Report on Southern Rural Water's Macalister Irrigation District (MID) Nutrient Monitoring Program

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1 Introduction

1.1 Purpose of report

The purpose of this report is to critically evaluate Southern Rural Water's nutrient monitoring program in the Macalister Irrigation District. It examines the effectiveness of current sampling methods and data management practices, identifies key shortcomings in capturing nutrient loads—especially during high flow events—and recommends improvements to ensure more accurate and reliable water quality assessments for the protection of the Gippsland Lakes.

The report has been compiled by Friends of the Gippsland Lakes Inc using data and reports kindly supplied by Southern Rural Water, with input from David Tiller, former senior freshwater scientist at Environment Protection Authority Victoria.

1.2 Key issues

Water quality and periodic algal blooms are key issues for the Lake Wellington catchment and the Gippsland Lakes bioregion. These issues, along with the persistent challenges in resolving them, are major concerns for stakeholders who are dedicated to protecting the Lakes' ecosystems and/or depend on them for both recreational enjoyment and commercial activities.

Water quality in rivers and the Gippsland Lakes is influenced by multiple factors, including floods and agricultural runoff rich in nutrients; especially nitrogen (N) and phosphorus (P).[1] The Macalister Irrigation District (MID) is well recognised as a key source of the N and P which deposit into Lake Wellington and contribute to periodic toxic algal blooms throughout the Gippsland Lakes.[2]

The main focus of the Lake Wellington Land & Water Management Plan (LWMP) is on reducing nutrient losses from irrigation farms and their impacts on the waterways of the Lake Wellington catchment.

Accurate measurement of nutrient levels flowing into Lake Wellington (and then into the deeper Lakes), is critical to adaptive land and water management and the protection of the Gippsland Lakes' Ramsar values.

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[1] Lake Wellington Land and Water Management Plan (2018) – Technical Appendices, Final Draft; p.87
[2] *ibid.,* p.19

The accuracy of the nutrient load estimates are largely determined by the recurrent annual monitoring budget. As acknowledged by the model development report:

> *"Precise measurements of nutrient loads exported from the MID would require very frequent (at least daily) nutrient monitoring at all waterways entering and leaving the area. Such monitoring is not practical and would simply cost too much."*

Devising a 'real-world' nutrient monitoring program involves investigating suitable sampling strategies across a range of monitoring sites that are capable of maximising the accuracy of the nutrient load estimates within the recurrent annual budget on an ongoing basis.

It is within this context that Friends of Gippsland Lakes (FOGL) have assessed the monitoring data and reports supplied by SRW. Our feedback is framed by an understanding that budgetary constraints have resulted in the current monitoring program being far from perfect. At best, the current program offers inconsistent estimates of Total Phosphorous (TP) loads under typical base flow conditions.

Importantly however, the model and sampling regime is currently incapable of producing accurate TP load results during high flow events, when nutrient loads are likely to be at their highest. The net result is the model is highly likely to **significantly underestimate total MID nutrient load exports into the Gippsland Lakes**.

We submit that an enhanced monitoring budget would permit flow-weighted sampling at key upstream and downstream sites along with subsurface nutrient testing for low flow sampling sites. However, the current operating budget and monitoring regime appears incapable of making consistently reliable and accurate nutrient load estimates under variable rainfall conditions

2 Key Findings

Friends of Gippsland Lakes makes the following findings and comments in relation to SRW's current monitoring regime for the MID.

2.1 SKM nutrient load model is unverified

Any model is only as robust as the data and assumptions it's based on.

The Jacobs-SKM model development report makes the following disclaimer:

> *"In preparing this report, SKM has relied upon, and <u>presumed accurate</u>, any information (or confirmation of the absence thereof) provided by Southern Rural Water and/or from other sources. Except as otherwise stated in the report, **SKM has not attempted to verify the accuracy or completeness of any such information**. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change (emphasis added).*
>
> *For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report.[3]"*

The Jacob-SKM (2014) model remains unverified and warrants an independent peer review of the modelling methodology, streamflow and TP data assumptions which underpin the estimated TP load calculations.

2.2 Scope of MID Monitoring program is too limited

2.2.1 Baseflow vs flow-weighted sampling regime

The MID Nutrient Monitoring Model is designed for baseflow monitoring rather than flow-weighted sampling. The model is intended to collect baseload data under 'normal' irrigation and rainfall conditions rather than accurately measure peak loads during high flow events.

Without high flow samples, the TP load calculations cannot be considered valid.

Even with high flow sampling, uncertainty is high and estimated loads can vary considerably. For the TP load estimates to be both credible and meaningful, they must be presented alongside error bars that quantify the inherent uncertainties in the measurements and modelling processes. Without these error margins, the estimates lack the contextual detail necessary for robust scientific interpretation and practical application.

It is noted that the methodology includes mixing of daily / two-day samples to form a weekly or fortnightly composite. This can present an error in the flow weighted concentration of a period as the sample volume collected is always the same and not in proportion to the flow. As a consequence, the model's weekly and fortnightly composite sampling method is likely to significantly underestimate TP loads, being more suitable for base flow rather than peak flow

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[3] Jacobs-SKM (2014) *MID Nutrient Method - Southern Rural Water; Method and Model Development – Final A | Final Report,* p.40

monitoring. It's well understood that high flows translate to high nutrient loads as explained in the modelling report:

> *"Examination of the TP records showed that the TP concentrations can vary considerably during a week, particularly when there is a large flow event. As a **large part of the quarterly nutrient load can be transported down the river systems during a few days with high flows**, even a small change in the TP concentrations estimated on these days can alter the estimated nutrient load considerably.[4]"*

Flow-weighted sampling collects composite samples that represent the average nutrient concentrations over time, weighted by the volume of water passing through a site. This contrasts with grab sampling that occurs at a set time regardless of flow volumes, which might miss critical flow-driven variability. The protocol ensures representations of nutrient loads are accurate, especially during events like irrigation releases or heavy rainfall.

Taking a single additional sample when flows exceed a high flow trigger level (95th percentile flows) makes some allowance for higher flows. However, this trigger method lacks the sampling resolution required to accurately measure the estimated nutrient load from high flow events. This is particularly important when one considers that over 80% of nutrient export will occur in larger rainfall events, necessitating more intensive sampling during higher flows to not miss the export of nutrients during these short duration, high flow events.[5]

Furthermore, the 95th percentile Flow Trigger appears to be based on mean daily flow data (ML/day) taken from DEPI's Water Measurement Information System (WMIS) prior to August 2014[6]. SKM modelers advised these levels needed to be reviewed after 12 months or earlier if deemed necessary[7], though it appears from discussions we've had with SRW staff that regular reviews and updates to trigger levels (or control charts for that matter) have not occurred.

The need to regularly review the trigger levels is due to:

a) the number of days within a year that have flow exceeding the 95th percentile flow can vary considerably, and
b) there may be a few consecutive years without any events and other years with up to 50 days that exceed the 95th percentile.

The modellers suggested "It may be possible to create rules that lower the trigger level in dry years and increase the trigger levels in wet years to balance out the number of additional samples taken across years".[8] Regular review and updates of the 95th percentile Flow Trigger Levels are essential to ensure the model has some capacity to capture peak loads during high flow events. Setting the level too high in dryer years or seasonal periods will result in the model missing a greater number of higher flow and peak TP load events, leading to significantly lower estimated TP loads.

We submit that the projected increase in extreme weather events, including more frequent and intense storms and higher extreme rainfall (and flash flooding) arising from climate change,

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[4] Jacobs-SKM (2014) *MID Nutrient Method - Southern Rural Water; Method and Model Development – Final A | Final Report,* p.13
[5] Pers. comm (17/02/2025), Scott Seymour – senior waterways manager (retired)
[6] Jacobs-SKM (2014) *MID Nutrient Method - Southern Rural Water; Method and Model Development – Final A | Final Report,* p.23
[7] *ibid*.
[8] *ibid*.

makes the case for flow weighted sampling all the more compelling.[9] This is acknowledged in the Lake Wellington LWMP which explains how:

> "Climate models project that the climate will become warmer and drier and that periodic extreme rainfall events will become more intense (Grose et al., 2015). This has potential (without effective adaptation) to exacerbate the processes contributing to sediment and nutrient movement into Lake Wellington and to increase the incidence of algal blooms."

Aside from being a form of effective adaptation, we submit that dual ISCO autosamplers are already necessary to more accurately estimate nutrient loads during high flow events. One machine to measure baseflow loads and the other for flow weighted sampling. Such an approach will more accurately capture the higher nutrient concentrations and loads associated with high flow events, especially at the La Trobe River sites which account for around 75% of the total TP load.[10]

Given the paired autosampler generally lays dormant for extended periods, it would only increase laboratory costs when flows exceed set trigger levels. The cost-benefit of capturing peak loads currently missed by the existing sampling regime ought to be considered if a credible and accurate estimation of MID TP loads entering the Gippsland Lakes is a genuine goal.

2.2.2 Model does not monitor subsurface nutrient flows

The current nutrient monitoring program only measures river and drain surface flows. The model appears to completely overlook the export of nutrients via subsurface flows or groundwater leaching. The export of nutrients via the subsurface gravels / groundwater system of the Avon River and the pumped groundwater of the Denison and Nambrock Groundwater Management Areas are not monitored.

When one considers groundwater discharge contributes 24-36% of annual average flow in the Avon River,[11] it's apparent that groundwater nutrient discharge into Lake Wellington also needs to be monitored.

Given many dairy intensive and grazing catchments have reported high nutrient levels in groundwater,[12] it's imperative that groundwater pump outs and subsurface flows discharging into the Gippsland Lakes be monitored and nutrient loads quantified. Moreover, a study of all major dairy intensive regions in Australia found Gippsland to have the highest risk score for nitrogen leaching into groundwater and phosphorous runoff.[13]

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[9] CSIRO (2022) *Final Report on the Vulnerability of the Gippsland Lakes Ramsar Site Catchment to Bushfire & Climate Change*, Department of Agriculture, Water and the Environment, Australia; p.46

[10] Jacobs-SKM (2014) *MID Nutrient Method - Southern Rural Water; Method and Model Development – Final A | Final Report,* p.13

[11] Lake Wellington Land and Water Management Plan (2018) – Technical Appendices, Final Draft; p.25

[12] Withers, P.J.A., et al. (2005). Hydrogeochemical impacts of intensive dairy farming on groundwater quality. *Journal of Hydrology*, 315(1-4), 1–12; see also Scarsbrook & Melland (2015*)* Dairying and water-quality issues in Australia and New Zealand*, Animal Production Science* 55(7) 856-868; and Melland et al (2008) Loss of phosphorus and nitrogen in runoff and subsurface drainage from high and low input pastures grazed by sheep in southern Australia, *Australian Journal of Soil Research* 46(2) 161-172

[13] Mellan et al. (2017) A stocktake of nutrient loss risk in the Australian dairy industry. In*: Science and policy: nutrient management challenges for the next generation*. (Eds L. D. Currie and M. J. Hedley);pp.7-8

2.2.3 The nutrient load model does not measure Nitrogen (N) loads

Nitrogen or high nitrate loads specifically are associated with the incidence of algal blooms in the Gippsland Lakes.[14] Research has shown that P controls the duration, size and severity of *Nodularia* blooms, but high N loads in winter and spring *prime* the Lakes for these blue-green algal blooms.[15] Similarly, high N:P ratios following floods suit nitrogen-dependant green algae - promoting the occurrence of these often-toxic algal blooms.

As noted by the Lake Wellington LWMP:

> *"Phosphorus controls the duration of blue-green algal blooms, and most of it is from lake sediments – of which there are large stores. However, nitrogen initiates the conditions fostering the release of phosphorus from the sediments. Reducing the nitrogen and phosphorus loads entering Lake Wellington must occur to reduce the further accumulation of phosphorus and the frequency of blue-green algal blooms in the deeper lakes."[16]*

Furthermore, research indicates that reducing N loads by 25%, will not eliminate algal blooms in the Gippsland Lakes but will likely reduce their frequency.[17] It has also been suggested that nitrogen load limits may be appropriate for Lakes Victoria and King as nitrogen dependent algal blooms are more common in their higher salinity waters.[18]

In a broader context, high nitrogen levels in surface and groundwater can lead to serious ecological impacts via eutrophication and associated human health risks.[19] Nitrates have much higher mobility compared to phosphate, resulting in more rapid groundwater contamination; underscoring the need for robust nitrogen monitoring in dairy catchments.[20] While both nitrogen and phosphorus are important sources of nutrient contamination, the high mobility of nitrogen makes it a more immediate indicator of environmental and human health risks in groundwater systems.

We submit that the EPA's call to limit P to 100 tonnes p.a. for Lake Wellington and ignore N in the Marine Pollutant load objectives of Environmental Reference Standards, is derived from an outdated understanding of the lake. The focus on limiting P loads entering Lake Wellington made sense when the Mean Annual Flows to the Lake were higher and the lake was predominantly

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[14] Lake Wellington Land and Water Management Plan (2018) – *Technical Appendices, Final Draft*; p.87; see also Day P, Cribb J and Burgi A (2011), *The ecology of algal blooms in the Gippsland Lakes*. Gippsland Lakes and Catchment Taskforce. Bairnsdale, Victoria

[15] Lake Wellington Land and Water Management Plan (2018) – *Technical Appendices, Final Draft*; pp.28-29; also, Zhu Y, McCowan A and Cook PLM (2017) Effects of changes in nutrient loading and composition on hypoxia dynamics and internal nutrient cycling of a stratified coastal lagoon. *Biogeosciences*, 14, 4423–4433.

[16] Lake Wellington Land and Water Management Plan (2018) – *Technical Appendices, Final Draft*; p.29

[17] Ladson A (2012). *Importance of catchment-sourced nitrogen loads as a factor in determining the health of the Gippsland Lakes*. Gippsland Lakes and Catchments Task Force. Moroka.

[18] DELWP (2017) Draft Victorian Rural Drainage Strategy. Dept of Environment, Land, Water & Planning.

[19] Zhang, Y., et al. (2020). "Nitrate Pollution in Water Sources: Global Occurrence, Health Impacts, and Management Strategies." *Water Research*, 184, 116–127; see also Li, X., et al. (2021). "Advances in Understanding Nitrate Dynamics in Agricultural Catchments and Implications for Water Quality." *Journal of Environmental Management*, 283, 111–125; see also Ward, M. H., et al. (2018). "Drinking Water Nitrate and Human Health: An Updated Review," *Environmental Health Perspectives*, 126(2), 027001.

[20] Hobbs, M., et al. (2020). "Recent trends in nitrate leaching from intensive dairy systems in Australia." *Journal of Environmental Quality*, 49(2), 345–354; see also Simpson, A., et al. (2018). "Dynamics of nitrogen and phosphorus in dairy catchments: Groundwater implications." *Journal of Hydrology*, 560, 246–256.

freshwater to brackish for the majority of the year. Under this scenario, it was reasonable to limit phosphorus.

However, the EPA monitors Lake Wellington as part of its long-term marine monitoring program, a reflection of the higher salinity and often persistent marine influence on both the deeper and shallow lakes. Given the strong marine influence on the Gippsland Lakes, it is more appropriate to adopt the EPA's most recent Port Phillip Bay targets, where N is the key target nutrient and not P.[21]

FOGL submits that SRW and partners commit to monitoring N as part of the revised MID monitoring program.

Moreover, the minimal additional cost of testing water samples for N at the laboratory makes the introduction of N monitoring a compelling cost-benefit proposition for land and water managers.

2.3 Control charts are outdated and inaccurate

The model relies heavily on statistical control charts to ensure data integrity. Upper and lower TP control limits were generated using composite samples taken between July 2012 and June 2014.[22] This period experienced below-average rainfall in the Gippsland region, and omitted the very heavy rainfall events of June 2012. Lower flows generally result in lower TP readings. Therefore, the use of a below-average rainfall period establishes a below-average baseline of TP control levels.

Similarly, the control charts do not incorporate data for **all flow events**. And not just high or low flows, but high flows following a wet period and also following a dry period.

Flow weighted sampling over an extended time period that covers a range of dry and wet periods is necessary to provide the high-quality flow and TP data necessary to 'calibrate' a load model's control charts.

Even with good data, TP load models have substantial error bars and can give anomalous results. It's critical that error bars in reporting be introduced to account for the high level of uncertainty that's inherent to TP load modelling estimates.

Importantly, any TP sampling gaps due to low or no flows, downstream influence, equipment failure or any gap greater than 10-20 days are treated as missing data periods and infill TP data is then derived from the centre value given in the control charts. Missing stream flow data is estimated using a regression relationship . Given how regularly data gaps occur, particularly for the two drain sites and the lower Avon River monitoring station, it's imperative the control charts are regularly reviewed and updated to maintain confidence in the accuracy of their load estimates.

This was clearly understood by the modellers and acknowledged in their user manual. The SKM user manual explained how "the control charts for the autosampler should be considered as a

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[21] Victorian Government Gazette S245 26 May 2021 p.43

[22] Jacobs-SKM (2014) *MID Nutrient Method - Southern Rural Water; Method and Model Development – Final A | Final Report,* p.11

work in progress and should continue to be updated as more data become available".[23] Similarly, the logarithmic regression analysis used to estimate missing flow data is itself based on limited historical data (mean daily flow) and not suitable for determining peak flow / load events. It is unfortunate that these critical control charts have not been regularly updated by SRW, with the last update reportedly occurring in 2016.[24]

2.4 Data integrity / reporting quality and cross-validation of samples

The current SRW TP load modelling program has experienced regular reporting and monitoring failures. Our review of data found reporting errors and anomalous results in the 2019/20, 2020/21, 2022-23 and 2023-24 reporting periods (outlined in the Quarterly Reports Analysis section pp.13-24). A consistent pattern of reissuing reports from previous quarters and years to account for 'anomalous' sampling results and/or reporting errors, does not imbue public confidence in the SRW monitoring regime.
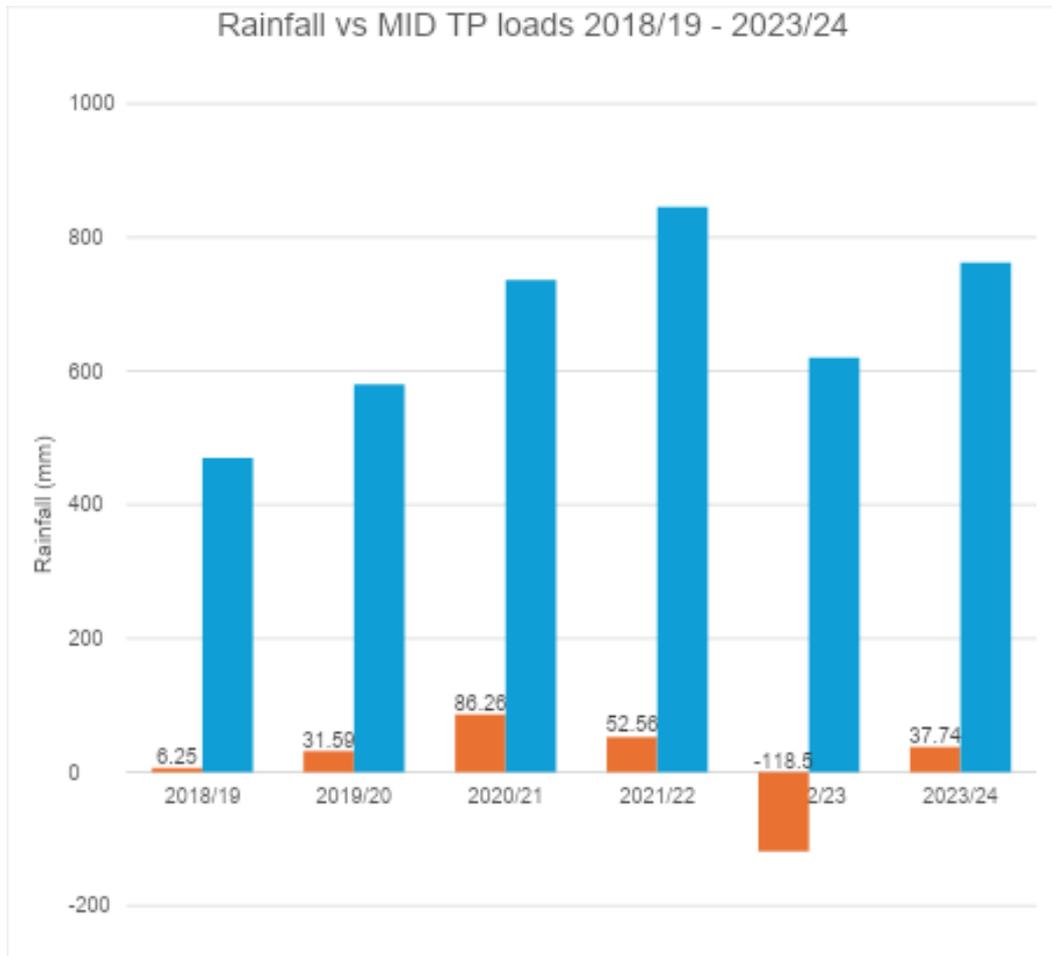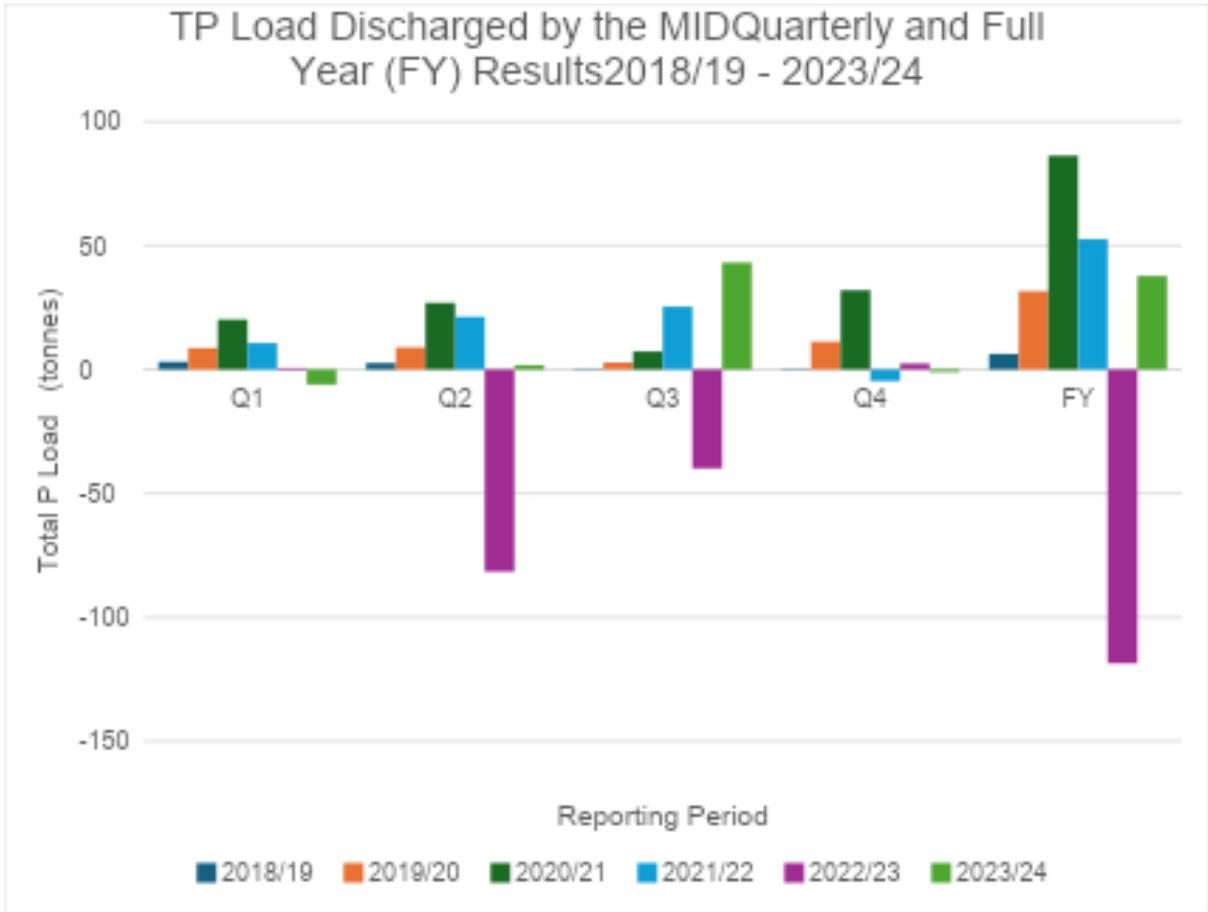
The graph of quarterly and annual MID TP loads from 2018 to 2024 and average yearly rainfall vs MID TP loads (shown on the next page) offers a snapshot of some notably anomalous phosphorus sampling results, which unfortunately represent a recurring issue in the current monitoring program.

The negative MID TP loads and the lack of correlation between rainfall and MID TP discharges, raises major credibility issues with the model and monitoring program which are discussed at length in this report.

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[23] SKM (2014), *MID Nutrient Model SRW User Manual, VW07424 Final B*; p.9
[24] Pers. comms. FOGL - SRW meeting (19/2/2025).

TP Load Discharged by the MIDQuarterly and Full Year (FY) Results2018/19 - 2023/24

Legend: 2018/19, 2019/20, 2020/21, 2021/22, 2022/23, 2023/24

Rainfall vs MID TP loads 2018/19 - 2023/24

Period	Value
2018/19	6.25
2019/20	31.59
2020/21	86.26
2021/22	52.56
2022/23	-118.5
2023/24	37.74

2.5 Suitability of sampling locations

The MID water monitoring stations are often subject to downstream impacts, namely the tidal influence and salt wedge travelling upstream from Lake Wellington. We are pleased to hear that the scope of the review of the MID monitoring program includes reviewing the suitability of existing sampling sites.

The frequency in which "downstream impacts" are noted in quarterly reports, is a real concern. Regularly relying on out-dated control chart TP load data and regression-derived flow estimates to replace unusable autosampler samples—caused by downstream influences—is both an inefficient use of monitoring resources and likely to produce inaccurate and indefensible TP load results.

Relocating the downstream sampling sites is necessary to reduce "downstream impacts" and ensure more reliable and ultimately credible monitoring results.

Another significant issue relates to the majority of quarterly monitoring reports not being date stamped. This is inconsistent with orderly and professional reporting standards. We submit that the lack of orderly and transparent reporting inhibits data analysis, and the effective tracking of management actions and results.

The lack of consistent, orderly and transparent reporting weakens the integrity and transparency of the MID TP monitoring program.

3 Quarterly reports analysis

3.1 2018/19 Reporting Period

The 2018/19 MID report produced an annual TP load of just 6.25 tonnes attributed to below average flows. It's unclear if this reporting period's extraordinarily low composite sampling results were ever cross-checked with grab samples to verify their accuracy. FOGL's attempt to cross check individual monitoring station records with available water quality data was not possible due to the inability of SRW to readily provide the raw spreadsheet datasets.

Quarterly Rainfall & Load - 2018/19
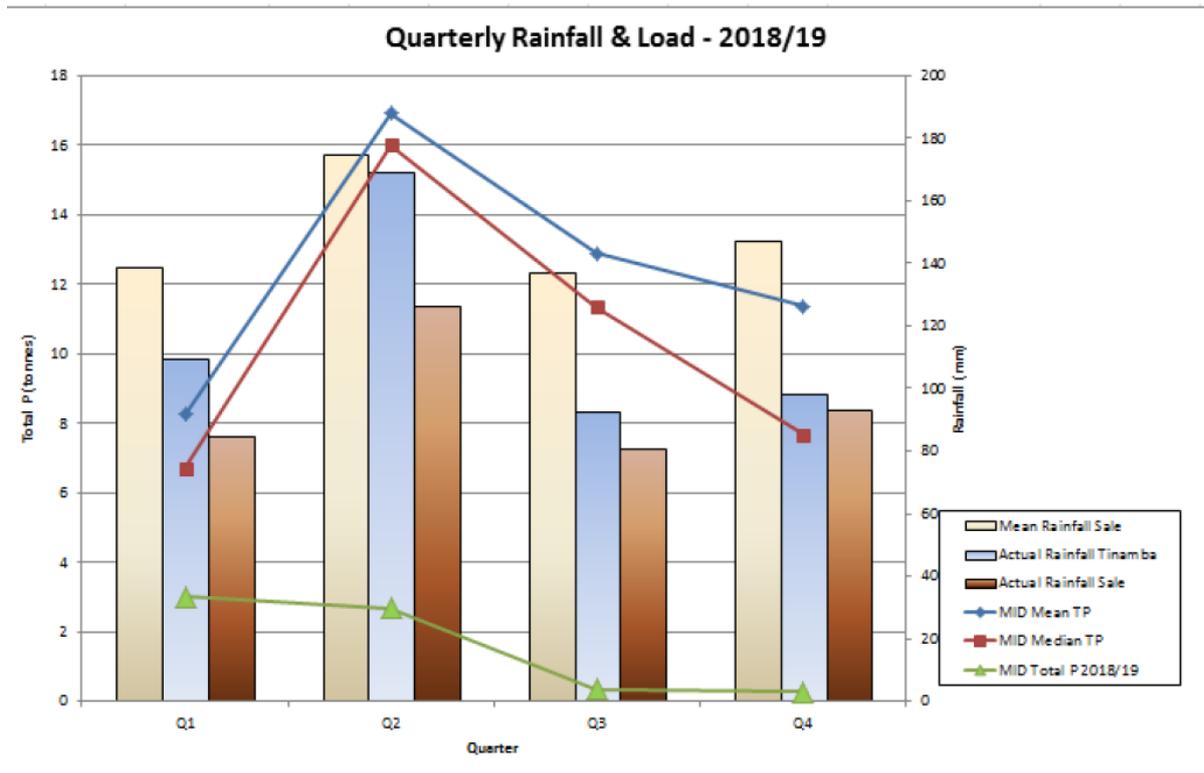
3.2 2019/20 Reporting Period

The 2019/20 quarterly MID nutrient reports highlighted above average rainfall for the months of January and February, yet the Avon River monitoring sites recorded higher upstream TP loads (4.5t @ Valencia Ck in the 3rd quarter) than downstream (2.72t @ Clydebank). This meant the Avon MID river catchment was acting as a nutrient sink rather than a source, precisely when high flows were likely to result in higher TP loads.

The 3rd quarter charts clearly indicated the low TP loads recorded were well below both the mean and median TP loads, despite actual rainfall being well above mean rainfall for Sale and Tinamba.[25] This illogical result did not ring alarm bells however, with the 3rd quarterly report simply noting this was "unusual" and acknowledged this result would reduce the calculated nutrient load from the MID.[26]

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[25] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 3 - 2019/20; pp.3
[26] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 3 - 2019/20; pp.1, 4

Quarterly Rainfall & Load - 2019/20
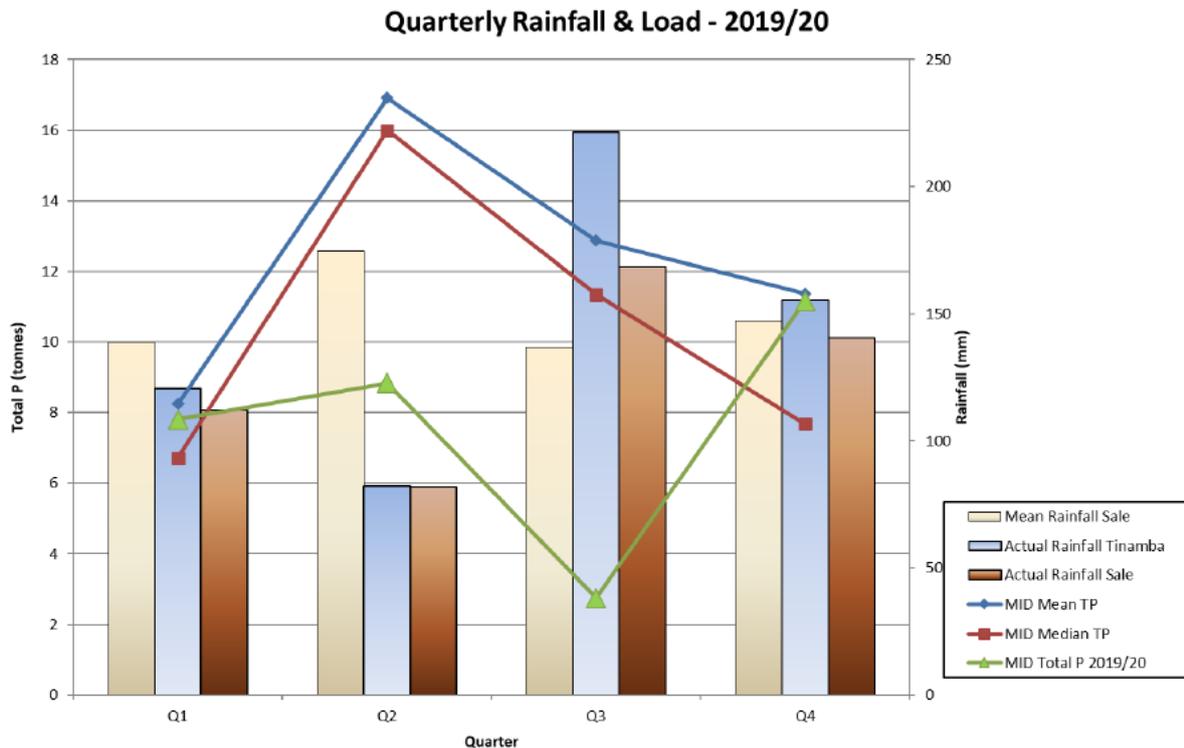
The 3rd quarter report also mentioned equipment error or irregular flow issues at the downstream Avon River site at Clydebank and the upstream Latrobe River site at Bowmans. Three weekly composite samples were collected as fortnightly samples, and eight grab samples were taken in replacement of composite samples. Given the lower sampling frequency during this above average rainfall (high flow) period, it is very likely the quarterly results substantially underestimated TP loads for the quarter.

In summary, the current model and monitoring regime appears to make no *effective* provision or allowance for augmenting TP load estimates when equipment fails, so as to account for peak load - high flow events.

This is underscored by the failure to regularly update TP load control charts and flow trigger levels, as per SKM's recommendations.

3.3 2020-21 Reporting Period

Once again, the 2020-21 MID Nutrient reports saw the Avon River MID catchment acting as a nutrient sink in 3 of the 4 quarters.

- Q1 upstream TP load at Valencia Ck recorded as 24.66t and just 9.9t downstream at Clydebank (**-14.76 tonnes**)

- Q2 upstream TP load at Valencia Ck recorded as 3.13t and just 1.84t downstream at Clydebank (**-1.29 tonnes**)

- Q4 upstream TP load at Valencia Ck recorded as 18.81t and just 10.63t downstream at Clydebank (**-8.18 tonnes**)

- Total TP load for Avon River MID catchment was **negative 24.24 tonnes** for the yearly reporting period (see chart below).
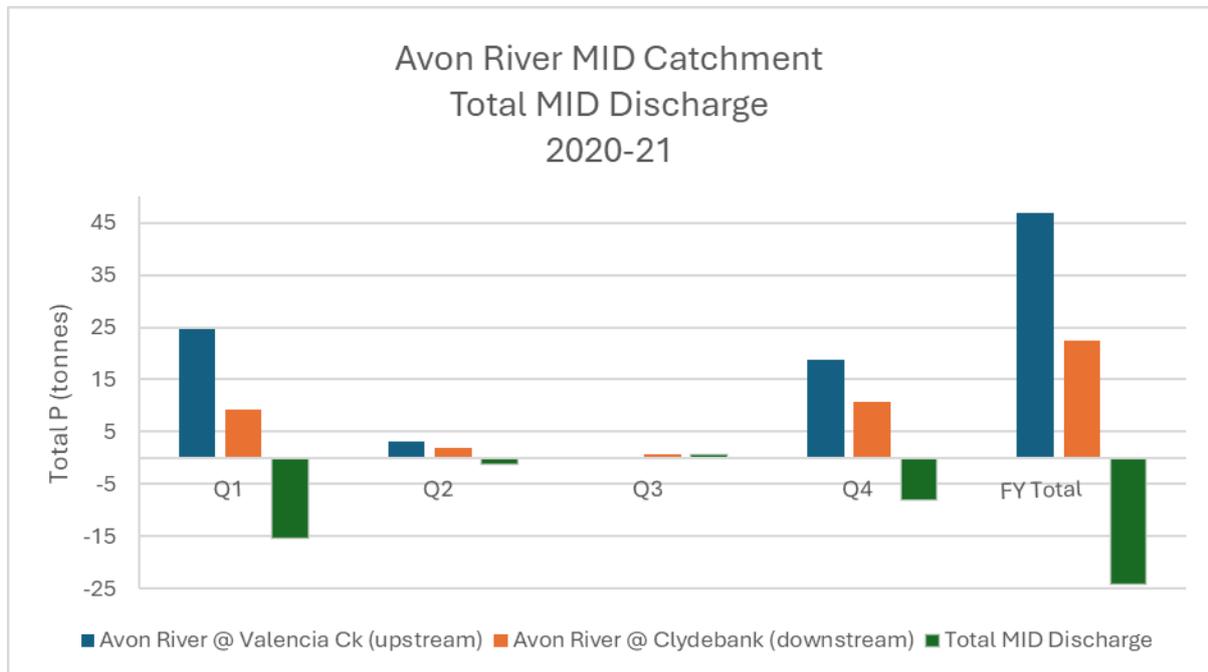
The Q1 (and replicated again in the Q4 Final Report for 2020/21) included the following discussion related Q1's highly unlikely negative TP loads for the Avon River MID catchment:

> *"It is important to note that higher TP values during periods of significant rainfall and flow are valid and to be expected, however the methodology used in this instance involves applying one composited result of total phosphorus to an entire fortnightly period, introducing significant uncertainty. The actual results indicate that the MID is a nutrient sink in the Avon System, which is highly unlikely to be the case given the anomalous data observed and the indication given by data in 2019/20. Apart from 2016/17, the results from Q1 of 2020/21 do not necessarily reflect historical data observed at this site".[27]*

No discussion was provided for the large anomalous Q4 TP load results for the Avon River catchment however. The discussion and review of the unlikely Q1 results considered three different scenarios, all of which would have increased the amount of TP discharged by the MID by 39%, 49% and 50% respectively. Despite the significant data quality assurance issues with Q1 results for the Avon MID catchment, the final report for the 2020/21 period retained the anomalous Q1 results in the Nutrient Breakdown Table.[28]

The published results of estimated yearly MID TP load came to 86.26 tonnes, with Table 2 Summary of results adding +/-24.66 tonnes to the yearly total.[29] We contend that the very broad confidence intervals (+/- 22% of Total MID TP load) associated with these results are far too wide, raising significant concerns regarding the program's ability to produce consistently reliable TP load estimates.

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[27] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 4 - 2020/21; p.11
[28] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 4 - 2020/21; p.2
[29] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 4 - 2020/21; p.1

The inclusion of TP loads known to be inaccurate into reports, raises data quality assurance concerns in relation to the model's accuracy and the integrity of data inputs. This was partially acknowledged in the discussion and review of the highly anomalous Q1 results:

> *"Moving forward, the implementation of a flow trigger would be useful during times of high flow, whereby increased sampling effort is made (such as taking daily phosphorous samples) to deliver measurements with greater accuracy. Increased sampling frequency during such times would improve the accuracy of the model in terms of how much the MID contributes.*
>
> *Alternatively, a long-term review of chosen sites could be undertaken. It is understood that the MID is a point source of pollution."*

It is unclear if a flow trigger and higher sampling effort were ever introduced, in part due to the lack of reporting transparency.

We contend that reissuing undated, unpublished quarterly reports without external verification of data and assumptions made, raises significant transparency and accountability concerns.

Other notable issues for this reporting period include:

- The underestimated 86.26 tonne MID TP load is well above the 40 tonne TP yearly target.

- The Q2 MID report listed 2020 Q1 Total MID TP Load as 20.2t and Q2 26.86t; despite minimal irrigation and only slightly higher than average rainfall in Q1.

- Curiously, Q3 results saw MID TP load of just 7.26 t (which is below the mean and median TP load for that quarter). This lower-than-expected result coincided with above average rainfall (see above chart) and the highest irrigation flows for the year, again indicating an anomalous result.[30]

- Q4 result was reported as 31.99 tonnes, attributed to above average rainfall for the year, though water deliveries for that period were well below Q3.

3.4 2021-22 Reporting Period

The 21-22 MID report estimated negative 4.69 tonnes of TP from the MID in Q4, despite the fourth quarter for the previous two years having the highest TP discharge.[31] Again, the reports postulated counterintuitively that the MID was once more acting as a nutrient sink rather than source. The Report simply noted that "this result is highly unusual and an outlier in comparison to previous quarters," making "this financial year irregular".[32]

Total TP load for the year was 52.56 tonnes, despite above average rainfall in all four quarters. The Q4 results were again atypical, with MID Total P being well under the mean and median TP load for the quarter despite above average rainfall (see chart overleaf).

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[30] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 3 - 2020/21; pp.2-3
[31] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 4 - 2021/22; p.1
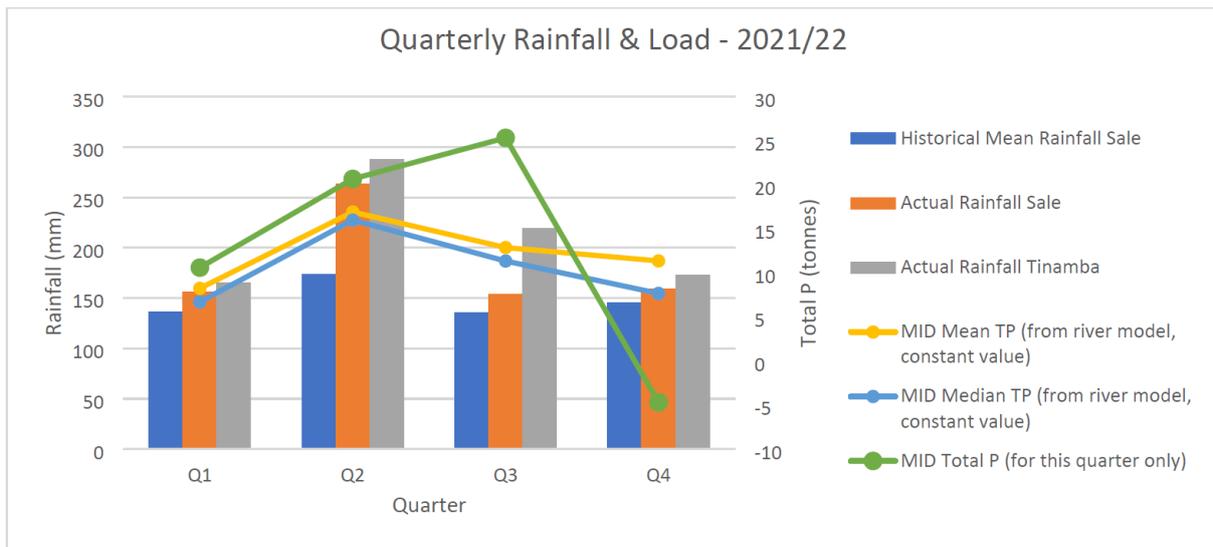[32] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 4 - 2021/22; p.1

Figure 1: Rainfall and TP load discharged by the MID, Q4 2021-22

Possible explanations given in the 2021/22 final report for the anomalous results included:

> "*A significant amount of TP data needed to be manually calculated for the Lake Wellington Main Drain using regression relationships which may have impacted results.*
>
> *SRW does not have data or information regarding fertilizer use on farms, which may be worth investigating.[33]*"

Once again however, anomalous results were retained, though this time no (+/-) allowance for uncertainties in the quality of data inputs and outputs, nor any acknowledgement of suspect or questionable results was made to the final annual MID TP load result.

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[33] SRW (undated) ANALYSIS OF MID NUTRIENT DISCHARGE - Quarter 4 - 2021/22; p.1

3.5 2022-23 Reporting Period

Figure 1: Rainfall and TP load discharged by the MID, Q4 2022-23
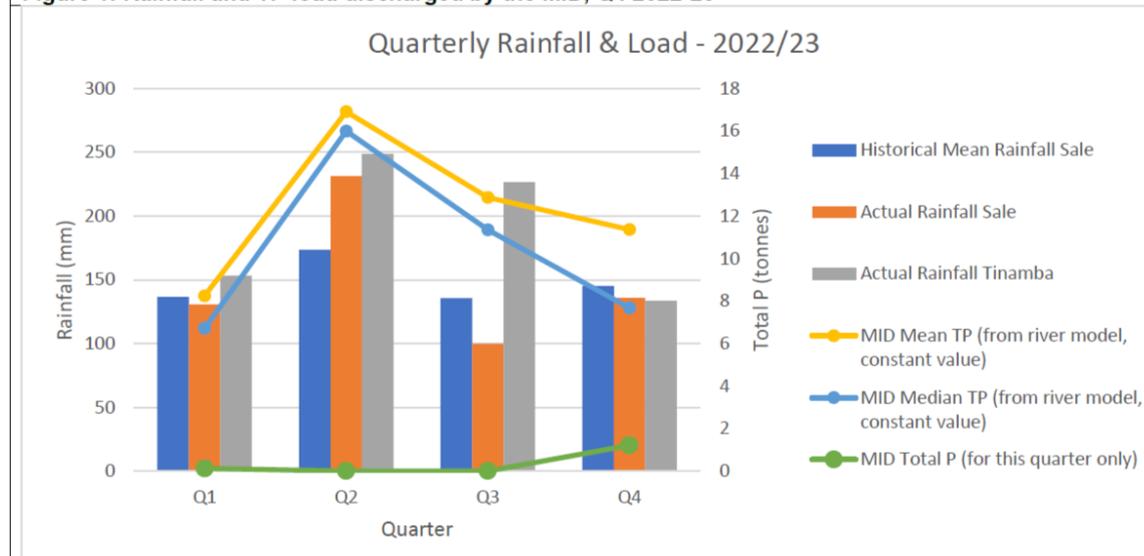
Perhaps the most alarming TP results were produced in the 2022-23 reporting period. Note the flat green line purportedly showing the quarterly MID Total P in the graph above.

- Q1 estimated 0% TP from the MID.
- Q2 estimated -80.35t or -114% % MID TP discharge.
- Q3 estimated -39.92t or a staggering -309% MID TP discharge

With an estimated Total MID discharge of **minus 118.50 tonnes for the year**, indicating the MID was once again a massive nutrient sink despite above average rainfall for much of the year and well over 20000 ML of irrigation flows during Q2, 3 and 4.

All the 2022-23 MID quarterly reports acknowledged these highly anomalous results were "unlikely", yet further analysis did not trigger 'alarm bells' prompting further investigations; such as immediate inspections / calibration of sampling equipment, nor more frequent cross-validation of subsequent results with grab samples.

These extraordinarily alarming results were simply accepted and reported as unusual at the time, with no cross-verification of samples or site inspections and/or equipment calibration protocols apparently triggered.

It wasn't until much later (in late 2024 or early 2025) that these extraordinarily anomalous results were rejected by SRW, and subsequently attributed to:

- equipment failure,

- three La Nina Years causing issues with flow data,

- flooding reducing access to the autosamplers.[34]

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[34] SRW (undated) MID Nutrient Monitoring Program Quarterly Reports (2018 to 2024) – Further Context, p2

Though SRW has now committed to update the 2022-23 reports to account for these illogical results, a clear lack of quality assurance and data integrity protocols was evident at the time.

The failure to identify and rectify sampling and reporting errors in a timely and systematic manner, represents a major failing of the current MID nutrient monitoring program.

It's absolutely clear that data and modelling integrity protocols are urgently needed to maintain public confidence in SRW's TP load estimates.

Similarly, greater rigour and transparency in TP load reporting is needed. For instance, the Q4 rainfall and TP load chart shown on the previous page, did not display the negative TP results; merely indicating zero MID Total TP loads. We submit such visual representations are inaccurate and rather misleading; downplaying or even obfuscating the extremely anomalous results of the report.

The chart below gives a far more accurate representation of the highly anomalous and concerning results reported in 2022/23.
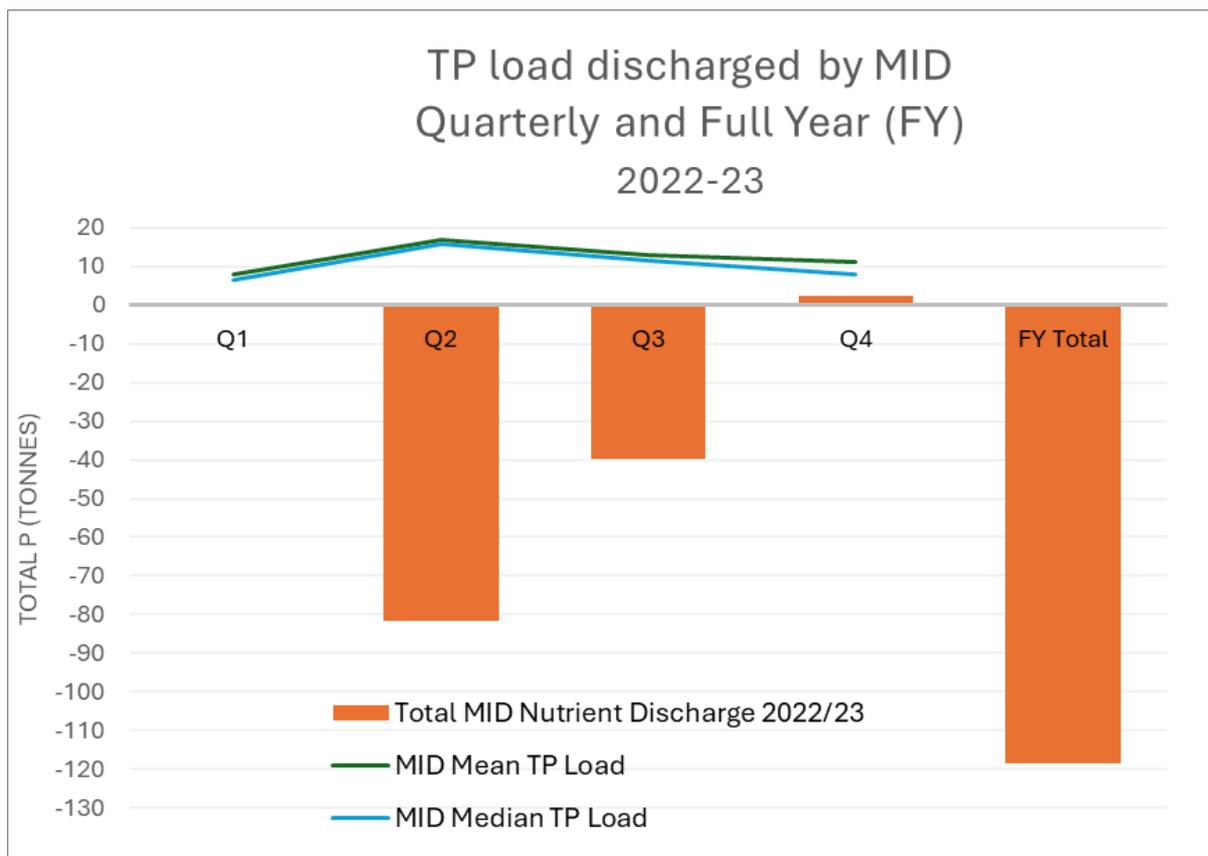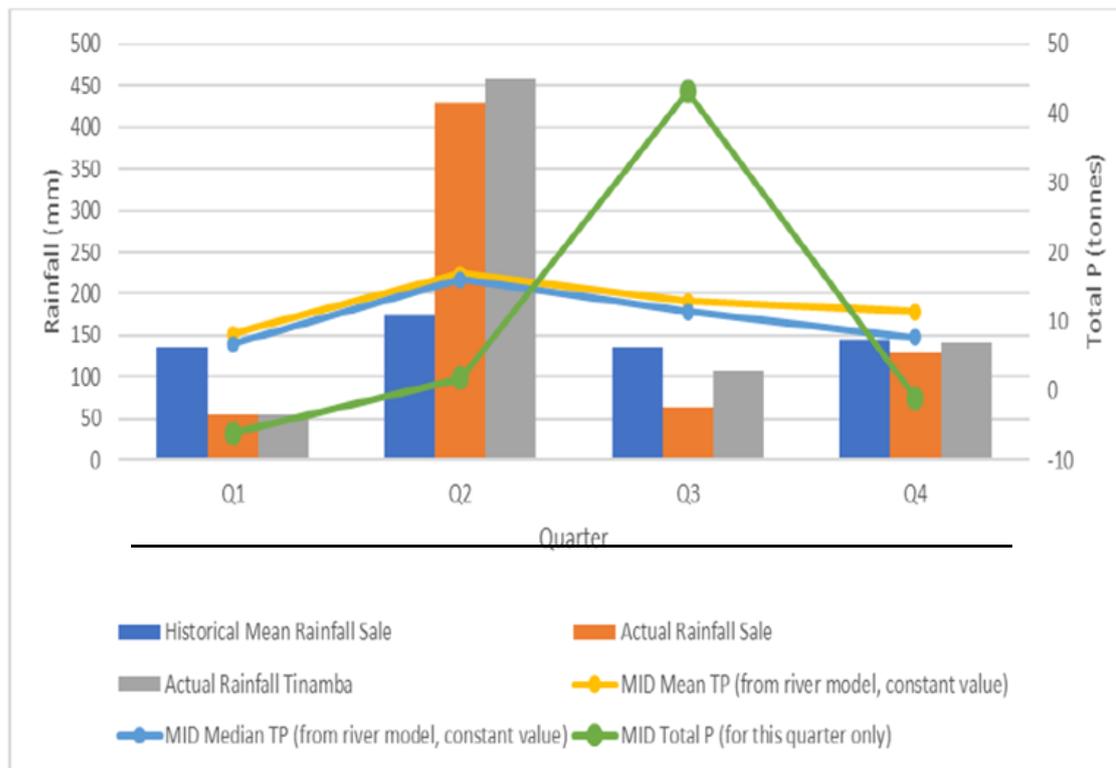

3.6   2023/24 Reporting Period

Unfortunately, SRW was not able to supply the original individual quarterly reports we'd requested, just the reissued Q4 2023/24 final report; making a comparative (time-based) analysis

of this reporting period impossible. The proceeding analysis is based solely on the revised 2023/24 Q4 final report produced in Feb 2025.

The graph below shows the revised TP load results for the 2023/24 reporting.

Figure 1: Rainfall and TP load discharged by the MID, Q4 2023-24

The 2023-24 reporting period saw two of the four quarters with negative MID TP load results (Q1 -6.09 t and Q4 -1.02 t) and an insignificant MID TP discharge (1.74 t) in Q2, despite almost three times above average rainfall for the quarter (see rainfall and TP load chart above).

Moreover, the TP spike recorded in Q3 occurred during a period of below average rainfall and below average irrigation flows (see Quarterly Water Delivery & Load chart overleaf). This is inconsistent with the historical pattern of elevated TP discharges occurring during high flow events. Similarly, the 2023/24 Q3 irrigation flows alone are highly unlikely to account for the anomalous MID TP spike reported in the updated Feb 2025 report.[35]

Furthermore, the Quarterly Water Delivery & Load chart shown above, strongly suggests there is no clear correlation between water volumes delivered (irrigation flows) and quarterly TP loads. Though the 3rd quarter (shown as a green bar) is when peak irrigation flows occur, TP loads show no correlation, being at their lowest when irrigation flows tend to be their highest (Q1).
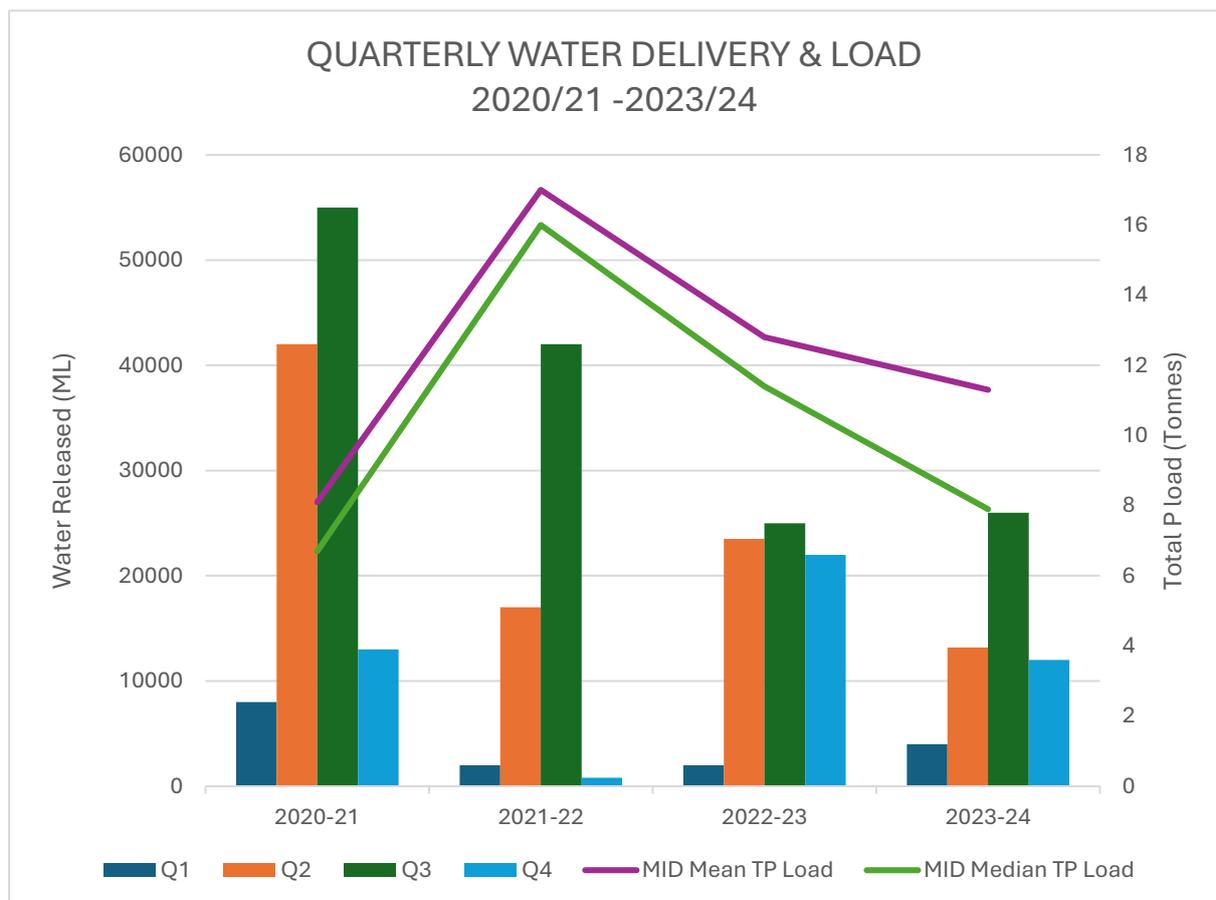
The 2023-24 period saw the Avon MID catchment returning negative TP results in all but the 4th quarter, once again indicating (rather counterintuitively) that the catchment was acting as a

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[35] NB: the water delivered chart above appears to be mislabelled having an extra zero added to the vertical axis. see SRW (undated) ANALYSIS OF MID NUTRIENT MONITORING DATA Q4 2023/24 – Annual Version 2. p.5
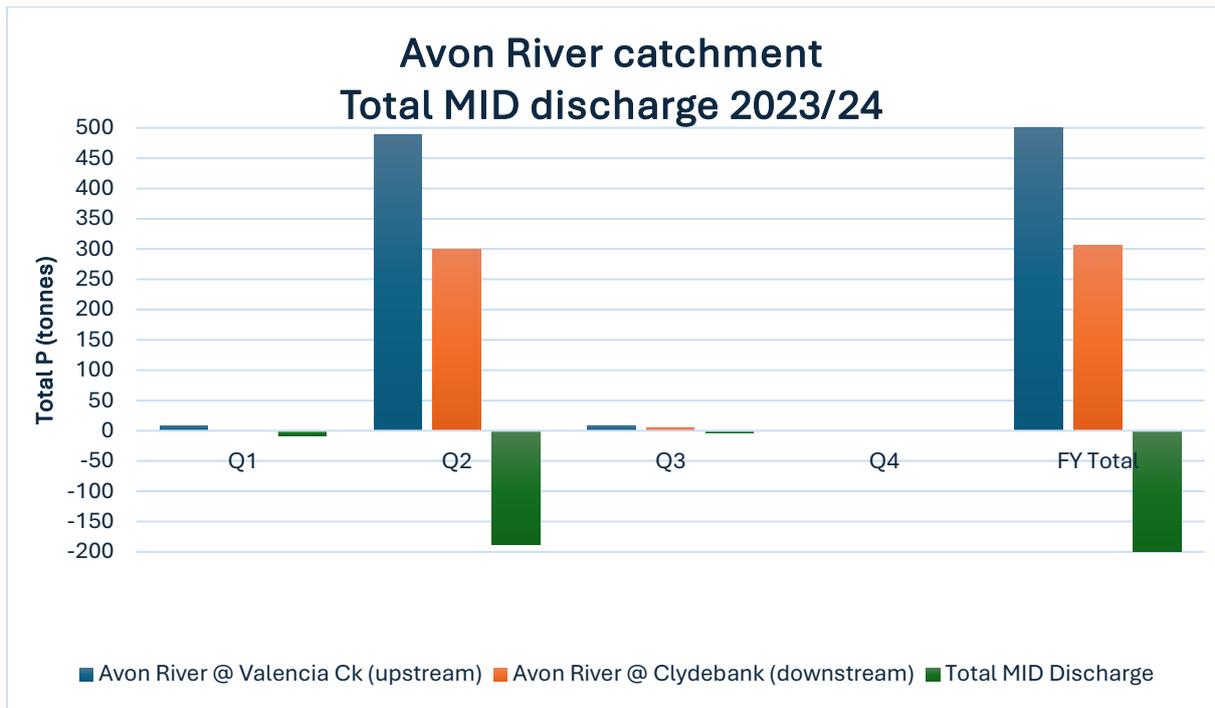
nutrient sink. These negative results were attributed to "in-stream losses" and "relatively dry conditions and no irrigation".[36]
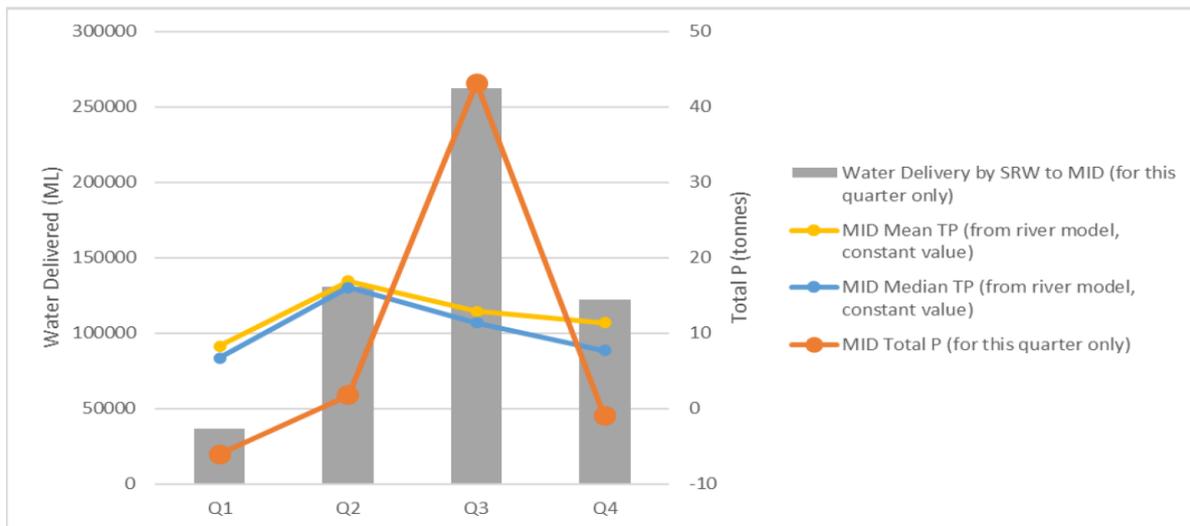
Curiously, the Q3 had below average rainfall, high irrigation flows yet reported a very significant TP load spike (43.12t). Conversely, Q4 had significant irrigation flows and near average rainfall yet produced a negative TP load of -1.02t. This is inconsistent with previous Q4 results.

Avon River catchment
Total MID discharge 2023/24

Legend: ■ Avon River @ Valencia Ck (upstream) ■ Avon River @ Clydebank (downstream) ■ Total MID Discharge

However, the most extraordinary results in the MID Nutrient Load Breakdown of 2023-24 were undoubtedly:

- the record-breaking Q2 results of **488.83 tonnes** recorded for the **upstream** Avon River Valencia Ck site, accounting for a whopping **-188.57 tonnes of MID TP load** for the quarter (see chart above).

- the **identical** 13.52 tonne results recorded for both the Lake Wellington Drain upstream sites (Rainbow Creek @Cowwarr Weir and Macalister River D/S of Lake Glenmaggie)

- the exceptionally elevated **300.26 tonnes** of TP load at the downstream Avon River site @ Clydebank recorded in Q2, yet returning a negative MID TP load of -188.57 tonnes for the Avon River MID catchment.

- the record-breaking **256.09 tonnes** of TP load recorded at the downstream LaTrobe River Swing Bridge site in Q2, producing a net MID TP load for the Latrobe, Thomson and Macalister River catchments of **224.55 tonnes** for the quarter.

Remarkably, despite these seemingly unprecedented and record-breaking results, the Feb 2025 revised report did not discuss or comment on them, restricting its discussion to only the relatively minor Q4 results.

We submit these record-breaking and highly anomalous results deserve greater attention, and quality assurance and data integrity protocols are urgently needed to ensure the credibility of anomalous TP load calculations.

The 2023/24 Q2 result for the upstream Avon River site @ Valencia Ck is clearly an outlier that does not accord with historical records supplied to us (see graph below). The exceptionally large TP spike in an upstream catchment is unprecedented, even when making allowances for above average flows.

Avon River @ Valencia Ck
Quarterly TP loads from 2019 to 2024
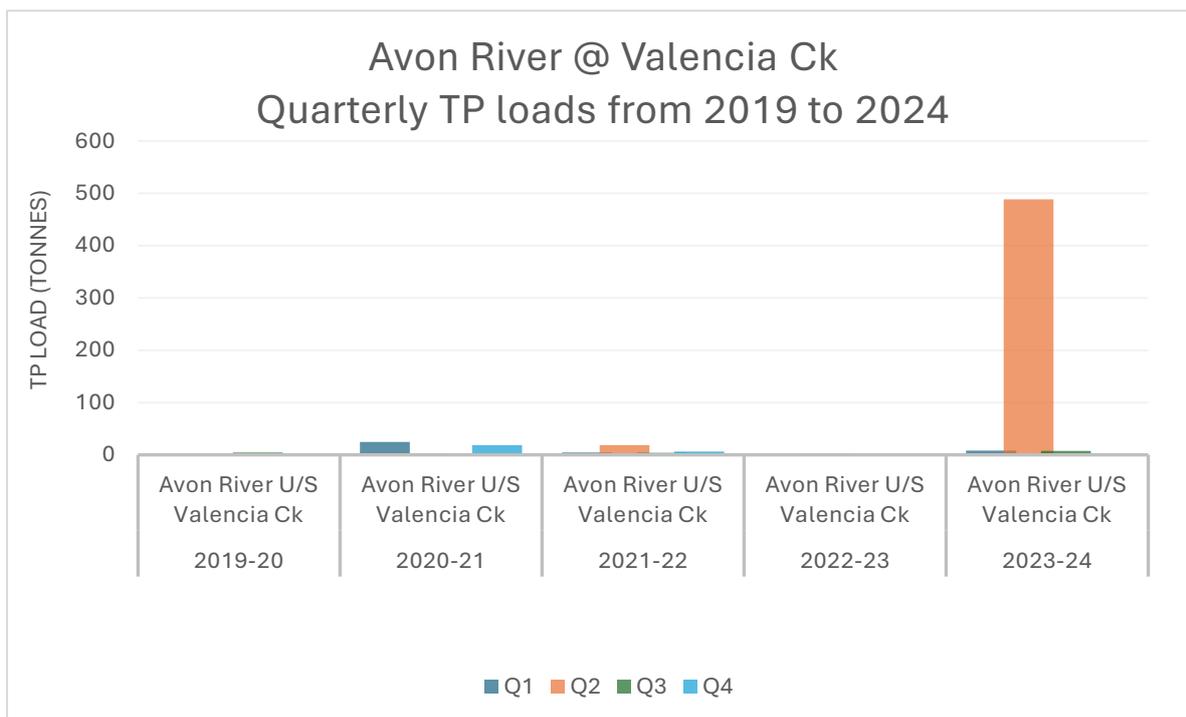
The revised 2023-24 results are still not credible and need to be rectified.

Subsequent to FOGL's FOI request in late 2024, SRW Q4 2023-24 MID monitoring report was reissued with the above revised results. The *MID Nutrient Monitoring Program Quarterly Reports (2018 to 2024) – Further Context* report (p.3) explained how:

> *Total MID Nutrient Discharge figures for Q1, Q2 and Annual Total were incorrect. During data transfer and analysis, certain formulas had been accidentally removed from the excel based model resulting in these errors. The Q4 report has been revised and re-issued with the correct data. Quarterly reports for Q1, Q2 and Q3 are currently being updated.*

Again, the relative ease with which reporting errors can occur and remain undetected for considerable periods of time, tends to indicate:

- the model's critical spreadsheet is prone to human error,

- the program lacks quality assurance protocols and/or

- the modelling interface is not robust enough to allow for reasonably foreseeable data entry and reporting errors.

We submit that a) the frequency of anomalous sampling results, combined with b) the failure to cross validate and investigate such results in a timely and systematic manner, casts a rather dark shadow on the credibility of the entire monitoring program.

Much greater transparency, accountability and data integrity protocols are needed to ensure public confidence in any revised nutrient monitoring program.

4 Conclusion

In conclusion, the review of the SRW Nutrient Monitoring Program reveals a pollutant monitoring framework that is fundamentally under-equipped to accurately assess nutrient loads entering the Gippsland Lakes. The current approach relies primarily on baseflow sampling techniques that fail to capture the dynamic nutrient concentrations occurring during high flow events. This limitation leads to a significant underestimation of total phosphorus (TP) loads, particularly during extreme weather conditions that are becoming more frequent with climate change.

This report identifies that the nutrient load model is unverified and based on outdated control charts derived from limited historical data. The inherent reliance on composite samples and regression methods to fill data gaps has produced inconsistent and often anomalous results—ranging from inexplicable negative TP loads to significant discrepancies between upstream and downstream measurements. These issues raise serious concerns about the overall data integrity and the robustness of the quality assurance protocols currently in place.

Moreover, the program's narrow focus on surface water measurements overlooks critical components such as subsurface nutrient flows and nitrogen (N) loads. Given that high nitrogen levels play a key role in fostering algal blooms—especially in the context of increased salinity and altered hydrology in the Gippsland Lakes—this omission is particularly alarming. The failure to monitor subsurface flows means that a substantial portion of the nutrient export remains unaccounted for, further compromising the reliability of the nutrient load estimates.

The cumulative impact of these methodological flaws and operational shortcomings is a monitoring system that does not adequately reflect the true state of nutrient discharges from the MID.

> **The frequent data anomalies and reporting inconsistencies have not only undermined public confidence, but also jeopardized the effectiveness of water quality management efforts.**

4.1 Recommendations

To address these challenges, the report advocates for a comprehensive review and overhaul of the current monitoring regime. Key recommendations include :

- Independent peer review of the SKM nutrient load model.

- Adoption of flow-weighted sampling and variable high-flow triggers.

- Incorporation of subsurface nutrient (incl. nitrogen) monitoring.

- Regular updates to control charts / trigger levels for more accurate phosphorus load estimates.

- Strengthened data sampling and integrity protocols

- Transparent reporting

- Relocation of sampling sites upstream to avoid tidal influence.

An increase in the monitoring budget would be necessary to enhance the accuracy and reliability of nutrient load assessments. We submit that SRW could show leadership by working alongside

other Gippsland Lakes Ramsar Site land managers to pool funds and resources to ensure the MID monitoring program is fit-for-purpose.

Credible nutrient monitoring data is valuable to many land and water managers; therefore, it is reasonable to expect that a more collaborative approach to MID nutrient monitoring will occur as an integral part of the Regional Water Monitoring Partnership.

Ultimately, only by adopting a more transparent, comprehensive and scientifically robust pollutant monitoring strategy can land and water managers effectively safeguard the health of the Gippsland Lakes and its catchments. This reassessment is essential to ensure that future nutrient reduction targets are based on credible data that truly reflect the environmental realities of the region.

Though outside SRW's remit, it's clear that the marine pollutant load objectives of the *EPA Act 2017 Environment Reference Standard* which apply to Lake Wellington, require an urgent update to include N as well as P pollutant reduction targets.