BATIQUITOS 2023 ANNUAL WATER QUALITY REPORT

Prepared by Keith Maruya and Anne-Catherine Roch-Levecq
Batiquitos Lagoon Foundation, North San Diego County Watershed Monitoring Program

Background

The Batiquitos Lagoon in north San Diego County consists of 610 acres with a drainage basin of about 55,000 acres. The watershed basin includes the cities of Carlsbad, San Marcos, and Encinitas, with its primary freshwater tributaries being San Marcos Creek from the east and Encinitas Creek which flows north along Green Valley, entering the lagoon under El Camino Real and La Costa Avenue, respectively.[1] A dam built in 1952 to create Lake San Marcos in the upper watershed dramatically reduced the amount of freshwater flow into San Marcos creek and subsequently the lagoon. Consequently, accumulated silt has been filling up Batiquitos Lagoon, and the lagoon was expected to fill up within 50 years. In response, a dredging and enhancement project began in 1994 to allow tidal exchange with the ocean, thus slowing down the siltation process. Completed in 1997, the dredging project was funded by the Port of Los Angeles. Even so, Batiquitos Lagoon remains listed as a 303(D) - impaired waterbody under federal and state Clean Water Act regulations for sedimentation.

In addition, there have been numerous concerns regarding water quality in San Marcos Creek as a result of the release of water from Lake San Marcos. For example, during rainstorm events, lake operators have released "acre-feet of polluted water into the lower San Marcos Creek, ending up in the Batiquitos Lagoon Ecological Reserve and ocean".[2] The Batiquitos Lagoon Foundation believes the Lake San Marcos dam operations and water releases are among the most significant ongoing threats to the lagoon's water quality.[2] These concerns have been brought to the attention of the San Diego Regional Water Quality Control Board, underscoring the need for on-going water quality monitoring in the Batiquitos watershed (or "BTQ").

For the 10-year period 2009-2018, San Diego Coastkeeper (SDCK) monitored BTQ on a regular schedule. Data for 2009-2016 are posted on the California Environmental Data Exchange Network (CEDEN). In the spring of 2019, Preserve Calavera created the North San Diego County Watershed Monitoring Program (NSDCWMP) to carry on the decade-long work of SDCK of assessing the health of local surface waters. Water quality in three coastal watersheds, all of which are part of the Carlsbad Hydrologic Unit (Fig. 1) and including BTQ (Fig. 2), is evaluated by sampling water at multiple locations on a bimonthly basis and measuring basic physical (temperature, conductivity, turbidity), chemical (pH, dissolved oxygen, nutrient and ammonia), and biological (total and pathogenic coliform bacteria) parameters.

NSDCWMP is an all-volunteer citizen science effort with a leadership management team comprised of three Preserve Calavera board members (also leaders of the Buena Vista Creek and Batiquitos Lagoon monitoring teams). Technical advisors from the California Water Resources Control Board as well as the San Diego Regional Water Quality Control Board (SDRWCB) provide guidance to the NSDCWMP. Data are posted at www.preservecalavera.org and on the CEDEN website and shared with SDRWCB and the city of Carlsbad.

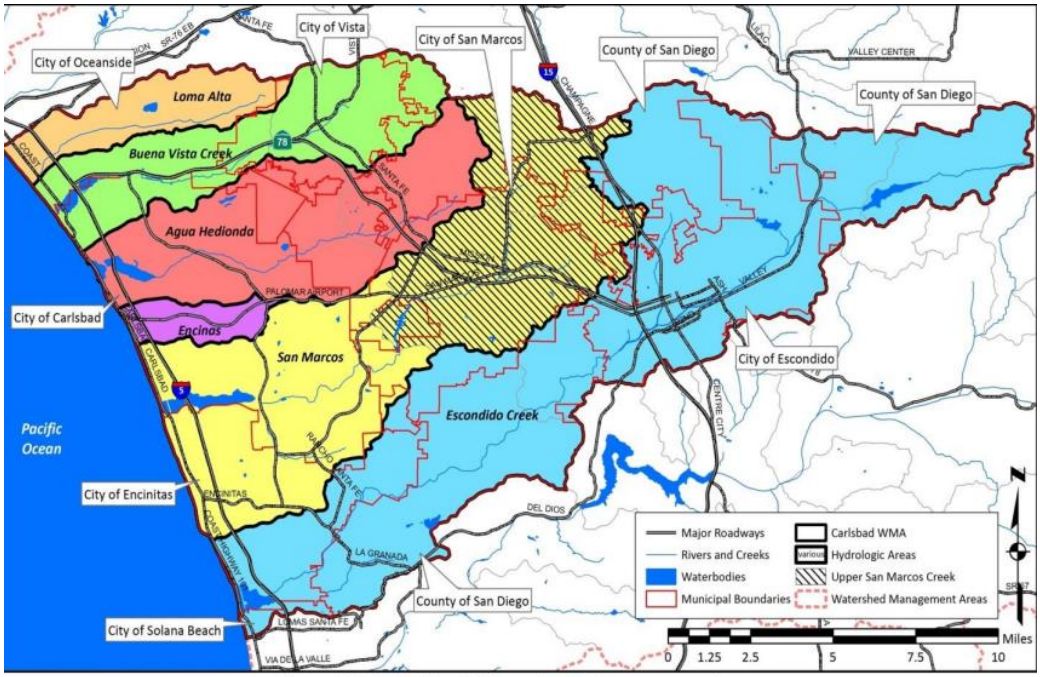


Figure ES-1: Carlsbad Watershed Management Area

Figure 1. Image from Prioritizing Invasive Species Management in the Carlsbad Hydrologic Unit
http://www.escondido.org/Data/Sites/1/media/pdfs/pubworks/carlsbad/150423_Final_Draft_Carlsbad_WQIP_Submittal.pdf

Figure 2. Image from Batiquitos Lagoon Ecological Reserve
https://wildlife.ca.gov/Lands/Places-to-Visit/Batiquitos-Lagoon-ER

Historically, SDCK monitored three sample sites within the BTQ (Fig. 3); two located on San Marcos Creek (BTQ020 and BTQ030), and the third on Encinitas Creek (BTQ010). Water is typically present year-round at BTQ010 and BTQ020; in contrast, BTQ030 is often dry during the summer and fall seasons. When water is present at BTQ030 during the dry season, it is likely the result of overflow or release from the San Marcos Lake Dam.

The NSDCWMP began in July 2019, with BTQ samples collected in July, September, and November of that year. Although dissolved oxygen, pH and conductivity were within ranges considered "normal" for such watersheds, some exceedances of macronutrients (nitrogen and phosphorus) and bacterial indicators were observed.[3] No samples were collected from BTQ030 due to lack of water at this site. This annual monitoring effort continued in 2020 with an abbreviated schedule (due to COVID restrictions)[4], and in subsequent years with a return to a full bi-monthly schedule.[5]

The purpose of this annual report is to 1) interpret the health of Batiquitos Lagoon for the testing period in 2023 and 2) look at historic trends (2009-present). Monitoring was conducted on a bimonthly schedule over the entire year (January, March, May, July, September, and November). Each water quality parameter was measured using standardized procedures and evaluated for anomalies against pre-established quality assurance/quality control (QA/QC) guidelines, including the analysis of field and lab blanks and sample duplicates. The overall state of the watershed compared with the previous year's (2019-22) monitoring data was summarized below for each parameter. First instituted in 2022[6], this year's report features a composite scorecard of water quality for the watershed.

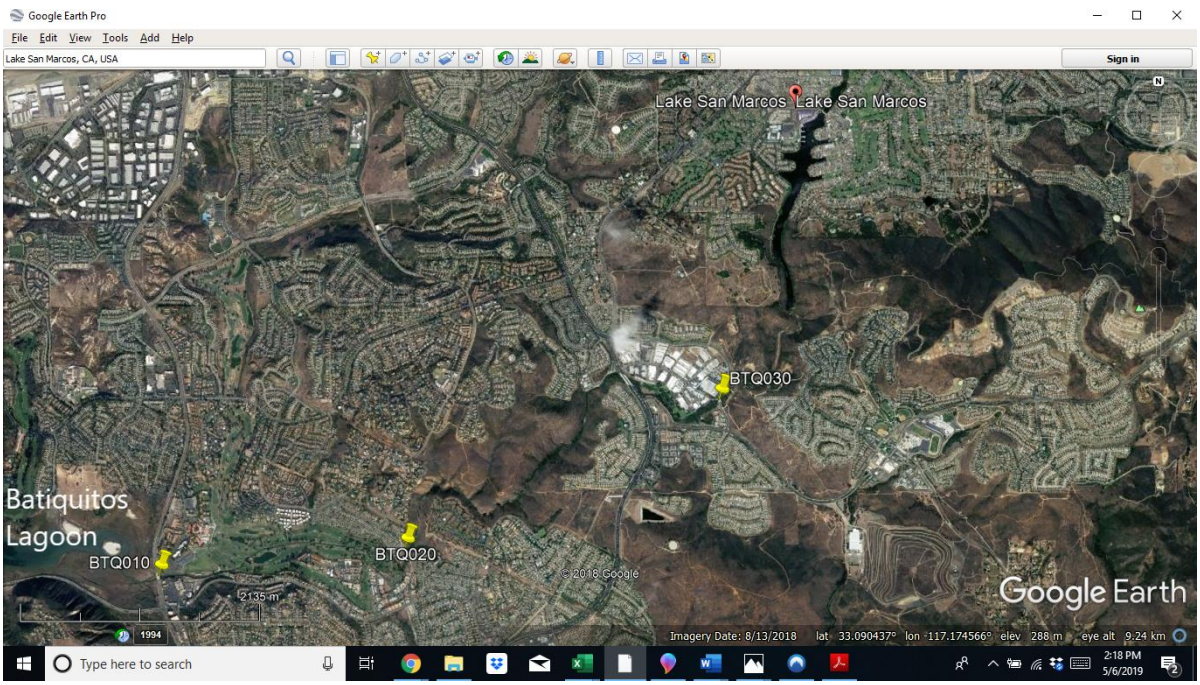


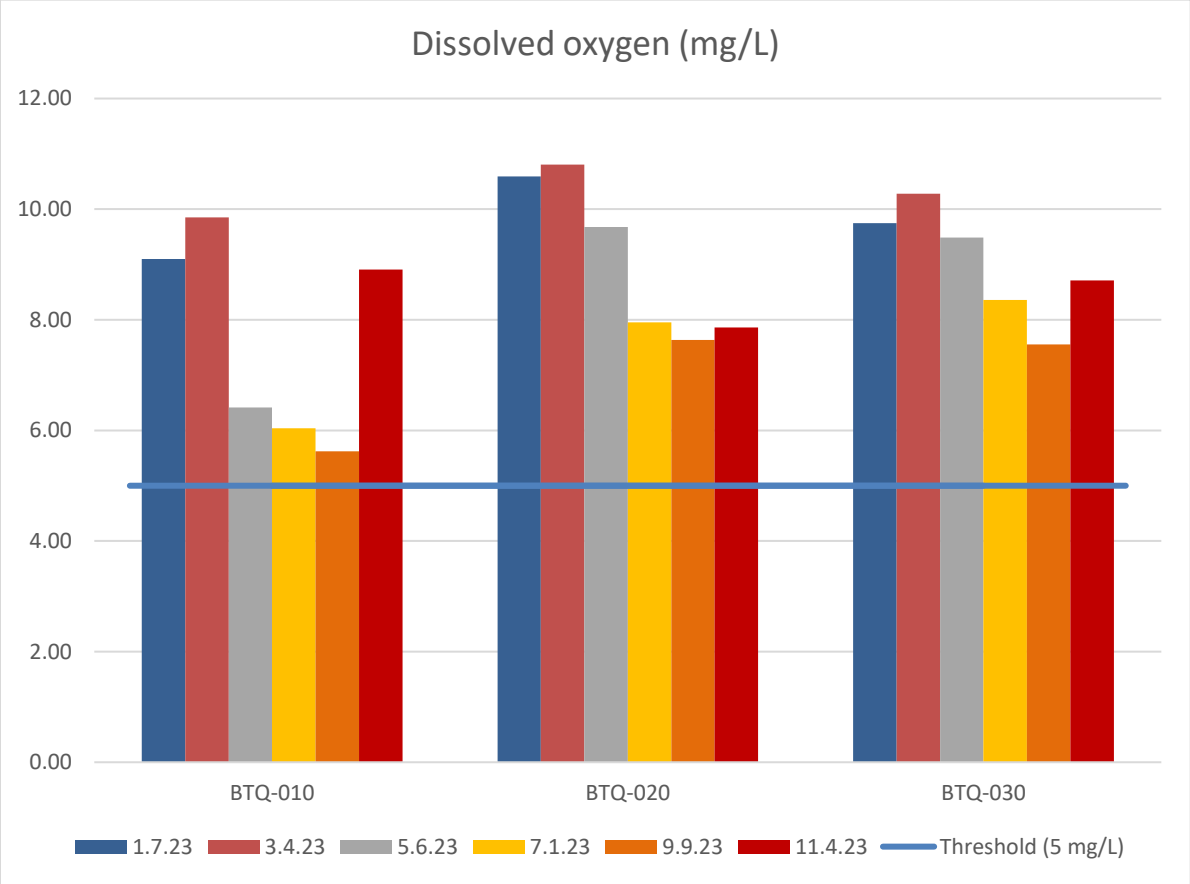
Figure 3. Batiquitos sampling sites.

Sampling Sites

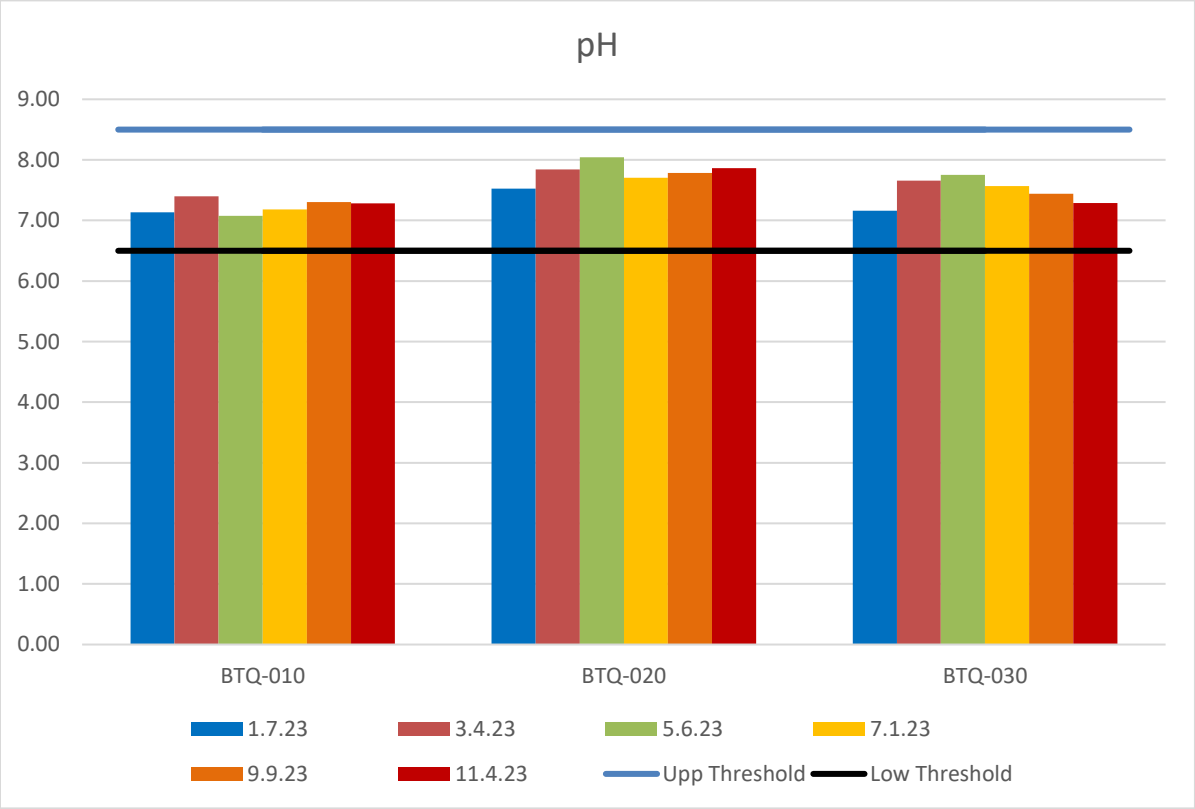
The Batiquitos team sampled the same three sites (BTQ 010, BTQ020, and BTQ030) as had been tested by SDCK (Fig. 3). Water samples were collected at all 3 sites for each sampling event, without exception.

Field Parameters

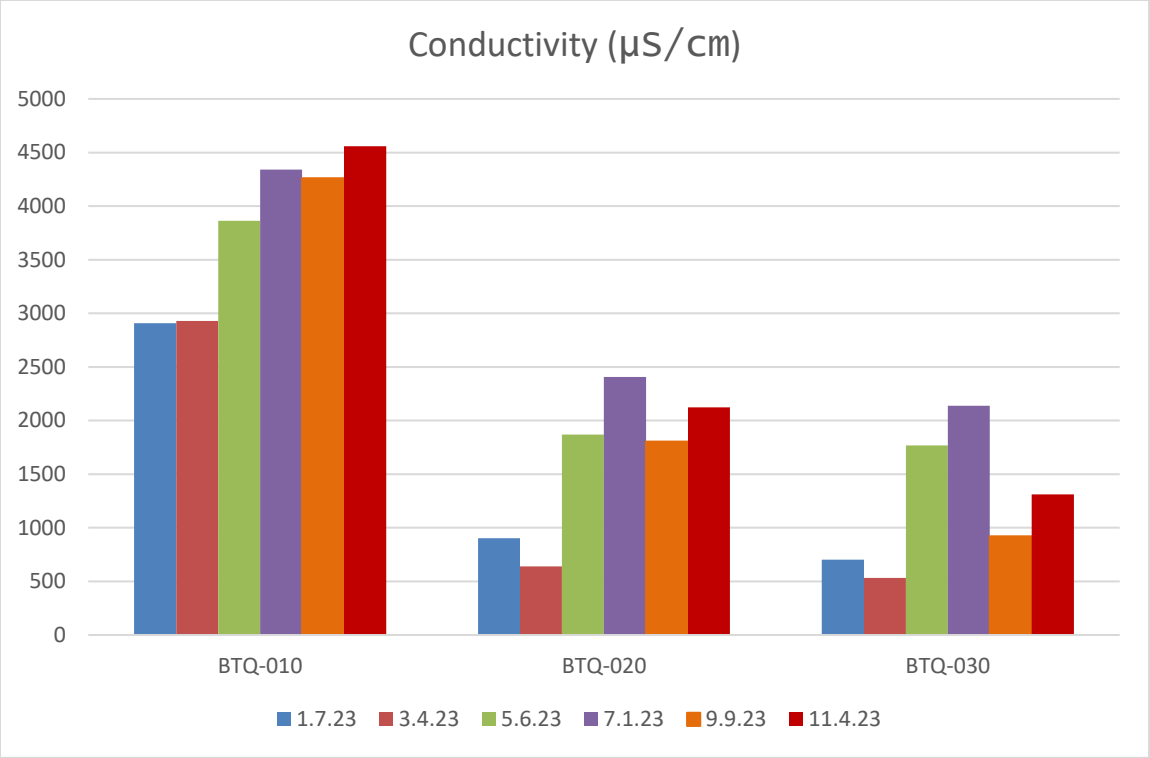
Dissolved oxygen (DO) for all six sampling events and sites was greater than the San Diego Basin Plan 3 threshold of 5.0 mg/L, without exception. The decrease in DO from May through September corresponded to the decrease in stream flow and increase in water temperature (~12 to 22 deg C) at these sites over that period. The relatively higher levels of DO at BTQ020 and BTQ030 suggested a higher degree of (i) aeration and/or (ii) primary productivity compared to the BTQ010 site. Compared with 2022, DO appeared to be slightly higher overall, perhaps due to the higher streamflow observed throughout 2023. These results suggest a healthy amount of oxygen in the water for aquatic animals for the period covered by these sampling events.



The pH ranged between 7.1 and 8.0 across all 3 sites for the entire year, well within the acceptable range for the Basin Plan 3 of 6.5-8.5. The relatively higher pH at BTQ020 compared to the other 2 sites (similar to the trend observed for DO, and consistent with the data reported for 2020-22) also supports the hypothesis that a higher degree of primary productivity is characteristic of this site, enabled perhaps by the greater depth and enhanced pooling.



Conductivity fluctuated between 2910-4560 µS/cm for BTQ010; 902-2410 µS/cm for BTQ020; and 532-2150 µS/cm for BTQ030. Conductivity appeared to steadily increase over the year for BTQ010, whereas it appeared to peak during the middle months (May and July) for BTQ020 and BTQ030, perhaps due to a corresponding decrease in freshwater runoff into the dry season. The variability across sampling events was greater than for 2021, but the trends among sites (i.e., BTQ010 > BTQ020 ~ BTQ030) was similar to previous years, perhaps indicative of the increasing level of urbanization from the top to the bottom of the watershed. There is no threshold for conductivity, as it merely reflects the amount of dissolved minerals in the water, which may originate from runoff from impervious surfaces (e.g., roadways, parking lots) as well as stream substrate.

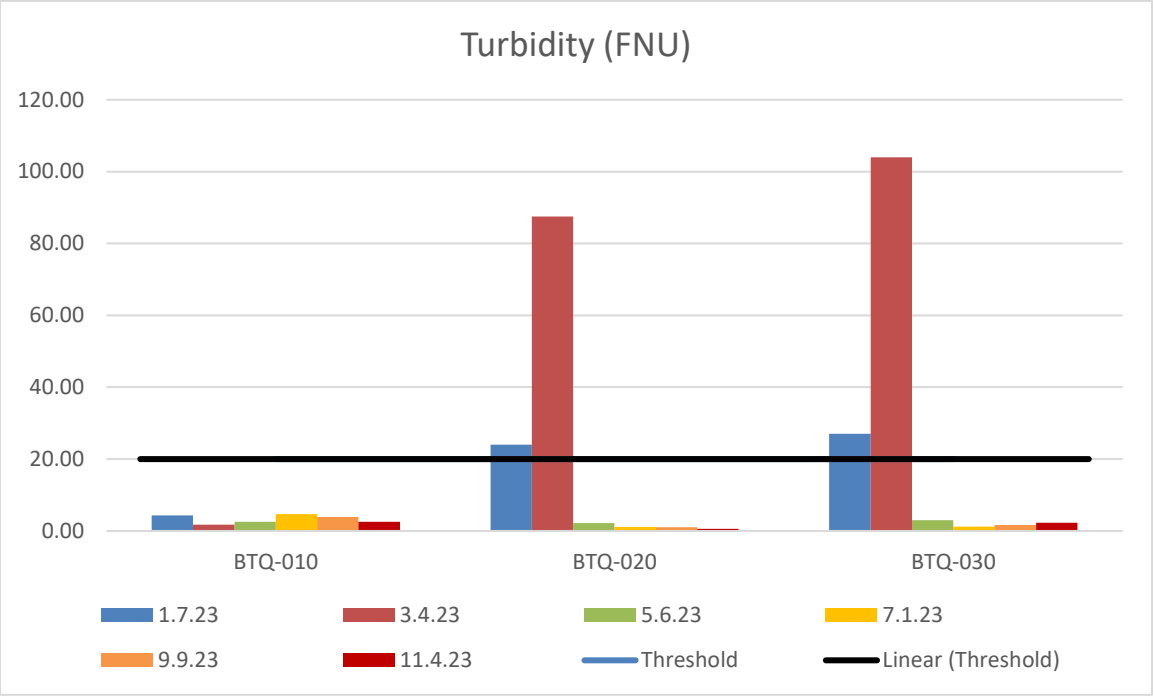


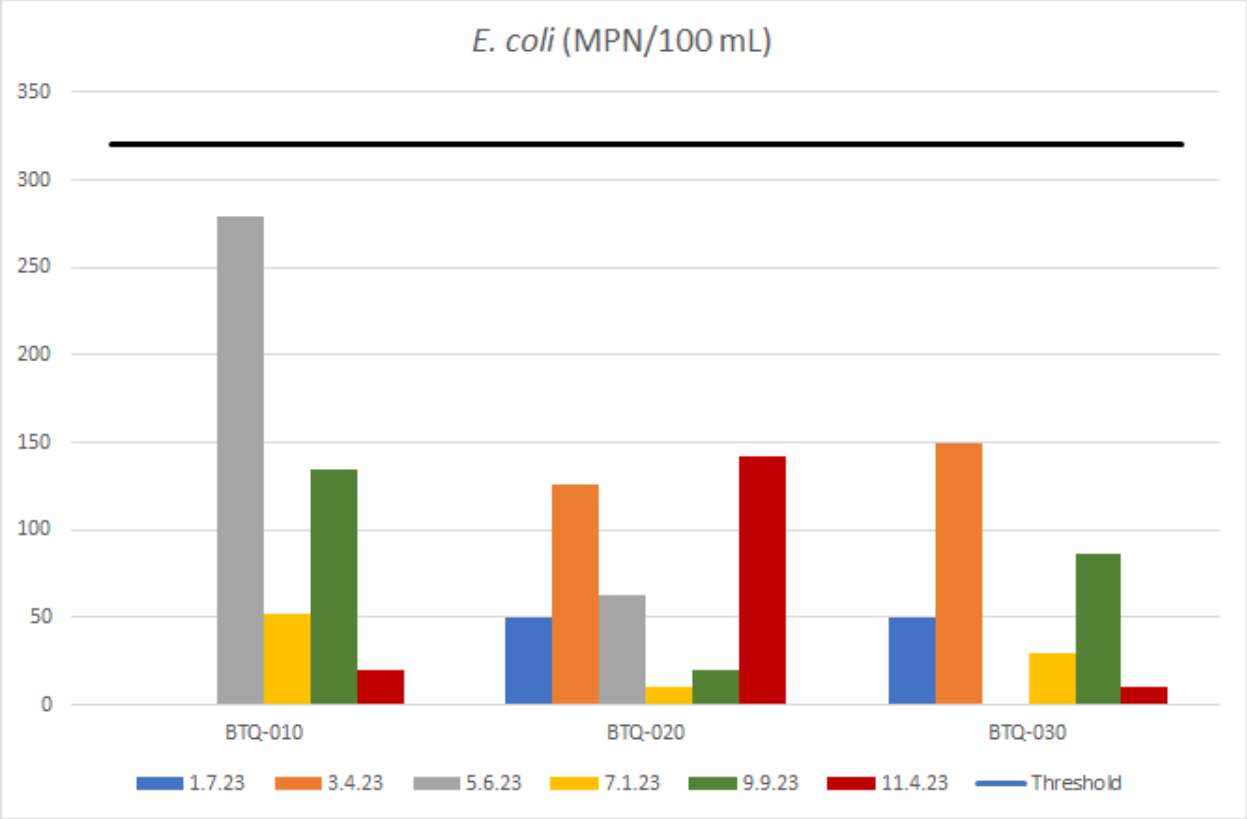
Laboratory tests

Turbidity (cloudiness), total coliform, *E. coli*, nitrates, total and reactive phosphorus, and ammonia are measured in the lab on grab samples collected in the field.

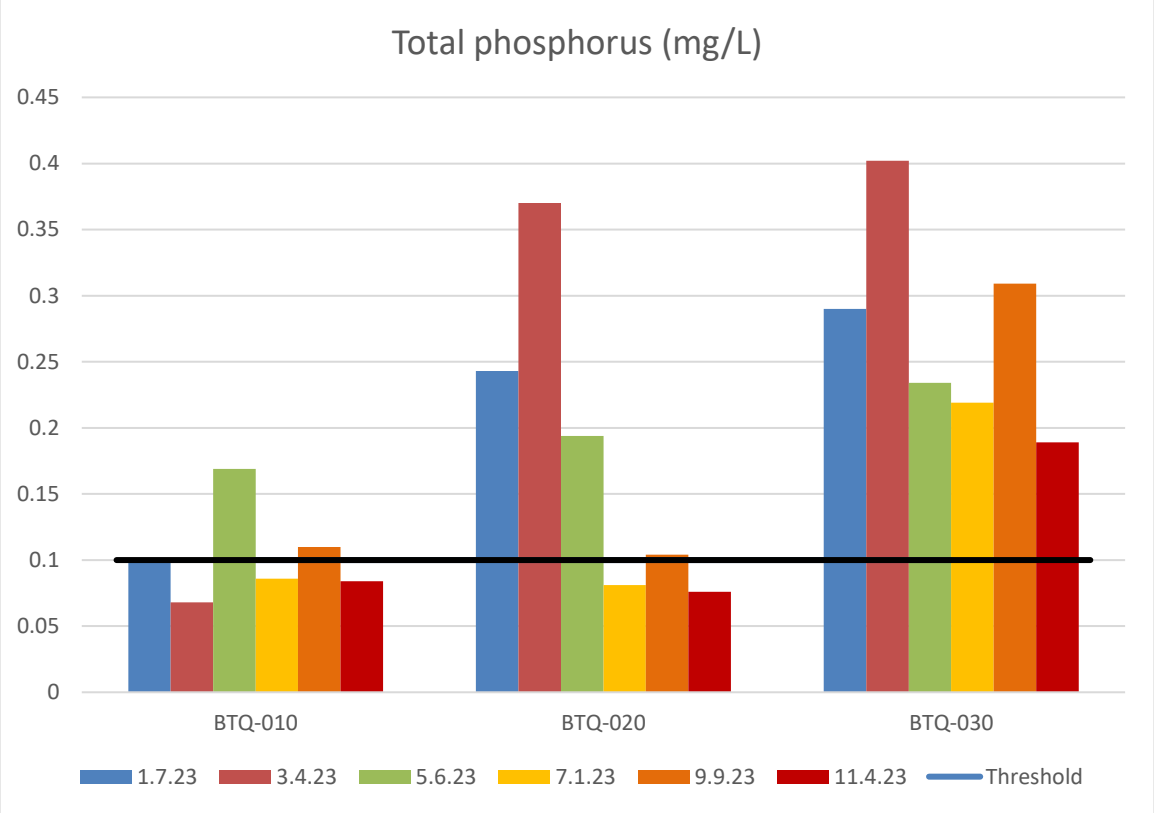
High turbidity can hinder light penetrating water which may affect photosynthesis. The threshold is 20 FNU, and only the measurements for BTQ020 and BTQ030 for January and March were above threshold. These exceedances were clearly result of the exceptionally high runoff associated with precipitation (i.e., strong winter storms) immediately preceding these sampling events (see also site images, Appendix A), and were reminiscent of 2020 where such spikes also corresponded to recorded precipitation (and subsequent increased runoff flow) during selected sampling events. The remaining data show no obvious spikes in turbidity across the sites, similar to the data reported for 2021-22.

Coliforms are a group of bacteria found in the digestive tracts of animals, including humans and their wastes. They are also found in plant and soil material. Because they are not reliable indicators of pathogenic bacteria and/or origin, there is no threshold for the measurement of total coliform (TC). *E. coli* is a better, but not perfect, indicator of pathogenic bacteria. The IDEXX Quanti-tray/Colilert method utilized in this program measures all *E. coli* (pathogenic or not). The threshold for *E. coli* is 320 MPN/100 mL^4. All measurements were below threshold, with only the May reading for BTQ010 (279) approaching the threshold. Unlike previous years, where elevated *E. coli* was observed during the warmer (May through November) months, no obvious site or time-of year trends were apparent.


Turbidity (FNU)
120.00
100.00
80.00
60.00
40.00
20.00
0.00
BTQ-010
BTQ-020
BTQ-030
1.7.23
3.4.23
5.6.23
7.1.23
9.9.23
11.4.23
Threshold
Linear (Threshold)

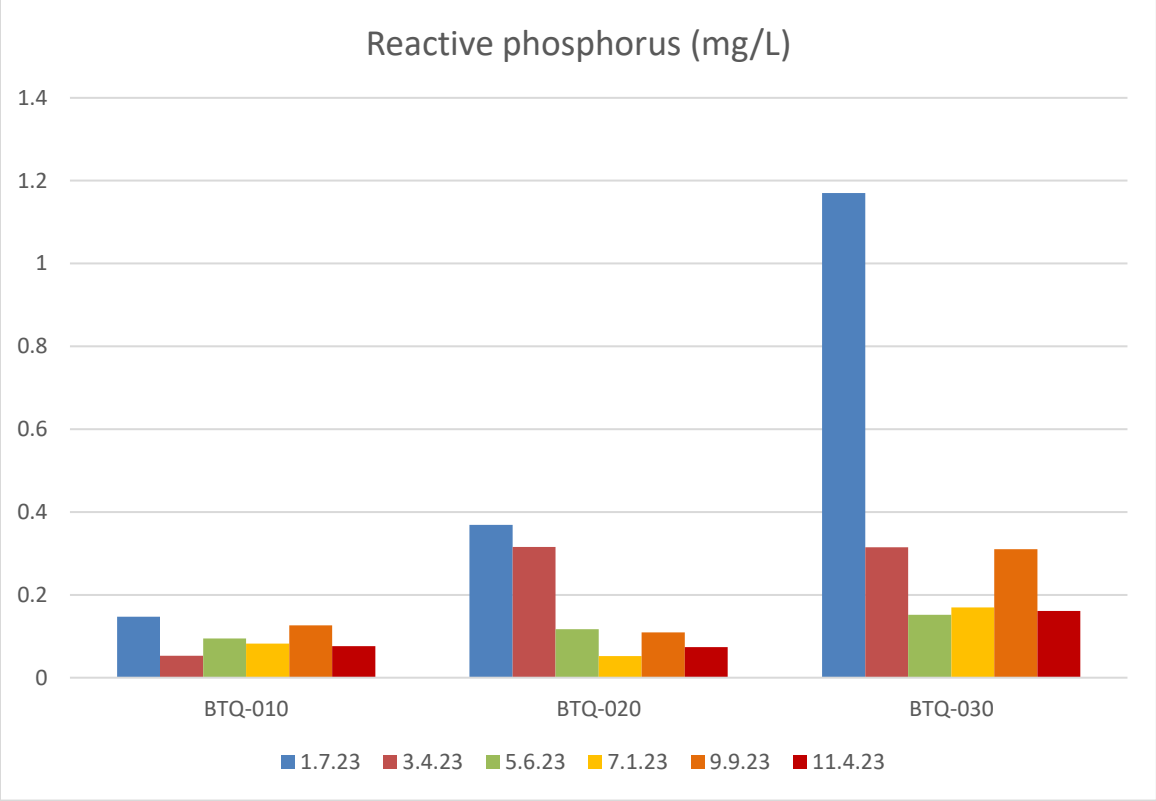

E. coli (MPN/100 mL)
350
300
250
200
150
100
50
0
BTQ-010
BTQ-020
BTQ-030
1.7.23
3.4.23
5.6.23
7.1.23
9.9.23
11.4.23
Threshold

Elevated total phosphorus (TP) is often the result of fertilizer runoff and can lead to algal blooms. TP can also be stored in lake or pond sediments, and can be effectively mobilized by entrainment into the water column when bottom sediments are disturbed, e.g., as a result of vigorous mixing due to turbulence or storms. The threshold for TP in San Diego watersheds is 0.1 mg/L[7]. For 2023, the range for total phosphorus was 0.08 to 0.40 mg/L with 11 of the 18 measurements at or above the threshold, most notably for BTQ030 where measurements across the entire sampling period exceeded the threshold. These levels were 2-3 times higher than corresponding TP readings in 2022. As was observed in 2019-22, TP was highest at BTQ030, clearly indicating its enrichment in water released from Lake San Marcos. Moreover, the correspondence of the elevated TP readings at BTQ020 and BTQ030 with turbidity (see above) reinforces the strong association of TP with suspended particulates in storm runoff (see also pictures, Appendix A).

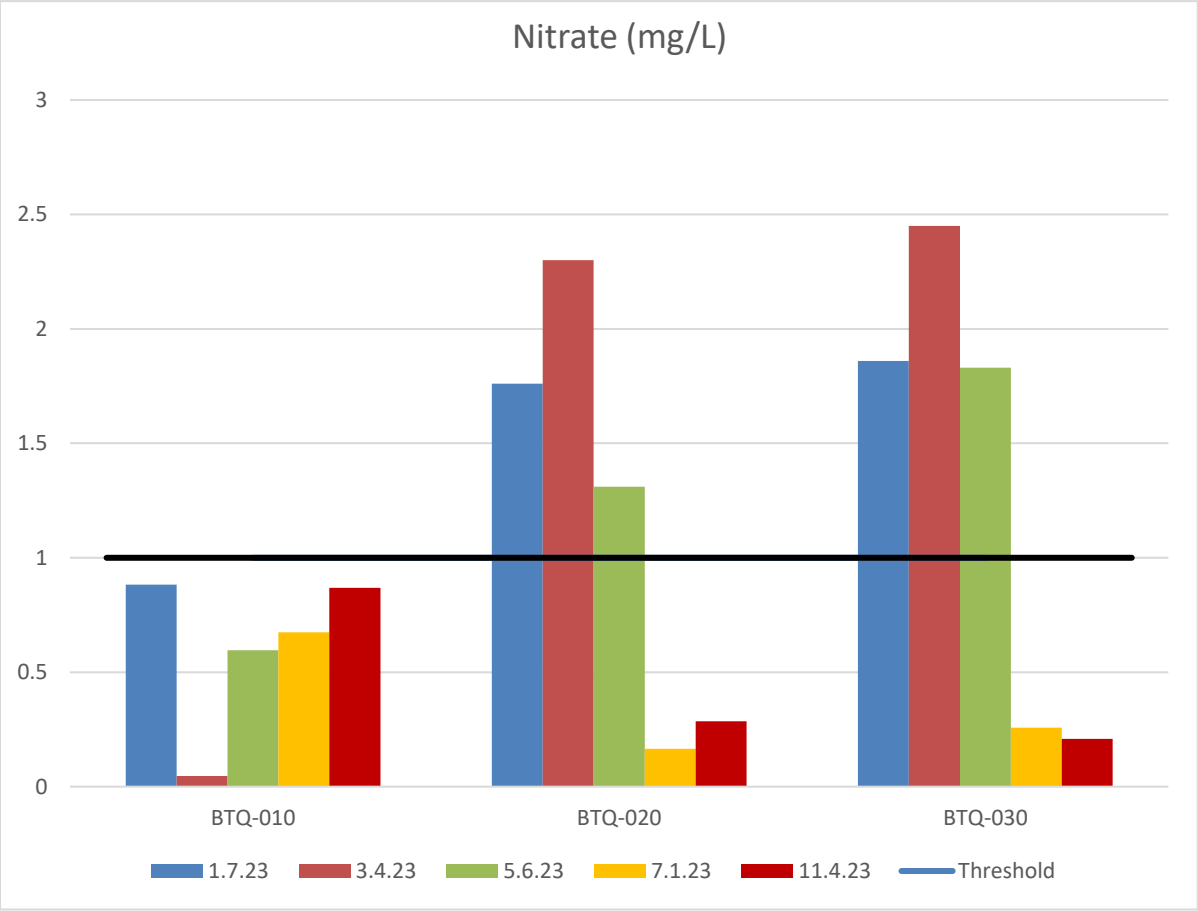


Reactive phosphorus (RP, aka “polyphosphates”) is the ionic form of this element that is preferred by living organisms, otherwise known as “bioavailable” phosphorus. There is no water quality threshold for RP, which ranged between 0.05 to 0.32 mg/L, levels which also surpassed those reported in 2022 (similar to TP). In contrast to 2022, RP was elevated at all 3 sites in January (and somewhat in March); however,

It should be noted that RP exceeded TP for the January readings, suggesting that these data were subject to artifacts that affected their accuracy and thus should be interpreted with caution. For all other sampling events, levels mirrored those reported in 2022, with TP exceeding RP indicating no artifactual issues. These results indicate a continued improvement in the quality of TP and RP measurements compared with pre-2022 data.

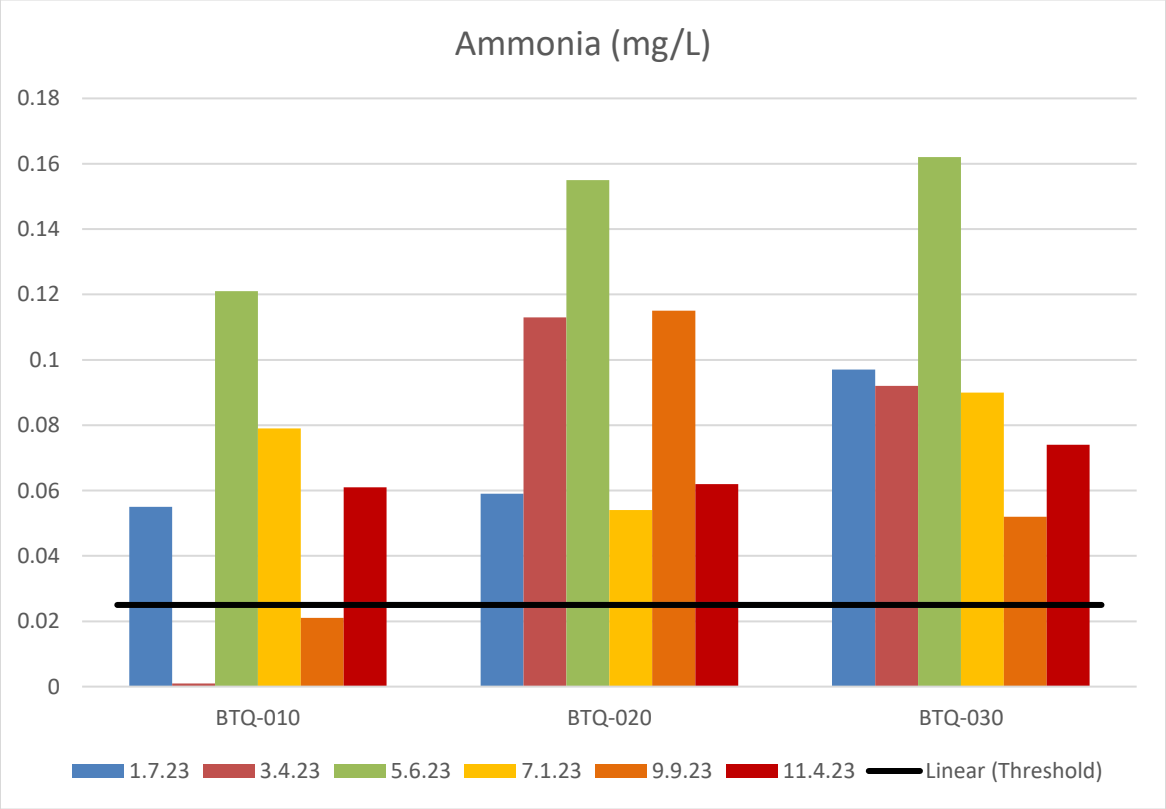


As with phosphorus, nitrate also enters waterways via fertilizer runoff, and to a lesser extent with mobilized suspended particulate from disturbed bottom sediment. With a threshold of 1.0 mg/L, nitrate ranged between 0.47 to 2.45 mg/L across all sites and sampling events. Similar to the event and site trends observed for TP and RP (as well as turbidity to a lesser extent), nitrate was highest during the January and March events for BTQ020 and BTQ030. Along with the May readings at these sites, these 6 readings exceeded the threshold. Moreover, the range of nitrate levels constituted a 2-fold increase over 2022 (similar to TP and RP). In contrast to 2019-22 where BTQ010 had higher levels of nitrate compared to the two other sites, the higher nitrate levels in the upper watershed suggest a mobilization of soluble nitrate from upstream of BTQ030, likely from the Lake San Marcos overflow/discharge.



Lastly, for ammonia, the threshold is 0.025 mg/L. Similar to 2020-22, multiple measurements exceeded the threshold, however, the number of exceedances was nearly 100% (17 of 18 total measurements). In contrast to previous years, the only non-exceedances were observed for BTQ010 (March and September). Moreover, the exceedances were irrespective of site, whereas in previous years, few to no exceedances were recorded for BTQ030. The highest values were recorded for the May event. Beyond that, no obvious pattern or trend was discernable in the data over time and/or across sites.

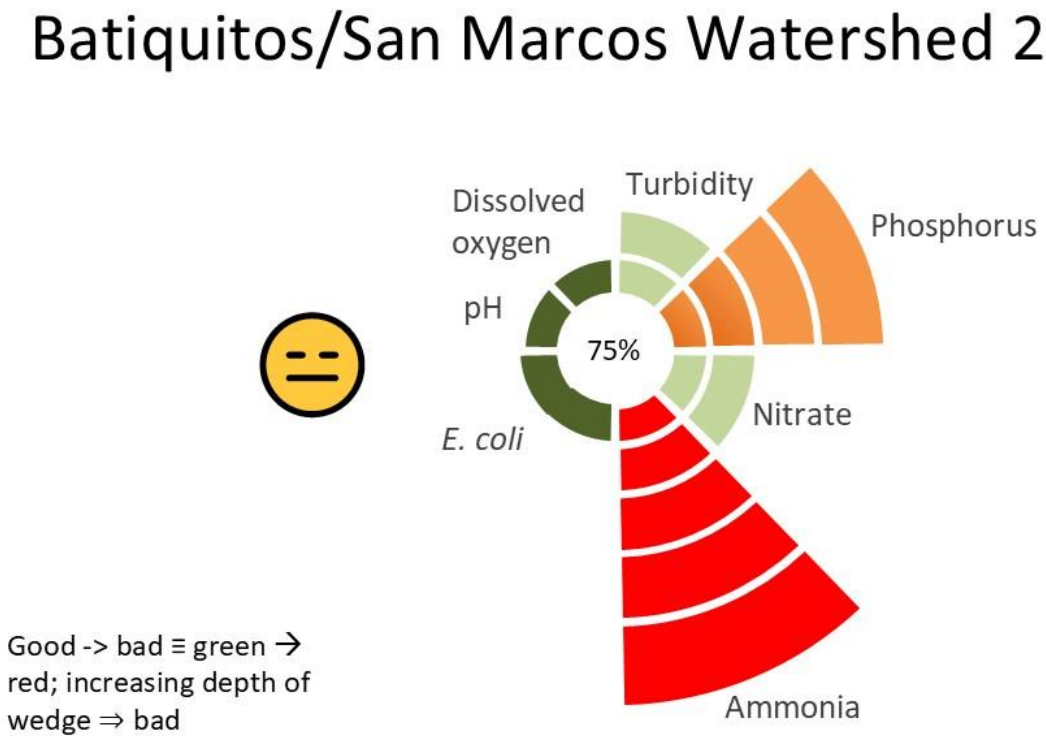
Unfortunately, both field and lab blank determinations for ammonia across all 6 sampling events revealed artifacts at lower levels (up to 0.077 mg/L). Thus, it is not difficult to conclude that ammonia measurements below 0.077 mg/L are unreliable, and any conclusions based on low-level ammonia results (i.e., 8 of the 16 measurements < 0.1 mg/L) should be made with extreme caution. This has been an on-going issue not unique to the 2023 data. It is strongly recommended that both the analytical method and selection of threshold be reviewed carefully to ensure the utility and relevance of ammonia measurements for future monitoring cycles.



Water Quality Report Card

Instituted in the 2022 Annual Report[6], the inclusion of composite water quality "fan" diagrams generated from scores (0-5) for each of the seven parameters with an established threshold (pH, DO, turbidity, Phosphorus (as measured by TP), nitrate, ammonia, and *E.coli*) for the watershed as a whole. A composite ranking (as a percentage) is computed from the weighted averages of all parameter scores (with *E. coli* weighted double). Rankings are classified as follows: 90-100% (Excellent); 80-90% (Good); 70-80% (Fair); 60-70% (Poor); <60% (Terrible).

Overall, the BTQ watershed was graded "Fair" (75% composite ranking) for 2023, compared with a "Good" ranking (83% composite ranking) in 2022. Parameters that were deemed as improvable were Phosphorus and ammonia. Ammonia was also identified as a parameter to watch in 2022. As seen in previous diagrams, exceedances for ammonia were not site specific. In contrast, exceedances for TP were most prevalent at the San Marcos Creek sites (BTQ020 and BTQ030).



Final thoughts

Precipitation and the resulting fluctuations in stream flow from runoff play a key role in water quality in coastal north San Diego watersheds. Threshold exceedances for total phosphorus, in concert with elevated nitrate and turbidity at the upper watershed sites (BTQ020 and BTQ030) suggest transport of these nutrients during elevated flow events. As seen in site pictures (Appendix A), stream flows were among the highest in recent years, particularly during the first half of 2023. Continued release of water from Lake San Marcos was another likely contributor to higher-than-normal antecedent flows. An indirect influence of increased precipitation and stream flow are the effects of dilution and aeration, perhaps explaining the decrease in exceedances for *E. coli*, and improvement in DO, relative to 2022.

Whereas BTQ010 routinely scored with the lowest overall water quality in past recent years, the upper watershed sites exhibited the majority of exceedances in 2023. This is attributed to increased stream flows, illustrating the effect of much higher than average precipitation for our coastal watersheds.

Lastly, the value of QA/QC in validating and correctly interpreting basic water quality monitoring data cannot be understated. Overall, the QA/QC results for 2023 indicate good performance in generating high quality data for their intended purpose (i.e., comparison to WQ thresholds). The clear exception was ammonia, where lab and field blank measurements were at or above the 0.025 mg/L threshold for all sampling events [0.054 mg/L (Jan); 0.025 mg/L (Mar); 0.035 mg/L (May); 0.078 mg/L (Jul); 0.051 mg/L (Sep); 0.047 mg/L (Nov)]. Moreover, poor precision as measured by a relative percent difference (RPD) > 50% for duplicate sample measurements (primarily the field duplicate samples) was noted for 3 of the 6 sampling events. These results indicate that ammonia measurements below blank levels (0.025 to 0.078 mg/L) are unreliable and raises serious issues regarding the accuracy of such data. The negative impact regarding interpretation of low-level ammonia (i.e., those < 0.1 mg/L) measurements is exacerbated by the extremely low threshold (0.025 mg/L). Thus, NSDCWMP should periodically revisit the performance limits of all assays, the utility and relevance of the current thresholds (especially for ammonia), as well as to continue to emphasize the importance of standardized procedures in their training of field and lab personnel to minimize measurement artifacts and anomalies.

[1]https://batiquitoslagoon.org/about.html
[2]https://batiquitoslagoon.org/blf_newsletter_2-2018.pdf
[3]Batiquitos 2019 Annual Report
[4]Batiquitos 2020 Annual Report
[5]Batiquitos 2021 Annual Report
[6]Batiquitos 2022 Annual Report
[7]https://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/docs/R9_Basin_Plan.pdf

Acknowledgements

The authors thank Andrea Dunning, Calvin Yuen, Paige DeCino, coordinator for the NSDCWMP, and her team of volunteers.

APPENDIX A

Sampling Site BTQ010 (Encinitas Creek @ Levante St. Bridge) – 7 January 2023

1 July 2023

Sampling Site BTQ020 (San Marcos Creek @ end of Gibraltar Ave) – 7 January 2023.

Higher than average stream flow necessitated sampling upstream of historic site

BTQ020 - 1 July 2023

Sampling Site BTQ030 (San Marcos Creek @ Melrose Ave bridge), 7 January 2023.

1 July 2023