Appendix B – Surface Water Assessment

PROJECT

SURFACE WATER ASSESSMENT
TWEED SAND PLANT EXPANSION
CUDGEN, NEW SOUTH WALES

PREPARED FOR

HANSON CONSTRUCTION MATERIALS PTY LTD

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SYNOPSIS This report describes the methodology and results of a Surface Water Assessment undertaken for the proposed expansion of the Hanson Construction Material's Tweed Sand Plant located in Cudgen, New South Wales. This report was prepared to satisfy the requirements of the Secretary's Environmental Assessment Requirements (SEAR) issued for the Project in December 2019.

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SUMMARY

Hanson Construction Materials Pty Ltd (Hanson) commissioned Gilbert & Sutherland Pty Ltd (G&S) to prepare a Surface Water Assessment (SWA) for the proposed expansion of its Tweed Sand Plant (TSP) located in Cudgen, New South Wales ('the site').

This report was prepared to satisfy the requirements of the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project in December 2019.

Surface water quality
An ongoing program of surface water quality compliance monitoring has been undertaken at the TSP site since 2001, resulting in a comprehensive data set for the site. Building on the existing water quality monitoring program, a further eight rounds of surface water monitoring were conducted across the proposed expansion area between March and October 2020, to establish baseline conditions and determine similarities and differences between the expansion area and current TSP site.

To provide context for the current water quality performance of the TSP site, surface water results were also compared with a selection of relevant guidelines including the;

- Tweed River Water Quality Objectives,
- ANZECC Water Quality Guidelines and
- NHRMC Recreation Water Quality Guidelines for primary contact recreation.

pH

The long-term median for pH of surface waters within the TSP Lake is 8.34. This value marginally exceeds the Tweed River Water Quality Objective of 8.0 but complies with the ANZECC 2000 criteria for primary contact recreation of 6.5 to 8.5.

Elevated pH results such as these can result from a variety of contributing factors, including the inherent acid neutralising capacity of the carbonate-rich materials within the strata at TSP, as well as algal growth which consumes carbon and produces hydroxide during photosynthesis thus increasing the pH of surface waters.

Dissolved oxygen

Dissolved oxygen concentrations within the TSP lake remain above the Tweed River, ANZECC and NHRMC Guideline minimums of 6.0 mg/L. As a constituent measure of waterbody health, DO at concentrations observed within the extraction lake are ideal for supporting normal aquatic ecosystem function.

Low DO concentrations were observed within agricultural drains located across the expansion footprint reflecting the no-flow conditions observed during monitoring events. These conditions favour high water temperatures, algal growth and decomposition of organic matter leading to poorly oxygenated environments that are characteristics of shallow drainage channels such as these.

Metals

Metal-rich surface waters (Al, Fe) commonly result from the disturbance of acid sulfate soils, where the oxidation of pyrite in disturbed soils increases the solubility of these metals. Negligible concentrations of metals were detected within the surface waters of the TSP lake and within the agricultural drains throughout the expansion site. Long term median levels within the TSP lake remain compliant with the ANZECC performance criteria for aquatic ecosystem protection and primary contact recreation.

Nutrients

Long-term median results for total nitrogen and total phosphorus recorded within the TSP lake exceed the Tweed River and ANZECC water quality objectives.

The dredging process can result in the release of nutrients or other toxicants contained within pore waters into the dredge lake with resulting water quality issues such as algal blooms. Long term groundwater monitoring of the existing TSP site and recent monitoring within the expansion area has recorded elevated nutrient levels within the site's groundwater environment likely related to the historic agricultural uses of the land.

Elevated nutrient levels have been recorded within the TSP lake although due to dilution from rainfall inflows, the levels are substantially lower than within the groundwater environment and are similar to those recorded within the nearby Tweed River.

Faecal coliforms

Bacteriological analyses of surface waters indicated low levels of faecal coliforms and enterococci, consistent with performance criteria for primary contact recreation.

The water quality recorded at the TSP site has remained largely stable over time. The soil and water management practices implemented at the site to date have proven successful in maintaining and in some instances improving water quality within the extraction lake. With continued implementation of existing soil and water management practices it is anticipated that existing water quality at the site will be maintained long-term.

Site water balance

A surface water balance model was developed for the site and verified against continuously monitored lake water levels over a 7 month period in 2020. The water balance was subsequently used to estimate the anticipated hydrological behaviour of the lake for each future phase of the development.

The model results indicate that:

- The median southern lake level for the currently approved phases of the development (Phases 1-4) is estimated to be RL 0.40 mAHD, providing 0.60 m freeboard to the overtopping level of 1.00 mAHD.
- The median lake level will increase to 0.67 mAHD, when the external catchment comes online in Phase 6.
- The median southern lake level is then expected to reduce gradually as the lake area expands, stabilising at 0.58 mAHD in the long term (Phase 9 onwards), providing 0.42 m freeboard.
- The median level in the north lake is estimated to be 0.37 mAHD in the long term, providing 0.63m freeboard.
- For the currently approved phases of the development (Phases 1-4), discharge from the southern lake is estimated to occur in 18% of years which equates to once every 5-6 years.
- Discharge frequency is estimated to increase to 58% of years (more than once every 2 years) when the southern external catchment comes online in Phase 6.
- Long term, discharge from the southern lake is estimated to occur in approximately 43% of years (or once every 3-4 years).

- For those years where discharge from the southern lake does occur, there is an average of 11 to 13 days discharge per year that actively discharge would occur.
- Discharge from the northern lake is estimated to occur less frequently, in 5% of years when works commence and 10% of years long term. In these years, discharge would occur for on average 6 to 7 days and always when the southern lake is also discharging.
- Overtopping of the southern lake bund is rare and estimated to occur in less than 2 percent of years long term, and for a single day only each time.
- The northern lake is not anticipated to overtop its bund (excluding the influence of regional flooding).
- Discharge volumes from the overall site represent a small proportion (1.7 to 12.2%) of surface inflows across all phases of the project and 6.7% long term once extraction is complete.
- Evaporative losses, on average, are less than surface water inflows. These losses amount to between 67% and 82% of total surface water flows (rainfall and runoff) entering the southern lake, and 88 to 89% of flows entering the northern lake.
- Both lakes act as groundwater recharge windows with average net recharge volumes increase over the duration of the project in conjunction with expansion of the lake area.

Surface water discharges to receiving environment – flood events

The existing TSP operation and the expansion area are located within the Tweed River floodplain and the site is subject to regular inundation during high rainfall events. To avoid flooding impacts on neighbouring lands this condition would be maintained at the site and flood waters would not be prevented from flowing across the subject lands.

The low velocities of flood waters traversing the site limits the potential for soil erosion or scour of banks and bunding and records of impacts from previous floods at the existing TSP site indicate that lake banks, bunding and operational areas have not required remediation following these events.

Flood waters entering the subject site during regional floods originate from the Tweed River catchment which includes large areas of agricultural lands. Flood waters, particularly those containing runoff from agricultural lands are usually highly turbid

and nutrient rich. Conversely, long term monitoring of waters contained within the TSP lake indicate low turbidity water and comparatively low nutrient concentrations (median Total Nitrogen of 625 μg/L and a median of 40μg/L for Total Phosphorus).

Flood waters enter the subject lands at low velocities thus minimising mixing with the waters within the lake. The potential for mixing is further reduced by the density differential between the relatively fresh, lower-density floodwaters and the higher density brackish waters of the lake. The relationship is such that the lower-density floodwaters will float on-top of the denser lake waters with a degree of mixing at the interface.

Given the poor quality of waters entering the subject site during flood events, the limited opportunity for mixing and the comparable (if not higher quality) water within the TSP extraction lake it is unlikely that discharges from the TSP site would result in a negative impact on the receiving environment in these conditions.

Post extraction water quality

Hanson will retain ownership of the site following completion of sand extraction and any proposed subsequent use of the site will be decided via the appropriate consultative, application and regulation processes in place at that time.

A comprehensive Soil and Water Management Plan has been prepared for the site and includes commitments to monitoring and management of surface and groundwaters at the site to ensure the existing water quality is maintained and where possible improved throughout the course of the development. Commitments are also included for the continuation of water quality monitoring post cessation of extraction.

Specific goals for end-use water quality would be determined at an appropriate juncture in the future as the ultimate end-use of the site is defined.

Soil and water management plan

Surface water will be managed in accordance with the measures prescribed in the Soil and Water Management Plan (Gilbert & Sutherland, 2021). This management plan outlines monitoring regimes and mitigation measures for the management of impacts to surface and groundwaters.

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12035-001	Existing Tweed Sand Plant Operation
12035-002	Proposed Tweed Sand Plant Expansion
Z19163-104	Concept Development Phasing
12035-003	Monitoring Locations
12035-101	NSW Wetlands (OEH)
12035-102	Coastal Wetlands SEPP (Coastal Management) 2018
12035-103	Groundwater Dependant Ecosystems

1 Introduction

Hanson Construction Materials Pty Ltd (Hanson) Tweed Sand Plant (TSP) operation, located off Altona Road in Cudgen, New South Wales, has a total extraction footprint of approximately 46 hectares (ha). Sand extraction has been undertaken at this location since 1983 with Hanson assuming operation of the site in 2007.

TSP operates under Development Application (DA) DA 152-6-2006 issued on 31 July 2006, as modified on 20 August 2018 (Notice of Modification MOD 1). The current MOD 1 approval remains valid until 1 July 2036 and authorises TSP to produce and transport from the site up to 500,000 tonnes of quarry products per financial year. Drawing 12035-001 shows the location of the TSP site.

To meet ongoing demand for sand, Hanson is proposing to expand its existing operations into lands to the north and west of the TSP site. The footprint of the expansion area is approximately 190 ha, giving a total combined footprint of 236 ha for the existing and future extraction areas.

1.1 Expansion proposal

The TSP site is level to gently inclined, exhibits elevations of less than five metres Australian Height Datum (<5 mAHD) and has a current extraction footprint of approximately 46 ha. The proposed expansion would see TSP's operations extend into some 190 ha of lands to the north and west of the existing TSP site.

The total sand resource within the expansion area is estimated to be around 30 to 35 million tonnes, extending to approximately 20 metres below ground level (mbgl). Overburden is limited to topsoils of around one metre thickness, while minimal interburden is present throughout the resource. Drawing 12035-002 shows the footprint of the proposed expansion area and existing TSP site with respect to neighbouring operations and roadways.

Consistent with current TSP operations, sand would be extracted using a dredge and pumped to an onshore wash plant, where the target sands are separated from the finer clay and silt materials ('the fines') through a hydrocyclone. The separated fines would then be returned to the lake under controlled conditions to minimise potential environmental impacts associated with these materials.

Sand extraction rates would be market driven, but capped at an annual maximum limit of 950,000 tonnes with a proposed project life of some 30 years. As extraction proceeds, the site office, washplant, stockpiling area and weighbridge would be moved from their current locations on the site's eastern perimeter to the northern end of Lot 2 DP1192506. Drawing Z19163-104 provides a conceptual overview of the progression of sand extraction throughout the proposed expansion area.

The nature and scale of the expansion classifies the proposal as a State Significant Development (SSD). In November 2019, a Scoping Study was completed for the project and submitted to the NSW Department of Planning, Industry and Environment (DPIE) for its consideration and subsequent issue of site-specific Secretary's Environmental Assessment Requirements (SEARs). These SEARs were issued on 17 December 2019 and form the basis of the Tweed Sand Plant Expansion (SSD – 10398) Environmental Impact Study (EIS), of which this report is a part.

1.2 Scope of this report

Seven surface water locations have been assessed throughout the proposed expansion area, in addition to the extensive historical dataset for the exiting TSP site. Surface water locations throughout the network of agricultural drains within the proposed expansion area have been selected in order to best characterise the site's current surface water quality including the quality of waters draining onto the site and the level of tidal influence from Tweed River as well as capturing the seasonal and environmental variation.

This report draws on the extensive historical dataset and water quality assessments conducted for the existing TSP operations area, which have characterised the water quality on site since 2001 along with the baseline surface water monitoring

program completed within the proposed expansion area in 2020 to respond to the SEARs relevant to the surface water environment.

The surface water investigation requirements detailed in the SEARS are reproduced below in Table 1.2.1. For ease of reference, this table also cites where each requirement is addressed in this report. Where the requirements of the SEARs overlap between disciplines, a specific issue may be addressed under separate cover (as indicated in the table). As the issues which relate to surface and groundwater are highly interlinked, this report should be read in conjunction with the Gilbert & Sutherland (January 2021) Groundwater Assessment, Tweed Sand Plant Expansion, Cudgen, New South Wales and the Burchills Engineering 2021, Flood and Stormwater Assessment.

In some instances, the SEARs were found not to be relevant to this Project. Where this occurs it has been noted in the Table.

Table 1.2.1 – SEARS relevant to this SWA

Department/Agency	Requirement	Section
Planning Secretary's Environmental Assessment Requirements	Key issues Water	
	- a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;	-Section 6
	- identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;	-Section 4.3 and the Groundwater Assessment (G&S, 2021)
	- demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);	- As above
	- a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	-As above
	- a detailed assessment of potential flooding impacts;	-Flood and Stormwater Assessment (Burchills, 2021)
	- an assessment of the likely impacts on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives, and paying particular attention to potential flood-related nutrient transfers, including algal blooms;	-Sections 4.4.3, 6.7.2 -Flood and Stormwater Assessment (Burchills, 2021)
	- an assessment of proposed interactions with groundwater, and the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users; and	Section 6 and the Groundwater Assessment (G&S, 2021)

Department/Agency	Requirement	Section
	- a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate and manage surface and groundwater impacts;	-Soil and Water Management Plan (G&S, 2021)
DPIE – Biodiversity and Conservation Division	Attachment A 9. The EIS must map the following features relevant to water and soils including: a) Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map) b) Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method) c) Wetlands as described in s4.2 of the Biodiversity Assessment Method d) Groundwater e) Groundwater dependant ecosystems f) Proposed intake and discharge locations 10. The EIS must describe background conditions for any water resource likely to be affected by the development, including: a) Existing surface and groundwater b) Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations c) Water Quality Objectives (as endorsed by the NSW Government) incl. groundwater as appropriate that represent the community's uses and values for the receiving waters d) Indicators and trigger values/criteria for the environmental values identified at c in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government. e) Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions 11. The EIS must assess the impacts of the development on water quality, including: a) The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the WQO over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	a) Acid sulfate soils assessment (G&S 2021) b) to f) Drawings 12035 101, 102 and 103, the Ecological Assessment (JWA 2021) and Flood and Stormwater Assessment (Burchills, 2021) a) Section 4.4 b) Sections 4.4.3 and 6.7.2 c)Section 3.3 and 4.4.2 d) Sections 3.3, 4.4.2 and 4.5 Section 1.4.1 a) Section 4.4, 4.5, 4.6 and Section 6.7. Flood and Stormwater Assessment (Burchills, 2021) Soil and Water Management Plan (G&S, 2021)

Department/Agency	Requirement	Section
	b) Identification of proposed monitoring of water quality including how the waterbodies will be managed and water quality will be maintained post quarrying. c) Consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan).	b) Soil and Water Management Plan (G&S, 2021) c) NA – no plan currently available.
	12. The EIS must assess the impact of the development on hydrology, including:	
	a) Water balance including quantity quality and source.	a) Sections 4.4 and 6
	b) Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas.	b) Sections 4.4.1, 4.4.3 and the Flood and Stormwater Assessment (Burchills, 2021)
	c) Effects to downstream water-dependant fauna and flora including groundwater dependant ecosystems.	c) Sections 4.1 and 4.4. Groundwater Assessment (G&S, 2021) and the Ecological Assessment (JWA 2021)
	d) Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).	d) Sections 4.4.3, 5.7.2 the Groundwater Assessment (G&S, 2021) and the Ecological Assessment (JWA 2021)
	e) Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water.	e) Groundwater Assessment (G&S, 20201)
	f) Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options.	f) Soil and Water Management Plan (G&S, 2021), Flood and Stormwater Assessment (Burchills, 2021) Section 4.4
	g) Identification of proposed monitoring of hydrological attributes.	g) Soil and Water Management Plan (G&S, 2021)
DPIE – Biodiversity and Conservation Division	1. The description of existing and proposed end use water quality/hydrology in the EIS must be based on suitable data (meaning data collection may be required) and must include:	

Department/Agency	Requirement	Section
Attachment B	a) Water chemistry b) A description of receiving water processes, circulation and mixing characteristics and hydrodynamic regimes c) Lake or estuary flushing characteristics d) Sensitive ecosystems or species conservation values e) Specific human uses and values (fishing, proximity to recreation areas) f) A description of any impacts from existing industry or activities on water quality g) A description of the condition of the local catchment e.g. erosion, soils, vegetation cover. h) An outline of baseline groundwater information, including, for example, depth to water table, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment. 2. The assessment of the development on water quality and hydrology in the EIS must include: a) Water circulation, current patterns, water chemistry and other appropriate characteristics such as clarity, temperature, nutrient and toxicants, and potential for erosion. b) Changes to hydrology (incl. drainage patterns, surface runoff yield, flow regimes and groundwater) c) Disturbance of ASS and PASS d) Stream bank stability and impacts on macro invertebrates e) Water quality and hydrology modelling and/or monitoring, where necessary. 3. The proposed monitoring of water quality must be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutant in NSW 2004. 4. The EIS must include a water quality and aquatic ecosystem monitoring program that includes: a) Adequate data for evaluating maintenance, or progress towards achieving, the relevant WQOs.	a) Section 4.4 b) Section 4.4, 5 Section 4.6 c) Section 4.6 and 6 d) Ecological Assessment (JWA 2021) e) Social Impact Assessment (2021) f) Section 4.4 g) Section 2 h) Groundwater assessment (G&S 2021) a) Section 4 b) Flood and Stormwater Assessment (Burchills, 2021) c) Acid sulfate soils assessment (G&S 2021) d) Geotechnical assessment and Ecological Assessment JWA 2021. e) Section 4 and 6 and the Flood and Stormwater Assessment (Burchills, 2021) 3) Section 3.2 4) Soil and Water Management Plan (G&S, 2021)

Department/Agency	Requirement	Section
	b) Measurement of pollutants identified or expected to be present. 5. The EIS must assess the impacts of the development on water quality, including consideration of the effect on the receiving water bodies if a flow impacts the site and disperses the site lake water into the adjacent environment and/or into receiving waters. 6. The EIS must assess the impact of the development on hydrology, including the projected impacts of sea level rise on the site as affecting hydrological flow and connectivity of the site to the surrounding lands and waterways.	5) Sections 4.4.3 and 5.7.2 6) Flood and Stormwater Assessment (Burchills, 2021) and Groundwater Assessment (G&S 2021)
Dept. of Primary Industries (DPI)	Surface and Groundwater protected - Proposed development design, operation and by-product management should be undertaken to avoid nutrient and sediment build up and minimise erosion, off site surface water movement and groundwater accession. - The proposal should detail how design and operation will be undertaken for by-product management in accordance with best practice to prevent excess build-up of nutrients and salts in the soil profile and increase the risk of leaching. A monitoring program should be developed.	Soil and Water Management Plan (G&S, 2021)
EPA B – The proposal	B – The proposal - Provide details of the project that are essential for predicting and assessing impacts to waters including: a) The quantity and physio-chemical properties of all potential water pollutants and the risks they pose to the environment and human health, including the risks they pose to Water Quality Objectives in the ambient waters (technical criteria from the ANZECC guidelines for Fresh and Marine Water Quality, 2000) b) The management of discharges with potential for water impacts c) Drainage works and associated infrastructure; land-forming and excavations; working capacity of structures; and water resource requirements of the proposal - Outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts e.g. effluent ponds) and showing potential areas of modification of contours, drainage etc.	a) Section 4 b) Soil and Water Management Plan (G&S, 2021) d) Flood and Stormwater Assessment (Burchills, 2021) and Groundwater Assessment (G&S 2021) - Flood and Stormwater Assessment (Burchills, 2021)

Department/Agency	Requirement	Section
	- Outline how total water cycle considerations are to be addressed showing total water balances for the development (with objective of minimising demands and impacts on water resources). Include water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	- Section 6
EPA	C – The location **Water** - Describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and/or economic perspective. The Water Quality and River Flow Objectives on the website should be used to identify the agreed environmental values and human uses for any affected waterways. This will help with the description of the local and regional area.	- Sections 2 and 4
EPA	E – The environmental issues **Describe baseline conditions** - Describe existing surface and groundwater quality – an assessment needs to be undertaken for any water resource likely to be affected by the proposal and for all conditions (e.g. a wet weather sampling program is needed if runoff events may cause impacts) - Provide site drainage details and surface runoff yield - State the ambient Water Quality and River Flow Objectives for the receiving waters, these refer to the community's agreed environmental values and human uses endorsed by the Government as goals for the ambient waters. The EIS should state the environmental values listed for the catchment and waterway type relevant to your proposal. - State the indicators and associated trigger values or criteria for the identified environmental values (ANZECC 2000 Guidelines for Fresh and Marine Water Quality). State any locally significant objectives, criteria or targets, which have been endorsed by the government - Where site specific studies are proposed to revise the trigger values supporting the ambient Water Quality and River Flow Objectives, and the results are to be used for regulatory purposes, then prior agreement from the EPA on the approach must be obtained. - Describe the state of the receiving waters and relate this to the relevant Water Quality and River Flow Objectives (i.e. which objectives are being achieved). Proponents are	- Sections 3 and 4 -Flood and Stormwater Assessment (Burchills, 2021) -Sections 4.2 and 4.4 -Section 4.4 -Section 3.4 -Section 4.4.3

Department/Agency	Requirement	Section
	generally only expected to source available data and information. However, proponents of large or high risk developments may be required to collect some ambient water quality/river flow/groundwater data to enable a suitable level of impact assessment. Issues to include in the description of the receiving waters could include: - Lake or estuary flushing characteristics - Specific human uses - A description of the condition of the local catchment e.g. erosion levels, soils, vegetation cover, etc **Assess impacts** - No proposal should breach clause 120 of the Protection of the Environment Operations Act 1997 - Identify and estimate the quantity of all pollutants that may be introduced onto the water cycle by source and discharge point including residual discharges after mitigation measures are implemented. - Include a rationale, along with relevant calculations, supporting the prediction of the discharges. - Describe the effects and significance of any pollutant loads on the receiving environment. This should include impacts of residual discharges through modelling, monitoring or both, depending on the scale of the proposal. Determine changes to hydrology (incl drainage patterns, surface runoff yield, flow enrichment or turbidity resulting from changes in frequency and magnitude of stream flow). - Identify potential impacts associated with geomorphological activities with potential to increase surface water and sediment runoff or to reduce surface runoff and sediment transport. - Also consider possible impacts such as bed lowering, bank lowering, instream siltation, floodplain erosion and floodplain siltation. - The significance of the impacts listed above should be predicted. When doing this it is important to predict the ambient water quality and river flow outcomes associated with the proposal and to demonstrate whether these are acceptable in terms of achieving protection of the water quality and river flow objectives. In particular the following questions should be answered: a) Will the proposal protect Water Quality and River Flow Objectives where they are currently achieved in the ambient waters; and b) Will the proposal contribute towards the achievement of Water Quality and River Flow Objectives over time, where they are not currently achieved in the ambient waters. - Consult with the EPA as soon as possible if a mixing zone is proposed (a mixing zone could exist where effluent is discharged into a receiving water body, where the quality of	- Section 2 - Noted -This SWA and the Soil and Water Management Plan (G&S, 2021) - Sections 4.4.3 and 6.7.2 - Section 6 Flood and Stormwater Assessment (Burchills, 2021) -Flood and Stormwater Assessment (Burchills, 2021) - NA Section 4.4.3

Department/Agency	Requirement	Section
	the water being discharged does not immediately meet water quality objectives. The mixing zone could result in dilution, assimilation and decay of the effluent to allow WQOs to be met further downstream, at the edge of the mixing zone). The EPA will advise the proponent under what conditions a mixing zone will and will not be acceptable, as well as the information and modelling requirements for assessment.	- No mixing zone proposed.
	- Where a licensed discharge is proposed, provide the rationale as to why it cannot be avoided through application of a reasonable level of performance, using available technology, management practice and industry guidelines.	- NA
	- Where a licensed discharge is proposed, provide the rationale as to why it represents the best environmental outcome and what measures can be taken to reduce its environmental impact.	- NA
	- Reference should be made to Managing Urban Stormwater: Soils and Construction (Landcom, 2004), Guidelines for Fresh and Marine Water Quality ANZECC 2000)	- Soil and Water Management Plan (G&S, 2021)
DPIE – Water and NRAR	**The SEARs should include:**	
	- The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.	-Groundwater Assessment (G&S 2021)
	- A detailed and consolidated site water balance.	- Section 6
	- Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	- Groundwater Assessment (G&S 2021)
	- Proposed surface and groundwater monitoring activities and methodologies.	-Soil and Water Management Plan (G&S, 2021)

1.3 Objectives

To address the SEARs with respect to surface water, Hanson commissioned Gilbert & Sutherland (G&S) to undertake a surface water assessment within the proposed expansion area, building on the robust historical dataset for the existing site. The investigation and analysis described in this report aims to adequately assess the surface water characteristics throughout the proposed expansion area, predict the likely characteristics of the extraction lakes once sand production has ceased and q determine suitable management measures for the proposed expansion of TSP.

1.4 Relevant guidelines

Scoping, investigation and preparation of this SWA considered the following guidelines and documents:

- NSW Government Water Quality and River Flow Objectives (EPA)
- ANZECC (2000) Guidelines for Fresh and Marine Water Quality
- National Health and Medical Research Council, 2008, Guidelines for Managing Risks in Recreational Water.
- Approved Methods for the Sampling and Analysis of Water Pollutant in NSW 2004.

1.4.1 Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning

This assessment and the associated management plan (Soil & Water Management Plan, G&S, 2020) have been prepared having considered the NSW Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning, ensuring:

- Consideration of the Environmental Values of the Tweed Catchment;
- Identification of the environmental objectives of the Tweed River catchment when setting benchmarks for design and practice;
- Protection of environmentally significant areas;
- Development of management strategies which minimize impacts of the development to the environment and ensure the highest possible environmental outcomes.

2 Site description

2.1 Property description and zoning

The project site comprises eight allotments with a total site footprint of approximately 236 ha (including the existing TSP operation) as shown on Drawing 12035-002. Table 2.1.1 summarises the property description, lot size and land zoning under Tweed Shire Council's (TSC) Tweed Local Environmental Plan (LEP) 2014.

Table 2.1.1 Property description and land zoning*

Property description	Land zoning (LEP 2014)	Lot size (ha)
Lot 22 DP1082435	RU1 – Primary production	74.56
Lot 23 DP1077509	RU1 – Primary production	2.552
Lot 494 DP720450	RU1 – Primary production	0.1042
Lot 1 DP1250570	RU1 – Primary production RU2 – Rural landscape	90.00
Lot 2 DP1192506	RU1 – Primary production	11.12
Lot 3 DP1243752	RU1 – Primary production	1.612
Lot 51 DP1166990	RU1 – Primary production	55.13
Lot 50 DP1056966	RU1 – Primary production	1.094

*Source: NSW Planning Portal, 23 October 2020

2.2 Existing land uses

TSP is located within the Tweed Valley Floodplain and is surrounded by various land uses. Located immediately north of the site is TSC's wastewater treatment facility and open grazing lands. Further to the north lies the Pacific Motorway, the township of Chinderah and the Tweed River. To the north-east is Chinderah Golf Course and some residential properties fronting Tweed Coast Road.

Immediately to the east lies the Cudgen Lakes Sand Extraction. Further to the east is the townships of Cudgen and Kingscliff and the Pacific Ocean.

The Cudgen Plateau, located immediately south of the project site, is primarily used for agricultural purposes including cropping and orchards. The Cudgen residential area is located to the southeast and incorporates Cudgen Public School directly west of the residential area.

To the west of the site lies open grazing lands, the Australian Bay Lobster Producers Limited facilities and the Pacific Motorway.

2.3 Topography and local drainage

Local topographic mapping indicates that the elevation of the property is uniform, with an average relative level (RL) of 1.0 metres Australian Height Datum (mAHD). The site's slopes are described as level (<1%) to very gently inclined (1-3%).[1] The project site abuts the Cudgen Plateau to the south, where elevations rise steeply to approximately 38 mAHD.

The site is located within the Tweed Valley Floodplain. Most runoff from the site passively infiltrates through the highly permeable sandy soils. Any remaining runoff is currently diverted towards the on-site extraction areas, or conveyed to a network of agricultural drains.

During high intensity rainfall events, the site becomes inundated and peak discharges may potentially flow toward the agricultural drainage lines constructed along the northern and western property boundaries. These drains convey runoff from the surrounding agricultural properties through flood gates to the Tweed River.

2.4 Regional drainage

The project site is located within the lower reaches of the Tweed River Floodplain. The headwaters of the Tweed River begin near Kunghur, approximately 50 km southwest of

[1] McDonald R. C., Isbell R. F., Speight J. G., Walker J. & Hopkins M. S. Australian Soil and Land Survey Field Handbook. Second Edition 1990, Inkata Press Pty Ltd.

Chinderah and generally flow in a north-easterly direction. Numerous rivers, creeks and tributaries feed into the Tweed River, including the Oxley River approximately 5 km southwest of Murwillumbah, and the Rouse River west of Tumbulgum.

The Tweed River discharges into the Pacific Ocean at the Tweed River mouth, immediately east of Tweed Heads. The tidal influence of the Pacific Ocean extends just upstream of Murwillumbah (WBM, 2005).[2]

The floodplain is criss-crossed by a network of interconnecting agricultural drains and flood gates which convey water from the floodplain to the Tweed River. The main drain through the catchment ('the western drain', shown in blue on Figure 4.4) flows westwards from Tweed Coast Road parallel to Altona Drive. The drain then turns northwards adjacent to the TSP site before discharging into the Tweed River through culverts under the Pacific Highway and Chinderah Bay Drive. These culverts have flood gates installed on the River side, under Chinderah Bay Drive. Other minor drains run east-west and north-south across the floodplain and generally discharge into the western drain.

The floodplain is subject to inundation from both local catchment floods as well as Tweed River overbank floods.

2.5 Soil landscapes

Soil Landscapes within the project site are described in the DPIE's Soil Landscapes of Central and Eastern NSW dataset 2020.[3]

The expansion area is within the 'Tweed landscape' (9541tw). This landscape is described as an extensive marine plain of the lower Tweed catchment, consisting of deep Quaternary alluvium and estuarine sediments.

The marine plain has been created by the in-filling of a large estuary or embayment during the Pleistocene era. Marine clays and muds have dominated these fill materials. Since this period of aggradation, the Tweed River has been creating a covered plain consisting of terrestrial sediments.

The eastern extents of the TSP site are mapped as a 'Tweed landscape variant b' (9541twb) (DPIE, 2020).[4] This landscape is described as consisting of deep Quaternary alluvium and estuarine sediments with landscape variant 'twb', described as Pleistocene sands overlain by alluvial soil material.

The project site lies within the Cudgen 1:25 000 Acid Sulfate Soil Planning Map (DLWC 1997). This mapping indicates that there is a high probability of ASS material being encountered within 1 m to 3 m of the ground surface.

2.6 Geology

A review of the 1:250,000 Geological Series SH56-3 (Tweed Heads) indicates that the site geology is comprised of Quaternary sedimentary deposits of river gravel, alluvium, sand and clay.

A hydrogeological investigation at the eastern neighbouring property described the regional bedrock as interbedded argillite and metagreywacke of the Neranleigh-Fernvale Beds of lower Palaeozoic age. The materials overlying this stratum were described as Quaternary organic clays, which were in turn overlain by Quaternary sands.[5]

The quaternary sands were described as poorly graded medium to fine grained quartzose sands with some coarse grains. These materials had a relatively uniform thickness of around 21 m across the site. The depositional environment for the Quaternary sands was identified as deltaic, with the presence of shell and organic fragments

[2] Flood Impact Assessment for the Proposed Sand Quarry Expansion at Crescent Street, Cudgen, WBM Oceanics Australia, 13 June 2005.

[3] Department of Planning, Industry and Environment, 2020, Soil Landscapes of Central and Eastern NSW - v2.1, NSW Office of Environment and Heritage, Sydney.

[4] Ibid, 2020.

[5] Coffey Geosciences (1999). Cudgen Sand Extraction – Hydrogeological Assessment and Installation of Monitoring Bores.

throughout the sequence, indicative of alternating marine and terrestrial influence.[6]

2.7 Vegetation

The TSP site and proposed expansion area is characterised by open grazing lands which have been largely cleared of native vegetation. Within the TSP site an area of approximately 20 ha is currently cultivated under tea tree.

The agricultural drains that traverse the site contain some native vegetation, which is described in detail under separate cover.

[6] Coffey and Partners (1985 - 1986). Geotechnical investigation for proposed extractive industry on Lot 2 DPG11021 and DP216705.

3 Methodology

This section describes the methodology employed by G&S in undertaking this Surface Water Assessment to satisfy the SEARs.

3.1 Desktop assessment

A desktop assessment was undertaken to investigate the surface water matters relevant for the Project. The following subsections detail the scope of the desktop assessment.

3.1.1 Environmental planning instruments

This assessment has been prepared with reference to the relevant environmental planning instruments[7] for NSW including:

- Tweed Local Environmental Plan (LEP) 2014.
- State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007.
- State Environmental Planning Policy (State and Regional Development) 2011.
- State Environmental Planning Policy (Infrastructure) 2007.

The relevance of the various LEP's and SEPPs to the proposed expansion is discussed by others under separate cover.

3.1.2 Online mapping and data

Various online resources and mapping tools were used to identify the presence of significant water bodies such as rivers, streams, wetlands, estuaries and any groundwater dependant ecosystems within the site locale. These sources included:

- NSW Environmental data[8];
- The Department of Agriculture, Water and the Environment's Protected Matters Search Tool[9];
- The Bureau of Meteorology 'Potential Groundwater Dependant Ecosystems Atlas'[10].

Relevant features from these sources were then compiled and a series of site-specific drawings created to depict water and groundwater features present in the site and surrounds.

3.1.3 Review of environmental values

Various sources were reviewed to determine the environmental values relevant to the TSP site and proposed expansion area. A description of these environmental values can be found in Section 4.2

3.1.4 Licensing requirements

Licensing requirements, relevant Water Sharing Plans (WSP) and their operating rules were reviewed for their applicability to the Project and to determine the relevant licencing and approvals requirements. Details of the site's groundwater licencing requirements under the WSP are contained in the *Gilbert & Sutherland, January 2021, Groundwater Assessment, Tweed Sand Plant Expansion, Cudgen, New South Wales.*.

3.2 Surface water monitoring

3.2.1 TSP ongoing monitoring program

A program of surface water quality compliance monitoring has been ongoing at the TSP site since 2001. This program includes sampling at three locations within the extraction lake for insitu analysis of pH, DO, temperature, turbidity, ORP and EC using calibrated field instruments. Samples are also collected from each location and delivered to a NATA accredited laboratory for analysis for concentrations of sodium (Na), potassium (K), magnesium (Mg), chloride (Cl), sulfate (SO_4), bicarbonate alkalinity ($CaCO_3$), dissolved iron (Fe), dissolved aluminium (Al), arsenic, ammonium (NH_4), chlorophyll-a, faecal coliforms and enterococci.

Monitoring is undertaken at three locations as shown on Drawing 12035-003 and described below:

- SW1 – North western corner of extraction lake
- SW2 – Acid sulfate soil fines return area within extraction lake

[7] NSW Legislation. https://www.legislation.nsw.gov.au/

[8] NSW Government. SEED Maps, https://www.seed.nsw.gov.au/

[9] Australian Government, Department of Agriculture, Water and Environment, Protected Matters Search Tool, https://www.environment.gov.au/epbc/protected-matters-search-tool

[10] Australian Government Bureau of Meteorology. Potential Groundwater Ecosystems Atlas. http://www.bom.gov.au/water/groundwater/gde/

- SW3 – Location where the site discharges (in high rainfall periods only) to the local drainage network.

As part of this program vertical profile monitoring of insitu parameters was also undertaken at one location central to the extraction lake to assess the presence or otherwise of salinity or temperature-based stratification profiles.

Cyanobacteria levels in the extraction lake were monitored at two locations (eastern side and western side) on a monthly basis. One location was on the eastern side of the lake and the other was on the western side.

At each location, a composite sample was taken for analysis of:

- algal cell count, biovolume and predominant genera
- Polymerase Chain Reaction (PCR) genetic toxin testing
- total nitrogen
- nitrogen-oxidised
- ammonia
- total phosphorus and
- orthophosphorus.

The results of ongoing monitoring at TSP are reported to the relevant local and state government authorities in a detailed Annual Review submitted in September each year.

3.2.2 Expansion area monitoring program

Building on the existing water quality monitoring program a further eight rounds of surface water monitoring was conducted across the TSP site and proposed expansion area between March and October 2020, with eight rounds of surface water monitoring and two rounds of rainfall event monitoring completed during this time.

A total of seven surface water locations were selected for this monitoring program at representative locations within the TSP site and across the expansion footprint. These monitoring locations are identified on Drawing 12035-003 and are described as follows:

- L1 – Agricultural drain on northern perimeter of expansion footprint
- L2 – Agricultural drain on north western perimeter of expansion footprint
- L3 – Agricultural drain on eastern perimeter of expansion footprint (within current TSP property, adjacent to tea-tree plantation).
- L4 – Agricultural drain on western perimeter of expansion footprint (adjacent Pacific Motorway)
- L5 – North western corner of extraction lake
- L6 – Agricultural drain on south western perimeter of expansion footprint
- L7 – Agricultural drain on South eastern perimeter of expansion footprint.

Monitoring was undertaken for the same suite of parameters described above for the compliance monitoring program.

Data loggers were installed at L1 to L7 to record water level information at time-controlled intervals over a period of ~ 6 months in order to assess seasonal influences and the presence or absence of tidal effects.

Two rounds of rainfall event-based monitoring were also undertaken following rainfall of >25 mm in 24 hours. Each event monitoring round comprised in situ analyses of pH, DO, temperature, turbidity, ORP and EC using calibrated field instruments and laboratory analysis of suspended solids (SS), dissolved metals and metalloids (Al, Fe, As), nutrients (TN, TP) and algae.

3.3 Water quality analysis

Water quality data obtained from the various monitoring programs described above was collated to form a comprehensive water quality data set for the TSP site and expansion area.

Analysis of the data set was then undertaken to characterise and describe the existing surface water conditions of the Project area and inform the various modelling exercises described herein. The data was then compared to relevant water quality guidelines as described in the following sections.

3.3.1 ANZECC Guidelines

Establishing water quality guidelines inform the planning and management of water quality within site surface waters, while setting the path to achieving strong local environmental outcomes in the future.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)[11] (the 'ANZECC Guidelines') provide water quality objectives for natural and semi-natural water resources. The Guidelines are based on the principles of Ecologically Sustainable Development (ESD) and provide guidance for the protection of existing and future environmental values for relevant water bodies.

Surface waters assessed as part of this investigation experience natural variation due to the unique land-use type, runoff regime and land management practices within the proposal area. The ANZECC 2000 Guidelines recommend establishing water quality criteria in the unique context of the site, taking into account the local environmental conditions. For sites that have been subject to historical disturbance and where existing site water quality does not meet the ANZECC Guideline values, the document provides a methodology for determining site-specific water quality criteria.

Table 3.3.1.1 provides a sub-set of available trigger values from the ANZECC Guideline relevant to the site's monitoring suite.

Table 3.3.1.1 ANZECC water quality trigger values for freshwater 95% species protection

Parameter	ANZECC Guideline water quality criteria
pH	6.5-8
Turbidity	5-20 NTU
Dissolved Oxygen	>6 mg/L or >90% saturation
Chlorophyll-a	<5 μg/L
Total Nitrogen	<0.5 mg/L
Nitrite+Nitrate NOx	<0.02 mg/L
Nitrate	<0.7 mg/L
Total Phosphorus	<0.05 mg/L
Aluminium	<0.055 mg/L
Arsenic	<0.024 mg/L

3.3.2 Tweed River Water Quality Objectives

The Tweed River Water Quality Objectives[12] were developed for NSW rivers and estuaries to provide guideline levels to assist water quality planning and management. The Tweed River water quality criteria comprise community-based environmental values and their associated national criteria drawn from the ANZECC Guidelines. For waterways affected by urban development, the criteria are aimed at the protection of aquatic ecosystems, maintaining visual amenity and supporting secondary and/or primary contact recreation.

The Tweed River water quality criteria selects relevant water quality indicators and related numerical criteria (default trigger values) from the ANZECC Guidelines 2000, relevant to assessing and monitoring the health of aquatic ecosystems. These criteria, as they originated from the ANZECC Guideline water quality criteria, are applicable to both surface water and groundwater.

Tweed River Water Quality Objectives[13] represent the water quality criteria for surface waters for the Tweed River catchment. Key indicators and their associated criteria are reproduced in Table 3.3.2.1.

Table 3.3.2.1 Tweed River Water Quality Objectives for the Tweed River catchment (Aquatic ecosystems - Lakes & reservoirs)

Parameter	Interim criteria
pH	6.5-8.0
Dissolved oxygen	80 – 110% saturation
Turbidity	1-20 NTU
Chlorophyll-a	<5 μg/L
Total Nitrogen	<0.35 mg/L
Total Phosphorus	<0.01 mg/L

[11] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000.

[12] Published online at: https://www.environment.nsw.gov.au/ieo/Tweed/report-02.htm

[13] Published online at: https://www.environment.nsw.gov.au/ieo/Tweed/report-02.htm

3.3.3 NHRMC Recreational water guidelines

The National Health and Medical Research Council, 2008, Guidelines for Managing Risks in Recreational Water (the 'NHRMC Guidelines') were developed to protect human health from threats posed by the recreational use of coastal, estuarine and fresh waters, such as natural and artificial hazards. These Guidelines bring together much of the international consensus on healthy recreational water use with the current understanding of Australian waters and provide guidance relevant to local conditions.

The NHRMC Guidelines supersede previous recreational water quality guidance, such as the ANZECC & ARMCANZ (2000) guidelines and the NHMRC (1990) Australian Guidelines for Recreational Use of Water. The relevant values are summarised in Table 3.3.3.2 below.

Table 3.3.3.2 – NHRMC Recreational water quality guidelines

Indicator	Guideline value
Temperature	16 - 34°C
Microbial quality	Preventive risk management practices should be adopted to ensure that designated recreational waters are protected against direct contamination by fresh faecal material, particularly of human or domesticated animal origin.
Cyanobacteria	Fresh recreational water bodies should not contain: • >10 µg/L total microcystins; >50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent • >4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume;
pH	6.5 – 8.5 (A wider ph range of 5–9 is acceptable for water with a very low buffering capacity.)
Dissolved Oxygen	>80% saturation

3.4 Determining site-specific water quality criteria

Surface and groundwater quality has been monitored at the site since 2001. Analysis of this data (as described in this report) indicated that in some instances the existing site water quality does not meet the ANZECC or TSC water quality criteria.

The ANZECC Guidelines recommend that for some water quality indicators, site-specific water quality criteria be derived and used instead of regional default guideline values (DGVs). The general approach recommended for deriving guideline values is as follows;

1. Determine the existing ecosystem condition and required level of protection.
2. Define the baseline or 'reference' condition for the site ideally based on appropriate site-specific data.
3. Depending on existing ecosystem condition and required level of protection, define trigger values choosing either a conservative percentile value (e.g. 80^{th} percentile value) to improve water quality, or a less conservative percentile (e.g. 90^{th} percentile) to maintain water quality.

The ANZECC Guideline recommends that a reference condition be defined to provide an appropriate management target and meaningful comparison for use in monitoring and assessment.

The robust historic dataset available for the TSP site allows for valid calculation of site-specific trigger values in instances where existing water quality does not align with the DGVs.

Site specific trigger values, calculated in accordance with the ANZECC methodology are described in Section 5.6.

4 Desktop assessment findings

The results and findings of the various desktop assessments undertaken to address the relevant SEAR's for the proposed expansion of Hanson's TSP operation are described in the following sections.

4.1 Online mapping and data

The subject site is located within the Tweed Valley flood plain, with the Tweed River located approximately 3 kilometres west of The Site.[14]

NSW Environmental Data, the Bureau of Meteorology's Groundwater Dependant Ecosystems Atlas and an EPBC Environmental Matters report identified wetlands and groundwater dependant ecosystems (GDE) located nearby the proposed expansion footprint. G&S drawings 12035-101 and 12035-102 show the site in its regional context, and proximities to these significant environmental features.

Groundwater dependant ecosystems are ecosystems with species composition and ecological processes determined largely by the availability of groundwater. GDE can be classified into three types of ecosystems. These are:

- Aquatic: ecosystems that rely on the expression of groundwater at the surface
- Terrestrial: ecosystems that rely on the presence of subsurface groundwater
- Subterranean: caves and aquifer ecosystems

A desktop assessment using the Bureau of Meteorology 'Potential Groundwater Dependant Ecosystems Atlas' determined the presence of one 'High potential' terrestrial GDE within the proposed project area.[15]. This GDE is located on the northern perimeter of the proposed expansion area, (see Drawing 12035-103).

This terrestrial GDE was recorded as a Paperbark GDE, within the Richmond River Region. Its geomorphology was identified as Coastal Lowlands on weak sedimentary rocks, with littoral and alluvial plains.

The GDE falls partly within the designated footprint of the ultimate dredge lake and the nominated haulage route for site vehicles. As such it is likely that part of this GDE will be removed within years 23 to 26 of the progression of the development. Further consideration of this GDE and the implications of its removal are discussed under separate cover in the ecological assessment undertaken for the expansion proposal.[16]

While no wetlands are present within the development footprint, coastal wetlands identified by Coastal Management SEPP 2018 are located to the east of the site and identified in drawing 12035-102. These Coastal Wetlands have been identified as plant communities dominated by any of the following vegetation types:[17]

- mangroves
- salt marshes
- melaleuca forests
- casuarina forests
- sedgelands
- brackish and freshwater swamps
- wet meadows.

The Department of Agriculture, Water and Environment's Protected Matters Search Tool identified Nationally Important Wetlands of the Cudgen Nature Reserve located approximately 5km south east of the proposed development site.

4.2 Environmental values

The NSW Water Quality and River Flow Objectives for the Tweed River catchment describe the regions environmental values to be considered when developing plans and actions with the potential to affect water quality.

[14] Flood and Stormwater Assessment, Burchills Engineering, October 2020.

[15] based on a regional study providing an analysis undertaken by various state and regional agencies

[16] JWA Ecological Consultants 2021.

[17] Wetlands: State Environmental Planning Policy (Coastal Management) 2018

The environmental values for the Tweed River catchment – Estuaries, as they relate to the Water Quality Objectives, are as follows:

- Aquatic ecosystems
- Visual amenity
- Secondary contact recreation
- Aquatic foods (cooked) and commercial shellfish production.

To ensure the environmental values of the region and community as endorsed by the NSW Government for the Tweed River Catchment are protected, critical water quality parameters for surface waters within the proposed development site have been identified and evaluated in the context of the Tweed River Water Quality Objectives and the ANZECC 2000 Guidelines for Fresh and Marine Water Quality. Meeting the water quality objectives relevant to the site provides the basis for the successful protection of the remaining environmental values.

4.3 Licensing requirements

TSP currently operates under the Environmental Protection License 11453, which authorises sand extraction activities at the subject site. The EPL contains provisions that govern:

- The scale and nature of activities that are permitted on the subject site.
- Discharges to air, water and application to land.
- Limit conditions for pollution of waters, load limits and concentration limits.
- Monitoring and recording conditions.
- Reporting conditions.

An amended EPL would be required for the expansion of the TSP operations and would be the subject of consultation with the NSW EPA.

4.3.1 Water sharing plan

The existing Tweed Sand Plant and proposed expansion area is located within the Tweed Brunswick Coastal Sands (TBCS) of the Tweed Coastal Sands Groundwater Management Area (GMA). Environmental water is accessed via licensed entitlements through the North Coast Coastal Sands Groundwater Source Water Sharing Plan (WSP).

TSP currently holds an allocation in the TBCS source for groundwater interference/take commensurate with the scale of its existing operation. Expansion of the operation and the proposed increase in extraction rate will necessitate an application for an additional volumetric share within the TBCS.

Quantification of the additional volume that would be required to support the proposed expansion is detailed in Section 4.3 of the Gilbert & Sutherland (January 2021), Groundwater Assessment, Tweed Sand Plant Expansion, Cudgen New South Wales.

5 Surface water quality results and interpretation

The following sections describe the long-term quality of surface waters within the TSP extraction lake, in addition to the locations monitored within the network of agricultural drains throughout the expansion footprint. Where appropriate, the results have been compared to available TSC, ANZECC and NHRMC Guideline values to provide context for the surface water quality at the site and its performance against established guidelines.

5.1 Piper and Durov diagrams

Piper and Durov Diagrams were created using the results obtained from all surface water monitoring locations within the current and proposed site area to characterise the sources of dissolved chemical constituents in waters across the site. Diagrams depicting the results of surface water monitoring conducted in June 2020 are included in Appendix 2.

The Piper diagram for surface waters presents similar proportions of cations and anions between monitoring locations, with all samples presenting as a sodium chloride water type, with the samples variously being dominated by either acids or alkalis. Surface water in location 3 (drain at entrance to TSP site from Altona Road) shows a slightly higher concentration of calcium cations.

In addition to cation/anion diagnostics, the Durov diagram allows for the comparison of pH and TDS indicators. The Durov diagram confirmed the close cation-anion grouping between surface water locations, and were shown to remain within a pH range of 7.5 to 8.7 pH units.

5.2 Surface water quality results summary

A comprehensive program of surface water quality monitoring has been conducted at the site since 2001. This data set has been supplemented by an additional eight rounds of monitoring during 2020. This data provides an indication of long-term water quality trends at the site throughout its operations at the existing TSP site.

Table 5.2.2 (end of Section 5) summarises the results of water quality compliance monitoring within the current TSP extraction lake since 2001 in the context of relevant water quality guidelines including:

- Tweed River Water Quality Objectives,
- ANZECC Water Quality Guidelines and
- NHRMC Recreation Water Quality Guidelines for primary contact recreation.

Appendix 2 provides long term graphs and results tables of all analytes monitored within the TSP extraction lake. They show water quality trends over time, during ongoing extraction at the site.

Appendix 5 provides the certificates of analysis for recent monitoring conducted in 2020.

The following sub-sections section review the results of recent and historical monitoring of surface waters in the context of the relevant environmental performance criteria.

5.2.1 pH

The long-term median for pH of surface waters within the TSP Lake is 8.34. This value marginally exceeds the Tweed River Water Quality Objective of 8.0, but complies with the ANZECC 2000 criteria for primary contact recreation of 6.5 to 8.5.

Elevated pH results such as these can result from a variety of contributing factors. These include the inherent acid neutralising capacity of the carbonate-rich materials within the strata at TSP, as well as algal growth, which consumes carbon and produces hydroxide during photosynthesis which increases the pH of surface waters.

5.2.2 Dissolved oxygen

Dissolved oxygen (DO) concentrations within the TSP lake remain above the Tweed River, ANZECC and NHRMC Guideline minimums of 6.0 mg/L. As a constituent measure of waterbody health, DO at concentrations observed within the extraction lake are ideal for supporting normal aquatic ecosystem function.

Low DO concentrations were observed within agricultural drains located across the expansion footprint, reflecting the no-flow conditions

observed during monitoring events. The drains' high water temperatures, algal growth and decomposition of organic matter, leads to the poorly oxygenated environments that are characteristic of these shallow drainage channels.

5.2.3 Metals

Metal-rich surface waters (Al, Fe) commonly result from the disturbance of acid sulfate soils. , The oxidation of pyrite in disturbed soils increases the solubility of these metals. Negligible concentrations of metals were detected within the surface waters of the TSP lake and within the agricultural drains throughout the expansion site. Long term median levels within the TSP lake remain compliant with the ANZECC performance criteria for aquatic ecosystem protection and primary contact recreation.

5.2.4 Nutrients

Long-term median results for total nitrogen and total phosphorus recorded within the TSP lake exceed the Tweed River and ANZECC water quality objectives.

The dredging process can result in the release of nutrients or other toxicants contained within pore waters into the dredge lake. This may cause water quality issues such as algal blooms. Long term groundwater monitoring of the existing TSP site and recent monitoring within the expansion area has recorded elevated nutrient levels within the site's groundwater environment. This is likely related to the historic agricultural uses of the land and adjacent properties. [18]

Elevated nutrient levels have been recorded within the TSP lake. However, dilution by rainfall inflows, results in nutrient concentrations which are substantially lower than the groundwater environment and are similar to those recorded within the nearby Tweed River[19] (see Section 7 for further discussion of Tweed River water quality).

5.2.5 Faecal coliforms

Bacteriological analyses of surface waters indicated low levels of faecal coliforms and enterococci, consistent with performance criteria for primary contact recreation.

The data set demonstrates that current surface water quality within the TSP dredge lake is largely compliant with relevant guidelines, indicating that the lake can be made suitable for end uses including Primary Contact Recreation activities.

5.3 Lake vertical profile results

Vertical profile monitoring of the TSP extraction lake has been ongoing since 2007. This monitoring involves the recovery of samples at 1.0 m increments for the total depth of the extraction lake. Samples are analysed insitu for pH, salinity, EC, DO, temperature and ORP. These investigations have historically been used to assess lake characteristics and the presence or absence of seasonal stratification.

Results of historical vertical profile monitoring have typically followed concentration-depth relationships characteristic of deep waterbodies and indicated advantageous water quality conditions for the safe reinterment of sulfidic fines material within the lake (i.e. low DO at depth) (see the Gilbert & Sutherland, 2021, Tweed Sand Plant Expansion, Acid Sulfate Soil Assessment for further details). Key parameters are discussed in further detail in the following sub-sections.

5.3.1 Salinity

Long-term salinity results recorded for the lake reflect a brackish environment with a median salinity of 1,566 ppm. Salinity within the lake reflects a combination of influences including rainfall and fresh shallow groundwater combined with saline deep groundwaters.

Vertical profile monitoring to date shows a well mixed water body with a general trend of increasing salinity with depth however, the difference between surface and deep salinity is

[18] Gilbert & Sutherland 2021. Groundwater Assessment, Tweed Sand Plant Expansion, Cudgen, New South Wales.

[19] Total Nitrogen concentrations were reported to range between 60 and 2400 µg/L over five years, and Total Phosphorous reported to range from <20 µg/L to 210 µg/L across all monitoring sites.

not substantial (a median difference between surface and full depth of 20ppm).

Figures A2.37, A2.38 and A2.39 of Appendix 2 provide a visual representation of salinity profiles recorded since the commencement of vertical profiling at the site. The observed salinity profiles are characteristic of deep coastal lakes in response to temperature, rainfall and groundwater influences. Increased temperatures and precipitation during warmer months cause lower density fresh water to remain at the lake's surface whilst cooler, more saline water sinks to the bottom of the lake due to increased density. Such processed do not result in large changes in salinity from the top of the lake to the bottom.

5.3.2 pH

pH levels show minimal variation with depth, with acidity increasing slightly relative to the depth of the lake (on average a reduction of approximately 1 pH unit). Again, this is typical of deep water bodies, where algal activity at the surface removes carbon (during photosynthesis), subsequently raising the level of hydroxide and increasing pH.

The presence of photosynthetic algae decreases with depth due to decreased sunlight penetration reducing hydroxide levels and resulting in comparatively lower pH at depth. Whilst pH levels marginally decreased with depth, the results remained within the range of 6.02 to 9.45 with no indication of acidification of sulfidic fines which are reinterred within the lake as part of the sites' acid sulfate soil management strategy (see the Gilbert & Sutherland, 2021, Tweed Sand Plant Expansion, Acid Sulfate Soil Assessment for further details).

5.3.3 Dissolved oxygen

DO concentrations generally decrease with increasing depth and this relationship becomes more pronounced during the summer months. This is typical of deep water bodies where surface waters are oxygenated by processes such as wind, turbulence, precipitation and algal photosynthesis, whilst deeper waters are subject to oxygen consumption from aquatic organism respiration and microbial decomposition processes. The low DO levels at depth are advantageous for the reinterment of sulfidic fines within the lake as part of the operations acid sulfate soil management strategy.

Results of vertical profile monitoring conducted at the TSP lake are presented in Appendix 2.

5.4 Cyanobacteria results

Long-term cyanobacteria and nutrient monitoring has been undertaken at TSP. The comprehensive data set indicates that seasonal algal blooms of species capable of producing toxins were frequently recorded from 2006 to early 2017, with data analysed herein against the Red, Amber and Green hierarchy in the National Health and Medical Research Council's Recreational Guideline.[20]

Since April 2017, the concentration of algal cells within the lake has not reached ''Red Level' and has thus achieved the NHRMC Guideline for primary contact recreation (<4 mm^3/L) since this time.

Results of recent rounds of cyanobacteria monitoring have indicated low densities of potentially toxic cyanobacteria, below 0.5 mm^3/L and within the 'Green' Alert Level classification for the majority of the annual monitoring periods.

Seasonal fluctuations are observed during the summer months when environmental conditions favour algal growth, with concentrations reaching the 'Amber' classification (0.5 to 1.8 mm^3/L for potentially toxic cyanobacteria) before rapidly returning to the 'Green' surveillance mode for the remainder of the reporting period.

Historical monitoring showed that concentrations of cyanobacteria within the extraction lake are progressively declining. Figure A2.44 in Appendix 2 show the long-term algal results for the site and highlight this trend.

[20] National Health and Medical Research Council, 2008, Guidelines for Managing Risks in Recreational Water.

The reduction in algal numbers is likely due to the gradual increase in lake size (as sand is removed) making the influx of nutrients from the dredging process proportionately smaller. This proportional reduction in nutrient influx limits the size of the algal population that may be sustained, resulting in lower concentrations of algal cells in the lake. This trend is expected to continue as disturbance and nutrient inputs from the dredge decrease relative to the increasing volume of the lake.

TSP's current approach to cyanobacteria management has proven effective over time with respect to risk reduction and hazard mitigation. No incidents relating to contact with the lake (by staff, contractors or visitors) have been reported to date and as noted above the hazard associated with the presence of cyanobacteria in the lake is reducing over time.

New approaches to cyanobacteria management frequently emerge and it is likely that TSP's current understanding and practices will evolve over time. TSP is committed to achieving stable water quality at the site that is acceptable for a range of end use scenarios. The Soil and Water Management Plan (Gilbert & Sutherland, 2021) prepared for the proposed expansion of TSP includes commitments to ongoing cyanobacteria monitoring and adaption of the site's hazard reduction strategies as novel approaches emerge.

5.5 Monitoring of agricultural drainage network

Eight rounds of water quality monitoring and two rounds of rainfall event monitoring were conducted within selected agricultural drainage lines across the expansion area. Monitoring was undertaken to assess the characteristics of waters within these drainage lines which currently convey runoff to the Tweed River.

The role of the agricultural drainage network with respect to stormwater conveyance is discussed in detail in the Burchills Stormwater and Flood Report. A relevant extract is provided below.

> *'In the existing scenario runoff that is generated over the vacant lots is collected by agricultural channels and conveyed to the central drainage lines that discharge to the culverts underneath the M1. Runoff that is produced over the existing sand extraction area is generally contained within the lake and prevented from over-topping into external drainage lines. A significant volume of runoff is produced over the external catchments to the south, this runoff is collected by existing drainage lines and conveyed to the culverts at the M1.*

Nutrient concentrations within the agricultural drainage network typically exceed concentrations within the TSP extraction lake.

The long-term median total phosphorous (TP) concentration within the extraction lake is 0.03 mg/L, compared to a median of 0.08 mg/L in the agricultural drainage network. Rainfall events saw a slight increase in TP loads with a recorded median of 0.11 mg/L across the two events.

The long-term median total nitrogen concentration within the extraction lake is 0.63 mg/L, compared to a median of 0.6 mg/L within the agricultural drainage network. Rainfall events did not appear to increase these loads with a median of 0.6 mg/L recorded across the two monitoring events.

Expansion of the extraction lake will necessitate removal of some of these drainage lines and in some instances, creation of new channels to ensure waters from external catchments continue to be diverted around the extraction lake. This is considered important from a water quality management perspective as an influx of nutrients from these drainage channels has the potential to negatively impact water quality and increase the likelihood of algal blooms.

Further details including a schematic of proposed stormwater conveyance and management measures is contained in the Burchills report.

5.6 Proposed water quality objectives

Water quality measured within the existing TSP lake has been compared against the Water Quality Objectives for the Tweed River, the ANZECC Guidelines for aquatic species protection and the NHRMC Guidelines.

In many instances the existing water quality in the TSP lake complies with the guidelines and in these instances it is proposed that the ANZECC Guideline value for freshwater 95% species protection would be adopted as the site's compliance criteria. In instances where the existing water quality does not meet the generic guidelines, site specific water quality criteria are proposed.

5.6.1 Required level of protection

The ANZECC Guidelines recognise three categories of ecosystem condition, with a level of protection ascribed to each:

1. High conservation/ecological value systems
2. Slightly to moderately disturbed systems
3. Highly disturbed systems.

Based on the guidance provided in Section 3.1.1 of the ANZECC Guidelines, the ecosystem condition that best describes the receiving environment of the Tweed River is '*slightly to moderately disturbed'* condition. This is defined by the Guideline as:

> *'Ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation; marine systems would largely intact habitats and associated biological communities. Slightly-moderately disturbed systems could include rural streams receiving runoff from land disturbed to carrying degrees by grazing or pastoralism, or marine ecosystems lying immediately adjacent to metropolitan areas.'*

The majority of the TSP site and proposed expansion area have been subject to historic disturbance including previous clearing, agricultural use, and sugarcane cultivation. These areas are best described as '*highly disturbed systems'* which are described by the Guideline as;

> *'…measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be some shipping ports and sections of harbours serving coastal cities, urban streams receiving road and stormwater runoff, or rural streams receiving runoff from intensive horticulture.'*

For this type of ecosystem, the ANZECC Guidelines recommend that site-specific water quality criteria for physical and chemical stressors be derived and used instead of regional default guideline values (DGVs). The general approach recommended for deriving guideline values described in Section 3.4 of this report.

Depending on existing ecosystem condition and required level of protection, site specific trigger values are defined by choosing either a conservative percentile value (e.g. 80th percentile value) to improve water quality, or a less conservative percentile (e.g. 90th percentile) to maintain water quality.

In this instance the more conservative 80th percentile value has been adopted to determine the site-specific criteria with the aim of improving water quality over time[21]. Proposed water quality objectives are presented in Table 5.6.1.

5.6.2 Interpreting results against water quality criteria

When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important[22].

It is important to note that when using the 80th percentiles to establish water quality criteria the probability of a single observation exceeding the 80th percentile is 20%. Thus, the probability of a Type 1 error (or the risk of triggering a false alarm) for this method of setting water quality criteria is 20%.

[21] Page 3.1-22 ANZECC Guidelines 2000.

[22] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

Table 5.6.1. Proposed water quality objectives – Surface water

Pollutant	Unit of measure	Water quality objective	Derivation
pH	pH units	6.5 - 8.5	ANZECC
Dissolved Oxygen	% saturation	>90	ANZECC
Turbidity	NTU	<5- 20	ANZECC
Dissolved Iron	mg/L	<0.13	80th percentile of site data
Dissolved Aluminium	mg/L	<0.055	ANZECC
Arsenic	mg/L	<0.024	ANZECC
Total Nitrogen	mg/L	<0.78	80th percentile of site data
Total Phosphorus	mg/L	<0.05	80th percentile of site data

It is recommended that the recording of a single result that exceeds the criteria should not automatically be deemed as a 'non-compliance'. Rather, the water quality criteria are designed to be used as a tool to prompt additional investigations or observations of the parameter in question to ascertain whether an adverse trend may be emerging and if so, allow early detection of the cause of the trend. The findings of such site investigations should be used to determine whether a non-compliance has occurred.

5.7 Post extraction water quality

Hanson will retain ownership of the site following completion of sand extraction and any proposed subsequent use of the site will be decided via the appropriate consultation, application and regulation processes in place at that time.

A comprehensive Soil and Water Management Plan has been prepared for the site and includes commitments to monitoring and management of surface and groundwaters at the site to ensure the existing water quality is maintained and where possible improved throughout the course of the development. Commitments are also included for the continuation of water quality monitoring post cessation of extraction.

Specific goals for end-use water quality would be determined at an appropriate juncture in the future as the ultimate end-use of the site is defined.

Table 5.2.1 - Compliance status key for Table 2

Colour code	Description
Compliant	Median results comply with the relevant performance criteria
Marginally non-compliant	Median results marginally exceed the relevant performance criteria
Non-compliant	Median results do not currently comply with the relevant performance criteria

Table 5.2.2 – **Lake surface water** quality comparison of data median with relevant standards

Parameter	Data range	Median	Tweed River WQO (aquatic ecosystems)	ANZECC Aquatic Ecosystems Guideline	NHRMC Guideline; or ANZECC Primary Contact	Comment
pH	6.36 – 9.85	8.34	6.5 - 8.0	6.5 - 8.0	6.5 to 8.5 or 5.0 to 9.0 in waters with poor buffering capacity	--
EC	207 – 3,920 µS/cm	2,527 µS/cm	125 - 2200 µS/cm	NA	NA	Due to the coastal nature of the site, waters experience saline influence from the Tweed River, resulting in chemical profiles representative of saline environments. ANZECC provides a guideline for salinity (EC) of 20 – 30 µS/cm for lakes and reservoirs, and states: *Conductivity in lakes and reservoirs is generally low, but will vary depending upon catchment geology. Values provided are typical of Tasmanian lakes and reservoirs*
Temperature	13.8 – 23.0°C	21.6°C	NA	NA	16 to 34°C	--
DO	2.75 - 14.93 mg/L	8.55 mg/L	> 6 mg/L	>6 mg/L	>6 mg/L	--
Sodium (Na)	203 - 565 mg/L	330 mg/L	NA	NA	<300 mg/L	Due to the coastal nature of the site, waters experience saline influence from the Tweed River, resulting in chemical profiles representative of saline environments.
Potassium (K)	12 - 27 mg/L	17 mg/L	NA	NA	NA	--
Magnesium (Mg)	35 - 90 mg/L	57 mg/L	NA	NA	NA	--

Parameter	Data range	Median	Tweed River WQO (aquatic ecosystems)	ANZECC Aquatic Ecosystems Guideline	NHRMC Guideline; or ANZECC Primary Contact	Comment
Chloride (Cl-)	330 – 1,050 mg/L	591 mg/L	NA	NA	<400 mg/L	Due to the site's coastal nature, waters experience saline influence from the Tweed River, resulting in chemical profiles representative of saline environments.
Sulfate (SO_4)	129 - 565 mg/L	246 mg/L	NA	NA	<400 mg/L	Due to the coastal nature of the site, waters experience saline influence from the Tweed River, resulting in chemical profiles representative of saline environments.
Bicarbonate (HCO_3)	73 - 225 mg/L	134 mg/L	NA	NA	NA	--
Iron (Fe)	0.002 – 0.560 mg/L	0.05 mg/L	NA	NA	<0.3 mg/L	--
Aluminium (Al)	0.005 - 1.98 mg/L	0.014 mg/L	NA	0.05 mg/L	<0.2 mg/L	ANZECC trigger value for freshwater – 95% Level of protection
Arsenic (As)	0.001 - 0.010 mg/L	0.002 mg/L	NA	0.024 mg/L	<0.05 mg/L	ANZECC trigger value for freshwater – 95% Level of protection
Ammonia (NH_3)	0.005 - 0.460 mg/L	0.032 mg/L	NA	<0.9 mg/L	NA	--
Total Nitrogen (µg/L)	100 – 2,440 µg/L	625 µg/L	<350 µg/L	<350 µg/L	NA	--
Total Phosphorous	0 - 700[23] µg/L	40 µg/L	<10 µg/L	<10 µg/L	NA	--
Chlorophyll-a	0.5 - 43 µg/L	8 µg/L	<5 µg/L	<5 µg/L	NA	--
Faecal coliforms	0.5 - 540 cfu/100mL	10 cfu/ 100mL	NA	NA	<150 cfu/100mL	ANZECC 2000 Guidelines recommend: Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month)
Enterococci	1 - 220 cfu/ 100mL	6 cfu/ 100mL	NA	NA	<35 cfu/ 100mL	ANZECC 2000 Guidelines recommend: Median over bathing season of < 35 enterococci per 100 mL

[23] The measured maximum values of 700ug/L iin the lake 1 event out of 220 monitoring months which occurred in September 2009 otherwise the maximum would be 170ug/L

Parameter	Data range	Median	Tweed River WQO (aquatic ecosystems)	ANZECC Aquatic Ecosystems Guideline	NHRMC Guideline; or ANZECC Primary Contact	Comment
						(maximum number in any one sample: 60-100 organisms/100 mL)

6 Water balance assessment

A site water balance has been prepared for the lake to address relevant items from the *Planning Secretary's Environmental Assessment Requirements* (SEAR's) in relation to surface and groundwaters at the site.

6.1 Site surface water management system

Operations at TSP have been designed and are managed to minimise impacts to onsite and offsite surface water environments.

The TSP extraction lake forms a groundwater window. Overburden (material above the sand resource and groundwater table) is removed periodically and stockpiled onsite for later use in site rehabilitation. All extraction below the groundwater table is via dredge, negating the need for any dewatering activities.

For the purpose of acid sulfate soil management, materials extracted from the lake are processed through the site's wash plant with excess water and fines returned to the lake via the fines return pipeline. There are no offsite water transfers and surface waters in the lake are hydraulically isolated from the external drainage lines under normal (i.e. not flooded) conditions, thereby minimising the potential for offsite impacts. To minimise the use of clean (potable) water, water required for operational purposes (such as dust suppression) is sourced from the lake.

Analysis of surface water quantity management (including site drainage, dewatering, flooding and water releases) is also provided in the *'Flood and Stormwater Assessment'* (Burchills, 2021).

6.2 Water supply and use

Water is required to be used for dust suppression on the site's internal roads and for other minor onsite uses (such as equipment washdown). To avoid the use of potable water for operational purposes, water for dust suppression is sourced from the extraction lake with an appropriate licence relevant to the volumetric take in place. The volume of water used for dust suppression is minimised to ensure that ponding of water or the generation of runoff is avoided. Approximate volumes for this water use are provided in the site's water balance.

Since all water extracted during the dredging process is either passively infiltrated as groundwater recharge (in the area of the wash plant) or returned to the lake in solution with the separated fines, any hydraulic losses from the lake and groundwater are limited to evaporation. The impacts of rainfall and evaporation are considered in the site's water balance.

6.3 Climate data analysis

To assess the lake's long term hydrological behaviour, a water balance assessment was performed using meteorological data sourced from the Queensland Government's *The Long Paddock* website.[24] This online facility generates a climatic profile for a given length of time based on a number of records in the site vicinity.

In the case of the TSP site, the rainfall records date from 1889 to the present. Evaporation records commenced in 1970 (with numerically generated daily averages used prior to that time). The water balance model used 132 complete years of data from 1 January 1889 to 31 December 2020. Table 6.3.1 provides statistics for the daily time-step rainfall and evaporation data use in the model.

Table 6.3.1 Rainfall and evaporation statistics for model dataset

	Rainfall (mm)	Evaporation (mm)
Minimum	802	1,276
5th percentile	1,074	1,418
20th percentile	1,351	1,540
Median	1,670	1,551
Average	1,709	1,543
80th percentile	2,061	1,555
95th percentile	2,453	1,659
Maximum	2,934	1,896

[24] https://www.longpaddock.qld.gov.au/silo/

On average, rainfall exceeds evaporation, however the rainfall depth in any given year is much more variable than the evaporation. It is noted there is minimal difference between the 20th percentile and 80th percentile evaporation depths as the dataset adopted the same evaporation values each year until 1970 and as such evaporation for 81 years of the 132 year model period was essentially fixed.

A more detailed analysis of the meteorological records on a monthly basis indicates that evaporation generally exceeds rainfall for the months of July through to January, with a relative excess in precipitation occurring between February and June. It must be noted that these qualifications are based on medians derived from the long-term data and the rainfall can be higher or lower than the evaporation in any given month.

Table 6.3.2 presents net rainfall-evaporation differential statistics for each calendar month within the 132 year dataset.

Table 6.3.2 Net monthly rainfall and evaporation differential (mm) for model dataset

Month	20th percentile	Median	80th percentile
January	-99	-28	121
February	-55	30	204
March	-42	71	201
April	-36	28	140
May	-25	54	154
June	-41	22	143
July	-62	-18	69
August	-89	-52	24
September	-115	-76	-12
October	-114	-59	3
November	-125	-71	3
December	-119	-63	42
Total	-213	117	510

The data indicates that for any given calendar month, evaporation exceeds rainfall in at least 20 percent of years (i.e. 26 of 132) and, similarly, rainfall exceeds evaporation in at least 20 percent of years (with the exception of September).

6.4 Water balance model method

A spreadsheet-based water balance model was established to characterise the anticipated long-term hydrological behaviour of the lake, including:

- fluctuations in the lake water surface level and storage volume;
- frequency and size of overflow events;
- evaporative losses; and
- groundwater exchange.

The model adopted a simple algorithm to calculate changes in the volume of water stored in the lake on a daily basis:

$$V_{end} = V_{ini} + V_{Sin} - V_{Sout} - V_{ev} + V_{ra} + V_{ro} - V_{use} - V_{over}$$

where:

V_{end} = End day stored volume
V_{ini} = Initial volume
V_{sin} = Seepage into lake
V_{sout} = Seepage out of lake
V_{ev} = Evaporation
V_{ra} = Direct rainfall on lake
V_{ro} = Catchment surface runoff into lake
V_{use} = Site water usage
V_{over} = Lake overflow

For modelling purposes, the lake has been assumed to be a closed loop with respect to inflows, and that no daily external flows into the lake occur, with the exception of direct runoff from the local contributing catchment. In practice, this means the water balance does not take into consideration large flood events where the surrounding land floods and fills the lake to capacity.

An initial (existing case) model was setup up to represent current site conditions and to allow for estimation of seepage rates through verification of the modelled water level against continuous lake level data recorded with an onsite data logger between March and October 2020.

Following quantification of suitable seepage rates, a long-term model was established for the entire 132 year period for which climate data is available. This model was then used to examine

the anticipated hydrological behaviour for each of the eight phases of lake expansion works.

6.5 Water balance model inputs

6.5.1 Lake geometry and catchment areas

The existing lake area for the verification model was measured from a June 2020 Nearmap image of the site.

For each development phase, the lake-full area was estimated from the development Concept Plan (Drawing No. Z19163-104 prepared by Zone Planning Group and included in Appendix 1).

For both the verification model and each development phase, internal batters were assumed at 1 in 4 throughout the range of active storage depths.

As the lake depths are variable, for modelling purposes, a total depth of 2.0 m below full storage was included as this covers the full range of anticipated water surface variation during the 132 year model period. As such the modelled lake volumes are the storage volume above this reference level, rather than the total volume of water contained within the lake.

In keeping with the assumptions of Burchills' 2020 flood assessment for the project, it has been assumed that the overflow weirs for the current and proposed future lakes are both situated at an elevation of RL 1.0 mAHD. This has been adopted as the full storage level for the lake across all phases of works.

The existing lake is surrounded by a discontinuous bund at approximately RL 1.30 mAHD, and thus a small additional catchment area may contribute surface runoff to the lake. As the southern lake expands to the south, diversion drains for an external catchment to the southeast of the southern lake will be consumed by the lake itself and this catchment will contribute runoff to the lake from Phase 6 onwards.

For each development phase, the contributing catchment for the southern lake has been determined in reference to the catchment plans in Burchills 2021 *'Flood and Stormwater Assessment'* and available LiDAR survey throughout the expansion area.

The northern lake (in Phases 10 and 11) has been assumed to be fully isolated from external catchment runoff by the proposed bund at RL 1.75 mAHD. The contributing catchment for this lake is limited to the bunded area.

Table 6.5.1 shows the modelled lake full and catchment areas adopted for each phase of development. It is noted that in Phases 10 and 11, a separate northern lake is formed. For these phases, the lake and catchment areas for the southern lake remain the same as for Phase 9 and the table presents the areas for the northern lake as well as total areas for both lakes.

Stage-storage relationships derived for each development phase are included in Appendix 3.

Table 6.5.1 Lake full and catchment areas

Phase	Lake full area (at RL 1.00 mAHD) (ha)	Catchment area (ha)
Existing	29.8	45.3
Phases 1-4	39.0	45.3
Phase 5	73.7	86.9
Phase 6	102.3	167.8
Phase 7	114.0	179.1
Phase 8	132.0	196.8
Phase 9	157.0	218.6
Phase 10 (north)	18.1	18.6
Phase 10 (total)	175.1	237.2
Phase 11 (north)	36.5	37.2
Phase 11 (total)	193.4	255.8

6.5.2 Rainfall and evaporation

Rainfall directly onto the lake and evaporation from the lake surface were adopted from the climate data described in Section 6.3. These were multiplied by the wet lake area calculated at the start of each day.

6.5.3 Catchment runoff

Runoff from the catchment, excluding the wet lake area, was calculated using a runoff co-efficient of 0.53 representing soils of high permeability with light vegetative cover.

6.5.4 Site water usage

During Phases 1 to 6, while the processing plant remains in its current location, a daily reuse volume of 24kL has been applied for watering of internal roads for dust suppression when the daily rainfall is up to 25 mm. If the daily rainfall exceeds 25 mm, it has been assumed that dust suppression water would not be required.

From Phase 7 onwards, once the plant has been relocated, the site's internal roads will be sealed and therefore water for dust suppression of these roads will no longer be required.

6.5.5 Seepage

The lake is a groundwater window and seepage can occur both into and out of the lake, depending on the hydraulic grade between the lake water level and the surrounding groundwater level. A simplified approach has been adopted to represent the influence of seepage on the lake water level.

G&S has undertaken periodic groundwater monitoring in the region surrounding the lake since 2001. Over that time, the average groundwater level across all bores is estimated at 0.3 mAHD. The model has assumed this level represents the long term average groundwater level immediately surrounding the lake. When the lake water level is above 0.3 mAHD, the model has assumed seepage is occurring out of the lake and if the lake level is lower, the model assumes seepage is occurring into the lake.

The surface area over which seepage occurs has been calculated using the product of the lake perimeter and the difference in depth between the lake level and the assumed groundwater level.

The existing case model was used to estimate an appropriate seepage rate by verifying the modelled lake levels against logger data recorded from March to October 2020. Based on this model a seepage rate of 35 mm/hour has been adopted in the water balance model for movement of water both into and out of the lake.

6.5.6 Lake discharge and overflow

The southern lake is bunded to a level of RL 1.3 mAHD and the northern lake to a level of RL 1.75 mAHD. Both lakes are proposed to be constructed with 10-metre wide weirs at RL 1.0 mAHD, which is considered to be the full storage level for modelling purposes.

Lake discharge was assumed to occur when the daily water level (following all other inputs and outputs) exceeds the full storage level of 1.0 mAHD. An analysis of the weir flow capacity indicates that the weir for each lake has sufficient capacity to discharge the full storage volume between the weir level and the bund in each lake, within 24 hours. Accordingly, given the daily timestep of the model, it has been assumed that all water entering the lake will discharge down to the weir level within a single model timestep.

Lake overflow occurs when the daily rainfall and runoff entering the lake is sufficient to fill the lake to above the level of the bund within a single 24 hour period. This is a rare occurrence that would mostly likely occur in conjunction with regional flooding (which the water balance model does not address). Again, any overflow volumes have been assumed to discharge from the lake within a single model timestep of one day.

Discharge and overflow volumes have been separated within the model to estimate the frequency at which each occurs.

6.5.7 Initial lake condition

TSP has undertaken monthly monitoring of the water level in the lake since 2008. Over the 12 years that data has been recorded, the median recorded lake level is 0.37 mAHD. This was adopted as the starting water level in the lake at the commencement of the model period.

6.6 Existing case model verification

As noted in Section 5.4, and existing case model was established to characterise the hydrological response of the lake to rainfall, to estimate seepage rates to apply to the model and to verify

those results against recorded lake level data from 3 March 2020 to 7 October 2020.

The existing case model was run over a shorter modelling period, from 1 January 2000 to 5 October 2020. Only the results for 2020 were used for model verification, however the longer timeframe was modelled to minimise the influence of any numerical effects of initial conditions applied to the model.

It is noted that, whilst monthly lake levels have been recorded on site since 2008, model verification over a longer period was not undertaken. This was due to the dynamic nature of the onsite operations, such that the landform (lake and catchment areas) adopted in the model differs in extent from that which would have been in place when the historical records were collected.

Given these considerations, comparing model results based on the current landform against field results from previous and varying landforms is not an appropriate verification tool.

Using an iterative approach, it was determined that a model seepage rate of 35 mm/hour, in combination with the other model assumptions described above, yielded results that provided the best correlation with the field data.

Figure A4.1 (in Appendix 4) shows a comparison of the recorded and modelled lake water levels.

6.7 Water balance model results

The water balance model was run for the 132 year model period for each of the development phases previously described in Table 5.5.1. Key results of the model across each development phase are described in the following sections.

6.7.1 Lake water level fluctuations

The modelled long term lake levels for each phase of the development are presented on Figures A4.2 to A4.9 (in Appendix 4).

Table 6.7.1.1 (following page) presents statistics on the range of anticipated lake levels for each phase of the development.

The median modelled level for the southern lake is anticipated to increase substantially from Phase 6 onwards, once the external catchments to the south of the lake come online and begin to contribute runoff to the lake. Subsequent to the external catchment coming online, the median modelled lake level gradually decreases over subsequent development phases (as the influence of the external catchment runoff relative to the lake area reduces).

Estimated water levels in the northern lake are substantially less than for the southern lake as it will be fully bunded and does not cater for runoff from any external catchments.

Table 6.7.1.1 Modelled lake water surface elevation fluctuation 1889-2020 - statistics based on daily results

Development Phase	Water surface elevation (mAHD)							
	Minimum	5th %ile	20th %ile	Median	80th %ile	95 %ile	Maximum	Average
Phases 1-4	-0.30	0.07	0.21	0.40	0.64	0.86	1.26	0.42
Phase 5	-0.41	0.07	0.23	0.45	0.71	0.92	1.35	0.46
Phase 6	-0.33	0.23	0.43	0.67	0.90	0.98	1.50	0.65
Phase 7	-0.34	0.22	0.41	0.65	0.89	0.98	1.48	0.64
Phase 8	-0.37	0.19	0.38	0.62	0.87	0.97	1.46	0.61
Phase 9	-0.40	0.16	0.34	0.58	0.83	0.97	1.43	0.58
Phase 10 (north)	-0.22	0.07	0.19	0.34	0.55	0.75	1.31	0.37
Phase 11 (north)	-0.34	0.04	0.17	0.37	0.59	0.82	1.40	0.39

6.7.2 Frequency and extent of discharge and overtopping

The model results indicate that discharge from the southern lake outlet weir for the initial phases 1-5 is likely to occur infrequently (in 18 to 28 percent of years). Once the external catchment comes online (in Phase 6), the additional runoff it contributes to the lake will increase the frequency of weir discharge to almost 60 % of years, with an average of 11 to 13 days of discharge occurring in each of those years. As the southern lake area expands, the relative influence of external catchment runoff reduces, and in its final form, discharge is anticipated to occur in 43 % of years.

The northern lake is estimated to discharge much less frequently than the southern lake, in 5 to 10 percent of all years and on an average of 6 to 7 days in each of those years.

Lake overflow (where the surrounding bund is overtopped) is a very rare occurrence, in response to significant rainfall events. It is likely that such rainfall events would also cause localised or regional flooding, generating additional flows into the lake that are not represented by the water balance model.

Table 6.7.2.1 provides a summary of the number and percentage of model years during which any weir discharge occurs, the total number of days of discharge throughout the 132 year model period and the average number of days of discharge for years in which it occurs.

Table 6.7.2.1 Lake weir discharge behaviour

Phase	No. of model years discharge occurs	Percent of years discharge occurs	Total no. of discharge days	Average discharge days in discharge years
1-4	24	18.2 %	124	5.2
5	36	27.3 %	256	7.1
6	77	58.3 %	967	12.6
7	74	56.1 %	867	11.7
8	66	50.0 %	762	11.5
9	57	43.2 %	616	10.8
10 (north)	7	5.3 %	46	6.6
10 (total)	57	43.2 %	616	10.8
11 (north)	13	9.8 %	81	6.2
11 (total)	57	43.2 %	616	10.8

The results indicate that discharge from the southern lake is likely to occur in 18 percent of years for the currently approved Phases 1-4 of the

development, up to 58 percent of years when the external catchment comes on line and approximately 43 percent of years long term. For those years where discharge does occur, there is an average of just 11 to 13 days in those years that the lake would be actively overtopping.

Discharge from the northern lake (from phase 11 onwards) is estimated to occurring in up to 10 percent of years long term and for an average of just 6 days per year. Based on the modelling, the northern lake never discharges in isolation, this is it only discharges on days the southern lake is also discharging.

At times when discharge from the lake does occur, the volume of discharge from the site is highly variable, based on the size of the rainfall event and also the lake condition prior to the event (influenced by rainfall in the preceding months), however we do see a trend in that at the size of the lake increases, in general the volume overflow lost from the lake system also increases.

Table 6.7.2.2 provides a summary of the bund overtopping behaviour.

Table 6.7.2.2 Lake bund overtopping behaviour

Phase	No. of model years overflow occurs	Percent of years overflow occurs	Total no. of overflow days
1-4	0	0 %	0
5	1	0.8 %	1
6	2	1.5 %	2
7	2	1.5 %	2
8	2	1.5 %	2
9	2	1.5 %	2
10 (north)	0	0 %	0
11 (north)	0	0 %	0

Lake overflow (defined by overtopping of the bund) from the southern lake is very rare and only estimated to occur for a single rainfall event in 1 to 2 percent of years. Under the modelled climatic conditions, the northern lake (which is surrounded by a higher bund) is not anticipated to overflow.

Table 6.7.2.3 shows the maximum weir discharge and bund overflow volumes leaving the lake for any calendar year as well as the average annual volume of discharge (over all model years) presented in comparison to average annual total of rainfall and runoff volumes entering the lake. For the currently approved development, overflow accounts for an average of two percent of all lake inflows.

For all future phases of the development, spill is estimated to account for up to twelve percent of all rainfall and runoff entering the southern lake and 1 percent of rainfall and runoff entering the northern lake.

6.7.3 Lake surface evaporation

The climate data analysis presented in Section 6.3 shows that, on average, annual rainfall depths exceed annual evaporation depths at the site. Table 6.7.3.1 compares the average annual volume of evaporation to the lake's average annual surface water inflows (rainfall and runoff).

Table 6.7.3.1 Average annual evaporation

Phase	Evaporation (m^3/year)	Surface water inflows (m^3/year)	Evaporation as proportion of surface inflows (%)
1-4	592,878	718,830	82 %
5	1,127,094	1,372,969	82 %
6	1,572,818	2,336,702	67 %
7	1,752,036	2,532,657	69 %
8	2,027,296	2,835,705	71 %
9	2,409,683	3,231,981	75 %
10 (north)	273,712	311,177	88 %
10 (total)	2,683,394	3,543,158	76 %
11 (north	554,579	625,040	89 %
11 (total)	2,964,261	3,857,021	77 %

Table 6.7.2.3 Lake overflow volumetric results

	Weir discharge		Bund overflow		Total discharge			
Phase	Maximum volume (m^3)	Average annual volume (m^3)	Maximum volume (m^3)	Average annual volume (m^3)	Maximum volume (m^3)	Average annual volume (m^3)	Average rainfall & runoff volume (m^3)	Average overflow vs surface inflow (%)
Phases 1-4	361,269	11,985	0	0	361,269	11,985	718,830	1.7 %
Phase 5	815,671	45,396	40,461	307	856,132	45,702	1,372,969	3.3 %
Phase 6	1,962,186	282,320	207,639	2,178	1,998,316	284,498	2,336,702	12.2 %
Phase 7	2,081,538	278,835	209,899	2,164	2,120,386	281,000	2,532,657	11.1 %
Phase 8	2,235,573	271,902	212,907	2,140	2,301,750	274,042	2,835,705	9.7 %
Phase 9	2,365,597	249,882	206,191	1,981	2,490,804	251,863	3,231,981	7.8 %
Phase 10 (north)	106,781	2,134	0	0	106,781	2,134	311,177	0.7 %
Phase 10 (total)	2,452,347	252,016	206,191	1,981	2,597,585	253,997	4,050,366	7.2 %
Phase 11 (north)	286,251	6,991	0	0	286,251	6,991	625,040	1.1 %
Phase 11	2,605,147	256,873	206,191	1,981	2,777,055	258,854	3,857,021	6.7 %

Across all future phases of the development, evaporation accounts for approximately 67 to 82 percent of all rainfall and runoff entering the southern lake and just under 90 percent of rainfall and runoff entering the northern lake.

6.7.4 Groundwater interaction

The surface water balance model undertaken for the lake gives a limited and rudimentary picture of surface water-groundwater exchange within the lake. Detailed groundwater balance modelling would be required to estimate groundwater exchange based on dynamic (rather than assumed static) groundwater levels. Nonetheless, based on the modelling undertaken, Table 6.7.4.1 provides a summary of the modelled volumetric exchange of seepage into and out of the lake.

The results indicate, that on average, both lakes behave as a groundwater recharge window, rather than a groundwater extraction.

Table 6.7.4.1 Rudimentary estimates of average annual groundwater exchange

Phase	Seepage into lake (m^3/year)	Seepage out of lake (m^3/year)	Net groundwater recharge (m^3/year)
1-4	37,336	142,550	105,214
5	46,947	237,798	190,851
6	12,510	479,815	467,305
7	15,992	511,642	495,650
8	23,142	553,318	530,176
9	38,748	605,098	566,350
10 (north)	26,133	61,359	35,227
10 (total)	64,881	666,457	601,576
11 (north)	41,700	104,939	63,239
11 (total)	80,448	710,037	629,589

7 Surface water discharges to receiving environment – flood events

The existing TSP operation and the expansion area are located within the Tweed River floodplain. As such, the site is subject to regular inundation during large regional rainfall events.

Incoming regional flood waters originate from the Tweed River and enter the subject site through the culverts that run beneath the M1 motorway. Flood waters generally recede from the site through the same culverts and/or flow to the rural area to the east of the site before ultimately draining back to the Tweed River.

Generally, flood velocities are low as the site does not form part of the major flood conveyance path and as such the site is characterised as flood storage. A comprehensive Flood & Stormwater Assessment has been prepared by Burchills Engineering Solutions and should be referred to for further detail with respect to stormwater and flood management. It includes maps of the velocity of floodwaters.

To avoid flooding impacts on neighbouring lands, the existing TSP site and proposed expansion area will continue to form part of the flood plain as flood waters will not be prevented from flowing across these lands.

The low velocities of the flood waters traversing the site minimises the potential for soil erosion or scour of banks and bunding. Records of impacts from previous floods at the existing TSP site indicate that lake banks, bunding and operational areas have not required remediation following such events.

The SEARs require consideration to be given to nutrient or algal transfers during times of flooding. With respect to this issue it is important to consider the quality of flood waters received by the site, the quality of waters within the dredge lake and the quality of waters within the ultimate receiving environment of the Tweed River during times of flood.

Flood waters entering the site during regional floods originate from the Tweed River catchment, which includes large areas of agricultural lands. Flood waters, particularly those containing runoff from agricultural lands, tend to be highly turbid and nutrient rich. Conversely, long-term monitoring of waters contained within the TSP lake indicate low turbidity water and comparatively low nutrient concentrations (median Total Nitrogen of 625 μg/L and a median of 40μg/L for Total Phosphorus).

Flood waters enter the site and surrounds at low velocities across a broad flow length entering at the surface of the lake, thus minimising the creation of turbulent mixing eddies within the waters within the lake. The potential for the formation of turbulent mixing eddies is further reduced by the density differential between the relatively fresh, lower-density floodwaters and the higher density brackish waters of the lake. The relationship is such that the lower-density floodwaters tend to float on-top of the denser lake waters with a degree of mixing at the interface.

To further explore the potential impacts of nutrient and algal transfers from the TSP lake to the receiving environment, a review of the Tweed River Estuary Water Quality Assessment Report[25] was completed. This review encompassed recent water quality conditions in the Tweed River 'Transitional' Estuary and compared them to long term results from within the TSP lake.

Monitoring was conducted by Tweed Shire Council on a monthly basis between January 2012 and November 2016 (5 years). Nutrients (TN, TP) were found to be elevated throughout the estuary, with results of samples taken during moderate to high flow conditions indicating nutrient concentrations (TN, TP) in excess of the Tweed WQO and ANZECC Guidelines within the transitional, middle and upper estuary sites.

[25] Coastal Management Program for the Tweed River Estuary: Water Quality Assessment (2017), Hydrosphere Consulting. https://www.yoursaytweed.com.au/21731/widgets/136097/documents/59065.

Total Nitrogen concentrations were reported to range between 60 and 2400 μg/L over five years, and Total Phosphorous reported to range from <20 μg/L to 210 μg/L across all monitoring sites. These results were attributed to catchment inputs of nutrients during rainfall events, in particular the discharges from the Kingscliff Wastewater Treatment Plant (WWTP) proximal to the TSP site.

In comparison, the long-term median for Total Nitrogen in the TSP lake is 625 μg/L (range from 20-2400μg/L) and 40μg/L (range 0-170 (700) μg/L[26]) for Total Phosphorus. These concentrations normally fall within the range recorded within the Tweed River and in many instances are lower than this receiving environment.

Chlorophyll-a concentrations (an indicator of algal biomass) within the Tweed River were reported to range from 0.4μg/L to 77μg/L. Concentrations generally increased with distance upstream, with transitional monitoring sites (proximal to TSP) reported to exceed the Tweed WQO of <5 μg/L more than 50% of the time in low to moderate flow conditions. Management of inputs from the nearby WWTP's was recommended to reduce nutrient inputs and improve water quality with respect to this parameter.

In comparison, the long-term median for Chlorophyll-a in the TSP lake is 8 μg/L. This concentration falls within the range recorded within the Tweed River and in many instances is lower than this receiving environment.

A summary overview of the data collected is outlined in Table 7.1

Table 7.1 Summary of range of values for TN, TP and chlorophyll-a for the Tweed River and the TSP lake

Parameter	Tweed River (Range)	TSP lake (Range; median)	TSP lake (median
TN (ug/L)	60-2,400	100-2,440	625
TP (ug/L)	20-210	0-170 (700)	40
Chlorophyll a (ug/L)	0.4-77	0.5-43	8

Given the turbid and nutrient laden waters entering the subject site during flood events, the limited opportunity for mixing and the comparable (if not higher quality) water within the TSP extraction lake, it is unlikely that discharges from the TSP site would result in a negative impact on the receiving environment in these conditions.

[26] The measured values in the lake in excess of the maximum for the Tweed river was 1 event out of 220 monitoring months which occurred in September 2009

8 Discussion and conclusions

8.1 Surface water quality

An ongoing program of surface water quality compliance monitoring has been undertaken at the TSP site since 2001, yielding a comprehensive data set. Building on the existing water quality monitoring program, a further eight rounds of surface water monitoring were conducted across the proposed expansion area between March and October 2020, to establish baseline conditions and determine similarities and differences between the expansion area and current TSP site.

To provide context for the current water quality performance of the TSP site, surface water results were also compared with the following relevant guidelines:

- Tweed River Water Quality Objectives
- ANZECC Water Quality Guidelines and
- NHRMC Recreation Water Quality Guidelines for primary contact recreation.

A discussion of results by parameter is as follows.

pH

The long-term median for pH of surface waters within the TSP Lake is 8.34. This value marginally exceeds the Tweed River Water Quality Objective of 8.0 but complies with the ANZECC 2000 criteria for primary contact recreation of 6.5 to 8.5.

Elevated pH results such as these can result from a variety of contributing factors, including the inherent acid neutralising capacity of the carbonate-rich materials within the strata at TSP, as well as algal growth which consumes carbon and produces hydroxide during photosynthesis thus increasing the pH of surface waters.

Dissolved oxygen

Dissolved oxygen concentrations within the TSP lake remain above the Tweed River, ANZECC and NHRMC Guideline minimums of 6.0 mg/L. As a constituent measure of waterbody health, DO at concentrations observed within the extraction lake are ideal for supporting normal aquatic ecosystem function.

Low DO concentrations were observed within agricultural drains located across the expansion footprint reflecting the no-flow conditions observed during monitoring events. The drains' high water temperatures, algal growth and decomposition of organic matter, leads to the poorly oxygenated environments that are characteristic of these shallow drainage channels.

Metals

Metal-rich surface waters (Al, Fe) commonly result from the disturbance of acid sulfate soils, where the oxidation of pyrite in disturbed soils increases the solubility of these metals. Negligible concentrations of metals were detected within the surface waters of the TSP lake and within the agricultural drains throughout the expansion site. Long term median levels within the TSP lake remain compliant with the ANZECC performance criteria for aquatic ecosystem protection and primary contact recreation.

Nutrients

Long-term median results for total nitrogen and total phosphorus recorded within the TSP lake exceed the Tweed River and ANZECC water quality objectives.

The dredging process may result in the release of nutrients or other toxicants contained within pore waters into the dredge lake with resulting water quality issues such as algal blooms. Long term groundwater monitoring of the existing TSP site and recent monitoring within the expansion area has recorded elevated nutrient levels within the site's groundwater environment, likely related to the historic agricultural uses of the land and adjacent properties.

Elevated nutrient levels have been recorded within the TSP lake although due to dilution from rainfall inflows, the levels are substantially lower than within the groundwater environment and are similar to those recorded within the nearby Tweed River.

Faecal coliforms

Bacteriological analyses of surface waters indicated low levels of faecal coliforms and enterococci, consistent with performance criteria for primary contact recreation.

8.2 Surface water balance modelling

A surface water balance model was developed for the site and verified against continuously monitored lake water levels over a 7 month period in 2020. The water balance was subsequently used to estimate the anticipated hydrological behaviour of the lake for each future phase of the development.

The model results indicate that:

- The median southern lake level for the currently approved phases of the development (Phases 1-4) is estimated to be RL 0.40 mAHD, providing 0.60 m freeboard to the overtopping level of 1.00 mAHD.
- The median lake level will increase to 0.67 mAHD, when the external catchment comes online in Phase 6.
- The median southern lake level is then expected to reduce gradually as the lake area expands, stabilising at 0.58 mAHD in the long term (Phase 9 onwards), providing 0.42 m freeboard.
- The median level in the north lake is estimated to be 0.37 mAHD in the long term, providing 0.63m freeboard.
- For the currently approved phases of the development (Phases 1-4), discharge from the southern lake is estimated to occur in 18% of years which equates to once every 5-6 years.
- Discharge frequency is estimated to increase to 58% of years (more than once every 2 years) when the southern external catchment comes online in Phase 6.
- Long term, discharge from the southern lake is estimated to occur in approximately 43% of years (or once every 3-4 years).
- For those years where discharge from the southern lake does occur, there is an average of 11 to 13 days discharge per year that actively discharge would occur.
- Discharge from the northern lake is estimated to occur less frequently, in 5% of years when works commence and 10% of years long term. In these years, discharge would occur for on average 6 to 7 days and always when the southern lake is also discharging.
- Overtopping of the southern lake bund is rare and estimated to occur in less than 2 percent of years long term, and for a single day only each time.
- The northern lake is not anticipated to overtop its bund (excluding the influence of regional flooding).
- Discharge volumes from the overall site represent a small proportion (1.7 to 12.2%) of surface inflows across all phases of the project and 6.7% long term once extraction is complete.
- Evaporative losses on average are less than surface water inflows. These losses amount to between 67% and 82% of total surface water flows (rainfall and runoff) entering the southern lake, and 88 to 89% of flows entering the northern lake.
- Both lakes act as groundwater recharge windows with average net recharge volumes increase over the duration of the project in conjunction with expansion of the lake area.

8.3 Surface water discharges to receiving environment – flood events

The existing TSP operation and the expansion area are located within the Tweed River floodplain and the site is subject to regular inundation during high rainfall events. To avoid flooding impacts on neighbouring lands this condition would be maintained at the site and flood waters would not be prevented from flowing across these lands.

The low velocities of flood waters traversing the site limits the potential for soil erosion or scour of banks and bunding and records of impacts from previous floods at the existing TSP site indicate that lake banks, bunding and operational areas have not required remediation following these events.

Flood waters entering the site during regional floods originate from the Tweed River catchment

which includes large areas of agricultural lands. Flood waters, particularly those containing runoff from agricultural lands are usually highly turbid and nutrient rich. Conversely, long term monitoring of waters contained within the TSP lake indicate low turbidity water and comparatively low nutrient concentrations (median Total Nitrogen of 625 μg/L and a median of 40μg/L for Total Phosphorus).

Flood waters enter the site and surrounds at low velocities thus minimising mixing with the waters within the lake. The potential for mixing is further reduced by the density differential between the relatively fresh, lower-density floodwaters and the higher density brackish waters of the lake. The relationship is such that the lower-density floodwaters will float on-top of the denser lake waters with a degree of mixing at the interface.

Given the turbid and nutrient laden of waters entering the subject site during flood events, the limited opportunity for mixing and the comparable (if not higher quality) water within the TSP extraction lake it is unlikely that discharges from the TSP site would result in a negative impact on the receiving environment in these conditions.

8.4 Post extraction water quality

Hanson will retain ownership of the site following completion of sand extraction and any proposed subsequent use of the site will be decided via the appropriate consultative, application and regulation processes in place at that time.

A comprehensive Soil and Water Management Plan has been prepared for the site and includes commitments to monitoring and management of surface and groundwaters at the site to ensure the existing water quality is maintained and where possible improved throughout the course of the development. Commitments are also included for the continuation of water quality monitoring post cessation of extraction.

Specific goals for end-use water quality would be determined at an appropriate juncture in the future as the ultimate end-use of the site is defined.

8.5 Soil and water management plan

Surface water will be managed in accordance with the measures prescribed in the Soil and Water Management Plan (Gilbert & Sutherland, 2021). That plan outlines monitoring regimes and mitigation measures for the management of impacts to surface and groundwaters.

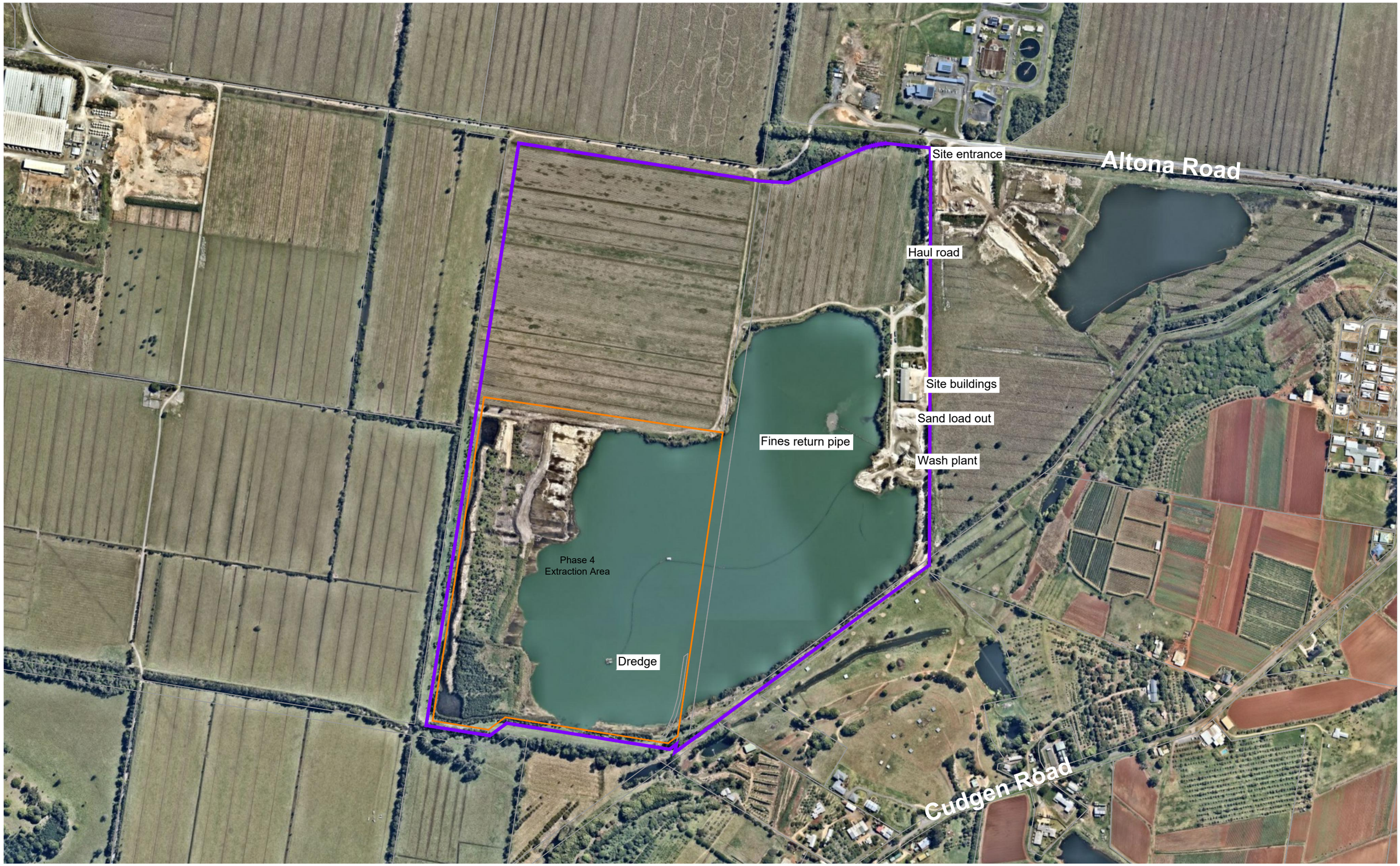
9 Limitations of reporting

Gilbert & Sutherland Pty Ltd has made every effort to ensure that the information provided in this report is accurate. The interpretation of scientific data, however, involves professional judgment and as such is open to error.

In recognising the potential for errors in scientific interpretation, Gilbert & Sutherland Pty Ltd does not guarantee that the information is totally accurate or complete and clients are advised not to rely solely on this information when making commercial decisions. Any representation, statement, opinion or advice, expressed or implied is made in good faith and on the basis that the authors, Gilbert & Sutherland Pty Ltd, their agents or employees are not liable (whether by reason of lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Furthermore, this information should not be relied upon by any persons other than the client, for whom it has been compiled. This information reflects the specific brief and the budget of the client concerned, who enjoys an individual tolerance of risk.

10 Appendix 1 – Drawings



ORIENTATION

SCALE
50 100 150 200 250 300
metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- Site Boundary
- Phase 4 Extraction Area (indicative only)

SOURCES

Image: Nearmap 2020. Image date: 14/09/2020

PROJECT	CLIENT	DRAWING
TWEED SAND PLANT EXPANSION	HANSON CONSTRUCTION MATERIALS	EXISTING TWEED SAND PLANT OPERATION

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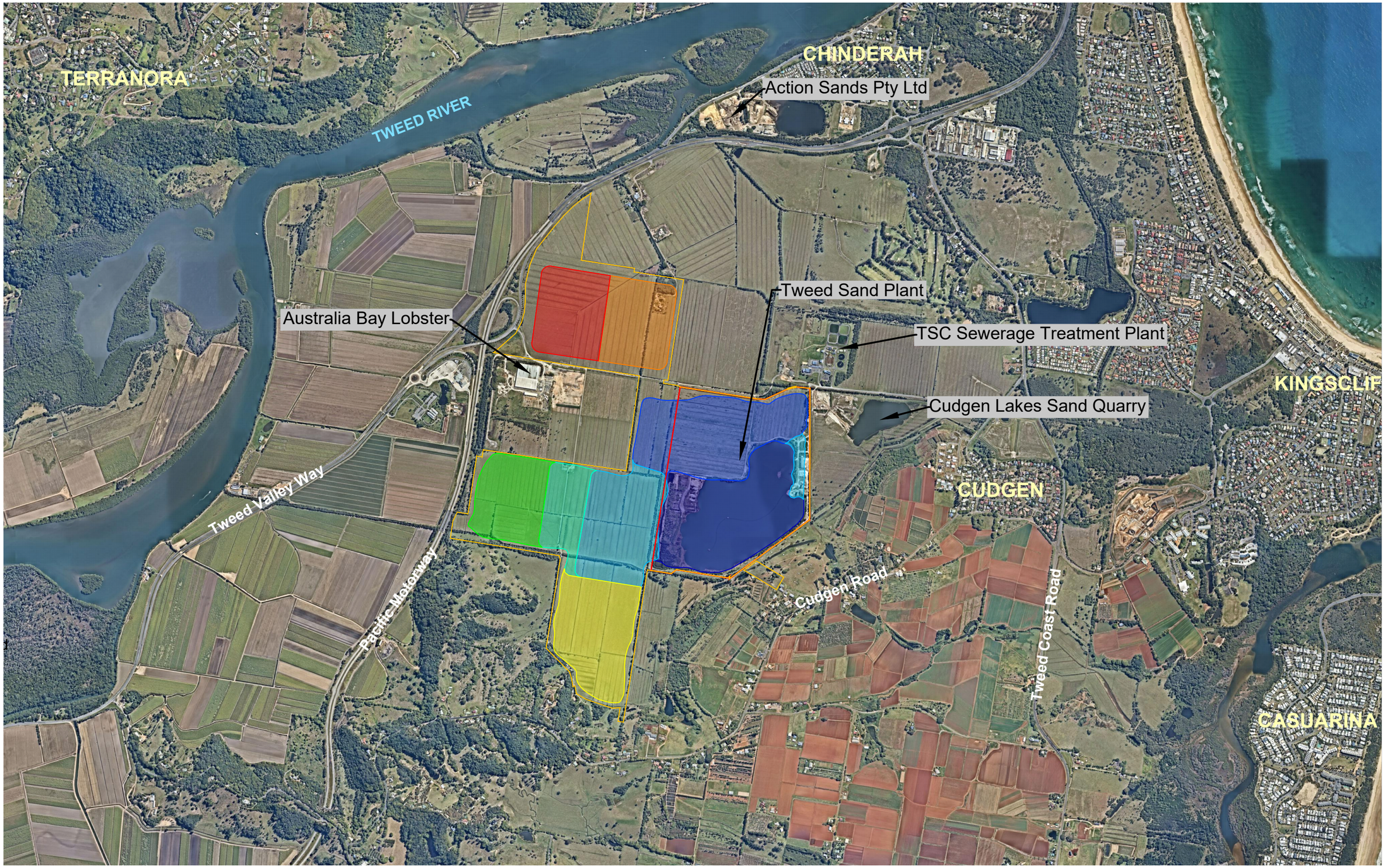
GILBERT SUTHERLAND



ORIENTATION

SCALE
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metres

ROBINA
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LEGEND
- Site boundary - existing
- Site boundary - expansion area

INDICTIVE EXPANSION AREA PHASES
- Phases 1-4 (approved)
- Phase 5
- Phase 6
- Phase 7
- Phase 8
- Phase 9
- Phase 10
- Phase 11

SOURCES
Image: Nearmap 2020. Image date: 14/09/2020

PROJECT
TWEED SAND PLANT EXPANSION

CLIENT
HANSON CONSTRUCTION MATERIALS

DRAWING
PROPOSED TWEED SAND PLANT EXPANSION

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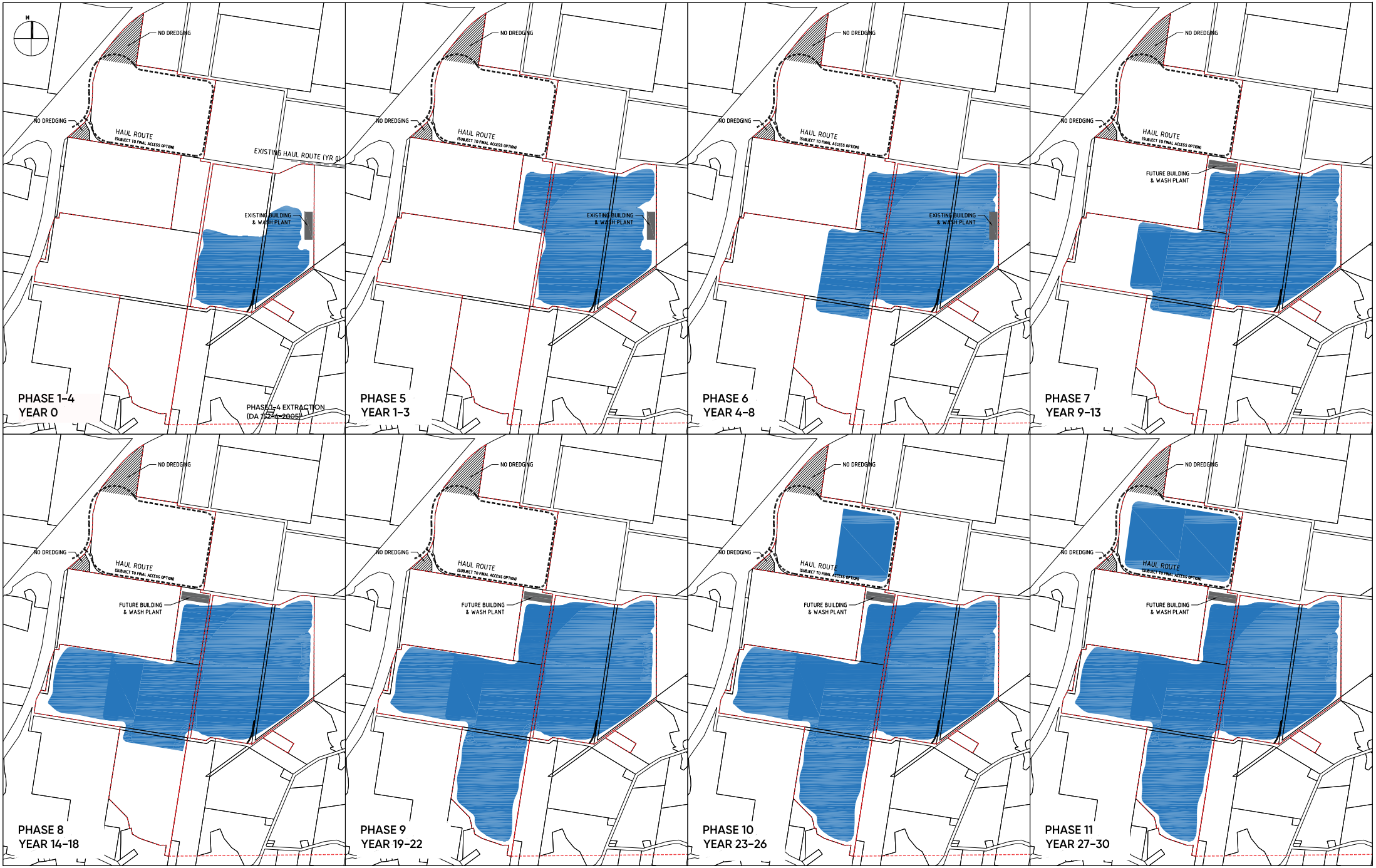
GILBER SUTHERLAN



PROJECT TITLE

HANSON TWEED SAND PLANT

PHASE 5-11

DRAWING TITLE

CONCEPT DEVELOPMENT PHASING

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ISSUE: PRELIMINARY	CLIENT: HANSON CONSTRUCTION MATERIALS PTY LTD
BASE PROVIDED BY: SIXMAPS DCDB	MANAGER: LANCE NEWLEY

ZONE PLANNING GROUP

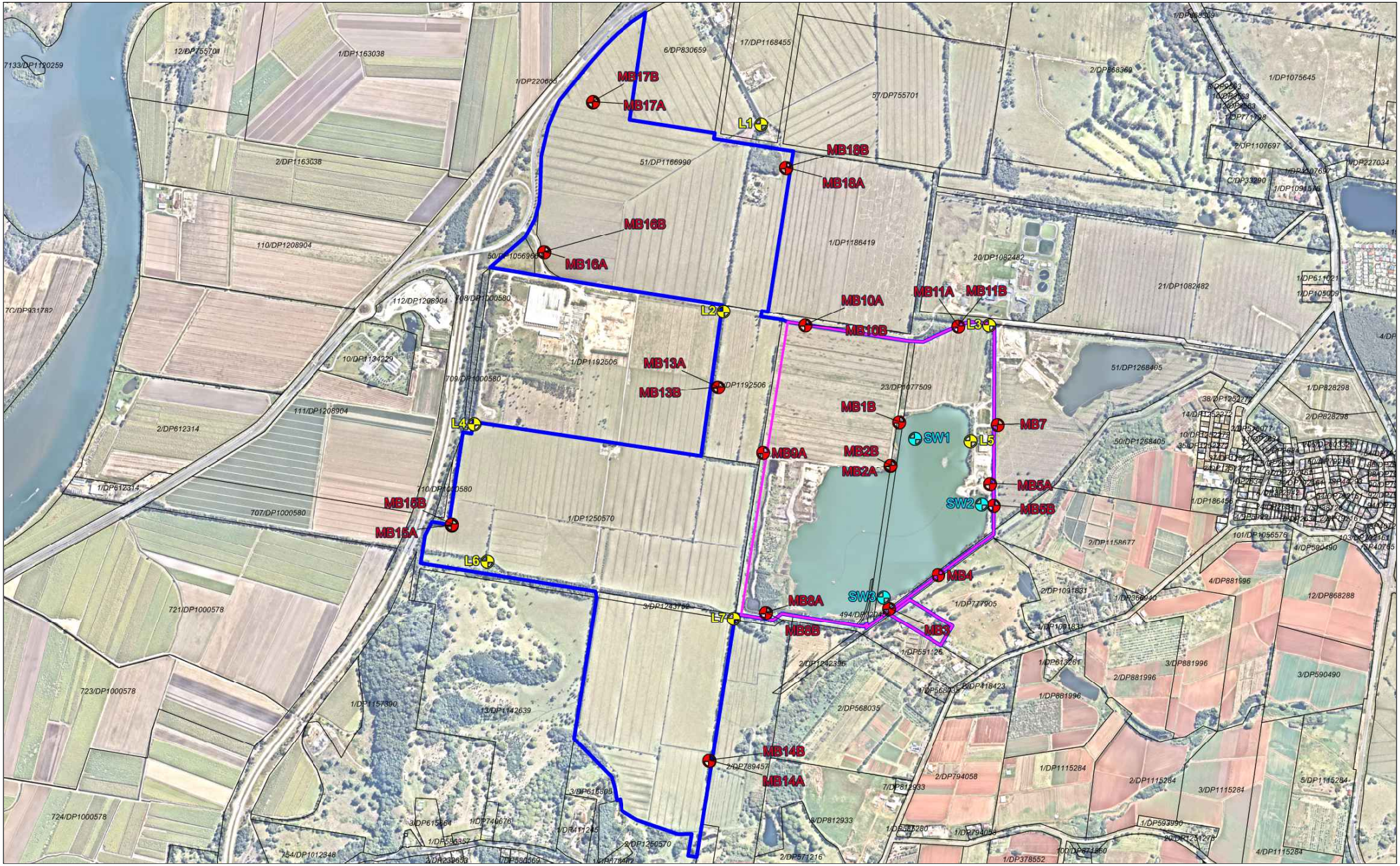
GOLD COAST
1638 Tweed Street, Burleigh Heads QLD 4220
PO Box 3805, Burleigh Town QLD 4220

GLADSTONE
2/172 Goondoon St, Gladstone, QLD 4680
PO Box 5332, Gladstone QLD 4680

zonelandscape.com.au | 07 55622303

JOB / DRAWING NO:
Z19163- 104

SHEET NO.
SHEET 01 OF 01



ORIENTATION

SCALE

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LEGEND

- Cadastral boundaries
- Site Boundary - Existing
- Site boundary - Expansion Area
- Groundwater monitoring bores
- Surface water monitoring locations
- Surface water loggers

SOURCES

Image: Nearmap image dated 14 September 2020.

Cadastral: NSW Six Maps, sourced 23/11/2020.

PROJECT
TWEED SAND PLANT EXPANSION

CLIENT
HANSON CONSTRUCTION MATERIALS

DRAWING
MONITORING LOCATIONS

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
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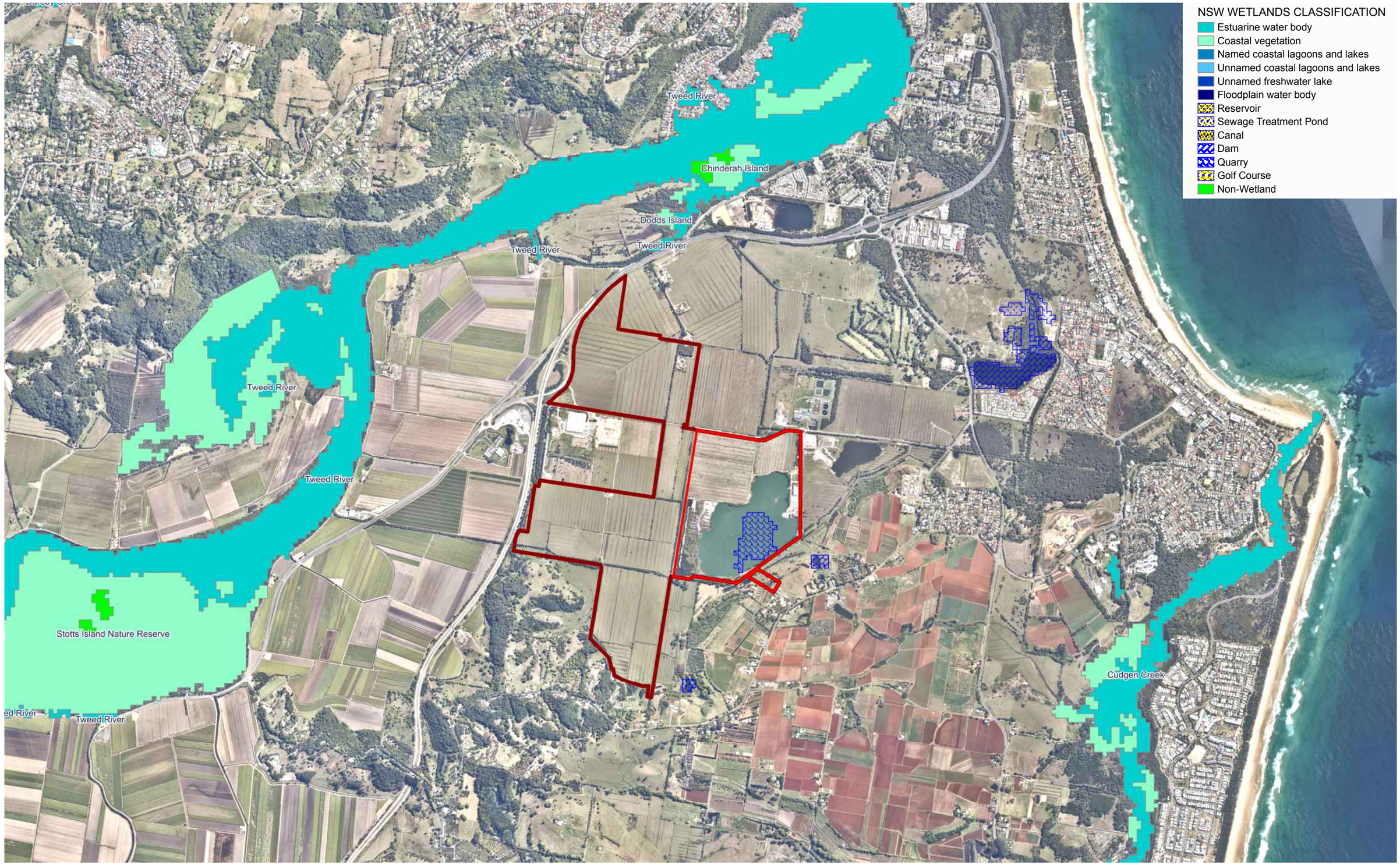

ORIENTATION

SCALE

250 500 750 1000 1250
metres

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LEGEND

Site Boundary - Existing

Site Boundary - Expansion Area

SOURCES

Image: Nearmap Image dated 14 September 2020.

Wetlands: NSW Wetlands vector dataset, Office of Environment and Heritage, State Government of NSW and Department of Planning, Industry and Environment 2010

PROJECT
TWEED SAND PLANT EXPANSION

CLIENT
HANSON CONSTRUCTION MATERIALS

DRAWING
NSW WETLANDS (OEH)

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
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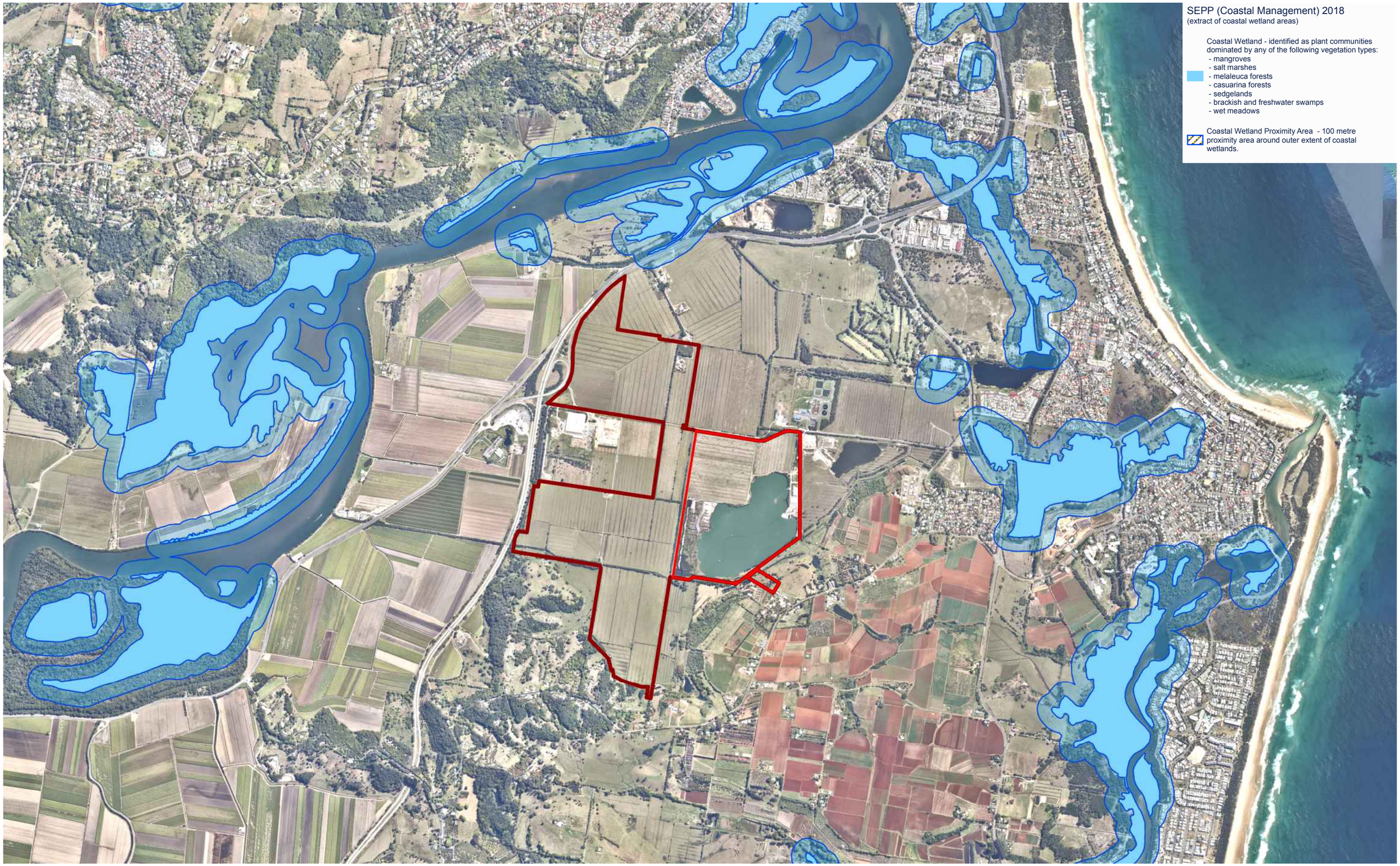
GILBERT SUTHERLAND



ORIENTATION

SCALE

250 500 750 1000 1250
metres

ROBINA
PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

Site Boundary - Existing

Site Boundary - Expansion Area

SOURCES

Image: Nearmap Image dated 14 September 2020.

Wetlands: State Environmental Planning Policy (Coastal Management) 2018

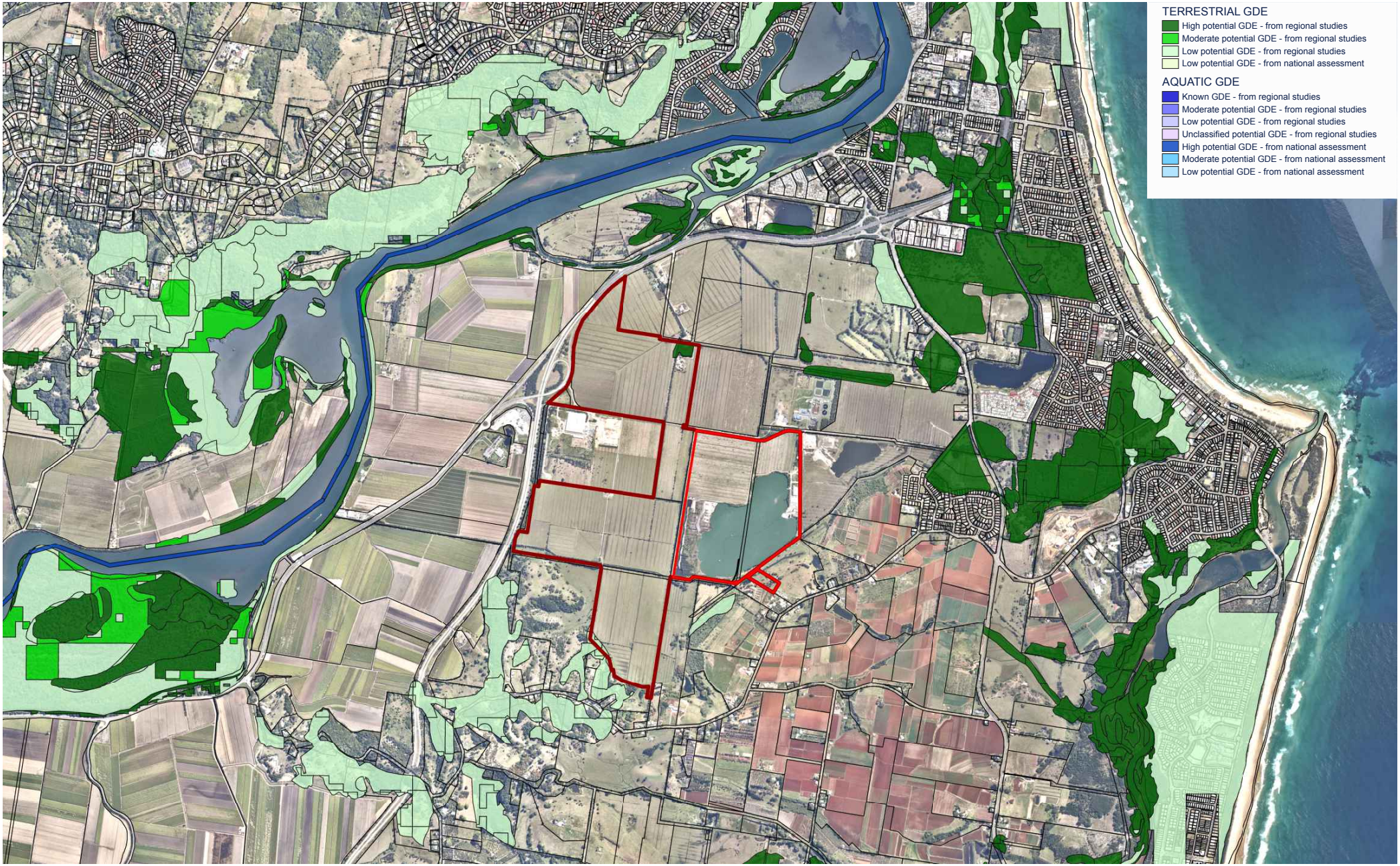
PROJECT
TWEED SAND PLANT EXPANSION

CLIENT
HANSON CONSTRUCTION MATERIALS

DRAWING
COASTAL WETLANDS SEPP (COASTAL MANAGEMENT) 2018

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:25 000@A3	8/12/2020	AJF	ELH	12035	102	-

GILBERT SUTHERLAND



ORIENTATION

SCALE

250 500 750 1000 1250
metres

ROBINA
PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- Cadastral boundaries
- Site Boundary - Existing
- Site Boundary - Expansion Area

SOURCES

Image: Nearmap Image dated 14 September 2020.

Cadastre: NSW Six Maps, sourced 23 November 2020.

GDE: Groundwater Dependent Ecosystem Atlas, Bureau of Meteorology

PROJECT
TWEED SAND PLANT EXPANSION

CLIENT
HANSON CONSTRUCTION MATERIALS

DRAWING
GROUNDWATER DEPENDENT ECOSYSTEMS

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:25 000@A3	19/01/2021	AJF	ELH	12035	103	-

GILBERT SUTHERLAND

11 Appendix 2 – Surface water results – graphs and tables

Figure A2.1 Lake Surface Water | pH

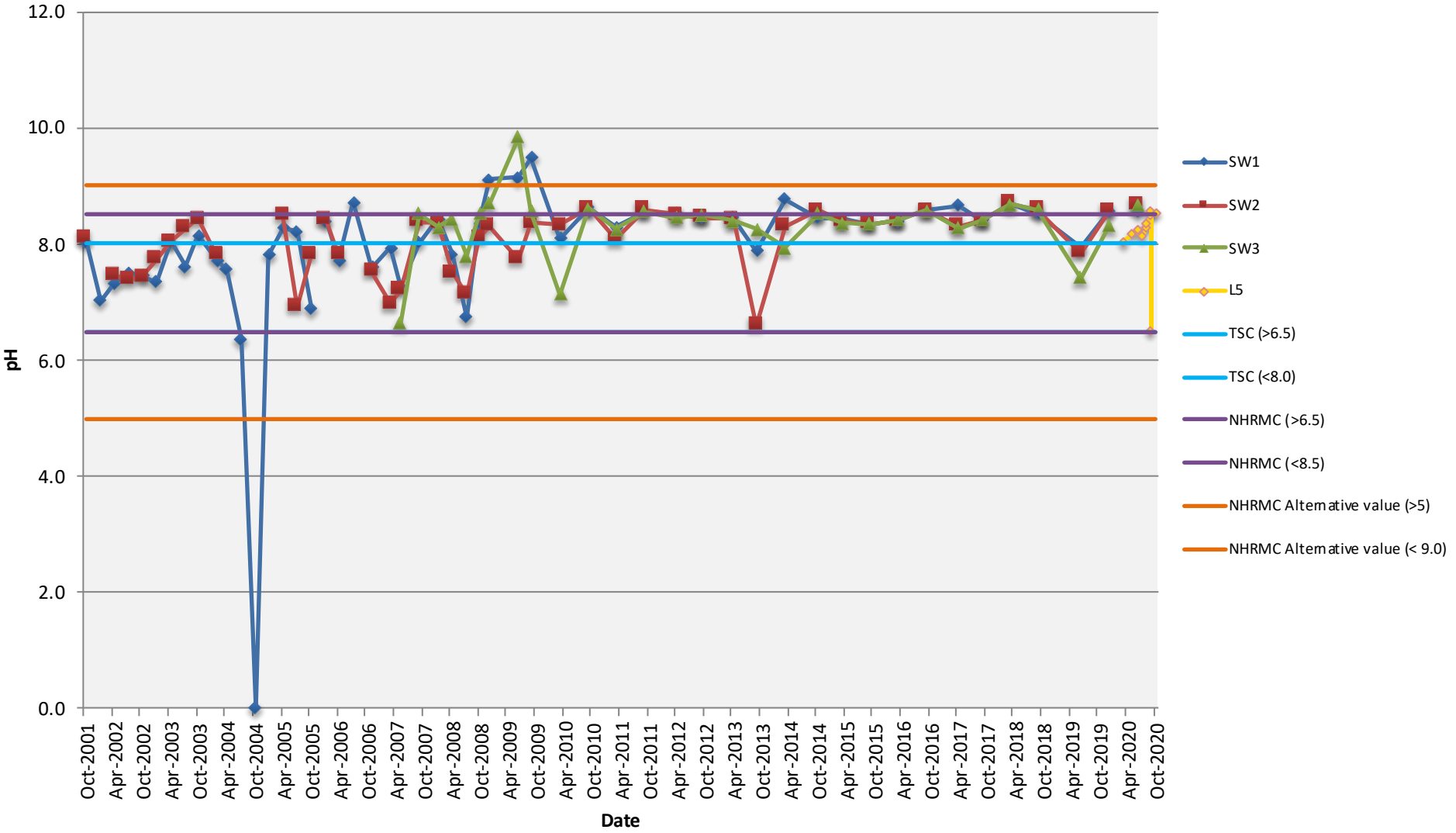


Figure A2.2 Surface Water | pH

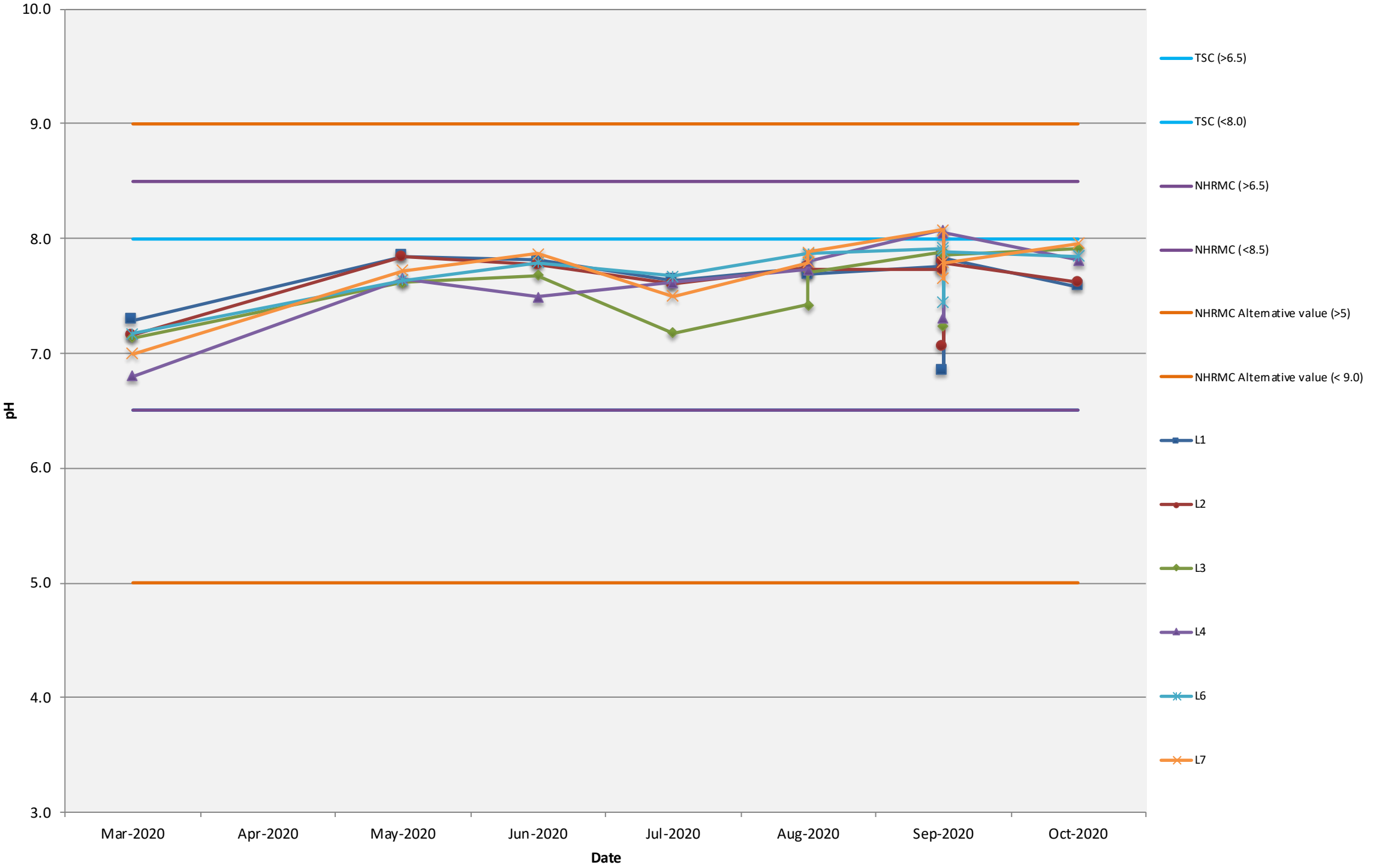


Figure A2.3 Lake Surface Water | Electrical Conductivity

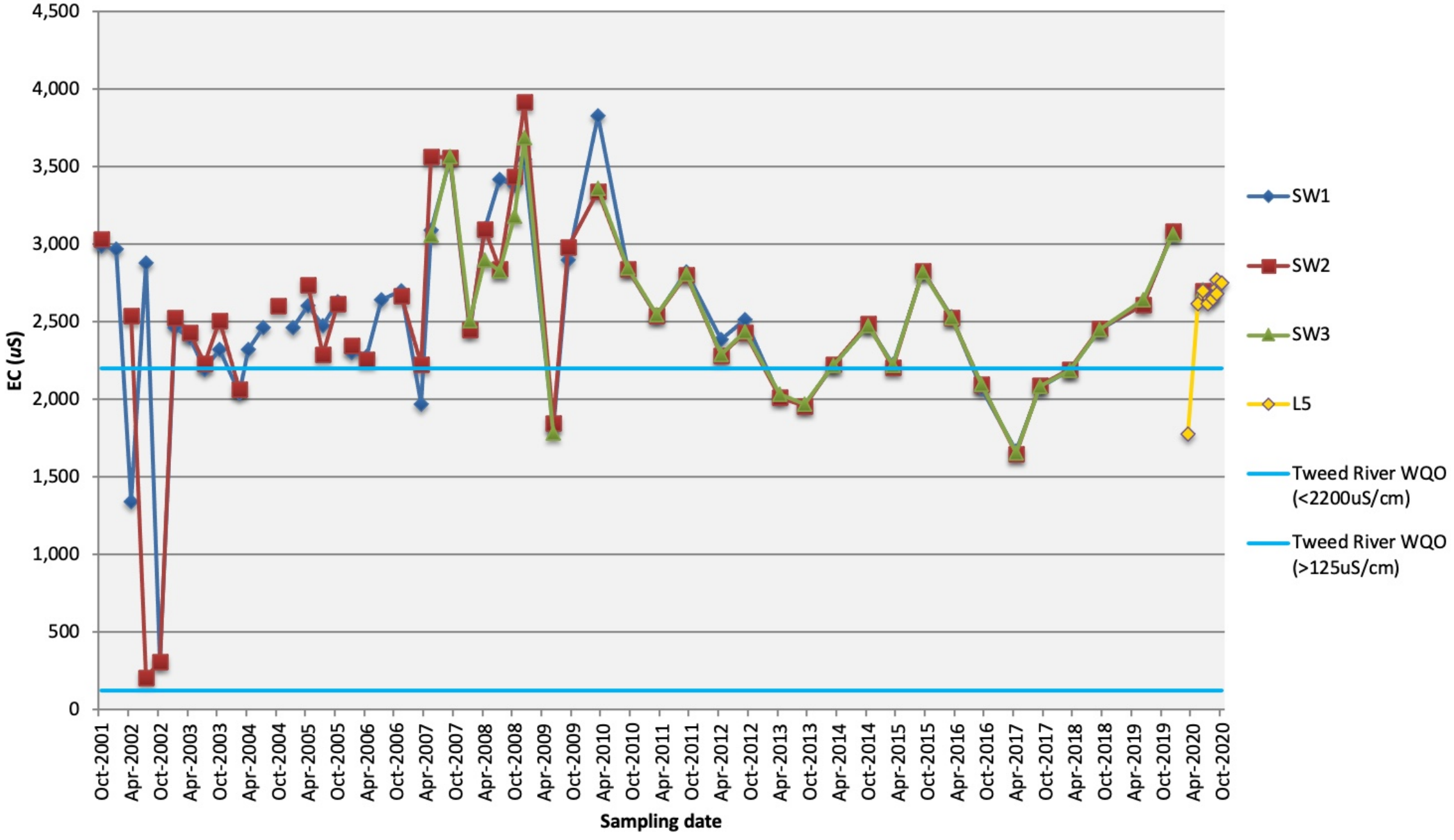


Figure A2.4 Surface Water | Electrical Conductivity

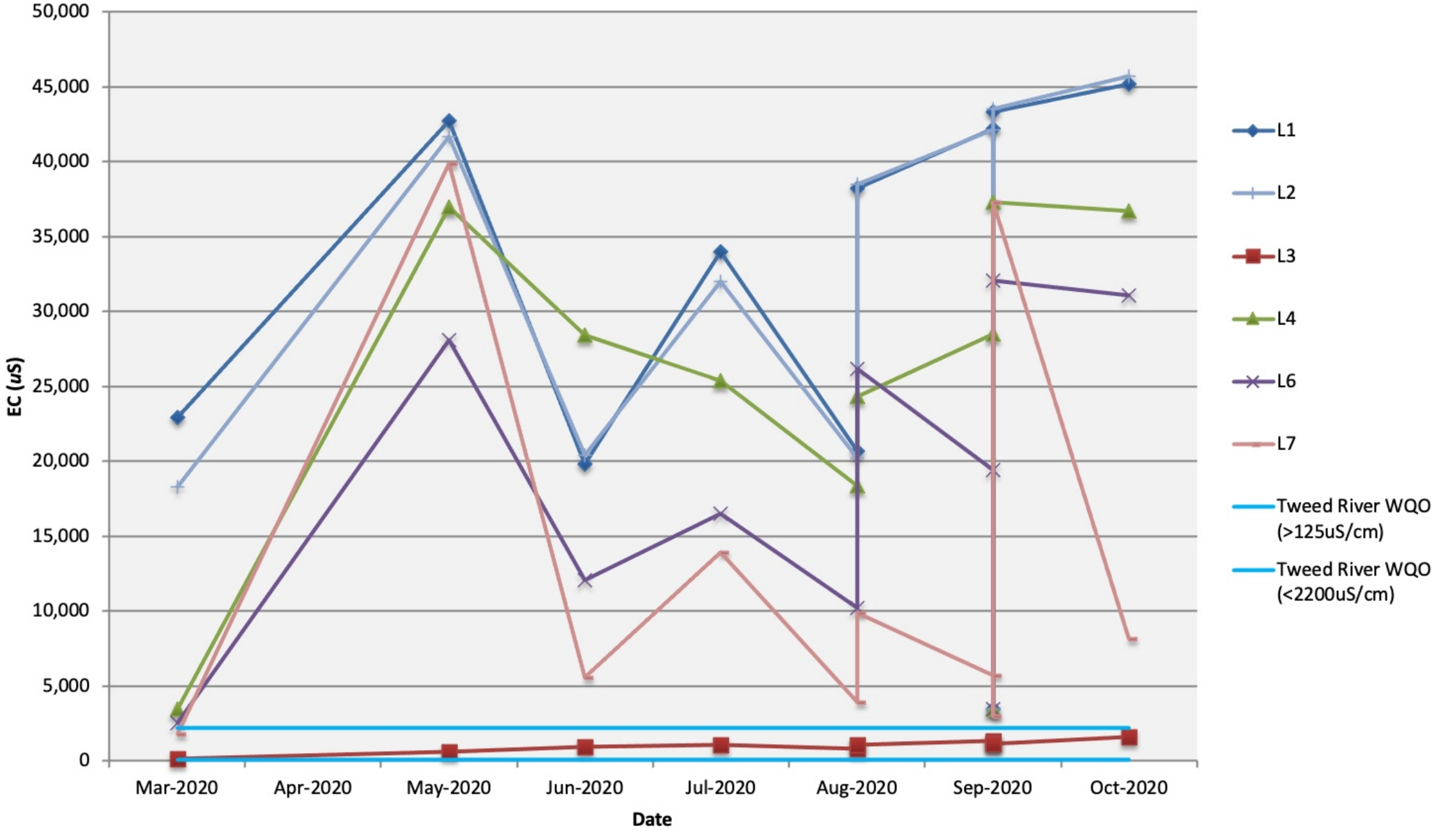


Figure A2.5 Surface Water | Temperature

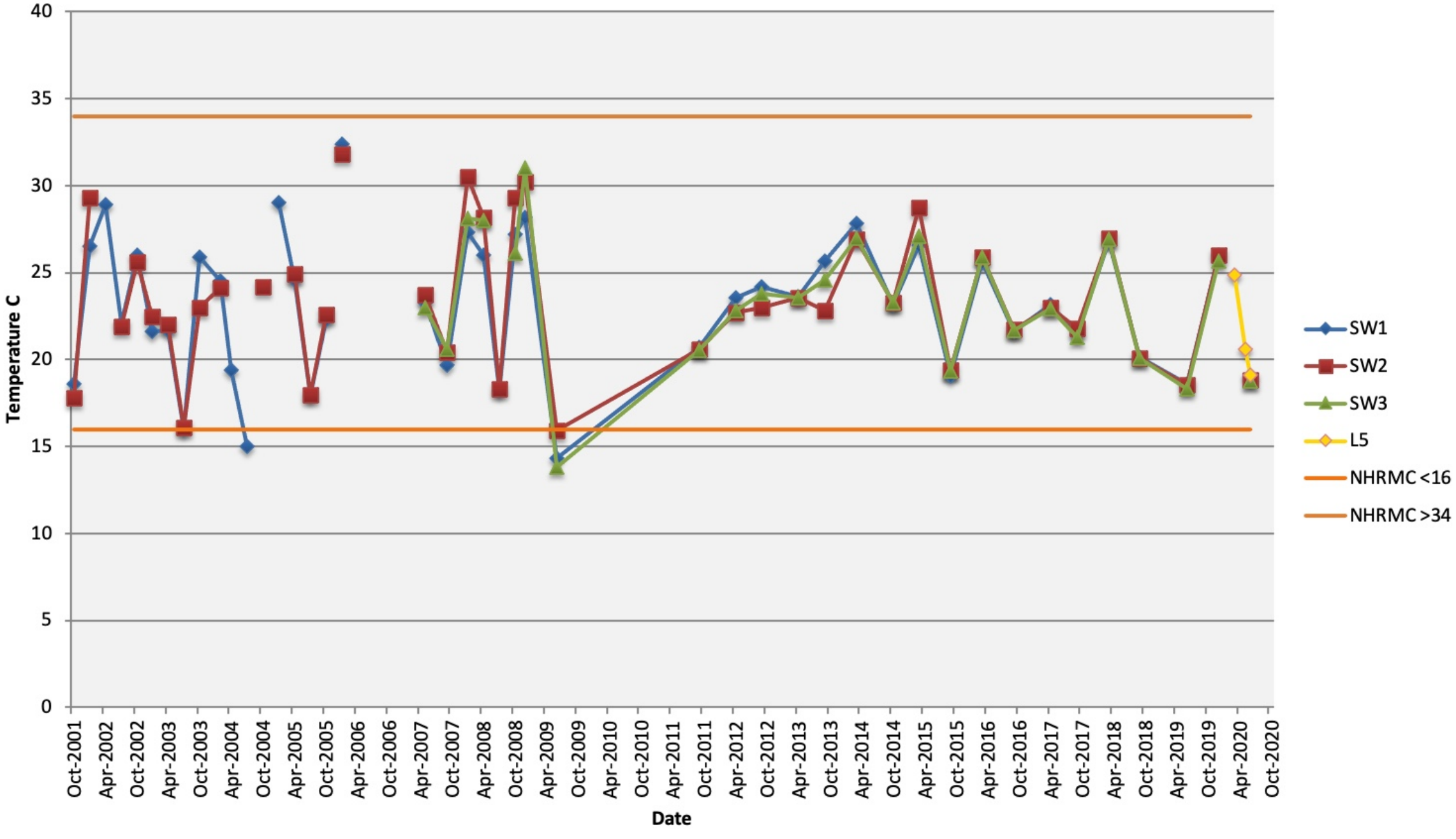


Figure A2.6 Lake Surface Water | Dissolved Oxygen

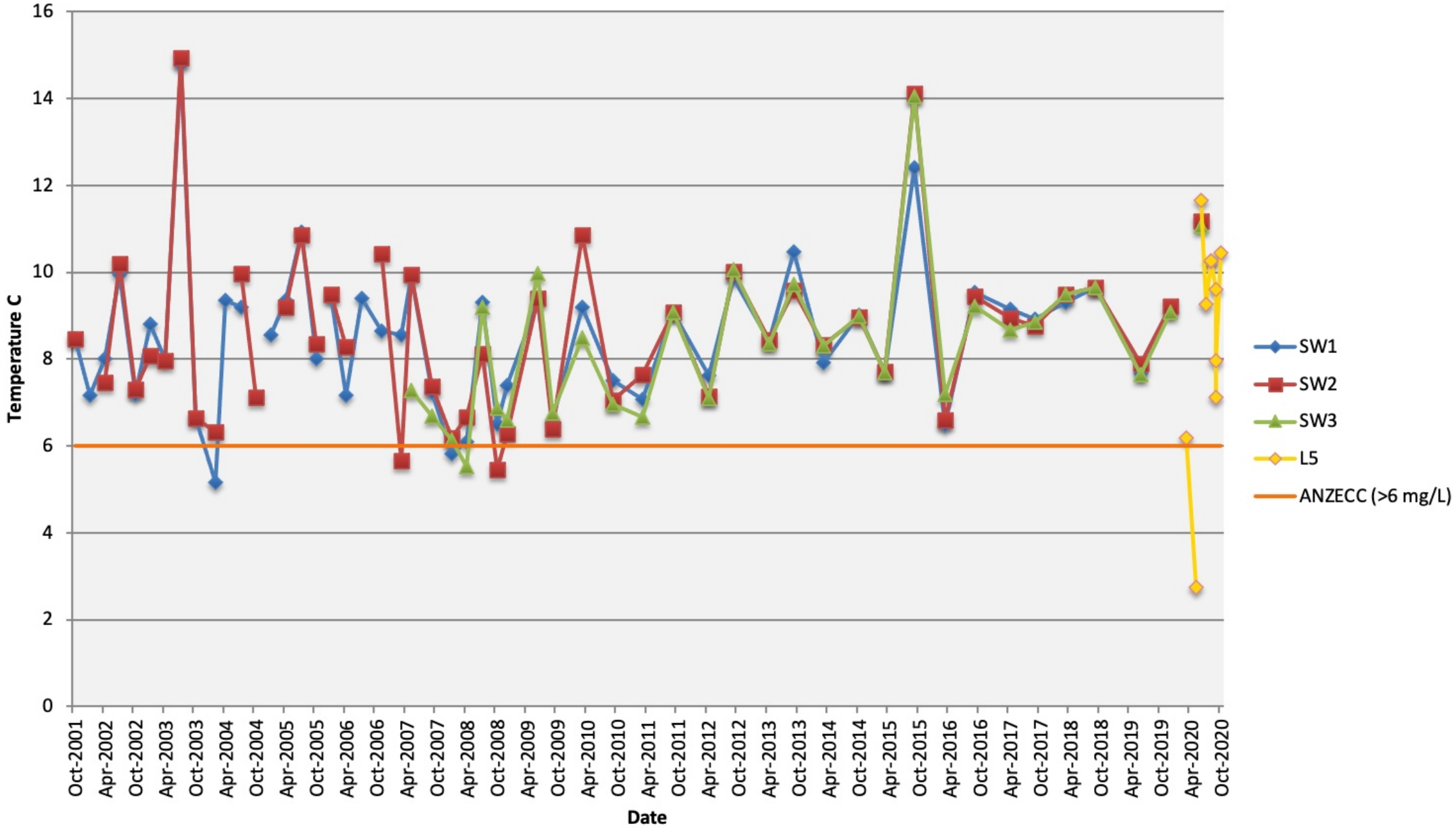


Figure A2.7 Surface Water | Dissolved Oxygen

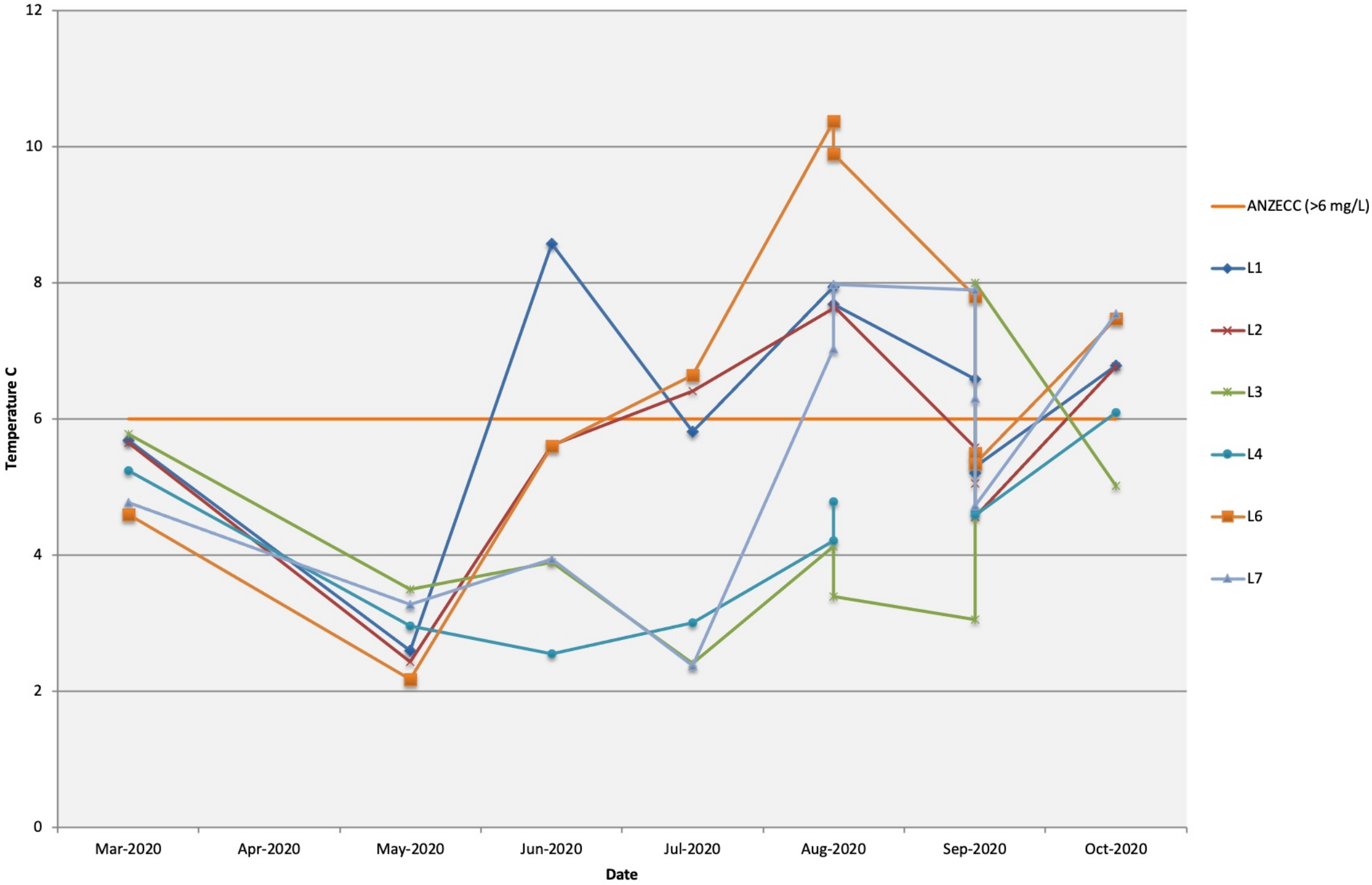


Figure A2.8 Lake Surface Water | Turbidity

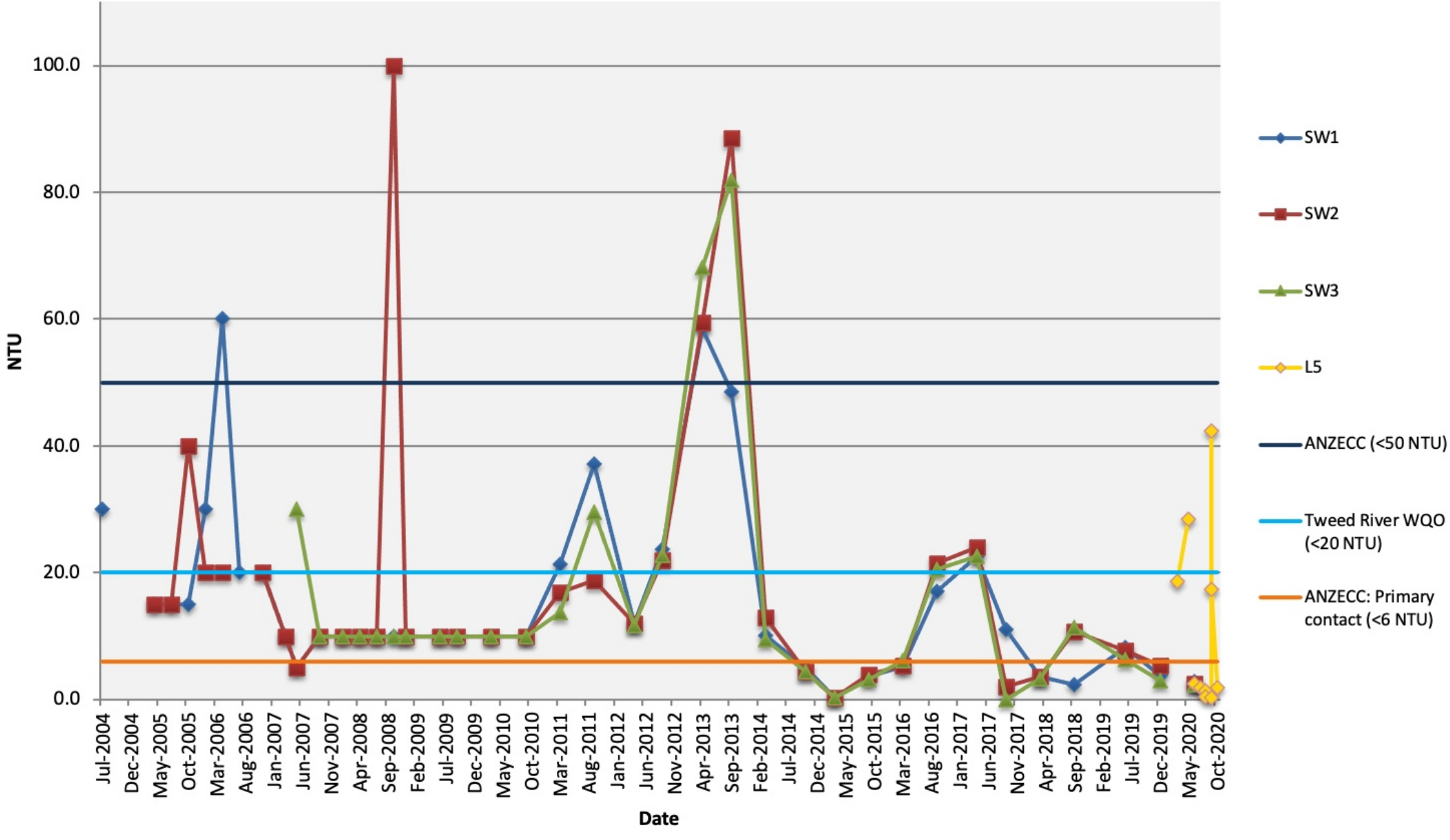


Figure A2.9 Surface Water | Turbidity

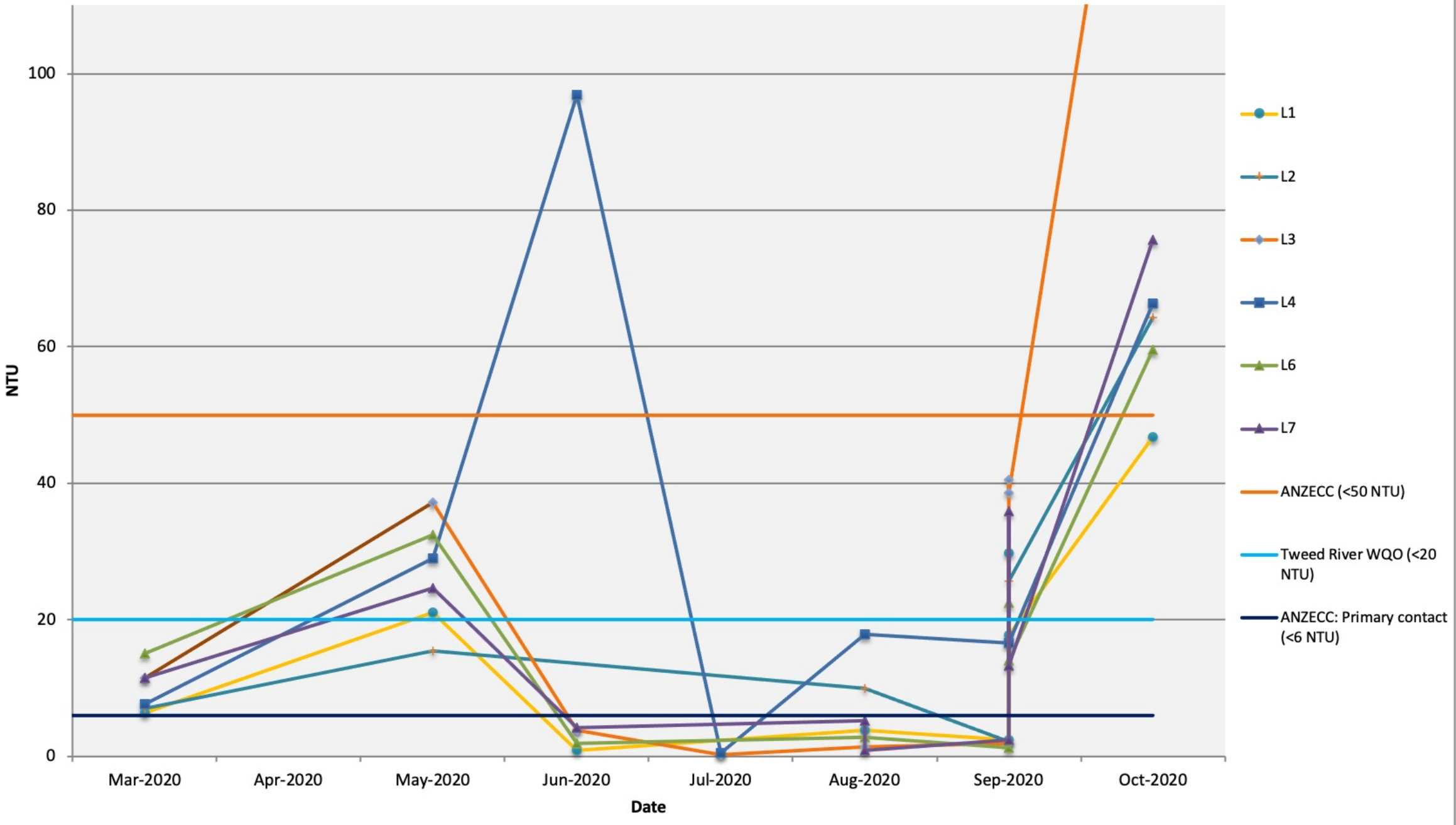


Figure A2.10 Lake Surface Water | Sodium

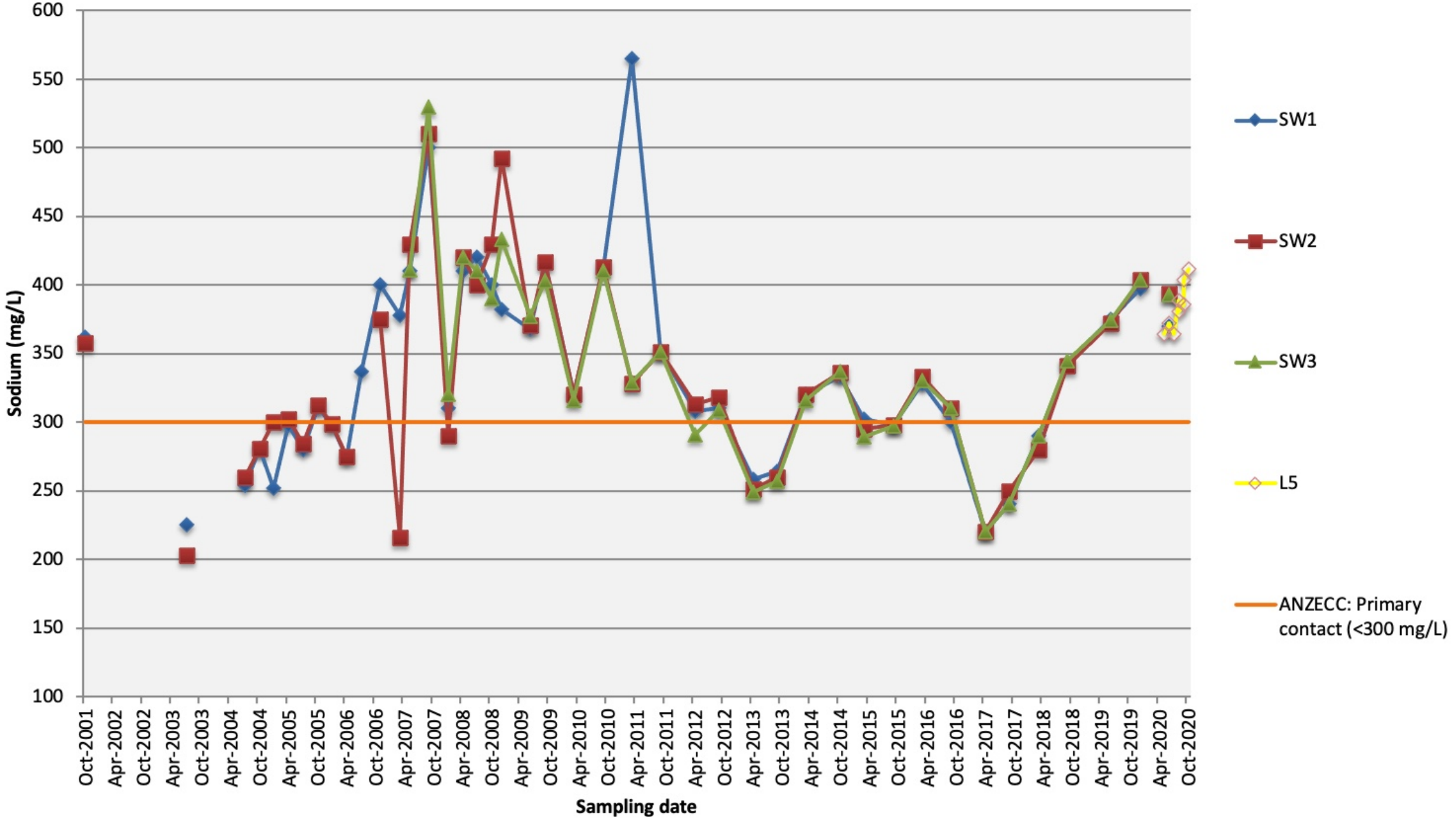


Figure A2.11 Surface Water | Sodium

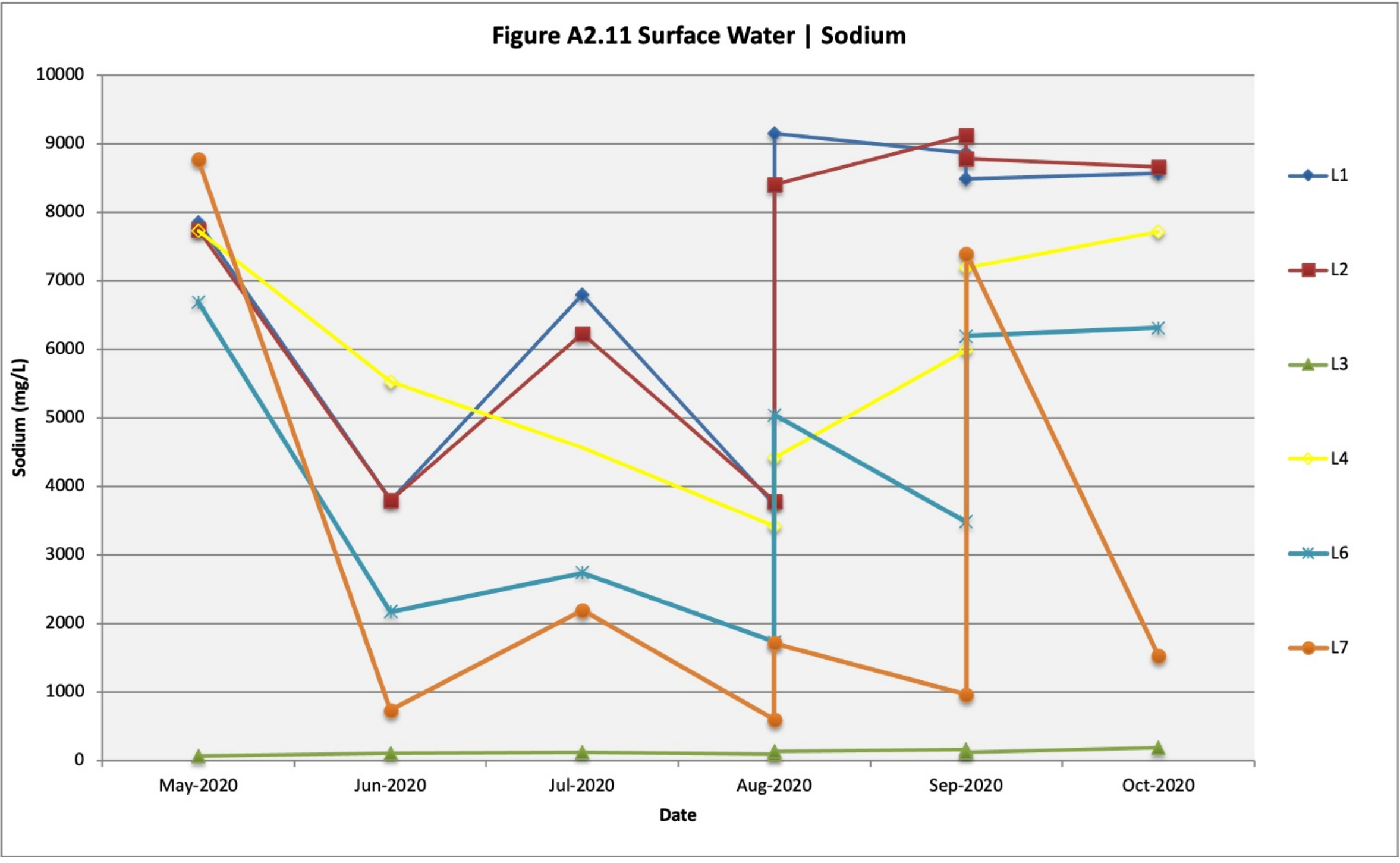


Figure A2.12 Lake Surface Water | Potassium

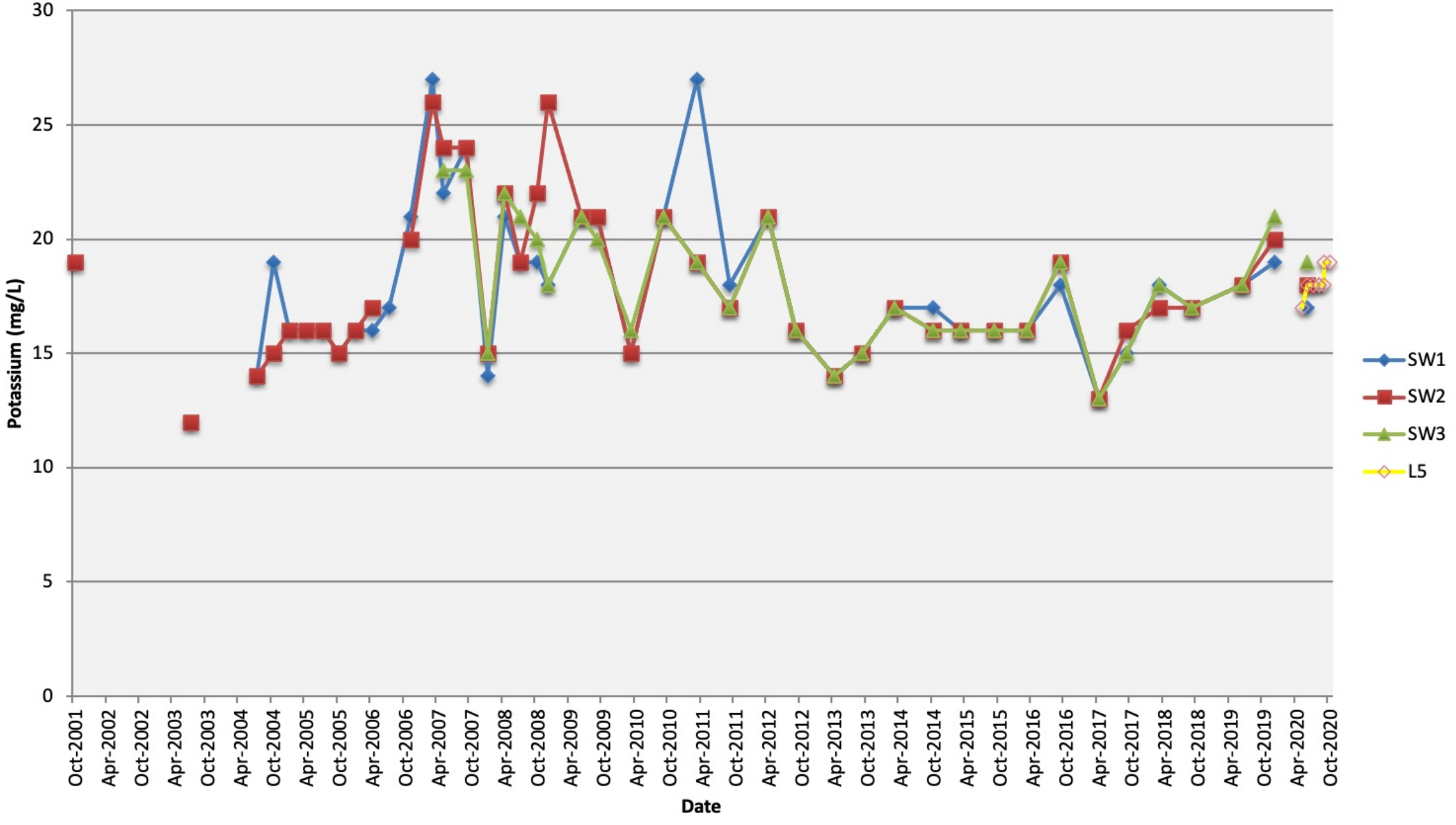


Figure A2.13 Surface Water | Potassium

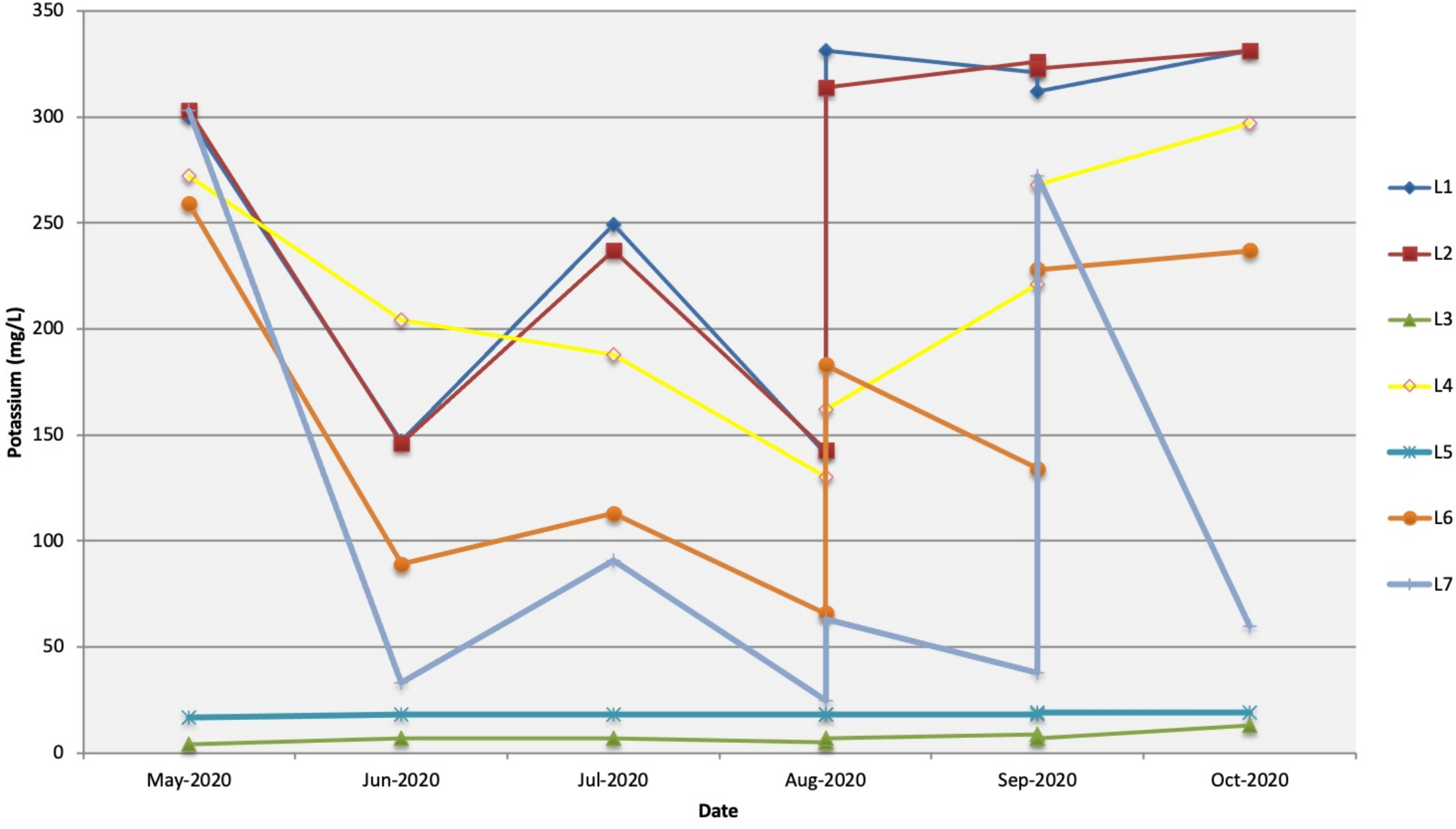


Figure A2.14 Lake Surface Water | Magnesium

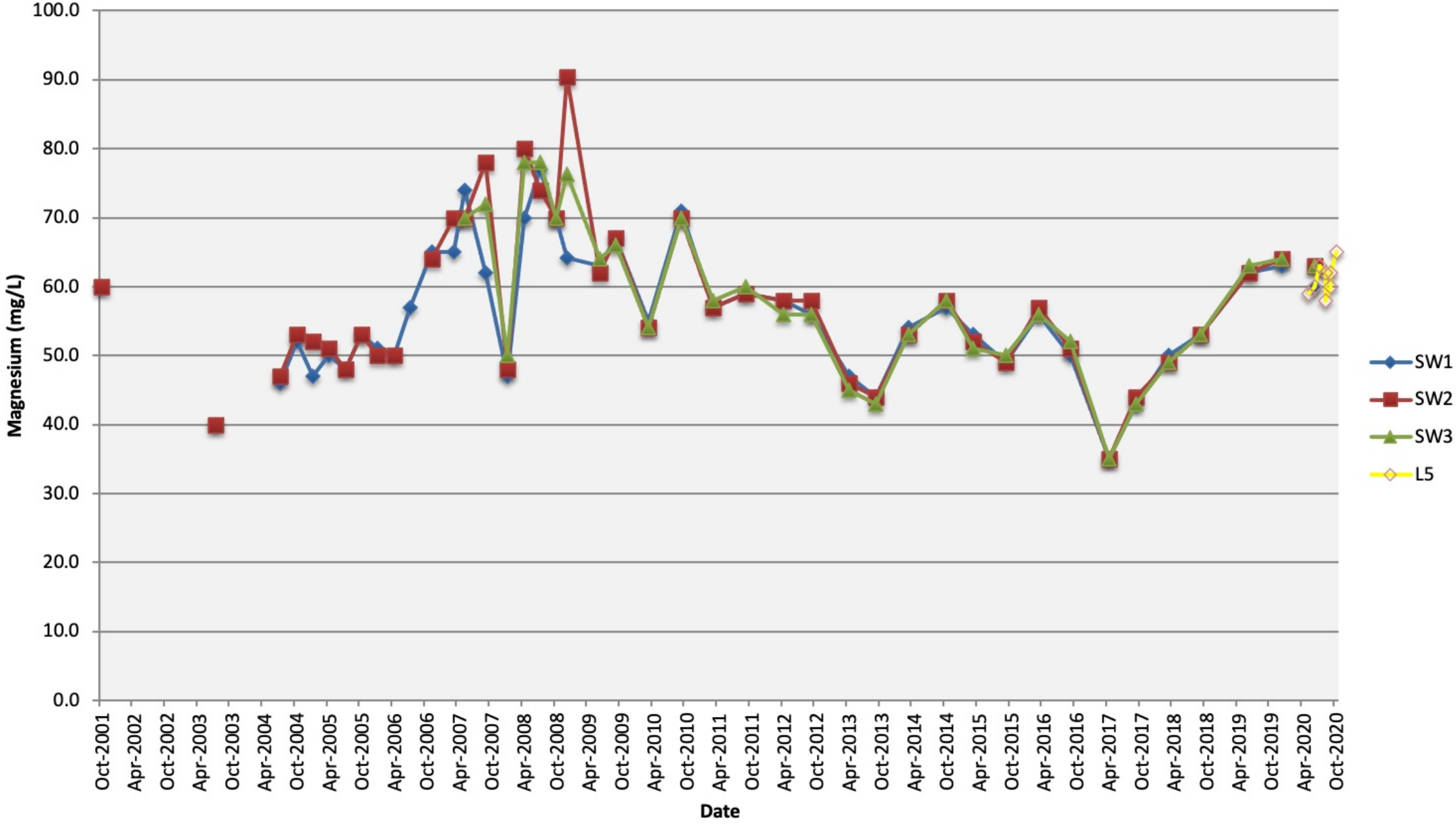


Figure A2.15 Surface Water | Magnesium

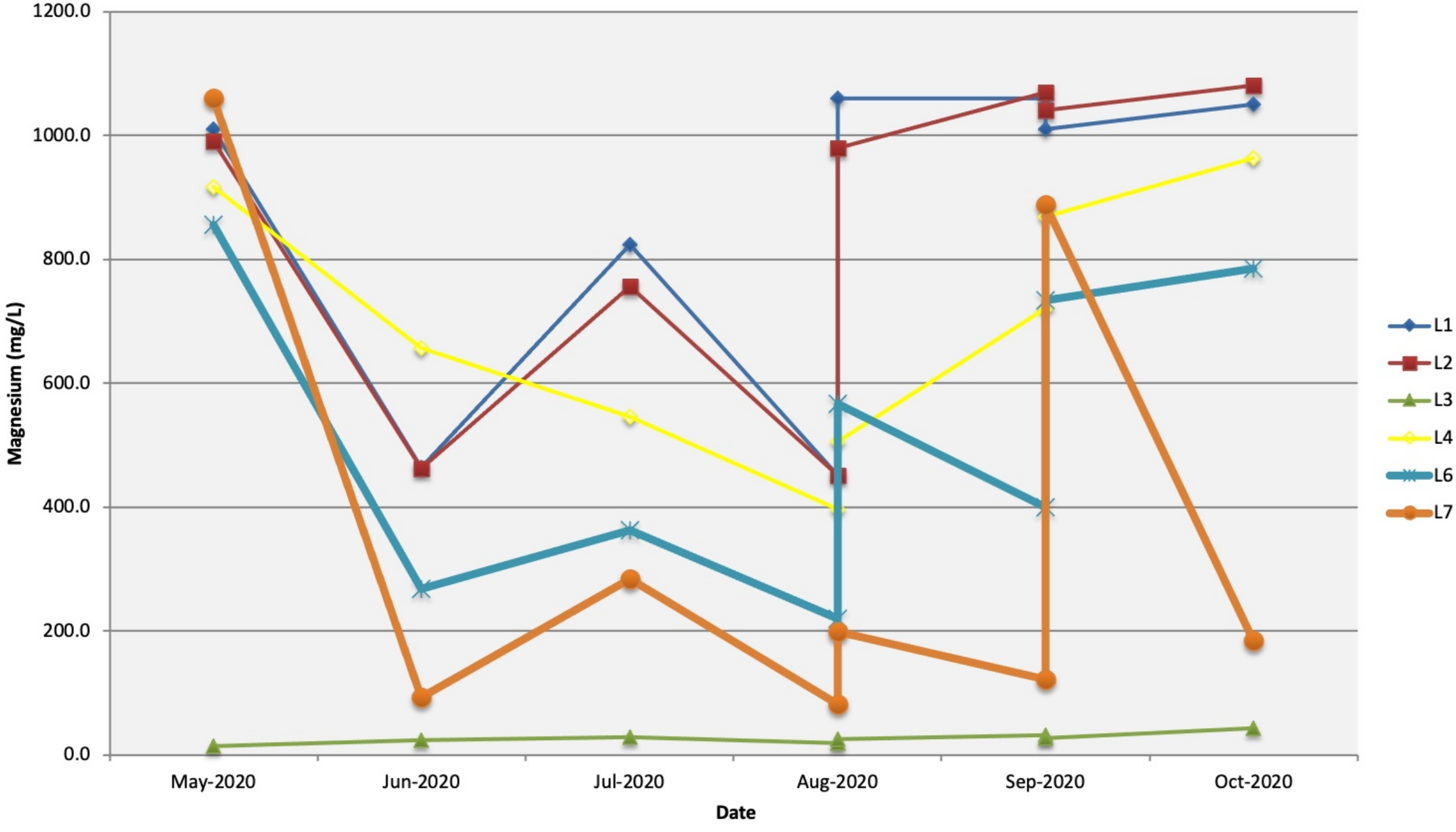


Figure A2.16 Lake Surface Water | Chloride

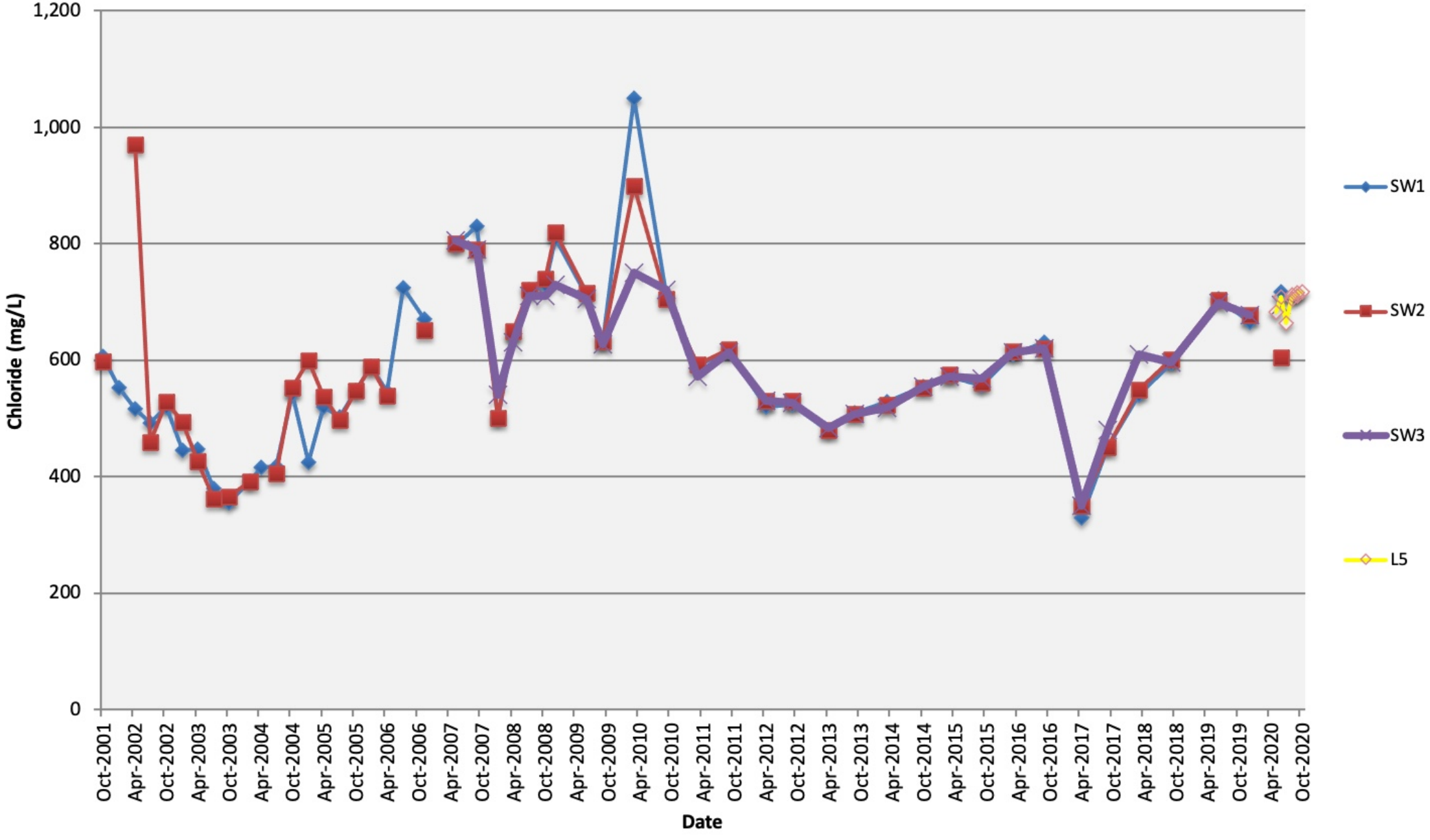


Figure A2.17 Surface Water | Chloride

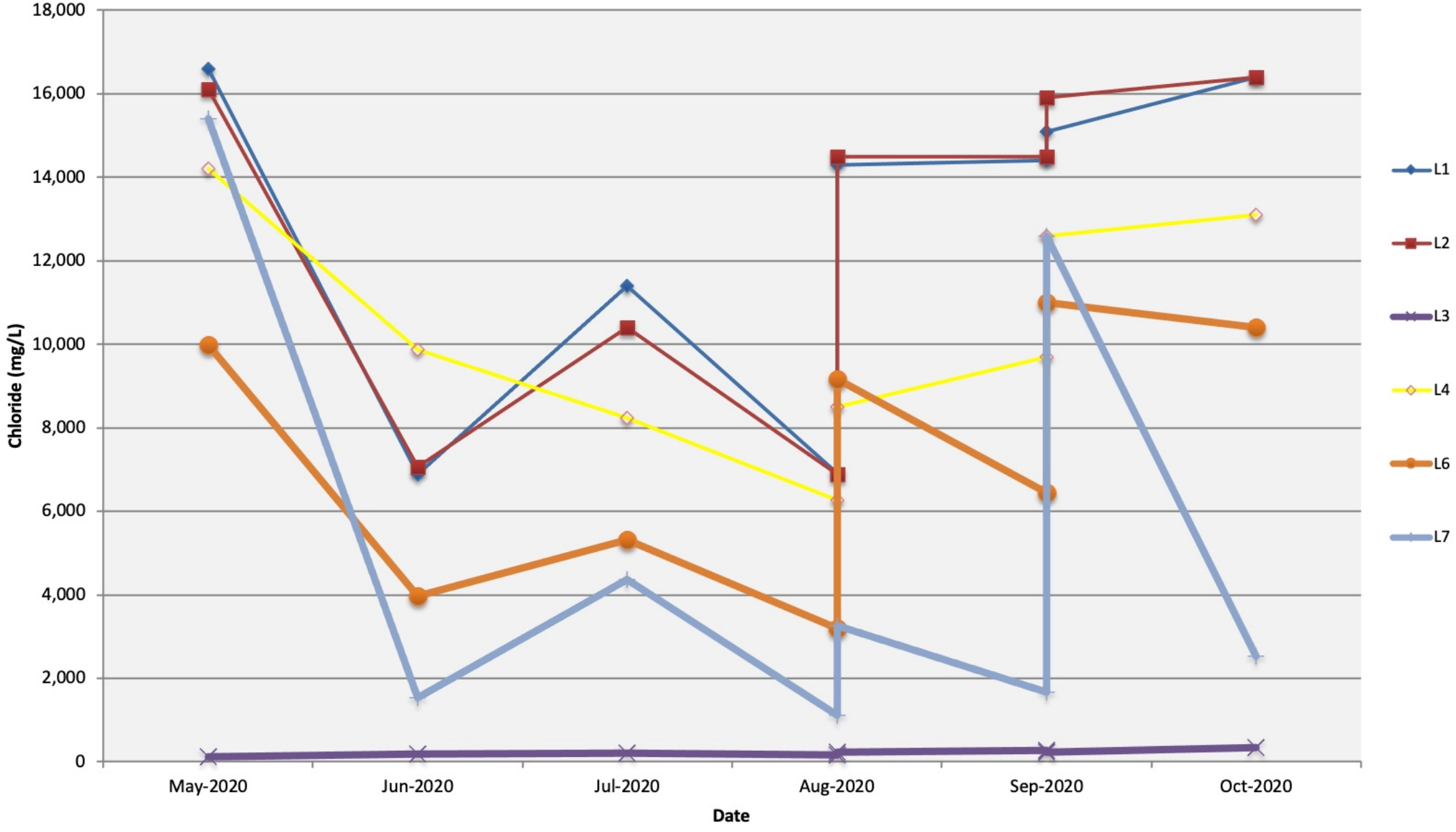


Figure A2.18 Lake Surface Water | Sulfate

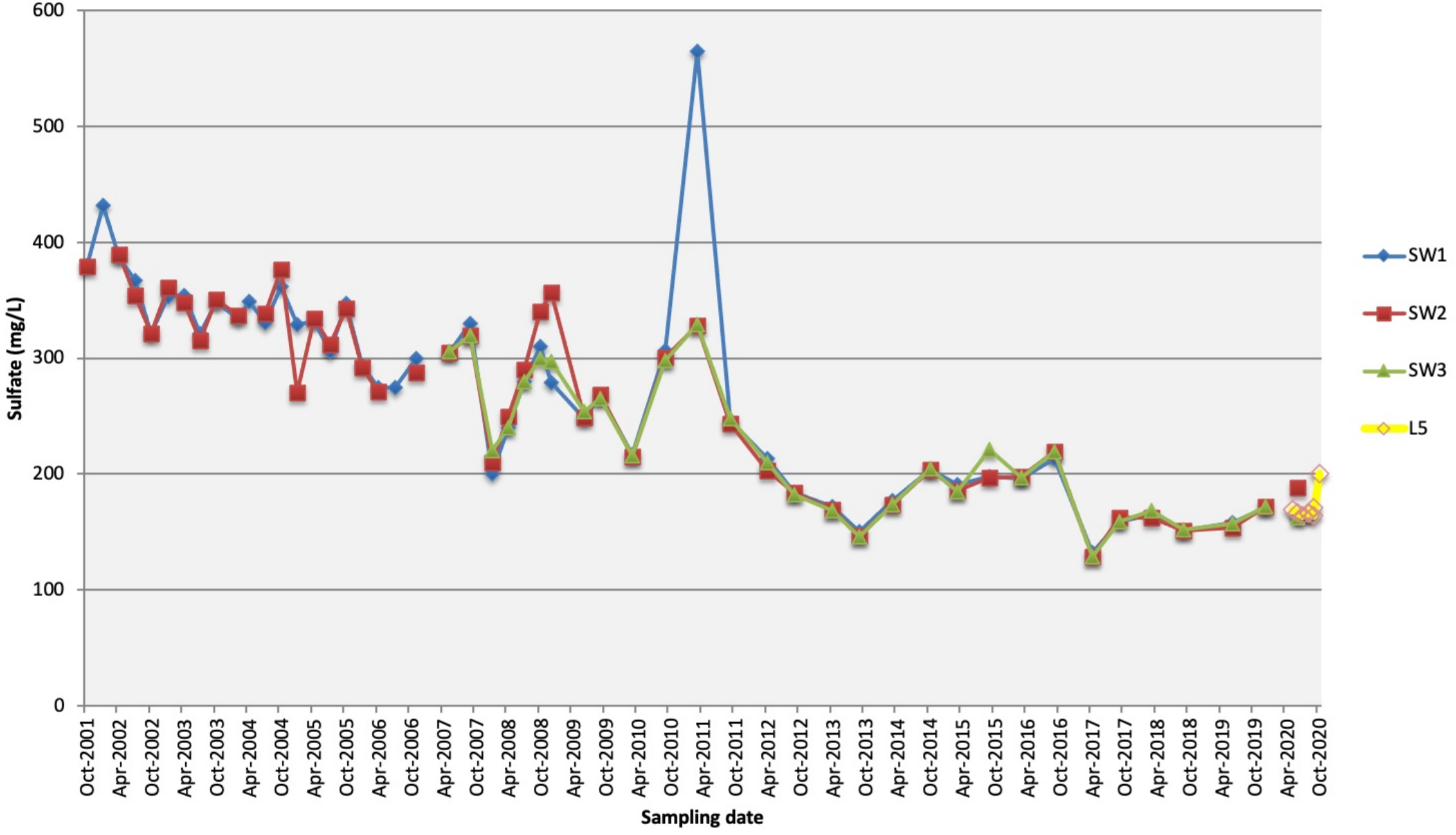


Figure A2.19 Surface Water | Sulfate

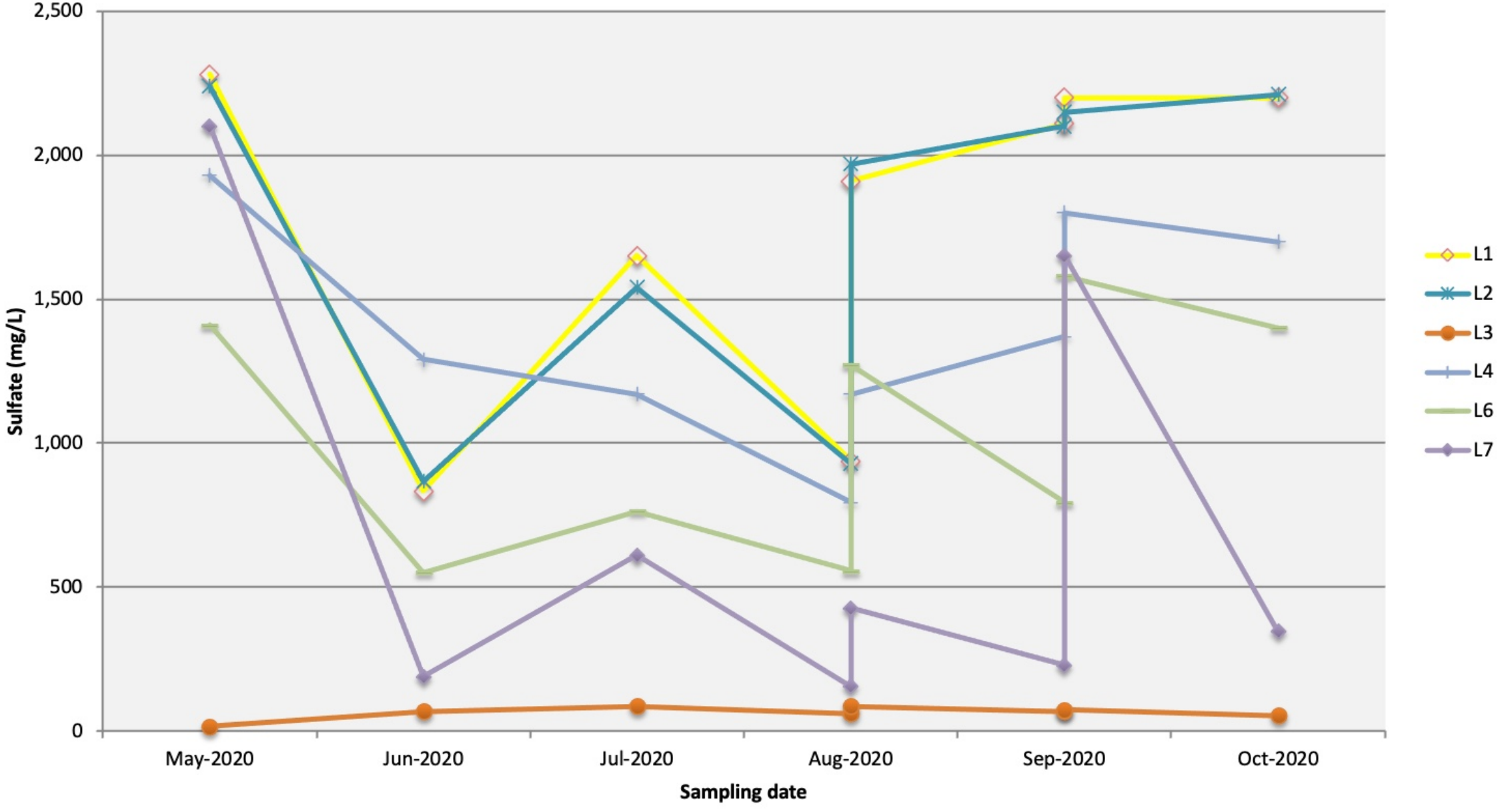


Figure A2.20 Lake Surface Water | Alkalinity

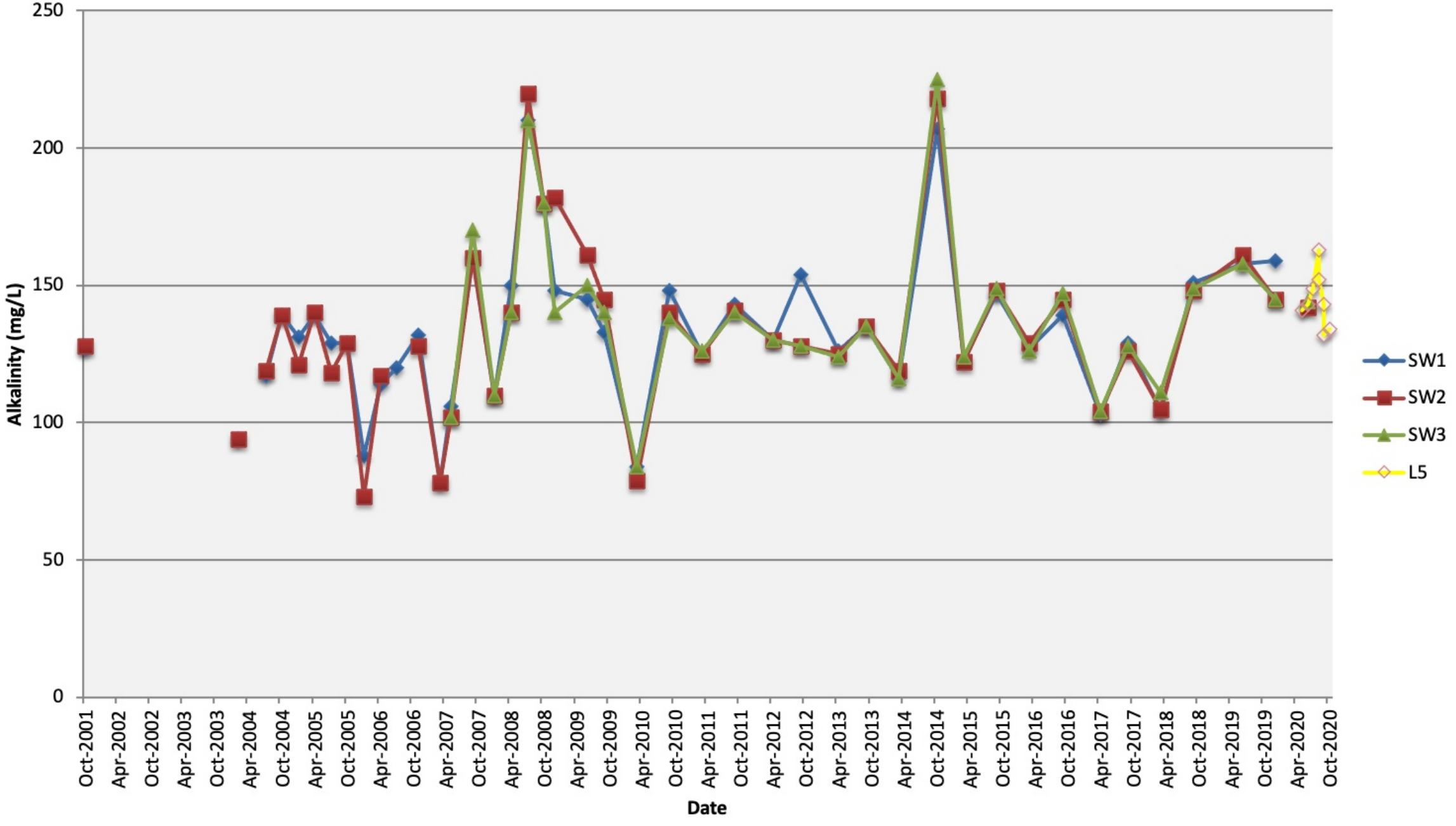


Figure A2.21 Surface Water | Alkalinity

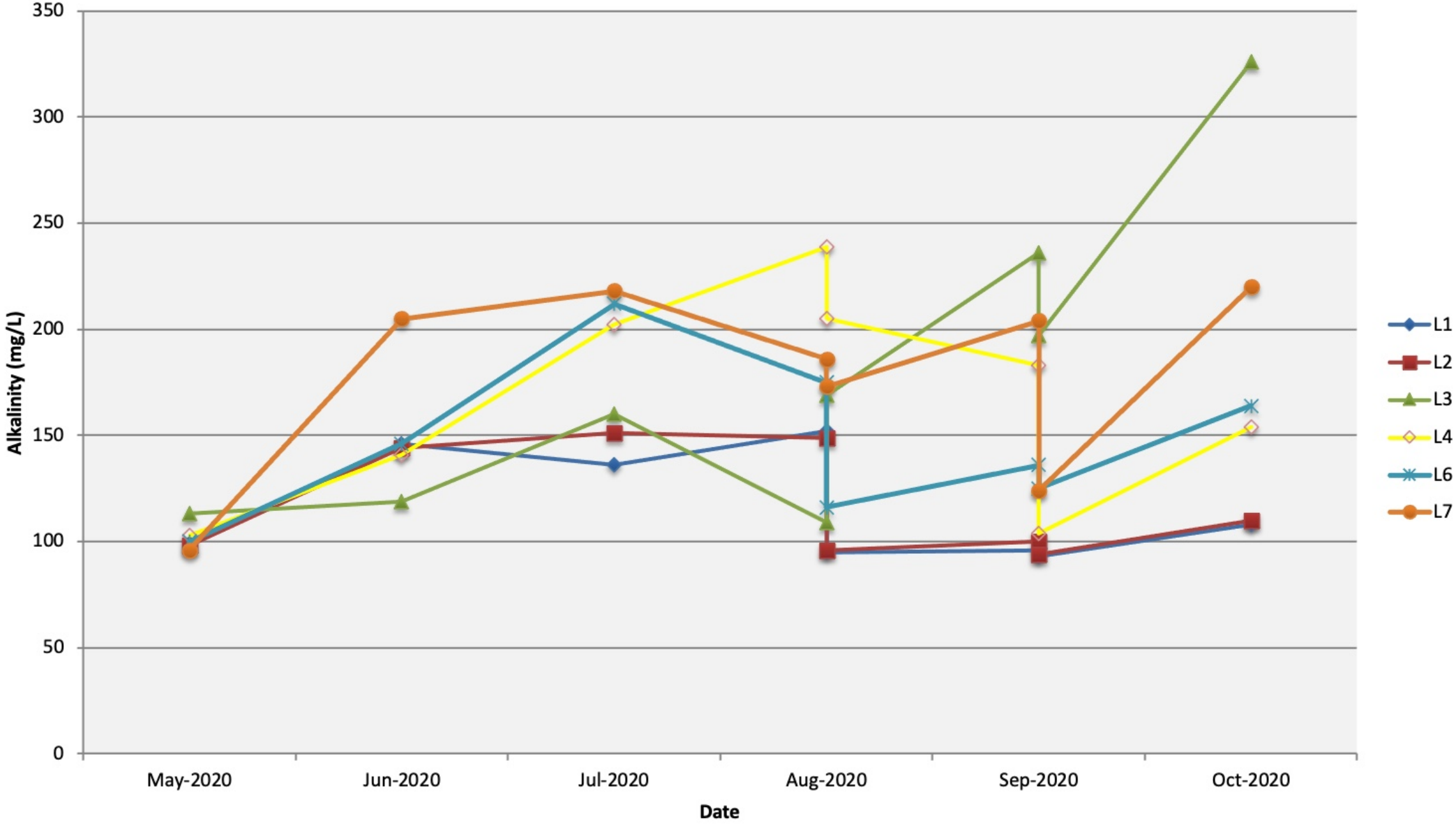
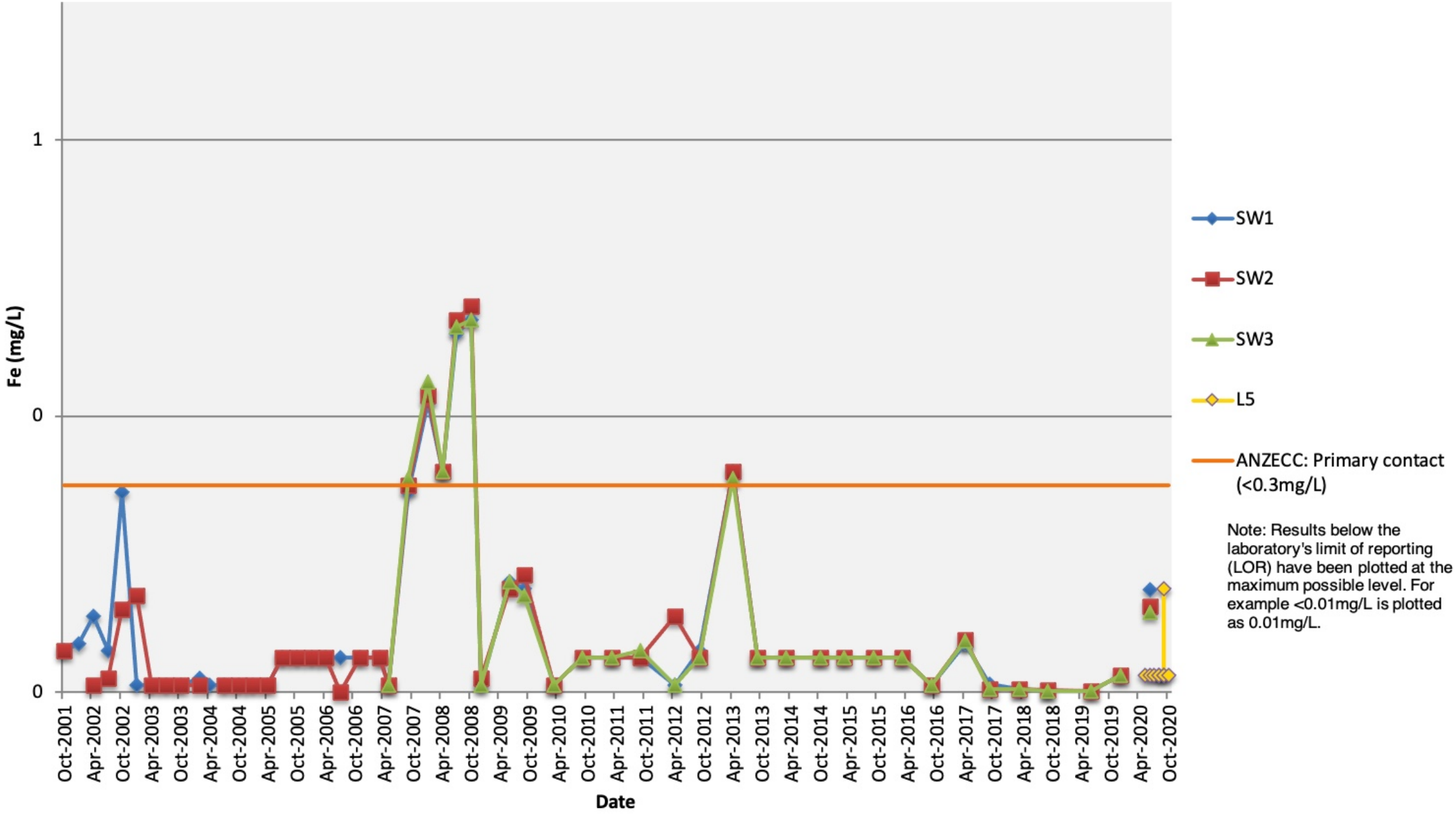
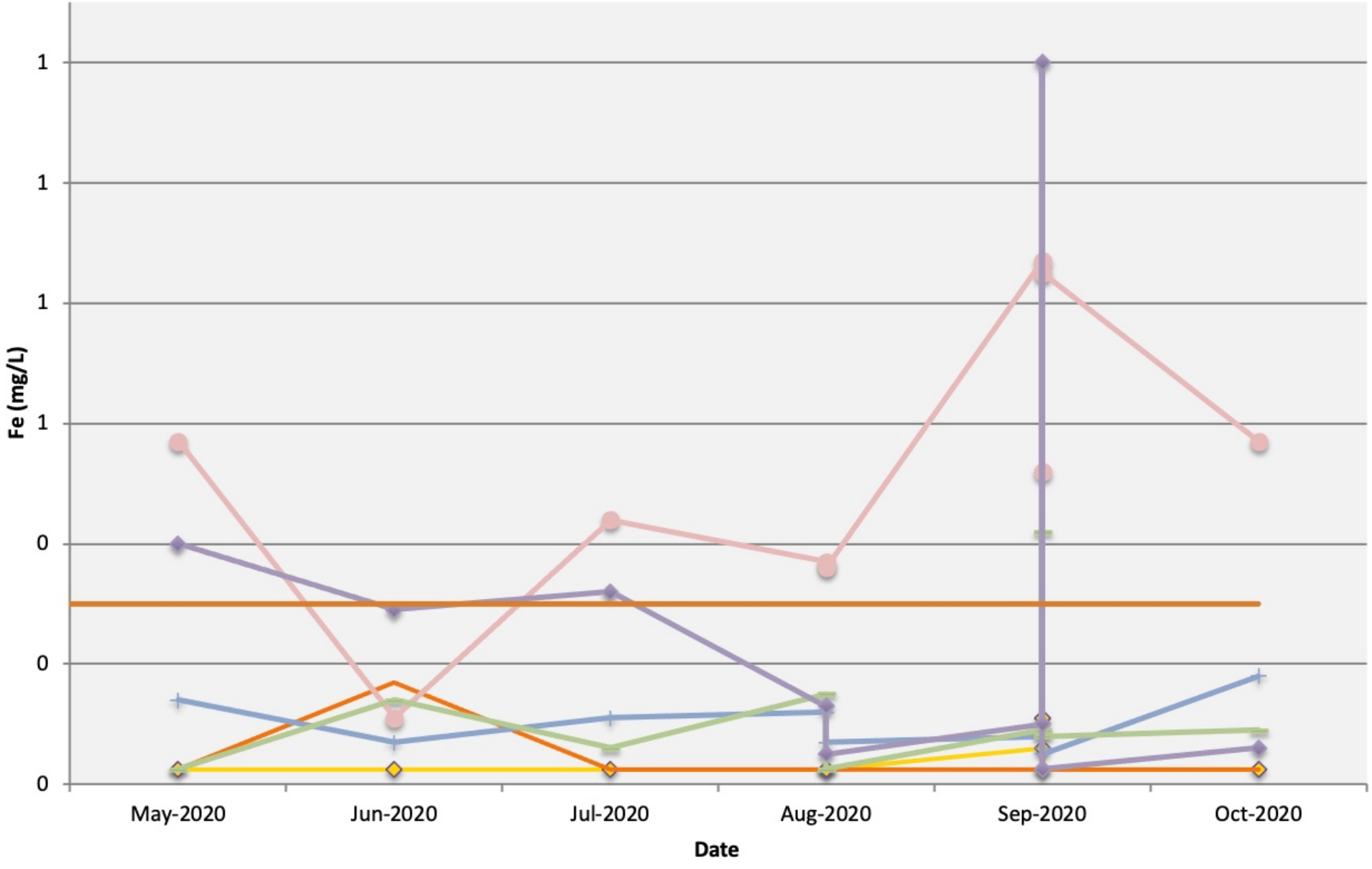


Figure A2.22 Lake surface Water | Dissolved Iron



Note: Results below the laboratory's limit of reporting (LOR) have been plotted at the maximum possible level. For example <0.01mg/L is plotted as 0.01mg/L.

Figure A2.23 Surface Water | Dissolved Iron



Note: Results below the laboratory's limit of reporting (LOR) have been plotted at the maximum possible level. For example <0.01mg/L is plotted as 0.01mg/L.

Figure A2.24 Lake Surface Water | Dissolved Aluminium

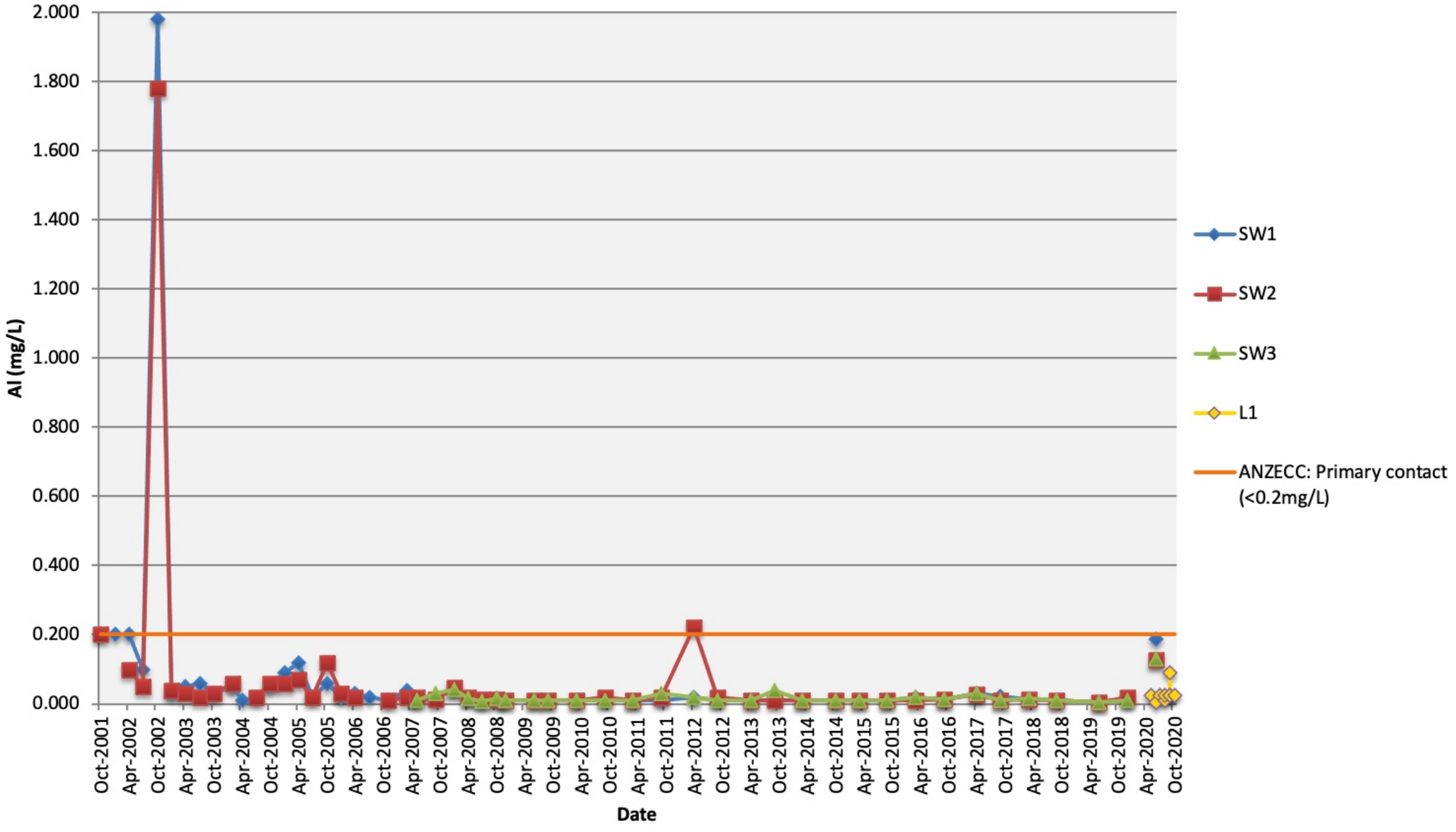
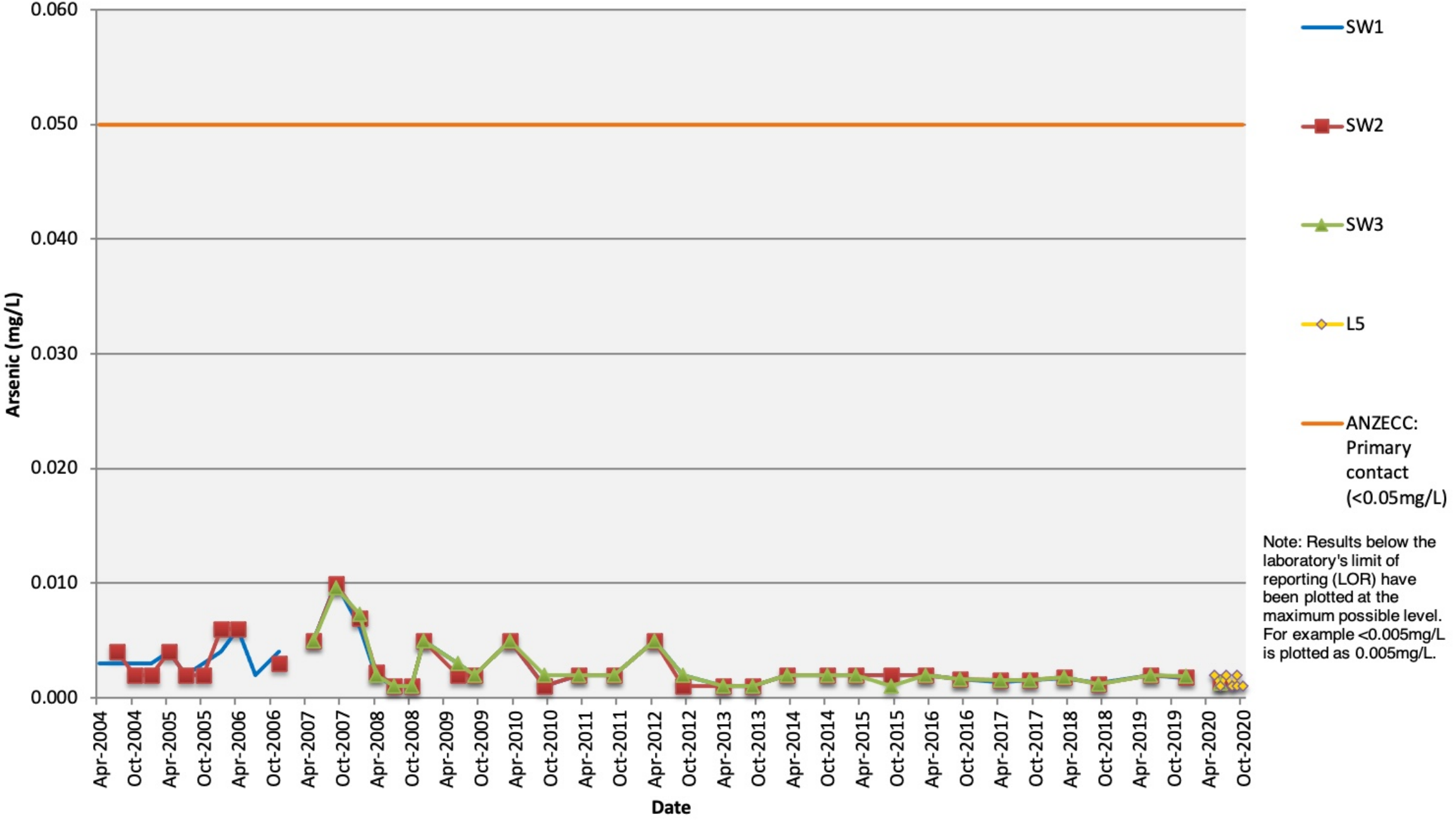


Figure A2.25 Lake Surface Water | Arsenic



Note: Results below the laboratory's limit of reporting (LOR) have been plotted at the maximum possible level. For example <0.005mg/L is plotted as 0.005mg/L.

Figure A2.26 Surface Water | Arsenic

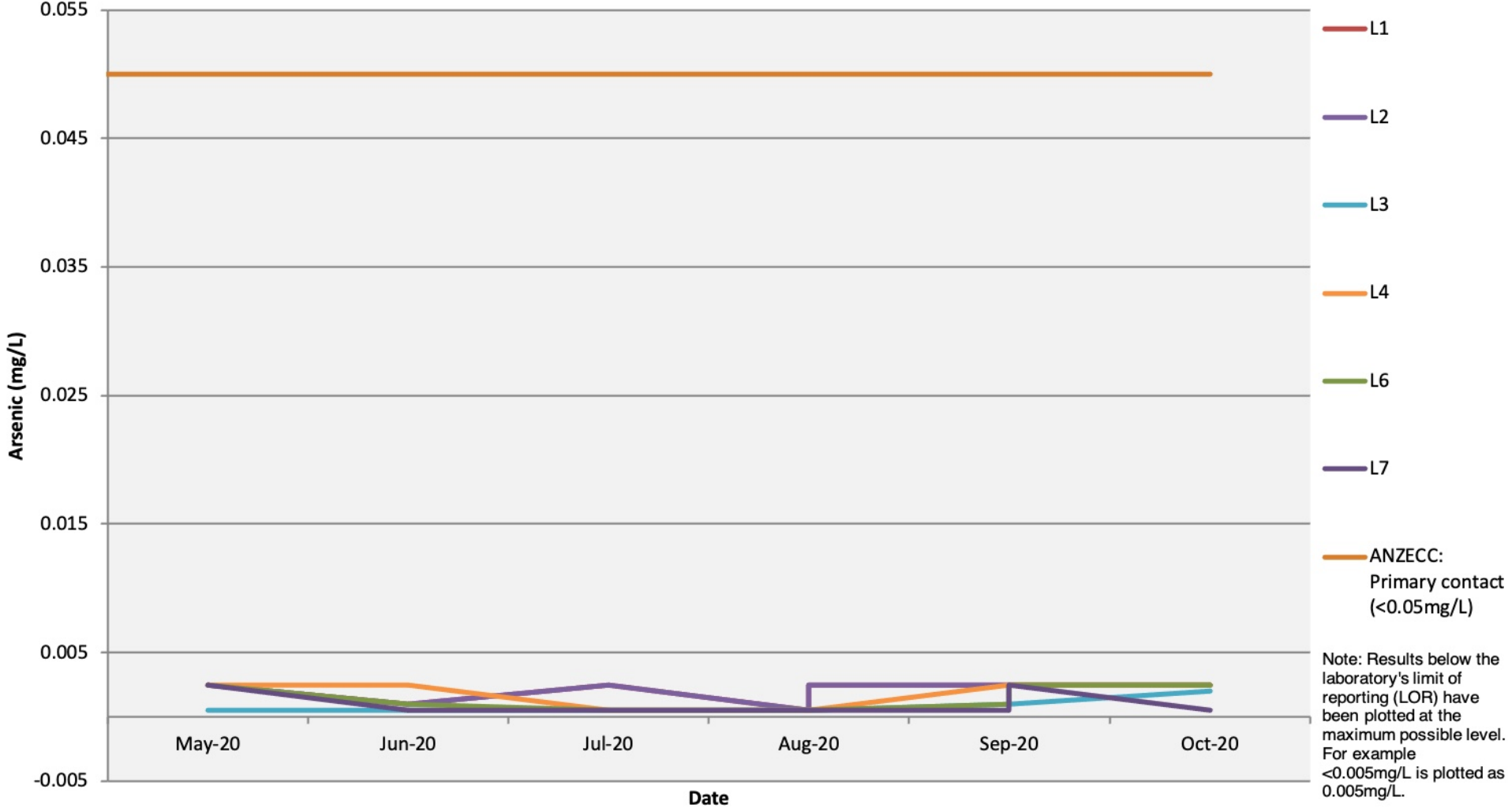


Figure A2.27 Lake Surface Water | Ammonia

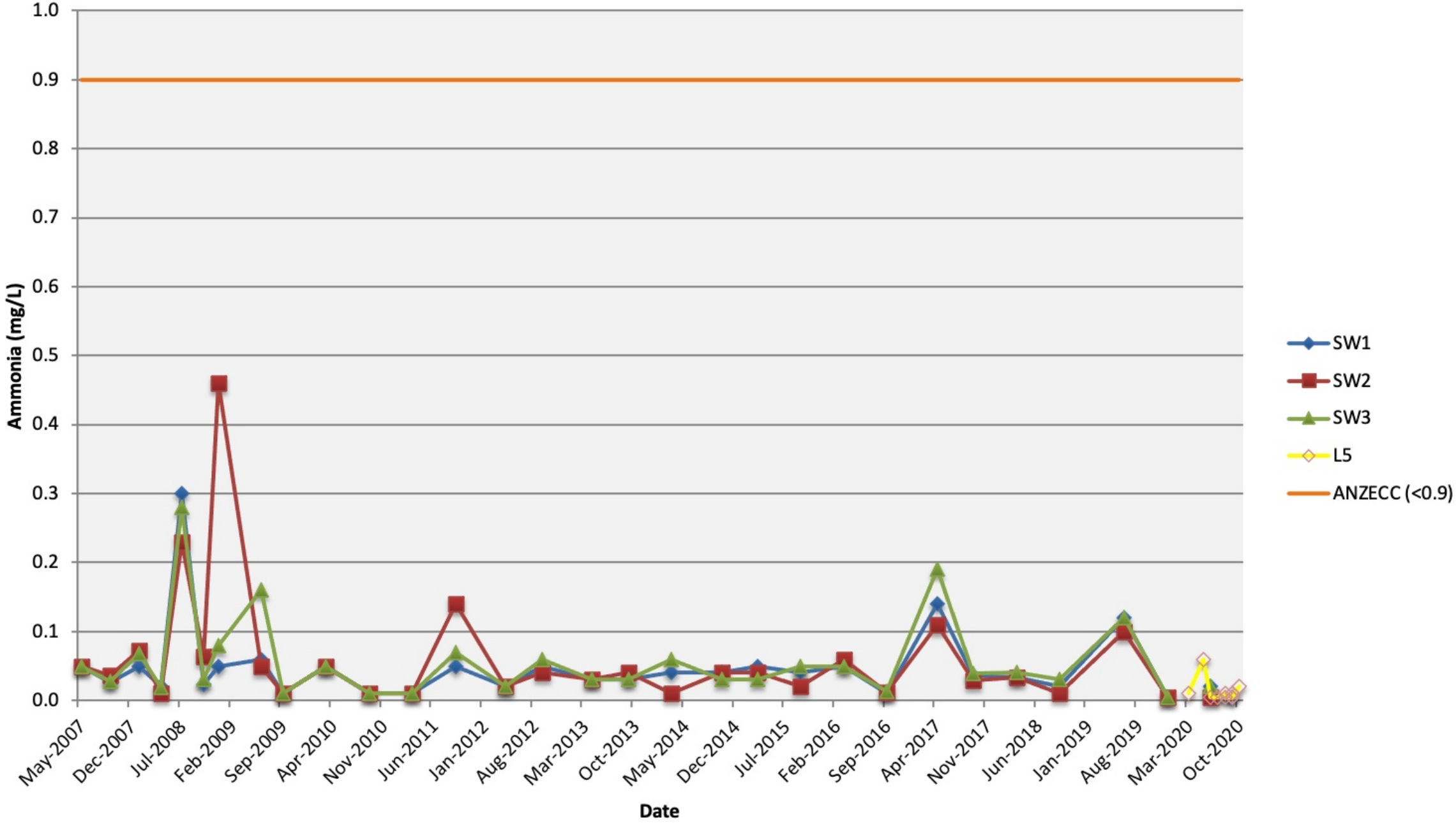


Figure A2.28 Surface Water | Ammonia

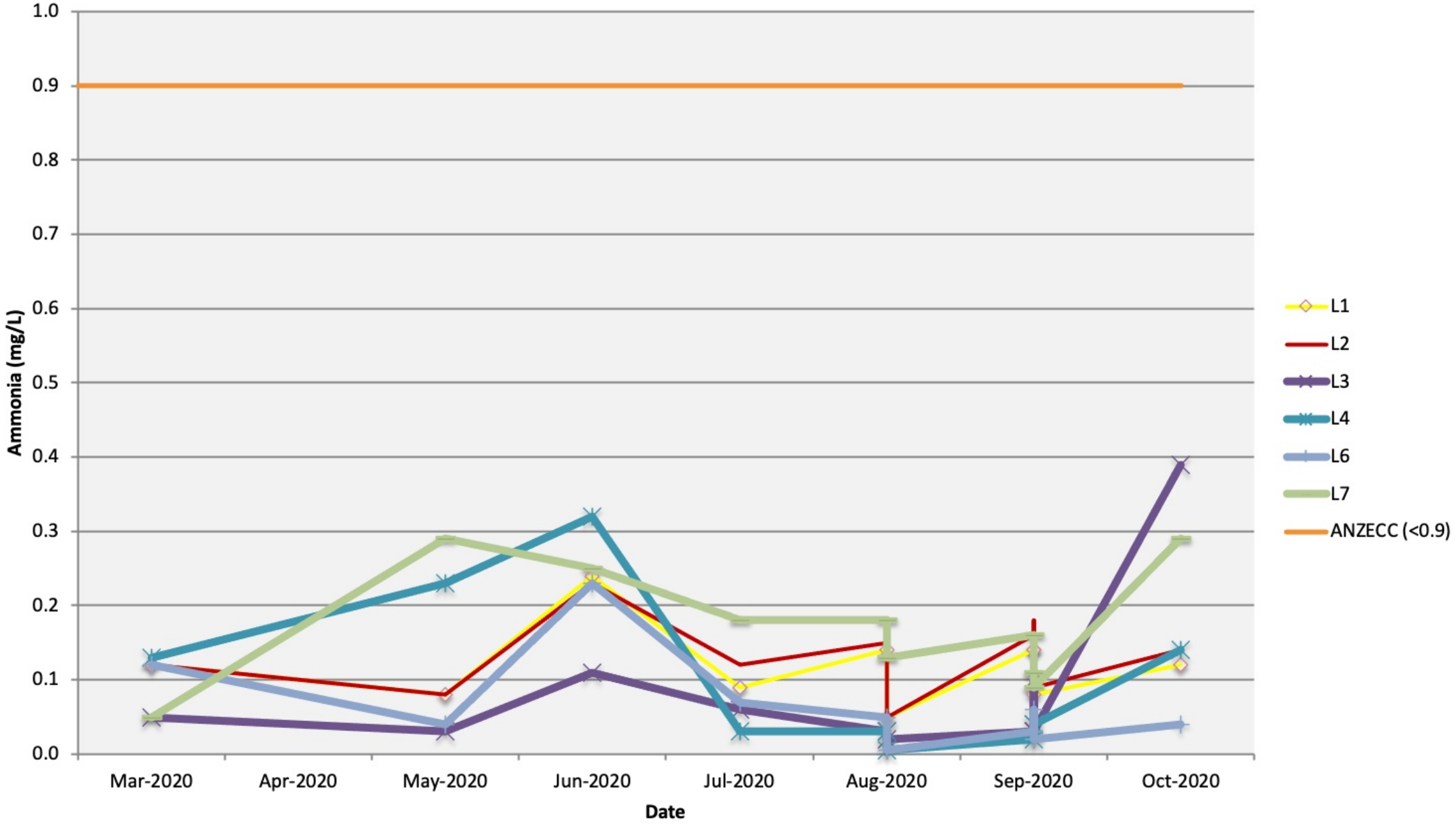


Figure A2.30 Lake Surface Water | Faecal coliforms

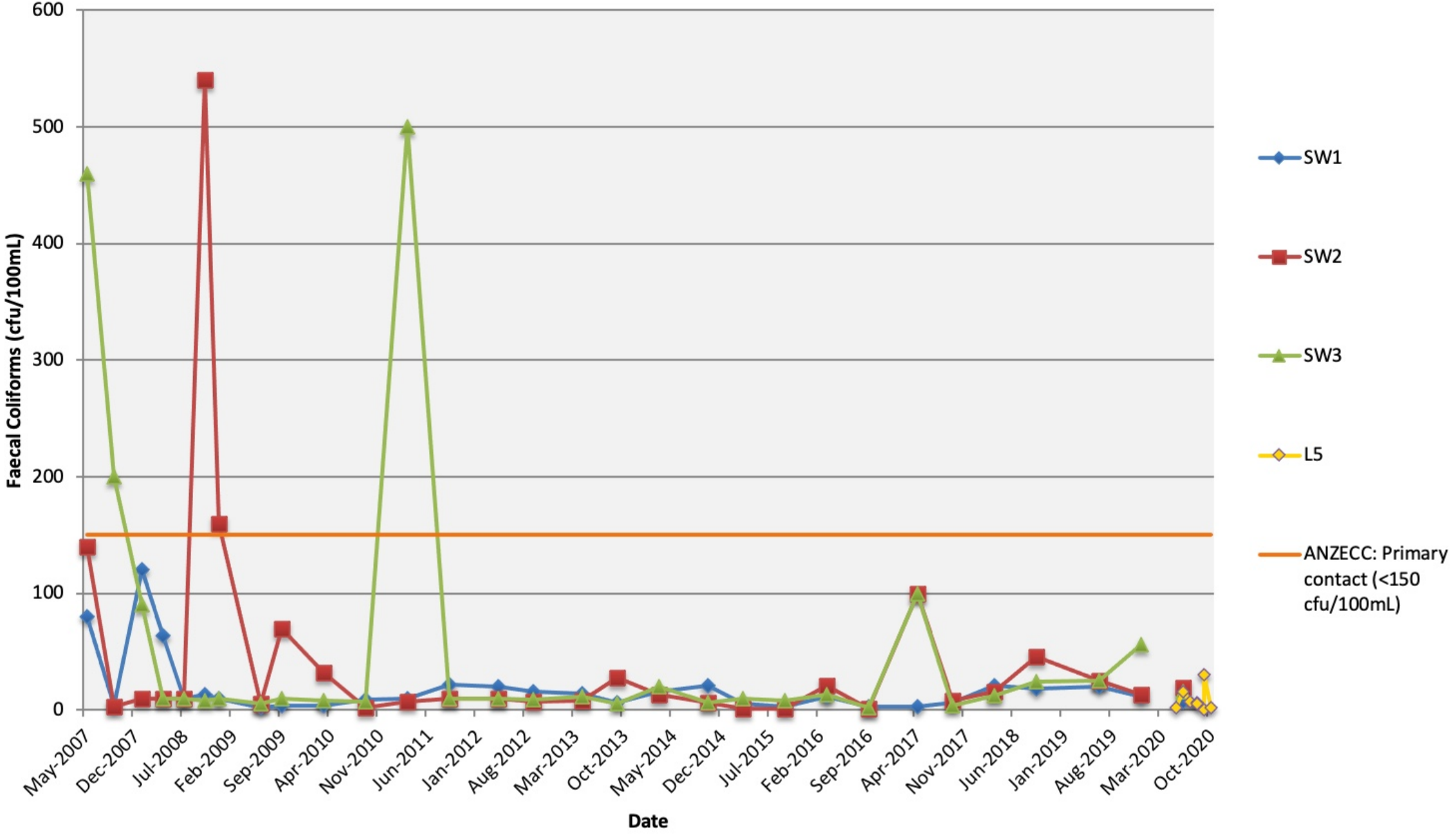


Figure A2.31 Surface Water | Faecal coliforms

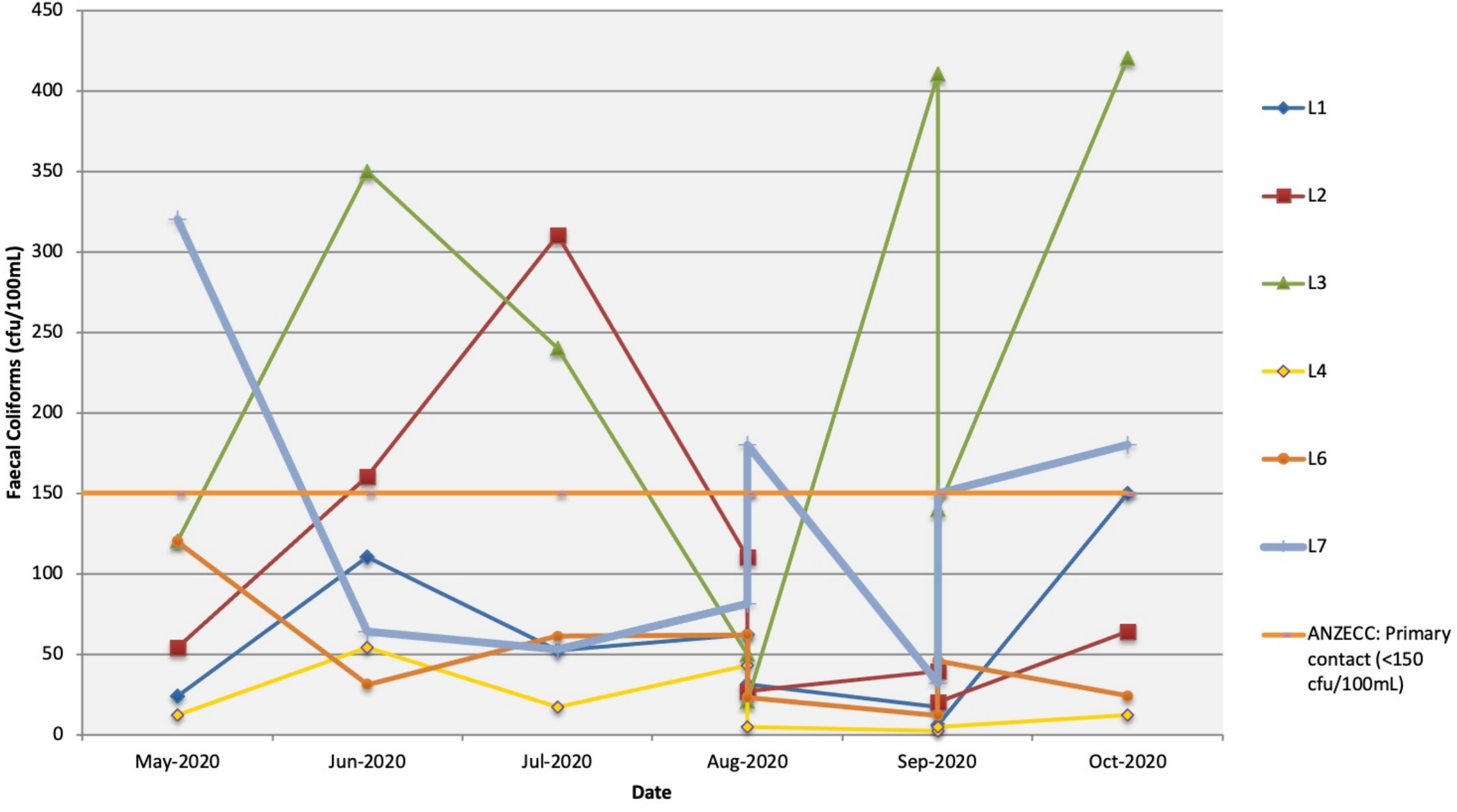


Figure A2.32 Lake Surface Water | Enterococci

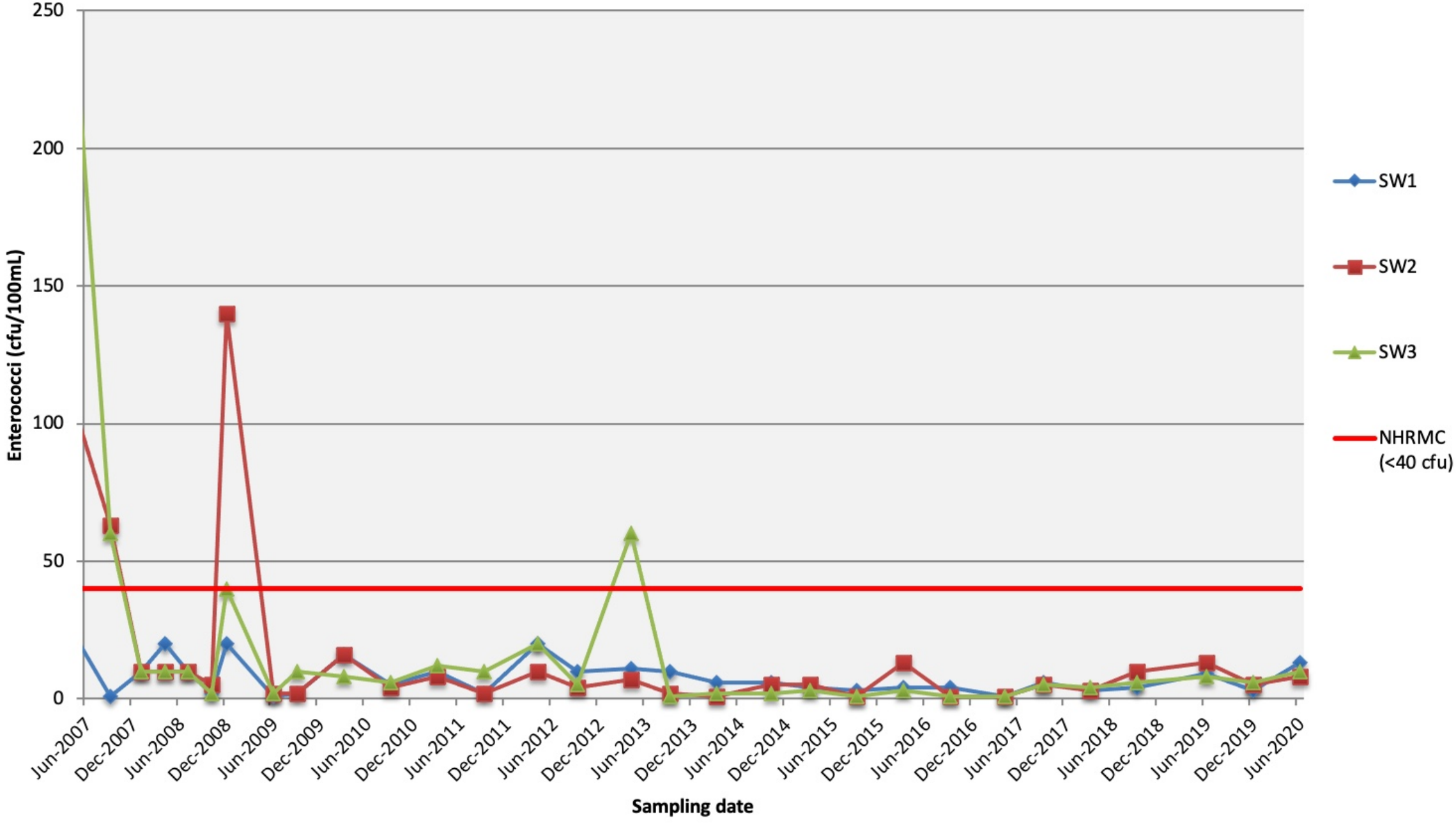


Figure A2.33 Lake Surface Water| Total Nitrogen

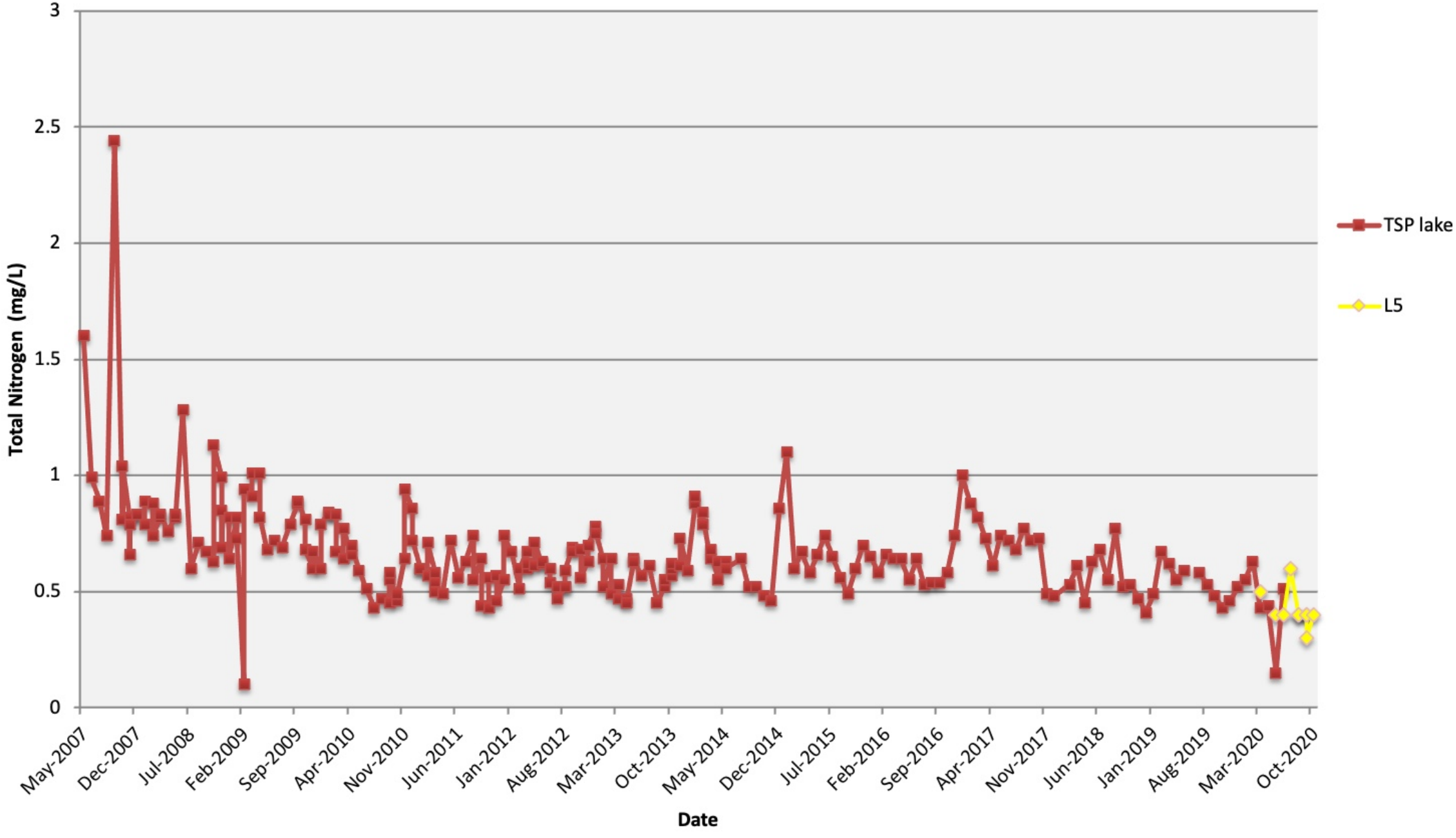


Figure A2.34 Surface Water| Total Nitrogen

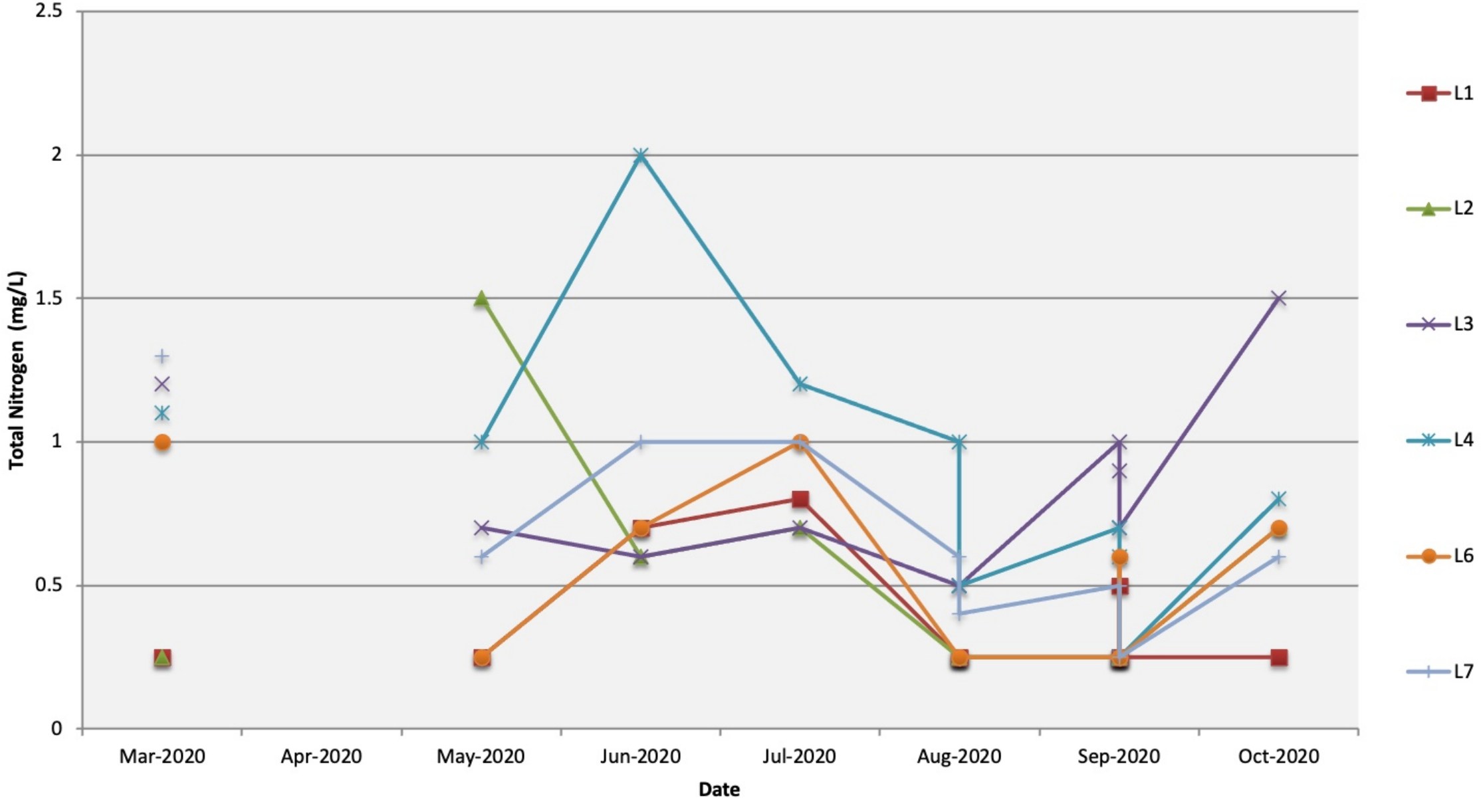


Figure A2.35 Lake Surface Water| Total Phosphorous

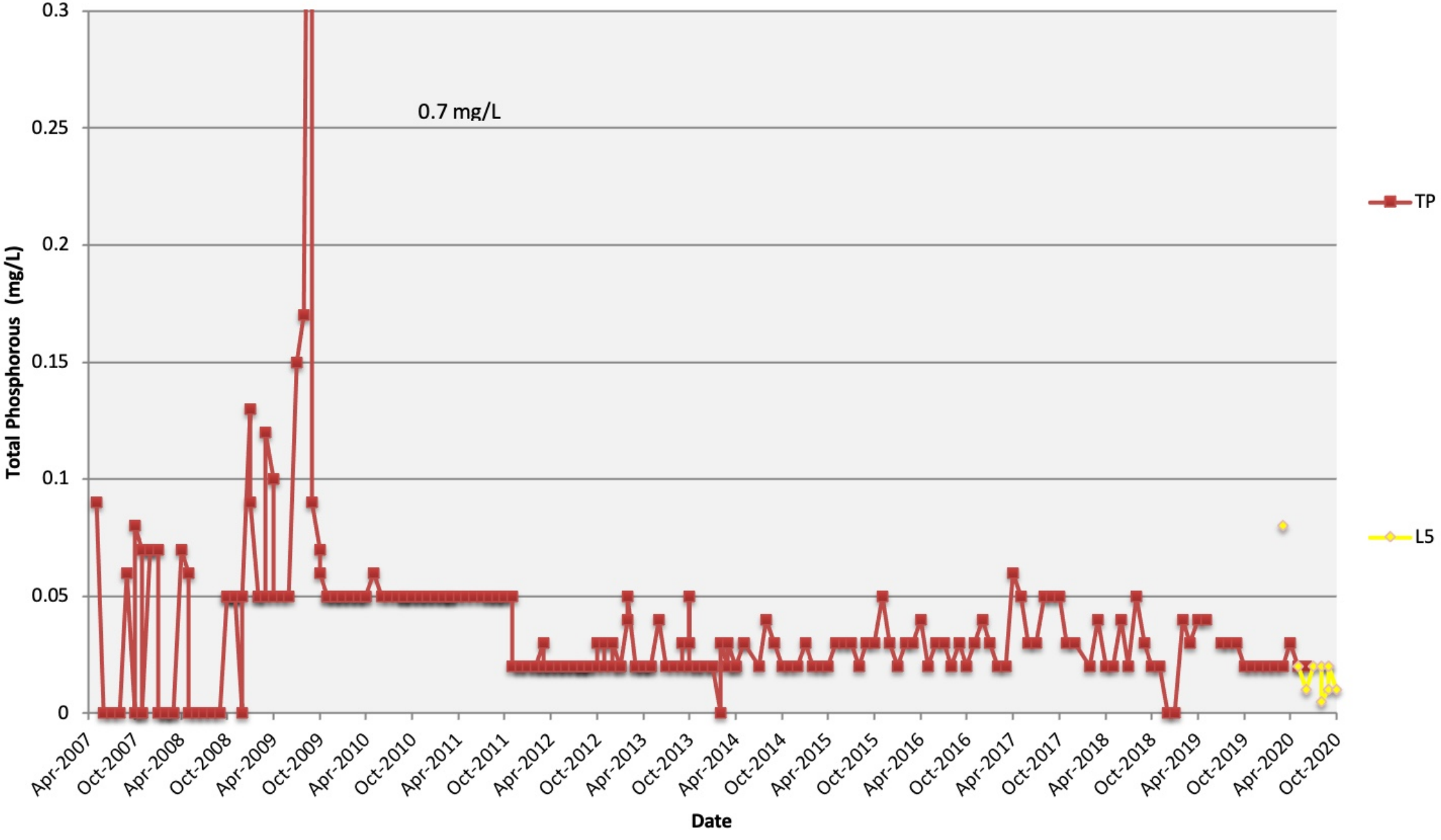


Figure A2.36 Surface Water| Total Phosphorous

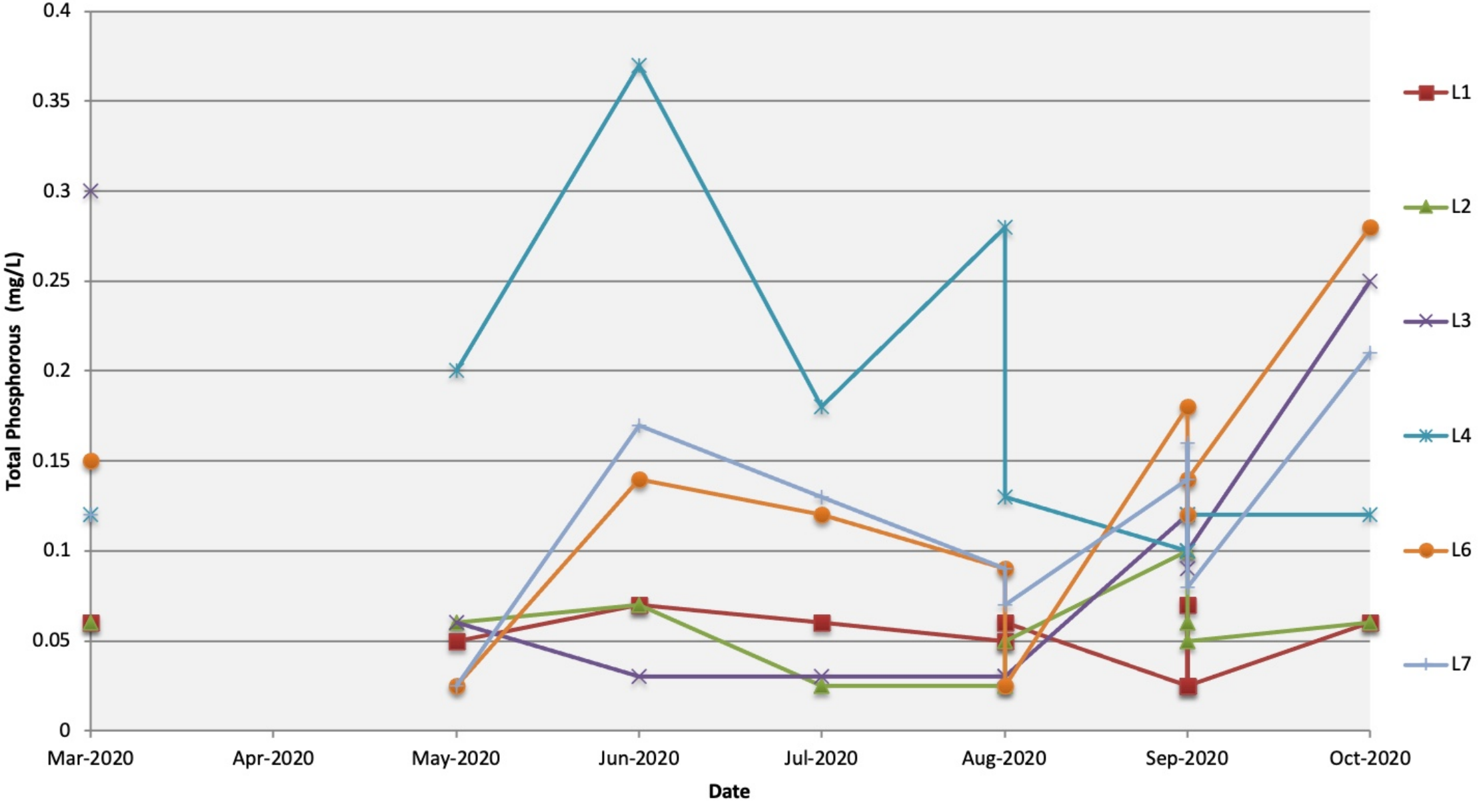


Figure A2.38 Vertical Profile Monitoring | Salinity

Figure A2.39 Salinity at depth intervals

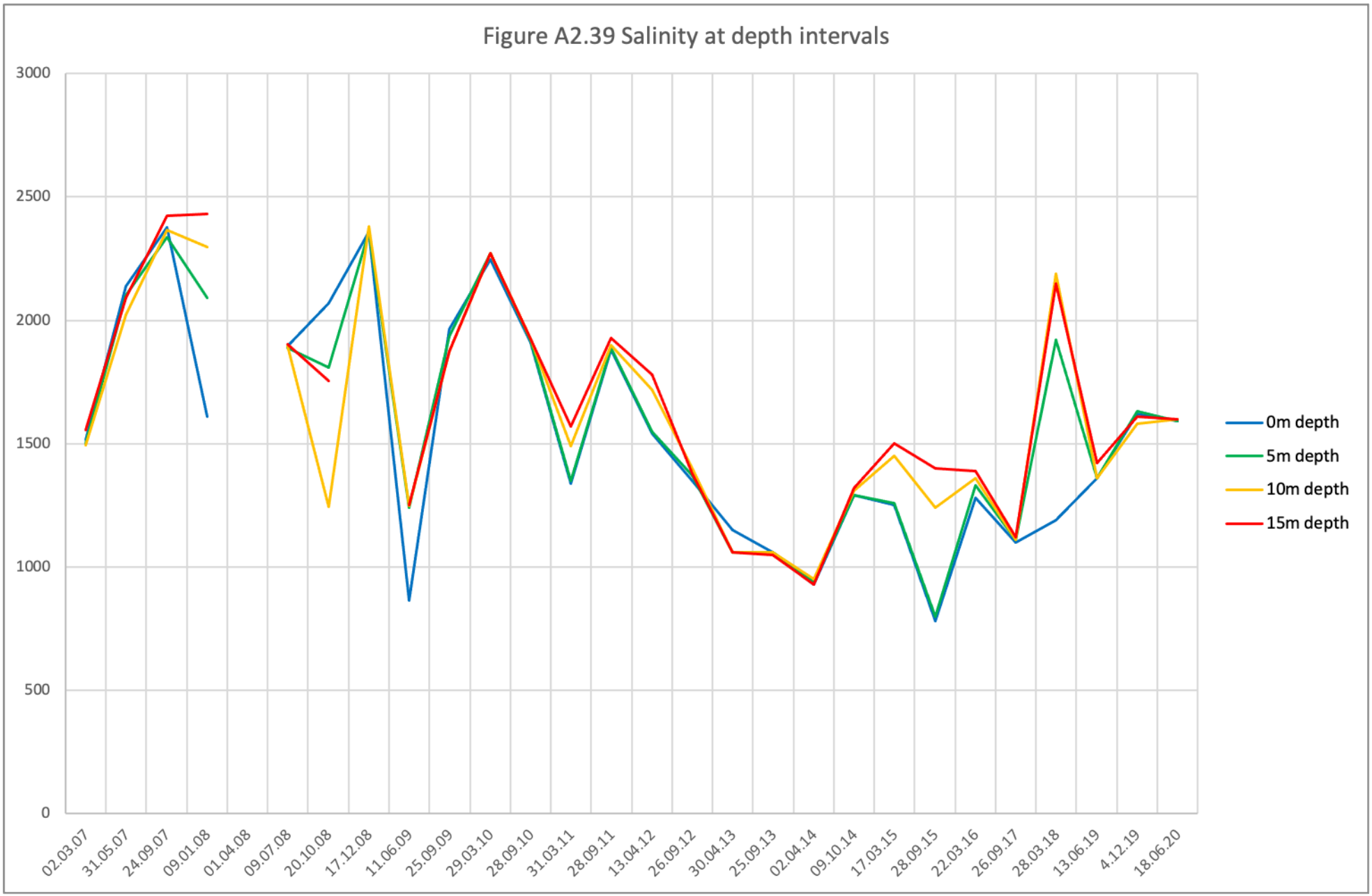


Figure A2.40 Vertical Profile Monitoring | pH

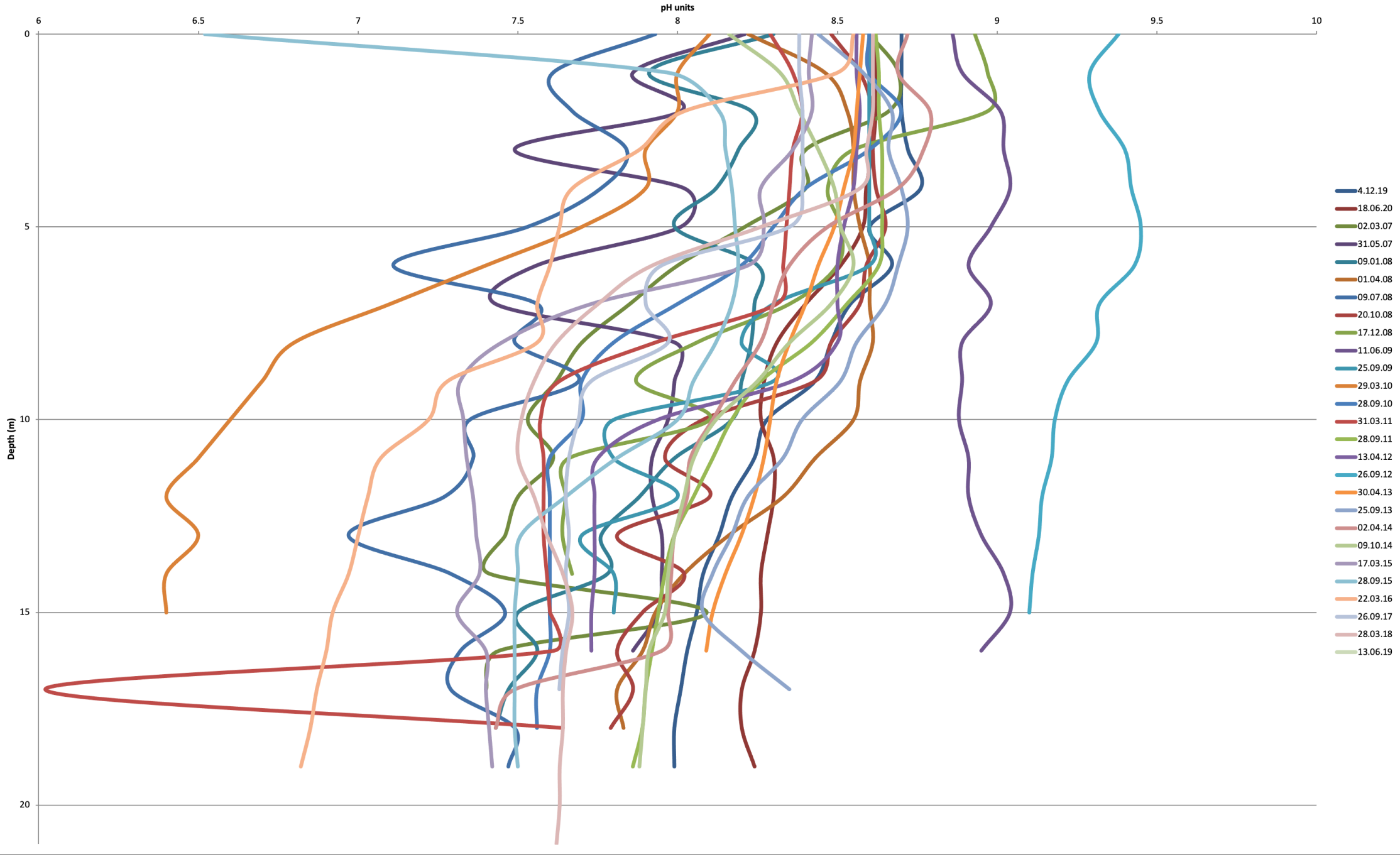


Figure A2.41 pH - Depth intervals (m)

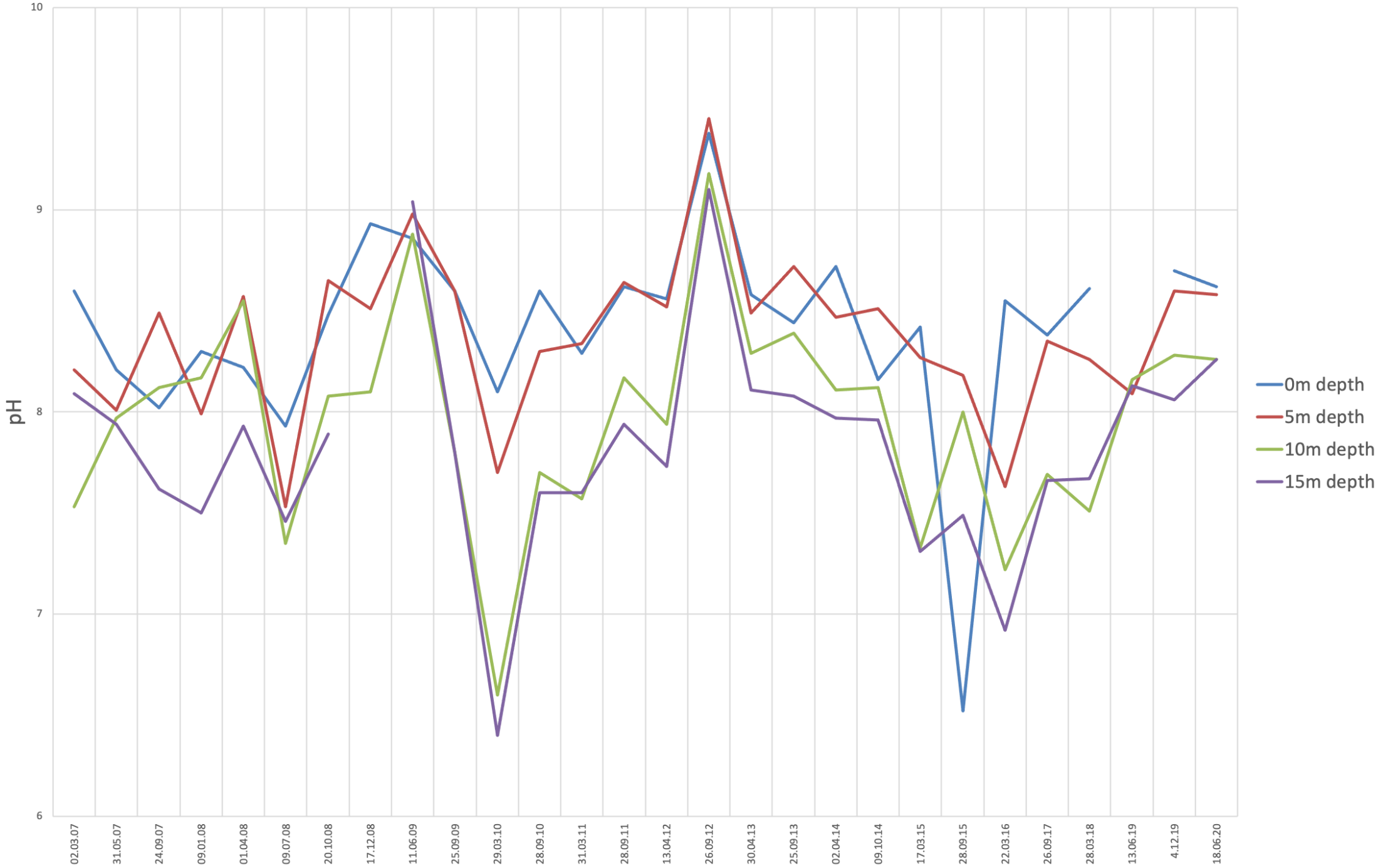
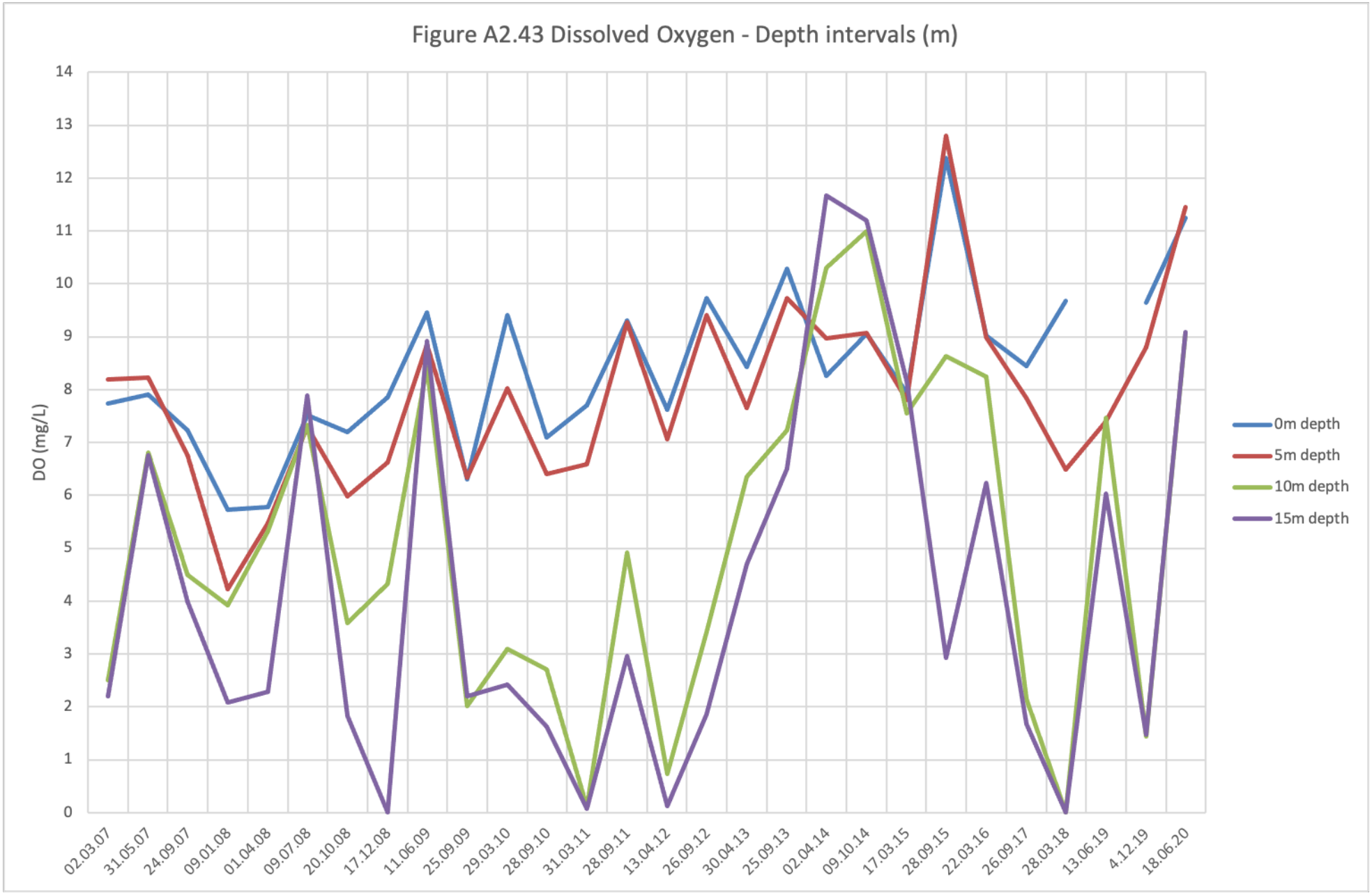


Figure A2.42 Vertical Profile Monitoring | DO

Figure A2.43 Dissolved Oxygen - Depth intervals (m)



Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Al**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	0.200	0.200	—	—	—	—	—	—	—	—
Jan-2002	0.200	—	—	—	—	—	—	—	—	—
Apr-2002	0.200	0.100	—	—	—	—	—	—	—	—
Jul-2002	0.100	0.050	—	—	—	—	—	—	—	—
Oct-2002	1.980	1.780	—	—	—	—	—	—	—	—
Jan-2003	0.030	0.040	—	—	—	—	—	—	—	—
Apr-2003	0.050	0.030	—	—	—	—	—	—	—	—
Jul-2003	0.060	0.020	—	—	—	—	—	—	—	—
Oct-2003	0.030	0.030	—	—	—	—	—	—	—	—
Feb-2004	0.050	0.060	—	—	—	—	—	—	—	—
Apr-2004	0.010	—	—	—	—	—	—	—	—	—
Jul-2004	0.020	0.020	—	—	—	—	—	—	—	—
Oct-2004	0.050	0.060	—	—	—	—	—	—	—	—
Jan-2005	0.090	0.060	—	—	—	—	—	—	—	—
Apr-2005	0.120	0.070	—	—	—	—	—	—	—	—
Jul-2005	0.020	0.020	—	—	—	—	—	—	—	—
Oct-2005	0.060	0.120	—	—	—	—	—	—	—	—
Jan-2006	0.020	0.030	—	—	—	—	—	—	—	—
Apr-2006	0.030	0.020	—	—	—	—	—	—	—	—
Jul-2006	0.020	—	—	—	—	—	—	—	—	—
Nov-2006	0.010	0.010	—	—	—	—	—	—	—	—
Mar-2007	0.040	0.020	—	—	—	—	—	—	—	—
May-2007	0.010	0.020	0.010	—	—	—	—	—	—	—
Sep-2007	0.012	0.013	0.029	—	—	—	—	—	—	—
Jan-2008	0.047	0.048	0.042	—	—	—	—	—	—	—
Apr-2008	0.019	0.020	0.016	—	—	—	—	—	—	—
Jul-2008	0.008	0.014	0.007	—	—	—	—	—	—	—
Oct-2008	0.015	0.014	0.015	—	—	—	—	—	—	—
Dec-2008	0.010	0.010	0.010	—	—	—	—	—	—	—
Jun-2009	0.010	0.010	0.010	—	—	—	—	—	—	—
Sep-2009	0.010	0.010	0.010	—	—	—	—	—	—	—
Mar-2010	0.010	0.010	0.010	—	—	—	—	—	—	—
Sep-2010	0.01	0.02	0.01	—	—	—	—	—	—	—
Mar-2011	0.010	0.010	0.010	—	—	—	—	—	—	—
Sep-2011	0.010	0.020	0.030	—	—	—	—	—	—	—
Apr-2012	0.02	0.22	0.02	—	—	—	—	—	—	—
Sep-2012	0.01	0.02	0.01	—	—	—	—	—	—	—
Apr-2013	0.010	0.01	0.010	—	—	—	—	—	—	—
Sep-2013	0.010	0.010	0.04	—	—	—	—	—	—	—
Mar-2014	0.010	0.010	0.01	—	—	—	—	—	—	—
Oct-2014	0.01	0.01	0.01	—	—	—	—	—	—	—
Mar-2015	0.01	0.01	0.01	—	—	—	—	—	—	—
Sep-2015	0.01	0.01	0.01	—	—	—	—	—	—	—
Mar-2016	0.02	0.01	0.02	—	—	—	—	—	—	—
Sep-2016	0.013	0.012	0.012	—	—	—	—	—	—	—
Apr-2017	0.029	0.027	0.031	—	—	—	—	—	—	—
Sep-2017	0.021	0.0089	0.011	—	—	—	—	—	—	—
Mar-2018	0.013	0.013	0.015	—	—	—	—	—	—	—
Sep-2018	0.009	0.01	0.01	—	—	—	—	—	—	—
Jun-2019	0.005	0.005	0.005	—	—	—	—	—	—	—
Dec-2019	0.01	0.02	0.01	—	—	—	—	—	—	—
May-2020	—	—	—	0.025	0.025	0.005	0.025	0.005	0.025	0.025
Jun-2020	0.187	0.128	0.131	0.005	0.01	0.005	0.025	0.005	0.005	0.005
Jul-2020	—	—	—	0.025	0.025	0.005	0.005	0.005	0.005	0.005
Aug-2020	—	—	—	0.01	0.01	0.01	0.005	0.005	0.005	0.005
Aug-2020	—	—	—	0.025	0.025	0.01	0.005	0.005	0.005	0.005
Sep-2020	—	—	—	0.025	0.025	0.005	0.025	0.005	0.005	0.005
Sep-2020	—	—	—	0.09	0.08	0.02	0.025	0.3	0.04	0.04
Sep-2020	—	—	—	0.025	0.025	0.02	0.025	0.01	0.025	0.025
Oct-2020	—	—	—	0.025	0.025	0.02	0.025	0.01	0.025	0.005
Median	0.020	0.020	0.010	0.025	0.025	0.010	0.025	0.005	0.005	0.005
Mean	0.076	0.071	0.019	0.028	0.028	0.011	0.018	0.039	0.016	0.013
Min	0.005	0.005	0.005	0.005	0.010	0.005	0.005	0.005	0.005	0.005
Max	1.980	1.780	0.131	0.090	0.080	0.020	0.025	0.300	0.040	0.040
80th percentile	0.050	0.054	0.022	0.025	0.025	0.020	0.025	0.010	0.025	0.025
20th percentile	0.010	0.010	0.010	0.019	0.019	0.005	0.005	0.005	0.005	0.005

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**As**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Apr-2004	0.003	—	—	—	—	—	—	—	—	—
Jul-2004	0.003	0.004	—	—	—	—	—	—	—	—
Oct-2004	0.003	0.002	—	—	—	—	—	—	—	—
Jan-2005	0.003	0.002	—	—	—	—	—	—	—	—
Apr-2005	0.004	0.004	—	—	—	—	—	—	—	—
Jul-2005	0.002	0.002	—	—	—	—	—	—	—	—
Oct-2005	0.003	0.002	—	—	—	—	—	—	—	—
Jan-2006	0.004	0.006	—	—	—	—	—	—	—	—
Apr-2006	0.006	0.006	—	—	—	—	—	—	—	—
Jul-2006	0.002	—	—	—	—	—	—	—	—	—
Nov-2006	0.004	0.003	—	—	—	—	—	—	—	—
Mar-2007	—	—	—	—	—	—	—	—	—	—
May-2007	0.005	0.005	0.005	—	—	—	—	—	—	—
Sep-2007	0.0100	0.0099	0.0096	—	—	—	—	—	—	—
Jan-2008	0.0062	0.0069	0.0073	—	—	—	—	—	—	—
Apr-2008	0.0019	0.0022	0.0020	—	—	—	—	—	—	—
Jul-2008	0.001	0.001	0.001	—	—	—	—	—	—	—
Oct-2008	0.001	0.001	0.001	—	—	—	—	—	—	—
Dec-2008	0.005	0.005	0.005	—	—	—	—	—	—	—
Jun-2009	0.0030	0.002	0.0030	—	—	—	—	—	—	—
Sep-2009	0.0020	0.002	0.0020	—	—	—	—	—	—	—
Mar-2010	0.005	0.005	0.005	—	—	—	—	—	—	—
Sep-2010	0.001	0.001	0.002	—	—	—	—	—	—	—
Mar-2011	0.002	0.002	0.002	—	—	—	—	—	—	—
Sep-2011	0.002	0.002	0.002	—	—	—	—	—	—	—
Apr-2012	0.005	0.005	0.005	—	—	—	—	—	—	—
Sep-2012	0.002	0.001	0.002	—	—	—	—	—	—	—
Apr-2013	0.001	0.001	0.001	—	—	—	—	—	—	—
Sep-2013	0.001	0.001	0.001	—	—	—	—	—	—	—
Mar-2014	0.002	0.002	0.002	—	—	—	—	—	—	—
Oct-2014	0.002	0.002	0.002	—	—	—	—	—	—	—
Mar-2015	0.002	0.002	0.002	—	—	—	—	—	—	—
Sep-2015	0.002	0.002	0.001	—	—	—	—	—	—	—
Mar-2016	0.002	0.002	0.002	—	—	—	—	—	—	—
Sep-2016	0.0016	0.0016	0.0016	—	—	—	—	—	—	—
Apr-2017	0.0014	0.0015	0.0015	—	—	—	—	—	—	—
Sep-2017	0.0015	0.0015	0.0015	—	—	—	—	—	—	—
Mar-2018	0.0017	0.0018	0.0018	—	—	—	—	—	—	—
Sep-2018	0.0013	0.0012	0.0012	—	—	—	—	—	—	—
Jun-2019	0.002	0.002	0.002	—	—	—	—	—	—	—
Dec-2019	0.0017	0.0018	0.0019	—	—	—	—	—	—	—
May-2020	—	—	—	0.0025	0.0025	0.0005	0.0025	0.002	0.0025	0.0025
Jun-2020	0.0016	0.0014	0.0013	0.001	0.001	0.0005	0.0025	0.001	0.001	0.0005
Jul-2020	—	—	—	0.0025	0.0025	0.0005	0.0005	0.002	0.0005	0.0005
Aug-2020	—	—	—	0.0005	0.0005	0.0005	0.0005	0.001	0.0005	0.0005
Aug-2020	—	—	—	0.0025	0.0025	0.0005	0.0005	0.001	0.0005	0.0005
Sep-2020	—	—	—	0.0025	0.0025	0.001	0.0025	0.002	0.001	0.0005
Sep-2020	—	—	—	0.0025	0.0025	0.001	0.0025	0.001	0.0025	0.0025
Oct-2020	—	—	—	0.0025	0.0025	0.002	0.0025	0.001	0.0025	0.0005
Median	0.002	0.002	0.002	0.003	0.003	0.001	0.003	0.001	0.001	0.001
Mean	0.003	0.003	0.003	0.002	0.002	0.001	0.002	0.001	0.001	0.001
Min	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Max	0.010	0.010	0.010	0.003	0.003	0.002	0.003	0.002	0.003	0.003
80th percentile	0.004	0.004	0.003	0.003	0.003	0.001	0.003	0.002	0.003	0.002
20th percentile	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Chlorophyll**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
May-2007	21	20	24	—	—	—	—	—	—	—
Sep-2007	25	18	18	—	—	—	—	—	—	—
Jan-2008	25	19	23	—	—	—	—	—	—	—
Apr-2008	18	9.8	15	—	—	—	—	—	—	—
Jul-2008	27	26	26	—	—	—	—	—	—	—
Oct-2008	14	11	12	—	—	—	—	—	—	—
Dec-2008	3.4	2.2	3.4	—	—	—	—	—	—	—
Jun-2009	10	31	43	—	—	—	—	—	—	—
Sep-2009	4	3	4	—	—	—	—	—	—	—
Mar-2010	12	11	14	—	—	—	—	—	—	—
Sep-2010	8	11	14	—	—	—	—	—	—	—
Mar-2011	8	8	8	—	—	—	—	—	—	—
Sep-2011	1	1	2	—	—	—	—	—	—	—
Apr-2012	16	19	13	—	—	—	—	—	—	—
Sep-2012	9	8	6	—	—	—	—	—	—	—
Apr-2013	6	7	6	—	—	—	—	—	—	—
Sep-2013	9	8	8	—	—	—	—	—	—	—
Mar-2014	11	14	15	—	—	—	—	—	—	—
Oct-2014	4	5	3	—	—	—	—	—	—	—
Mar-2015	8	8	8	—	—	—	—	—	—	—
Sep-2015	2	2	1	—	—	—	—	—	—	—
Mar-2016	6	9	8	—	—	—	—	—	—	—
Sep-2016	15	15	14	—	—	—	—	—	—	—
Apr-2017	24	17	41	—	—	—	—	—	—	—
Sep-2017	12	12	15	—	—	—	—	—	—	—
Mar-2018	14	14	8.8	—	—	—	—	—	—	—
Sep-2018	4	4	4	—	—	—	—	—	—	—
Jun-2019	7	7	8	—	—	—	—	—	—	—
Dec-2019	3	3	3	—	—	—	—	—	—	—
May-2020	—	—	—	2	1	3	26	2	2	1
Jun-2020	2	1	3	0.5	0.5	0.5	81	2	0.5	2
Jul-2020	—	—	—	0.5	1	0.5	36	2	3	2
Aug-2020	—	—	—	3	0.5	2	49	6	3	3
Aug-2020	—	—	—	1	2	1	27	3	1	1
Sep-2020	—	—	—	0.5	2	2	7	4	7	1
Sep-2020	—	—	—	0.5	0.5	2	15	2	2	2
Sep-2020	—	—	—	2	2	3	0.5	2	9	3
Oct-2020	—	—	—	1	2	34	21	2	11	1
Median	9.0	9.4	8.4	1.0	1.0	2.0	26.0	2.0	3.0	2.0
Mean	10.9	10.8	12.4	1.2	1.3	5.3	29.2	2.8	4.3	1.8
Min	1.0	1.0	1.0	0.5	0.5	0.5	0.5	2.0	0.5	1.0
Max	27.0	31.0	43.0	3.0	2.0	34.0	81.0	6.0	11.0	3.0
80th percentile	16.4	17.2	15.6	2.0	2.0	3.0	41.2	3.4	7.8	2.4
20th percentile	4.0	3.8	3.9	0.5	0.5	0.8	11.8	2.0	1.6	1.0

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Cl**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	606	598	—	—	—	—	—	—	—	—
Jan-2002	552	—	—	—	—	—	—	—	—	—
Apr-2002	517	970	—	—	—	—	—	—	—	—
Jul-2002	493	460	—	—	—	—	—	—	—	—
Oct-2002	520	529	—	—	—	—	—	—	—	—
Jan-2003	445	494	—	—	—	—	—	—	—	—
Apr-2003	447	426	—	—	—	—	—	—	—	—
Jul-2003	380	363	—	—	—	—	—	—	—	—
Oct-2003	356	366	—	—	—	—	—	—	—	—
Feb-2004	392	392	—	—	—	—	—	—	—	—
Apr-2004	416	—	—	—	—	—	—	—	—	—
Jul-2004	418	406	—	—	—	—	—	—	—	—
Oct-2004	542	552	—	—	—	—	—	—	—	—
Jan-2005	424	600	—	—	—	—	—	—	—	—
Apr-2005	519	538	—	—	—	—	—	—	—	—
Jul-2005	503	498	—	—	—	—	—	—	—	—
Oct-2005	548	548	—	—	—	—	—	—	—	—
Jan-2006	590	590	—	—	—	—	—	—	—	—
Apr-2006	545	539	—	—	—	—	—	—	—	—
Jul-2006	724		—	—	—	—	—	—	—	—
Nov-2006	670	651	—	—	—	—	—	—	—	—
Mar-2007	—	—	—	—	—	—	—	—	—	—
May-2007	797	801	805	—	—	—	—	—	—	—
Sep-2007	830	790	790	—	—	—	—	—	—	—
Jan-2008	500	500	540	—	—	—	—	—	—	—
Apr-2008	640	650	630	—	—	—	—	—	—	—
Jul-2008	720	720	710	—	—	—	—	—	—	—
Oct-2008	730	740	710	—	—	—	—	—	—	—
Dec-2008	810	820	730	—	—	—	—	—	—	—
Jun-2009	711	716	706	—	—	—	—	—	—	—
Sep-2009	630	632	627	—	—	—	—	—	—	—
Mar-2010	1050	900	750	—	—	—	—	—	—	—
Sep-2010	713	706	720	—	—	—	—	—	—	—
Mar-2011	591	592	572	—	—	—	—	—	—	—
Sep-2011	616	618	614	—	—	—	—	—	—	—
Apr-2012	520	530	530	—	—	—	—	—	—	—
Sep-2012	523	531	526	—	—	—	—	—	—	—
Apr-2013	479	480	483	—	—	—	—	—	—	—
Sep-2013	510	507	508	—	—	—	—	—	—	—
Mar-2014	529	523	518	—	—	—	—	—	—	—
Oct-2014	554	553	554	—	—	—	—	—	—	—
Mar-2015	571	575	572	—	—	—	—	—	—	—
Sep-2015	556	561	569	—	—	—	—	—	—	—
Mar-2016	610	615	614	—	—	—	—	—	—	—
Sep-2016	630	620	620	—	—	—	—	—	—	—
Apr-2017	330	350	350	—	—	—	—	—	—	—
Sep-2017	450	450	480	—	—	—	—	—	—	—
Mar-2018	540	550	610	—	—	—	—	—	—	—
Sep-2018	595	601	596	—	—	—	—	—	—	—
Jun-2019	705	703	698	—	—	—	—	—	—	—
Dec-2019	665	678	677	—	—	—	—	—	—	—
May-2020	—	—	—	16600	16100	114	14200	682	9990	15400
Jun-2020	717	605	695	6890	7070	196	9880	708	3970	1530
Jul-2020	—	—	—	11400	10400	210	8240	664	5320	4360
Aug-2020	—	—	—	6920	6880	158	6260	713	3190	1110
Aug-2020	—	—	—	14300	14500	223	8510	705	9170	3250
Sep-2020	—	—	—	14400	14500	271	9700	711	6440	1660
Sep-2020	—	—	—	15100	15900	225	12600	716	11000	12600
Oct-2020	—	—	—	16400	16400	345	13100	717	10400	2540
Median	552	568	614	14350	14500	217	9790	710	7805	2895
Mean	577	586	617	12751	12719	218	10311	702	7435	5306
Min	330	350	350	6890	6880	114	6260	664	3190	1110
Max	1050	970	805	16600	16400	345	14200	717	11000	15400
80th percentile	705	693	710	15880	16020	253	12900	715	10236	9304
20th percentile	479	496	529	8712	8402	173	8348	691	4510	1582

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**DO**	D	Destroyed
Units:	**mg/L**	—	Not monitored or inaccessible
Data Collected by:	**G+S**		

Surface water Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	8.46	8.47	—	—	—	—	—	—	—	—
Jan-2002	7.16	—	—	—	—	—	—	—	—	—
Apr-2002	8.01	7.47	—	—	—	—	—	—	—	—
Jul-2002	9.95	10.20	—	—	—	—	—	—	—	—
Oct-2002	7.20	7.30	—	—	—	—	—	—	—	—
Jan-2003	8.80	8.08	—	—	—	—	—	—	—	—
Apr-2003	7.98	7.96	—	—	—	—	—	—	—	—
Jul-2003	14.77	14.93	—	—	—	—	—	—	—	—
Oct-2003	6.65	6.64	—	—	—	—	—	—	—	—
Feb-2004	**5.16**	6.32	—	—	—	—	—	—	—	—
Apr-2004	9.35	—	—	—	—	—	—	—	—	—
Jul-2004	9.20	9.98	—	—	—	—	—	—	—	—
Oct-2004	—	7.13	—	—	—	—	—	—	—	—
Jan-2005	8.55	—	—	—	—	—	—	—	—	—
Apr-2005	9.36	9.19	—	—	—	—	—	—	—	—
Jul-2005	10.92	10.86	—	—	—	—	—	—	—	—
Oct-2005	8.02	8.36	—	—	—	—	—	—	—	—
Dec-2005	—	—	—	—	—	—	—	—	—	—
Jan-2006	9.42	9.49	—	—	—	—	—	—	—	—
Apr-2006	7.16	8.28	—	—	—	—	—	—	—	—
Jul-2006	9.4		—	—	—	—	—	—	—	—
Nov-2006	8.65	10.42	—	—	—	—	—	—	—	—
Mar-2007	8.56	**5.67**	—	—	—	—	—	—	—	—
May-2007	9.93	9.94	7.27	—	—	—	—	—	—	—
Sep-2007	7.23	7.36	6.68	—	—	—	—	—	—	—
Jan-2008	**5.83**	6.18	6.15	—	—	—	—	—	—	—
Apr-2008	6.10	6.67	**5.53**	—	—	—	—	—	—	—
Jul-2008	9.30	8.12	9.19	—	—	—	—	—	—	—
Oct-2008	6.51	**5.45**	6.87	—	—	—	—	—	—	—
Dec-2008	7.39	6.28	6.59	—	—	—	—	—	—	—
Jun-2009	9.33	9.41	9.97	—	—	—	—	—	—	—
Sep-2009	6.59	6.38	6.76	—	—	—	—	—	—	—
Mar-2010	9.20	10.86	8.49	—	—	—	—	—	—	—
Sep-2010	7.50	7.05	6.97	—	—	—	—	—	—	—
Mar-2011	7.08	7.65	6.66	—	—	—	—	—	—	—
Sep-2011	9.07	9.08	9.08	—	—	—	—	—	—	—
Apr-2012	7.63	7.14	7.10	—	—	—	—	—	—	—
Sep-2012	9.86	10.01	10.07	—	—	—	—	—	—	—
Apr-2013	8.41	8.45	8.36	—	—	—	—	—	—	—
Sep-2013	10.48	9.58	9.71	—	—	—	—	—	—	—
Mar-2014	7.92	8.33	8.31	—	—	—	—	—	—	—
Oct-2014	9.01	8.96	8.98	—	—	—	—	—	—	—
Mar-2015	7.70	7.71	7.70	—	—	—	—	—	—	—
Sep-2015	12.41	14.11	14.05	—	—	—	—	—	—	—
Mar-2016	6.49	6.59	7.19	—	—	—	—	—	—	—
Sep-2016	9.53	9.45	9.22	—	—	—	—	—	—	—
Apr-2017	9.14	8.95	8.68	—	—	—	—	—	—	—
Sep-2017	8.93	8.77	8.86	—	—	—	—	—	—	—
Mar-2018	9.30	9.50	9.50	—	—	—	—	—	—	—
Sep-2018	9.66	9.65	9.64	—	—	—	—	—	—	—
Jun-2019	7.67	7.90	7.65	—	—	—	—	—	—	—
Dec-2019	9.12	9.21	9.08	—	—	—	—	—	—	—
Jun-2020	—	—	—	—	—	—	—	—	—	—
Mar-2020	—	—	—	**5.69**	**5.65**	**5.78**	**5.24**	6.18	**4.6**	**4.77**
May-2020	—	—	—	**2.6**	**2.44**	**3.5**	**2.96**	**2.75**	**2.18**	**3.28**
Jun-2020	11.21	11.17	11.06	8.57	**5.61**	**3.9**	**2.55**	11.65	**5.6**	**3.94**
Jul-2020	—	—	—	**5.82**	6.41	**2.41**	**3.01**	9.27	6.65	**2.38**
Aug-2020	—	—	—	7.94	7.63	**4.13**	**4.21**	10.25	10.37	7.03
Aug-2020	—	—	—	7.68	7.66	**3.39**	**4.79**	10.27	9.9	7.98
Sep-2020	—	—	—	6.59	**5.58**	**3.05**	—	9.6	7.8	7.9
Sep-2020	—	—	—	**5.21**	**5.06**	**5.31**	**4.65**	7.11	**5.5**	6.31
Sep-2020	—	—	—	**5.3**	**4.56**	8	**4.59**	7.96	**5.35**	**4.73**
Oct-2020	—	—	—	6.79	6.77	**5.02**	6.1	10.45	7.48	7.55
Median	8.65	8.41	8.43	6.21	5.63	4.02	4.59	9.44	6.13	5.54
Mean	8.59	8.60	8.38	6.22	5.74	4.45	4.23	8.55	6.54	5.59
Min	5.16	5.45	5.53	2.60	2.44	2.41	2.55	2.75	2.18	2.38
Max	14.77	14.93	14.05	8.57	7.66	8.00	6.10	11.65	10.37	7.98
80th percentile	9.42	9.82	9.53	7.73	6.94	5.40	4.97	10.31	8.22	7.62
20th percentile	7.20	7.08	6.85	5.28	4.96	3.32	2.99	6.92	5.20	3.81

Project TSP, Cudgen, NSW <LOR
Parameter: EC
Units: uS/cm D Destroyed
Data Collected by: G+S — Not monitored or inaccessible

Sampling Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	2,990	3,033	—	—	—	—	—	—	—	—
Jan-2002	2,970	—	—	—	—	—	—	—	—	—
Apr-2002	1,344	2,542	—	—	—	—	—	—	—	—
Jul-2002	2,880	207	—	—	—	—	—	—	—	—
Oct-2002	307	309	—	—	—	—	—	—	—	—
Jan-2003	2,465	2,527	—	—	—	—	—	—	—	—
Apr-2003	2,400	2,433	—	—	—	—	—	—	—	—
Jul-2003	2,195	2,232	—	—	—	—	—	—	—	—
Oct-2003	2,325	2,507	—	—	—	—	—	—	—	—
Feb-2004	2,044	2,068	—	—	—	—	—	—	—	—
Apr-2004	2,326	—	—	—	—	—	—	—	—	—
Jul-2004	2,467	—	—	—	—	—	—	—	—	—
Oct-2004	—	2,607	—	—	—	—	—	—	—	—
Jan-2005	2,465	—	—	—	—	—	—	—	—	—
Apr-2005	2,607	2,740	—	—	—	—	—	—	—	—
Jul-2005	2,480	2,294	—	—	—	—	—	—	—	—
Oct-2005	2,633	2,619	—	—	—	—	—	—	—	—
Dec-2005	—	—	—	—	—	—	—	—	—	—
Jan-2006	2,306	2,349	—	—	—	—	—	—	—	—
Apr-2006	2,279	2,261	—	—	—	—	—	—	—	—
Jul-2006	2,644	—	—	—	—	—	—	—	—	—
Nov-2006	2,700	2,671	—	—	—	—	—	—	—	—
Mar-2007	1,970	2,230	—	—	—	—	—	—	—	—
May-2007	3,090	3,570	3,060	—	—	—	—	—	—	—
Sep-2007	3,550	3,560	3,570	—	—	—	—	—	—	—
Jan-2008	2,442	2,453	2,510	—	—	—	—	—	—	—
Apr-2008	3,100	3,100	2,900	—	—	—	—	—	—	—
Jul-2008	3,420	2,840	2,830	—	—	—	—	—	—	—
Oct-2008	3,380	3,440	3,180	—	—	—	—	—	—	—
Dec-2008	3,550	3,920	3,690	—	—	—	—	—	—	—
Jun-2009	1,812	1,847	1,782	—	—	—	—	—	—	—
Sep-2009	2,903	2,982	—	—	—	—	—	—	—	—
Mar-2010	3,830	3,340	3,360	—	—	—	—	—	—	—
Sep-2010	2,840	2,840	2,850	—	—	—	—	—	—	—
Mar-2011	2,542	2,538	2,546	—	—	—	—	—	—	—
Sep-2011	2,822	2,805	2,808	—	—	—	—	—	—	—
Apr-2012	2,390	2,287	2,291	—	—	—	—	—	—	—
Sep-2012	2,513	2,433	2,436	—	—	—	—	—	—	—
Apr-2013	2,017	2,015	2,034	—	—	—	—	—	—	—
Sep-2013	1,966	1,955	1,972	—	—	—	—	—	—	—
Mar-2014	2,220	2,227	2,222	—	—	—	—	—	—	—
Oct-2014	2,480	2,490	2,480	—	—	—	—	—	—	—
Mar-2015	2,230	2,210	2,220	—	—	—	—	—	—	—
Sep-2015	2,822	2,828	2,824	—	—	—	—	—	—	—
Mar-2016	2,533	2,529	2,526	—	—	—	—	—	—	—
Sep-2016	2,070	2,100	2,100	—	—	—	—	—	—	—
Apr-2017	1,667	1,652	1,655	—	—	—	—	—	—	—
Sep-2017	2,082	2,090	2,083	—	—	—	—	—	—	—
Mar-2018	2,186	2,196	2,190	—	—	—	—	—	—	—
Sep-2018	2450	2460	2450	—	—	—	—	—	—	—
Jun-2019	2,611	2,614	2,644	—	—	—	—	—	—	—
Dec-2019	3,086	3,083	3,069	—	—	—	—	—	—	—
Mar-2020	—	—	—	22,950	18,310	142	3,483	1,780	2,528	1,799
May-2020	—	—	—	42,700	41,700	608	37,000	2,620	28,100	39,900
Jun-2020	2,697	2,703	2,708	19,800	20,400	942	28,400	2,700	12,100	5,560
Jul-2020	—	—	—	34,000	32,000	1,100	25,400	2,620	16,500	13,900
Aug-2020	—	—	—	20,700	20,200	798	18,400	2,660	10,200	3,940
Aug-2020	—	—	—	38,200	38,500	1,110	24,300	2,650	26,200	9,880
Sep-2020	—	—	—	42,200	42,100	1,330	28,500	2,720	19,400	5,720
Sep-2020	—	—	—	3,503	3,460	1,207	3,450	2,680	3,442	3,021
Sep-2020	—	—	—	43,300	43,500	1,160	37,300	2,770	32,100	37,300
Oct-2020	—	—	—	45,200	45,700	1,650	36,700	2,750	31,100	8,150
Median	**2512**	**2507**	**2526**	**36100**	**35250**	**1105**	**26900**	**2670**	**17950**	**6935**
Mean	**2474**	**2499**	**2526**	**36100**	**35250**	**1105**	**26900**	**2670**	**17950**	**6935**
Min	**307**	**207**	**1655**	**3503**	**3460**	**142**	**3450**	**1780**	**2528**	**1799**
Max	**3830**	**3920**	**3690**	**45200**	**45700**	**1650**	**37300**	**2770**	**32100**	**39900**
80th percentile	**2903**	**2840**	**2964**	**42820**	**42380**	**1231.6**	**36760**	**2726**	**28700**	**18580**
20th percentile	**2186**	**2198.8**	**2154**	**20520**	**19822**	**760**	**15416.6**	**2620**	**8848.4**	**3756.2**

Project	**TSP, Cudgen, NSW**	<LOR
Parameter:	**Enterococci**	
Units:	**cfu/100ml**	
Data Collected by:	**G+S**	

	Surface Water		
Date	SW1	SW2	SW3
May-2007	20	100	220
Sep-2007	1	63	60
Jan-2008	10	10	10
Apr-2008	20	10	10
Jul-2008	10	10	10
Oct-2008	2	5	2
Dec-2008	20	140	40
Jun-2009	1	2	2
Sep-2009	2	2	10
Mar-2010	16	16	8
Sep-2010	5	4	6
Mar-2011	10	8	12
Sep-2011	2	2	10
Apr-2012	20	10	20
Sep-2012	10	4	5
Apr-2013	11	7	60
Sep-2013	10	2	1
Mar-2014	6	1	2
Oct-2014	6	5	2
Mar-2015	4	5	3
Sep-2015	3	1	1
Mar-2016	4	13	3
Sep-2016	4	1	1
Apr-2017	1	1	1
Sep-2017	6	5	5
Mar-2018	3	3	4
Sep-2018	4	10	6
Jun-2019	9	13	8
Dec-2019	3	5	6
Jun-2020	13	8	10

Median	6.0	5.0	6.0
Mean	7.9	15.5	17.9
Min	1.0	1.0	1.0
Max	20.0	140.0	220.0
80th percentile	11.4	10.6	10.4
20th percentile	2.8	2.0	2.0

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Faecal coliforms**	D	Destroyed
Units:	**cfu/100ml**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
May-2007	80	140	460	—	—	—	—	—	—	—
Sep-2007	4	3	200	—	—	—	—	—	—	—
Jan-2008	120	10	90	—	—	—	—	—	—	—
Apr-2008	64	10	10	—	—	—	—	—	—	—
Jul-2008	10	10	10	—	—	—	—	—	—	—
Oct-2008	13	540	8	—	—	—	—	—	—	—
Dec-2008	10	160	10	—	—	—	—	—	—	—
Jun-2009	2	5	5	—	—	—	—	—	—	—
Sep-2009	4	70	10	—	—	—	—	—	—	—
Mar-2010	4	32	8	—	—	—	—	—	—	—
Sep-2010	9	2	7	—	—	—	—	—	—	—
Mar-2011	10	7	500	—	—	—	—	—	—	—
Sep-2011	22	10	10	—	—	—	—	—	—	—
Apr-2012	20	10	10	—	—	—	—	—	—	—
Sep-2012	16	7	9	—	—	—	—	—	—	—
Apr-2013	14	8	11	—	—	—	—	—	—	—
Sep-2013	6	28	5	—	—	—	—	—	—	—
Mar-2014	16	13	20	—	—	—	—	—	—	—
Oct-2014	21	6	6	—	—	—	—	—	—	—
Mar-2015	5	1	10	—	—	—	—	—	—	—
Sep-2015	3	1	8	—	—	—	—	—	—	—
Mar-2016	11	21	13	—	—	—	—	—	—	—
Sep-2016	3	1	2	—	—	—	—	—	—	—
Apr-2017	2.7	100	100	—	—	—	—	—	—	—
Sep-2017	6	8	4	—	—	—	—	—	—	—
Mar-2018	21	16	12	—	—	—	—	—	—	—
Sep-2018	18	46	24	—	—	—	—	—	—	—
Jun-2019	20	25	25	—	—	—	—	—	—	—
Dec-2019	11	13	56	—	—	—	—	—	—	—
May-2020	—	—	—	24	54	120	12	2	120	320
Jun-2020	7	19	16	110	160	350	54	16	31	64
Jul-2020	—	—	—	52	310	240	17	7	61	53
Aug-2020	—	—	—	62	110	50	43	6	62	81
Aug-2020	—	—	—	31	27	21	5	5	23	180
Sep-2020	—	—	—	17	39	410	2	0.5	12	32
Sep-2020	—	—	—	6	20	140	5	30	46	150
Oct-2020	—	—	—	150	64	420	12	2	24	180
Median	10.5	10.0	10.0	41.5	59.0	190.0	12.0	5.5	38.5	115.5
Mean	18.4	44.1	55.3	56.5	98.0	218.9	18.8	8.6	47.4	132.5
Min	2.0	1.0	2.0	6.0	20.0	21.0	2.0	0.5	12.0	32.0
Max	120.0	540.0	500.0	150.0	310.0	420.0	54.0	30.0	120.0	320.0
80th percentile	20.2	34.8	31.2	90.8	140.0	386.0	32.6	12.4	61.6	180.0
20th percentile	4.0	5.8	7.8	19.8	31.8	78.0	5.0	2.0	23.4	57.4

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Fe**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	0.06	0.06	—	—	—	—	—	—	—	—
Jan-2002	0.07	—	—	—	—	—	—	—	—	—
Apr-2002	0.11	0.01	—	—	—	—	—	—	—	—
Jul-2002	0.06	0.02	—	—	—	—	—	—	—	—
Oct-2002	0.29	0.12	—	—	—	—	—	—	—	—
Jan-2003	0.01	0.14	—	—	—	—	—	—	—	—
Apr-2003	0.01	0.01	—	—	—	—	—	—	—	—
Jul-2003	0.01	0.01	—	—	—	—	—	—	—	—
Oct-2003	0.01	0.01	—	—	—	—	—	—	—	—
Feb-2004	0.02	0.01	—	—	—	—	—	—	—	—
Apr-2004	0.01	—	—	—	—	—	—	—	—	—
Jul-2004	0.01	0.01	—	—	—	—	—	—	—	—
Oct-2004	0.01	0.01	—	—	—	—	—	—	—	—
Jan-2005	0.01	0.01	—	—	—	—	—	—	—	—
Apr-2005	0.01	0.01	—	—	—	—	—	—	—	—
Jul-2005	0.05	0.05	—	—	—	—	—	—	—	—
Oct-2005	0.05	0.05	—	—	—	—	—	—	—	—
Jan-2006	0.05	0.05	—	—	—	—	—	—	—	—
Apr-2006	0.05	0.05	—	—	—	—	—	—	—	—
Jul-2006	0.05	—	—	—	—	—	—	—	—	—
Nov-2006	0.05	0.05	—	—	—	—	—	—	—	—
Mar-2007	0.05	0.05	—	—	—	—	—	—	—	—
May-2007	0.01	0.01	0.01	—	—	—	—	—	—	—
Sep-2007	0.29	0.30	0.31	—	—	—	—	—	—	—
Jan-2008	0.42	0.43	0.45	—	—	—	—	—	—	—
Apr-2008	0.32	0.32	0.32	—	—	—	—	—	—	—
Jul-2008	0.52	0.54	0.53	—	—	—	—	—	—	—
Oct-2008	0.54	0.56	0.54	—	—	—	—	—	—	—
Dec-2008	0.01	0.02	0.01	—	—	—	—	—	—	—
Jun-2009	0.16	0.15	0.16	—	—	—	—	—	—	—
Sep-2009	0.15	0.17	0.14	—	—	—	—	—	—	—
Mar-2010	0.01	0.01	0.01	—	—	—	—	—	—	—
Sep-2010	0.05	0.05	0.05	—	—	—	—	—	—	—
Mar-2011	0.05	0.05	0.05	—	—	—	—	—	—	—
Sep-2011	0.05	0.05	0.06	—	—	—	—	—	—	—
Apr-2012	0.01	0.11	0.01	—	—	—	—	—	—	—
Sep-2012	0.06	0.05	0.05	—	—	—	—	—	—	—
Apr-2013	0.32	0.32	0.31	—	—	—	—	—	—	—
Sep-2013	0.05	0.05	0.05	—	—	—	—	—	—	—
Mar-2014	0.05	0.05	0.05	—	—	—	—	—	—	—
Oct-2014	0.05	0.05	0.05	—	—	—	—	—	—	—
Mar-2015	0.05	0.05	0.05	—	—	—	—	—	—	—
Sep-2015	0.05	0.05	0.05	—	—	—	—	—	—	—
Mar-2016	0.05	0.05	0.05	—	—	—	—	—	—	—
Sep-2016	0.01	0.01	0.01	—	—	—	—	—	—	—
Apr-2017	0.07	0.076	0.074	—	—	—	—	—	—	—
Sep-2017	0.011	0.005	0.005	—	—	—	—	—	—	—
Mar-2018	0.005	0.005	0.005	—	—	—	—	—	—	—
Sep-2018	0.002	0.003	0.002	—	—	—	—	—	—	—
Jun-2019	0.002	0.002	0.002	—	—	—	—	—	—	—
Dec-2019	0.025	0.025	0.025	—	—	—	—	—	—	—
Mar-2020	—	—	—	—	—	—	—	—	—	—
May-2020	—	—	—	0.025	0.025	0.57	0.14	0.025	0.025	0.4
Jun-2020	0.148	0.124	0.115	0.025	0.17	0.11	0.07	0.025	0.14	0.29
Jul-2020	—	—	—	0.025	0.025	0.44	0.11	0.025	0.06	0.32
Aug-2020	—	—	—	0.025	0.025	0.37	0.12	0.025	0.15	0.13
Aug-2020	—	—	—	0.025	0.025	0.36	0.07	0.025	0.025	0.05
Sep-2020	—	—	—	0.06	0.025	0.87	0.08	0.025	0.09	0.1
Sep-2020	—	—	—	0.11	0.12	0.52	0.06	0.15	0.42	1.2
Sep-2020	—	—	—	0.025	0.025	0.85	0.05	0.025	0.08	0.025
Oct-2020	—	—	—	0.025	0.025	0.57	0.18	0.025	0.09	0.06
Median	0.050	0.050	0.050	0.025	0.025	0.520	0.080	0.025	0.090	0.130
Mean	0.089	0.091	0.118	0.038	0.052	0.518	0.098	0.039	0.120	0.286
Min	0.002	0.002	0.002	0.025	0.025	0.110	0.050	0.025	0.025	0.025
Max	0.540	0.560	0.540	0.110	0.170	0.870	0.180	0.150	0.420	1.200
80th percentile	0.118	0.122	0.190	0.039	0.063	0.682	0.128	0.025	0.144	0.352
20th percentile	0.010	0.010	0.010	0.025	0.025	0.366	0.066	0.025	0.046	0.056

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**SO4**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	127	128	—	—	—	—	—	—	—	—
Jan-2002	—	—	—	—	—	—	—	—	—	—
Apr-2002	—	—	—	—	—	—	—	—	—	—
Jul-2002			—	—	—	—	—	—	—	—
Oct-2002	—	—	—	—	—	—	—	—	—	—
Jan-2003	—	—	—	—	—	—	—	—	—	—
Apr-2003	—	—	—	—	—	—	—	—	—	—
Jul-2003	—	—	—	—	—	—	—	—	—	—
Oct-2003	—	—	—	—	—	—	—	—	—	—
Feb-2004	94	94	—	—	—	—	—	—	—	—
Apr-2004	—	—	—	—	—	—	—	—	—	—
Jul-2004	117	119	—	—	—	—	—	—	—	—
Oct-2004	139	139	—	—	—	—	—	—	—	—
Jan-2005	131	121	—	—	—	—	—	—	—	—
Apr-2005	139	140	—	—	—	—	—	—	—	—
Jul-2005	129	118	—	—	—	—	—	—	—	—
Oct-2005	129	129	—	—	—	—	—	—	—	—
Jan-2006	88	73	—	—	—	—	—	—	—	—
Apr-2006	114	117	—	—	—	—	—	—	—	—
Jul-2006	120	—	—	—	—	—	—	—	—	—
Nov-2006	132	128	—	—	—	—	—	—	—	—
Mar-2007	78	78	—	—	—	—	—	—	—	—
May-2007	106	102	102	—	—	—	—	—	—	—
Sep-2007	160	160	170	—	—	—	—	—	—	—
Jan-2008	110	110	110	—	—	—	—	—	—	—
Apr-2008	150	140	140	—	—	—	—	—	—	—
Jul-2008	210	220	210	—	—	—	—	—	—	—
Oct-2008	180	180	180	—	—	—	—	—	—	—
Dec-2008	148	182	140	—	—	—	—	—	—	—
Jun-2009	145	161	150	—	—	—	—	—	—	—
Sep-2009	133	145	140	—	—	—	—	—	—	—
Mar-2010	84	79	84	—	—	—	—	—	—	—
Sep-2010	148	140	138	—	—	—	—	—	—	—
Mar-2011	125	125	126	—	—	—	—	—	—	—
Sep-2011	143	141	140	—	—	—	—	—	—	—
Apr-2012	130	130	130	—	—	—	—	—	—	—
Sep-2012	154	128	128	—	—	—	—	—	—	—
Apr-2013	126	125	124	—	—	—	—	—	—	—
Sep-2013	135	135	135	—	—	—	—	—	—	—
Mar-2014	116	119	116	—	—	—	—	—	—	—
Oct-2014	207	218	225	—	—	—	—	—	—	—
Mar-2015	123	122	124	—	—	—	—	—	—	—
Sep-2015	147	148	149	—	—	—	—	—	—	—
Mar-2016	127	129	126	—	—	—	—	—	—	—
Sep-2016	139	145	147	—	—	—	—	—	—	—
Apr-2017	103	104	104	—	—	—	—	—	—	—
Sep-2017	129	126	128	—	—	—	—	—	—	—
Mar-2018	104	105	111	—	—	—	—	—	—	—
Sep-2018	151	148	149	—	—	—	—	—	—	—
Jun-2019	158	161	158	—	—	—	—	—	—	—
Dec-2019	159	145	145	—	—	—	—	—	—	—
May-2020	—	—	—	99	98	113	103	141	100	96
Jun-2020	143	142	144	146	144	119	141	143	146	205
Jul-2020	—	—	—	136	151	160	202	149	212	218
Aug-2020	—	—	—	152	149	109	239	163	175	186
Aug-2020	—	—	—	95	96	169	205	152	116	173
Sep-2020	—	—	—	96	100	236	183	143	136	204
Sep-2020	—	—	—	93	94	197	104	132	125	124
Oct-2020	—	—	—	108	110	326	154	134	164	220
Median	131	129	139	104	105	165	169	143	141	195
Mean	133	133	139	116	118	179	166	145	147	178
Min	78	73	84	93	94	109	103	132	100	96
Max	210	220	225	152	151	326	239	163	212	220
80th percentile	149	147	149	142	147	220	204	151	171	213
20th percentile	115	117	122	95	97	115	119	137	120	144

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**K**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Sampling Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	19.0	19.0	—	—	—	—	—	—	—	—
Jan-2002	—	—	—	—	—	—	—	—	—	—
Apr-2002	—	—	—	—	—	—	—	—	—	—
Jul-2002	—	—	—	—	—	—	—	—	—	—
Oct-2002	—	—	—	—	—	—	—	—	—	—
Jan-2003	—	—	—	—	—	—	—	—	—	—
Apr-2003	—	—	—	—	—	—	—	—	—	—
Jul-2003	12.0	12.0	—	—	—	—	—	—	—	—
Oct-2003	—	—	—	—	—	—	—	—	—	—
Feb-2004	—	—	—	—	—	—	—	—	—	—
Apr-2004	—	—	—	—	—	—	—	—	—	—
Jul-2004	14.0	14.0	—	—	—	—	—	—	—	—
Oct-2004	19.0	15.0	—	—	—	—	—	—	—	—
Jan-2005	16.0	16.0	—	—	—	—	—	—	—	—
Apr-2005	16.0	16.0	—	—	—	—	—	—	—	—
Jul-2005	16.0	16.0	—	—	—	—	—	—	—	—
Oct-2005	15.0	15.0	—	—	—	—	—	—	—	—
Jan-2006	16.0	16.0	—	—	—	—	—	—	—	—
Apr-2006	16.0	17.0	—	—	—	—	—	—	—	—
Jul-2006	17.0	—	—	—	—	—	—	—	—	—
Nov-2006	21.0	20.0	—	—	—	—	—	—	—	—
Mar-2007	27.0	26.0	—	—	—	—	—	—	—	—
May-2007	22.0	24.0	23.0	—	—	—	—	—	—	—
Sep-2007	24.0	24.0	23.0	—	—	—	—	—	—	—
Jan-2008	14.0	15.0	15.0	—	—	—	—	—	—	—
Apr-2008	21.0	22.0	22.0	—	—	—	—	—	—	—
Jul-2008	19.0	19.0	21.0	—	—	—	—	—	—	—
Oct-2008	19.0	22.0	20.0	—	—	—	—	—	—	—
Dec-2008	18.0	26.0	18.0	—	—	—	—	—	—	—
Jun-2009	21.0	21.0	21.0	—	—	—	—	—	—	—
Sep-2009	21.0	21.0	20.0	—	—	—	—	—	—	—
Mar-2010	15.0	15.0	16.0	—	—	—	—	—	—	—
Sep-2010	21.0	21.0	21.0	—	—	—	—	—	—	—
Mar-2011	27.0	19.0	19.0	—	—	—	—	—	—	—
Sep-2011	18.0	17.0	17.0	—	—	—	—	—	—	—
Apr-2012	21.0	21.0	21.0	—	—	—	—	—	—	—
Sep-2012	16.0	16.0	16.0	—	—	—	—	—	—	—
Apr-2013	14.0	14.0	14.0	—	—	—	—	—	—	—
Sep-2013	15.0	15.0	15.0	—	—	—	—	—	—	—
Mar-2014	17.0	17.0	17.0	—	—	—	—	—	—	—
Oct-2014	17.0	16.0	16.0	—	—	—	—	—	—	—
Mar-2015	16.0	16.0	16.0	—	—	—	—	—	—	—
Sep-2015	16.0	16.0	16.0	—	—	—	—	—	—	—
Mar-2016	16.0	16.0	16.0	—	—	—	—	—	—	—
Sep-2016	18.0	19.0	19.0	—	—	—	—	—	—	—
Apr-2017	13.0	13.0	13.0	—	—	—	—	—	—	—
Sep-2017	15.0	16.0	15.0	—	—	—	—	—	—	—
Mar-2018	18.0	17.0	18.0	—	—	—	—	—	—	—
Sep-2018	17.0	17.0	17.0	—	—	—	—	—	—	—
Jun-2019	18.0	18.0	18.0	—	—	—	—	—	—	—
Dec-2019	19.0	20.0	21.0	—	—	—	—	—	—	—
May-2020	—	—	—	300.0	303.0	4.0	272.0	17.0	259.0	303.0
Jun-2020	17.0	18.0	19.0	147.0	146.0	7.0	204.0	18.0	89.0	33.0
Jul-2020	—	—	—	249.0	237.0	7.0	188.0	18.0	113.0	91.0
Aug-2020	—	—	—	141.0	143.0	5.0	130.0	18.0	66.0	25.0
Aug-2020	—	—	—	331.0	314.0	7.0	162.0	18.0	183.0	63.0
Sep-2020	—	—	—	321.0	326.0	9.0	221.0	18.0	134.0	38.0
Sep-2020	—	—	—	312.0	323.0	7.0	268.0	19.0	228.0	272.0
Oct-2020	—	—	—	331.0	331.0	13.0	297.0	19.0	237.0	60.0
Median	17	17	18	306	309	7	213	18	159	62
Mean	18	18	18	267	265	7	218	18	164	111
Min	13	13	13	141	143	4	130	17	66	25
Max	27	26	23	331	331	13	297	19	259	303
80th percentile	21	21	21	327	325	8	270	19	233	200
20th percentile	16	16	16	188	182	6	172	18	99	35

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Mg**	D	Destroyed
Units:	**mg/L**	–	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	**SW1**	**SW2**	**SW3**	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**
Oct-2001	60.0	60.0	–	–	–	–	–	–	–	–
Jan-2002	–	–	–	–	–	–	–	–	–	–
Apr-2002	–	–	–	–	–	–	–	–	–	–
Jul-2002	–	–	–	–	–	–	–	–	–	–
Oct-2002	–	–	–	–	–	–	–	–	–	–
Jan-2003	–	–	–	–	–	–	–	–	–	–
Apr-2003	–	–	–	–	–	–	–	–	–	–
Jul-2003	40.0	40.0	–	–	–	–	–	–	–	–
Oct-2003	–	–	–	–	–	–	–	–	–	–
Feb-2004	–	–	–	–	–	–	–	–	–	–
Apr-2004	–	–	–	–	–	–	–	–	–	–
Jul-2004	46.0	47.0	–	–	–	–	–	–	–	–
Oct-2004	52.0	53.0	–	–	–	–	–	–	–	–
Jan-2005	47.0	52.0	–	–	–	–	–	–	–	–
Apr-2005	50.0	51.0	–	–	–	–	–	–	–	–
Jul-2005	48.0	48.0	–	–	–	–	–	–	–	–
Oct-2005	53.0	53.0	–	–	–	–	–	–	–	–
Jan-2006	51.0	50.0	–	–	–	–	–	–	–	–
Apr-2006	50.0	50.0	–	–	–	–	–	–	–	–
Jul-2006	57.0	–	–	–	–	–	–	–	–	–
Nov-2006	65.0	64.0	–	–	–	–	–	–	–	–
Mar-2007	65.0	70.0	–	–	–	–	–	–	–	–
May-2007	74.0	70.0	70.0	–	–	–	–	–	–	–
Sep-2007	62.0	78.0	72.0	–	–	–	–	–	–	–
Jan-2008	47.0	48.0	50.0	–	–	–	–	–	–	–
Apr-2008	70.0	80.0	78.0	–	–	–	–	–	–	–
Jul-2008	77.0	74.0	78.0	–	–	–	–	–	–	–
Oct-2008	70.0	70.0	70.0	–	–	–	–	–	–	–
Dec-2008	64.2	90.4	76.3	–	–	–	–	–	–	–
Jun-2009	63.0	62.0	64.0	–	–	–	–	–	–	–
Sep-2009	67.0	67.0	66.0	–	–	–	–	–	–	–
Mar-2010	55.0	54.0	54.0	–	–	–	–	–	–	–
Sep-2010	71.0	70.0	70.0	–	–	–	–	–	–	–
Mar-2011	57.0	57.0	58.0	–	–	–	–	–	–	–
Sep-2011	59.0	59.0	60.0	–	–	–	–	–	–	–
Apr-2012	58.0	58.0	56.0	–	–	–	–	–	–	–
Sep-2012	56.0	58.0	56.0	–	–	–	–	–	–	–
Apr-2013	47.0	46.0	45.0	–	–	–	–	–	–	–
Sep-2013	44.0	44.0	43.0	–	–	–	–	–	–	–
Mar-2014	54.0	53.0	53.0	–	–	–	–	–	–	–
Oct-2014	57.0	58.0	58.0	–	–	–	–	–	–	–
Mar-2015	53.0	52.0	51.0	–	–	–	–	–	–	–
Sep-2015	49.0	49.0	50.0	–	–	–	–	–	–	–
Mar-2016	56.0	57.0	56.0	–	–	–	–	–	–	–
Sep-2016	50.0	51.0	52.0	–	–	–	–	–	–	–
Apr-2017	35.0	35.0	35.0	–	–	–	–	–	–	–
Sep-2017	43.0	44.0	43.0	–	–	–	–	–	–	–
Mar-2018	50.0	49.0	49.0	–	–	–	–	–	–	–
Sep-2018	53.0	53.0	53.0	–	–	–	–	–	–	–
Jun-2019	62.0	62.0	63.0	–	–	–	–	–	–	–
Dec-2019	63.0	64.0	64.0	–	–	–	–	–	–	–
May-2020	–	–	–	1010.0	990.0	14.0	917.0	59.0	855.0	1060.0
Jun-2020	60.0	63.0	63.0	464.0	462.0	23.0	656.0	60.0	267.0	93.0
Jul-2020	–	–	–	823.0	756.0	28.0	545.0	63.0	363.0	284.0
Aug-2020	–	–	–	451.0	451.0	19.0	396.0	62.0	220.0	81.0
Aug-2020	–	–	–	1060.0	979.0	25.0	506.0	58.0	566.0	198.0
Sep-2020	–	–	–	1060.0	1070.0	31.0	721.0	60.0	400.0	122.0
Sep-2020	–	–	–	1010.0	1040.0	27.0	868.0	62.0	734.0	888.0
Oct-2020	–	–	–	1050.0	1080.0	42.0	964.0	65.0	785.0	184.0
Median	56.0	55.5	57.0	1010.0	984.5	26.0	688.5	61.0	483.0	191.0
Mean	56.3	57.8	58.5	866.0	853.5	26.1	696.6	61.1	523.8	363.8
Min	35.0	35.0	35.0	451.0	451.0	14.0	396.0	58.0	220.0	81.0
Max	77.0	90.4	78.0	1060.0	1080.0	42.0	964.0	65.0	855.0	1060.0
80th percentile	64.2	67.6	70.0	1056.0	1058.0	29.8	897.4	62.6	764.6	646.4
20th percentile	49.0	49.0	50.0	607.6	579.6	20.6	521.6	59.4	305.4	104.6

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Na**	D	Destroyed
Units:	**mg/L**	—	Not monitored or inaccessible
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	362	358	—	—	—	—	—	—	—	—
Jan-2002	—	—	—	—	—	—	—	—	—	—
Apr-2002	—	—	—	—	—	—	—	—	—	—
Jul-2002	—	—	—	—	—	—	—	—	—	—
Oct-2002	—	—	—	—	—	—	—	—	—	—
Jan-2003	—	—	—	—	—	—	—	—	—	—
Apr-2003	—	—	—	—	—	—	—	—	—	—
Jul-2003	225	203	—	—	—	—	—	—	—	—
Oct-2003	—	—	—	—	—	—	—	—	—	—
Feb-2004	—	—	—	—	—	—	—	—	—	—
Apr-2004	—	—	—	—	—	—	—	—	—	—
Jul-2004	254	260	—	—	—	—	—	—	—	—
Oct-2004	281	281	—	—	—	—	—	—	—	—
Jan-2005	252	300	—	—	—	—	—	—	—	—
Apr-2005	298	302	—	—	—	—	—	—	—	—
Jul-2005	280	284	—	—	—	—	—	—	—	—
Oct-2005	311	312	—	—	—	—	—	—	—	—
Jan-2006	298	299	—	—	—	—	—	—	—	—
Apr-2006	274	275	—	—	—	—	—	—	—	—
Jul-2006	337	—	—	—	—	—	—	—	—	—
Nov-2006	400	375	—	—	—	—	—	—	—	—
Mar-2007	378	216	—	—	—	—	—	—	—	—
May-2007	410	430	411	—	—	—	—	—	—	—
Sep-2007	500	510	530	—	—	—	—	—	—	—
Jan-2008	310	290	320	—	—	—	—	—	—	—
Apr-2008	410	420	420	—	—	—	—	—	—	—
Jul-2008	420	400	410	—	—	—	—	—	—	—
Oct-2008	400	430	390	—	—	—	—	—	—	—
Dec-2008	382	492	433	—	—	—	—	—	—	—
Jun-2009	368	371	377	—	—	—	—	—	—	—
Sep-2009	416	417	403	—	—	—	—	—	—	—
Mar-2010	320	320	316	—	—	—	—	—	—	—
Sep-2010	412	413	410	—	—	—	—	—	—	—
Mar-2011	565	328	329	—	—	—	—	—	—	—
Sep-2011	352	351	351	—	—	—	—	—	—	—
Apr-2012	308	313	291	—	—	—	—	—	—	—
Sep-2012	310	318	309	—	—	—	—	—	—	—
Apr-2013	258	251	249	—	—	—	—	—	—	—
Sep-2013	264	260	257	—	—	—	—	—	—	—
Mar-2014	320	320	316	—	—	—	—	—	—	—
Oct-2014	333	336	337	—	—	—	—	—	—	—
Mar-2015	302	295	289	—	—	—	—	—	—	—
Sep-2015	298	298	297	—	—	—	—	—	—	—
Mar-2016	328	333	330	—	—	—	—	—	—	—
Sep-2016	300	310	310	—	—	—	—	—	—	—
Apr-2017	220	220	220	—	—	—	—	—	—	—
Sep-2017	240	250	240	—	—	—	—	—	—	—
Mar-2018	290	280	290	—	—	—	—	—	—	—
Sep-2018	343	341	345	—	—	—	—	—	—	—
Jun-2019	375	372	374	—	—	—	—	—	—	—
Dec-2019	397	404	404	—	—	—	—	—	—	—
May-2020	—	—	—	7850	7740	70	7730	364	6690	8770
Jun-2020	370	394	393	3790	3790	114	5530	372	2170	731
Jul-2020	—	—	—	6800	6230	122	4560	364	2740	2190
Aug-2020	—	—	—	3730	3780	93	3420	389	1730	600
Aug-2020	—	—	—	9150	8400	130	4420	381	5040	1710
Sep-2020	—	—	—	8860	9120	160	5990	386	3480	961
Sep-2020	—	—	—	8480	8780	127	7180	404	6190	7390
Oct-2020	—	—	—	8560	8660	190	7710	412	6310	1520
Median	320	319	334	8165	8070	125	5760	384	4260	1615
Mean	339	334	345	7153	7063	126	5818	384	4294	2984
Min	220	216	220	3730	3780	70	3420	364	1730	600
Max	565	510	530	9150	9120	190	7730	412	6690	8770
80th percentile	400	401	405	8740	8732	148	7498	398	6262	5310
20th percentile	281	281	291	4994	4766	101	4476	367	2398	823

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**NH3**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
May-2007	0.05	0.05	0.05	—	—	—	—	—	—	—
Sep-2007	0.026	0.037	0.028	—	—	—	—	—	—	—
Jan-2008	0.050	0.072	0.068	—	—	—	—	—	—	—
Apr-2008	0.021	0.011	0.019	—	—	—	—	—	—	—
Jul-2008	0.300	0.230	0.280	—	—	—	—	—	—	—
Oct-2008	0.024	0.064	0.031	—	—	—	—	—	—	—
Dec-2008	0.050	0.460	0.080	—	—	—	—	—	—	—
Jun-2009	0.060	0.050	0.160	—	—	—	—	—	—	—
Sep-2009	0.010	0.010	0.010	—	—	—	—	—	—	—
Mar-2010	0.050	0.050	0.050	—	—	—	—	—	—	—
Sep-2010	0.010	0.010	0.010	—	—	—	—	—	—	—
Mar-2011	0.010	0.010	0.010	—	—	—	—	—	—	—
Sep-2011	0.05	0.14	0.07	—	—	—	—	—	—	—
Apr-2012	0.02	0.02	0.02	—	—	—	—	—	—	—
Sep-2012	0.05	0.04	0.06	—	—	—	—	—	—	—
Apr-2013	0.03	0.03	0.03	—	—	—	—	—	—	—
Sep-2013	0.03	0.04	0.03	—	—	—	—	—	—	—
Mar-2014	0.04	0.01	0.06	—	—	—	—	—	—	—
Oct-2014	0.04	0.04	0.03	—	—	—	—	—	—	—
Mar-2015	0.05	0.04	0.03	—	—	—	—	—	—	—
Sep-2015	0.04	0.02	0.05	—	—	—	—	—	—	—
Mar-2016	0.05	0.06	0.05	—	—	—	—	—	—	—
Sep-2016	0.01	0.012	0.013	—	—	—	—	—	—	—
Apr-2017	0.14	0.11	0.19	—	—	—	—	—	—	—
Sep-2017	0.036	0.029	0.039	—	—	—	—	—	—	—
Mar-2018	0.034	0.033	0.04	—	—	—	—	—	—	—
Sep-2018	0.02	0.01	0.03	—	—	—	—	—	—	—
Jun-2019	0.12	0.1	0.12	—	—	—	—	—	—	—
Dec-2019	0.005	0.005	0.005	—	—	—	—	—	—	—
Mar-2020	—	—	—	0.12	0.12	0.05	0.13	0.01	0.12	0.05
May-2020	—	—	—	0.08	0.08	0.03	0.23	0.06	0.04	0.29
Jun-2020	0.02	0.005	0.02	0.24	0.23	0.11	0.32	0.005	0.23	0.25
Jul-2020	—	—	—	0.09	0.12	0.06	0.03	0.005	0.07	0.18
Aug-2020	—	—	—	0.14	0.15	0.03	0.03	0.01	0.05	0.18
Aug-2020	—	—	—	0.05	0.05	0.02	0.005	0.005	0.005	0.13
Sep-2020	—	—	—	0.14	0.16	0.03	0.02	0.005	0.03	0.16
Sep-2020	—	—	—	0.14	0.18	0.1	0.04	0.01	0.06	0.11
Sep-2020	—	—	—	0.08	0.09	0.03	0.04	0.005	0.02	0.09
Oct-2020	—	—	—	0.12	0.14	0.39	0.14	0.02	0.04	0.29
Median	0.038	0.039	0.035	0.120	0.130	0.040	0.040	0.008	0.045	0.170
Mean	0.048	0.060	0.056	0.120	0.132	0.085	0.099	0.014	0.067	0.173
Min	0.005	0.005	0.005	0.050	0.050	0.020	0.005	0.005	0.005	0.050
Max	0.300	0.460	0.280	0.240	0.230	0.390	0.320	0.060	0.230	0.290
80th percentile	0.050	0.066	0.068	0.140	0.164	0.102	0.158	0.012	0.080	0.258
20th percentile	0.020	0.010	0.020	0.080	0.088	0.030	0.028	0.005	0.028	0.106

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**pH**		
Units:	**n/a**	–	Not monitored or inaccessible
Data Collected by:	**G+S**		

	Surface water									
Sampling Date	**SW1**	**SW2**	**SW3**	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**
Oct-2001	8.04	8.09	–	–	–	–	–	–	–	–
Jan-2002	7.03	–	–	–	–	–	–	–	–	–
Apr-2002	7.32	7.47	–	–	–	–	–	–	–	–
Jul-2002	7.51	7.38	–	–	–	–	–	–	–	–
Oct-2002	7.45	7.44	–	–	–	–	–	–	–	–
Jan-2003	7.34	7.74	–	–	–	–	–	–	–	–
Apr-2003	8.05	8.04	–	–	–	–	–	–	–	–
Jul-2003	7.62	8.27	–	–	–	–	–	–	–	–
Oct-2003	8.15	8.44	–	–	–	–	–	–	–	–
Feb-2004	7.73	7.81	–	–	–	–	–	–	–	–
Apr-2004	7.56	–	–	–	–	–	–	–	–	–
Jul-2004	6.36	–	–	–	–	–	–	–	–	–
Oct-2004	–	–	–	–	–	–	–	–	–	–
Jan-2005	7.81	–	–	–	–	–	–	–	–	–
Apr-2005	8.27	8.49	–	–	–	–	–	–	–	–
Jul-2005	8.22	6.92	–	–	–	–	–	–	–	–
Oct-2005	6.89	7.83	–	–	–	–	–	–	–	–
Dec-2005	–	–	–	–	–	–	–	–	–	–
Jan-2006	8.4	8.41	–	–	–	–	–	–	–	–
Apr-2006	7.72	7.81	–	–	–	–	–	–	–	–
Jul-2006	8.72	–	–	–	–	–	–	–	–	–
Nov-2006	7.59	7.53	–	–	–	–	–	–	–	–
Mar-2007	7.93	6.98	–	–	–	–	–	–	–	–
May-2007	7.28	7.2	6.64	–	–	–	–	–	–	–
Sep-2007	8.02	8.38	8.53	–	–	–	–	–	–	–
Jan-2008	8.44	8.37	8.3	–	–	–	–	–	–	–
Apr-2008	7.82	7.51	8.43	–	–	–	–	–	–	–
Jul-2008	6.75	7.13	7.8	–	–	–	–	–	–	–
Oct-2008	8.36	8.12	8.53	–	–	–	–	–	–	–
Dec-2008	9.12	8.31	8.7	–	–	–	–	–	–	–
Jun-2009	9.15	7.74	9.85	–	–	–	–	–	–	–
Sep-2009	9.49	8.37	8.56	–	–	–	–	–	–	–
Mar-2010	8.1	8.33	7.14	–	–	–	–	–	–	–
Sep-2010	8.63	8.62	8.62	–	–	–	–	–	–	–
Mar-2011	8.3	8.07	8.26	–	–	–	–	–	–	–
Sep-2011	8.56	8.59	8.56	–	–	–	–	–	–	–
Apr-2012	8.53	8.5	8.46	–	–	–	–	–	–	–
Sep-2012	8.47	8.46	8.51	–	–	–	–	–	–	–
Apr-2013	8.46	8.43	8.39	–	–	–	–	–	–	–
Sep-2013	7.88	6.59	8.26	–	–	–	–	–	–	–
Mar-2014	8.78	8.31	7.93	–	–	–	–	–	–	–
Oct-2014	8.45	8.58	8.52	–	–	–	–	–	–	–
Mar-2015	8.44	8.40	8.36	–	–	–	–	–	–	–
Sep-2015	8.34	8.35	8.35	–	–	–	–	–	–	–
Mar-2016	8.4	8.39	8.41	–	–	–	–	–	–	–
Sep-2016	8.6	8.57	8.57	–	–	–	–	–	–	–
Apr-2017	8.66	8.31	8.28	–	–	–	–	–	–	–
Sep-2017	8.41	8.4	8.41	–	–	–	–	–	–	–
Mar-2018	8.69	8.7	8.69	–	–	–	–	–	–	–
Sep-2018	8.52	8.59	8.59	–	–	–	–	–	–	–
Jun-2019	7.94	7.84	7.41	–	–	–	–	–	–	–
Dec-2019	8.57	8.57	8.33	–	–	–	–	–	–	–
Mar-2020	–	–	–	7.29	7.16	7.14	6.8	8.04	7.17	7
May-2020	–	–	–	7.85	7.84	7.62	7.65	8.16	7.64	7.72
Jun-2020	8.56	8.67	8.66	7.81	7.77	7.68	7.49	8.26	7.79	7.87
Jul-2020	–	–	–	7.64	7.6	7.18	7.62	8.13	7.67	7.5
Aug-2020	–	–	–	7.74	7.75	7.42	7.73	8.28	7.87	7.79
Aug-2020	–	–	–	7.69	7.73	7.71	7.8	8.35	7.87	7.88
Sep-2020	–	–	–	7.76	7.73	7.89	8.08	8.5	7.92	8.08
Sep-2020	–	–	–	6.85	7.06	7.24	7.31	6.5	7.44	7.65
Sep-2020	–	–	–	7.83	7.79	7.86	8.05	8.57	7.89	7.79
Oct-2020	–	–	–	7.58	7.62	7.92	7.81	8.54	7.85	7.96
Median	**8.27**	**8.31**	**8.42**	**7.72**	**7.73**	**7.65**	**7.69**	**8.27**	**7.82**	**7.79**
Mean	**8.11**	**8.07**	**8.34**	**7.60**	**7.61**	**7.57**	**7.63**	**8.13**	**7.71**	**7.72**
Min	**6.36**	**6.59**	**6.64**	**6.85**	**7.06**	**7.14**	**6.80**	**6.50**	**7.17**	**7.00**
Max	**9.49**	**8.70**	**9.85**	**7.85**	**7.84**	**7.92**	**8.08**	**8.57**	**7.92**	**8.08**
80th percentile	**8.56**	**8.49**	**8.57**	**7.81**	**7.77**	**7.87**	**7.86**	**8.51**	**7.87**	**7.90**
20th percentile	**7.59**	**7.53**	**8.26**	**7.52**	**7.51**	**7.23**	**7.45**	**8.11**	**7.60**	**7.62**

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**SO4**	D	Destroyed
Units:	**mg/L**	–	Not monitored
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	380	379	–	–	–	–	–	–	–	–
Jan-2002	432	–	–	–	–	–	–	–	–	–
Apr-2002	387	390	–	–	–	–	–	–	–	–
Jul-2002	367	354	–	–	–	–	–	–	–	–
Oct-2002	321	321	–	–	–	–	–	–	–	–
Jan-2003	353	361	–	–	–	–	–	–	–	–
Apr-2003	354	348	–	–	–	–	–	–	–	–
Jul-2003	321	315	–	–	–	–	–	–	–	–
Oct-2003	348	351	–	–	–	–	–	–	–	–
Feb-2004	334	337	–	–	–	–	–	–	–	–
Apr-2004	349	–	–	–	–	–	–	–	–	–
Jul-2004	331	339	–	–	–	–	–	–	–	–
Oct-2004	362	377	–	–	–	–	–	–	–	–
Jan-2005	329	270	–	–	–	–	–	–	–	–
Apr-2005	332	334	–	–	–	–	–	–	–	–
Jul-2005	306	312	–	–	–	–	–	–	–	–
Oct-2005	347	343	–	–	–	–	–	–	–	–
Jan-2006	294	292	–	–	–	–	–	–	–	–
Apr-2006	275	271	–	–	–	–	–	–	–	–
Jul-2006	275	–	–	–	–	–	–	–	–	–
Nov-2006	300	288	–	–	–	–	–	–	–	–
Mar-2007	–	–	–	–	–	–	–	–	–	–
May-2007	305	305	306	–	–	–	–	–	–	–
Sep-2007	330	320	320	–	–	–	–	–	–	–
Jan-2008	200	210	220	–	–	–	–	–	–	–
Apr-2008	240	250	240	–	–	–	–	–	–	–
Jul-2008	280	290	280	–	–	–	–	–	–	–
Oct-2008	310	340	300	–	–	–	–	–	–	–
Dec-2008	279	357	297	–	–	–	–	–	–	–
Jun-2009	248	249	254	–	–	–	–	–	–	–
Sep-2009	267	269	265	–	–	–	–	–	–	–
Mar-2010	217	215	216	–	–	–	–	–	–	–
Sep-2010	307	301	298	–	–	–	–	–	–	–
Mar-2011	565	328	329	–	–	–	–	–	–	–
Sep-2011	246	244	248	–	–	–	–	–	–	–
Apr-2012	213	203	210	–	–	–	–	–	–	–
Sep-2012	184	184	182	–	–	–	–	–	–	–
Apr-2013	172	169	168	–	–	–	–	–	–	–
Sep-2013	150	147	146	–	–	–	–	–	–	–
Mar-2014	177	174	174	–	–	–	–	–	–	–
Oct-2014	204	204	205	–	–	–	–	–	–	–
Mar-2015	191	186	185	–	–	–	–	–	–	–
Sep-2015	198	197	221	–	–	–	–	–	–	–
Mar-2016	196	198	197	–	–	–	–	–	–	–
Sep-2016	213	219	219	–	–	–	–	–	–	–
Apr-2017	132	129	129	–	–	–	–	–	–	–
Sep-2017	159	162	159	–	–	–	–	–	–	–
Mar-2018	165	162	168	–	–	–	–	–	–	–
Sep-2018	151	151	152	–	–	–	–	–	–	–
Jun-2019	158	154	157	–	–	–	–	–	–	–
Dec-2019	171	172	172	–	–	–	–	–	–	–
May-2020	–	–	–	2280	2240	17	1930	169	1410	2100
Jun-2020	163	188	162	833	867	68	1290	167	551	190
Jul-2020	–	–	–	1650	1540	86	1170	164	763	610
Aug-2020	–	–	–	937	929	61	793	167	556	155
Aug-2020	–	–	–	1910	1970	87	1170	166	1270	427
Sep-2020	–	–	–	2110	2100	69	1370	171	794	228
Sep-2020	–	–	–	2200	2150	74	1800	164	1580	1650
Oct-2020	–	–	–	2200	2210	55	1700	200	1400	346
Median	279	271	213	2010	2035	69	1330	167	1032	387
Mean	272	264	219	1765	1751	65	1403	171	1041	713
Min	132	129	129	833	867	17	793	164	551	155
Max	565	390	329	2280	2240	87	1930	200	1580	2100
80th percentile	347	340	283	2200	2186	81	1760	170	1406	1234
20th percentile	184	185	167	1222	1173	57	1170	165	639	205

Project	**TSP, Cudgen, NSW**	—	Not monitored
Parameter:	**EC**	D	Destroyed
Units:	**uS/cm**		
Data Collected by:	**G+S**		

	Surface water									
Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Oct-2001	18.6	17.8	—	—	—	—	—	—	—	—
Jan-2002	26.5	29.3	—	—	—	—	—	—	—	—
Apr-2002	28.9	—	—	—	—	—	—	—	—	—
Jul-2002	22.1	21.9	—	—	—	—	—	—	—	—
Oct-2002	26.0	25.6	—	—	—	—	—	—	—	—
Jan-2003	21.6	22.5	—	—	—	—	—	—	—	—
Apr-2003	21.7	22.0	—	—	—	—	—	—	—	—
Jul-2003	16.0	16.1	—	—	—	—	—	—	—	—
Oct-2003	25.9	23.0	—	—	—	—	—	—	—	—
Feb-2004	24.5	24.1	—	—	—	—	—	—	—	—
Apr-2004	19.4	—	—	—	—	—	—	—	—	—
Jul-2004	15.0	—	—	—	—	—	—	—	—	—
Oct-2004	—	24.2	—	—	—	—	—	—	—	—
Jan-2005	29.0	—	—	—	—	—	—	—	—	—
Apr-2005	24.6	24.9	—	—	—	—	—	—	—	—
Jul-2005	17.9	18.0	—	—	—	—	—	—	—	—
Oct-2005	22.3	22.6	—	—	—	—	—	—	—	—
Dec-2005	—	—	—	—	—	—	—	—	—	—
Jan-2006	32.4	31.8	—	—	—	—	—	—	—	—
Apr-2006	—	—	—	—	—	—	—	—	—	—
Jul-2006	—	—	—	—	—	—	—	—	—	—
Nov-2006	—	—	—	—	—	—	—	—	—	—
Mar-2007	—	—	—	—	—	—	—	—	—	—
May-2007	23.3	23.7	23.0	—	—	—	—	—	—	—
Sep-2007	19.7	20.4	20.6	—	—	—	—	—	—	—
Jan-2008	27.3	30.5	28.1	—	—	—	—	—	—	—
Apr-2008	26.0	28.2	28.0	—	—	—	—	—	—	—
Jul-2008	18.2	18.3		—	—	—	—	—	—	—
Oct-2008	27.2	29.3	26.1	—	—	—	—	—	—	—
Dec-2008	28.2	30.2	31.0	—	—	—	—	—	—	—
Jun-2009	14.3	15.9	13.8	—	—	—	—	—	—	—
Sep-2011	20.7	20.6	20.5	—	—	—	—	—	—	—
Apr-2012	23.6	22.7	22.8	—	—	—	—	—	—	—
Sep-2012	24.2	23.0	23.8	—	—	—	—	—	—	—
Apr-2013	23.6	23.6	23.6	—	—	—	—	—	—	—
Sep-2013	25.67	22.84	24.59	—	—	—	—	—	—	—
Mar-2014	27.84	26.91	26.96	—	—	—	—	—	—	—
Oct-2014	23.14	23.29	23.25	—	—	—	—	—	—	—
Mar-2015	26.60	28.75	27.10	—	—	—	—	—	—	—
Sep-2015	19.07	19.37	19.33	—	—	—	—	—	—	—
Mar-2016	25.62	25.9	25.90	—	—	—	—	—	—	—
Sep-2016	21.64	21.75	21.69	—	—	—	—	—	—	—
Apr-2017	23.16	23.01	22.95	—	—	—	—	—	—	—
Sep-2017	21.44	21.79	21.26	—	—	—	—	—	—	—
Mar-2018	26.80	27	26.90	—	—	—	—	—	—	—
Sep-2018	20.15	20.06	20.06	—	—	—	—	—	—	—
Jun-2019	18.60	18.56	18.33	—	—	—	—	—	—	—
Dec-2019	26.03	25.99	25.68	—	—	—	—	—	—	—
Mar-2020	—	—	—	24.51	23.97	22.5	21.94	24.87	21.96	21.47
May-2020	—	—	—	18.79	18.69	16.3	16.52	20.62	16.09	16.81
Jun-2020	18.94	18.84	18.75	20.67	17.66	18.21	20.19	19.12	19.62	17.14
Jul-2020	—	—	—	14.87	14.25	14.67	13.17	17.11	14.27	13.14
Aug-2020	—	—	—	16.41	16.87	15.8	20.12	17.41	17.46	17.09
Aug-2020	—	—	—	16.94	16.94	14.93	15.97	17.84	16.71	16.42
Sep-2020	—	—	—	20.26	19.68	19.01	19.79	20.9	19.95	19.92
Sep-2020	—	—	—	18.17	18.67	16.87	18.81	19.06	18.92	17.47
Sep-2020	—	—	—	23.6	25.08	22.48	28.3	22.5	23.39	25.22
Oct-2020	—	—	—	22.86	20.72	18.44	19.94	23.08	21.07	21.62
Median	23.3	23.0	23.3	19.5	18.7	17.5	19.9	19.9	19.3	17.3
Mean	23.1	23.4	23.4	19.7	19.3	17.9	19.5	20.3	18.9	18.6
Min	14.3	15.9	13.8	14.9	14.3	14.7	13.2	17.1	14.3	13.1
Max	32.4	31.8	31.0	24.5	25.1	22.5	28.3	24.9	23.4	25.2
80th percentile	26.6	26.9	26.9	23.0	21.4	19.7	20.5	22.6	21.2	21.5
20th percentile	19.2	19.9	20.4	16.8	16.9	15.6	16.4	17.8	16.6	16.7

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**Turbidity**	D	Destroyed
Units:	**NTU**	—	Not monitored or inaccessible
Data Collected by:	**G+S**		

Surface water Date	SW1	SW2	SW3	L1	L2	L3	L4	L5	L6	L7
Jul-2004	30.0	—	—	—	—	—	—	—	—	—
Oct-2004	—	—	—	—	—	—	—	—	—	—
Jan-2005	—	—	—	—	—	—	—	—	—	—
Apr-2005	15.0	15.0	—	—	—	—	—	—	—	—
Jul-2005	15.0	15.0	—	—	—	—	—	—	—	—
Oct-2005	15.0	40.0	—	—	—	—	—	—	—	—
Jan-2006	30.0	20.0	—	—	—	—	—	—	—	—
Apr-2006	60.0	20.0	—	—	—	—	—	—	—	—
Jul-2006	20.0	—	—	—	—	—	—	—	—	—
Nov-2006	20.0	20.0	—	—	—	—	—	—	—	—
Mar-2007	10.0	10.0	—	—	—	—	—	—	—	—
May-2007	5.0	5.0	30.0	—	—	—	—	—	—	—
Sep-2007	10.0	10.0	10.0	—	—	—	—	—	—	—
Jan-2008	10.0	10.0	10.0	—	—	—	—	—	—	—
Apr-2008	10.0	10.0	10.0	—	—	—	—	—	—	—
Jul-2008	10.0	10.0	10.0	—	—	—	—	—	—	—
Oct-2008	10.0	100.0	10.0	—	—	—	—	—	—	—
Dec-2008	10.0	10.0	10.0	—	—	—	—	—	—	—
Jun-2009	10.0	10.0	10.0	—	—	—	—	—	—	—
Sep-2009	10.0	10.0	10.0	—	—	—	—	—	—	—
Mar-2010	10.0	10.0	10.0	—	—	—	—	—	—	—
Sep-2010	10.0	10.0	10.0	—	—	—	—	—	—	—
Mar-2011	21.3	16.9	13.7	—	—	—	—	—	—	—
Sep-2011	37.1	18.8	29.6	—	—	—	—	—	—	—
Apr-2012	12.0	11.9	11.7	—	—	—	—	—	—	—
Sep-2012	23.7	22.0	22.7	—	—	—	—	—	—	—
Apr-2013	58.5	59.5	68.1	—	—	—	—	—	—	—
Sep-2013	48.5	88.6	81.9	—	—	—	—	—	—	—
Mar-2014	10.1	13.0	9.4	—	—	—	—	—	—	—
Oct-2014	5.0	4.4	4.4	—	—	—	—	—	—	—
Mar-2015	0.2	0.2	0.2	—	—	—	—	—	—	—
Sep-2015	3.6	3.9	3.1	—	—	—	—	—	—	—
Mar-2016	5.2	5.4	6.1	—	—	—	—	—	—	—
Sep-2016	17.1	21.5	20.6	—	—	—	—	—	—	—
Apr-2017	22.6	24.0	22.5	—	—	—	—	—	—	—
Sep-2017	11.0	2.0	0.0	—	—	—	—	—	—	—
Mar-2018	3.6	3.6	3.2	—	—	—	—	—	—	—
Sep-2018	2.4	10.7	11.3	—	—	—	—	—	—	—
Jun-2019	8.2	7.7	6.3	—	—	—	—	—	—	—
Dec-2019	3.7	5.3	2.9	—	—	—	—	—	—	—
Jun-2020	2.8	2.5	2.3	—	—	—	—	—	—	—
Mar-2020	—	—	—	6.3	7.0	11.5	7.6	18.6	15.1	11.4
May-2020	—	—	—	21.0	15.4	37.2	29.0	28.5	32.4	24.6
Jun-2020	—	—	—	0.9	—	3.8	96.9	2.5	1.9	4.2
Jul-2020	—	—	—	—	—	0.2	0.5	1.9	—	—
Aug-2020	—	—	—	3.8	9.9	1.4	17.9	1.4	2.8	5.2
Aug-2020	—	—	—	—	—	—	—	0.5	—	0.9
Sep-2020	—	—	—	2.4	2.1	1.9	—	0.3	1.2	2.4
Sep-2020	—	—	—	29.8	16.3	40.5	16.6	42.4	22.4	35.9
Sep-2020	—	—	—	17.7	25.6	38.6	—	17.3	14.0	13.2
Oct-2020	—	—	—	46.7	64.3	171.6	66.3	1.8	59.5	75.6
Median	10.00	10.00	10.00	12.00	15.40	11.50	17.90	2.20	14.55	11.40
Mean	15.81	17.75	15.00	16.08	20.09	34.08	33.54	11.52	18.66	19.27
Min	0.20	0.20	0.00	0.90	2.10	0.20	0.50	0.30	1.20	0.90
Max	60.00	100.00	81.90	46.70	64.30	171.60	96.90	42.40	59.50	75.60
80th percentile	21.82	20.00	20.98	26.28	23.74	39.36	58.84	20.58	28.40	29.12
20th percentile	5.12	5.32	4.16	2.96	7.58	1.70	9.40	1.22	2.26	3.48

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**TN**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water							
Date	**TSP lake**	**L5**	L1	L2	L3	L4	L6	L7
01-May-07	1.6	-	-	-	-	-	-	-
28-Jun-07	0.99	-	-	-	-	-	-	-
26-Jul-07	0.89	-	-	-	-	-	-	-
24-Aug-07	0.74	-	-	-	-	-	-	-
20-Sep-07	2.44	-	-	-	-	-	-	-
04-Oct-07	0.81	-	-	-	-	-	-	-
18-Oct-07	1.04	-	-	-	-	-	-	-
01-Nov-07	0.82	-	-	-	-	-	-	-
16-Nov-07	0.66	-	-	-	-	-	-	-
29-Nov-07	0.79	-	-	-	-	-	-	-
13-Dec-07	0.83	-	-	-	-	-	-	-
27-Dec-07	0.83	-	-	-	-	-	-	-
10-Jan-08	0.79	-	-	-	-	-	-	-
24-Jan-08	0.89	-	-	-	-	-	-	-
07-Feb-08	0.88	-	-	-	-	-	-	-
21-Feb-08	0.74	-	-	-	-	-	-	-
06-Mar-08	0.82	-	-	-	-	-	-	-
20-Mar-08	0.83	-	-	-	-	-	-	-
03-Apr-08	0.76	-	-	-	-	-	-	-
01-May-08	0.82	-	-	-	-	-	-	-
29-May-08	0.83	-	-	-	-	-	-	-
26-Jun-08	1.28	-	-	-	-	-	-	-
24-Jul-08	0.6	-	-	-	-	-	-	-
21-Aug-08	0.71	-	-	-	-	-	-	-
18-Sep-08	0.67	-	-	-	-	-	-	-
02-Oct-08	0.63	-	-	-	-	-	-	-
17-Oct-08	1.13	-	-	-	-	-	-	-
03-Nov-08	0.99	-	-	-	-	-	-	-
21-Nov-08	0.69	-	-	-	-	-	-	-
28-Nov-08	0.85	-	-	-	-	-	-	-
12-Dec-08	0.82	-	-	-	-	-	-	-
23-Dec-08	0.64	-	-	-	-	-	-	-
08-Jan-09	0.82	-	-	-	-	-	-	-
22-Jan-09	0.73	-	-	-	-	-	-	-
05-Feb-09	0.1	-	-	-	-	-	-	-
26-Feb-09	0.94	-	-	-	-	-	-	-
05-Mar-09	0.91	-	-	-	-	-	-	-
19-Mar-09	1.01	-	-	-	-	-	-	-
02-Apr-09	1.01	-	-	-	-	-	-	-
30-Apr-09	0.82	-	-	-	-	-	-	-
28-May-09	0.68	-	-	-	-	-	-	-
25-Jun-09	0.72	-	-	-	-	-	-	-
23-Jul-09	0.69	-	-	-	-	-	-	-
20-Aug-09	0.79	-	-	-	-	-	-	-
03-Sep-09	0.88	-	-	-	-	-	-	-
17-Sep-09	0.89	-	-	-	-	-	-	-
01-Oct-09	0.81	-	-	-	-	-	-	-
15-Oct-09	0.68	-	-	-	-	-	-	-
12-Nov-09	0.6	-	-	-	-	-	-	-
26-Nov-09	0.67	-	-	-	-	-	-	-
10-Dec-09	0.6	-	-	-	-	-	-	-
23-Dec-09	0.79	-	-	-	-	-	-	-
07-Jan-10	0.84	-	-	-	-	-	-	-
21-Jan-10	0.83	-	-	-	-	-	-	-
04-Feb-10	0.83	-	-	-	-	-	-	-
19-Feb-10	0.67	-	-	-	-	-	-	-
04-Mar-10	0.64	-	-	-	-	-	-	-
18-Mar-10	0.77	-	-	-	-	-	-	-
01-Apr-10	0.66	-	-	-	-	-	-	-
29-Apr-10	0.7	-	-	-	-	-	-	-
27-May-10	0.59	-	-	-	-	-	-	-
24-Jun-10	0.51	-	-	-	-	-	-	-
22-Jul-10	0.43	-	-	-	-	-	-	-
19-Aug-10	0.47	-	-	-	-	-	-	-
01-Sep-10	0.45	-	-	-	-	-	-	-
15-Sep-10	0.55	-	-	-	-	-	-	-
29-Sep-10	0.58	-	-	-	-	-	-	-
14-Oct-10	0.46	-	-	-	-	-	-	-

28-Oct-10	0.49	-	-	-	-	-	-	-
11-Nov-10	0.64	-	-	-	-	-	-	-
25-Nov-10	0.94	-	-	-	-	-	-	-
09-Dec-10	0.86	-	-	-	-	-	-	-
23-Dec-10	0.72	-	-	-	-	-	-	-
05-Jan-11	0.6	-	-	-	-	-	-	-
20-Jan-11	0.6	-	-	-	-	-	-	-
03-Feb-11	0.57	-	-	-	-	-	-	-
17-Feb-11	0.71	-	-	-	-	-	-	-
03-Mar-11	0.58	-	-	-	-	-	-	-
17-Mar-11	0.54	-	-	-	-	-	-	-
31-Mar-11	0.5	-	-	-	-	-	-	-
14-Apr-11	0.49	-	-	-	-	-	-	-
12-May-11	0.72	-	-	-	-	-	-	-
09-Jun-11	0.56	-	-	-	-	-	-	-
07-Jul-11	0.63	-	-	-	-	-	-	-
04-Aug-11	0.74	-	-	-	-	-	-	-
31-Aug-11	0.55	-	-	-	-	-	-	-
15-Sep-11	0.64	-	-	-	-	-	-	-
29-Sep-11	0.44	-	-	-	-	-	-	-
13-Oct-11	0.43	-	-	-	-	-	-	-
27-Oct-11	0.56	-	-	-	-	-	-	-
10-Nov-11	0.57	-	-	-	-	-	-	-
24-Nov-11	0.46	-	-	-	-	-	-	-
09-Dec-11	0.55	-	-	-	-	-	-	-
21-Dec-11	0.74	-	-	-	-	-	-	-
12-Jan-12	0.67	-	-	-	-	-	-	-
02-Feb-12	0.51	-	-	-	-	-	-	-
16-Feb-12	0.6	-	-	-	-	-	-	-
01-Mar-12	0.67	-	-	-	-	-	-	-
15-Mar-12	0.6	-	-	-	-	-	-	-
29-Mar-12	0.62	-	-	-	-	-	-	-
12-Apr-12	0.61	-	-	-	-	-	-	-
26-Apr-12	0.71	-	-	-	-	-	-	-
10-May-12	0.62	-	-	-	-	-	-	-
24-May-12	0.63	-	-	-	-	-	-	-
08-Jun-12	0.6	-	-	-	-	-	-	-
22-Jun-12	0.54	-	-	-	-	-	-	-
05-Jul-12	0.52	-	-	-	-	-	-	-
19-Jul-12	0.47	-	-	-	-	-	-	-
02-Aug-12	0.52	-	-	-	-	-	-	-
16-Aug-12	0.52	-	-	-	-	-	-	-
29-Aug-12	0.59	-	-	-	-	-	-	-
13-Sep-12	0.69	-	-	-	-	-	-	-
27-Sep-12	0.67	-	-	-	-	-	-	-
10-Oct-12	0.68	-	-	-	-	-	-	-
25-Oct-12	0.56	-	-	-	-	-	-	-
08-Nov-12	0.63	-	-	-	-	-	-	-
22-Nov-12	0.7	-	-	-	-	-	-	-
06-Dec-12	0.78	-	-	-	-	-	-	-
20-Dec-12	0.75	-	-	-	-	-	-	-
10-Jan-13	0.64	-	-	-	-	-	-	-
24-Jan-13	0.52	-	-	-	-	-	-	-
07-Feb-13	0.64	-	-	-	-	-	-	-
21-Feb-13	0.49	-	-	-	-	-	-	-
07-Mar-13	0.53	-	-	-	-	-	-	-
21-Mar-13	0.47	-	-	-	-	-	-	-
04-Apr-13	0.47	-	-	-	-	-	-	-
18-Apr-13	0.45	-	-	-	-	-	-	-
06-May-13	0.64	-	-	-	-	-	-	-
30-May-13	0.63	-	-	-	-	-	-	-
27-Jun-13	0.57	-	-	-	-	-	-	-
24-Jul-13	0.61	-	-	-	-	-	-	-
22-Aug-13	0.45	-	-	-	-	-	-	-
05-Sep-13	0.52	-	-	-	-	-	-	-
19-Sep-13	0.55	-	-	-	-	-	-	-
02-Oct-13	0.57	-	-	-	-	-	-	-
24-Oct-13	0.6	-	-	-	-	-	-	-
31-Oct-13	0.62	-	-	-	-	-	-	-
14-Nov-13	0.61	-	-	-	-	-	-	-
28-Nov-13	0.73	-	-	-	-	-	-	-
12-Dec-13	0.59	-	-	-	-	-	-	-
08-Jan-14	0.88	-	-	-	-	-	-	-
23-Jan-14	0.91	-	-	-	-	-	-	-

06-Feb-14	0.79	-	-	-	-	-	-	-
22-Feb-14	0.84	-	-	-	-	-	-	-
06-Mar-14	0.64	-	-	-	-	-	-	-
20-Mar-14	0.68	-	-	-	-	-	-	-
03-Apr-14	0.55	-	-	-	-	-	-	-
16-Apr-14	0.63	-	-	-	-	-	-	-
01-May-14	0.63	-	-	-	-	-	-	-
29-May-14	0.6	-	-	-	-	-	-	-
31-Jul-14	0.64	-	-	-	-	-	-	-
28-Aug-14	0.52	-	-	-	-	-	-	-
24-Sep-14	0.52	-	-	-	-	-	-	-
30-Oct-14	0.48	-	-	-	-	-	-	-
24-Nov-14	0.46	-	-	-	-	-	-	-
23-Dec-14	0.86	-	-	-	-	-	-	-
15-Jan-15	1.10	-	-	-	-	-	-	-
26-Feb-15	0.60	-	-	-	-	-	-	-
26-Mar-15	0.67	-	-	-	-	-	-	-
23-Apr-15	0.58	-	-	-	-	-	-	-
21-May-15	0.66	-	-	-	-	-	-	-
25-Jun-15	0.74	-	-	-	-	-	-	-
22-Jul-15	0.65	-	-	-	-	-	-	-
27-Aug-15	0.56	-	-	-	-	-	-	-
24-Sep-15	0.49	-	-	-	-	-	-	-
14-Oct-15	0.6	-	-	-	-	-	-	-
18-Nov-15	0.7	-	-	-	-	-	-	-
16-Dec-15	0.65	-	-	-	-	-	-	-
27-Jan-16	0.58	-	-	-	-	-	-	-
18-Feb-16	0.66	-	-	-	-	-	-	-
17-Mar-16	0.64	-	-	-	-	-	-	-
13-Apr-16	0.64	-	-	-	-	-	-	-
12-May-16	0.55	-	-	-	-	-	-	-
16-Jun-16	0.64	-	-	-	-	-	-	-
21-Jul-16	0.53	-	-	-	-	-	-	-
18-Aug-16	0.54	-	-	-	-	-	-	-
15-Sep-16	0.54	-	-	-	-	-	-	-
20-Oct-16	0.58	-	-	-	-	-	-	-
17-Nov-16	0.74	-	-	-	-	-	-	-
12-Dec-16	1	-	-	-	-	-	-	-
25-Jan-17	0.88	-	-	-	-	-	-	-
16-Feb-17	0.82	-	-	-	-	-	-	-
16-Mar-17	0.73	-	-	-	-	-	-	-
13-Apr-17	0.61	-	-	-	-	-	-	-
18-May-17	0.74	-	-	-	-	-	-	-
17-Jun-17	0.72	-	-	-	-	-	-	-
20-Jul-17	0.68	-	-	-	-	-	-	-
17-Aug-17	0.77	-	-	-	-	-	-	-
19-Sep-17	0.72	-	-	-	-	-	-	-
19-Oct-17	0.73	-	-	-	-	-	-	-
16-Nov-17	0.49	-	-	-	-	-	-	-
13-Dec-17	0.48	-	-	-	-	-	-	-
15-Feb-18	0.53	-	-	-	-	-	-	-
14-Mar-18	0.61	-	-	-	-	-	-	-
12-Apr-18	0.45	-	-	-	-	-	-	-
17-May-18	0.63	-	-	-	-	-	-	-
14-Jun-18	0.68	-	-	-	-	-	-	-
23-Jul-18	0.55	-	-	-	-	-	-	-
17-Aug-18	0.77	-	-	-	-	-	-	-
20-Sep-18	0.52	-	-	-	-	-	-	-
18-Oct-18	0.53	-	-	-	-	-	-	-
19-Nov-18	0.47	-	-	-	-	-	-	-
17-Dec-18	0.41	-	-	-	-	-	-	-
16-Jan-19	0.49	-	-	-	-	-	-	-
21-Feb-19	0.67	-	-	-	-	-	-	-
27-Mar-19	0.62	-	-	-	-	-	-	-
18-Apr-19	0.55	-	-	-	-	-	-	-
16-May-19	0.59	-	-	-	-	-	-	-
01-Jun-19		-	-	-	-	-	-	-
01-Jul-19	0.58	-	-	-	-	-	-	-
01-Aug-19	0.53	-	-	-	-	-	-	-
01-Sep-19	0.48	-	-	-	-	-	-	-
01-Oct-19	0.43	-	-	-	-	-	-	-
01-Nov-19	0.46	-	-	-	-	-	-	-
01-Dec-19	0.52	-	-	-	-	-	-	-
01-Jan-20	0.55	-	-	-	-	-	-	-

01-Feb-20	0.63	-	-	-	-	-	-	-
01-Mar-20	0.43	0.5	0.25	0.25	1.2	1.1	1	1.3
01-Apr-20	0.44	-	-	-	-	-	-	-
01-May-20	0.15	0.4	0.25	1.5	0.7	1	0.25	0.6
01-Jun-20	0.51	0.4	0.7	0.6	0.6	2	0.7	1
15-Jul-20		0.6	0.8	0.7	0.7	1.2	1	1
11-Aug-20		0.4	0.25	0.25	0.5	1	0.25	0.6
27-Aug-20		0.4	0.25	0.25	0.5	0.5	0.25	0.4
10-Sep-20		0.4	0.25	0.25	1	0.7	0.25	0.5
11-Sep-20		0.4	0.5	0.25	0.9	0.6	0.6	0.5
22-Sep-20		0.3	0.25	0.25	0.7	0.25	0.25	0.25
07-Oct-20		0.4	0.25	0.7	1.5	0.8	0.7	0.6

Median	**0.64**	**0.40**	**0.25**	**0.25**	**0.70**	**0.90**	**0.43**	**0.60**
Min	**0.10**	**0.30**	**0.25**	**0.25**	**0.50**	**0.25**	**0.25**	**0.25**
Max	**2.44**	**0.60**	**0.80**	**1.50**	**1.50**	**2.00**	**1.00**	**1.30**
Mean	**0.67**	**0.42**	**0.38**	**0.50**	**0.83**	**0.92**	**0.53**	**0.68**
20th Percentile	**0.53**	**0.40**	**0.25**	**0.25**	**0.58**	**0.58**	**0.25**	**0.48**
80th Percentile	**0.79**	**0.42**	**0.54**	**0.70**	**1.04**	**1.12**	**0.76**	**1.00**

Project	**TSP, Cudgen, NSW**	<LOR	
Parameter:	**TP**	D	Destroyed
Units:	**mg/L**	—	Not monitored
Data Collected by:	**G+S**		

	Surface water							
Date	**TSP lake**	**L5**	L1	L2	L3	L4	L6	L7
01-May-07	0.09	-	-	-	-	-	-	-
28-Jun-07	0	-	-	-	-	-	-	-
26-Jul-07	0	-	-	-	-	-	-	-
24-Aug-07	0	-	-	-	-	-	-	-
20-Sep-07	0.06	-	-	-	-	-	-	-
04-Oct-07	0	-	-	-	-	-	-	-
18-Oct-07	0.08	-	-	-	-	-	-	-
01-Nov-07	0.07	-	-	-	-	-	-	-
16-Nov-07	0	-	-	-	-	-	-	-
29-Nov-07	0	-	-	-	-	-	-	-
13-Dec-07	0.07	-	-	-	-	-	-	-
27-Dec-07	0.07	-	-	-	-	-	-	-
10-Jan-08	0.07	-	-	-	-	-	-	-
24-Jan-08	0	-	-	-	-	-	-	-
07-Feb-08	--	-	-	-	-	-	-	-
21-Feb-08	0	-	-	-	-	-	-	-
06-Mar-08	0	-	-	-	-	-	-	-
20-Mar-08	0	-	-	-	-	-	-	-
03-Apr-08	0.07	-	-	-	-	-	-	-
01-May-08	0.06	-	-	-	-	-	-	-
29-May-08	0	-	-	-	-	-	-	-
26-Jun-08	0	-	-	-	-	-	-	-
24-Jul-08	0	-	-	-	-	-	-	-
21-Aug-08	0	-	-	-	-	-	-	-
18-Sep-08	0	-	-	-	-	-	-	-
02-Oct-08	0.05	-	-	-	-	-	-	-
17-Oct-08	0.05	-	-	-	-	-	-	-
03-Nov-08	0.05	-	-	-	-	-	-	-
21-Nov-08	0.05	-	-	-	-	-	-	-
28-Nov-08	0.05	-	-	-	-	-	-	-
12-Dec-08	--	-	-	-	-	-	-	-
23-Dec-08	0.05	-	-	-	-	-	-	-
08-Jan-09	0.13	-	-	-	-	-	-	-
22-Jan-09	0.09	-	-	-	-	-	-	-
05-Feb-09	0.05	-	-	-	-	-	-	-
26-Feb-09	0.05	-	-	-	-	-	-	-
05-Mar-09	0.05	-	-	-	-	-	-	-
19-Mar-09	0.12	-	-	-	-	-	-	-
02-Apr-09	0.1	-	-	-	-	-	-	-
30-Apr-09	0.05	-	-	-	-	-	-	-
28-May-09	0.05	-	-	-	-	-	-	-
25-Jun-09	0.05	-	-	-	-	-	-	-
23-Jul-09	0.15	-	-	-	-	-	-	-
20-Aug-09	0.17	-	-	-	-	-	-	-
03-Sep-09	0.7	-	-	-	-	-	-	-
17-Sep-09	0.09	-	-	-	-	-	-	-
01-Oct-09	0.07	-	-	-	-	-	-	-
15-Oct-09	0.06	-	-	-	-	-	-	-
12-Nov-09	0.05	-	-	-	-	-	-	-
26-Nov-09	0.05	-	-	-	-	-	-	-
10-Dec-09	0.05	-	-	-	-	-	-	-
23-Dec-09	0.05	-	-	-	-	-	-	-
07-Jan-10	0.05	-	-	-	-	-	-	-
21-Jan-10	0.05	-	-	-	-	-	-	-
04-Feb-10	0.05	-	-	-	-	-	-	-
19-Feb-10	0.05	-	-	-	-	-	-	-
04-Mar-10	0.05	-	-	-	-	-	-	-
18-Mar-10	0.05	-	-	-	-	-	-	-
01-Apr-10	0.05	-	-	-	-	-	-	-
29-Apr-10	0.05	-	-	-	-	-	-	-
27-May-10	0.06	-	-	-	-	-	-	-
24-Jun-10	0.05	-	-	-	-	-	-	-
22-Jul-10	0.05	-	-	-	-	-	-	-
19-Aug-10	0.05	-	-	-	-	-	-	-
01-Sep-10	0.05	-	-	-	-	-	-	-
15-Sep-10	0.05	-	-	-	-	-	-	-
29-Sep-10	0.05	-	-	-	-	-	-	-

14-Oct-10	0.05	-	-	-	-	-	-	-
28-Oct-10	0.05	-	-	-	-	-	-	-
11-Nov-10	0.05	-	-	-	-	-	-	-
25-Nov-10	0.05	-	-	-	-	-	-	-
09-Dec-10	0.05	-	-	-	-	-	-	-
23-Dec-10	0.05	-	-	-	-	-	-	-
05-Jan-11	0.05	-	-	-	-	-	-	-
20-Jan-11	0.05	-	-	-	-	-	-	-
03-Feb-11	0.05	-	-	-	-	-	-	-
17-Feb-11	0.05	-	-	-	-	-	-	-
03-Mar-11	0.05	-	-	-	-	-	-	-
17-Mar-11	0.05	-	-	-	-	-	-	-
31-Mar-11	0.05	-	-	-	-	-	-	-
14-Apr-11	0.05	-	-	-	-	-	-	-
12-May-11	0.05	-	-	-	-	-	-	-
09-Jun-11	0.05	-	-	-	-	-	-	-
07-Jul-11	0.05	-	-	-	-	-	-	-
04-Aug-11	0.05	-	-	-	-	-	-	-
31-Aug-11	0.05	-	-	-	-	-	-	-
15-Sep-11	0.05	-	-	-	-	-	-	-
29-Sep-11	0.05	-	-	-	-	-	-	-
13-Oct-11	0.05	-	-	-	-	-	-	-
27-Oct-11	0.05	-	-	-	-	-	-	-
10-Nov-11	0.05	-	-	-	-	-	-	-
24-Nov-11	0.02	-	-	-	-	-	-	-
09-Dec-11	0.02	-	-	-	-	-	-	-
21-Dec-11	0.02	-	-	-	-	-	-	-
12-Jan-12	0.02	-	-	-	-	-	-	-
02-Feb-12	0.02	-	-	-	-	-	-	-
16-Feb-12	0.02	-	-	-	-	-	-	-
01-Mar-12	0.03	-	-	-	-	-	-	-
15-Mar-12	0.02	-	-	-	-	-	-	-
29-Mar-12	0.02	-	-	-	-	-	-	-
12-Apr-12	0.02	-	-	-	-	-	-	-
26-Apr-12	0.02	-	-	-	-	-	-	-
10-May-12	0.02	-	-	-	-	-	-	-
24-May-12	0.02	-	-	-	-	-	-	-
08-Jun-12	0.02	-	-	-	-	-	-	-
22-Jun-12	0.02	-	-	-	-	-	-	-
05-Jul-12	0.02	-	-	-	-	-	-	-
19-Jul-12	0.02	-	-	-	-	-	-	-
02-Aug-12	0.02	-	-	-	-	-	-	-
16-Aug-12	0.02	-	-	-	-	-	-	-
29-Aug-12	0.02	-	-	-	-	-	-	-
13-Sep-12	0.02	-	-	-	-	-	-	-
27-Sep-12	0.02	-	-	-	-	-	-	-
10-Oct-12	0.02	-	-	-	-	-	-	-
25-Oct-12	0.03	-	-	-	-	-	-	-
08-Nov-12	0.03	-	-	-	-	-	-	-
22-Nov-12	0.02	-	-	-	-	-	-	-
06-Dec-12	0.02	-	-	-	-	-	-	-
20-Dec-12	0.03	-	-	-	-	-	-	-
10-Jan-13	0.02	-	-	-	-	-	-	-
24-Jan-13	0.02	-	-	-	-	-	-	-
07-Feb-13	0.04	-	-	-	-	-	-	-
21-Feb-13	0.05	-	-	-	-	-	-	-
07-Mar-13	0.02	-	-	-	-	-	-	-
21-Mar-13	0.02	-	-	-	-	-	-	-
04-Apr-13	0.02	-	-	-	-	-	-	-
18-Apr-13	0.02	-	-	-	-	-	-	-
06-May-13	0.02	-	-	-	-	-	-	-
30-May-13	0.02	-	-	-	-	-	-	-
27-Jun-13	0.04	-	-	-	-	-	-	-
24-Jul-13	0.02	-	-	-	-	-	-	-
22-Aug-13	0.02	-	-	-	-	-	-	-
05-Sep-13	0.02	-	-	-	-	-	-	-
19-Sep-13	0.03	-	-	-	-	-	-	-
02-Oct-13	0.03	-	-	-	-	-	-	-
24-Oct-13	0.05	-	-	-	-	-	-	-
31-Oct-13	0.02	-	-	-	-	-	-	-
14-Nov-13	0.02	-	-	-	-	-	-	-
28-Nov-13	0.02	-	-	-	-	-	-	-
12-Dec-13	0.02	-	-	-	-	-	-	-

08-Jan-14	0.02	-	-	-	-	-	-	-
23-Jan-14	0.02	-	-	-	-	-	-	-
06-Feb-14	<0.02	-	-	-	-	-	-	-
22-Feb-14	0.03	-	-	-	-	-	-	-
06-Mar-14	0.02	-	-	-	-	-	-	-
20-Mar-14	0.03	-	-	-	-	-	-	-
03-Apr-14	0.02	-	-	-	-	-	-	-
16-Apr-14	0.02	-	-	-	-	-	-	-
01-May-14	0.03	-	-	-	-	-	-	-
29-May-14	0.03	-	-	-	-	-	-	-
31-Jul-14	0.02	-	-	-	-	-	-	-
28-Aug-14	0.04	-	-	-	-	-	-	-
24-Sep-14	0.03	-	-	-	-	-	-	-
30-Oct-14	0.02	-	-	-	-	-	-	-
24-Nov-14	0.02	-	-	-	-	-	-	-
23-Dec-14	0.02	-	-	-	-	-	-	-
15-Jan-15	0.03	-	-	-	-	-	-	-
26-Feb-15	0.02	-	-	-	-	-	-	-
26-Mar-15	0.02	-	-	-	-	-	-	-
23-Apr-15	0.02	-	-	-	-	-	-	-
21-May-15	0.03	-	-	-	-	-	-	-
25-Jun-15	0.03	-	-	-	-	-	-	-
22-Jul-15	**0.03**	-	-	-	-	-	-	-
27-Aug-15	**0.02**	-	-	-	-	-	-	-
24-Sep-15	**0.03**	-	-	-	-	-	-	-
14-Oct-15	**0.03**	-	-	-	-	-	-	-
18-Nov-15	**0.05**	-	-	-	-	-	-	-
16-Dec-15	**0.03**	-	-	-	-	-	-	-
27-Jan-16	**0.02**	-	-	-	-	-	-	-
18-Feb-16	**0.03**	-	-	-	-	-	-	-
17-Mar-16	**0.03**	-	-	-	-	-	-	-
13-Apr-16	**0.04**	-	-	-	-	-	-	-
12-May-16	**0.02**	-	-	-	-	-	-	-
16-Jun-16	**0.03**	-	-	-	-	-	-	-
21-Jul-16	0.03	-	-	-	-	-	-	-
18-Aug-16	0.02	-	-	-	-	-	-	-
15-Sep-16	0.03	-	-	-	-	-	-	-
20-Oct-16	0.02	-	-	-	-	-	-	-
17-Nov-16	0.03	-	-	-	-	-	-	-
12-Dec-16	0.04	-	-	-	-	-	-	-
25-Jan-17	0.03	-	-	-	-	-	-	-
16-Feb-17	0.02	-	-	-	-	-	-	-
16-Mar-17	0.02	-	-	-	-	-	-	-
13-Apr-17	0.06	-	-	-	-	-	-	-
18-May-17	0.05	-	-	-	-	-	-	-
17-Jun-17	0.03	-	-	-	-	-	-	-
20-Jul-17	0.03	-	-	-	-	-	-	-
17-Aug-17	0.05	-	-	-	-	-	-	-
19-Sep-17	0.05	-	-	-	-	-	-	-
19-Oct-17	0.05	-	-	-	-	-	-	-
16-Nov-17	0.03	-	-	-	-	-	-	-
13-Dec-17	0.03	-	-	-	-	-	-	-
15-Feb-18	0.02	-	-	-	-	-	-	-
14-Mar-18	0.04	-	-	-	-	-	-	-
12-Apr-18	0.02	-	-	-	-	-	-	-
17-May-18	0.02	-	-	-	-	-	-	-
14-Jun-18	0.04	-	-	-	-	-	-	-
23-Jul-18	0.02	-	-	-	-	-	-	-
17-Aug-18	0.05	-	-	-	-	-	-	-
20-Sep-18	0.03	-	-	-	-	-	-	-
18-Oct-18	0.02	-	-	-	-	-	-	-
19-Nov-18	0.02	-	-	-	-	-	-	-
17-Dec-18	<0.02	-	-	-	-	-	-	-
16-Jan-19	<0.02	-	-	-	-	-	-	-
21-Feb-19	0.04	-	-	-	-	-	-	-
27-Mar-19	0.03	-	-	-	-	-	-	-
18-Apr-19	0.04	-	-	-	-	-	-	-

16-May-19	0.04	-	-	-	-	-	-	-
01-Jun-19		-	-	-	-	-	-	-
01-Jul-19	0.03	-	-	-	-	-	-	-
01-Aug-19	0.03	-	-	-	-	-	-	-
01-Sep-19	0.03	-	-	-	-	-	-	-
01-Oct-19	0.02	-	-	-	-	-	-	-
01-Nov-19	0.02	-	-	-	-	-	-	-
01-Dec-19	0.02	-	-	-	-	-	-	-
01-Jan-20	0.02	-	-	-	-	-	-	-
01-Feb-20	0.02	-	-	-	-	-	-	-
01-Mar-20	0.02	-	-	-	-	-	-	-
01-Apr-20	0.03	-	-	-	-	-	-	-
01-May-20	0.02	0.02	0.05	0.06	0.06	0.2	0.025	0.025
01-Jun-20	0.02	0.01	0.07	0.07	0.03	0.37	0.14	0.17
15-Jul-20		0.02	0.06	0.025	0.03	0.18	0.12	0.13
11-Aug-20		0.02	0.05	0.025	0.03	0.28	0.09	0.09
27-Aug-20		0.005	0.06	0.05	0.03	0.13	0.025	0.07
10-Sep-20		0.01	0.025	0.1	0.12	0.1	0.18	0.14
11-Sep-20		-	-	-	-	-	-	-
22-Sep-20		0.02	0.025	0.05	0.1	0.12	0.14	0.08
07-Oct-20		0.01	0.06	0.06	0.25	0.12	0.28	0.21

Median	**0.03**	**0.02**	**0.06**	**0.06**	**0.05**	**0.16**	**0.13**	**0.11**
Min	**0.00**	**0.01**	**0.03**	**0.03**	**0.03**	**0.10**	**0.03**	**0.03**
Max	**0.70**	**0.02**	**0.07**	**0.10**	**0.25**	**0.37**	**0.28**	**0.21**
Mean	**0.04**	**0.01**	**0.05**	**0.06**	**0.08**	**0.19**	**0.13**	**0.11**
20th Percentile	**0.02**	**0.01**	**0.04**	**0.04**	**0.03**	**0.12**	**0.05**	**0.07**
80th Percentile	**0.05**	**0.02**	**0.06**	**0.07**	**0.11**	**0.25**	**0.16**	**0.16**

VERTICAL PROFILE MONITORING - pH

Depth \ Date	02.03.07	31.05.07	24.09.07	09.01.08	01.04.08	09.07.08	20.10.08	17.12.08	11.06.09	25.09.09	29.03.10	28.09.10	31.03.11	28.09.11	13.04.12	26.09.12	30.04.13	25.09.13	02.04.14	09.10.14	17.03.15	28.09.15	22.03.16	26.09.17	28.03.18	13.06.19	4.12.19	18.06.20
0	8.6	8.21	8.02	8.3	8.22	7.93	8.48	8.93	8.86	8.6	8.1	8.6	8.29	8.62	8.56	9.38	8.58	8.44	8.72	8.16	8.42	6.52	8.55	8.38	8.61		8.7	8.62
1	8.69	7.86	8.57	7.91	8.46	7.61	8.57	8.97	8.89	8.6	8	8.6	8.36	8.63	8.56	9.29	8.57	8.58	8.69	8.32	8.41	7.97	8.5	8.38	8.61	7.98	8.7	8.62
2	8.66	8.01	8.57	8.23	8.53	7.67	8.61	8.97	9.01	8.6	8	8.7	8.39	8.63	8.57	9.32	8.56	8.67	8.79	8.38	8.42	8.13	8.02	8.39	8.61	8.01	8.7	8.62
3	8.4	7.49	8.56	8.19	8.55	7.84	8.61	8.55	9.02	8.6	7.9	8.6	8.36	8.64	8.56	9.4	8.55	8.66	8.77	8.44	8.36	8.15	7.88	8.39	8.59	8.04	8.72	8.61
4	8.4	8.02	8.55	8.12	8.55	7.76	8.62	8.47	9.04	8.6	7.9	8.4	8.35	8.64	8.55	9.42	8.52	8.7	8.69	8.49	8.26	8.17	7.67	8.39	8.57	8.06	8.76	8.59
5	8.21	8.01	8.49	7.99	8.57	7.53	8.65	8.51	8.98	8.6	7.7	8.3	8.34	8.64	8.52	9.45	8.49	8.72	8.47	8.51	8.27	8.18	7.63	8.35	8.26	8.09	8.6	8.58
6	8	7.56	8.51	8.25	8.6	7.11	8.59	8.5	8.91	8.6	7.4	8.2	8.33	8.63	8.5	9.43	8.44	8.69	8.35	8.55	8.22	8.19	7.6	7.95	7.92	8.11	8.67	8.51
7	7.85	7.43	8.5	8.24	8.6	7.56	8.57	8.35	8.98	8.3	7.1	8	8.31	8.53	8.5	9.32	8.4	8.65	8.3	8.48	7.73	8.17	7.56	7.9	7.75	8.12	8.54	8.4
8	7.7	7.99	8.33	8.23	8.61	7.49	8.48	8.06	8.89	8.2	6.8	7.8	7.93	8.42	8.5	9.31	8.35	8.56	8.26	8.35	7.45	8.12	7.56	7.97	7.62	8.14	8.48	8.31
9	7.62	7.99	8.24	8.2	8.57	7.69	8.43	7.87	8.89	8.3	6.7	7.7	7.63	8.26	8.36	9.22	8.31	8.51	8.18	8.25	7.32	8.05	7.28	7.73	7.55	8.15	8.43	8.27
10	7.53	7.97	8.12	8.17	8.55	7.35	8.08	8.1	8.88	7.8	6.6	7.7	7.57	8.17	7.94	9.18	8.29	8.39	8.11	8.12	7.33	8	7.22	7.69	7.51	8.16	8.28	8.26
11	7.61	7.92	7.99	7.99	8.43	7.36	7.96	7.66	8.91	7.8	6.5	7.6	7.58	8.11	7.75	9.17	8.27	8.33	8.04	8.05	7.34	7.81	7.07	7.66	7.5	8.15	8.24	8.3
12	7.5	7.92	7.78	7.88	8.33	7.27	8.1	7.65	8.91	8	6.4	7.6	7.58	8.05	7.74	9.14	8.24	8.22	8.03	8.02	7.36	7.65	7.03	7.65	7.55	8.15	8.17	8.3
13	7.46	7.95	7.87	7.76	8.16	6.97	7.81	7.64	8.95	7.7	6.5	7.6	7.58	7.99	7.74	9.13	8.2	8.17	7.99	7.99	7.37	7.51	7	7.66	7.59	8.14	8.13	8.28
14	7.41	7.95	7.8	7.78	8.02	7.29	8.02	7.67	9.02	7.8	6.4	7.6	7.59	7.96	7.74	9.11	8.15	8.11	7.98	7.97	7.38	7.5	6.97	7.65	7.64	8.13	8.08	8.26
15	8.09	7.94	7.62	7.5	7.93	7.46	7.89		9.04	7.8	6.4	7.6	7.6	7.94	7.73	9.1	8.11	8.08	7.97	7.96	7.31	7.49	6.92	7.66	7.67	8.13	8.06	8.26
16	7.44	7.86	7.55	7.56	7.89	7.32	7.81	--	8.95	--	--	7.6	7.61	7.92	7.73	--	8.09	8.2	7.95	7.91	7.4	7.49	6.9	7.64	7.65	8.12	8.03	8.24
17	7.4	--	7.65	7.47	7.81	7.29	7.86	--	--	--	--	7.56	6.02	7.9	--	--	--	8.35	7.49	7.90	7.4	7.49	6.87	7.63	7.64	8.11	8.01	8.2
18	--	--	--	7.43	7.83	7.49	7.79	--	--	--	--	7.56	7.64	7.89	--	--	--	--	7.43	7.89	7.41	7.49	6.85		7.64	8.11	7.99	8.2
19	--	--	--	--	--	7.47	--	--	--	--	--	--	--	7.86	--	--	--	--	--	7.88	7.42	7.5	6.82		7.63	7.97	7.99	8.24
20																									7.63	7.88		
21																									7.62			

VERTICAL PROFILE MONITORING - SALINITY

Depth \ Date	02.03.07	31.05.07	24.09.07	09.01.08	01.04.08	09.07.08	20.10.08	17.12.08	11.06.09	25.09.09	29.03.10	28.09.10	31.03.11	28.09.11	13.04.12	26.09.12	30.04.13	25.09.13	02.04.14	09.10.14	17.03.15	28.09.15	22.03.16	26.09.17	28.03.18	13.06.19	4.12.19	18.06.20
0	1514	2137	2378	1610		1896	2070	2358	863	1966	2245	1910	1340	1880	1540	1350	1150	1060	930	1290	1250	780	1280	1100	1190	1360	1620	1590
1	1554	2117	2378	1581		1956	2050	2399	1318	1964	2245	1916	1340	1890	1550	1360	1060	1060	930	1290	1250	790	1300	1100	1340	1360	1620	1590
2	1554	2103	2371	1616		1903	2064	2358	1233	1957	2251	1916	1340	1890	1550	1360	1060	1060	930	1290	1260	800	1300	1100	1630	1360	1620	1590
3	1527	2110	2378	1760		1896	1849	2345	1241	1958	2218	1916	1350	1890	1550	1370	1060	1050	930	1290	1250	800	1310	1110	1760	1360	1620	1590
4	1360	2137	2378	1935		1896	1075	2338	1248	1556	2265	1916	1350	1890	1550	1360	1060	1060	950	1290	1260	800	1310	1110	1840	1360	1630	1590
5	1500	2103	2338	2090		1889	1807	2358	1242	1935	2271	1916	1350	1890	1550	1370	1060	1060	940	1290	1260	800	1330	1110	1920	1360	1630	1590
6	1534	2063	2391	2204		1896	1642	2358	1225	1962	2265	1923	1350	1890	1550	1400	1060	1060	930	1300	1260	1360	1340	1110	1990	1360	1630	1590
7	1534	2090	2378	2291		1896	1085	2338	1257	1912	2265	1923	1350	1900	1550	1370	1060	1050	950	1300	1300	1160	1340	1120	2030	1360	1600	1550
8	1520	2117	2391	2271		1903	1203	2345	1237	1912	2271	1923	1390	1910	1550	1380	1060	1060	960	1300	1340	1400	1350	1100	2060	1360	1600	1600
9	1507	2090	2391	2304		1896	2077	2358	1244	1926	2245	1923	1420	1890	1590	1390	1060	1060	950	1310	1400	1400	1370	1110	2160	1360	1560	1600
10	1494	2023	2365	2298		1896	1244	2379	1247	1875	2271	1923	1490	1900	1720	1400	1060	1060	950	1310	1450	1240	1360	1110	2190	1360	1580	1600
11	1507	2083	2391	2365		1903	2074	2332	1266	1897	2271	1923	1530	1900	1740	1360	1060	1060	950	1320	1460	1420	1370	1110	2240	1390	1600	1600
12	1514	2050	2405	2378		1930	1951	2365	1253	1844	2265	1923	1550	1910	1760	1400	1060	1060	950	1320	1480	1320	1380	1110	2240	1390	1600	1600
13	1520	2103	2391	2378		1910	2068	2385	1260	1848	2278	1923	1560	1920	1780	1370	1060	1050	930	1320	1490	1390	1380	1110	2220	1390	1600	1600
14	1581	2083	2391	2365		1903	2318	2385	1276	1743	2211	1923	1570	1920	1780	1370	1060	1060	920	1320	1500	1390	1390	1110	2170	1420	1610	1600
15	1554	2090	2425	2432		1903	1754		1253	1875	2271	1923	1570	1930	1780	1380	1060	1050	930	1320	1500	1400	1390	1120	2150	1420	1610	1600
16	1587	2123	2385	2405		1910	2039		1283			1923	1570	1930	1790		1060	1050	910	1320	1510	1400	1390	1120	2150	1420	1610	1600
17	1520		2418	2432		1916	2033					1930	1580	1930				1050	900	1320	1520	1400	1400	1120	2140	1420	1610	1600
18				2177		1930	2045					1930	1580	1930					880	1320	1490	1400	1400		2140	1420	1610	1600
19						1916								1930						1140	1500	1400	1410		2120	1420	1610	1600
20																									2120	1380		
21																									2120			

VERTICAL PROFILE MONITORING - REDOX POTENTIAL

Depth \ Date	02.03.07	31.05.07	24.09.07	09.01.08	01.04.08	09.07.08	20.10.08	17.12.08	11.06.09	25.09.09	29.03.10	28.09.10	31.03.11	28.09.11	13.04.12	26.09.12	30.04.13	25.09.13	02.04.14	09.10.14	17.03.15	28.09.15	22.03.16	26.09.17	28.03.18	13.06.19	4.12.19	18.06.20
0	130	145	147.2	58.8	1.8	–	166.6	–	–	316	13	258	-122	-71	-115	-101	189	455	425	396	277	330	411	303	449		449	413
1	129	112	127.1	61.5	0.2	–	166.6	–	–	310	37	248	-123	-67	-113	-102	192	443	424	397	270	320	411	306	451	487	451	413
2	77	107.2	124.4	58.2	5.1	–	176.1	–	–	305	35	251	-120	-65	-112	-98	196	444	422	397	268	314	408	308	452	488	451	414
3	57	109.1	118.8	48.1	9.3	–	178.8	–	–	305	45	254	-119	-65	-111	-96	193	441	421	396	268	312	405	310	453	488	451	415
4	56	95	115.7	71.7	8.7	–	181.2	–	–	302	36	259	-117	-63	-111	-94	179	439	420	394	268	310	404	312	456	488	451	416
5	48	68.3	97.6	65.4	9	–	182.7	–	–	316	41	260	-115	-63	-110	-94	182	437	420	393	262	309	401	312	457	488	452	417
6	15	63.7	92.8	91.1	11.4	–	184.3	–	–	300	39	262	-113	-63	-110	-97	184	436	419	391	262	309	399	314	459	487	452	419
7	98	63.1	97.8	94	11.3	–	191	–	–	307	21	265	-110	-60	-109	-105	182	434	418	390	262	308	398	314	460	487	457	420
8	105	38.7	101.5	99.3	17	–	192.5	–	–	306	18	267	-119	-60	-108	-108	184	433	417	391	232	307	396	313	460	486	458	421
9	113	-0.9	91.9	91.7	12.5	–	175	–	–	305	16	268	-234	-59	-107	-112	185	432	416	391	39	307	395	312	447	486	454	422
10	120	7	96.4	46.3	13.1	–	185.1	–	–	301	10	268	-299	-59	-211	-115	187	431	191	390	31	305	398	311	381	486	445	418
11	108	37.3	89.8	3.9	102.3	–	161.3	–	–	301	16	268	-329	-60	-256	-118	187	430	120	390	29	304	280	310	200	486	427	419
12	114	35.8	88.6	-37.3	31.6	–	168.6	–	–	300	14	268	-354	-61	-276	-121	189	430	88	390	29	298	191	310	130	485	406	420
13	110	47.8	96	-65.6	-24.6	–	136.2	–	–	305	6	268	-374	-63	-293	-125	194	429	59	390	27	289	108	309	60	485	386	420
14	118	65.2	96.9	-69.5	-56.9	–	137.6	–	–	295	11	286	-396	-65	-308	-130	199	429	42	390	27	287	91	307	10	484	358	421
15	47	55.1	97.3	-76.1	-73.1	–	116.8	–	–	297	8	267	-430	-66	-322	-134	200	427	30	390	25	284	57	307	-25	482	333	421
16	116	57	99.6	-78.6	-86.7	–	116	–	–	–	-57	267	-456	-66	-335	–	200	428	1	390	23	282	42	306	-54	482	297	422
17	119	–	92.2	-80.7	-96.6	–	118.2	–	–	–	–	266	-469	-68	–	–	–	435	-25	399	21	280	33	306	-67	481	271	423
18	–	–	–	-74.9	-97.9	–	120.3	–	–	–	–	265	-484	-69	–	–	–	–	-31	390	17	278	1		-77	481	257	423
19	–	–	–	–	–	–	–	–	–	–	–	–	–	-71	–	–	–	–	–	281	14	270	-3		-87	481	239	424
20																									-93	475		
21																									-99			

VERTICAL PROFILE MONITORING - DISSOLVED OXYGEN

Date	02.03.07	31.05.07	24.09.07	09.01.08	01.04.08	09.07.08 **	20.10.08	17.12.08	11.06.09	25.09.09	29.03.10	28.09.10	31.03.11	28.09.11	13.04.12	24.09.12	30.04.13	25.09.13	02.04.14 **	09.10.14 **	17.03.15 **	28.09.15	22.03.16	26.09.17	28.03.18	13.06.19	4.12.19	18.06.20 **
0	7.74	7.9	7.23	5.72	5.77	7.52	7.19	7.85	9.45	6.3	9.4	7.1	7.7	9.31	7.61	9.73	8.43	10.29	8.26	9.05	7.94	12.38	9.01	8.44	9.67		9.65	11.25
1	6.69	8.64	7.02	5.27	5.39	7.87	6.16	6.76	9.91	6.23	9.08	7.17	7.69	9.3	7.75	9.89	8.36	9.93	8.27	9.05	7.86	12.98	8.82	8.44	9.41	7.29	9.64	11.34
2	7	8.24	6.66	5.38	5.38	7.43	6.31	6.53	9.45	6.4	9.08	7.55	7.46	9.3	7.61	10.66	8.3	10.08	8.32	9.05	7.86	13.02	9.13	8.4	9.32	7.28	9.6	11.38
3	6.41	7.79	7.19	5.28	4.97	6.83	5.9	6.56	9.96	6.4	9.08	7.95	6.84	9.29	7.52	10.48	7.88	9.85	8.38	9.04	8.07	12.99	9.2	8.36	9.19	7.37	9.59	11.39
4	6.22	7.87	7	4.4	5.21	7.42	6.33	6.52	9.07	6.28	8.48	7.2	6.72	9.29	7.34	10.58	7.77	9.78	8.57	9.04	7.82	12.91	9.07	8.26	9.03	7.37	9.27	11.44
5	8.19	8.23	6.75	4.22	5.47	7.29	5.98	6.62	8.84	6.33	8.02	6.4	6.58	9.27	7.06	9.41	7.65	9.72	8.97	9.06	7.80	12.79	8.98	7.83	6.48	7.4	8.79	11.44
6	4.1	8.3	6.82	4.46	5.26	7.32	5.85	6.68	9.86	6.25	7.99	5.35	6.47	8.99	6.86	5.32	7.2	9.52	9.18	9.11	7.76	12.68	8.9	4.64	3.26	7.41	8.16	11.23
7	3.47	7.76	6.74	4.35	5.28	7.07	5.67	5.57	8.99	4.67	5.5	3.7	6.26	7.82	6.83	5.05	6.93	8.45	9.29	10.01	7.56	13.31	8.9	3.51	1.65	7.37	3.51	10.61
8	2.75	7.58	5.28	4.17	6.34	7.6	5.23	3.93	9.17	4.37	4.66	2.96	1.61	7.23	6.83	4.43	6.86	8.32	9.41	10.60	7.26	12.98	8.72	2.5	0.32	7.48	1.79	9.48
9	2.81	7.41	5.27	3.88	4.75	7.13	5.06	3.05	9.53	4.69	3.5	2.83	0.15	5.63	4.64	3.87	6.31	7.65	9.78	10.79	7.41	11.12	8.51	2.41	0.08	7.4	1.67	9.36
10	2.5	6.8	4.5	3.92	5.32	7.33	3.58	4.33	8.42	2.01	3.1	2.7	0.1	4.91	0.73	3.41	6.35	7.22	10.3	11.00	7.55	8.63	8.24	2.15	0	7.47	1.44	9.07
11	3.23	7.37	3.95	3.04	4.56	7.92	2.89	2.46	10.34	3.87	3.3	2.5	0.09	4.5	0.3	3.11	6.13	6.34	10.66	11.11	7.68	6.52	8.01	2.02	0	6.83	1.47	9.96
12	2.2	7.41	7.2	2.48	2.26	7.61	4.05	2.08	7.91	3.94	2.79	2.33	0.08	3.93	0.15	2.85	5.78	6.61	11	11.16	7.89	4.82	7.63	1.96	0	6.76	1.45	9
13	2.11	7.3	3.2	1.66	2.77	7.87	1.86	2.25	9.33	2.87	2.6	1.93	0.08	3.33	0.14	2.62	5.45	6.09	11.28	11.18	7.99	3.81	7.21	1.19	0	6.35	1.45	9.12
14	3.58	6.84	3.83	1.86	2.44	7.88	3.75	2.6	8.86	2.27	2.41	1.67	0.07	3.11	0.14	2.21	4.82	6.02	11.51	11.18	8.08	3.41	7.04	1.73	0	6.16	1.46	9.33
15	2.2	6.75	3.98	2.08	2.29	7.89	1.83	--	8.92	2.19	2.42	1.62	0.07	2.96	0.12	1.86	4.69	6.51	11.67	11.19	8.15	2.92	6.23	1.67	0	6.03	1.47	9.08
16	2.48	6.69	3.75	1.51	2	7.16	2.04	--	8.48	--	1.73	1.64	0.07	2.81	0.12	--	4.28	8.98	11.77	11.16	8.23	2.7	6.88	1.5	0	5.99	1.51	8.9
17	3.08	--	3.18	1.47	1.65	8.05	2.21	--	--	--	--	1.66	0.07	2.68	--	--	--	3.9	11.75	11.16	8.27	2.41	5.33	1.35	0	5.96	1.5	8.51
18	--	--	--	1.68	2.18	8.36	2.38	--	--	--	--	1.73	0.06	2.48	--	--	--	--	11.71	11.15	8.37	2.23	4.7		0	5.97	1.52	8.6
19	--	--	--	--	--	8.28	--	--	--	--	--	--	--	2.3	--	--	--	--	--	11.20	8.41	1.95	2.91		0	5.42	1.44	9.19
20																									0	1.9		
21																									0			

** Data potentially erroneous due to probe error

VERTICAL PROFILE MONITORING - TEMPERATURE

Date	25.07.10	24.08.10	07.09.20	20.09.10	12.10.10	18.10.10	29.10.10	15.11.10	30.11.10	10.12.10	30.12.10	11.01.11	01.02.11	08.02.11	21.02.11	07.03.11	18.03.11	04.04.11	16.05.11	21.06.11	28.09.10	31.03.11	28.09.11	13.04.12	26.09.12	30.04.13	25.09.13	02.04.14	09.10.14	17.03.15	28.09.15	22.03.16	26.09.17	28.03.18	13.06.19	4.12.19	18.06.20
0	17.3	18.9	18.9	21.2	23	21.2	24.3	24.5	24.1	26.1	24.7	27.5	28	30.6	28.7	28.4	26.7	25.3	20.1	18	22.8	26.12	20.63	22.81	22.68	24.19	24.97	27.02	23.14	26.54	19.59	27.04	21.5	27.17		26.01	18.9
1	17	18.6	18.6	20.8	23	21	24.2	24.4	24.1	26.1	24.7	27.5	28	30.5	28.1	28.2	26.8	25.2	20.1	18	22.5	25.9	20.93	22.83	22.45	24.44	24.49	26.97	23.11	26.54	18.87	27.03	21.48	27.17	18.85	25.99	18.9
2	16.8	17.9	18.2	20.7	22.7	20.9	23.4	24.3	23.9	26	24.7	27.1	27.8	30.2	27.9	28	26.7	24.8	20.1	18	22.2	25.13	20.92	22.81	22.18	24.37	23.85	26.89	23.11	26.35	18.69	27.01	21.45	27.15	18.87	25.99	18.9
3	16.7	17.8	18	20.6	22.4	20.9	22.8	24.1	23.8	24.4	24.7	26.6	27.8	29.7	27.1	27.1	26.2	24.8	20.1	18	20.6	24.76	20.82	22.72	20.97	23.83	23.91	26.84	23.09	25.56	18.62	26.96	21.42	27.11	18.87	25.99	18.89
4	16.7	17.6	17.5	20.2	20	20.8	21.8	22	23.8	24	24.7	24.7	25.8	28.6	26.6	26.5	25.4	24.8	20.1	18	19.2	24.74	20.8	22.6	20.3	23.72	23.3	26.68	23.09	25.48	18.59	26.98	21.32	27.07	18.87	25.8	18.88
5	16.7	17.3	17.1	19.4	19.1	20.7	20.5	20.9	23.7	23.3	24.7	23.7	25.1	29.6	25.4	25.7	25	24.8	20.1	18	18.9	24.72	20.72	22.5	17.99	23.64	23.18	26.37	23.05	25.45	18.59	26.97	21.16	26.17	18.87	25.72	18.89
6	16.6	16.8	16.9	18.7	18.6	20.1	19.9	20.2	21.6	22.5	23.3	23.3	24.1	25.5	23.3	25.2	24.8	24.7	20.1	18	18.8	24.7	20.22	22.48	17.13	23.61	23.07	26.15	22.95	25.41	18.56	26.95	20.12	25.39	18.86	25.33	18.89
7	16.6	16.7	16.8	18.1	18.3	19.4	19.7	19.5	20.2	21.3	21.9	22.8	22.8	23.7	22.1	24	24.4	24.1	20.1	18	18.3	24.68	19.46	22.48	16.74	23.6	22.13	26	20.51	24.93	18.51	26.8	19.7	25.1	18.87	22.85	18.86
8	16.6	16.6	16.8	17.9	18	18.9	19.4	19.2	19.8	20.4	21	21.6	21.4	22.6	21	22.3	23.1	24	20.1	18	18	24.31	19.02	22.46	16.46	23.59	21.88	25.88	19.14	24.23	18.41	26.54	19.27	24.75	18.87	20.73	18.75
9	16.6	16.6	16.7	17.9	17.9	18.6	19	18.9	19.4	20	20.4	20.5	21.2	21.7	20.6	21.2	21.8	22.5	20.1	17.9	17.8	23.28	17.73	22.22	16.23	23.57	21.2	25.5	18.75	23.35	18.34	26.03	19.12	24.11	18.87	19.14	18.73
10	16.5	16.6	16.7	17.8	17.6	18.2	18.9	18.7	19.2	19.6	20	19.9	20.4	21.2	20.2	20.5	20.9	21.5	20.1	17.9	17.7	21.99	17.4	20.88	16.1	23.56	20.35	24.6	18.29	22.81	18.22	25.7	19.02	23.45	18.87	18.57	18.68
11	16.5	16.5	16.6	17.8	17.5	18.1	18.6	18.5	19	19.3	19.7	19.6	19.6	20.9	19.7	20.2	20.3	20.8	20.1	17.9	17.6	20.9	17.26	20.24	16	23.55	19.71	23.92	18.10	22.39	17.86	25.17	18.96	22.8	18.9	18.32	18.69
12	16.4	16.5	16.6	17.7	17.5	17.9	18.5	18.5	18.8	19.1	19.5	19.4	19.4	20.6	19.5	19.9	19.9	19.9	20.1	17.9	17.6	20.47	17.02	19.61	15.9	23.54	19.33	23.29	18.00	22.03	17.73	24.93	18.91	22.37	18.92	18.24	18.68
13	16.4	16.5	16.6	17.7	17.4	17.8	18.4	18.4	18.7	18.9	19.4	19.2	19.2	20.4	19.4	19.6	19.6	19.8	20.1	17.9	17.5	20.15	16.87	19.6	15.74	23.53	19.3	22.84	17.95	21.59	17.56	24.62	18.87	22.21	18.94	18.03	18.68
14	16.4	16.5	16.6	17.6	17.3	17.8	18.4	18.3	18.7	18.8	19.2	19	19.1	20.2	19.4	19.4	19.5	19.8	20.1	17.9	17.5	19.91	16.83	18.92	15.7	23.52	19.15	22.45	17.95	21.32	17.51	24.18	18.79	21.93	18.94	18.02	18.68
15	16.4	16.5	16.5	17.6	17.3	17.8	18.4	18.2	18.6	18.8	19.2	19	19	20.1	19.4	19.1	19.5	19.7	20.1	17.9	17.5	19.78	16.81	18.84	15.67	23.52	20.04	22.18	17.93	21.17	17.44	23.52	18.72	21.87	18.94	18.01	18.67
16	16.4	16.5	16.5	17.5	17.3	17.8	18.3	18.2	18.6	18.8	19.1	18.9	19	20.1	19.4	19	19.4	19.7	20.1	17.9	17.5	19.68	16.74	18.74	--	23.51	21.9	22.01	17.92	20.59	17.4	23.37	18.55	21.93	18.93	18	18.68
17	16.3	16.5	16.5	17.8	17.3	17.8	18.3	18.1	18.6	18.8	19.1	18.9	19	20	19.4	18.9	19.4	19.7	20.1	17.9	17.6	19.65	16.7		--	--	19.92	22.05	17.92	20.81	17.38	22.19	18.55	21.98	18.93	18.02	18.68
18	16.3	16.5	16.5	--	17.3	17.8	18.3	18.1	18.6	--	19.1	18.9	--	20	19.4	18.8	19.3	19.6	20	18	17.6	19.63	16.66	--	--	--	--	22.1	17.92	20.66	17.38	22.61		22.02	18.94	18.07	18.68
19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.95	20.49	17.36	21.07		22.86	18.94	18.11	18.68
20																																		22.09	18.95		
21																																		22.11			

12 Appendix 3 – Stage-storage assumptions for lake water balance

Table A5.1 Modelled southern lake stage-storage characteristics – Phases 1-4

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	368,027	0	2,743
-0.75	370,725	92,344	2,730
-0.50	373,454	185,366	2,759
-0.25	376,171	279,070	2,749
0	378,909	373,455	2,754
0.25	381,657	468,525	2,757
0.50	384,422	564,285	2,770
0.75	387,196	660,738	2,779
1.00 (full storage)	389,984	757,885	2,792
1.30 (bund level)	393,344	875,385	2,809

Table A5.2 Modelled southern lake stage-storage characteristics – Phase 5

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	707,053	0	3,771
-0.75	710,777	177,229	3,753
-0.50	714,527	355,392	3,778
-0.25	718,260	534,490	3,763
0	722,009	714,524	3,763
0.25	725,767	895,496	3,762
0.50	729,535	1,077,408	3,769
0.75	733,307	1,260,264	3,773
1.00 (full storage)	737,088	1,444,063	3,783
1.30 (bund level)	741,634	1,665,872	3,795

Table A5.3 Modelled southern lake stage-storage characteristics – Phase 6

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	988,609	0	4,303

-0.75	992,913	247,690	4,308
-0.50	997,225	496,458	4,315
-0.25	1,001,543	746,303	4,321
0	1,005,867	997,230	4,328
0.25	1,010,201	1,249,238	4,334
0.50	1,014,541	1,502,331	4,341
0.75	1,018,888	1,756,509	4,348
1.00 (full storage)	1,023,241	2,011,775	4,354
1.30 (bund level)	1,028,470	2,319,532	4,362

Table A5.4 Modelled southern lake stage-storage characteristics – Phase 7

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	1,101,725	0	4,768
-0.75	1,106,497	276,028	4,773
-0.50	1,111,275	553,249	4,780
-0.25	1,116,059	831,666	4,787
0	1,120,850	1,111,280	4,793
0.25	1,125,646	1,392,092	4,800
0.50	1,130,448	1,674,103	4,807
0.75	1,135,256	1,957,316	4,813
1.00 (full storage)	1,140,071	2,241,732	4,820
1.30 (bund level)	1,145,858	2,584,622	4,828

Table A5.5 Modelled southern lake stage-storage characteristics – Phase 8

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	1,275,541	0	5,490
-0.75	1,281,032	319,572	5,495
-0.50	1,286,530	640,517	5,502
-0.25	1,292,035	962,838	5,508
0	1,297,546	1,286,535	5,515
0.25	1,303,065	1,611,611	5,521
0.50	1,308,589	1,938,068	5,528
0.75	1,314,121	2,265,907	5,534
1.00 (full storage)	1,319,658	2,595,129	5,541

1.30 (bund level)	1,326,311	2,992,025	5,549

Table A5.6 Modelled southern lake stage-storage characteristics – Phase 9 (and Phases 10 and 11)

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	1,516,271	0	6,666
-0.75	1,522,939	379,901	6,672
-0.50	1,529,612	761,470	6,678
-0.25	1,536,293	1,144,708	6,685
0	1,542,979	1,529,617	6,691
0.25	1,549,675	1,916,199	6,697
0.50	1,556,378	2,304,456	6,703
0.75	1,563,086	2,694,389	6,710
1.00 (full storage)	1,569,800	3,085,999	6,716
1.30 (bund level)	1,577,863	3,558,149	6,723

Table A5.7 Modelled northern lake stage-storage characteristics – Phase 10

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	168,151	0	1,620
-0.75	169,773	42,240	1,627
-0.50	171,402	84,887	1,634
-0.25	173,039	127,942	1,641
0	174,682	171,408	1,648
0.25	176,333	215,284	1,655
0.50	177,991	259,575	1,663
0.75	179,657	304,281	1,670
1.00 (full storage)	181,329	349,404	1,677
1.75 (bund level)	186,393	404,563	1,698

Table A5.8 Modelled northern lake stage-storage characteristics – Phase 11

Lake level (mAHD)	Surface area (m^2)	Storage volume above RL -2 mAHD (m^3)	Perimeter (m)
-1.00	345,636	0	2,352
-0.75	347,991	86,703	2,358

-0.50	350,352	173,996	2,364
-0.25	352,719	261,880	2,371
0	355,092	350,357	2,377
0.25	357,465	439,426	2,383
0.50	359,847	529,091	2,389
0.75	362,234	619,351	2,396
1.00 (full storage)	364,627	710,209	2,402
1.75 (bund level)	371,862	820,682	2,421

13 Appendix 4 – Water balance results – lake water surface elevation plots

Figure A4.1: Water balance model verification: modelled water levels versus field data

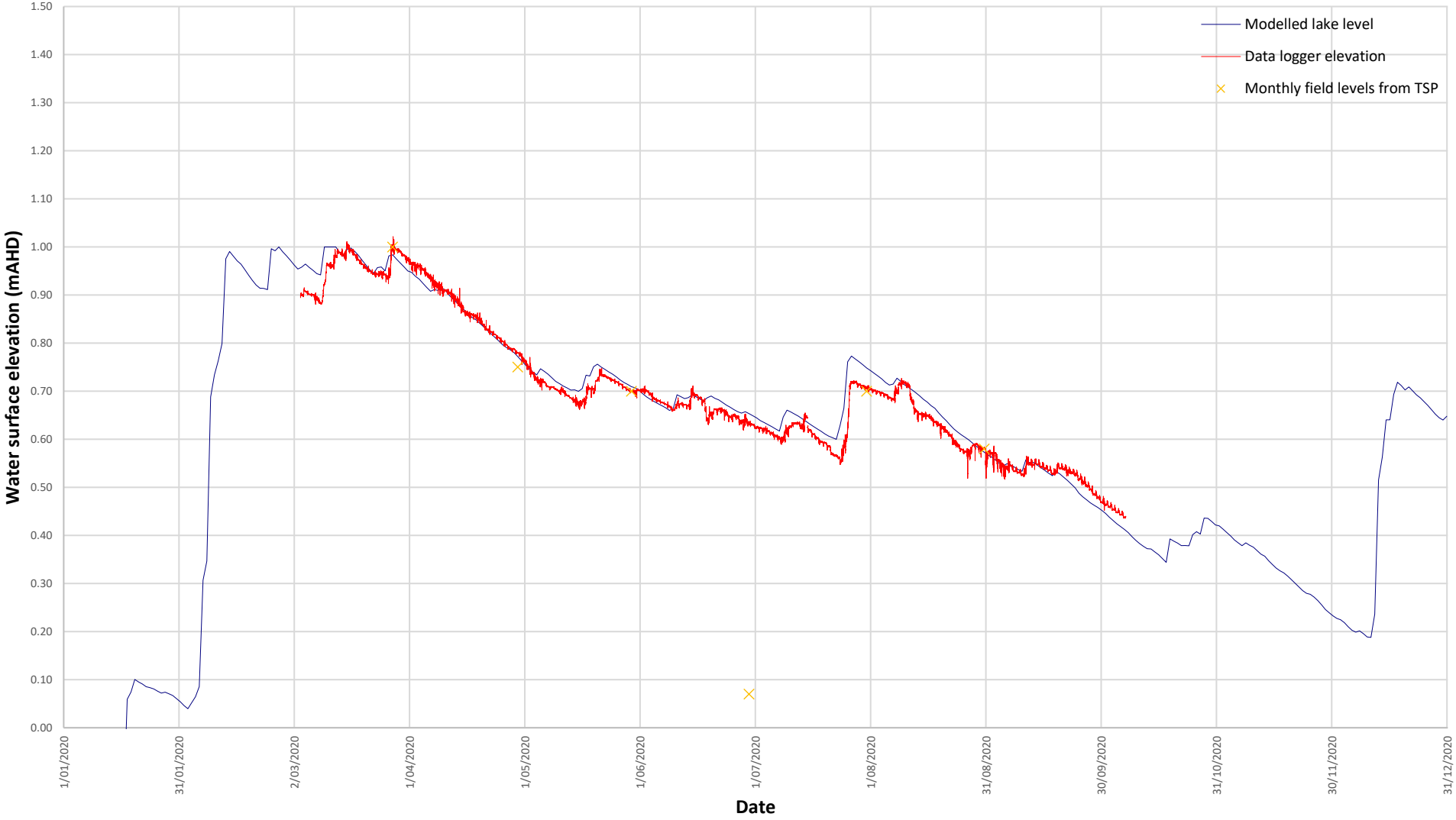


Figure A4.2: Phase 1-4: modelled lake water surface elevation (mAHD)

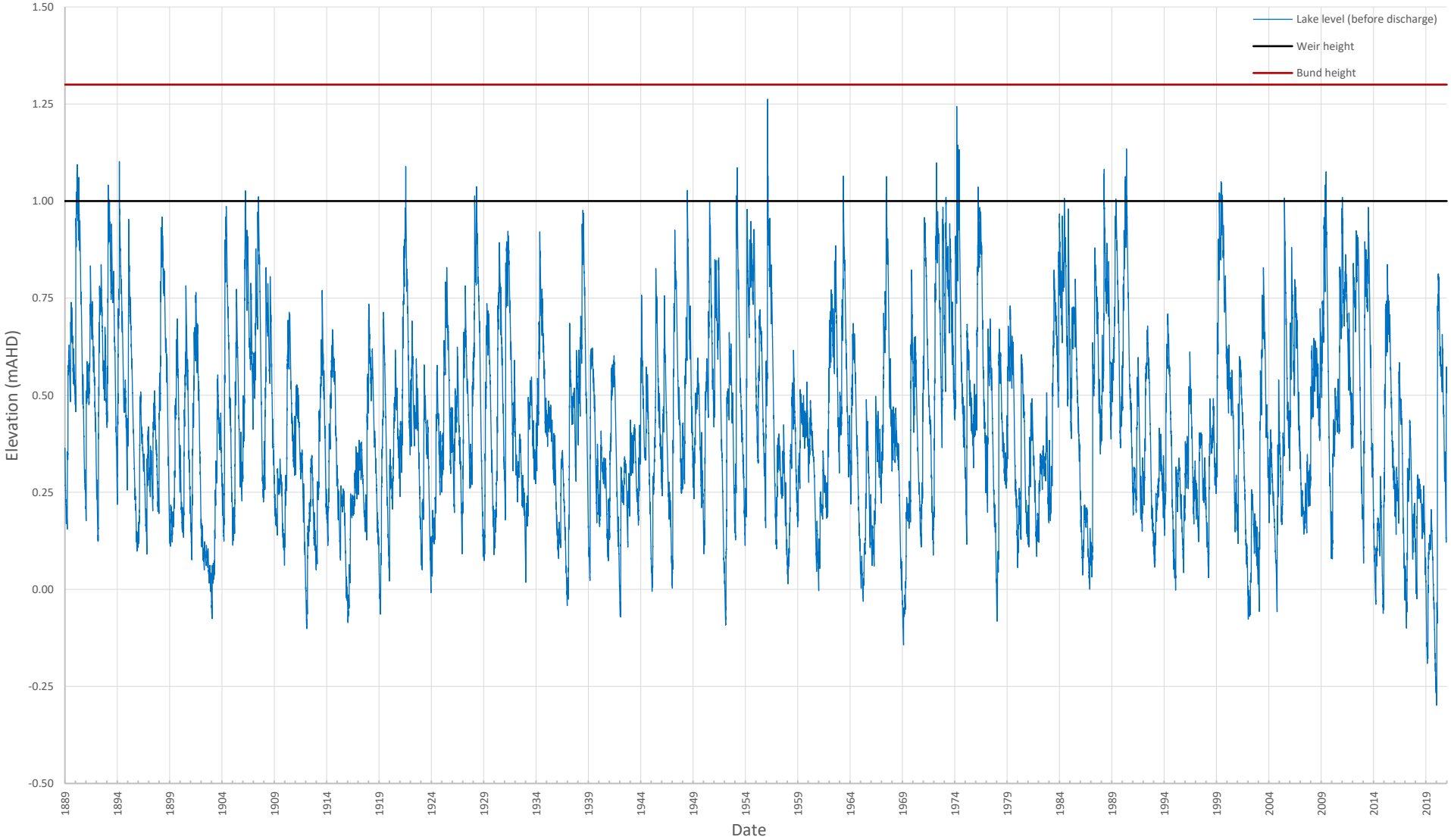


Figure A4.3: Phase 5: modelled lake water surface elevation (mAHD)

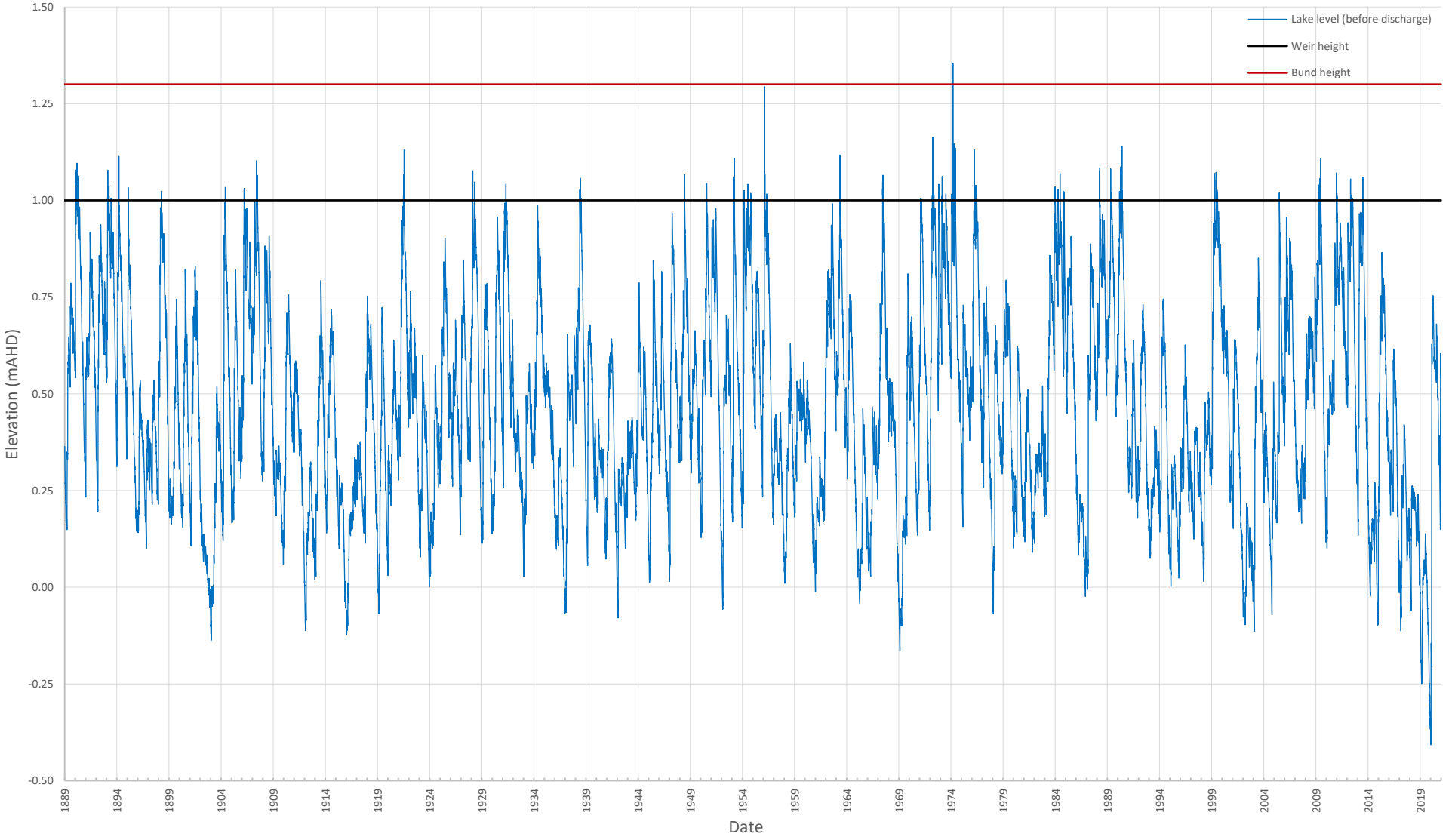


Figure A4.4: Phase 6: modelled lake water surface elevation (mAHD)

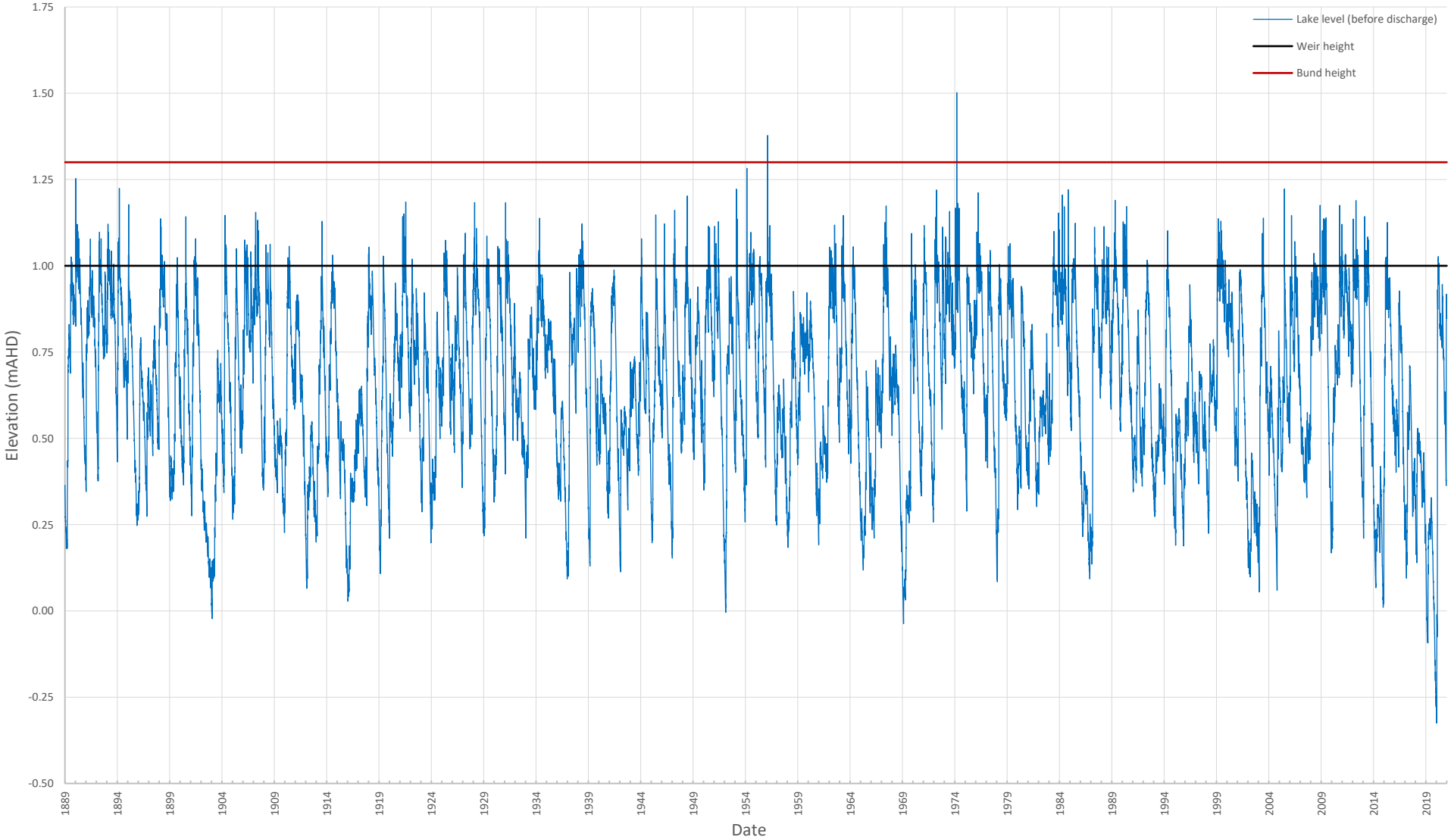


Figure A4.5: Phase 7: modelled lake water surface elevation (mAHD)

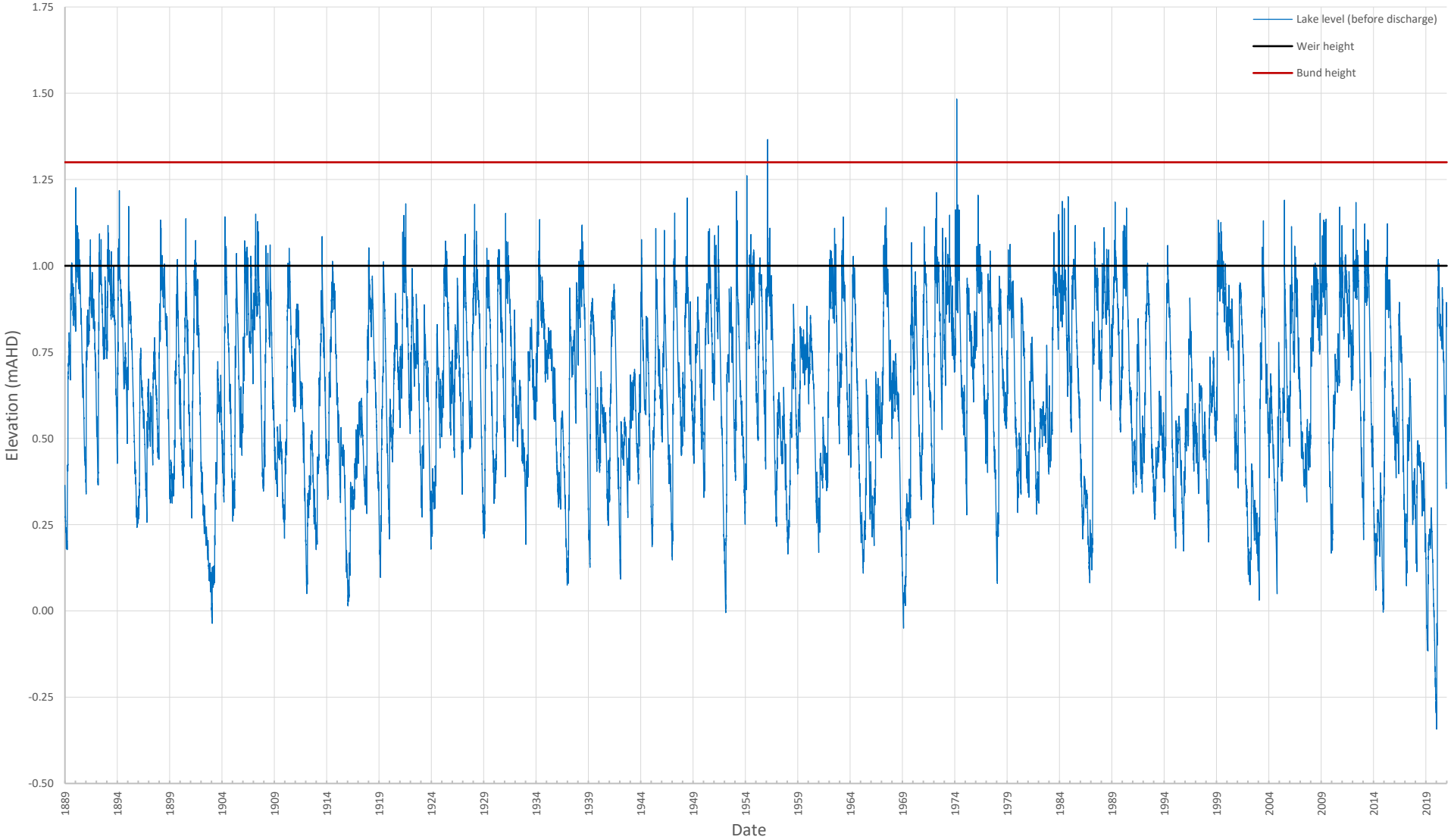


Figure A4.6: Phase 8: modelled lake water surface elevation (mAHD)

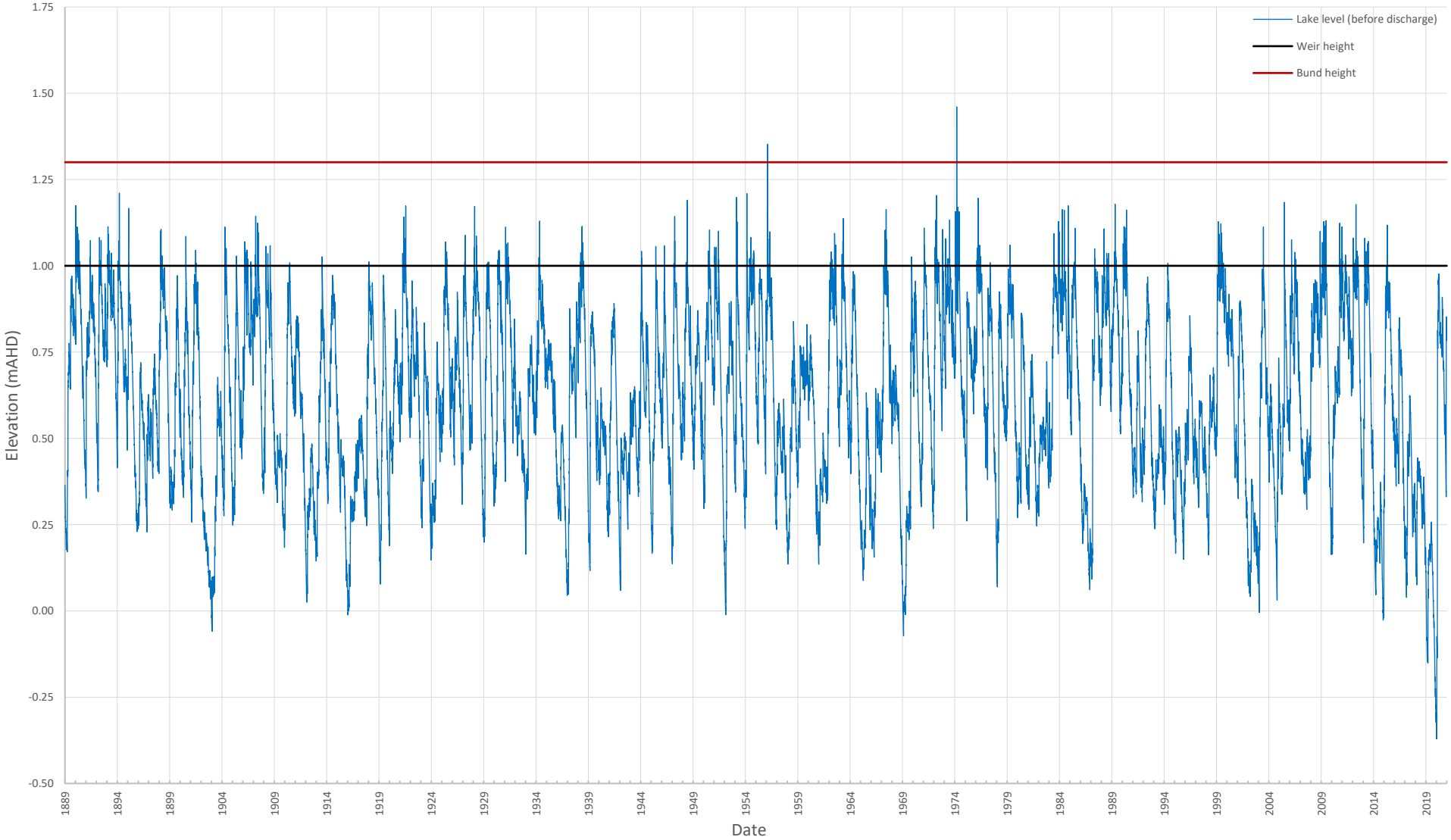


Figure A4.7: Phase 9: modelled lake water surface elevation (mAHD)

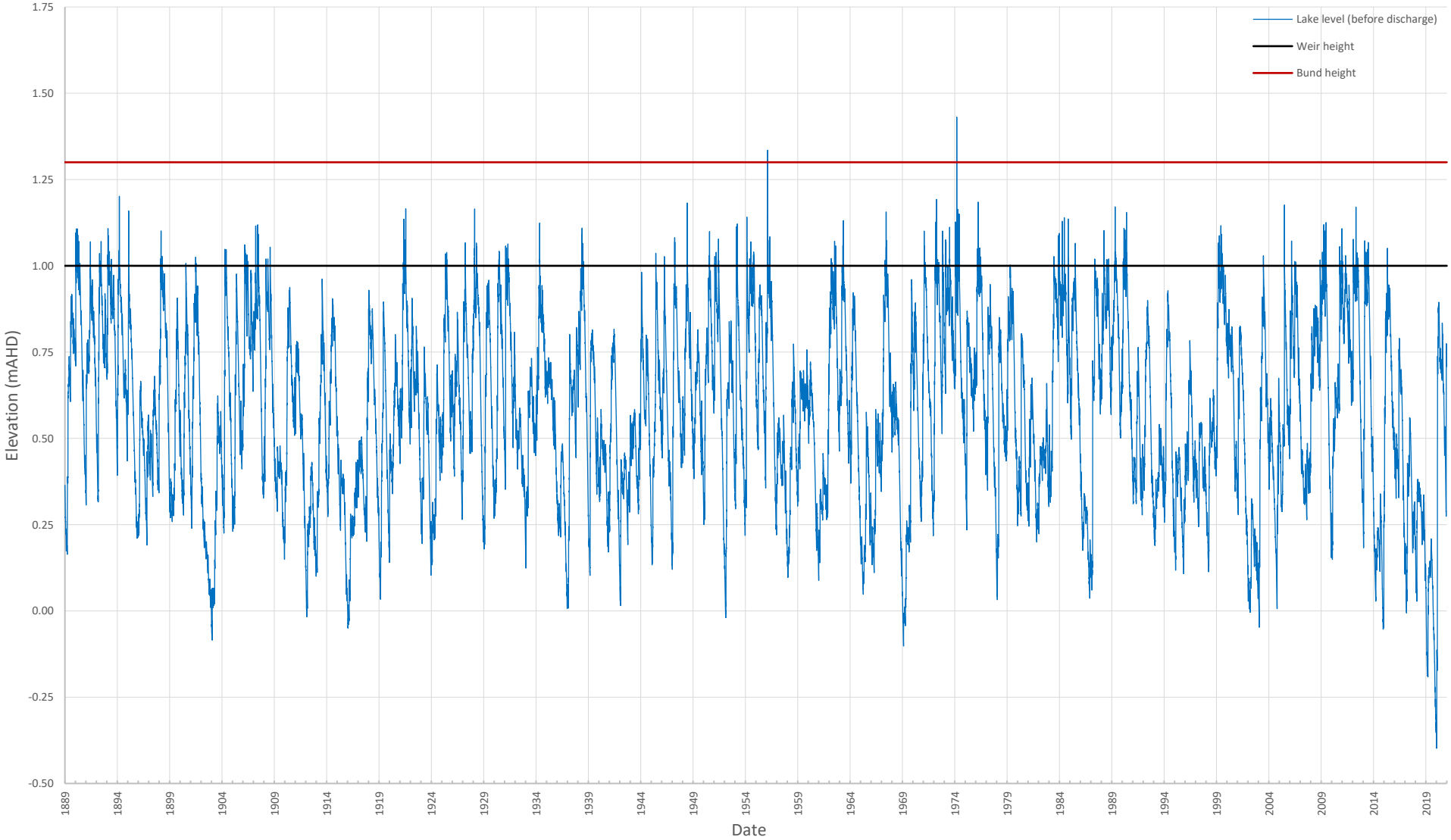


Figure A4.8: Phase 10: modelled lake water surface elevation (mAHD)

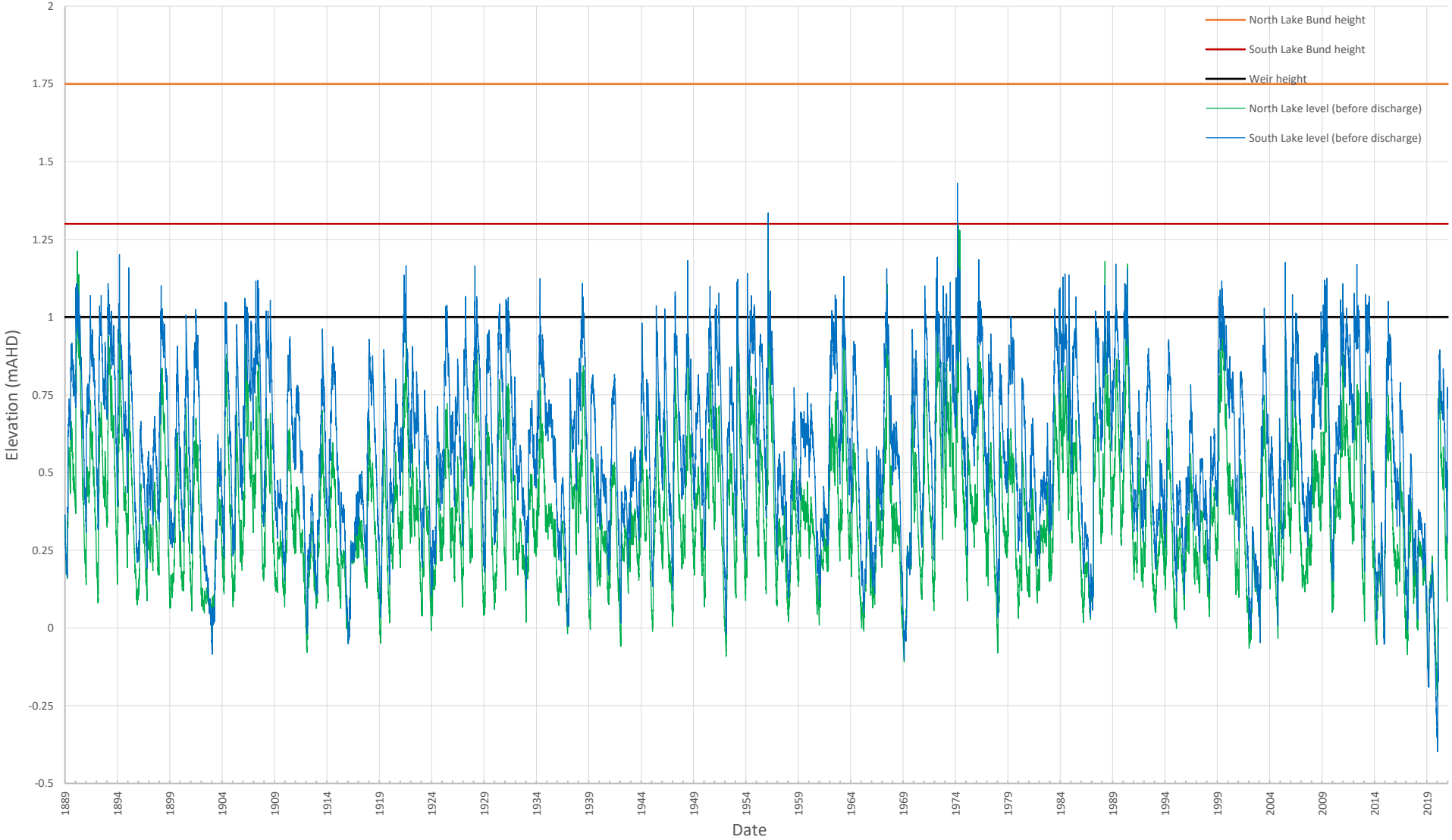
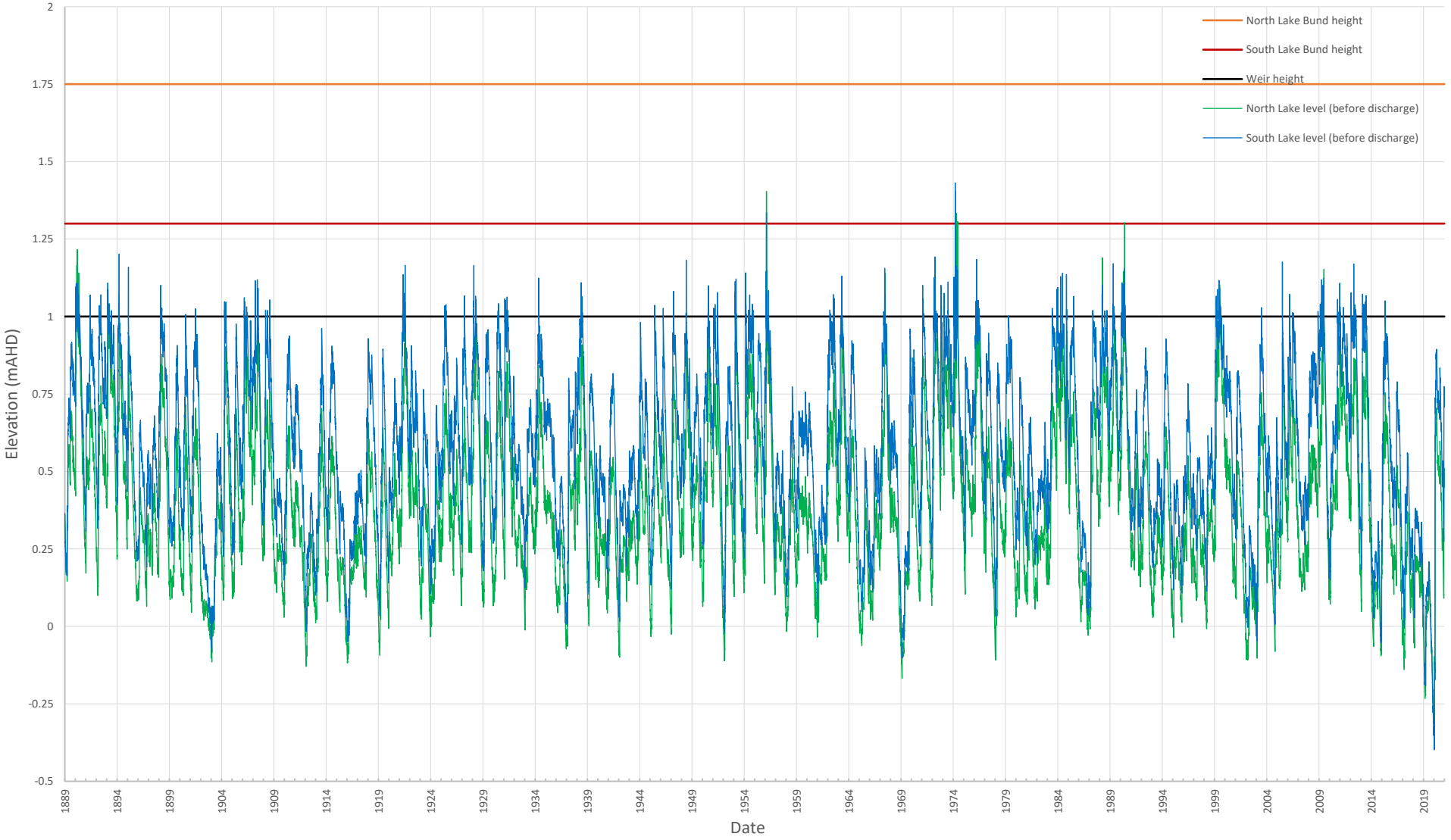


Figure A4.9: Phase 11: modelled lake water surface elevation (mAHD)



14 Appendix 5 – Certificates of analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2006826**	Page	: 1 of 4
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 11-Mar-2020 11:35
Order number	: ----	Date Analysis Commenced	: 11-Mar-2020
C-O-C number	: ----	Issue Date	: 17-Mar-2020 15:49
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G (Total Kjeldahl Nitrogen as N): Some samples were diluted due to matrix interference. LOR adjusted accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	L1	L2	L3	L4	L5
				Client sampling date / time	10-Mar-2020 00:00	10-Mar-2020 00:00	10-Mar-2020 00:00	10-Mar-2020 00:00	10-Mar-2020 00:00
Compound	CAS Number	LOR	Unit		EB2006826-001	EB2006826-002	EB2006826-003	EB2006826-004	EB2006826-005
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**7**	**9**	**7**	<5	**10**
EA045: Turbidity									
Turbidity	----	0.1	NTU		**6.3**	**7.0**	**11.5**	**7.6**	**18.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.12**	**0.12**	**0.05**	**0.13**	**0.01**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.06**	**0.06**	**0.05**	**0.08**	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.06**	**0.06**	**0.05**	**0.08**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**1.2**	**1.0**	**0.5**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		<0.5	<0.5	**1.2**	**1.1**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	**0.06**	**0.30**	**0.12**	**0.08**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.12**	**0.02**	**0.02**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	L6	L7	----	----	----
				Client sampling date / time	10-Mar-2020 00:00	10-Mar-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2006826-006	EB2006826-007	--------	--------	--------
					Result	Result	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**10**	**8**	----	----	----
EA045: Turbidity									
Turbidity	----	0.1	NTU		**15.1**	**11.4**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.12**	**0.05**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.02**	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.0**	**1.3**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.0**	**1.3**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.15**	**0.12**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	**0.01**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2012355**	Page	: 1 of 10
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 08-May-2020 15:40
Order number	: ----	Date Analysis Commenced	: 08-May-2020
C-O-C number	: ----	Issue Date	: 15-May-2020 16:55
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 19		
No. of samples analysed	: 19		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Luke Evans	Microbiologist	Brisbane Microbiological, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020F (Dissolved Metals by ICP-MS): Limit of reporting raised for some samples due to matrix interference.
- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorus as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- ED041G (Sulfate as SO4 2-) Sample EB2012355_008 (MB16b) was diluted due to matrix interference. LOR adjusted accordingly.
- MF = membrane filtration
- CFU = colony forming unit
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Microbiological Comment: Membrane filtration result for EB2012355-01,-02 and -03 is reported <100 CFU/100mL where the filtered sample at 10mL were overgrown and therefore the presumptive colonies were confirmed at 1mL sample filtered and confirmation of suspected organisms were not detected.
- Microbiological Comment: Membrane filtration result for EB2012355-06,-08,-10 and -12 is reported <1000 CFU/100mL where the filtered sample at 10 and 1mL were overgrown and therefore the presumptive colonies were confirmed at 0.1mL sample filtered and confirmation of suspected organisms were not detected.
- Microbiological Comment: Membrane filtration result is reported <10 CFU/100mL where 10mL sample was filtered because the sample was turbid, insufficient for filtration at higher volume and there were no target organisms confirmed.
- Microbiological Comment: Membrane filtration result for EB2012355-04 and -07is reported <10000 CFU/100mL where the filtered sample at 10 ,1 and 0.1mL were overgrown and therefore the presumptive colonies were confirmed at 0.01mL sample filtered and confirmation of suspected organisms were not detected.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MB13a	MB13b	MB14a	MB14b	MB15a
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012355-001	EB2012355-002	EB2012355-003	EB2012355-004	EB2012355-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.53	7.67	7.42	7.66	7.69
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	27100	626	31400	530	25300
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	465	261	1020	216	1060
Total Alkalinity as CaCO3	----	1	mg/L	465	261	1020	216	1060
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1330	2	1870	<1	2080
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	9630	35	11200	36	8080
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	437	81	164	80	193
Magnesium	7439-95-4	1	mg/L	700	10	717	6	823
Sodium	7440-23-5	1	mg/L	4860	39	6210	25	4580
Potassium	7440-09-7	1	mg/L	142	5	148	1	164
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	3970	243	3360	224	3870
^ Sodium Adsorption Ratio	----	0.01	-	33.5	1.09	46.6	0.72	32.0
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.01	<0.05	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.001	<0.005	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	9.28	3.59	7.38	5.17	0.96
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.3	0.7	0.5	0.2	0.4
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	8.30	0.35	19.9	0.47	11.8
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	0.08	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB13a	MB13b	MB14a	MB14b	MB15a
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2012355-001	EB2012355-002	EB2012355-003	EB2012355-004	EB2012355-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.08**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**9.8**	**0.9**	**24.0**	**1.8**	**13.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**9.8**	**0.9**	**24.1**	**1.8**	**13.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.51**	**0.35**	**0.33**	**0.38**	**0.59**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.04**	<0.01	<0.01	**0.34**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**309**	**6.24**	**375**	**5.33**	**292**
ø Total Cations	----	0.01	meq/L		**294**	**6.69**	**341**	**5.60**	**281**
ø Ionic Balance	----	0.01	%		**2.35**	**3.44**	**4.77**	**2.45**	**2.03**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~3700**	**8100**	**1100**	**270000**	**61000**
Escherichia coli	----	1	CFU/100mL		<100	<100	<100	<10000	<1000

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MB15b	MB16a	MB16b	MB17a	MB17b
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012355-006	EB2012355-007	EB2012355-008	EB2012355-009	EB2012355-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.60**	**7.33**	**7.31**	**7.85**	**7.75**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3710**	**23900**	**955**	**13400**	**510**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**572**	**1210**	**283**	**763**	**175**
Total Alkalinity as CaCO3	----	1	mg/L	**572**	**1210**	**283**	**763**	**175**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**188**	**701**	<5	**583**	**40**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**812**	**8090**	**122**	**4310**	**24**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**132**	**222**	**96**	**124**	**53**
Magnesium	7439-95-4	1	mg/L	**109**	**650**	**18**	**364**	**6**
Sodium	7440-23-5	1	mg/L	**506**	**4350**	**85**	**2260**	**53**
Potassium	7440-09-7	1	mg/L	**38**	**144**	**8**	**83**	**2**
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**778**	**3230**	**314**	**1810**	**157**
^ Sodium Adsorption Ratio	----	0.01	-	**7.89**	**33.3**	**2.09**	**23.1**	**1.84**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.002**	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	**4.60**	**0.29**	**16.1**	**1.11**	**3.25**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.6**	**0.4**	**0.6**	**0.5**	**0.2**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**1.33**	**9.46**	**0.44**	**7.03**	**0.35**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.04**	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB15b	MB16a	MB16b	MB17a	MB17b
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2012355-006	EB2012355-007	EB2012355-008	EB2012355-009	EB2012355-010
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.7**	**13.6**	**1.2**	**8.2**	**0.9**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**2.7**	**13.6**	**1.2**	**8.2**	**0.9**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.42**	**0.92**	**0.80**	**0.50**	**0.18**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.63**	**0.06**	**0.24**	**0.02**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**38.2**	**267**	**9.10**	**149**	**5.01**
ø Total Cations	----	0.01	meq/L		**38.5**	**257**	**10.2**	**136**	**5.50**
ø Ionic Balance	----	0.01	%		**0.38**	**1.81**	**5.59**	**4.34**	**4.65**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**48000**	**430000**	**12000**	**24000**	**~120000**
Escherichia coli	----	1	CFU/100mL		<1000	<10000	<1000	<1000	<1000

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MB18a	MB18b	L1	L2	L3
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2012355-011	EB2012355-012	EB2012355-013	EB2012355-014	EB2012355-015
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.47	7.54	7.85	7.84	7.62
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	15600	693	42700	41700	608
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	710	246	99	98	113
Total Alkalinity as CaCO3	----	1	mg/L	710	246	99	98	113
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1690	6	2280	2240	17
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4890	64	16600	16100	114
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	341	72	346	342	25
Magnesium	7439-95-4	1	mg/L	504	12	1010	990	14
Sodium	7440-23-5	1	mg/L	2620	57	7850	7740	70
Potassium	7440-09-7	1	mg/L	86	6	300	303	4
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	2930	229	5020	4930	120
^ Sodium Adsorption Ratio	----	0.01	-	21.1	1.64	48.2	48.0	2.78
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.05	<0.05	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.005	<0.005	<0.001
Iron	7439-89-6	0.05	mg/L	15.4	9.31	<0.05	<0.05	0.57
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.3	0.7	0.8	0.2
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	2.46	0.26	0.08	0.08	0.03
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	0.01	<0.01	0.08
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB18a	MB18b	L1	L2	L3
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2012355-011	EB2012355-012	EB2012355-013	EB2012355-014	EB2012355-015
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.01**	<0.01	**0.08**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**3.6**	**1.4**	<0.5	**1.5**	**0.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**3.6**	**1.4**	<0.5	**1.5**	**0.7**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.32**	**0.36**	**0.05**	**0.06**	**0.06**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**187**	**6.84**	**518**	**503**	**5.83**
ø Total Cations	----	0.01	meq/L		**175**	**7.21**	**450**	**443**	**5.55**
ø Ionic Balance	----	0.01	%		**3.50**	**2.62**	**7.05**	**6.32**	**2.47**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**----**	**----**	**2**	**1**	**3**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~60**	**57000**	**24**	**54**	**120**
Escherichia coli	----	1	CFU/100mL		<10	<1000	**17**	**54**	**110**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	L4	L5	L6	L7	----
			Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	----
Compound	CAS Number	LOR	Unit	EB2012355-016	EB2012355-017	EB2012355-018	EB2012355-019	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.65	8.16	7.64	7.72	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	37000	2620	28100	39900	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	103	141	100	96	----
Total Alkalinity as CaCO3	----	1	mg/L	103	141	100	96	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1930	169	1410	2100	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	14200	682	9990	15400	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	327	66	294	358	----
Magnesium	7439-95-4	1	mg/L	917	59	855	1060	----
Sodium	7440-23-5	1	mg/L	7730	364	6690	8770	----
Potassium	7440-09-7	1	mg/L	272	17	259	303	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	4590	408	4260	5260	----
^ Sodium Adsorption Ratio	----	0.01	-	49.6	7.84	44.6	52.6	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.01	<0.05	<0.05	----
Arsenic	7440-38-2	0.001	mg/L	<0.005	0.002	<0.005	<0.005	----
Iron	7439-89-6	0.05	mg/L	0.14	<0.05	<0.05	0.40	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.8	0.4	0.5	0.7	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.23	0.06	0.04	0.29	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.04	0.04	<0.01	0.09	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	L4	L5	L6	L7	----
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	----
Compound	CAS Number	LOR	Unit		EB2012355-016	EB2012355-017	EB2012355-018	EB2012355-019	--------
					Result	Result	Result	Result	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.04**	<0.01	**0.09**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.0**	**0.4**	<0.5	**0.5**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.0**	**0.4**	<0.5	**0.6**	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.20**	**0.02**	<0.05	<0.05	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**443**	**25.6**	**313**	**480**	----
ø Total Cations	----	0.01	meq/L		**435**	**24.4**	**383**	**494**	----
ø Ionic Balance	----	0.01	%		**0.89**	**2.31**	**9.99**	**1.46**	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**26**	**2**	**2**	**1**	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**12**	**~2**	**120**	**320**	----
Escherichia coli	----	1	CFU/100mL		**12**	<1	**90**	**320**	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2016243**	Page	: 1 of 10
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 10026	Date Samples Received	: 18-Jun-2020 15:40
Order number	: ----	Date Analysis Commenced	: 18-Jun-2020
C-O-C number	: ----	Issue Date	: 26-Jun-2020 15:03
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 17		
No. of samples analysed	: 17		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Luke Evans	Microbiologist	Brisbane Microbiological, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- It has been noted that EK071G (Reactive Phosphorus as P) is greater than EK067G (Total Phosphorus as P) for sample EB2016243_012 (MB15a), however this difference is within the limits of experimental variation.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Microbiological Comment: Accordance with ALS work instruction, membrane filtration result for EB2016243-13, -16 & -17 is estimated, where there are overgrown non-typical colonies on the filtered membrane that may have inhibited the growth of the target organisms. It may be informative to record this fact.
- Microbiological Comment: Membrane filtration result is reported <2 CFU/100mL where 50mL sample was filtered because the sample was turbid, insufficient for filtration at higher volume and there were no target organisms confirmed.
- Microbiological Comment: Membrane filtration result is reported <10 CFU/100mL where 10mL sample was filtered because the sample was turbid, insufficient for filtration at higher volume and there were no target organisms confirmed.
- EG020-F (Dissolved Metals by ICP-MS): Limit of reporting raised for some samples due to matrix interference.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	SW4	SW6	SW7
			Client sampling date / time	17-Jun-2020 00:00	17-Jun-2020 00:00	17-Jun-2020 00:00	17-Jun-2020 00:00	17-Jun-2020 00:00
Compound	CAS Number	LOR	Unit	EB2016243-001	EB2016243-002	EB2016243-004	EB2016243-006	EB2016243-007
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.81	7.77	7.49	7.79	7.87
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	19800	20400	28400	12100	5560
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	146	144	141	146	205
Total Alkalinity as CaCO3	----	1	mg/L	146	144	141	146	205
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	833	867	1290	551	190
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	6890	7070	9880	3970	1530
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	176	174	236	128	73
Magnesium	7439-95-4	1	mg/L	464	462	656	267	93
Sodium	7440-23-5	1	mg/L	3790	3790	5530	2170	731
Potassium	7440-09-7	1	mg/L	147	146	204	89	33
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	2350	2340	3290	1420	565
^ Sodium Adsorption Ratio	----	0.01	-	34.0	34.1	41.9	25.1	13.4
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.01	<0.05	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	<0.005	0.001	<0.001
Iron	7439-89-6	0.05	mg/L	<0.05	0.17	0.07	0.14	0.29
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.7	0.7	0.7	0.6	0.6
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.24	0.23	0.32	0.23	0.25
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.02	0.03	<0.01	0.02	0.05
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW4	SW6	SW7
				Client sampling date / time	17-Jun-2020 00:00	17-Jun-2020 00:00	17-Jun-2020 00:00	17-Jun-2020 00:00	17-Jun-2020 00:00
Compound	CAS Number	LOR	Unit		EB2016243-001	EB2016243-002	EB2016243-004	EB2016243-006	EB2016243-007
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	**0.03**	<0.01	**0.02**	**0.05**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.7**	**0.6**	**2.0**	**0.7**	**0.9**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**0.6**	**2.0**	**0.7**	**1.0**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.07**	**0.07**	**0.37**	**0.14**	**0.17**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.03**	**0.04**	**0.10**	**0.07**	**0.05**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**215**	**220**	**308**	**126**	**51.2**
ø Total Cations	----	0.01	meq/L		**216**	**215**	**312**	**125**	**43.9**
ø Ionic Balance	----	0.01	%		**0.22**	**1.16**	**0.51**	**0.54**	**7.64**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	**81**	<1	**2**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**110**	**160**	**54**	**~31**	**64**
Escherichia coli	----	1	CFU/100mL		**110**	**160**	**50**	**~25**	**49**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2016338**	Page	: 1 of 4
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 19-Jun-2020 13:50
Order number	: 12035	Date Analysis Commenced	: 19-Jun-2020
C-O-C number	: ----	Issue Date	: 26-Jun-2020 13:27
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Anuththara Jayasuriya	Microbiologist	Brisbane Microbiological, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW3	SW5	----	----	----
			Client sampling date / time	18-Jun-2020 00:00	18-Jun-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2016338-001	EB2016338-002	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.68**	**8.26**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**942**	**2700**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**119**	**143**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**119**	**143**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**68**	**167**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**196**	**708**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**44**	**67**	----	----	----
Magnesium	7439-95-4	1	mg/L	**23**	**60**	----	----	----
Sodium	7440-23-5	1	mg/L	**114**	**372**	----	----	----
Potassium	7440-09-7	1	mg/L	**7**	**18**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**204**	**414**	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	**3.47**	**7.95**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.11**	<0.05	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.5**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.11**	<0.01	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.13**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW3	SW5	----	----	----
				Client sampling date / time	18-Jun-2020 00:00	18-Jun-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2016338-001	EB2016338-002	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.13**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.6**	**0.3**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.6**	**0.4**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	**0.01**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**9.32**	**26.3**	----	----	----
ø Total Cations	----	0.01	meq/L		**9.23**	**24.9**	----	----	----
ø Ionic Balance	----	0.01	%		**0.52**	**2.70**	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	**2**	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~350**	**16**	----	----	----
Escherichia coli	----	1	CFU/100mL		**~270**	**14**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2018737**	Page	: 1 of 6
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 16-Jul-2020 11:20
Order number	: ----	Date Analysis Commenced	: 16-Jul-2020
C-O-C number	: ----	Issue Date	: 22-Jul-2020 10:23
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Luke Evans	Microbiologist	Brisbane Microbiological, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020F (Dissolved Metals by ICP-MS): Limit of reporting raised for some samples due to matrix interference.
- EK067G (Total Phosphorus as P): Sample EB2018737_002 (SW2) was diluted due to matrix interference. LOR adjusted accordingly.
- MF = membrane filtration
- CFU = colony forming unit
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Microbiological Comment: Accordance with ALS work instruction, membrane filtration result for EB2018737-07 is estimated, where there are overgrown non-typical colonies on the filtered membrane that may have inhibited the growth of the target organisms. It may be informative to record this fact.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	SW3	SW4	SW5
			Client sampling date / time	15-Jul-2020 00:00	15-Jul-2020 00:00	15-Jul-2020 00:00	15-Jul-2020 00:00	15-Jul-2020 00:00
Compound	CAS Number	LOR	Unit	EB2018737-001	EB2018737-002	EB2018737-003	EB2018737-004	EB2018737-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.64	7.60	7.18	7.62	8.13
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	34000	32000	1100	25400	2620
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	136	151	160	202	149
Total Alkalinity as CaCO3	----	1	mg/L	136	151	160	202	149
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1650	1540	86	1170	164
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	11400	10400	210	8240	664
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	263	248	73	211	77
Magnesium	7439-95-4	1	mg/L	823	756	28	545	63
Sodium	7440-23-5	1	mg/L	6800	6230	122	4560	364
Potassium	7440-09-7	1	mg/L	249	237	7	188	18
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	4040	3730	298	2770	452
^ Sodium Adsorption Ratio	----	0.01	-	46.5	44.4	3.08	37.7	7.45
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.05	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	<0.001	<0.001	0.002
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.44	0.11	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.9	0.9	0.3	1.0	0.5
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.09	0.12	0.06	0.03	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	0.05	0.14
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW5
				Client sampling date / time	15-Jul-2020 00:00	15-Jul-2020 00:00	15-Jul-2020 00:00	15-Jul-2020 00:00	15-Jul-2020 00:00
Compound	CAS Number	LOR	Unit		EB2018737-001	EB2018737-002	EB2018737-003	EB2018737-004	EB2018737-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	**0.05**	**0.14**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.8**	**0.7**	**0.7**	**1.2**	**0.5**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.8**	**0.7**	**0.7**	**1.2**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	<0.05	**0.03**	**0.18**	**0.02**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.01**	**0.02**	<0.01	**0.04**	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**359**	**328**	**10.9**	**261**	**25.1**
ø Total Cations	----	0.01	meq/L		**383**	**352**	**11.4**	**258**	**25.3**
ø Ionic Balance	----	0.01	%		**3.28**	**3.41**	**2.34**	**0.44**	**0.39**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	**1**	<1	**36**	**2**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**52**	**310**	**240**	**17**	**~7**
Escherichia coli	----	1	CFU/100mL		**50**	**310**	**240**	**13**	**~6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW6	SW7	----	----	----
			Client sampling date / time	15-Jul-2020 00:00	15-Jul-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2018737-006	EB2018737-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.67**	**7.50**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**16500**	**13900**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**212**	**218**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**212**	**218**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**763**	**610**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**5320**	**4360**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**175**	**149**	----	----	----
Magnesium	7439-95-4	1	mg/L	**363**	**284**	----	----	----
Sodium	7440-23-5	1	mg/L	**2740**	**2190**	----	----	----
Potassium	7440-09-7	1	mg/L	**113**	**91**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**1930**	**1540**	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	**27.1**	**24.3**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.06**	**0.32**	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.8**	**0.8**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.07**	**0.18**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW6	SW7	----	----	----
				Client sampling date / time	15-Jul-2020 00:00	15-Jul-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2018737-006	EB2018737-007	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		1.0	1.0	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		1.0	1.0	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.12	0.13	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.02	0.02	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		170	140	----	----	----
ø Total Cations	----	0.01	meq/L		161	128	----	----	----
ø Ionic Balance	----	0.01	%		2.87	4.34	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		3	2	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		61	53	----	----	----
Escherichia coli	----	1	CFU/100mL		48	53	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2021203**	Page	: 1 of 6
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 12-Aug-2020 12:10
Order number	: ----	Date Analysis Commenced	: 12-Aug-2020
C-O-C number	: ----	Issue Date	: 21-Aug-2020 08:48
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Anuththara Jayasuriya	Microbiologist	Brisbane Microbiological, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorus as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- MF = membrane filtration
- CFU = colony forming unit
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Microbiological Comment: Accordance with ALS work instruction, membrane filtration result for EB2021203-03, -05 & -06 is estimated, where there are overgrown non-typical colonies on the filtered membrane that may have inhibited the growth of the target organisms. It may be informative to record this fact.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	L1	L2	L3	L4	L5
			Client sampling date / time	11-Aug-2020 00:00	11-Aug-2020 00:00	11-Aug-2020 00:00	11-Aug-2020 00:00	11-Aug-2020 00:00
Compound	CAS Number	LOR	Unit	EB2021203-001	EB2021203-002	EB2021203-003	EB2021203-004	EB2021203-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.74**	**7.75**	**7.42**	**7.73**	**8.28**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**20700**	**20200**	**798**	**18400**	**2660**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**152**	**149**	**109**	**239**	**163**
Total Alkalinity as CaCO3	----	1	mg/L	**152**	**149**	**109**	**239**	**163**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**937**	**929**	**61**	**793**	**167**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**6920**	**6880**	**158**	**6260**	**713**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**187**	**185**	**42**	**168**	**79**
Magnesium	7439-95-4	1	mg/L	**451**	**451**	**19**	**396**	**62**
Sodium	7440-23-5	1	mg/L	**3730**	**3780**	**93**	**3420**	**389**
Potassium	7440-09-7	1	mg/L	**141**	**143**	**5**	**130**	**18**
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**2320**	**2320**	**183**	**2050**	**452**
^ Sodium Adsorption Ratio	----	0.01	-	**33.7**	**34.2**	**2.99**	**32.9**	**7.95**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.01**	**0.01**	**0.01**	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.37**	**0.12**	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.6**	**0.7**	**0.2**	**0.8**	**0.6**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.14**	**0.15**	**0.03**	**0.03**	**0.01**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.04**	**0.04**	<0.01	<0.01	**0.09**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	L1	L2	L3	L4	L5
				Client sampling date / time	11-Aug-2020 00:00	11-Aug-2020 00:00	11-Aug-2020 00:00	11-Aug-2020 00:00	11-Aug-2020 00:00
Compound	CAS Number	LOR	Unit		EB2021203-001	EB2021203-002	EB2021203-003	EB2021203-004	EB2021203-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.04**	<0.01	<0.01	**0.09**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**0.5**	**1.0**	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**0.5**	**1.0**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.05**	<0.05	**0.03**	**0.28**	**0.02**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	**0.02**	<0.01	**0.11**	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**218**	**216**	**7.90**	**198**	**26.8**
ø Total Cations	----	0.01	meq/L		**212**	**214**	**7.83**	**193**	**26.4**
ø Ionic Balance	----	0.01	%		**1.27**	**0.46**	**0.46**	**1.23**	**0.79**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**3**	<1	**2**	**49**	**6**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**62**	**~110**	**50**	**~43**	**~6**
Escherichia coli	----	1	CFU/100mL		**60**	**~110**	**50**	**~28**	**~6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	L6	L7	----	----	----
			Client sampling date / time	11-Aug-2020 00:00	11-Aug-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2021203-006	EB2021203-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.87**	**7.79**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**10200**	**3940**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**175**	**186**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**175**	**186**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**556**	**155**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3190**	**1110**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**124**	**90**	----	----	----
Magnesium	7439-95-4	1	mg/L	**220**	**81**	----	----	----
Sodium	7440-23-5	1	mg/L	**1730**	**600**	----	----	----
Potassium	7440-09-7	1	mg/L	**66**	**25**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**1220**	**558**	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	**21.6**	**11.0**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.15**	**0.13**	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.6**	**0.5**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.05**	**0.18**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.06**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	L6	L7	----	----	----
				Client sampling date / time	11-Aug-2020 00:00	11-Aug-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2021203-006	EB2021203-007	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.06**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	**0.5**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		<0.5	**0.6**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.09**	**0.09**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.01**	**0.01**	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**105**	**38.2**	----	----	----
ø **Total Cations**	----	0.01	meq/L		**101**	**37.9**	----	----	----
ø **Ionic Balance**	----	0.01	%		**1.85**	**0.47**	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**3**	**3**	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~62**	**~81**	----	----	----
Escherichia coli	----	1	CFU/100mL		**~57**	**~81**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2023884**	Page	: 1 of 6
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 10-Sep-2020 12:20
Order number	: ----	Date Analysis Commenced	: 10-Sep-2020
C-O-C number	: ----	Issue Date	: 17-Sep-2020 15:31
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Liz Heizmann	Microbiology Laboratory Technician	Brisbane Microbiological, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- MF = membrane filtration
- CFU = colony forming unit
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorus as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	SW3	SW4	SW5
			Client sampling date / time	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit	EB2023884-001	EB2023884-002	EB2023884-003	EB2023884-004	EB2023884-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.76	7.73	7.89	8.08	8.50
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	42200	42100	1330	28500	2720
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	12
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	96	100	236	183	143
Total Alkalinity as CaCO3	----	1	mg/L	96	100	236	183	155
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2110	2100	69	1370	171
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	14400	14500	271	9700	711
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	351	354	76	258	78
Magnesium	7439-95-4	1	mg/L	1060	1070	31	721	60
Sodium	7440-23-5	1	mg/L	8860	9120	160	5990	386
Potassium	7440-09-7	1	mg/L	321	326	9	221	18
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	5240	5290	317	3610	442
^ Sodium Adsorption Ratio	----	0.01	-	53.2	54.6	3.91	43.4	7.99
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.05	<0.01	<0.05	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	0.001	<0.005	0.002
Iron	7439-89-6	0.05	mg/L	0.06	<0.05	0.87	0.08	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.7	0.6	0.3	0.6	0.4
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.14	0.16	0.03	0.02	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.02
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW5
				Client sampling date / time	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EB2023884-001	EB2023884-002	EB2023884-003	EB2023884-004	EB2023884-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.02**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**1.0**	**0.7**	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**1.0**	**0.7**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.05	**0.10**	**0.12**	**0.10**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	**0.01**	**0.01**	**0.02**	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**452**	**455**	**13.8**	**306**	**26.7**
ø Total Cations	----	0.01	meq/L		**498**	**511**	**13.5**	**338**	**26.1**
ø Ionic Balance	----	0.01	%		**4.87**	**5.80**	**0.96**	**5.06**	**1.20**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	**2**	**2**	**7**	**4**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**17**	**39**	**~410**	**~2**	<1
Escherichia coli	----	1	CFU/100mL		**13**	**31**	**~320**	**~2**	<1

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW6	SW7	----	----	----
			Client sampling date / time	09-Sep-2020 00:00	09-Sep-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2023884-006	EB2023884-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.92**	**8.08**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**19400**	**5720**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**136**	**204**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**136**	**204**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**794**	**228**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**6440**	**1660**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**164**	**94**	----	----	----
Magnesium	7439-95-4	1	mg/L	**400**	**122**	----	----	----
Sodium	7440-23-5	1	mg/L	**3480**	**961**	----	----	----
Potassium	7440-09-7	1	mg/L	**134**	**38**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**2060**	**737**	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	**33.4**	**15.4**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	<0.001	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.09**	**0.10**	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.5**	**0.4**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.03**	**0.16**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.03**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW6	SW7	----	----	----
				Client sampling date / time	09-Sep-2020 00:00	09-Sep-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2023884-006	EB2023884-007	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.03**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.5**	**0.5**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.5**	**0.5**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.18**	**0.14**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.08**	**0.03**	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**201**	**55.6**	----	----	----
ø **Total Cations**	----	0.01	meq/L		**196**	**57.5**	----	----	----
ø **Ionic Balance**	----	0.01	%		**1.26**	**1.64**	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**7**	**1**	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**12**	**32**	----	----	----
Escherichia coli	----	1	CFU/100mL		**12**	**19**	----	----	----

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorus as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- MF = membrane filtration
- CFU = colony forming unit
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Microbiological Comment: Accordance with ALS work instruction, membrane filtration result for EB2024970-05 is estimated, where there are overgrown non-typical colonies on the filtered membrane that may have inhibited the growth of the target organisms. It may be informative to record this fact.
- EG020-F (Dissolved Metals by ICP-MS): Limit of reporting raised due to matrix interference.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	SW3	SW4	SW5
			Client sampling date / time	21-Sep-2020 00:00	21-Sep-2020 00:00	21-Sep-2020 00:00	21-Sep-2020 00:00	21-Sep-2020 00:00
Compound	CAS Number	LOR	Unit	EB2024970-001	EB2024970-002	EB2024970-003	EB2024970-004	EB2024970-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.83	7.79	7.86	8.05	8.57
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	43300	43500	1160	37300	2770
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	13
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	93	94	197	104	132
Total Alkalinity as CaCO3	----	1	mg/L	93	94	197	104	146
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2200	2150	74	1800	164
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	15100	15900	225	12600	716
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	336	348	65	284	72
Magnesium	7439-95-4	1	mg/L	1010	1040	27	868	62
Sodium	7440-23-5	1	mg/L	8480	8780	127	7180	404
Potassium	7440-09-7	1	mg/L	312	323	7	268	19
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	5000	5150	273	4280	435
^ Sodium Adsorption Ratio	----	0.01	-	52.2	53.2	3.34	47.7	8.42
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.05	0.02	<0.05	0.01
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	0.001	<0.005	0.001
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.85	0.05	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.7	0.7	0.2	0.7	0.4
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.08	0.09	0.03	0.04	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW5
				Client sampling date / time	21-Sep-2020 00:00	21-Sep-2020 00:00	21-Sep-2020 00:00	21-Sep-2020 00:00	21-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EB2024970-001	EB2024970-002	EB2024970-003	EB2024970-004	EB2024970-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**0.7**	<0.5	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	**0.7**	<0.5	**0.3**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.05	**0.05**	**0.10**	**0.12**	**0.02**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.01**	**0.05**	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**474**	**495**	**11.8**	**395**	**26.5**
ø Total Cations	----	0.01	meq/L		**477**	**493**	**11.2**	**405**	**26.8**
ø Ionic Balance	----	0.01	%		**0.33**	**0.20**	**2.85**	**1.22**	**0.42**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**2**	**2**	**3**	<1	**2**
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~6**	**20**	**140**	**~5**	**30**
Escherichia coli	----	1	CFU/100mL		**~6**	**15**	**100**	**~5**	**22**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW6	SW7	----	----	----
			Client sampling date / time	21-Sep-2020 00:00	21-Sep-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2024970-006	EB2024970-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.89**	**7.79**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**32100**	**37300**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**125**	**124**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**125**	**124**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**1580**	**1650**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**11000**	**12600**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**248**	**296**	----	----	----
Magnesium	7439-95-4	1	mg/L	**734**	**888**	----	----	----
Sodium	7440-23-5	1	mg/L	**6190**	**7390**	----	----	----
Potassium	7440-09-7	1	mg/L	**228**	**272**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**3640**	**4400**	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	**44.6**	**48.5**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.05	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.08**	<0.05	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.6**	**0.7**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**0.09**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW6	SW7	----	----	----
				Client sampling date / time	21-Sep-2020 00:00	21-Sep-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2024970-006	EB2024970-007	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	<0.5	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		<0.5	<0.5	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.14**	**0.08**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.04**	**0.02**	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**346**	**392**	----	----	----
ø **Total Cations**	----	0.01	meq/L		**348**	**416**	----	----	----
ø **Ionic Balance**	----	0.01	%		**0.31**	**2.97**	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**9**	**3**	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**46**	**150**	----	----	----
Escherichia coli	----	1	CFU/100mL		**28**	**150**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2026546**	Page	: 1 of 6
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS ERIN HOLTON	Contact	: Carsten Emrich
Address	: P O BOX 4115 ROBINA QLD, AUSTRALIA 4230	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: +61 7 3552 8616
Project	: 12035	Date Samples Received	: 09-Oct-2020 14:20
Order number	: ----	Date Analysis Commenced	: 09-Oct-2020
C-O-C number	: ----	Issue Date	: 16-Oct-2020 16:31
Sampler	: MIAH CLAYTON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G (Total Kjeldahl Nitrogen as N): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- EG020-F (Dissolved Metals by ICP-MS): Limit of reporting raised for some samples due to matrix interference.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	SW3	SW4	SW5
			Client sampling date / time	07-Oct-2020 00:00	07-Oct-2020 00:00	07-Oct-2020 00:00	07-Oct-2020 00:00	07-Oct-2020 00:00
Compound	CAS Number	LOR	Unit	EB2026546-001	EB2026546-002	EB2026546-003	EB2026546-004	EB2026546-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.58	7.62	7.92	7.81	8.54
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	45200	45700	1650	36700	2750
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	18
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	108	110	326	154	134
Total Alkalinity as CaCO3	----	1	mg/L	108	110	326	154	152
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2200	2210	55	1700	200
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	16400	16400	345	13100	717
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	356	363	104	347	75
Magnesium	7439-95-4	1	mg/L	1050	1080	42	964	65
Sodium	7440-23-5	1	mg/L	8560	8660	190	7710	412
Potassium	7440-09-7	1	mg/L	331	331	13	297	19
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	5210	5350	433	4840	455
^ Sodium Adsorption Ratio	----	0.01	-	51.6	51.5	3.97	48.2	8.40
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.05	0.02	<0.05	0.01
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	0.002	<0.005	0.001
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.57	0.18	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.7	0.7	0.4	0.7	0.5
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.12	0.14	0.39	0.14	0.02
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.02	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW5
				Client sampling date / time	07-Oct-2020 00:00	07-Oct-2020 00:00	07-Oct-2020 00:00	07-Oct-2020 00:00	07-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EB2026546-001	EB2026546-002	EB2026546-003	EB2026546-004	EB2026546-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	**0.7**	**1.5**	**0.8**	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.5	**0.7**	**1.5**	**0.8**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	**0.06**	**0.25**	**0.12**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.04**	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**510**	**511**	**17.4**	**408**	**27.4**
ø Total Cations	----	0.01	meq/L		**485**	**492**	**17.2**	**440**	**27.5**
ø Ionic Balance	----	0.01	%		**2.57**	**1.86**	**0.42**	**3.73**	**0.13**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**1**	**2**	**34**	**21**	**2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW6	SW7	----	----	----
			Client sampling date / time	07-Oct-2020 00:00	07-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2026546-006	EB2026546-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.85**	**7.96**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**31100**	**8150**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**164**	**220**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**164**	**220**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**1400**	**346**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**10400**	**2540**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**294**	**118**	----	----	----
Magnesium	7439-95-4	1	mg/L	**785**	**184**	----	----	----
Sodium	7440-23-5	1	mg/L	**6310**	**1520**	----	----	----
Potassium	7440-09-7	1	mg/L	**237**	**60**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**3970**	**1050**	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	**43.6**	**20.4**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.05	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.001	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.09**	**0.06**	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.7**	**0.5**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**0.29**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.03**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW6	SW7	----	----	----
				Client sampling date / time	07-Oct-2020 00:00	07-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2026546-006	EB2026546-007	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.03**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.7**	**0.6**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**0.6**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.28**	**0.21**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.12**	**0.04**	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**326**	**83.2**	----	----	----
ø Total Cations	----	0.01	meq/L		**360**	**88.7**	----	----	----
ø Ionic Balance	----	0.01	%		**4.96**	**3.16**	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**11**	**1**	----	----	----