72 hours in duration. The Supervising Scientist has also developed an interpretative framework for Mg pulse exposures



of less than 72 hours, which integrates the magnitude and the duration of any given pulse exposure. Details can be found on the [Ecotoxicology Electrical Conductivity-Magnesium Pulse Framework](#) page.

The EC trace indicates that magnesium was below the Chronic Exposure Limit throughout the season. Discrete samples collected from downstream Gulungul confirmed this interpretation with magnesium concentrations well below the limit.

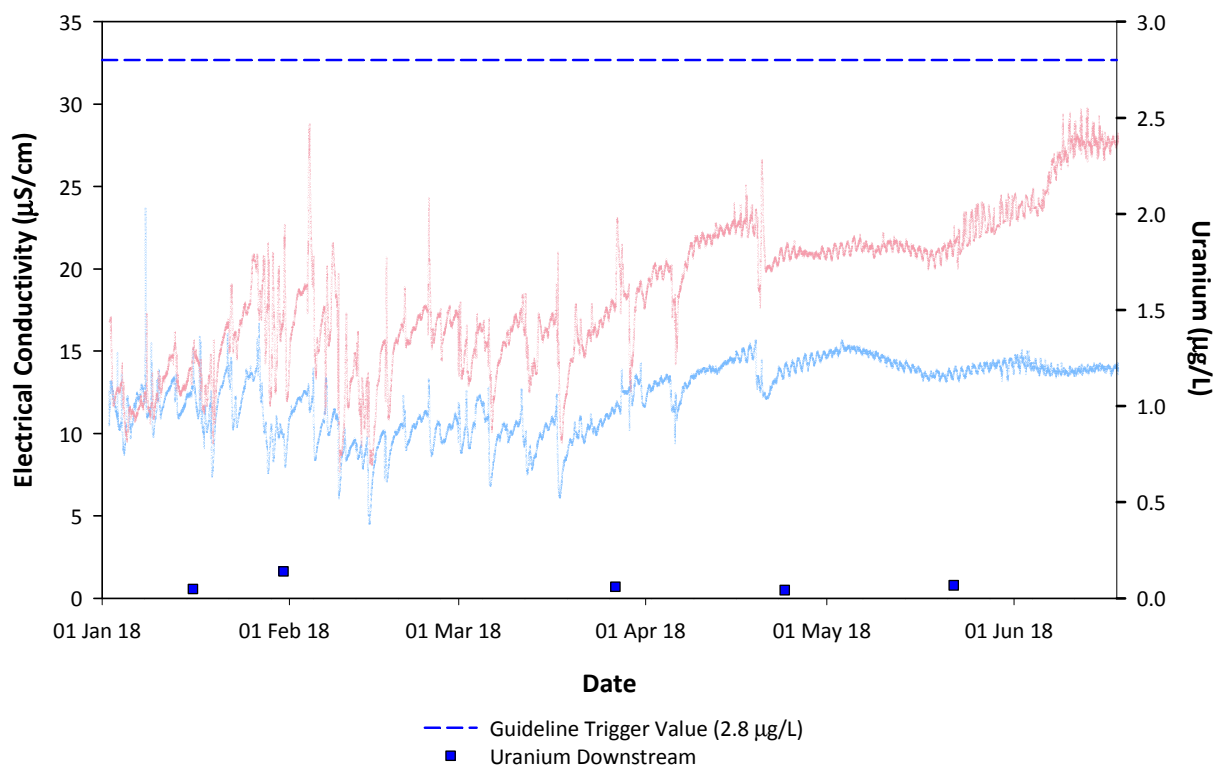


Gulungul Creek magnesium data for the 2017-18 wet season (continuous EC data shown in background for reference, blue = upstream, red = downstream).

Uranium in Gulungul Creek

The uranium *Limit Trigger Value* of 2.8 µg/L has been derived using local ecotoxicological data in accordance with the Australian Water Quality Guidelines to protect 99% of the species present.

The uranium concentration in samples collected during the 2017-18 wet season were low and well below the trigger value at the Gulungul Creek downstream site.

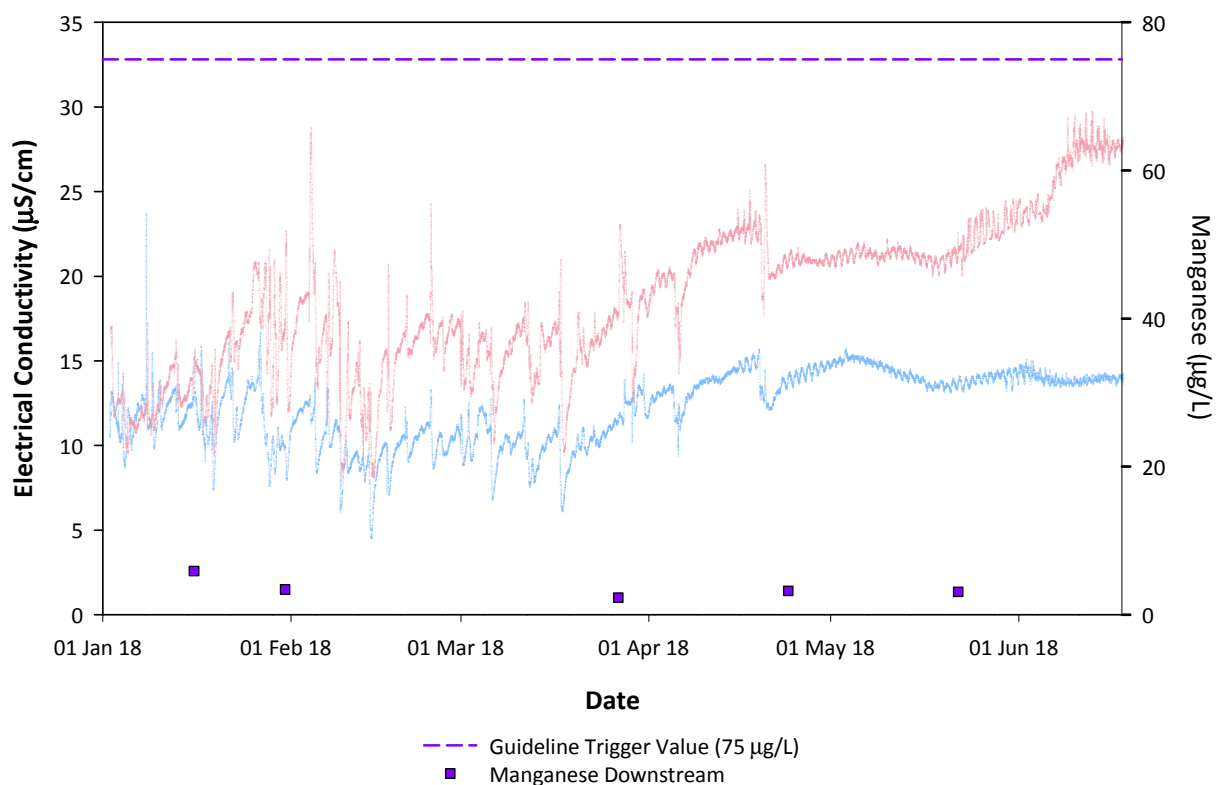


Gulungul Creek uranium data for the 2017-18 wet season (continuous EC data shown in background for reference, blue = upstream, red = downstream).

Manganese in Gulungul Creek

The manganese *Limit Trigger Value* of 75 µg/L has been derived using local ecotoxicological data and applies only when creek flows are greater than 1 cumec. Flows less than 1 cumec are indicative of groundwater-dominated inputs, which are likely to be higher in manganese. This guideline may be exceeded occasionally due to natural events but should not be exceeded due to mining activities.

The manganese concentration in the samples collected during the 2017-18 wet season were low and below the trigger value at the Gulungul Creek downstream site.

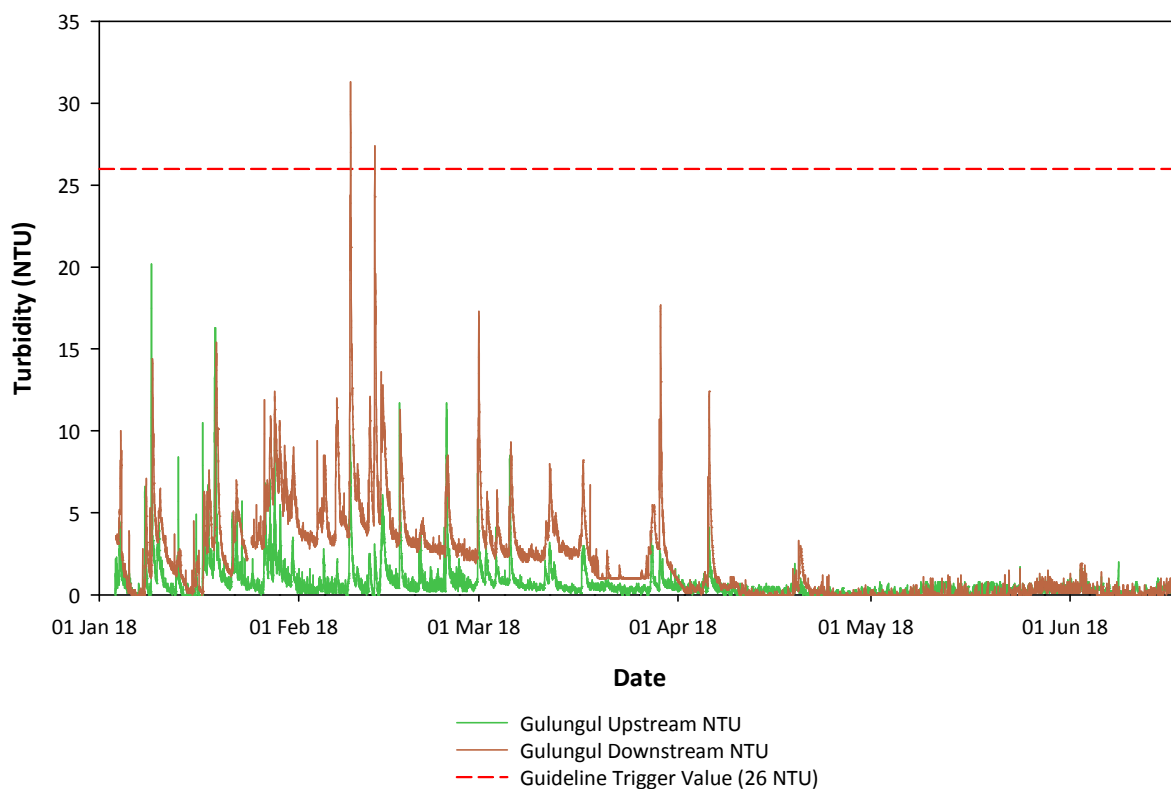


Gulungul Creek manganese data for the 2017-18 wet season (continuous EC data shown in background for reference, blue = upstream, red = downstream).

Turbidity in Gulungul Creek

The turbidity *Guideline Trigger Value* of 26 NTU has been derived statistically from historical weekly grab sampling data at reference sites, and applies to water quality measured in grab samples. This guideline may be exceeded occasionally due to natural events but should not be exceeded due to mining activities.

The turbidity values recorded in Gulungul Creek were generally below the guideline value for the 2017-18 wet season. Peaks in turbidity are associated with rainfall events and do not reflect a trend of increased turbidity at the downstream site, or a specific mining-related effect. At the downstream site, turbidity was recorded above the guideline value twice in February. These peaks coincided with large rainfall events and, although to a lesser extent, elevated NTU was also observed at the upstream site.

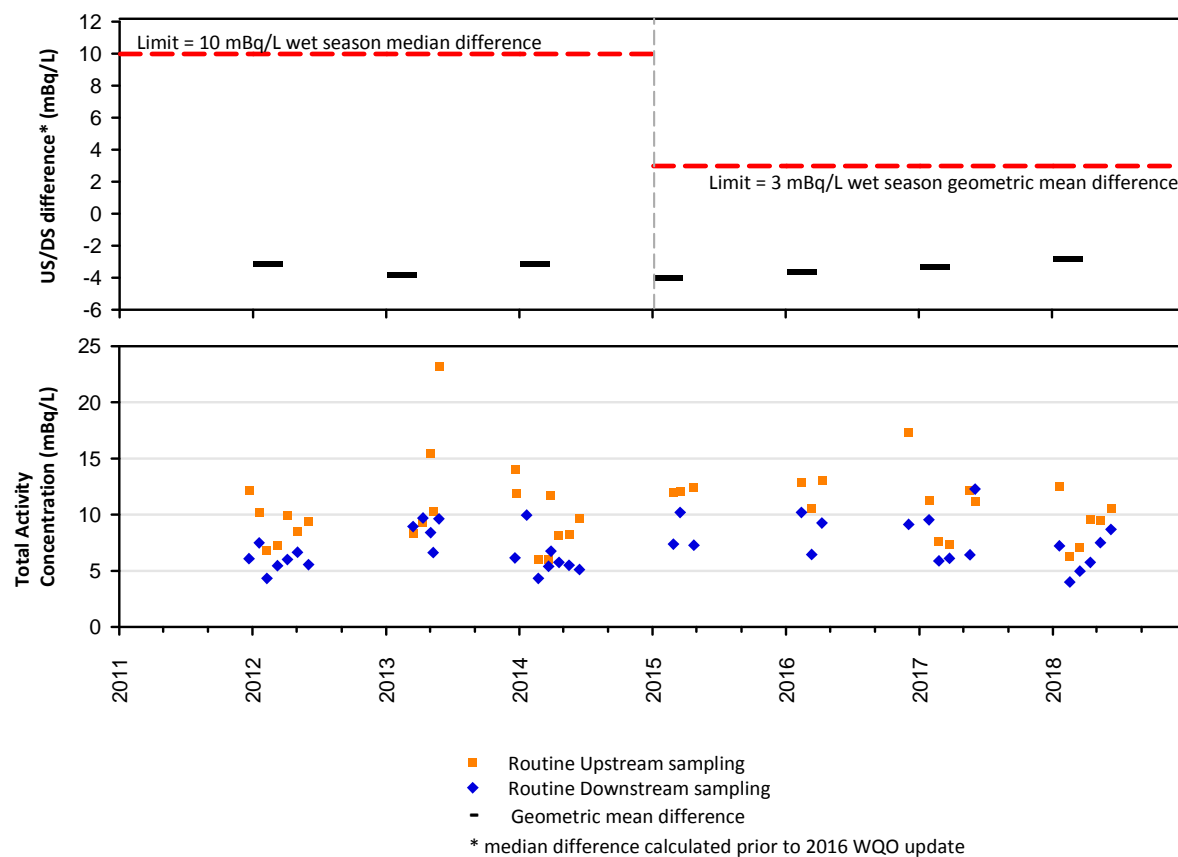


Gulungul Creek continuous turbidity monitoring data for the 2017- 18 wet season.

Radium-226 in Gulungul Creek

The activity concentration limit for radium-226 was developed to ensure the radiation dose received by people who consume mussels from downstream waterways remains below safe levels. The radium-226 *Trigger Value* of less than 3 mBq/L is calculated as the geometric mean difference between the upstream and downstream values for the entire wet season.

Radium samples are similar to previous seasons at both the upstream and downstream sites. The seasonal geometric mean remained below the 3 mBq/L trigger value for the 2017-18 wet season.



Historical Gulungul Creek Ra-226 monitoring data from the commencement of the 2011-12 wet season to the 2017-18 wet season.