STRATEGIC ENVIRONMENTAL
AND ENGINEERING CONSULTING

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Gene Gill
Transport for NSW
By email: Gene.Gill@transport.nsw.gov.au

our reference: 22000129-R-02
your reference:

14 June 2022

Dear Gene,

Review of Surface and Ground Water Quality: Windsor Bridge

Introduction

As requested, SEEC has coordinated a review of the Water Quality Management Program (WQMP) for the Windsor Bridge Replacement Project prepared by Jacobs on behalf of Transport for NSW. The WQMP describes the required water quality sampling and testing regime to determine if the proposed construction of the new bridge over the Hawkesbury River at Windsor has impacted local surface and ground water environments.

The surface water aspects of this review were undertaken by SEEC, and are detailed in the following report. Ground water quality aspects were assessed separately by Epic Environmental, and their summary is provided in a separate report.

Construction of the bridge commenced in 2018, the bridge was opened to traffic in May 2020 with the project operational in December 2020.

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Water Quality Management Program

The Water Quality Management Plan has been presented in the following reports which were included in this review.

- Jacobs (2021): Windsor Bridge Replacement Project - Construction and operational water quality monitoring report - October 2020 – September 2021. Technical Report. Prepared for Transport for NSW. 21 December 2021.
- Jacobs (2020b): Windsor Bridge Replacement Project - Construction water quality monitoring report - October 2019 – September 2020 (Year 2). Technical Report. Prepared for Transport for NSW. 30 November 2020.
- Jacobs (2020a): Windsor Bridge Replacement Project – Water Quality Management Program. Technical Report. Prepared for Transport for NSW. June 2020.

The WQMP confirmed baseline water quality and relevant water quality targets for surface water quality. The following targets have been established for the management of soil and water impacts during the project:

- Ensure full compliance with the relevant legislative requirements and the Ministers Conditions of Approval (MCoA).
- Meet Project water quality discharge parameters for all planned basin discharges (i.e. those within design capacity).
- Manage downstream water quality impacts attributable to the project (i.e. maintain waterway health by avoiding the introduction of nutrients, sediment and chemicals outside of that permitted by the environmental protection licence and/or ANZECC/ARMCANZ guidelines).
- Ensure training on best practice soil and water management is provided to all construction personnel through site inductions.

The WQMP committed to a minimum monitoring period of three years following the completion of construction or until the affected waterways and/or groundwater resources are certified by an independent expert as being rehabilitated to an acceptable condition. The monitoring shall also confirm the establishment of operational water control measures (such as sedimentation basins and vegetation swales).

The WQMP prepared by Jacobs should be referenced for further information.

Water Quality Samples

Sampling was conducted at the monitoring sites shown in Figure 1 and comprise:

- Pre-construction phase:
    - One dry weather event sampling per month for 6 months at 4 sites (NC-RS50, SC-RS50, NC-IS50 DS and SC-IS50 DS).

- Three wet weather sampling events over the 6 month period at all 6 sites (additional 2 wet weather sites, NC-CS1 and SC-CS2).

- Construction and demolition phase:
  - One dry weather sample collected at the end of each month at 8 sites (NC-RS50, SC-RS50, NC-IS50 DS, SC-IS50 DS, NC-IS10 US, NC-IS10 DS, SC-IS10 US, and SC-IS10 DS) and;
  - One wet weather sampling event from all 10 sites (including wet weather sites) within 24 hours of a rainfall event greater than 20mm.

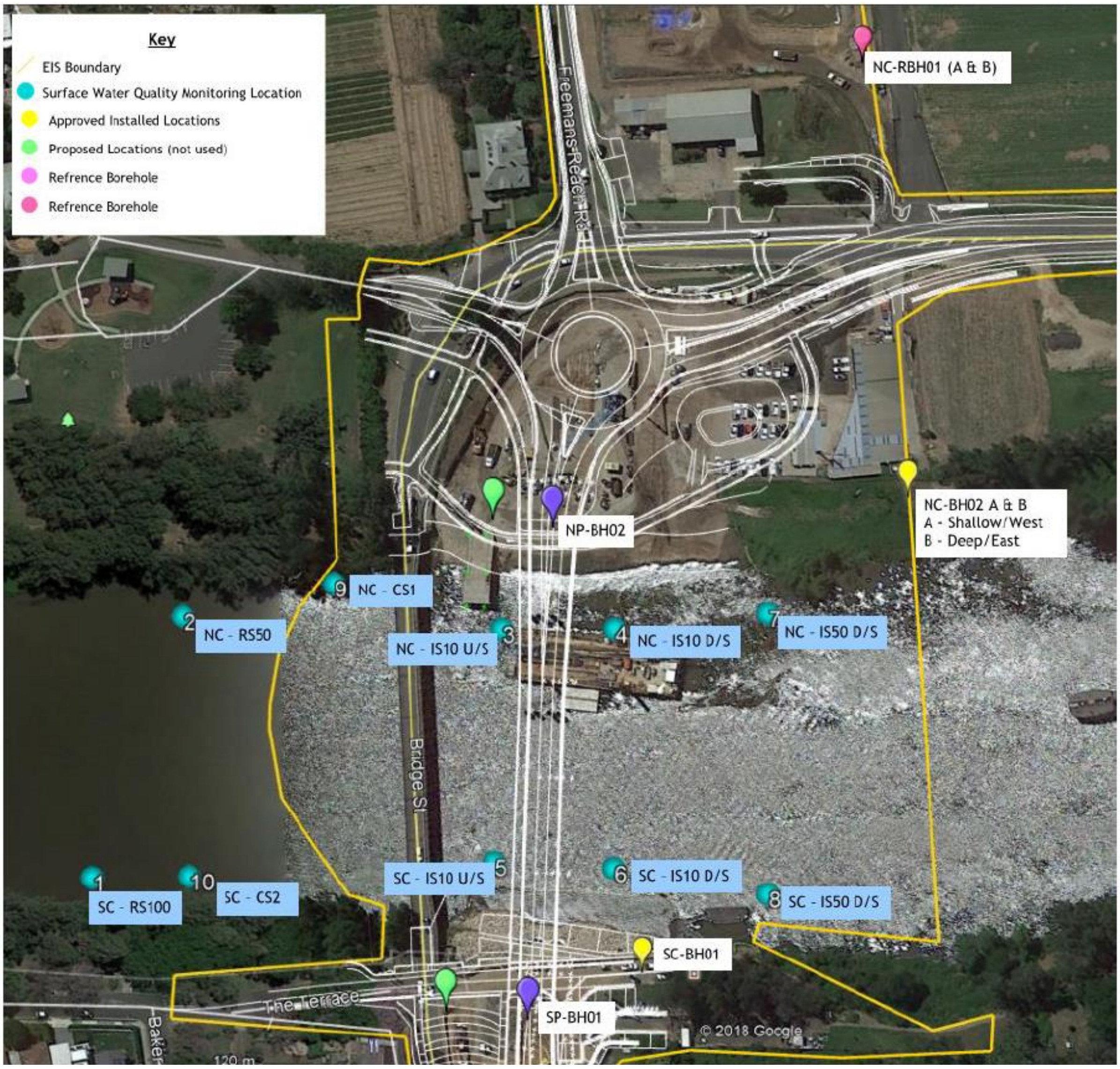

Figure 1: Monitoring locations (Source: Jacobs 2020)

Sampling was undertaken as per the WQMP, during the pre-construction, construction / demolition and post construction (operational) phase. Jacobs (2020b) reported that there were no controlled discharges from the site during the second year of construction and therefore this type of monitoring event did not occur. As such, monitoring during the construction phase comprised of a maximum of two events per month, one during dry weather and one during wet weather (when sufficient rainfall occurred).

Pre-construction phase monitoring ceased on 11 October 2018 following the third and final wet weather event during pre-construction. Construction phase monitoring commenced on 31 October 2018 and has continued on a monthly basis. Decommissioning and demolition of the original Windsor Bridge commenced in September 2020.

The WQMP states that operational-phase data will be collated after the first year of sampling and assessed by an independent water quality expert to review sampling data, sampling regime and frequency to determine if monitoring commitments can be reduced, changes can be made to improve the sampling regime or if surface water quality monitoring is to be discontinued. Key criteria to be considered by the Independent water quality expert are:

- Rehabilitated areas disturbed by the project are to have sufficient ground cover established to prevent erosion, and may be considered adequately rehabilitated once a C-factor of 0.05 (equivalent to 70 per cent ground cover) is achieved and is likely to be maintained (Landcom, 2004)
- Operational phase monitoring confirms operational water control measures (northern retention basin, southern Gross Pollutant Trap (GPT) and surface control measures including the vegetated swales) are meeting water quality parameters representative of baseline results and relevant receiving water parameter guidelines.

The following parameters were analysed during all phases of surface water monitoring.

- pH
- Turbidity
- Temperature (deg C)
- Dissolved oxygen
- Electrical conductivity
- Redox potential
- Total suspended solids
- Total dissolved solids
- Total nitrogen
- Total phosphorus
- Inorganics and heavy metals
- Organic compounds
- Major anions
- Major cations

Potential post construction water quality risks identified in the WQMP include:

- Hydrocarbons and combustion derivatives, lubricating oil, rubber, heavy metals (such as lead, zinc, copper, cadmium, chromium and nickel) and brake pad dust.
- Non-biodegradable garbage and food wastes.

- Accidental spillage of petroleum, chemicals or other hazardous liquids.

Site Specific Trigger Values

The WQMP states that data collected during construction, demolition and operation phases was compared to their relative ANZECC/ARMCANZ (2000a) guidelines or Site Specific Trigger Values (SSTVs), which is the 80th or 20th percentile (depending on the parameter) of a data set, of the reference and baseline data set from upstream and downstream data. Data collected during construction, operation and demolition will be compared to reference sites to ensure climatic variations are considered and aid in the identification of potential construction/operation/demolition impacts on water quality.

The SSTVs for reference and upstream sites for surface water quality are to be derived during pre-construction baseline sampling and consistently (after each monitoring event) updated with newly collected monitoring data. The updated SSTVs at reference/upstream sites have therefore been updated with the latest monitoring data.

Water quality results from the post construction phase were also compared with the nominal trigger values from ANZECC guidelines. The ANZECC values are provided in Table 1 together with the SSTVs (80^{th} and 20^{th} percentile values) from the north and south bank reference sites located upstream of the project site. Values that exceed the ANZECC trigger values have been highlighted.

Table 1: Summary ANZECC trigger values and Site Specific Trigger Values.

Parameter	Guideline Value	North Bank		South Bank	
		80^{th} %ile	20^{th} %ile	80^{th} %ile	20^{th} %ile
pH	6.5 – 8.5	7.69	6.89	7.75	7.1
Turbidity (NTU)	< 50	32.3	14.1	29.2	12
Temperature (Deg C)	N.G	24.494	16.438	24.64	16.708
Dissolved Oxygen (%)	85-110	101.8	76.7	107.8	78.5
Electrical Conductivity (ms/cm)	0.125-2.2	0.362	0.179	0.35	0.1703
Redox Potential ORP (mV)	N.G.	177.13	52	167.8	36.86
Salinity (ppt)	N.G.	0.182	0.094	0.176	0.097
Total Suspended Solids (mg/L)	50	20	10	18	8
Total Dissolved Solids (mg/L)	N.G.	206	116	205.6	126.4
Calcium (mg/L)	N.G.	12	7	11	7
Magnesium (mg/L)	N.G.	8	5	8	5
Sodium (mg/L)	N.G.	44	18	42	18
Potassium (mg/L)	N.G.	5	3	5	3
Total Nitrogen (mg/L)	0.35	1.08	0.6	1.16	0.6
Total Phosphorus (mg/L)	0.025	**0.05**	0.016	**0.07**	0.02
Zinc	0.008	**0.0116**	0.0068	**0.0116**	0.007

Parameter	Guideline Value	North Bank		South Bank	
		80th %ile	20th %ile	80th %ile	20th %ile
Manganese	1.9	0.0358	0.0024	0.0314	0.004
Aluminium	0.055	**0.09**	0.02	**0.078**	0.02
Chromium	0.001	0.002	0.001	0.0026	0.001
Lithium	N.G.	0.008	0.002	0.008	0.002
Iron	0.3	**0.334**	0.092	**0.36**	0.082
Hydrocarbons (Polynuclear Aromatic Hydrocarbons)	Generally N.G.	< Limit Of Reporting	< Limit Of Reporting	< Limit Of Reporting	< Limit Of Reporting
Total Petroleum Hydrocarbons	N.G.	< Limit Of Reporting	< Limit Of Reporting	< Limit Of Reporting	< Limit Of Reporting
Pesticides (Organochlorine and Organophosphorus)	Generally N.G.	< Limit Of Reporting	< Limit Of Reporting	< Limit Of Reporting	< Limit Of Reporting

N.G = No Guideline

Surface Water Quality Results During Construction Phase

Water samples were collected between October 2019 and September 2020. Jacobs noted the following limitations.

- Significant rainfall occurred between 7 and 10 February 2020 (205 mm) resulting in extremely high water levels. The river was inaccessible and unable to be sampled within 24 hours of the event for safety reasons. Therefore, this wet weather event was not monitored. Additional rain fell on 13 February 2020 (15.6mm), 14 February 2020 (9.2mm) and 16 February 2020 (13.2m) with monitoring undertaken on 17 February 2020, and classified as a wet (post flood) event.
- Sampling undertaken on 27 February 2020, whilst classified as a dry event, was still showing evidence of flood from the rainfall event two weeks prior as mentioned above.
- The 80th and 20th percentile trigger values have been recalculated during both dry and wet weather for reference sites to incorporate pre-construction and ongoing construction monitoring results. The ANZG (2018) recommend a minimum of 24 sampling events required to determine site specific trigger values (SSTVs). For dry weather a total of 23 sampling events have been used in deriving the SSTVs up until September 2020 and therefore, technically do not meet the minimum number. There were insufficient wet weather events to determine SSTVs for wet weather.

Plots of the sampled water quality are provided in Jacobs WQMP (2020b) and examples are provided below.

North Bank - Dry Weather

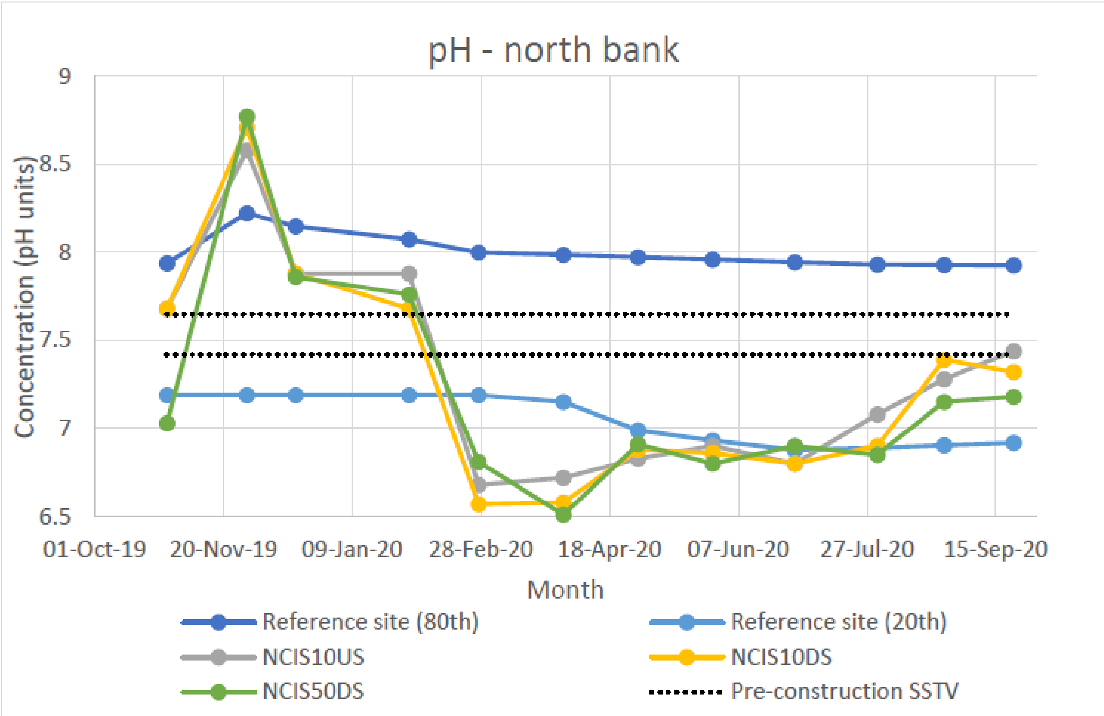

Figure 2: Example dry weather plots for pH at the north bank locations, construction phase.

North Bank - Dry Weather

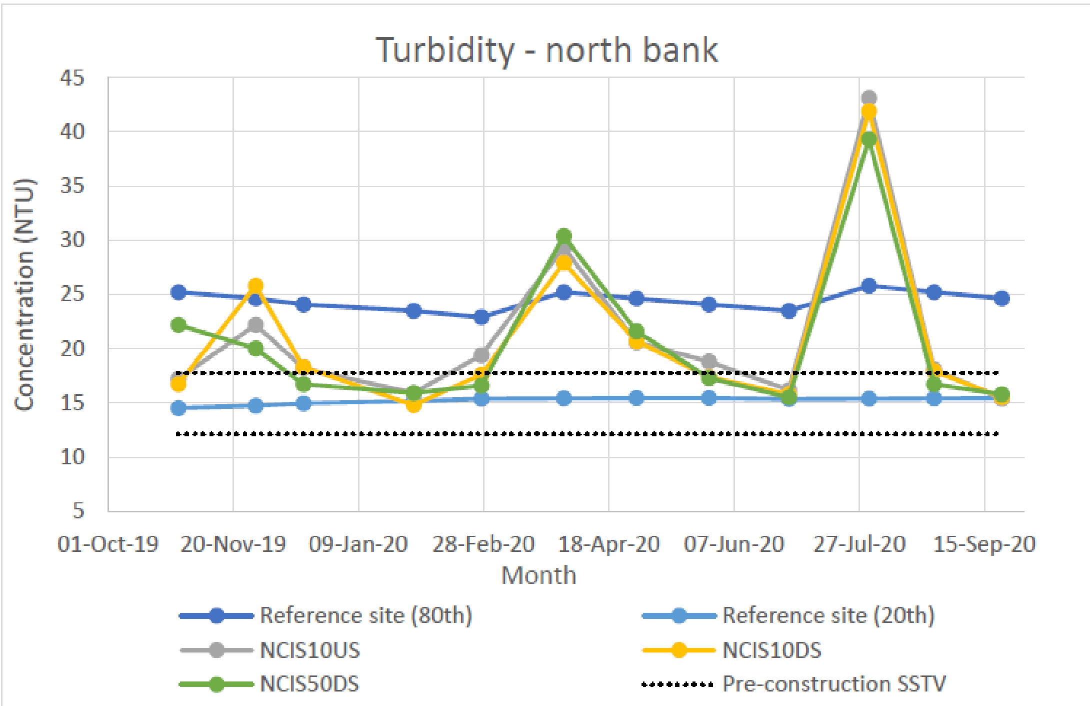

Figure 3: Example dry weather plots for Turbidity at the north bank locations, construction phase.

The Jacobs report highlighted that although the SSTVs were not met, on most occasions the pH levels were within ANZECC trigger values and were only exceeded during large rainfall events. Turbidity levels were lower than the ANZECC trigger values and were generally within the SSTVs except after significant rainfall events.

Dissolved oxygen levels exceeded the ANZECC levels (above and below the trigger values) however the sampling location closer to the construction site had better water quality than the sample further downstream indicating the fluctuation was unlikely to be due to construction activities.

Total Nitrogen (TN) and Total Phosphorus (TP) exceeded the SSTVs and the ANZECC guideline values however they were generally less than the 80th perceentile value from the reference site. TP spiked above the reference site values on two occasions however the upstream values rose even higher indicating that the increase was unlikely to be due to construction activities.

Metal concentrations were generally below the Limit of Reporting and within the ANZECC guidelines where available. Exceptions included aluminium, chromium and iron concentrations which peaked once after heavy rainfall, as did the upstream concentrations. Hydrocarbons and pesticides were detected during the construction period. Given that the increases correlated with upstream increases, these fluctuations were unlikely to be due to construction activities.

A summary of the plots are provided in Table 2. Wet weather results are provided in brackets. North bank results include NCIS10US, NCIS10DS and NCIS50DS. South Bank results include SCIS10US, SCIS10DS and SCIS50DS.

The comparison between upstream and downstream results is also included to provide an indication if water quality decreased downstream of the site.

Table 2: Summary of results during the construction phase against the SSTVs and ANZECC trigger values.

Parameter	North Bank (Wet Weather)			South Bank (Wet Weather)		
	SSTV	ANZECC	DS < US	SSTV	ANZECC	DS < US
pH	No	No (No)	No (No)	No	No (No)	No (No)
Turbidity (NTU)	No	Yes (No)	No (Yes)	No	Yes (No)	No (Yes)
Dissolved Oxygen (%)	No	No (No)	No (Yes)	No	No (No)	No (No)
Total Nitrogen	No	No (No)	No (No)	No	No (No)	Yes (No)
Total Phosphorus	No	No (No)	No (No)	No	No (No)	No (No)
Aluminium	No	No (No)	Yes (No)	No	No (Not Accessible)	Yes (Not Accessible)
Lithium	Yes	N.G.	Yes (Yes)	Yes	N.G.	Yes (Not Accessible)
Iron	No	No (No)	No (No)	No	No (No)	No (Yes)

N.G. = No Guideline value
DS = Downstream
US = Upstream
Yes = Within nominated WQO either SSTV or ANZECC
No = Exceeded nominated WQO either SSTV or ANZECC
(Yes/No) = Wet weather results

Surface Water Quality Results Post Construction Phase

Water samples were collected during the final two months of construction (October and November 2020) and post construction from December 2020 to March 2022. Plots of key water quality parameters and a description of the test results are provided below for both the north bank sites and the south bank sites. The plots match the format previously presented by Jacobs for consistency.

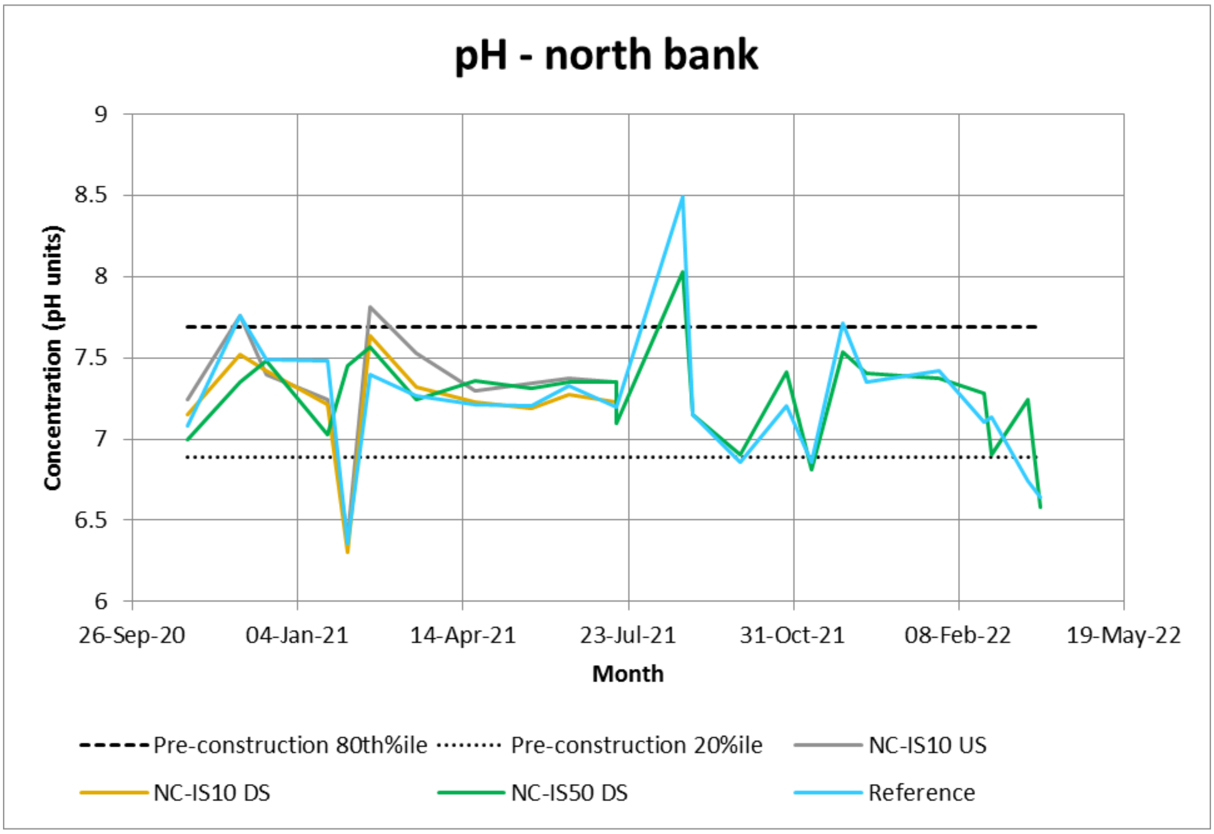

Figure 4: Plot of pH at the north bank locations, post construction phase.

Based on the data in Figure 4, pH is generally within the pre-construction SSTVs and within the ANZECC guideline values (8.5-6.5) except for 6.39 on 3 February 2021 and 6.29 on 22 March 2022, both of which were wet days. pH also decreased at the upstream reference site indicating that the variation was unlikely to be due to the Windsor Bridge project.

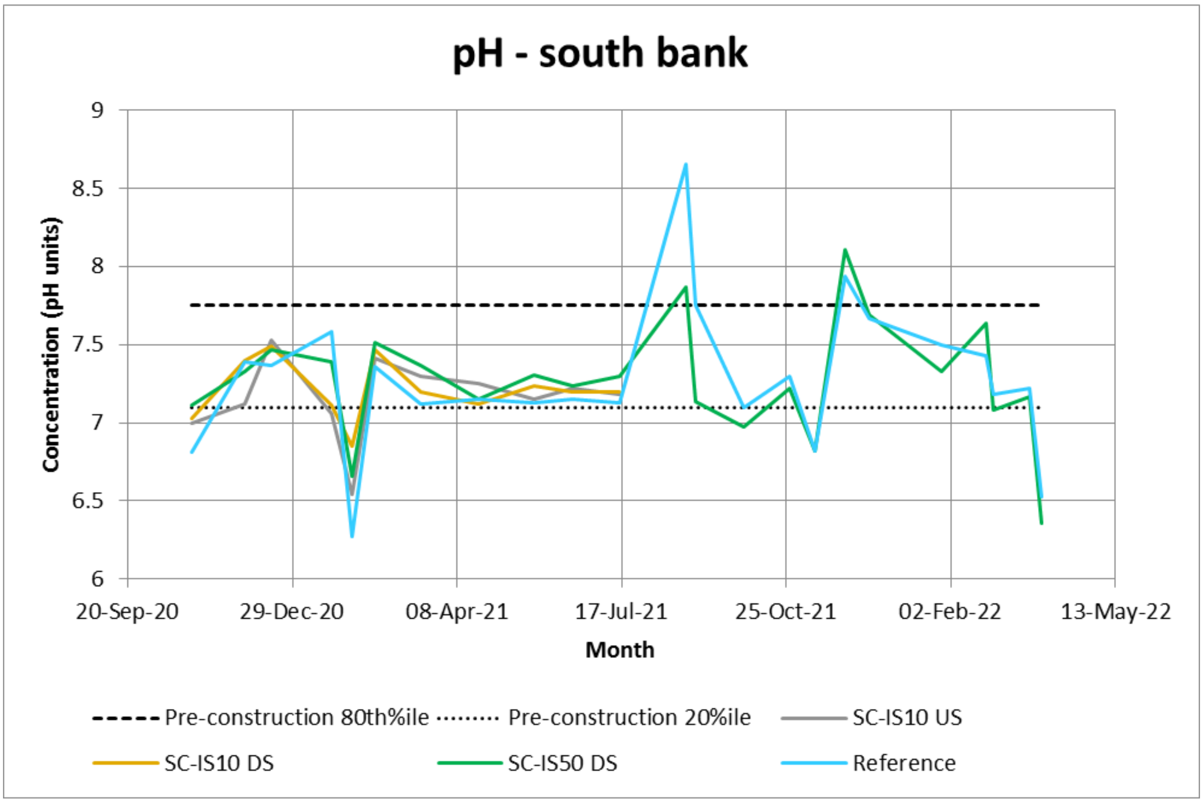

Figure 5: Plot of pH at the south bank locations, post construction phase.

Turbidity was generally within the SSTVs and was lower than the ANZECC guideline value of 50 NTU. Turbidity only exceeded the SSTVs following rainfall and matched the change in turbidity observed at the upstream reference site.

The south bank impact site 50m downstream of the bridge had two instances where turbidity exceeded the ANZECC trigger value. Both were following significant rainfall events in August 2021 and March 2022. The downstream turbidity during the August event exceeded the upstream reference site turbidity however the March event did not. This increase could have been due to exposed soil at the project site however given the possibility that turbidity could have been derived from surrounding agricultural lands, it is not possible to confirm this. Furthermore and as noted above, this anomaly was not repeated during the March 2022 wet weather event.

Several other high rainfall events occurred after the August 2021 round of monitoring, and the turbidity at the project impact site was consistently less than the reference site. This indicates that, if the August 2021 increase was due to construction activities, it had been resolved, possibly by the completion of works and the application of ground cover to limit erosion.

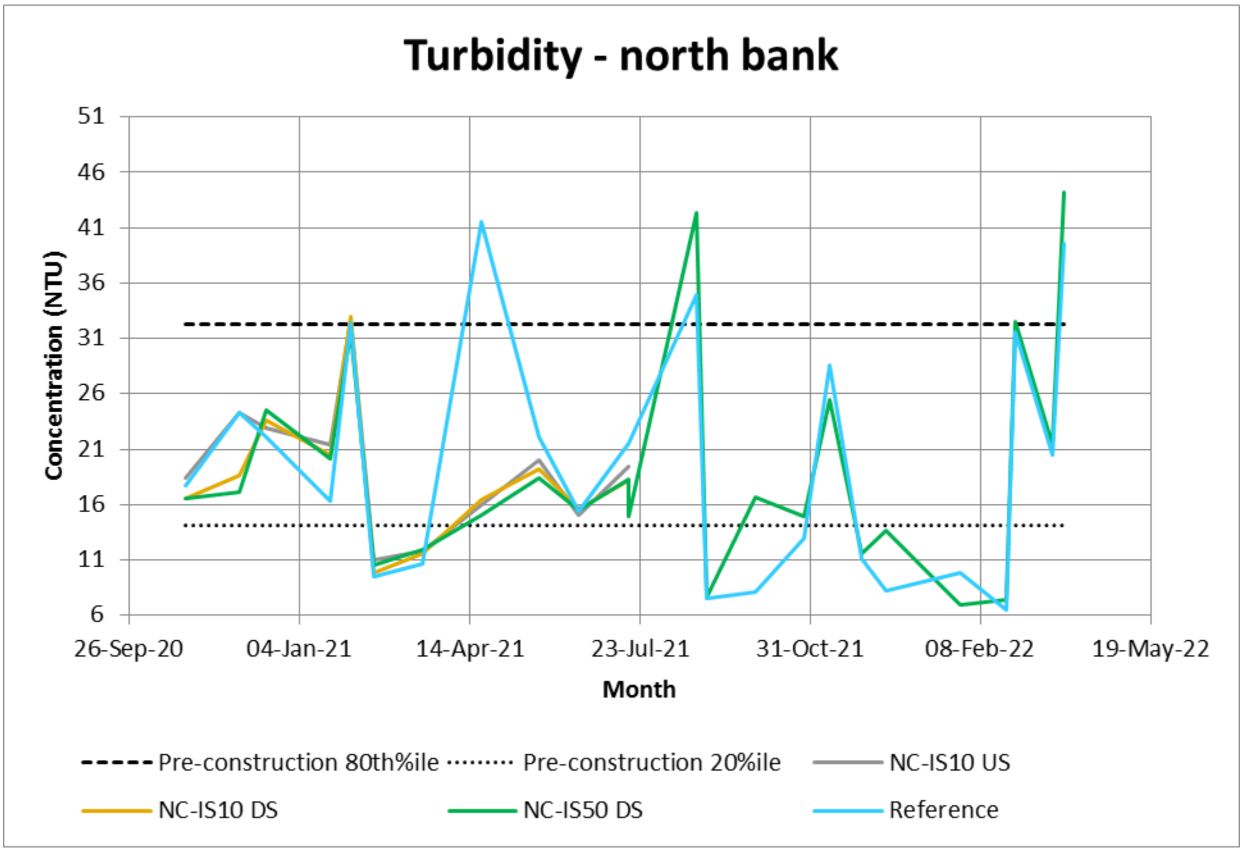

Figure 6: Plot of Turbidity at the north bank locations, post construction.

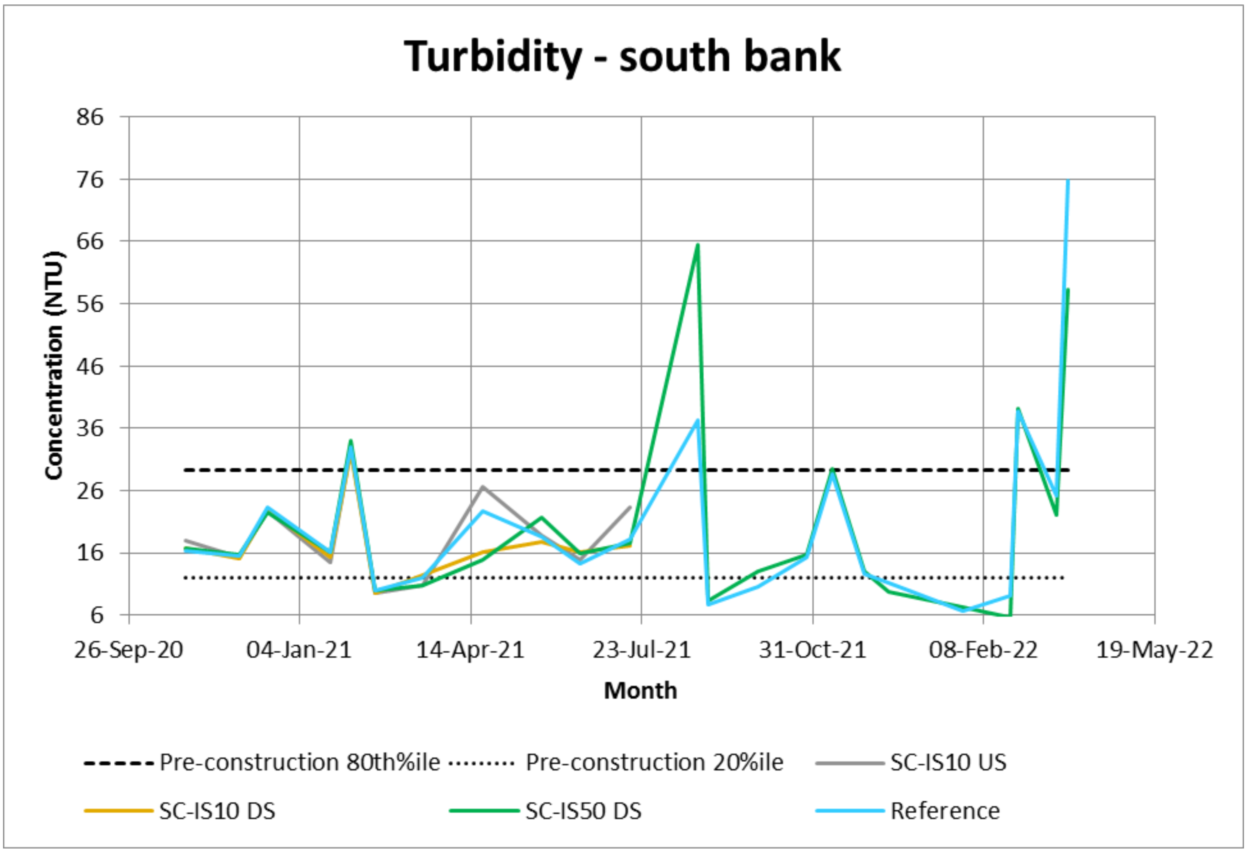

Figure 7: Plot of Turbidity at the south bank locations, post construction.

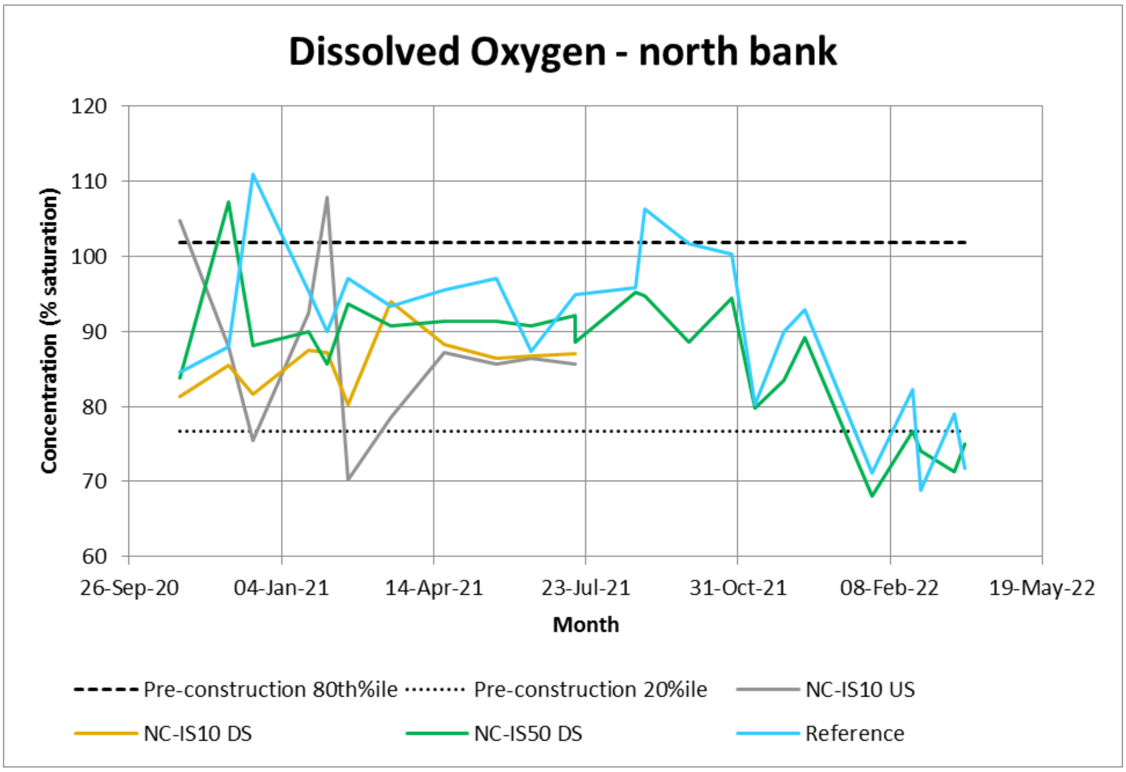

Figure 8: Plot of Dissolved Oxygen at the north bank locations, post construction.

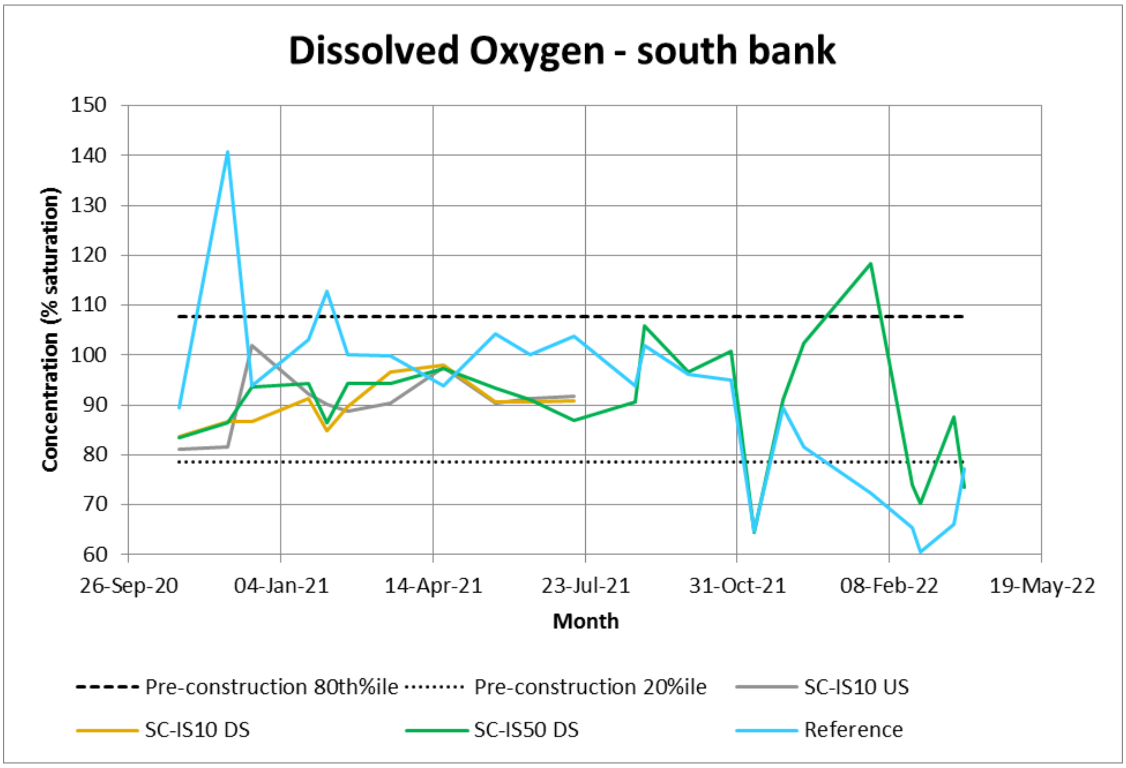

Figure 9: Plot of Dissolved Oxygen at the south bank locations, post construction.

Dissolved oxygen was generally within the SSTVs. Values dropped below the SSTVs at the north bank between February and March however this trend also occurred at the reference site indicating that it is unlikely that the project was the cause for the observed change in dissolved oxygen levels.

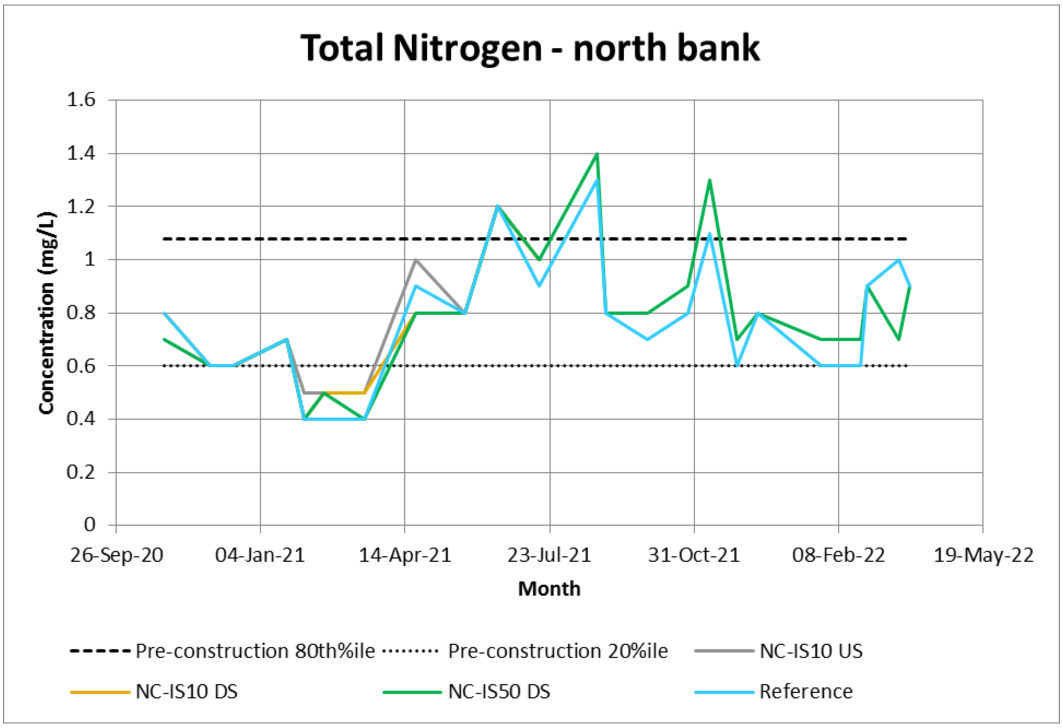

Figure 10: Plot of Total Nitrogen concentrations at the north bank locations, post construction.

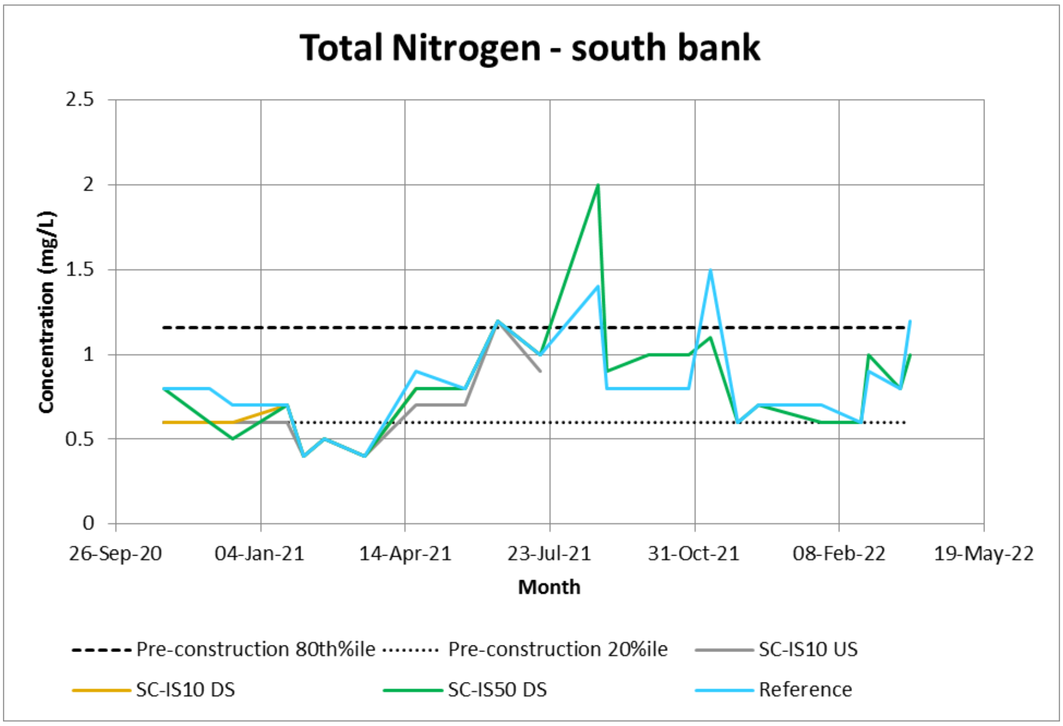

Figure 11: Plot of Total Nitrogen concentrations at the south bank locations, post construction.

Total nitrogen levels exceeded the ANZECC trigger value of 0.35mg/L but were generally within or below the SSTVs. Observed increases occurred after rainfall events apart from the elevated value observed on 17 June 2021. However this increase also occurred at the reference site indicating that it is unlikely that the project was the cause for the observed change in nitrogen concentrations. The south bank had a spike on 25 August 2021 following a significant rain event. It is unclear if this was due to the project, and we noted that nitrogen levels were below the reference site for all subsequent rain events.

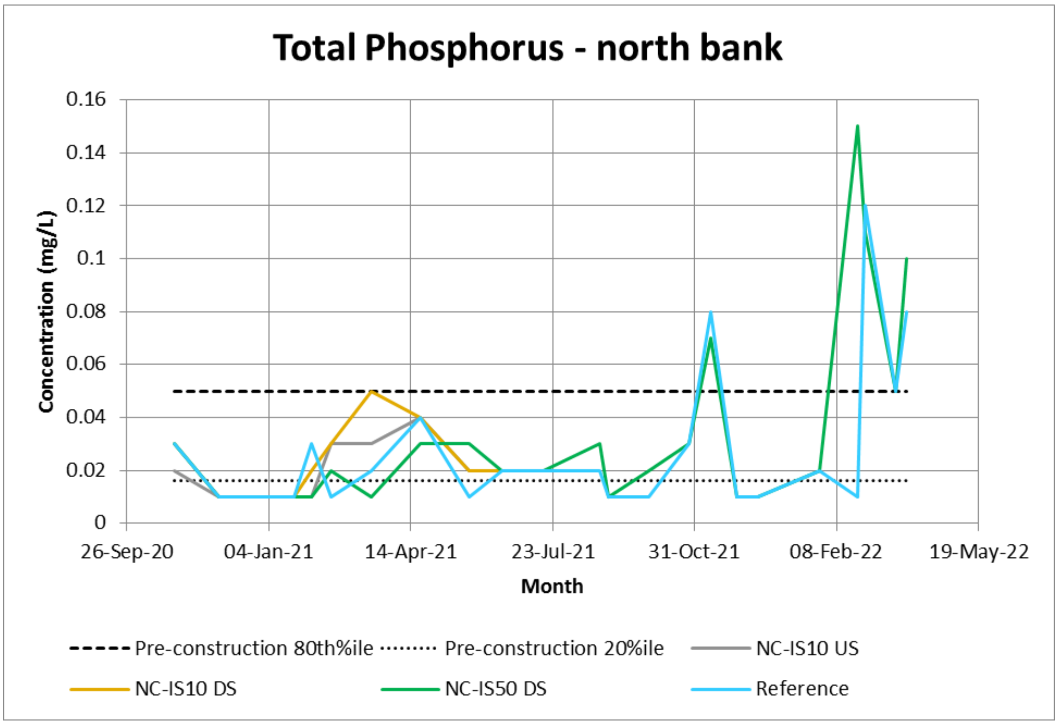

Figure 12: Plot of Total Phosphorus concentrations at the north bank locations, post construction.

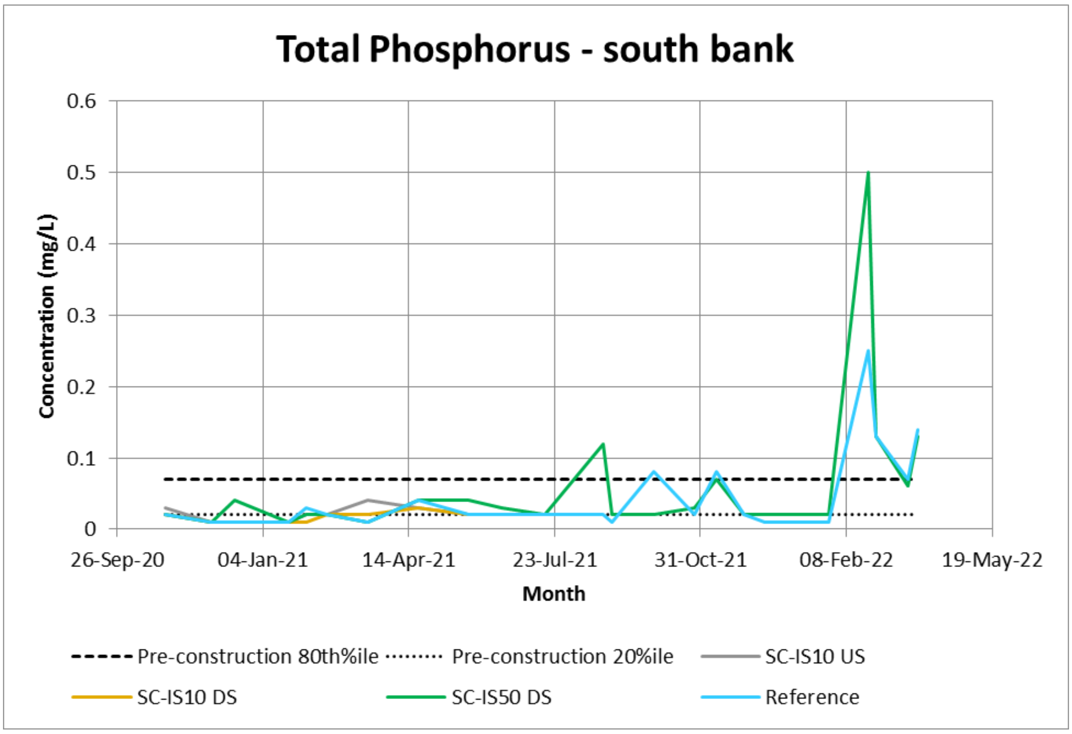

Figure 13: Plot of Total Phosphorus concentrations at the south bank locations, post construction.

Total phosphorus levels exceeded the ANZECC trigger value of 0.025mg/L several times but were generally within the SSTVs. Observed increases occurred after rainfall at both the impact sites and at the reference site. The spike after the rainfall event on 23 February 2022 exceeded the reference site increase however the recorded value at SC-CS2 (upstream south bank wet weather site) had a Total Phosphorus value of 0.51mg/L which was more than the value recorded downstream. As any increases also occurred upstream or at the reference site it is unlikely that the project caused any change in observed phosphorus concentrations.

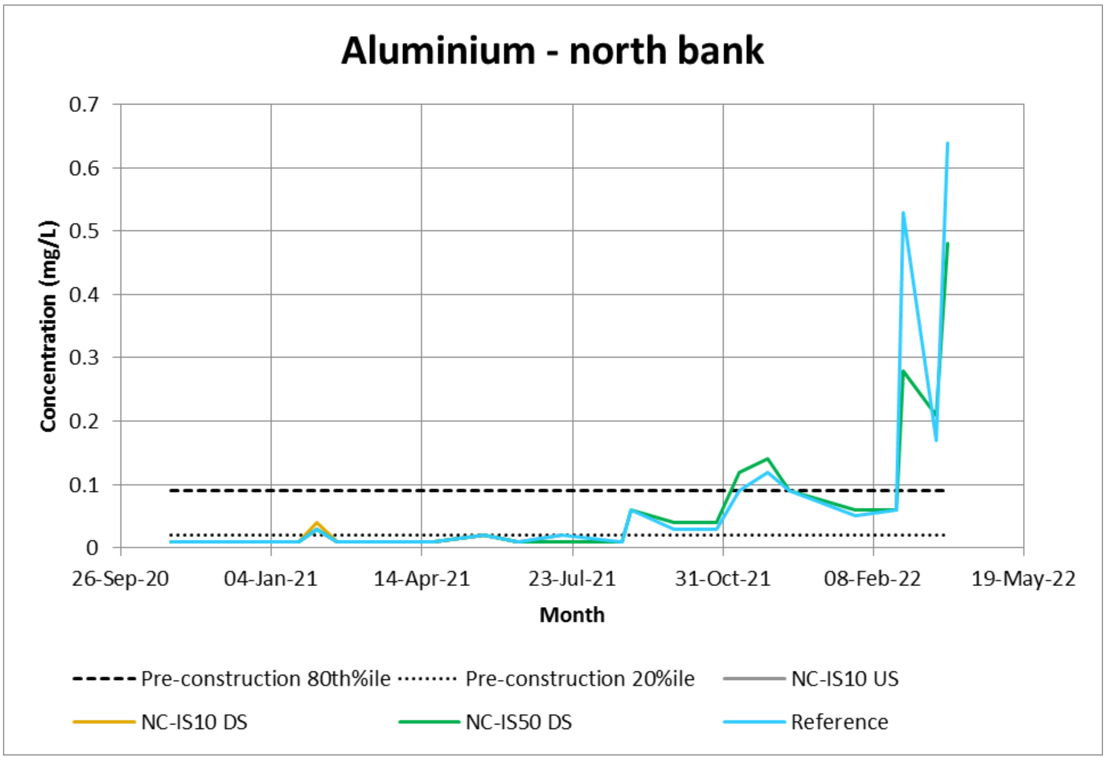

Figure 14: Plot of Aluminum concentrations at the north bank locations, post construction.

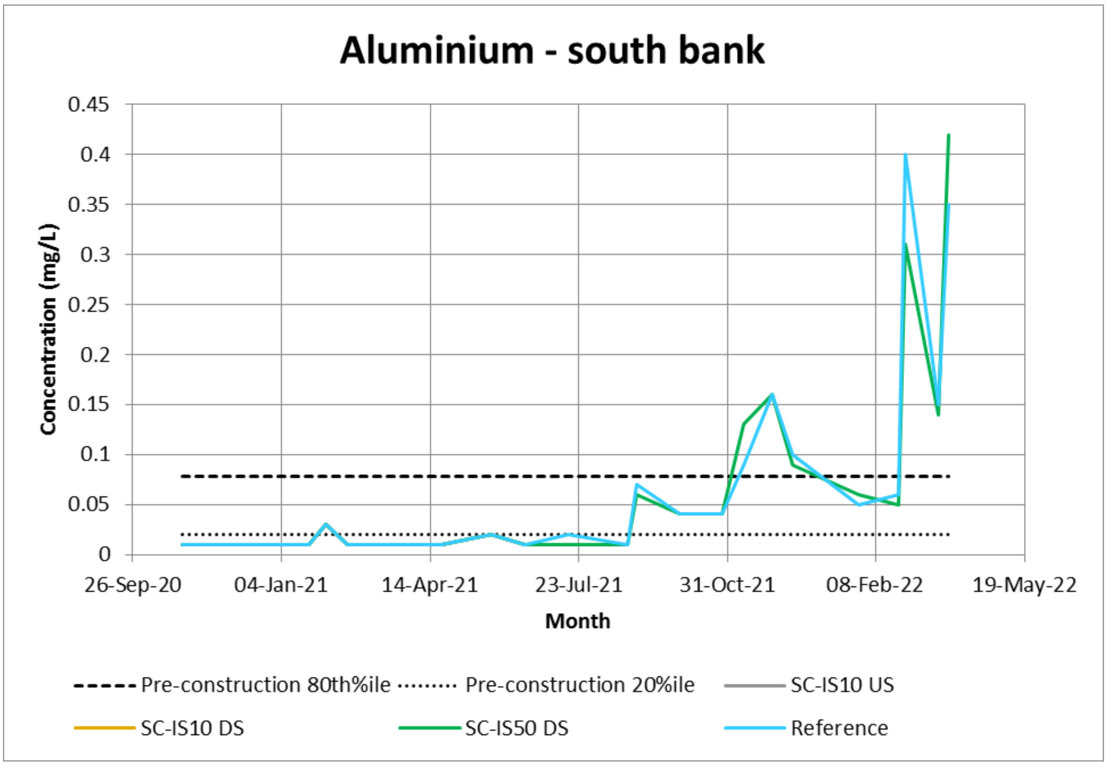

Figure 15: Plot of Aluminum concentrations at the south bank locations, post construction.

Aluminium levels were below the SSTV and ANZECC trigger value of 0.055mg/L between September 2020 and August 2021 (i.e. during the construction period). However after this date aluminium levels spiked above the SSTV and the ANZECC trigger levels. This increase also occurred at the upstream reference site indicating that it is unlikely that the project was the cause of the observed change in aluminium concentrations.

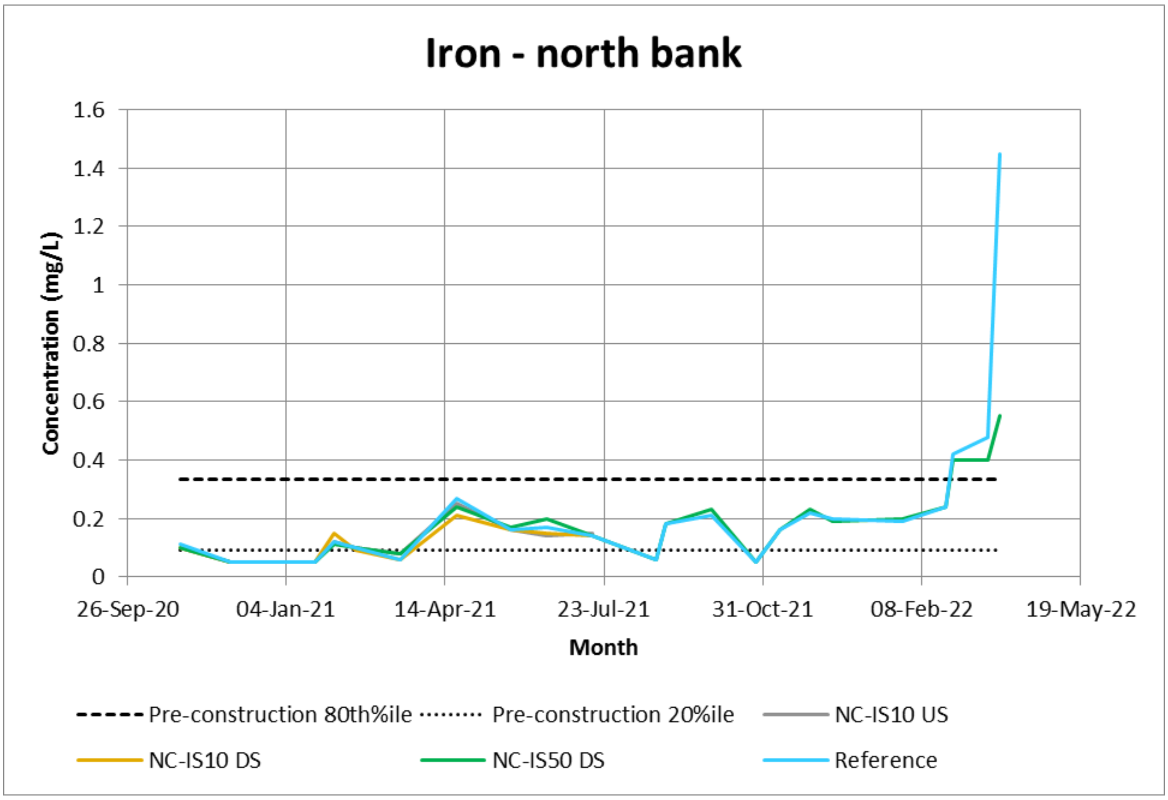

Figure 16: Plot of Iron concentrations at the north bank locations, post construction.

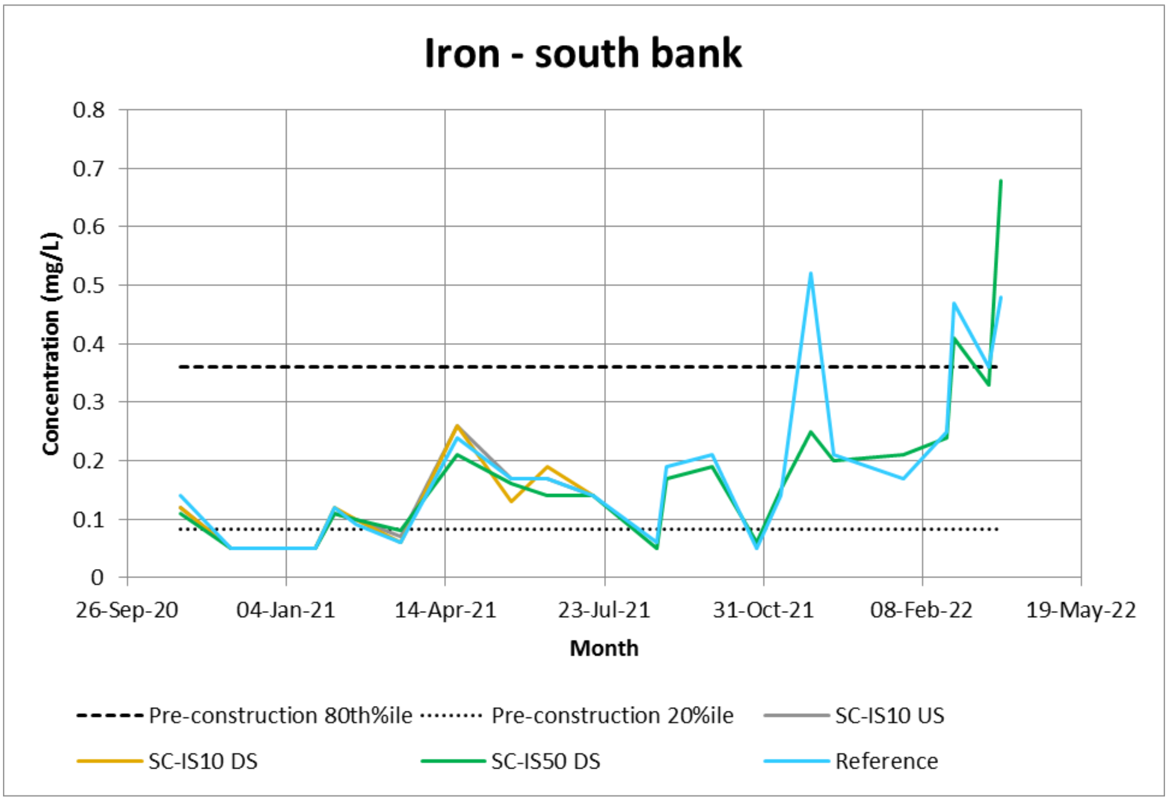

Figure 17: Plot of Iron concentrations at the south bank locations, post construction.

Similar to the observed aluminium concentrations, iron levels were below the ANZECC trigger value of 0.3mg/L and then spiked towards the end of the monitoring period. Prior to this time there were no increases above the SSTV. The final observed iron concentration for the south bank exceeded the value recorded at the reference site and at the upstream wet weather monitoring site (SC-CS2). As the monitoring occurred after a major flood event (590mm recorded in March 2022) it is difficult to conclude that the increase is based solely as a result of the project when flood water would likely still be contaminated from runoff from an extended catchment well upstream of the project site.

Lithium concentrations were lower than the SSTV of 0.008mg/L except for 11 November 2021, when they reached 0.09mg/L at the north bank. As the upstream reference site also reached 0.009mg/L it is unlikely that the project was a causal factor in the observed changes in lithium concentrations.

Site Inspection

Andrew Macleod from SEEC undertook a site inspection on 13 April 2022. The region was impacted by significant rainfall in early March (429.8mm 1 to 9 March 2022 and 137.4mm 24 to 31 March 2022) which resulted in flood levels overtopping the bridge.

Figure 18: Photos of Windsor bridge during and after the March flood event. Source: http://www.extremestorms.com.au/windsor-after-the-flood-the-cleanup-begins-sunday-13-march-2022/

Andrew observed some flood damage to the soft landscaping which was in the process of being repaired. The bridge, bank and associated scour protection works appeared to be unaffected as the rock armouring was designed for the 1 in 2000 year Average Recurrence Interval (ARI) flood event. Given the full extent of flooding at the site, the observed level of damage appeared minimal.

The site inspection indicated that the although the site was damaged by the recent floods, rehabilitated areas disturbed by the project have sufficient ground cover established to prevent erosion, and are considered to be adequately rehabilitated with a C-factor no higher than 0.05 (equivalent to at least 70 per cent ground cover in accordance with Landcom, 2004). As observed on site, maintenance work has been ongoing to repair and maintain an adequate level of groundcover after the recent flood events.

Figure 19: Landscaping damaged by floodwaters and deposited silt on service road.

Figure 20: Under bridge looking south.

Figure 21: Looking north to the old bridge abutment.

Figure 22: Old bridge alignment with a rock armoured and grassed bank.

Recommendations

The sampling undertaken since construction was completed in December 2020 has monitored the operational phase of the bridge across a range of climatic events. Testing of individual retention basins, Gross Pollutant Traps and other surface water quality control measures such as vegetated swales has not been undertaken however the sampling of the receiving waters downstream of the project site and comparison with upstream reference sites indicates that the project has not impacted water quality based on the results provided to SEEC.

Based on these observations it is concluded that the site has been rehabilitated to an acceptable condition and that regular monthly surface water quality monitoring can be discontinued.

If you would like to discuss any aspect of the above, please feel free to contact me on 02 4862 1633 or 0407 261 515 or bjohnson@seec.com.au.

Yours faithfully,

Bill Johnson
Director, SEEC