

Real-Time Water Quality Deployment Report

TECK Duck Pond Operations 2023



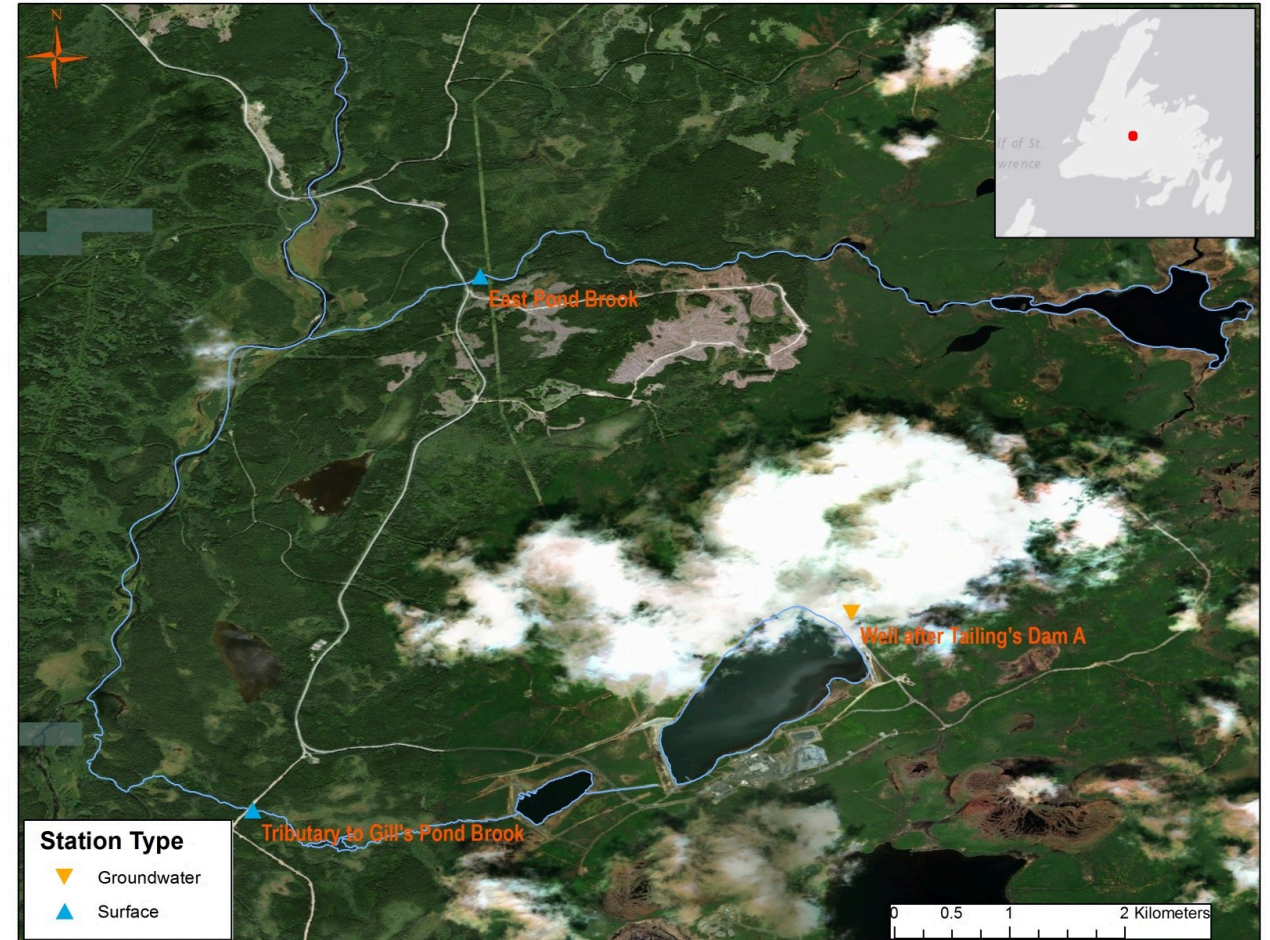
Real-Time Water Quality Deployment Report

Teck Duck Pond Operations 2023

Real-time water quality (RTWQ) monitoring of surface and groundwater quality on Teck: Duck Pond Operations (DPO) site is carried out by the Department of Environment and Climate Change, Water Resources Management Division. Work is undertaken in circumstances where industrial development has the potential to impact water bodies. The RTWQ program consists of more than 30 stations across the province.

RTWQ work at Teck Duck Pond Operations has been ongoing since 2006 with the installation of three monitoring stations: East Pond Brook station, Tributary to Gill's Pond Brook station, and Monitoring Well after Tailings Dam A station. These stations, identified in the photo to the right, were situated to observe water quality at key locations over the course of the Teck DPO project. East Pond Brook station was placed to intercept potential seepage from underneath flow control structures that maintain the tailings management area. Tributary to Gills Pond Brook is placed to observe water quality following the ultimate discharge of treated effluent from the polishing pond into the environment. Well after Tailings Dam A is also located in the East Pond Brook watershed, but is immediately adjacent to the flow control structure that ensures the tailings management area drains towards the polishing pond and the eventual discharge point above Tributary to Gills Pond Brook station. In this report, notable events and trends from 2023 are identified and discussed in relation to previous years.

Work under the RTWQ program is conducted according to the [Protocols Manual for Real-Time Water Quality Monitoring in NL](#). Hydrolab DS5X multi-parameter sondes are used at Teck Duck Pond surface stations. In May 2021, WRMD upgraded monitoring equipment at the well station.





Surface Water Temperature

Water Temperature is a crucial factor used to describe water quality. Temperature has major implications on both the ecology and chemistry of a water body, governing processes such as the metabolic rate of aquatic plants and animals and the degree of dissolved oxygen saturation. Further, many other parameters (specific conductivity, dissolved oxygen saturation) use temperature to calculate values.

Both stations had higher average temperatures when compared to previous years; however, the maximum temperature reached at EPG is lower than previous years. There is an increasing trend, indicated by the black dashed line to the right, at both stations. This warming trend is most likely do to climate change rather than local influences.

Temperatures generally peak in July and August, when air temperatures are warmest. Conversely, water temperatures generally approach (and sometimes exceed) 0°C in December and remain low until March. East Pond Brook is on average slightly warmer than Tributary to Gill's Pond; it is a larger stream with less canopy cover, which may influence the water temperature.

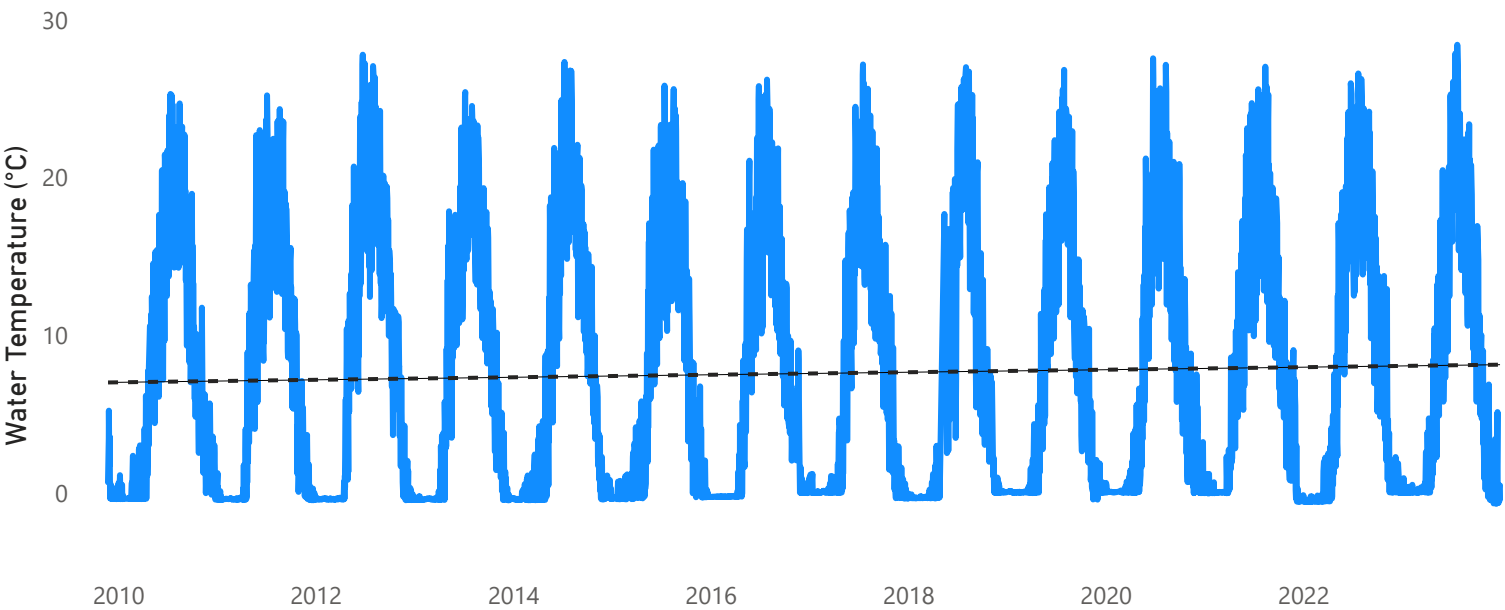
Gills Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	7.59	4.85	-0.68	28.43
Before 2023	7.28	4.68	-0.55	27.80

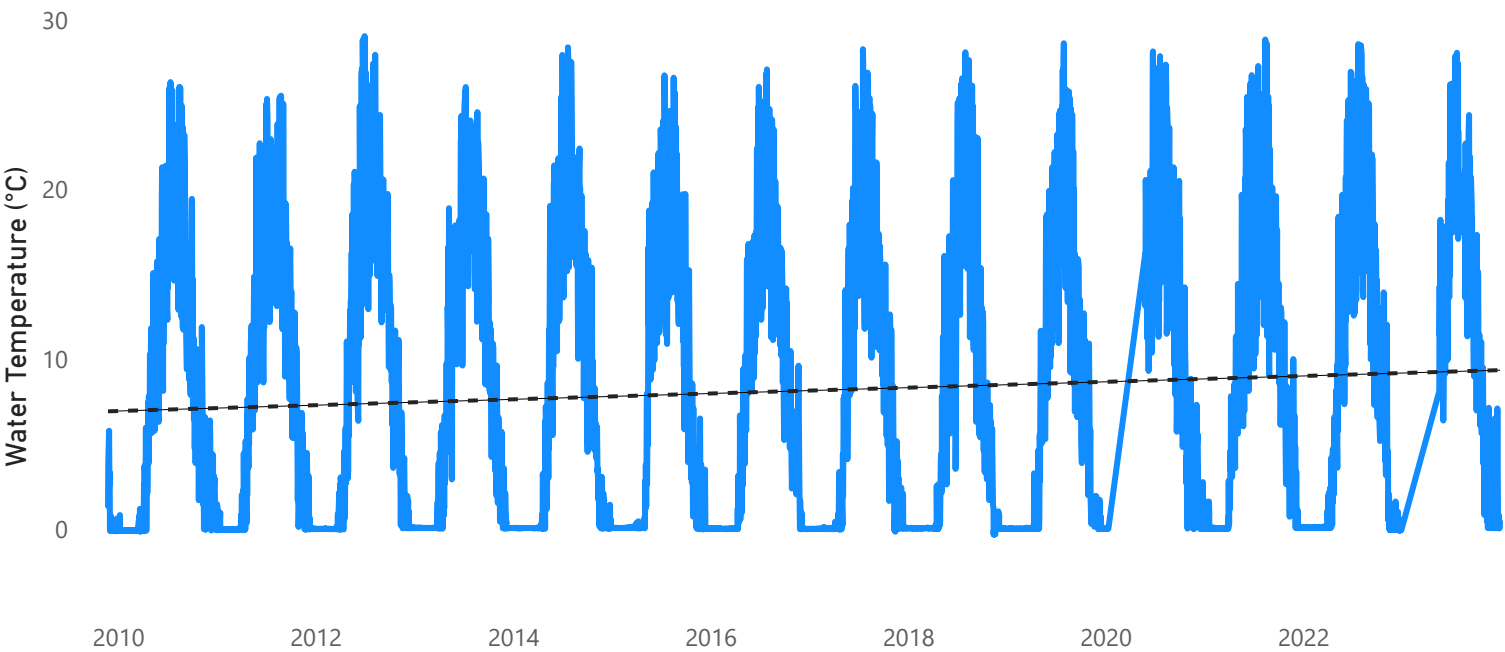
East Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	10.93	11.19	0.05	28.07
Before 2023	7.59	5.53	-0.32	29.05

Water Temperature in Tributary to Gills Pond Brook



Water Temperature in East Pond Brook





Surface Water pH

pH indicates the acidity or alkalinity of a solution. A value of 7.00 pH units denotes a neutral solution, lower values are acidic, and higher values are basic. pH is influenced by precipitation runoff and tends to decrease as stage increases.

The Canadian Council of Ministers of the Environment ([CCME guideline](#)) noted on the pH graph is a range by which to compare pH levels across Canada. It does not indicate the health of the brook. Since 2010, both stations have recorded values below CCME's maximum pH for the protection of Aquatic Life Guideline (pH 9); however, both stations are regularly below CCME's minimum pH for the protection of aquatic life guideline (pH 6.5).

Due to the soil composition and natural geology of Newfoundland and Labrador, many of the brooks and waterways in the province have naturally lower pH ranges. However, water in Tributary to Gills Pond Brook is influenced by treated effluent discharged from an upstream polishing pond, which is treated to maintain a near-basic pH of 7.0.

At both stations, pH is generally highest during the late summer or early fall and the pH is lowest towards the end of the winter into early spring. There is also a similar increasing trend (indicated by the black dashed line) at both stations. The average pH at East Pond Brook was slightly lower than previous years.

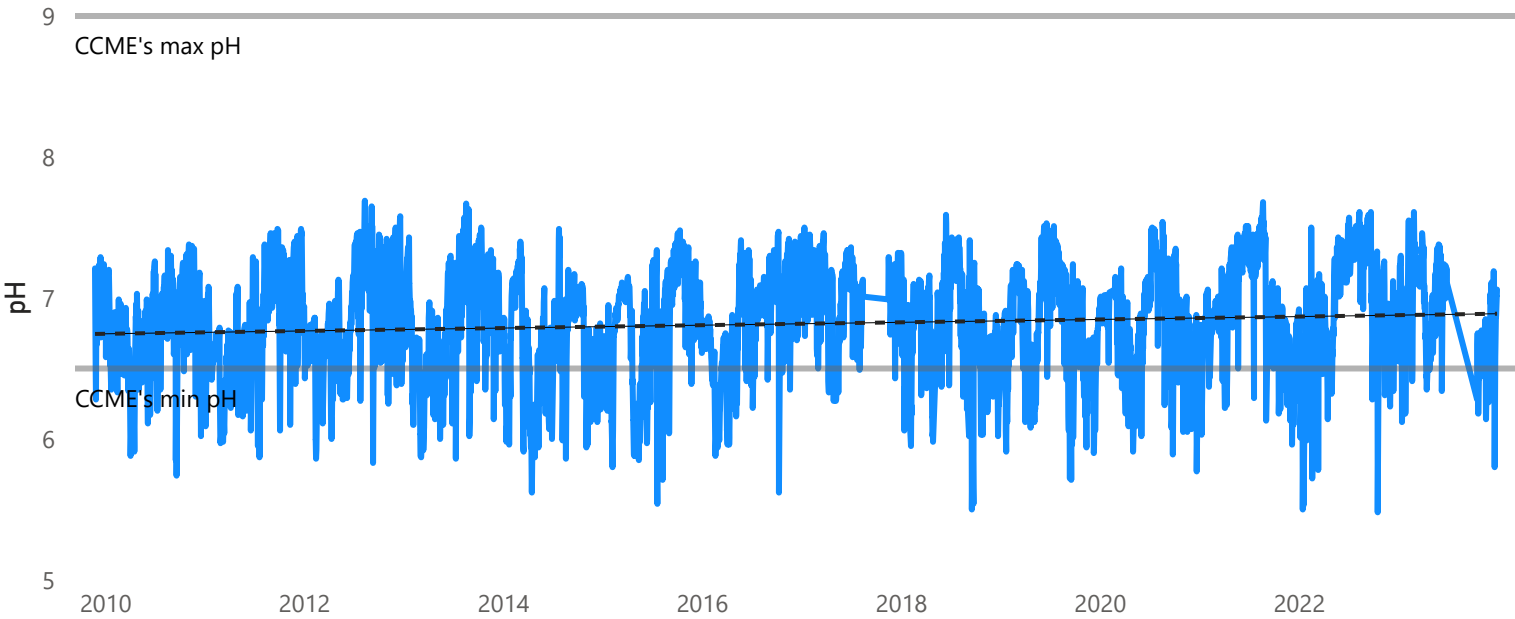
Gills Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	6.88	6.94	5.80	7.61
Before 2023	6.81	6.84	5.48	7.69

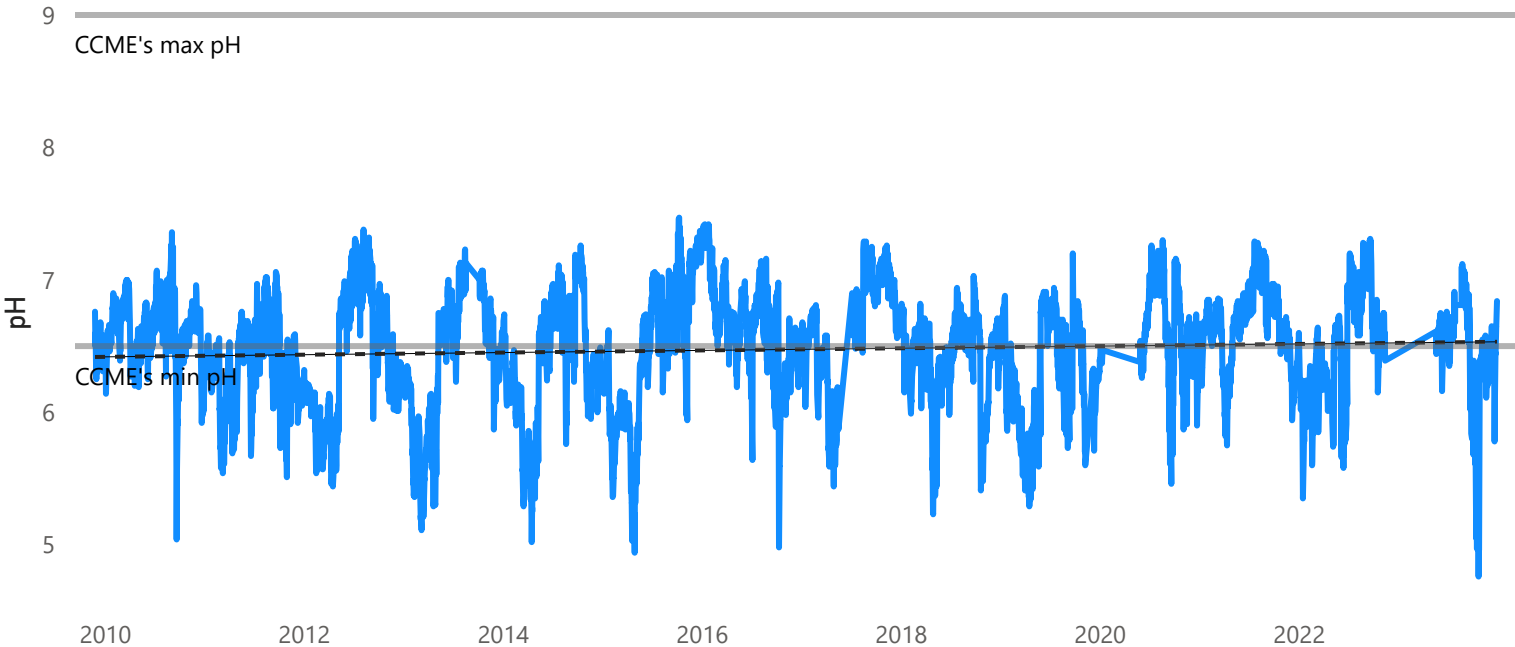
East Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	6.41	6.50	4.76	7.12
Before 2023	6.47	6.54	4.94	7.47

pH in Tributary to Gills Pond Brook



pH in East Pond Brook





Surface Water Specific Conductivity

Conductivity relates to the ability of an electric charge to pass through a solution. Conductivity is highly influenced by the concentration of dissolved ions in solution; distilled water has zero conductivity (infinite resistance), while salty solutions have high conductivity (low resistance). Specific conductance is corrected to 25°C to allow comparison across variable temperatures.

There is a significant difference between the specific conductivity of Gills Pond Brook's waters and East Pond Brook's waters; this is influenced by the polishing pond effluent, upstream of Gills Pond Brook. The specific conductivity of Gills Pond Brook has decreased since the decommissioning of the mine as indicated by the black dashed trendline to the right. East Pond Brook has seen a slight decrease in specific conductivity. This may be a result of the effects of increased precipitation events due to climate change, which stirs up the water column.

Cyclical patterns are also apparent at both sites. When water levels drop in the late summer, the concentration of dissolved ions become concentrated, which increases the specific conductivity. There is often a similar less pronounced peak in February or March.

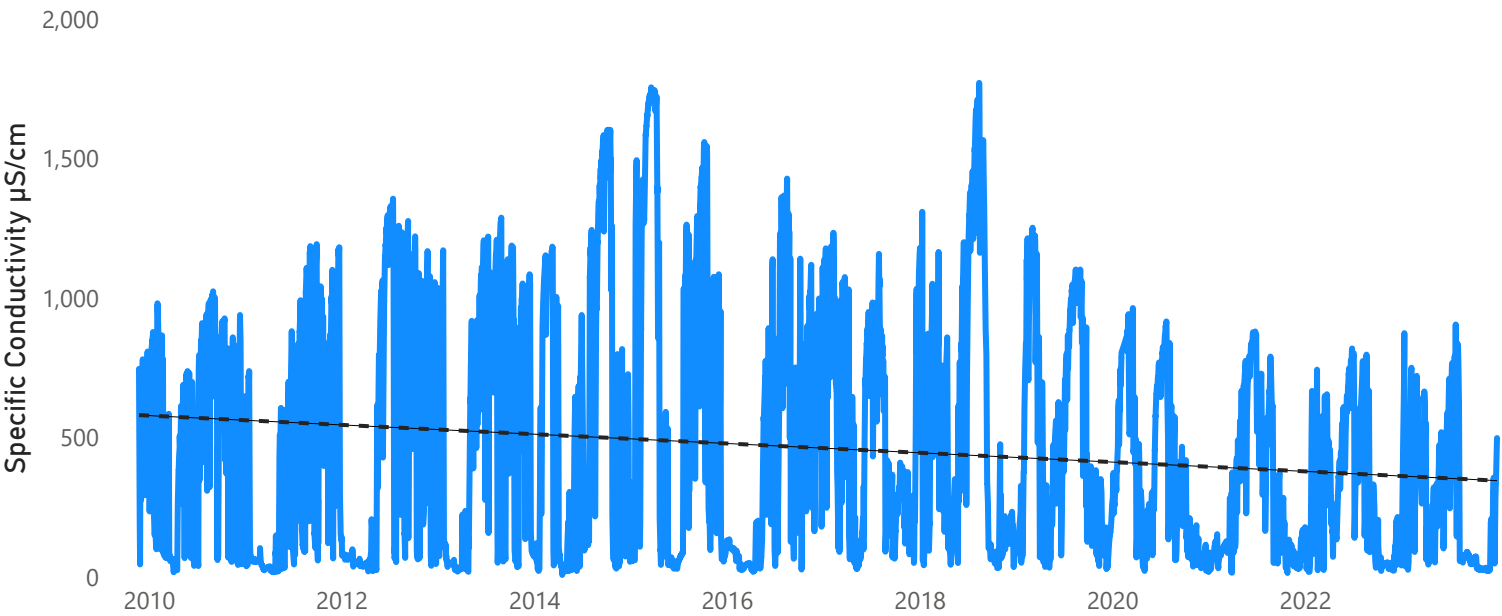
Gills Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	265.02	201.00	21.00	905.00
Before 2023	475.89	358.00	7.40	1,771.00

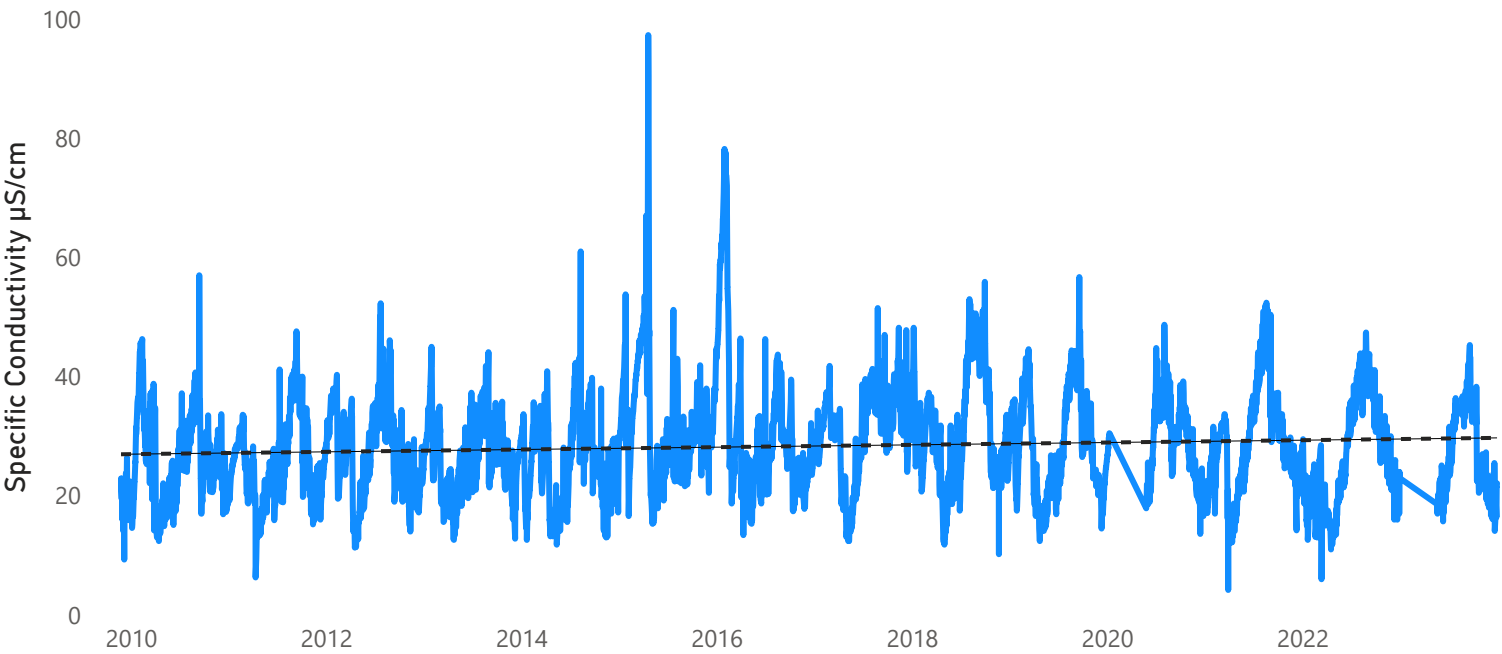
East Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	26.56	23.70	14.10	45.30
Before 2023	28.27	27.10	4.20	97.30

Specific Conductivity in Tributary to Gills Pond Brook



Specific Conductivity in East Pond Brook



Surface Water Dissolved Oxygen

Dissolved oxygen (DO) is a metabolic requirement for life. The [CCME guidelines](#) for the protection for other life stages (6.5 mg/L) and the guideline for the protection for early life stages (9.5 mg/L) is indicated in grey on the DO graphs to the right. During 2023, both rivers met the CCME's guideline for other life stages; however, there were periods when both rivers did not meet the CCME's guidelines for early life stages.

The amount of dissolved oxygen in water depends on several factors, particularly water temperature. Cooler water can hold more dissolved oxygen; as a result of increasing water temperatures, the dissolved oxygen levels are decreasing. The trend lines, indicated with a black dashed line, for Gills Pond Brook and East Pond Brook illustrate this decreasing trend.

Over the 14 year deployment, cyclical fluctuations are apparent. During the winter when air and water temperatures are colder, dissolved oxygen levels are higher, and during the summer, the opposite it true.

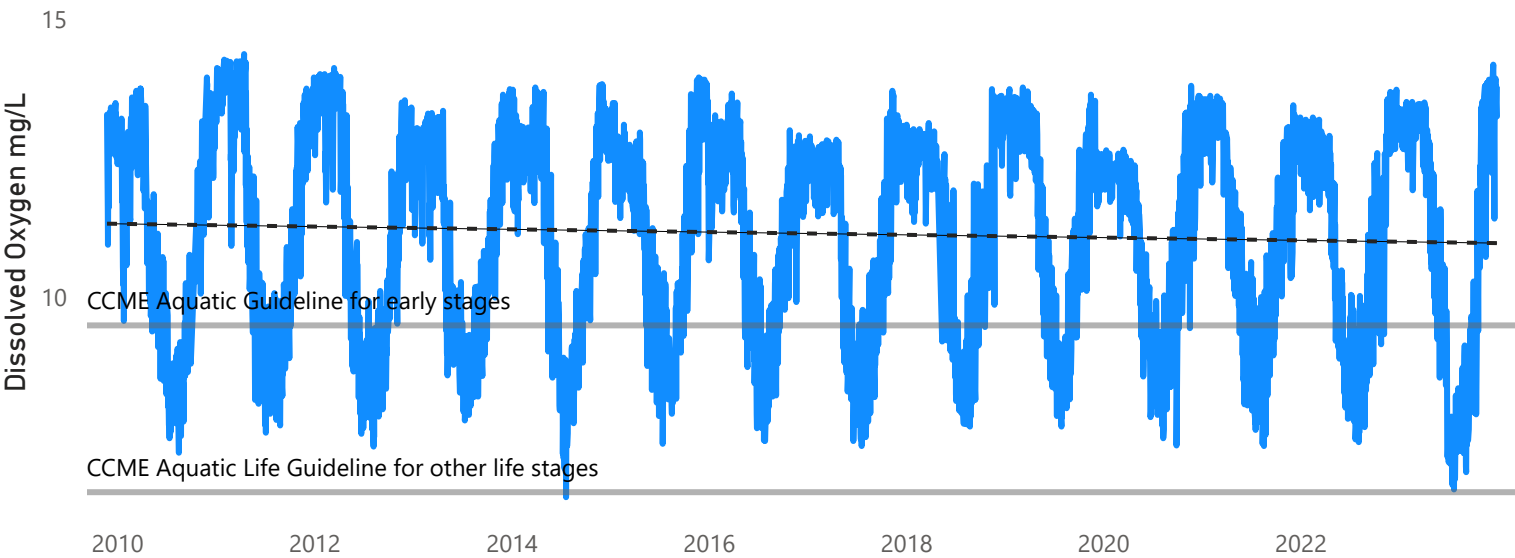
Gills Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	10.98	11.70	6.55	14.19
Before 2023	11.18	11.58	6.41	14.38

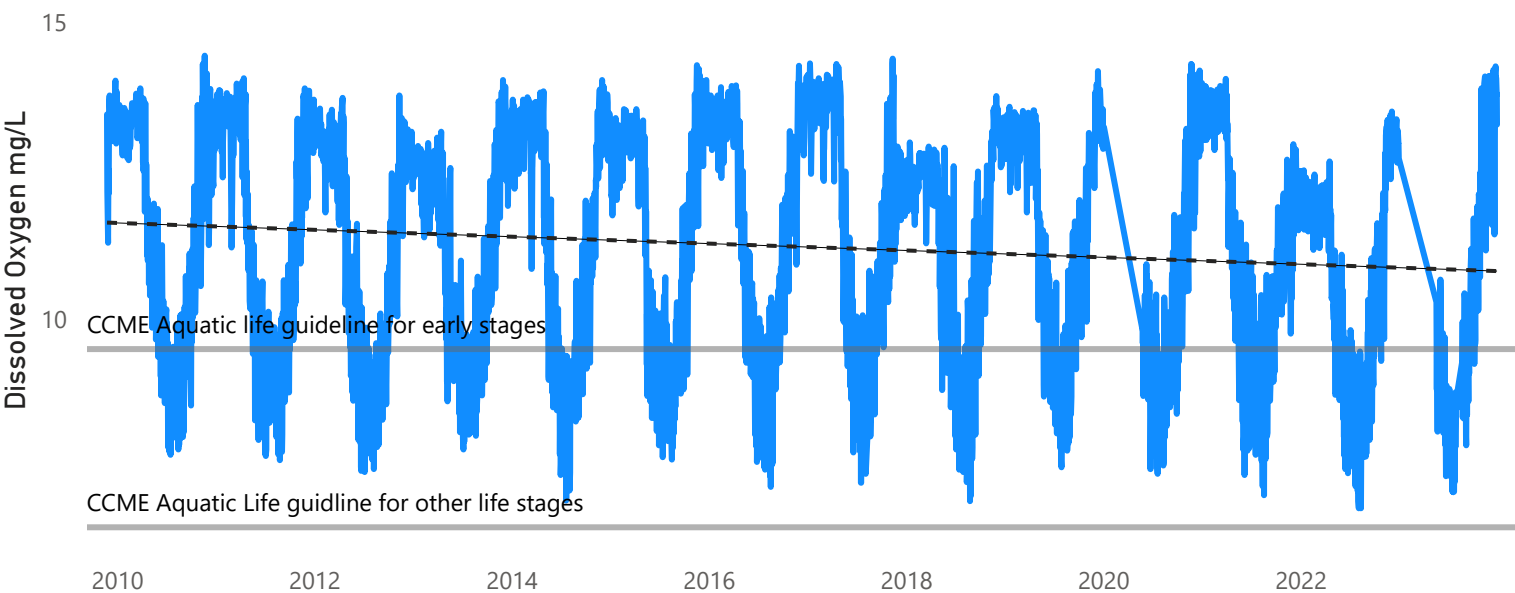
East Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	10.63	10.08	7.09	14.26
Before 2023	11.28	11.59	6.82	14.44

Dissolved Oxygen in Tributary to Gills Pond Brook



Dissolved Oxygen in East Pond Brook





Surface Water Turbidity

Turbidity sensors measure the amount of fine solids, such as silt, clay, or organic materials, suspended in the water column. This parameter is monitored because turbid waters can prevent light from reaching photosynthetic organisms, settle on benthic organisms and spawning areas, and damage delicate respiratory organs.

Turbidity levels at Gill's Pond Brook and East Pond brook are both generally low; however, turbidity sensors are prone to errors from debris that can get caught around the sensors. During the 14 years of deployment at Gills Pond Brook, the quality assurance and quality control readings and grab samples have recorded values ranging from 0.0 NTU to 44.30 NTU and 0.2 to 4.1 NTU respectively. During the 14 years of deployment at East Pond Brook, the quality assurance and quality control readings and grab samples have recorded values ranging from 0.0 NTU to 25.0 NTU and 0.2 to 2.3 NTU respectively. The deployed sensors will often return readings much higher throughout the deployment due to sediment becoming trapped in the sensor's protective cage. In order to see an accurate picture of the fluctuations at the site, readings above 25 NTU were omitted from this report.

A trendline For Gills Pond Brook values shows how turbidity dropped after nearby mining operations concluded. Conversely, turbidity at East Pond Brook has marginally increased during this same time frame; possibly as a result of increased extreme weather events.

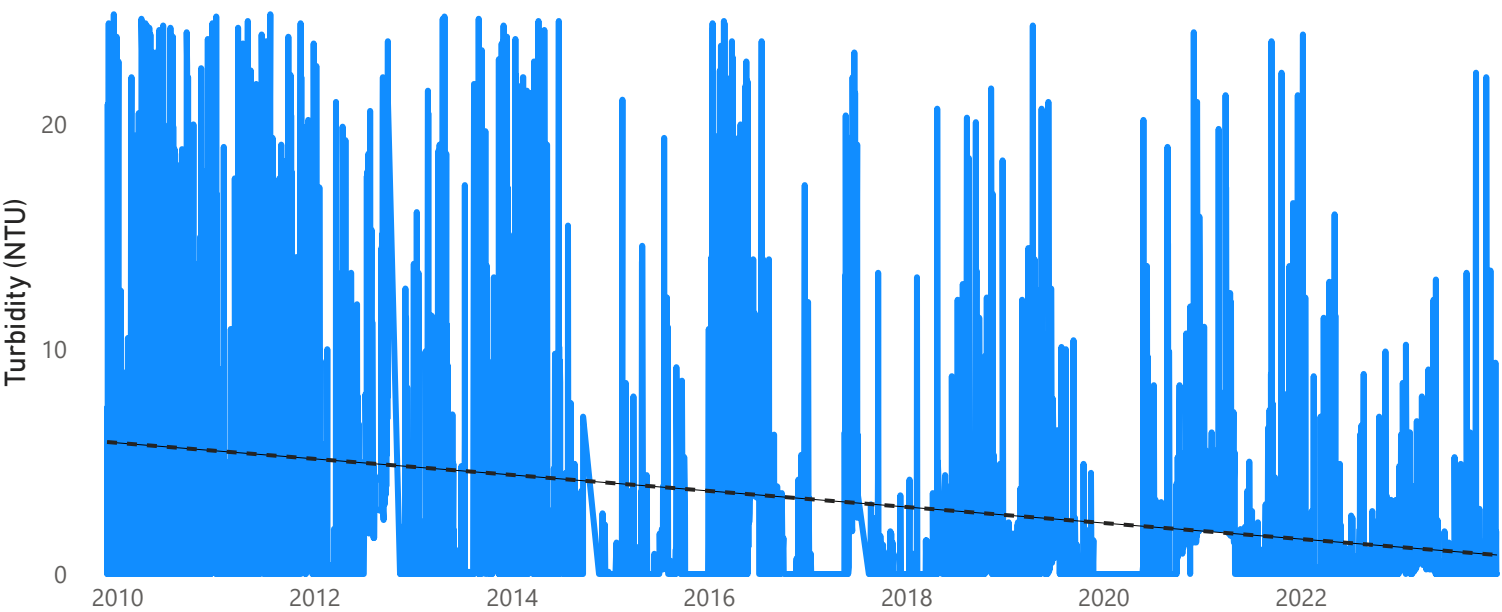
Gills Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	0.39	0.00	0.00	22.30
Before 2023	0.82	0.00	0.00	24.90

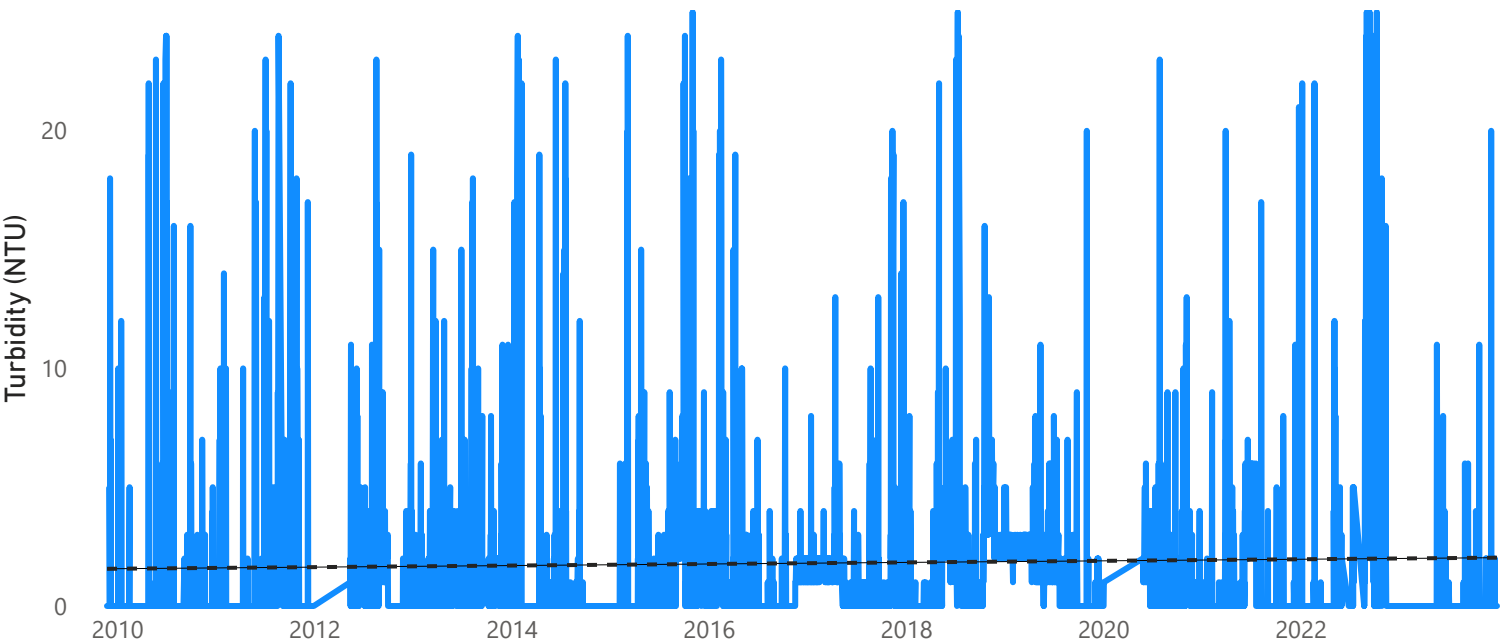
East Pond Brook

Report Year	Average	Median	Minimum	Maximum
2023	0.09	0	0	20
Before 2023	0.71	0	0	25

Turbidity in Tributary to Gills Pond Brook



Turbidity in East Pond Brook



Well Water Temperature

Well after Tailings Pond

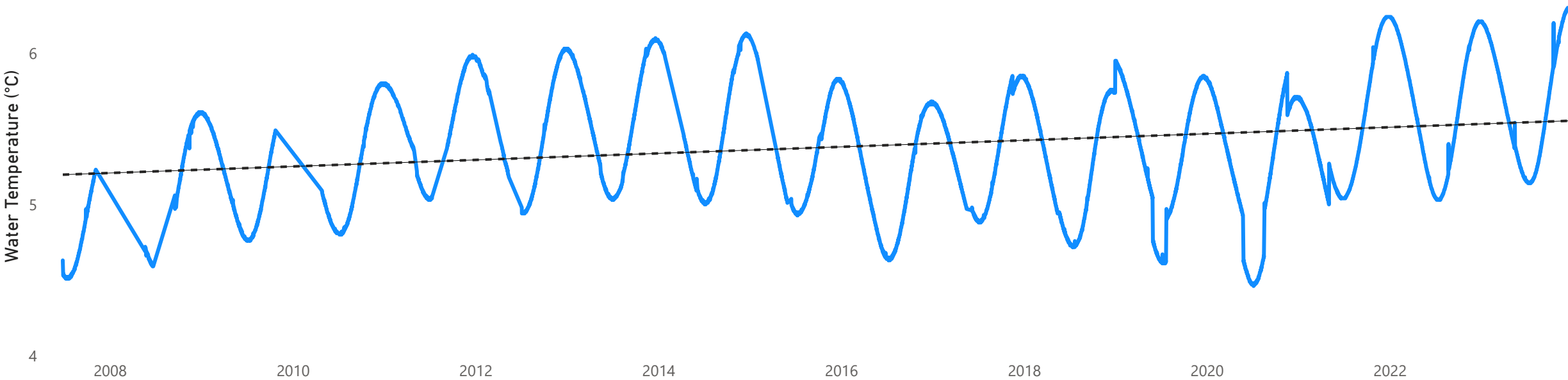
Report Year	Average	Median	Minimum	Maximum
2023	5.71	5.72	5.14	6.31
Before 2023	5.36	5.35	4.46	6.24

In 2023, the water temperature in the well after tailings pond ranged from 5.14°C to 8.05°C. The average temperature was 5.71°C compared to 5.36°C observed in past years. The highest temperatures observed in the well, 8.05°C, occurred on October 18, 2023 during sonde replacement. The lowest temperatures occurred in 2020.

There has been a general warming trend, which is indicated by the black dashed line below. However, the average water temperature in 2011, the first complete year of deployment, was 5.54°C, 0.17°C cooler than 2023. Temperatures slightly dipped from 2016 until 2020.

The coolest temperatures tend to occur in July, while the warmest temperatures occur in December and January. This is a stark contrast to surface water which displays the opposite pattern. This is due to delayed seasonal warming as a result of the insulative properties of soil. Overall the well water temperatures are fairly consistent throughout the year, with a temperature range of 2.91°C in 2023. The overall temperature range (2007-2023) was 1.98°C.

Water Temperature in Well after Tailings Pond



Well Water pH

In 2023, the average pH was 7.68 pH units, less than 1 pH unit lower than the 2007-2022 average (8.42 pH units). As previously mentioned, waters in Newfoundland tend to be slightly acidic (lower pH) due to the soil composition and geology. When monitoring began, the pH was much higher; however, it has been trending towards more typical readings for the island.

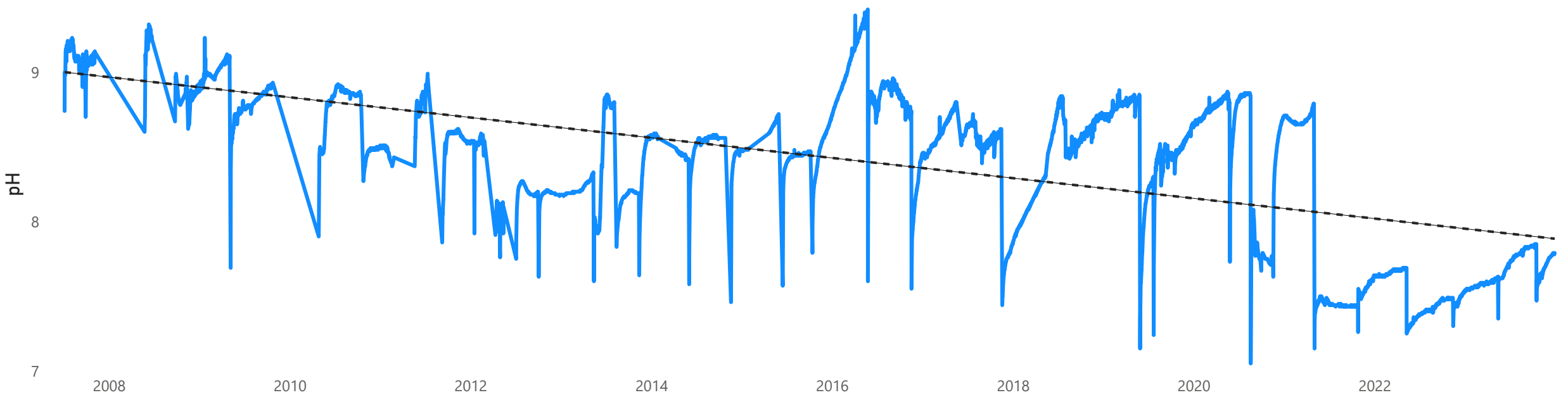
The general decreasing trend, is indicated by the black dashed line below. The average pH in 2008 was 8.92 pH units, which is 1.24 pH units higher than 2023. This is opposite to the two surface water stations which show an increasing pH trend. The downward trending pH in the well may be a result of the decommissioning of the mine, or it may be a result of warming water temperatures. This correlation was noted in 2021; the pH at this site often decreases when water temperatures increase.

When the sonde is removed, the well is purged, which is represented in the graph by downward spikes. Because the pH sensor requires longer to stabilize than other sensors, the disruption is more evident. In 2021 the well sonde was changed to an EXO. The pH readings have been lower since this change was made.

Well after Tailings Pond

Report Year	Average	Median	Minimum	Maximum
2023	7.68	7.65	7.35	7.85
Before 2023	8.42	8.54	7.05	9.42

pH in Well after Tailings Pond





Well Water Specific Conductivity

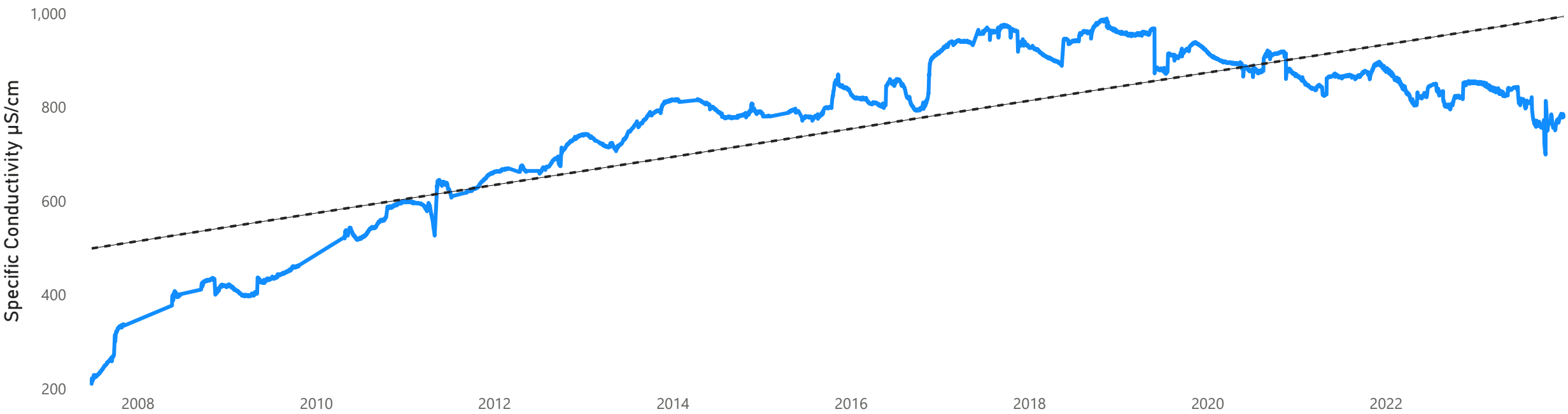
In 2023, the average specific conductivity was 809.17 $\mu\text{S}/\text{cm}$. The average specific conductivity for 2007-2022 was 769.53 $\mu\text{S}/\text{cm}$. The maximum specific conductivity in 2023 was 855.01 $\mu\text{S}/\text{cm}$, and the maximum specific conductivity overall was 989.00 $\mu\text{S}/\text{cm}$, which occurred on 11/15/2018.

Well after Tailings Pond

Report Year	Average	Median	Minimum	Maximum
2023	809.26	817.10	698.80	855.01
Before 2023	769.53	819.00	210.00	989.00

There is an increasing trend for specific conductivity from 2007 to 2014; followed by a plateau phase from 2014 to 2016; another increase from 2016 to 2018; and finally, a decreasing trend from 2018 onward. The conductivity most likely increased from 2007 to 2014 as a result of mining activities. From 2014-2016 the water level in the tailings pond was lowered to perform long-term stabilization work. The lowering of water levels may have concentrated the tailings pond, resulting in the increased specific conductivity from 2016 to 2018.

Specific Conductivity in Well after Tailings Pond



Well Water Oxidization Reduction Potential

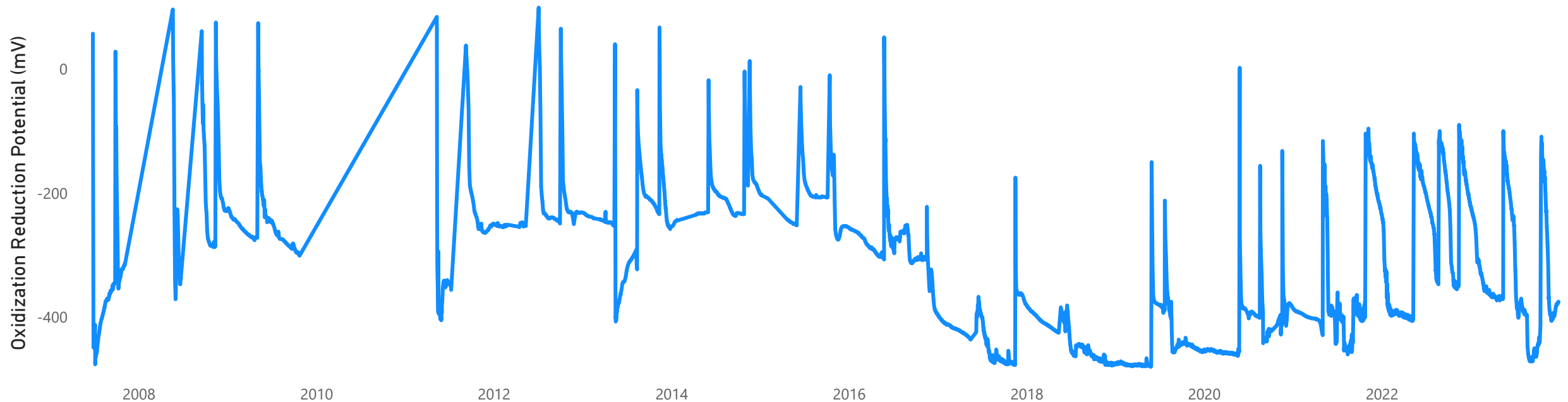
Well after Tailings Pond

Report Year	Average	Median	Minimum	Maximum
2023	-335.10	-366	-471	-100
Before 2023	-319.11	-309	-480	99

In 2023, the average oxidization reduction potential (ORP) was -335.07 mV. The average ORP for 2007-2022 was -319.11 mV. The maximum ORP in 2023 was -93.0 mV, and the maximum ORP overall was 99 mV.

Like pH, the ORP sensor takes longer to settle than other sensors, resulting in upward spikes in the data. ORP values increased from 2007 until 2015, with a plateau occurring from 2010 to 2014. ORP dropped throughout 2016 to 2018, and once again plateaued until 2021. Since 2021, ORP has been increasing again.

Oxidization Reduction Potential in Well after Tailings Pond



Well Water Elevation

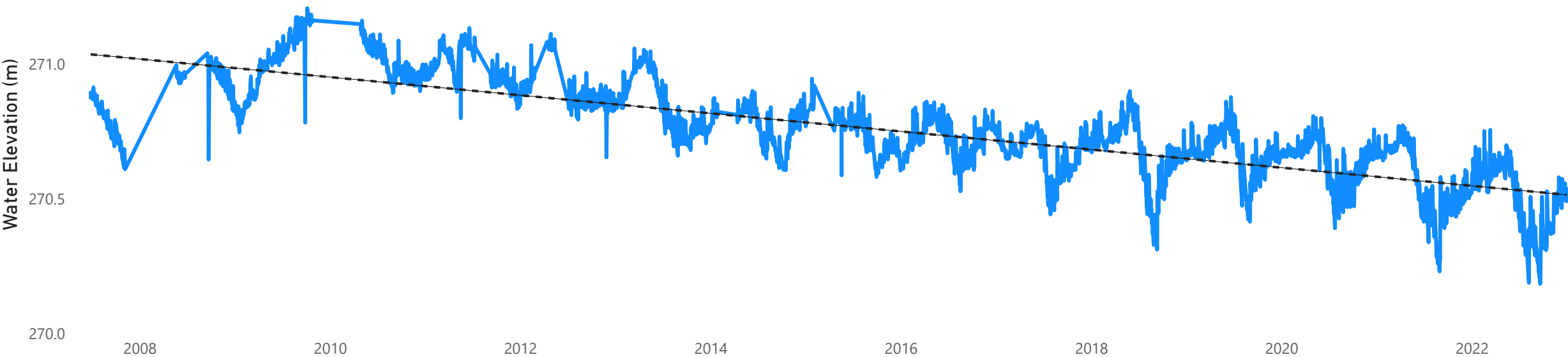
Well after Tailings Pond

Report Year	Average	Median	Minimum	Maximum
Before 2023	270.74	270.73	270.18	271.21

Water elevation indicates the surface of the aquifer above sea level. In 2023, the average water elevation was 270.51 m, 23 cm lower than the 2007-2022 average, 270.74 m. The lowest elevation in 2023 was 262.68 m, which is the lowest recorded elevation since monitoring began in 2007. The highest elevation in 2022 was 270.73 m, and a there was a total range of 8.05m. The steep decline is observed on Oct 18, 2023, when the sondes were being switched. At that time the pump was not working and the well was not purged as sondes were switched over.

The well reached maximum water elevation on 10/6/2009, and the water elevation has been decreasing since.

Water Elevation in Well after Tailings Pond

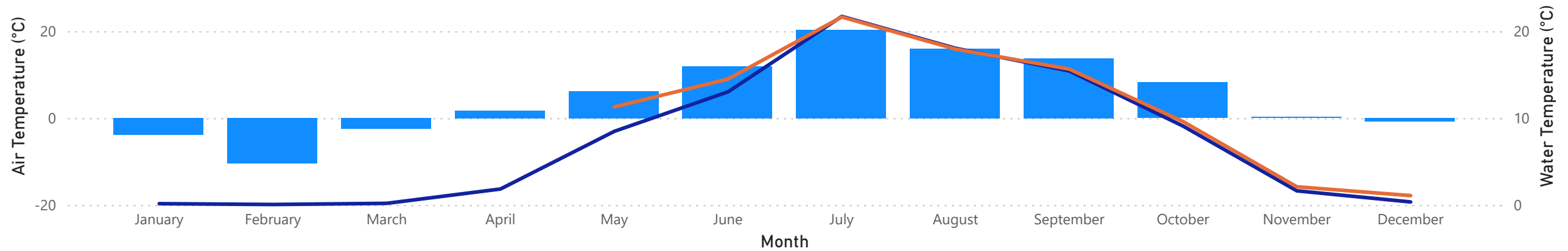


Climate Data from Millertown Climate Station

Precipitation data and air temperature from Environment Canada's Millertown, Newfoundland and Labrador weather station.

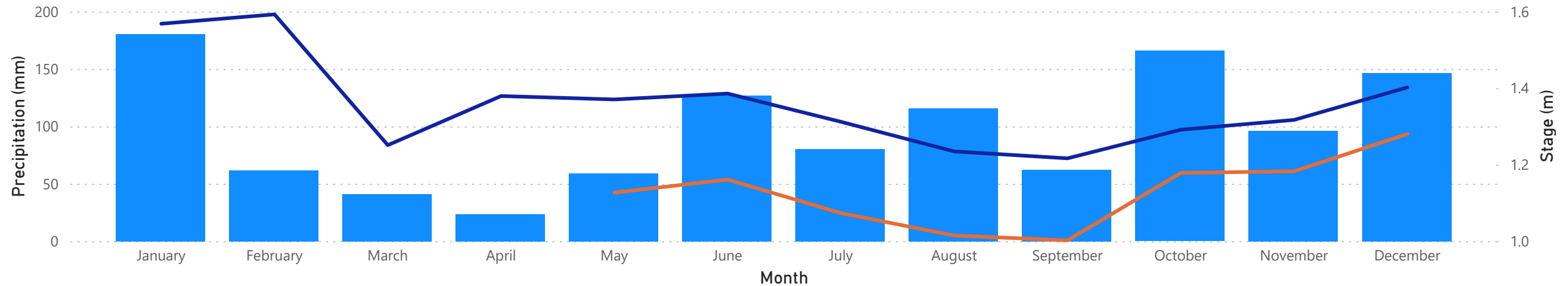
Millertown Mean Air Temperature and TECK Surface Mean Water Temperature

● Millertown Mean Air Temperature ● Trib to Gills Mean Water Temperature ● East Pond Brook Mean Water Temperature



Millertown Total Precipitation and TECK Mean Water Levels (Stage)

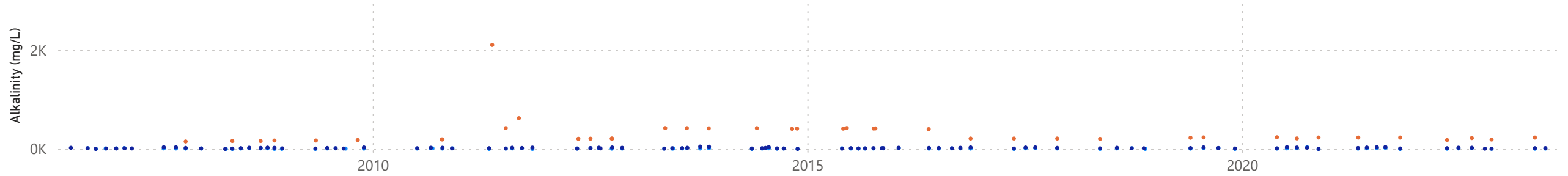
● Millertown Total Precipitation ● Trib to Gills Mean Stage ● East Pond Brook Mean Stage



Appendix - Grab Sample Graphs

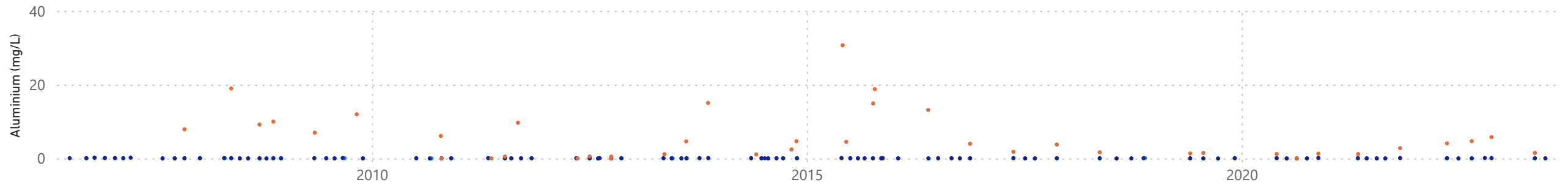
Grab Samples Alkalinity (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



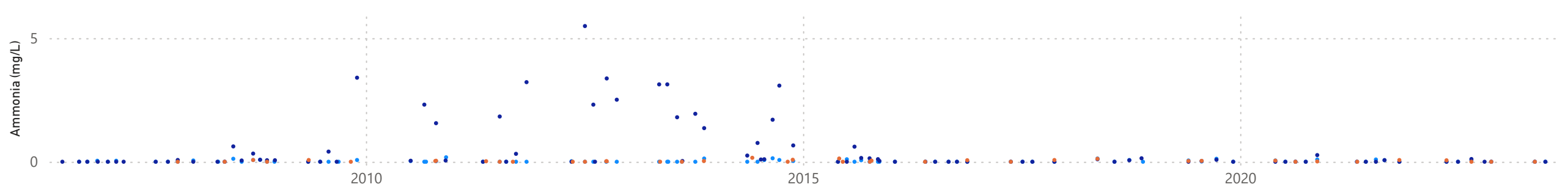
Grab Samples Aluminium (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Ammonia (mg/L)

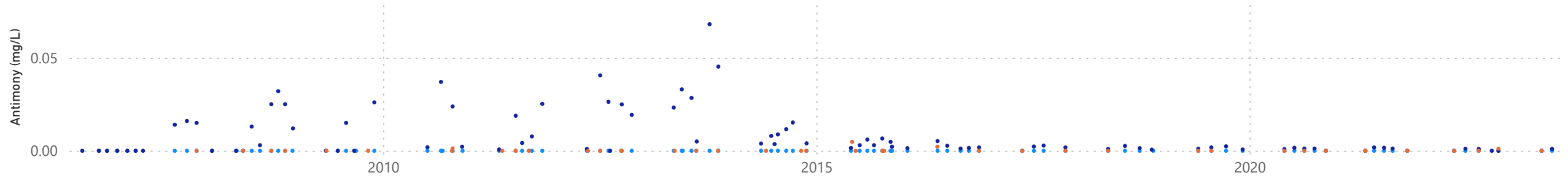
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

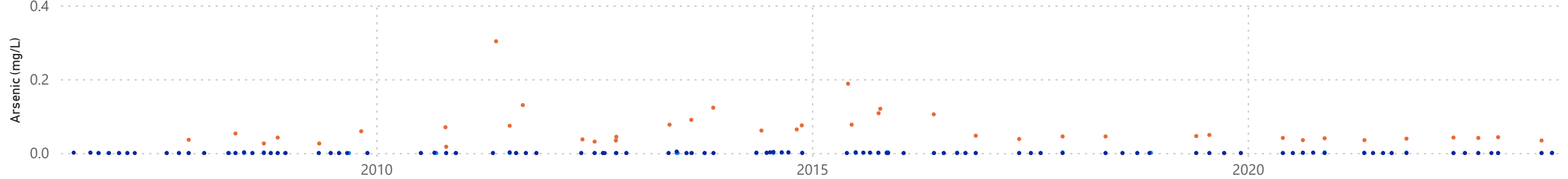
Grab Samples Antimony (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



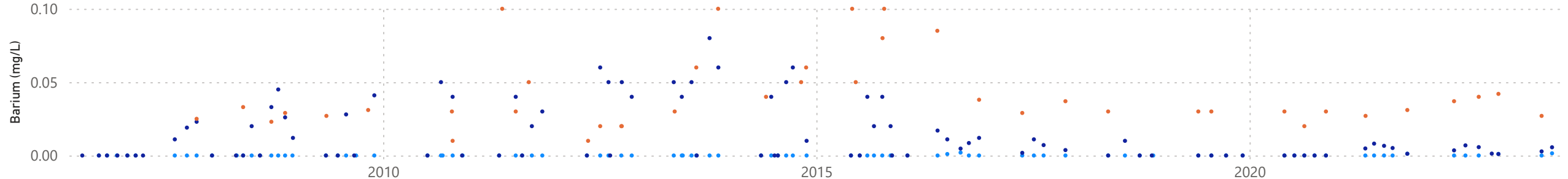
Grab Samples Arsenic (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Barium (mg/L)

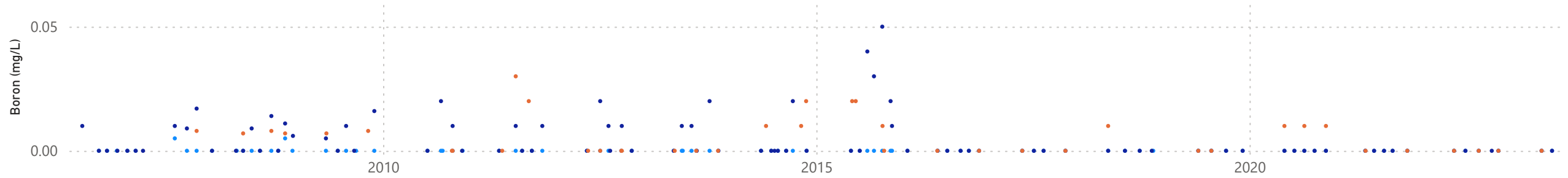
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

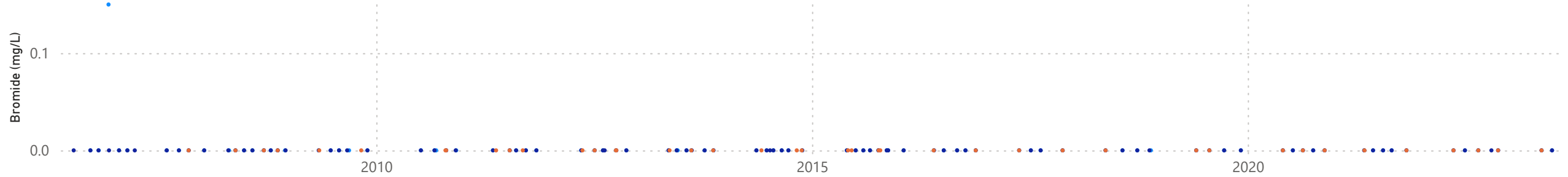
Grab Samples Boron (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



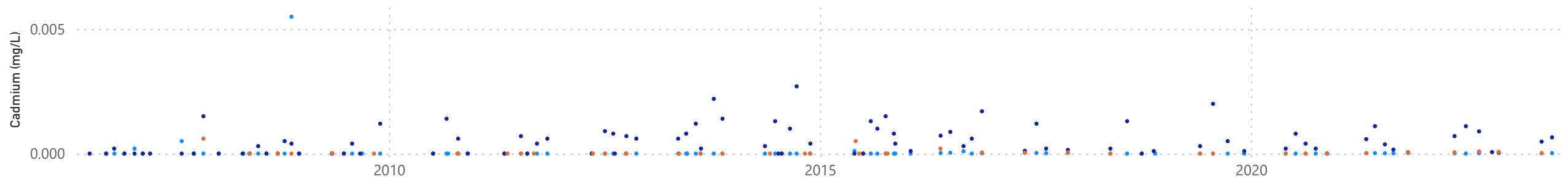
Grab Samples Bromide (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Cadmium (mg/L)

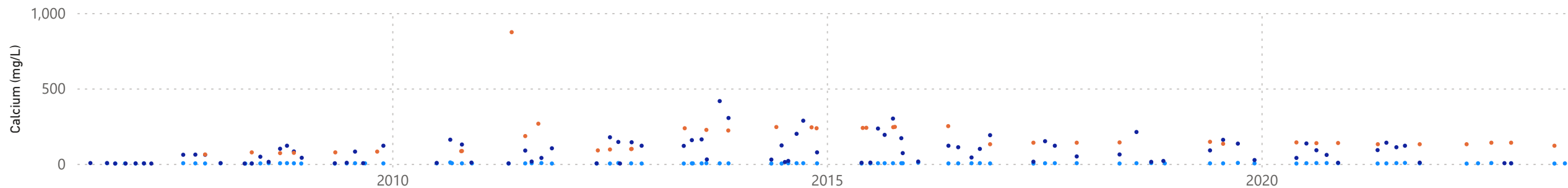
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

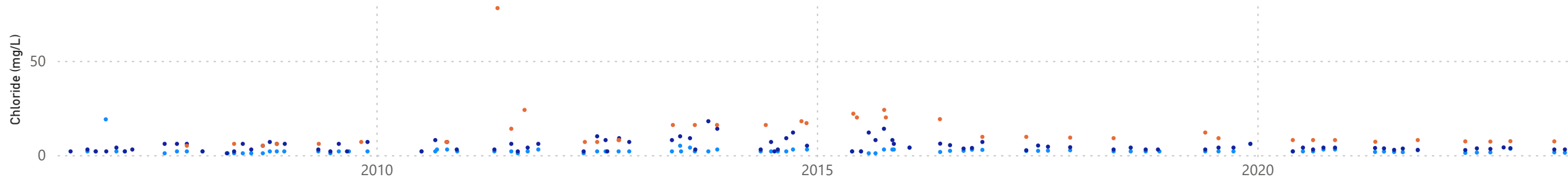
Grab Samples Calcium (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



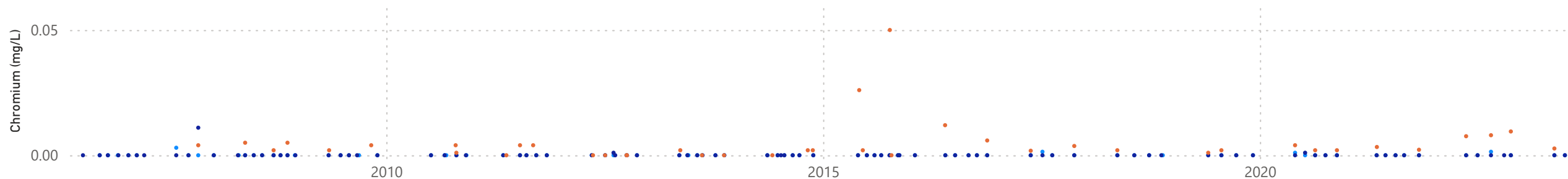
Grab Samples Chloride (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Chromium (mg/L)

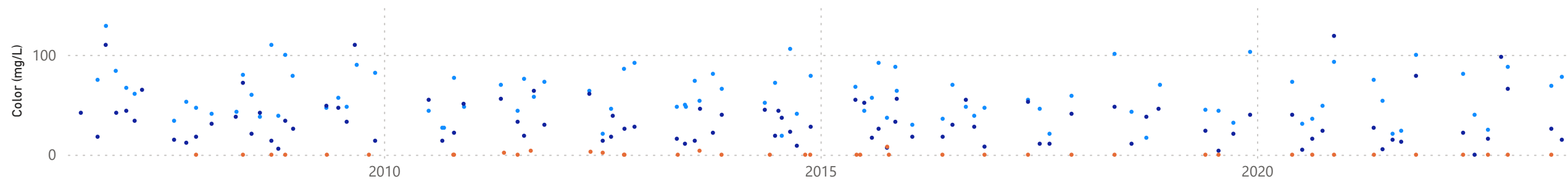
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

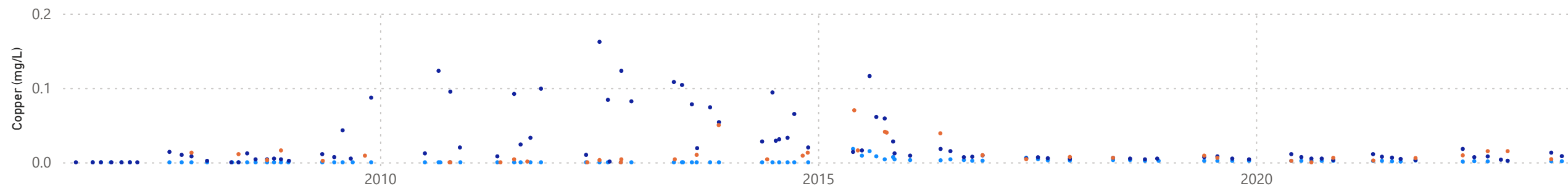
Grab Samples Color (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



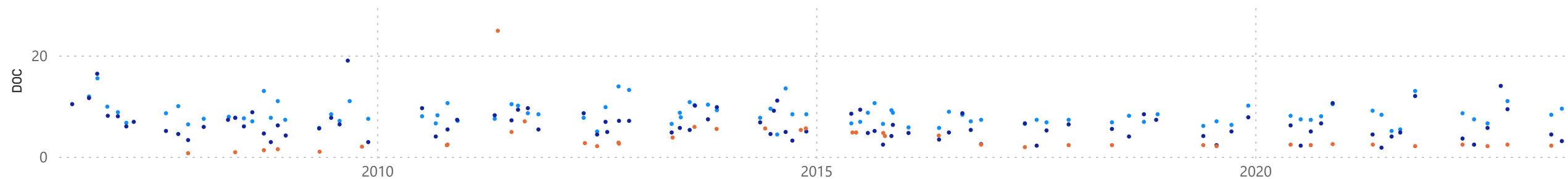
Grab Samples Copper (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Chromium (mg/L)

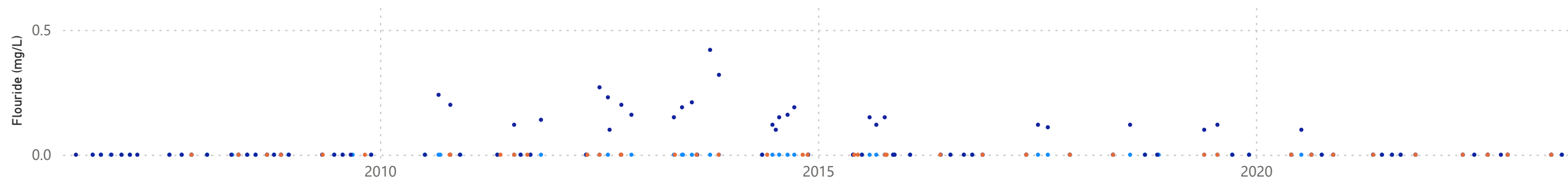
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

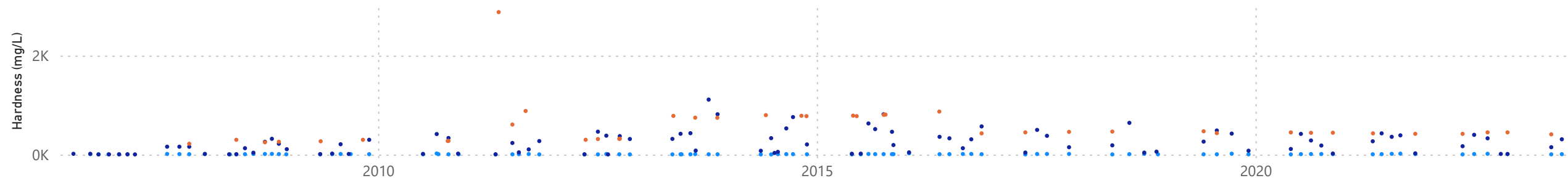
Grab Samples Flouride (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



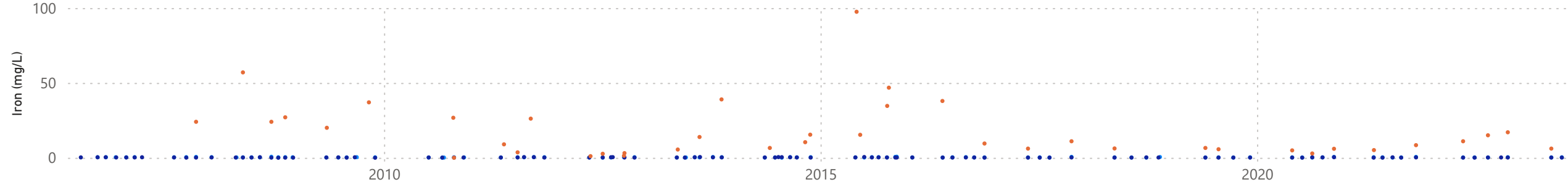
Grab Samples Hardness (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



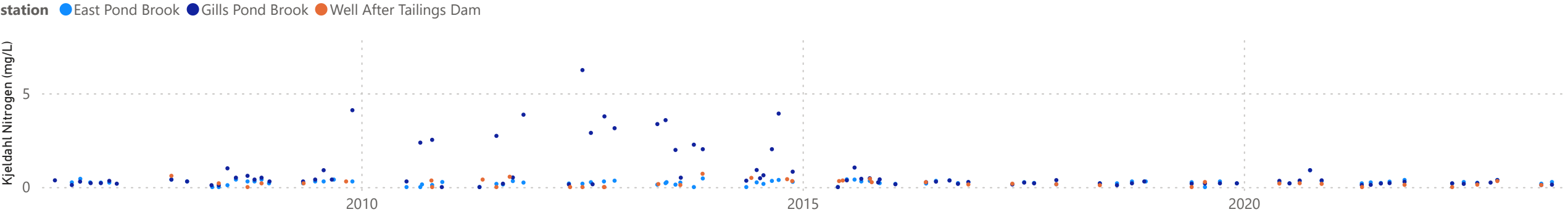
Grab Samples Iron (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam

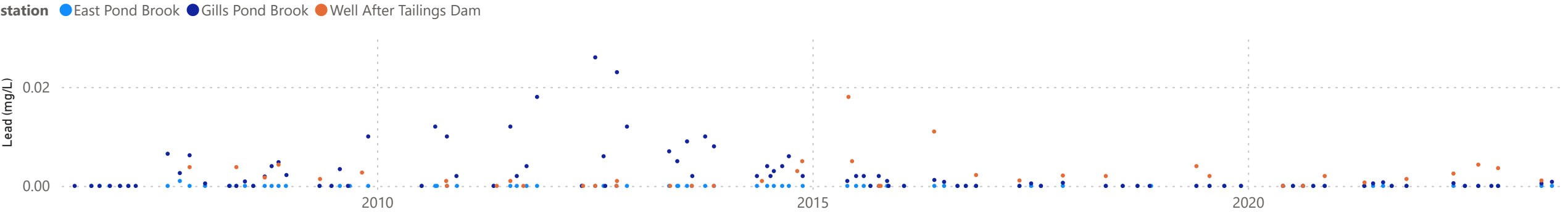


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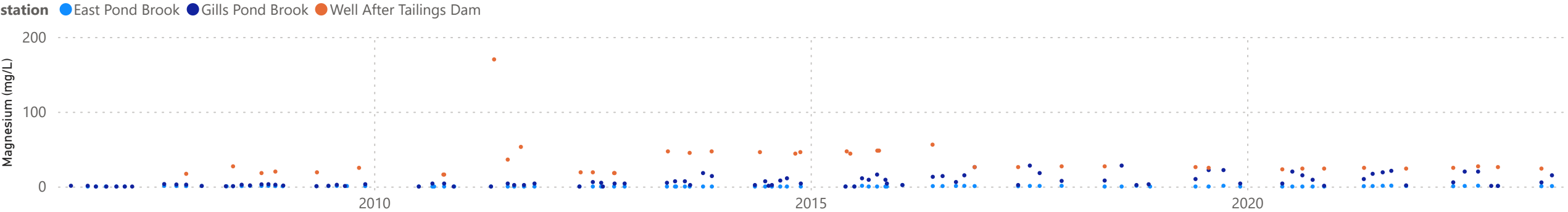
Grab Samples Kjeldahl Nitrogen (mg/L)



Grab Samples Lead (mg/L)



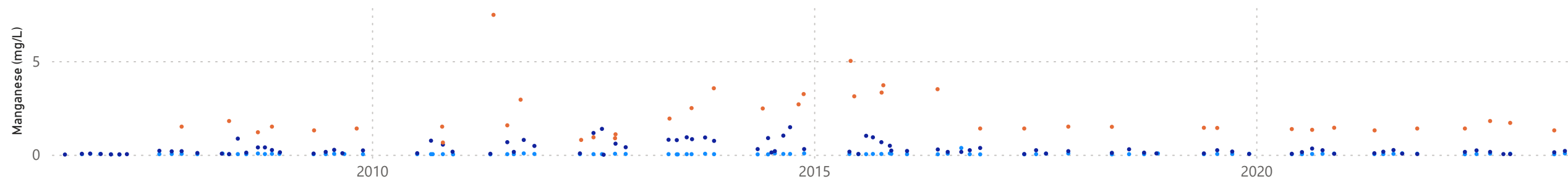
Grab Samples Magnesium (mg/L)



Appendix - Grab Sample Graphs

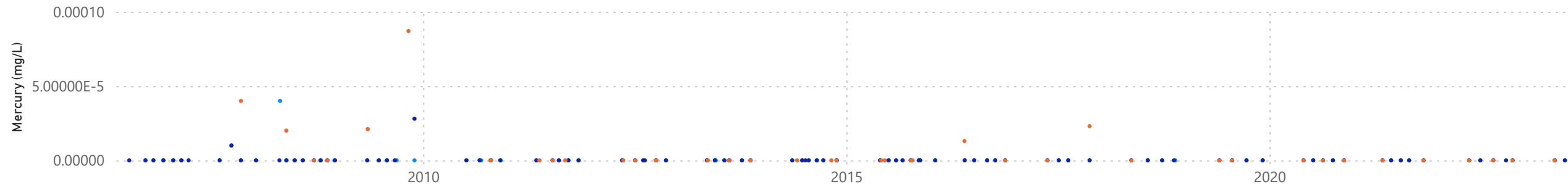
Grab Samples Manganese (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



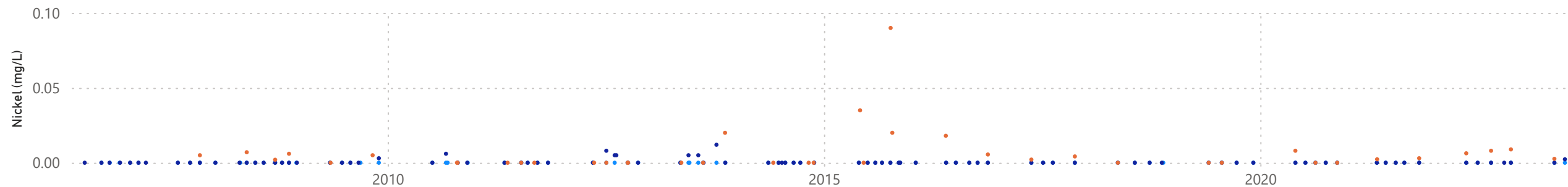
Grab Samples Mercury (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Nickel (mg/L)

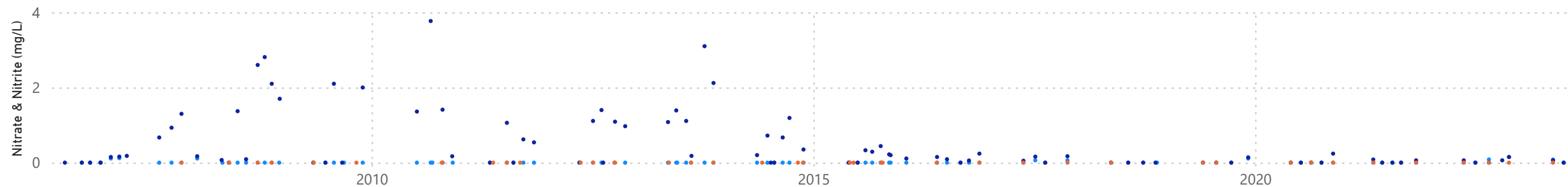
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

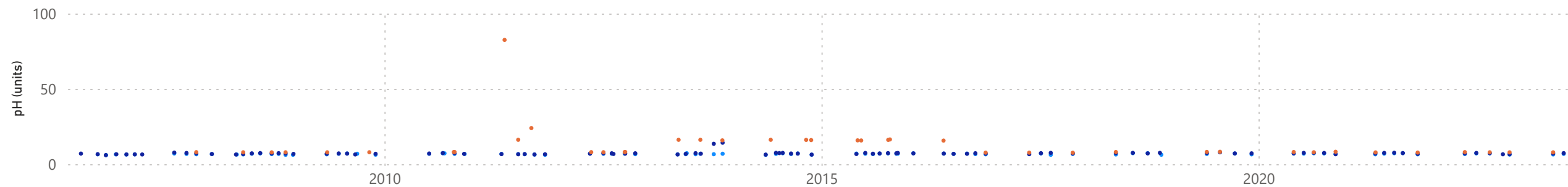
Grab Samples Nitrate & Nitrite (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



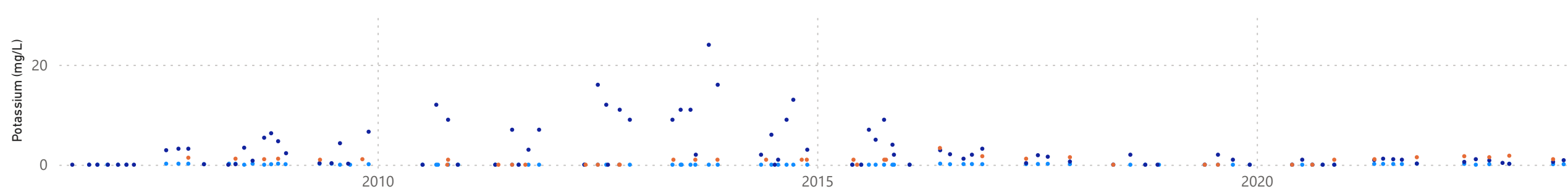
Grab Samples pH (units)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Potassium (mg/L)

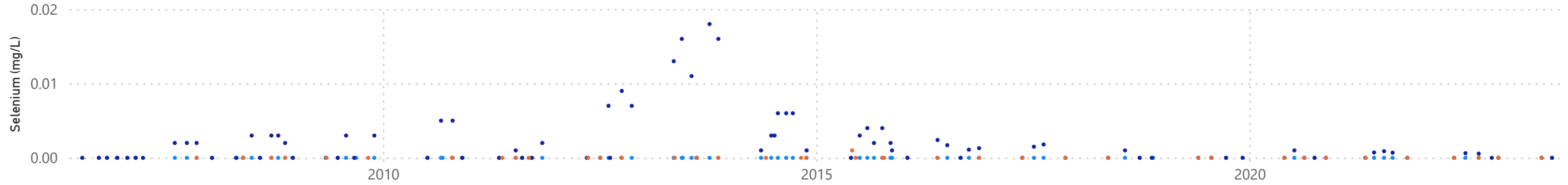
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

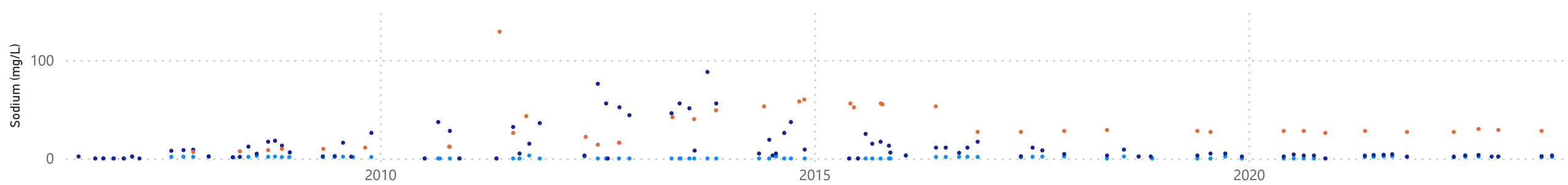
Grab Samples Selenium (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



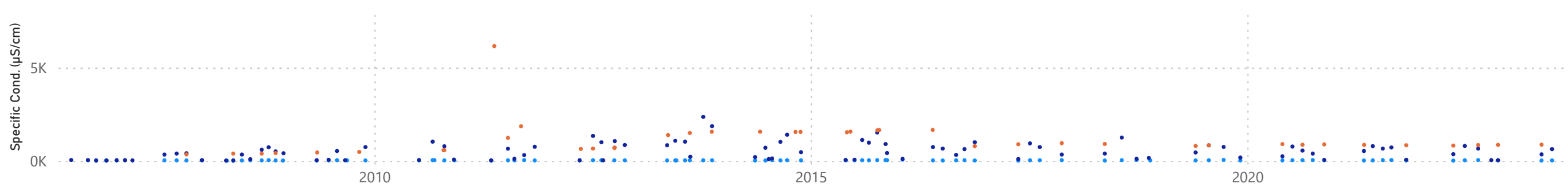
Grab Samples Sodium (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Specific Conductivity (µS/cm)

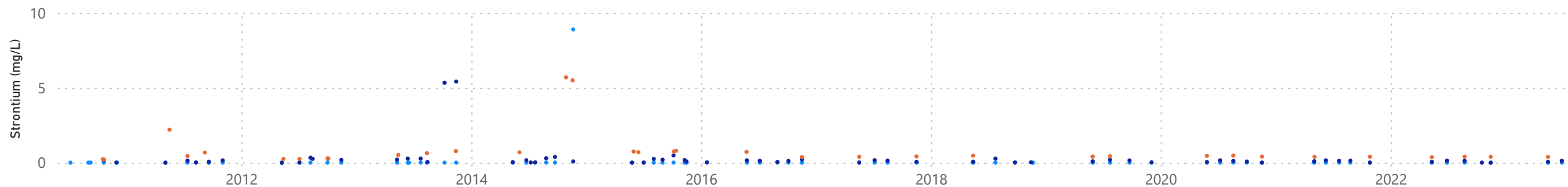
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

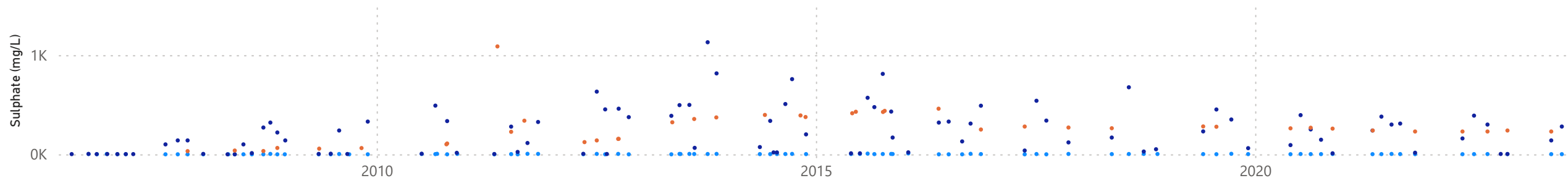
Grab Samples Strontium (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



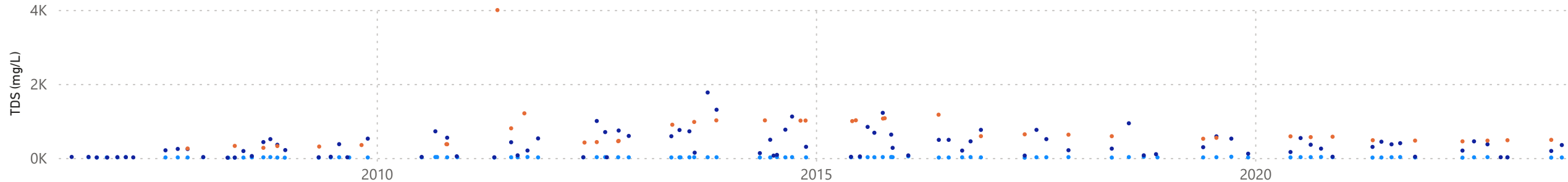
Grab Samples Sulphate (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam

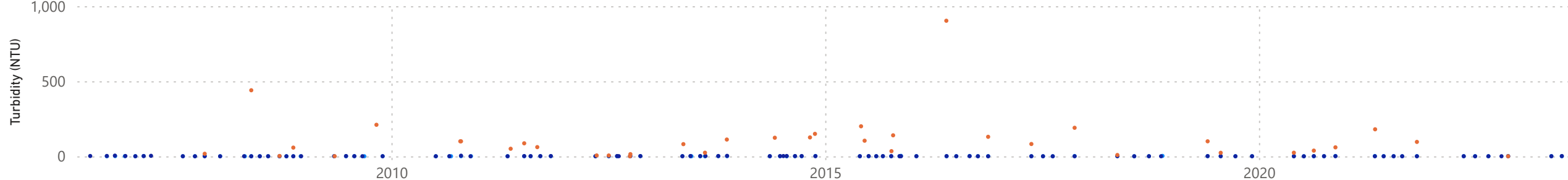


Grab Samples Total Dissolved Solids (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



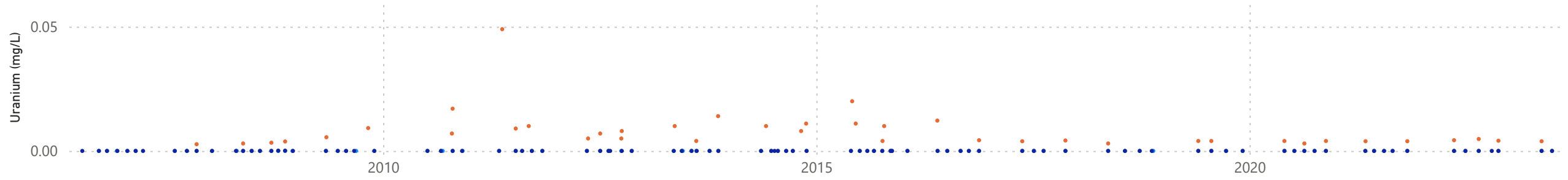
station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Appendix - Grab Sample Graphs

Grab Samples Uranium (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam



Grab Samples Zinc (mg/L)

station ● East Pond Brook ● Gills Pond Brook ● Well After Tailings Dam

