NUTRIENT SAMPLING IN PETRONILA CREEK

Final Report

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Table of Contents

List of Figures

Acknowledgments

NRA staff would like to acknowledge the CBBEP for their continuing support for the Petronila Creek Nutrient Study. Data acquired for the study will help yield valuable information on the amounts and timing of nutrient inputs to the Baffin Bay System. NRA would also like to thank the laboratories that run the analysis on water samples including the City of Corpus Water Utilities Laboratory (WUL) and Texas A&M-Corpus Christi's Center for Coastal Studies (CCS).

Executive Summary

Petronila Creek Above Tidal is a 44-mile-long creek in coastal South Texas that flows from its headwaters in western Nueces County to the confluence of Tunas Creek in eastern Kleberg County. The tidal portion of the creek drains to Baffin Bay through Cayo Del Mazón and Alazan Bay, located on the northern portion of Baffin Bay. Petronila Creek Above Tidal is listed in the 2020 Texas Integrated Report for Surface Water Quality as having elevated levels of chloride, sulfate, total dissolved solids, bacteria (E. coli), and chlorophyll-*a* concentrations. The integrated report also lists the tidal portion of the creek as having excessive concentrations of bacteria (enterococcus) and chlorophyll-*a.* The receiving waterbody, Baffin Bay, is listed for excessive concentrations of chlorophyll-*a.* To determine the nutrient contributions of surface water entering Baffin Bay from Petronila Creek and its tributaries, two previous studies titled "Nutrient Sampling in Petronila Creek" were conducted prior to this study. CBBEP Project #2003 was conducted from January through December 2000 and CBBEP Project #2133 was conducted from February 2021 through July 2021. CBBEP #2233 runs from September 2021 through August 2022. Water quality data for Project #2233 were collected monthly from September 2021 through August 2022 at 13 stations that are located throughout the southeastern portion of the watershed, east of US 77. Four surface water quality monitoring stations are located on the main stem of the creek and nine stations are located on the tributaries of the creek. All water monitoring occurred during low flow conditions. Flow rates at the main stem creek sites ranged between 0.5 ft^3/s and 3.0 ft^3/s and tributary stations ranged from <0.1 ft^3/s to 0.2 ft^3/s. Nutrient parameters analyzed for the study include ammonia, nitrate-nitrogen, nitrite-nitrogen, total phosphorus (TP), total kjeldahl nitrogen (TKN), dissolved kjeldahl nitrogen (DTKN), chlorophyll-*a,* and pheophytin. For this report (#2233), streamflow totals and nutrient concentrations from Projects #2003, #2133, and #2233 have been included in the data results graphs to show temporal variability from January 2020 through August 2022. Nutrient concentrations were highly variable throughout the study period. A seasonal bias for higher concentrations for ammonia, DTKN, TKN, and TP occurred in spring months. Nitrate-nitrogen showed a season bias in spring and fall months. Chlorophyll-*a,* and pheophytin showed a seasonal bias toward higher concentrations in winter months.

Introduction

Surface water quality monitoring in Texas is routinely conducted by the Texas Commission on Environmental Quality (TCEQ) and its Clean Rivers Program (CRP) partners to assess the status of water quality in streams, rivers, lakes, and bays throughout the state. The Texas Surface Water Quality Standards establish criteria to protect the designated uses of waterbodies, including aquatic life, water supply, and recreation, against water quality degradation. The criteria for evaluating support of the designated uses include dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria. However, TCEQ does not have numerical criteria for nutrients in their surface water quality standards. In Texas, nutrient controls have taken the form of narrative criteria, watershed rules, and anti-degradation considerations in permitting actions. TCEQ screens ammonia, nitrate nitrogen, total phosphorus, and chlorophyll-*a* monitoring data as a preliminary indication of areas of possible concern (TCEQ). The following charts explains the potential causes and impacts when water quality screening levels for certain water quality parameters are not met.

Parameter	Nutrient Screening Levels for Petronila Creek Above Tidal	Calculation Used for Concern
Ammonia-Nitrogen	0.33 mg/l	20% of samples are above the criteria
Nitrate	1.95 mg/l	
Total phosphorus	0.69 mg/l	
Chlorophyll-*a*	14.1 µg/l	

Figure 1. TCEQ screening levels for nutrient parameters

Figure 2. Algal growth at Tributary Station 21598

Parameter	Cause	Impact
Ammonia	Ammonia is excreted by animals and is produced during the decomposition of plants and animals. It is an ingredient in many fertilizers and is also present in sewage, storm water runoff, certain industrial wastewaters, and runoff from animal feedlots.	Elevated levels of ammonia in the environment can adversely affect fish and invertebrate reproductive capacity and reduced growth of the young.
Nitrates & Total phosphorus	Nutrients are found in effluent released from wastewater treatment plants (WWTP)s, fertilizers, and agricultural runoff carrying animal waste from farms and ranches. Soil erosion and runoff from farms, lawns, and gardens can add nutrients to the water.	These nutrients increase plant and algae growth. When plants and algae die, the bacteria that decompose them consume dissolved oxygen leaving less available for fish and other living aquatic life. High levels of nitrate and nitrites can produce Nitrite Toxicity, or "brown blood disease," in fish. This disease reduces the ability of blood to transport oxygen throughout the body.
Chlorophyll-*a*	Modifications to the riparian zone, human activity that causes increases in organic matter, nutrients, bacteria, and over abundant algae in water.	Chlorophyll-*a* is the photosynthetic pigment found in all green plants, algae, and cyanobacteria. Elevated levels indicate abundant plant growth which could lead to reduced DO levels.

Figure 3. Causes and impacts of excess nutrient parameters

The designated uses for Petronila Creek Above Tidal (TCEQ Segment 2204) include primary contact recreation and intermediate aquatic life use. Segment 2204 is listed in TCEQs 2020 Texas Integrated Report for Surface Water Quality as being impaired for chloride, sulfate, total dissolved solids, and bacteria (*E. coli*). In response to the dissolved mineral impairments, a Total Maximum Daily Load (TMDL) project for TDS, sulfate, and chloride has been developed that includes increased water quality monitoring of the main stem and select tributary stations. The bacteria impairment will likely be analyzed through a standards-review process called a Recreation Use Attainability Analysis (RUAA) in the future. Segment 2204 also has screening level concerns for chlorophyll-*a* which indicates a possible degradation of water quality due to excessive nutrient loadings.

Petronila Creek Tidal (TCEQ Segment 2203) is listed in the 2020 Texas Integrated Report for Surface Water Quality as being impaired for bacteria (enterococcus) and having a screening level concern for chlorophyll-*a.*

For the receiving water body, Baffin Bay (TCEQ Segment 2492), surface water quality monitoring by TCEQ has identified an exceedance to the screening level for chlorophyll-*a* (14.1 µg/l) since 2002. In the last decade, water quality issues resulting in the disruptions of food webs, low dissolved oxygen events, fish kills, and excessive growth of phytoplankton indicators including chlorophyll-*a* have led to an increase in concern and awareness from the public, academia, and governmental agencies. Scientists at the Harte Research Institute (HRI) at Texas A&M University – Corpus Christi (TAMU-CC) have determined that the primary causes of the water quality concern are due to excessive nutrients in the bay. Efforts to determine the source of nutrient enrichment have centered on the contributions of surface waters from three main tributaries: Petronila, San Fernando, and Los Olmos creeks, all of which have current quarterly water quality monitoring stations funded by TCEQ's Clean Rivers Program.

To provide further clarity regarding nutrient inputs into the Baffin Bay system, this study presents twelve months of water quality data from thirteen stations. Four stations are located on the main stem and nine are located on the tributaries of the creek. Nutrients analyzed include ammonia, total kjeldahl nitrogen (TKN), dissolved total kjeldahl nitrogen (DTKN), total phosphate (TP), nitrate-nitrogen, nitrite-nitrogen, chlorophyll-*a*, and pheophytin.

Figure 4. Algal growth at Tributary Station 13096

Watershed Characteristics

Description - Petronila Creek Above Tidal (TCEQ Segment 2204) is a shallow creek (< 2.0 m depth) that flows 44 miles from the confluence of Aqua Dulce and Banquete creeks in Nueces County to a point 0.6 miles upstream of a private road crossing near Laureles Ranch in Northern Kleberg County. The watershed area is 675 square miles. The receiving water bodies for Segment 2204 include Petronila Creek Tidal Segment (TCEQ Segment 2203), Cayo Del Mazón, Alazan Bay, and Baffin Bay (TCEQ Segment 2492). The study area is located east of US 77 in the southeastern portion of the watershed. Land use is dominated by cultivated cropland with cotton, corn and sorghum being the most common crops observed. The northwestern end of the watershed is a mixture of cultivated cropland, hay or pasture, shrub or scrub and mixed forest. There are nine regulated dischargers of effluent to Petronila Creek and/or the tributaries of the creek (See Appendix B).

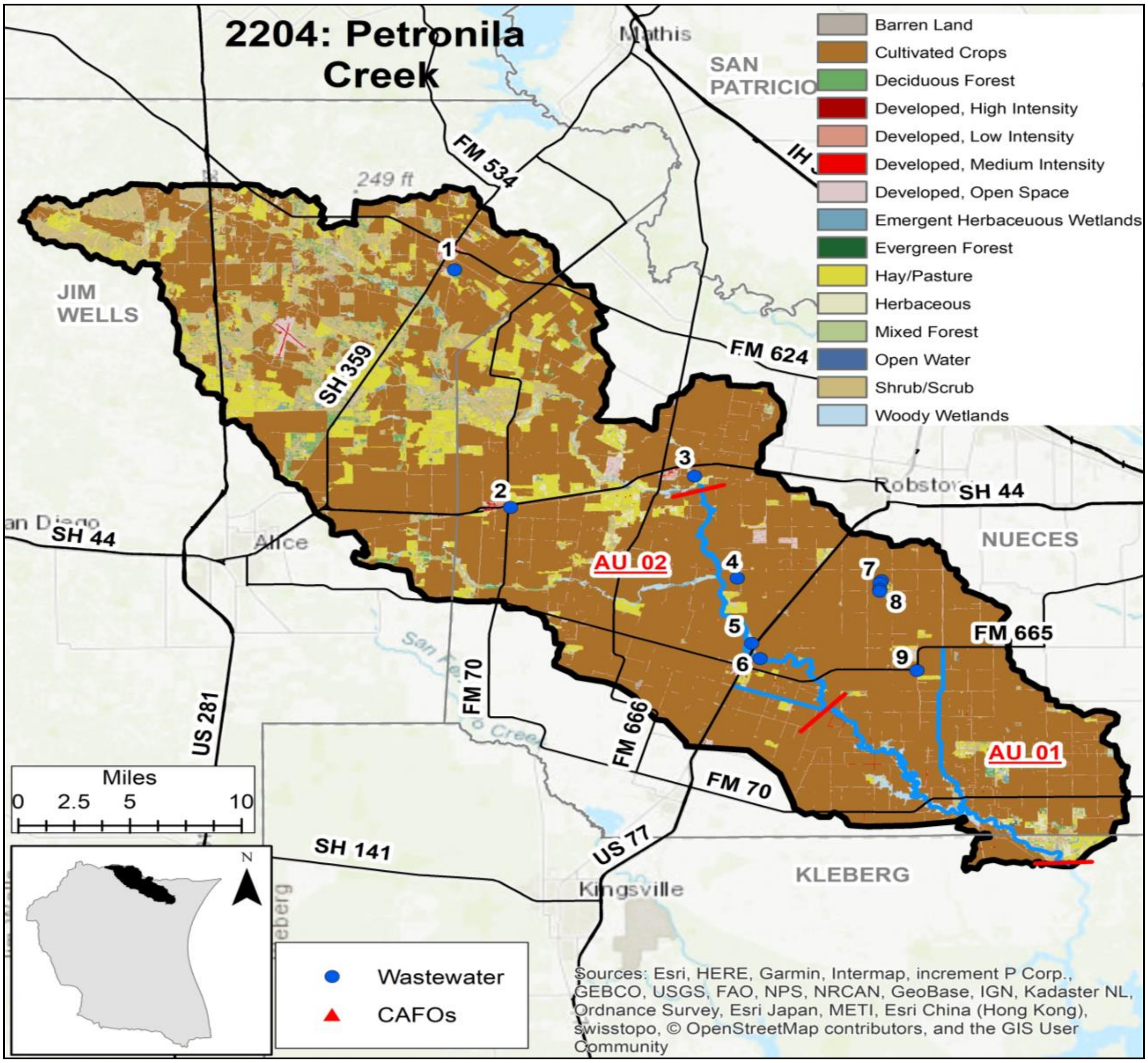


Figure 5. Land Use Land Cover and permitted dischargers to Petronila Creek

Climate – The climate in the Petronila Creek Watershed is characterized as subtropical, humid, with hard winter freezes that are uncommon but sufficiently frequent to exclude tropical plant species. Rainfall is sparse throughout the year with average precipitation of 28.98 inches per year.

Sampling Site Locations – Sampling site locations were identified based on the current sampling locations used in the Petronila Creek Above Tidal TMDL sampling project funded by TCEQ for chloride, sulfate, and total dissolved salts (TDS). There are six tributaries sampled for the project. Three of the tributaries have two sampling stations each including 21594 & 18484, 21931 & 18642, and 21929 & 21598. The other three tributaries (13030, 21596, and 13032) are monitored by a single sampling site. Four stations (13093, 13094, 13095, and 13096) are located on the main stem of the creek.

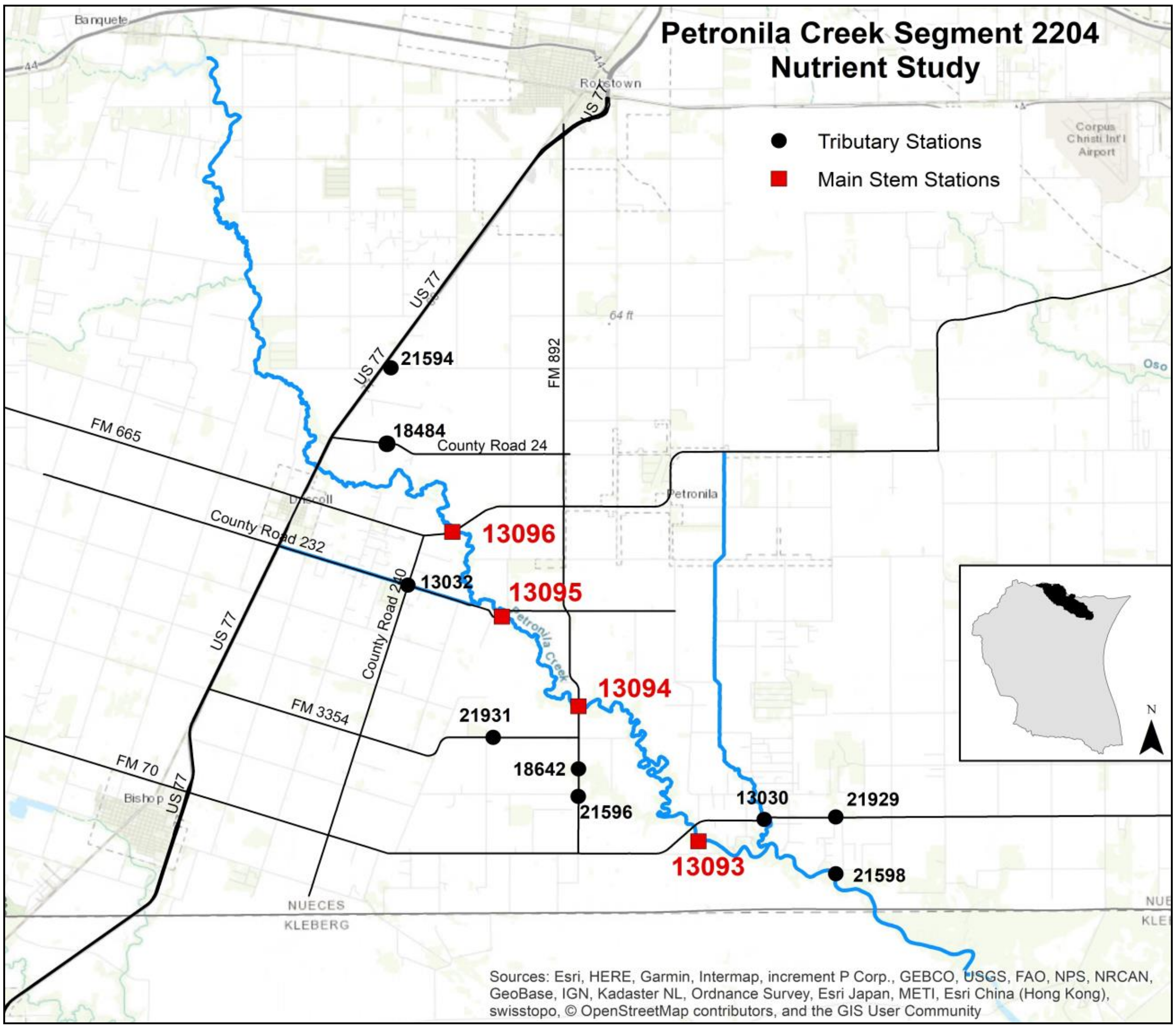


Figure 6. Map of sampling stations in Petronila Creek Above Tidal Segment 2204

Hydrological - Streamflow is typically very low in the segment, often measuring between 0.5 and 3.0 ft^3/s during dry weather on the main stem of the creek. Streamflow is measured by a USGS stream gauge located on FM 665. This location also serves at Station 13096, the uppermost sampling location on the main stem of the creek. Station 13096 is also closest in proximity to the Driscoll WWTP (WQ0011541-001 – City of Driscoll: <100,000 gpd treated domestic wastewater via Petronila Creek). Streamflow at the tributary locations is estimated due to low flow conditions that are insufficient depth (< 0.05 m) for the operation of a flow meter. A map of sampling stations is provided below.

Meteorological data – During monthly site visits at each station, NRA field staff recorded meteorological information including air temperature, wind direction, wind velocity and precipitation data including days since last precipitation, amount of precipitation in the past day and past seven days. Monthly precipitation data was provided by the National Weather Service (NWS) and National Oceanic and Atmospheric Administration (NOAA) using the link provided: https://www.weather.gov/crp/monthlyrainfall

Sample collection – Surface water quality data including field and laboratory data were collected monthly from September 2021 through August 2022 at four sampling stations on the main stem of the creek and at nine sampling stations on the tributaries. At each sampling location, field data including water appearance/odor, water depth, water temperature, pH, dissolved oxygen and specific conductance were obtained using a Hydrolab MS5 datasonde following sampling guidelines found in TCEQs Surface Water Quality Manual Procedures (SWQM) Procedures, Volume 2 (RG-416). The datasonde was calibrated before each sampling event and post calibrated immediately after returning from the field. Water samples were taken from the centroid of flow (point of maximum flow) at each station using a sample dipper that was pre-rinsed with site sample water. Many of the stations had accessibility issues which required sampling from the bridge top by lowering a 1-gallon bucket into the stream. During high flow, samples were taken from the bridge-top at all but one station (21958) where there was no bridge. During low flow conditions, all stations but one, had sampling depths less than 0.3 m which required a sampling depth of half the total depth. Station 13093 had water deep enough (1.6 m) to require a profile of datasonde readings at 0.3 m below the water surface, at mid depth, and at 0.3 m above the bottom of the water column. Surface water quality samples were collected, preserved with acid when applicable and stored on ice and delivered to the laboratories that afternoon for analysis.

Sample Analysis – Surface water samples were collected and analyzed for nutrient components by two laboratories. Nutrient samples including ammonia, nitrate, nitrite, TKN, dissolved TKN and total phosphorus were analyzed by the City of Corpus Christi Water Utilities Lab (WUL). All analytes were analyzed by the WUL using National Environmental Laboratory Accreditation Program (NELAP) accredited methods. Chlorophyll-*a* and pheophytin samples were analyzed at the Texas A&M University-Corpus Christi's Center for Coastal Studies Laboratory (CCSL). NELAP accreditation for chlorophyll-*a* and pheophytin parameters are not required.

Results

Precipitation – Precipitation totals from September 2021 through July 2022 totalled approximately 17.3 inches (Figure 8) according to NOAA estimates. Most precipitation fell in September, October, January, and May. Precipitation amounts in August 2022 were not used in this report due to the final sample collection date of August 1st, 2022.

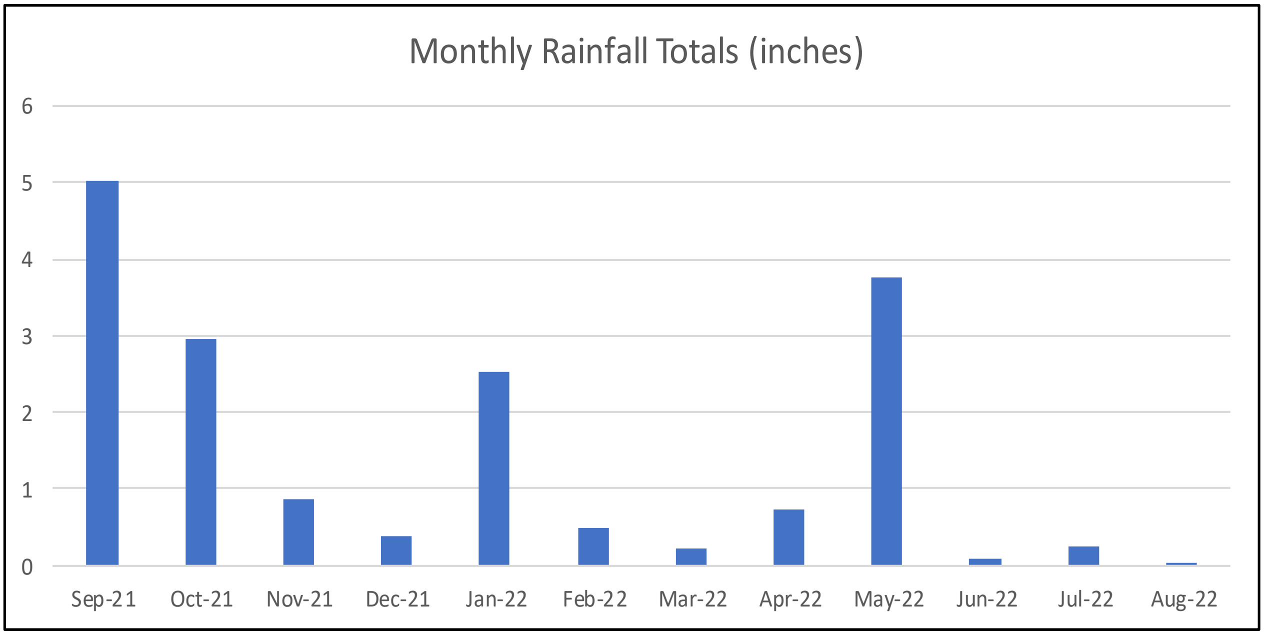


Figure 7. Monthly rainfall totals from September 2021 through August 1, 2022

Texas surface water drought monitor status at the beginning of the study period indicated drought-free conditions following a relatively wet summer in 2021 that saw multiple flood events. Normal precipitation amounts in the first half of the study period were followed by severe drought condtions in June and July, 2022 (Figure 8).

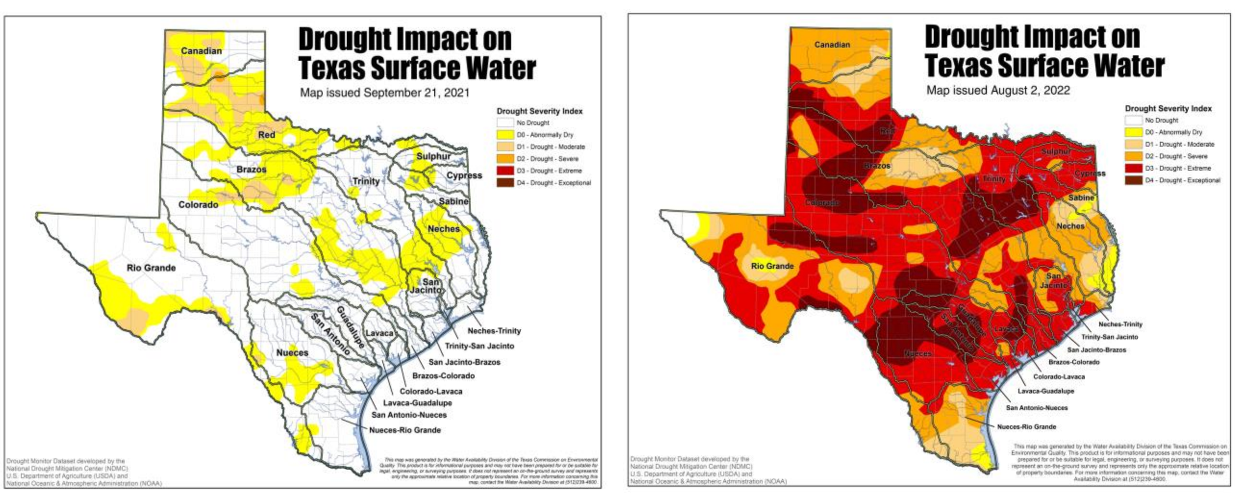


Figure 8. Drought status in September 2021 and August 2022

Streamflow – The Petronila Creek watershed experienced two precipitation events in the first two months (September – October 2021) of the study period, resulting in streamflow rates spiking to approximately 275 and 215 ft^3/sec in late September/early October. A third flow event with a magnitude of approximately 100 ft^3/sec occurred in May 2022 before drought conditions began to take hold in June and July 2022.

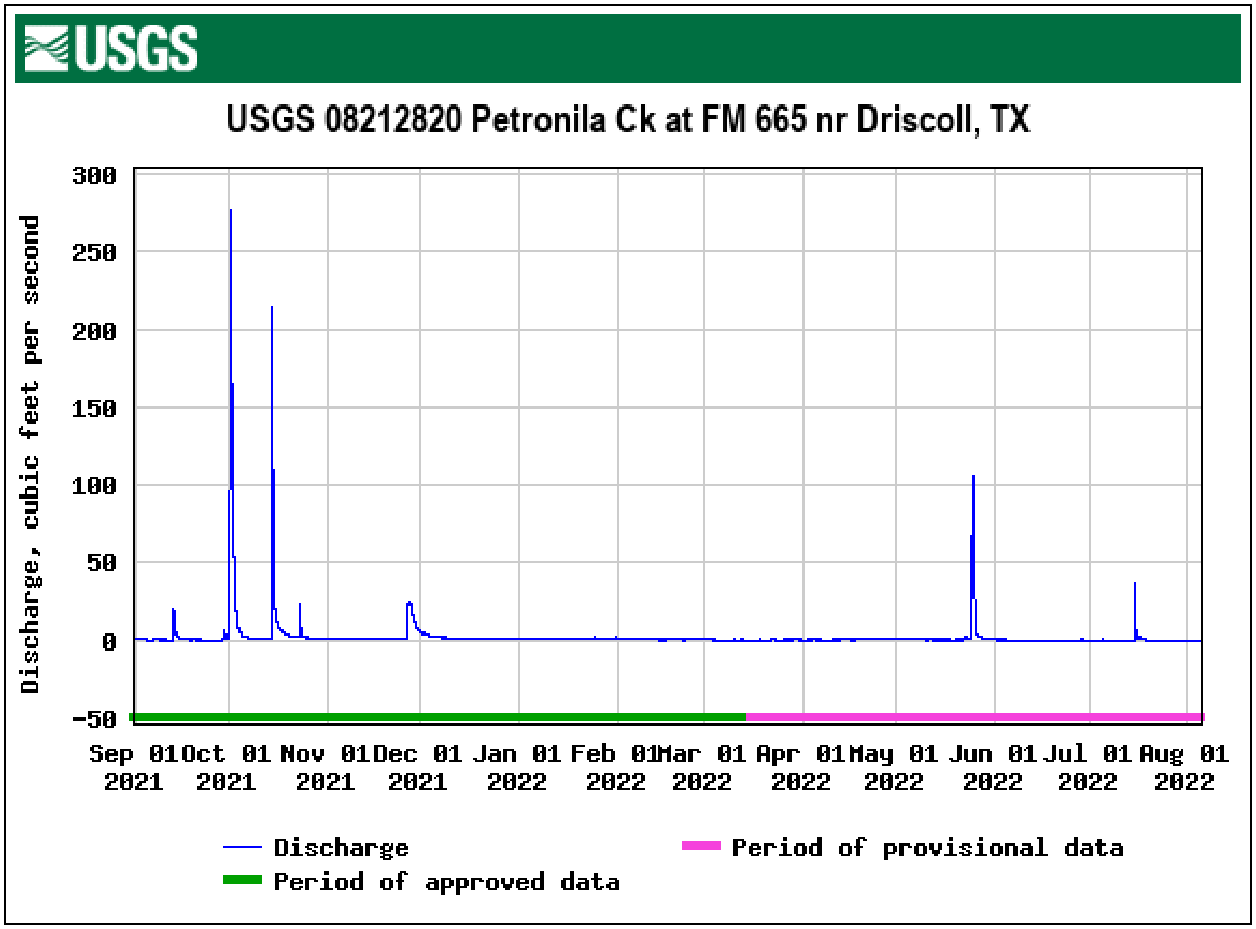


Figure 9. Streamflow at Petronila Creek Above Tidal

Water Quality Monitoring – Monitoring data for Project #2233 occurred from September 2021 and ended on August 1, 2022. Precipitation and streamflow data from August 2022 are not used in this report. All sampling occurred under base flow conditions with none being conducted during high flow events. All sites had flowing water from September 2021 through March 2022 except for Station 21931 which was not flowing in November 2021 and March 2022. From April through June 2022, flows tapered somewhat with the number dry/non flowing sites growing to three stations (21931, 13032, and 21594). By July and August, the number of non-flowing/dry sites grew to seven including stations 21929, 13030, 21956, 18642, 21931, 13032, and 21594.

Data Results
for
Nutrient Parameters

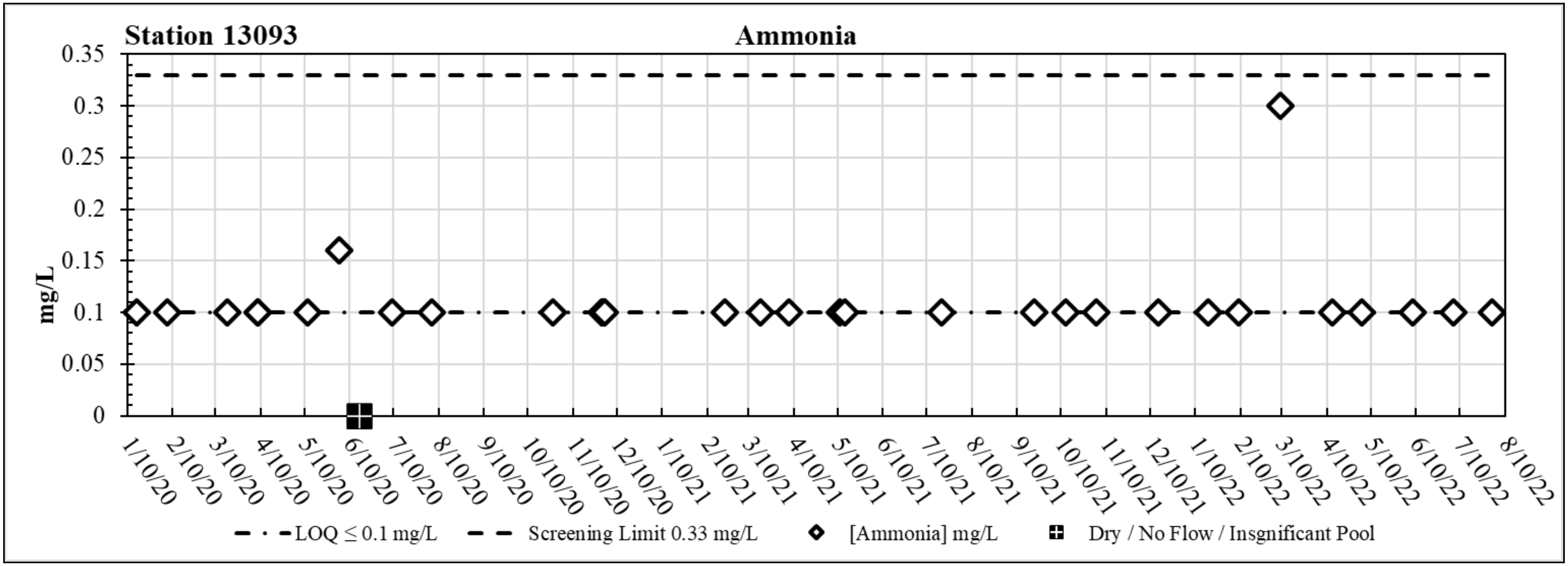


Figure 10. [Ammonia] at Main Stem Station 13093

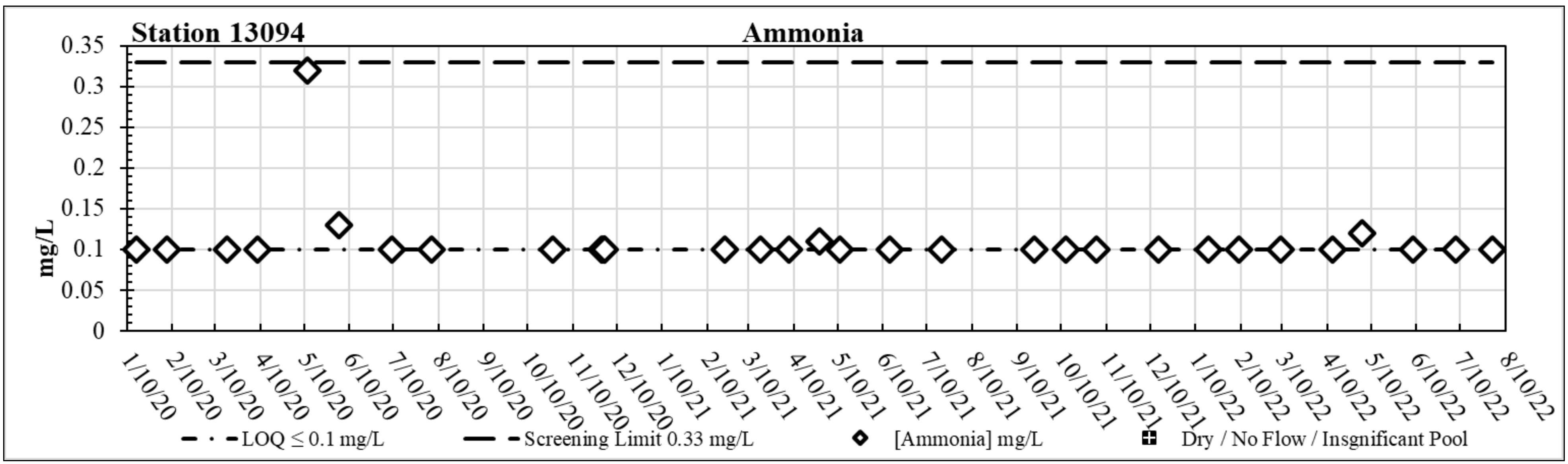


Figure 11. [Ammonia] at Main Stem Station 13094

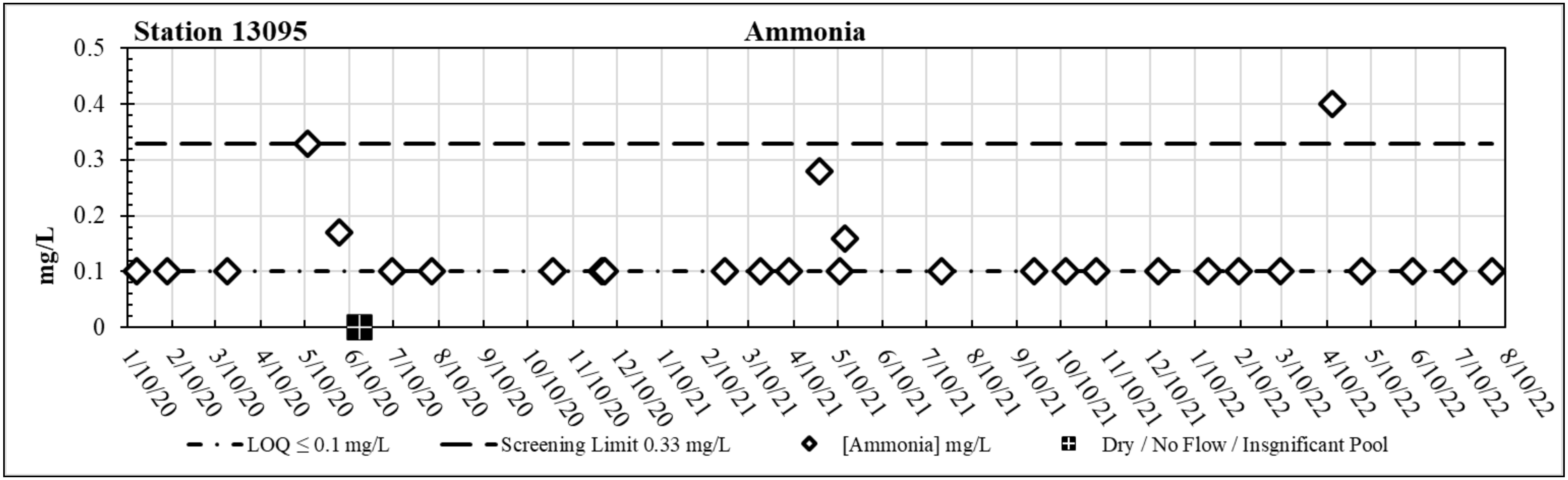


Figure 12. [Ammonia] at Main Stem Station 13095

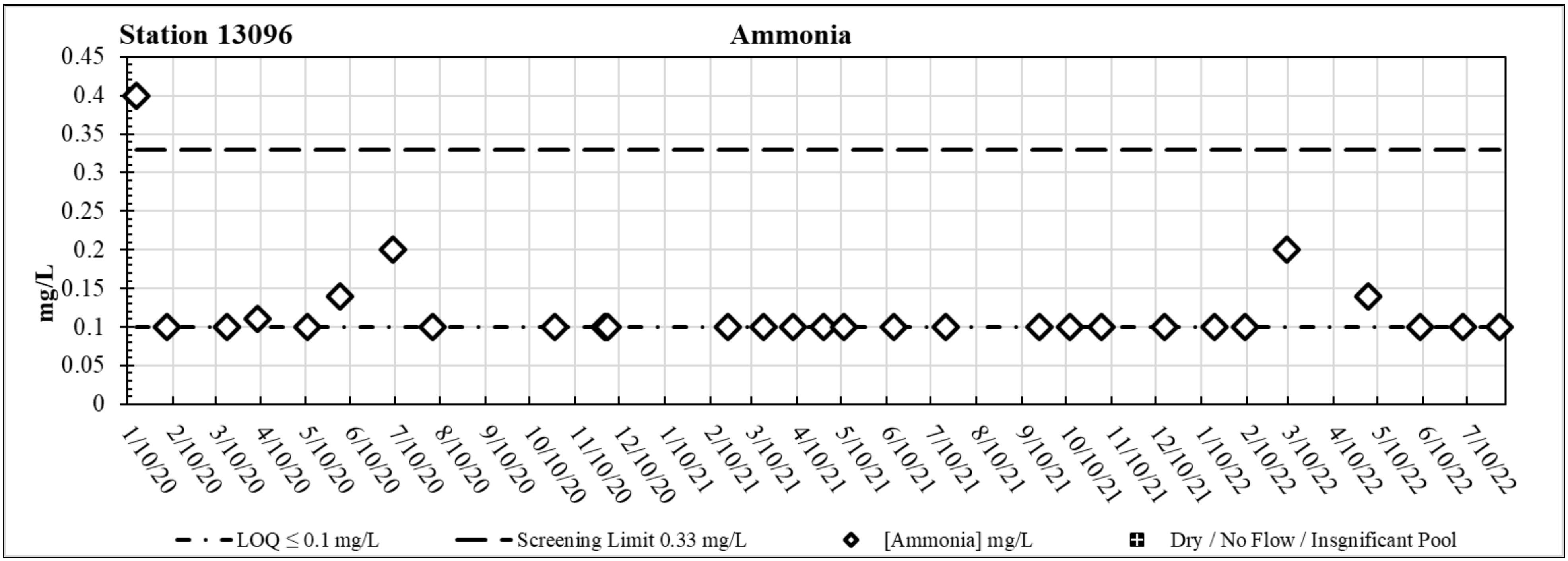


Figure 13. [Ammonia] at Main Stem Station 13096

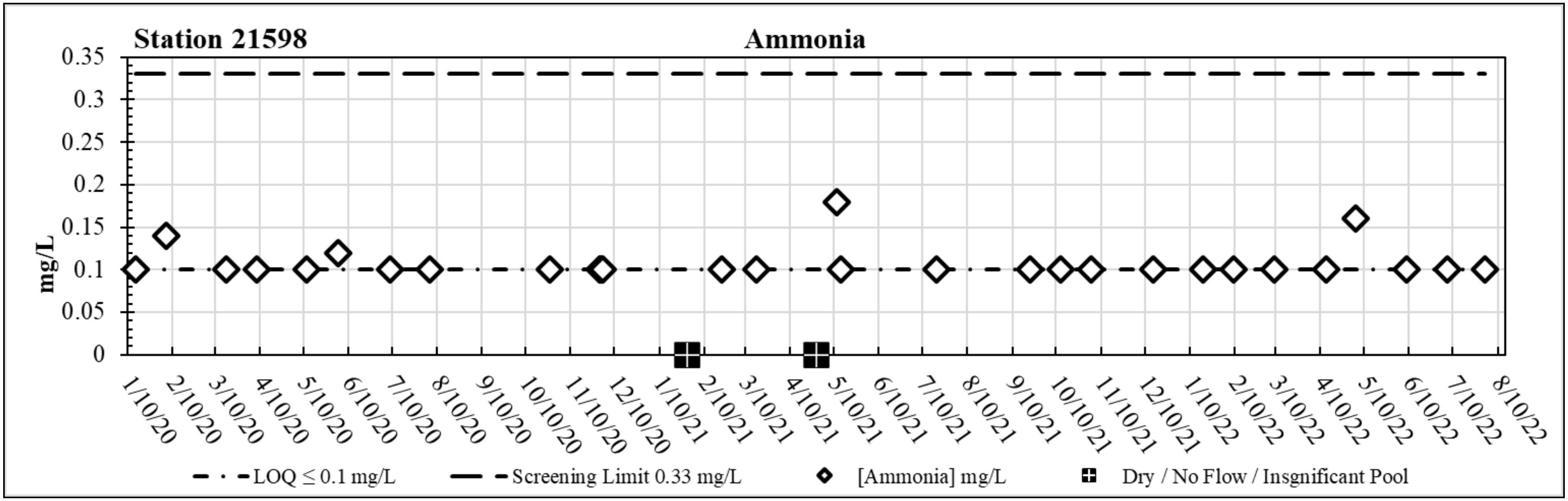


Figure 14. [Ammonia] at Tributary Station 21598

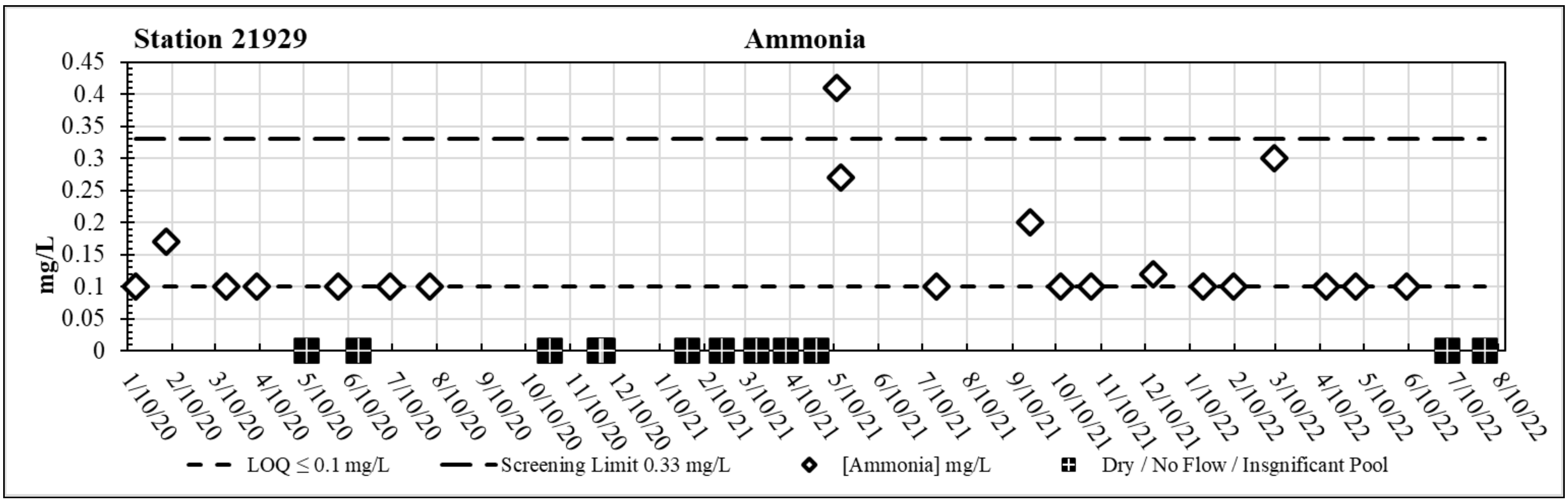


Figure 15. [Ammonia] at Tributary Station 21929

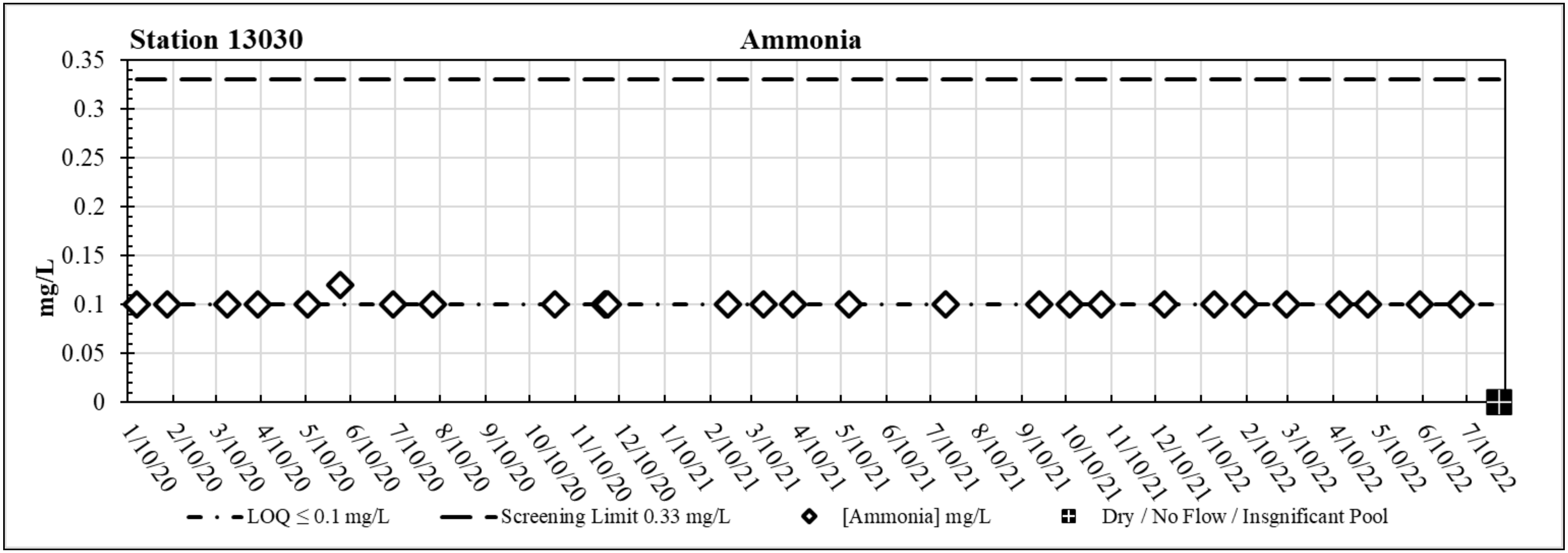


Figure 16. [Ammonia] at Tributary Station 13030

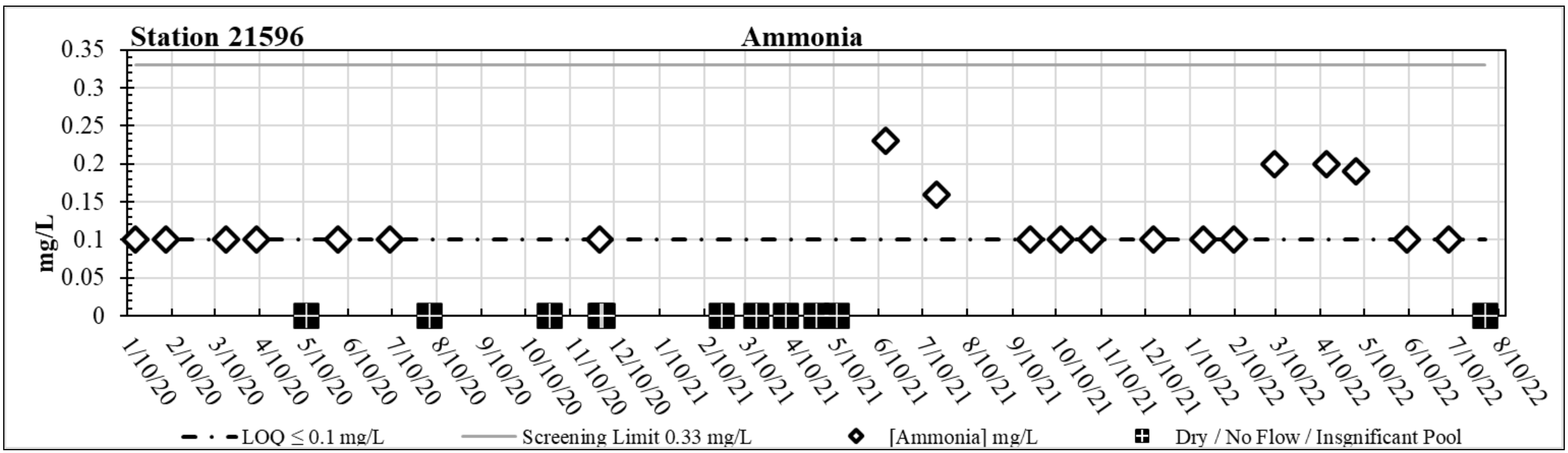


Figure 17. [Ammonia] at Tributary Station 21596

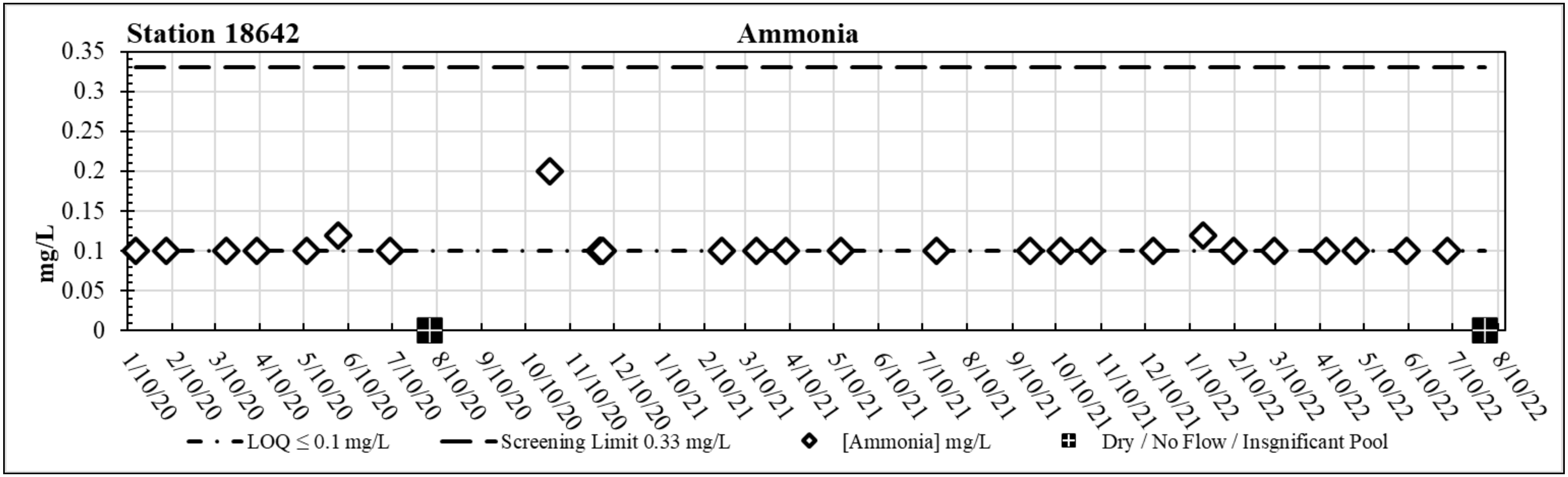
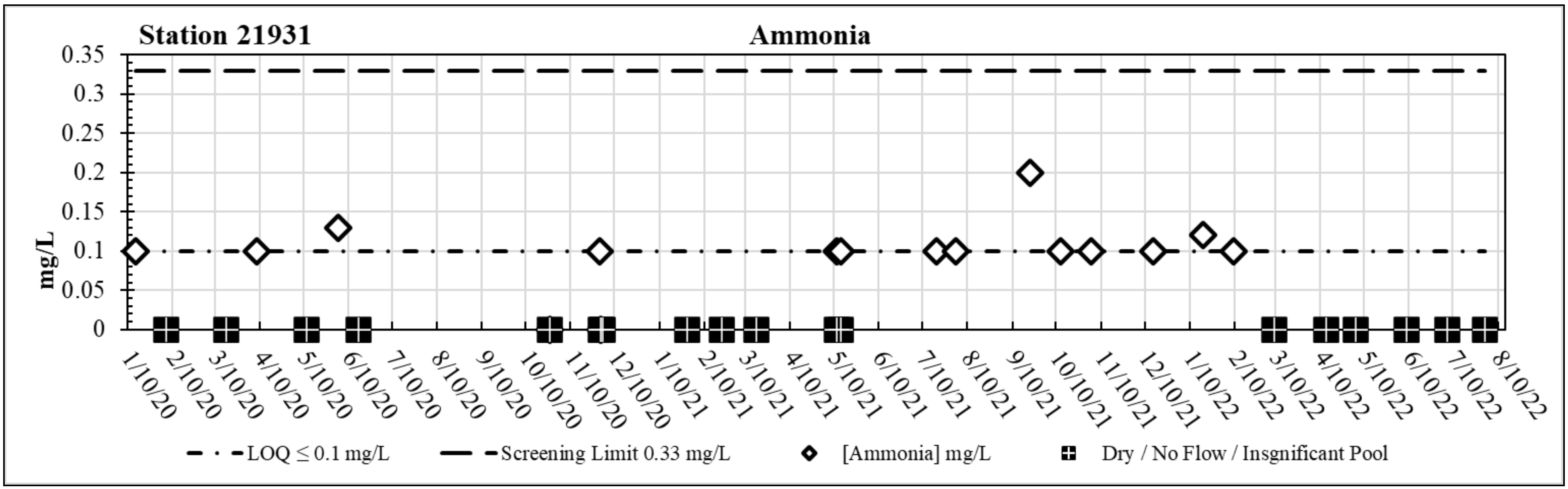


Figure 18. [Ammonia] at Tributary Station 18642



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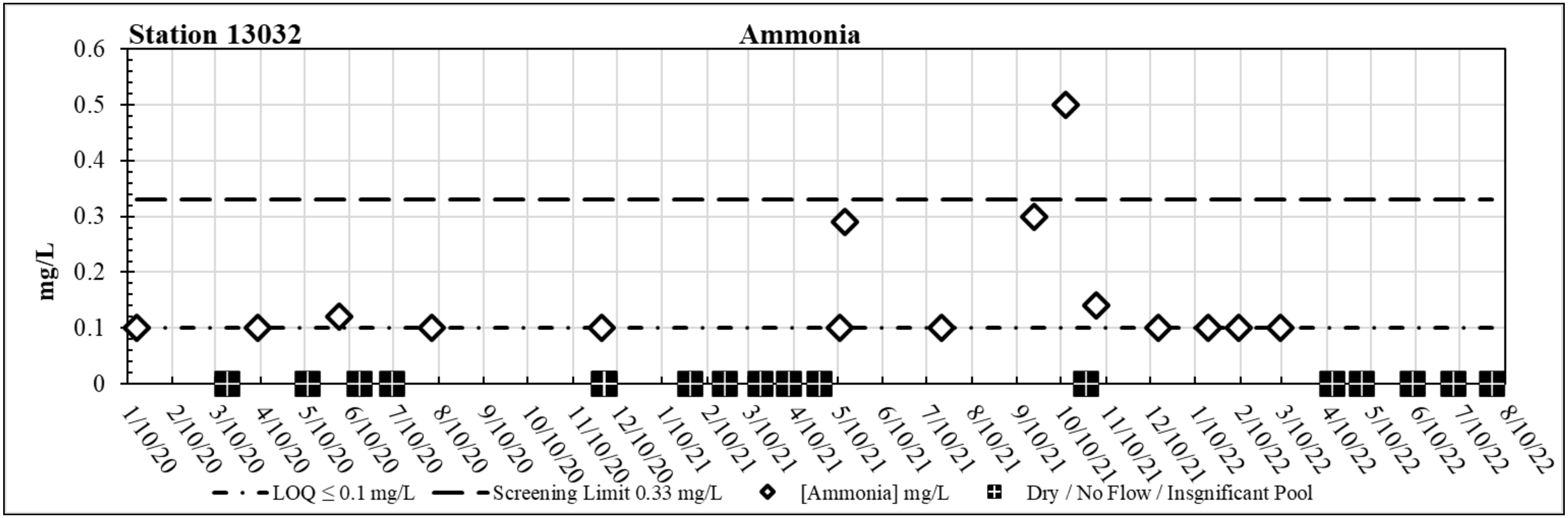

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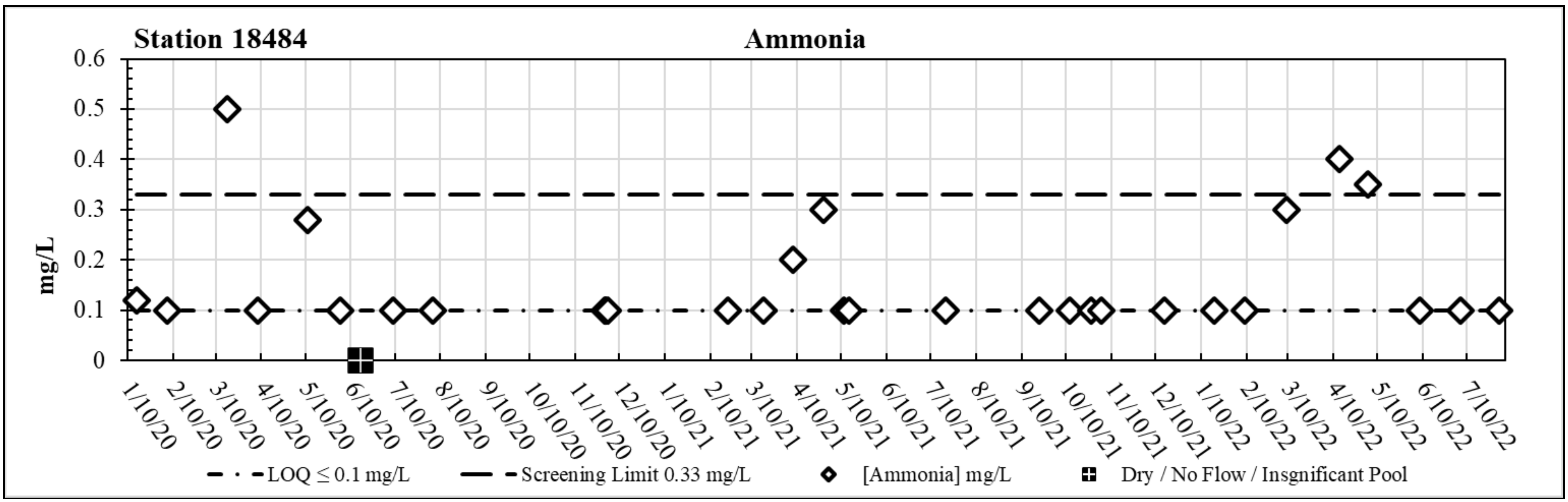

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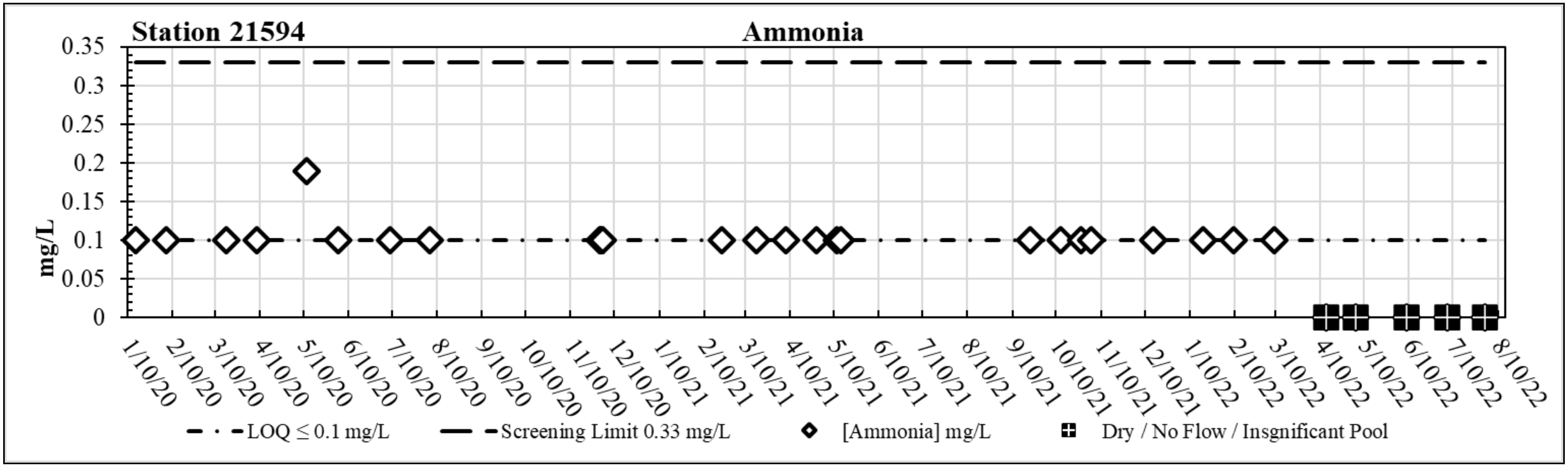

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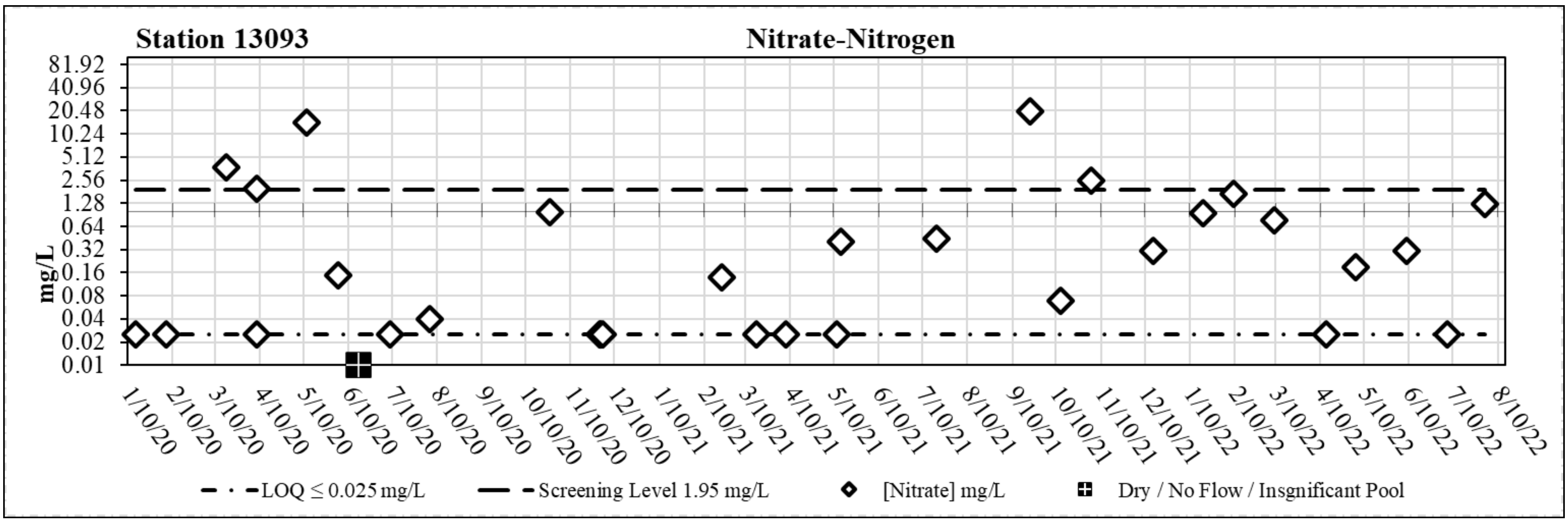
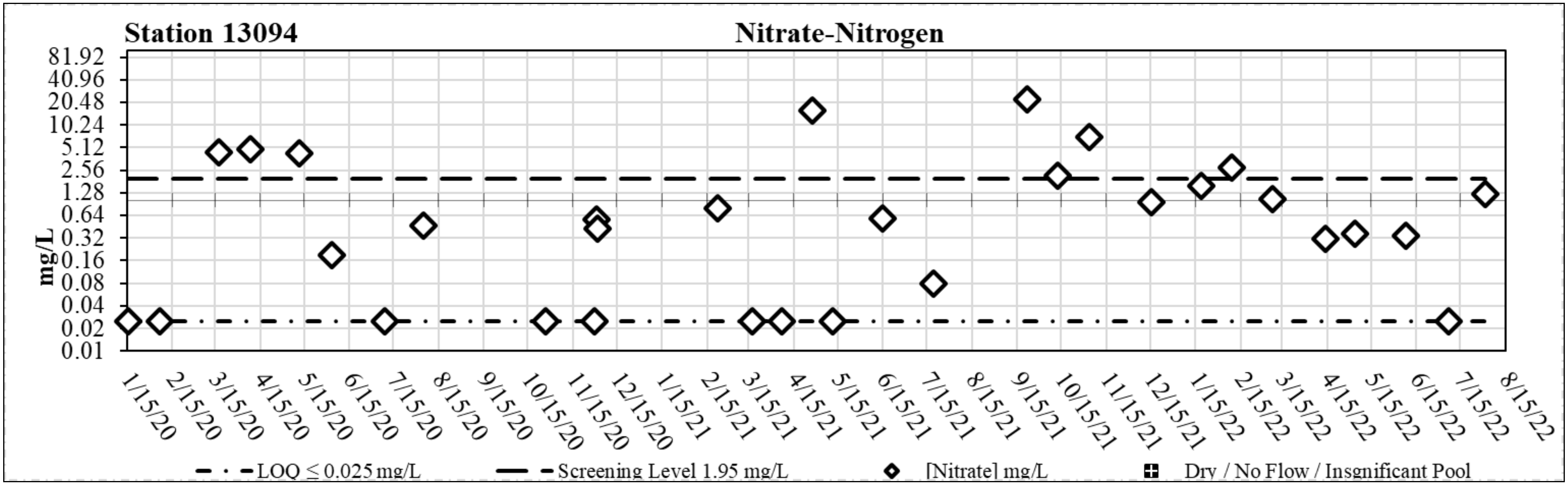


Figure 23. [Nitrate-Nitrogen] at Main Stem Station 13093



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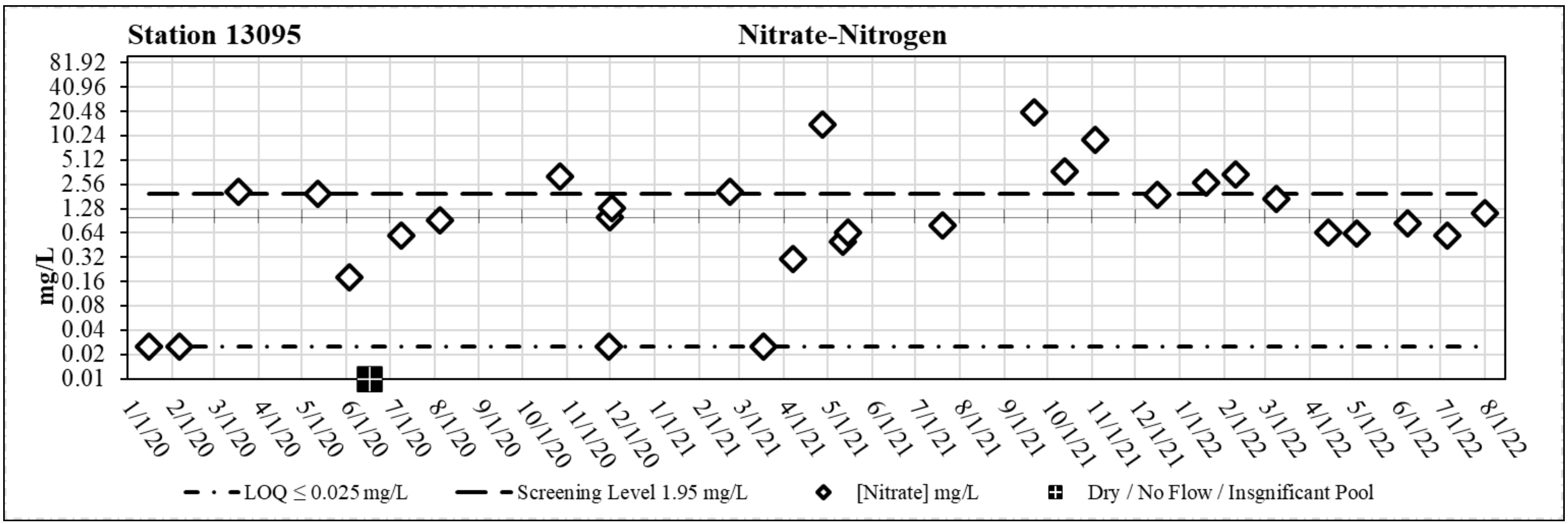
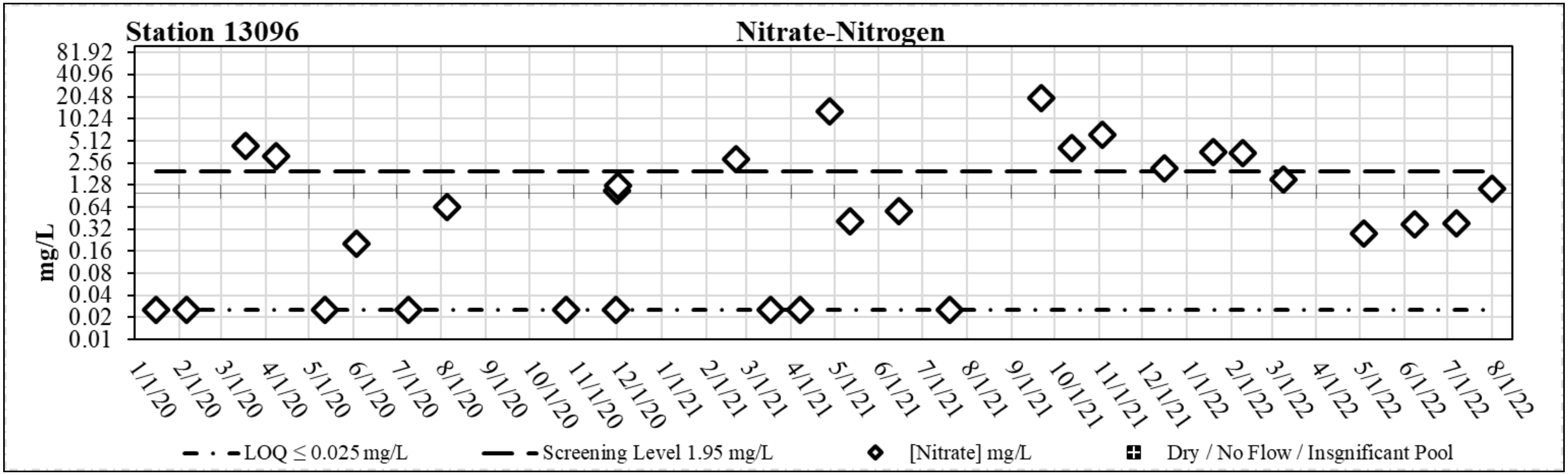


Figure 25. [Nitrate-Nitrogen] at Main Stem Station 13095



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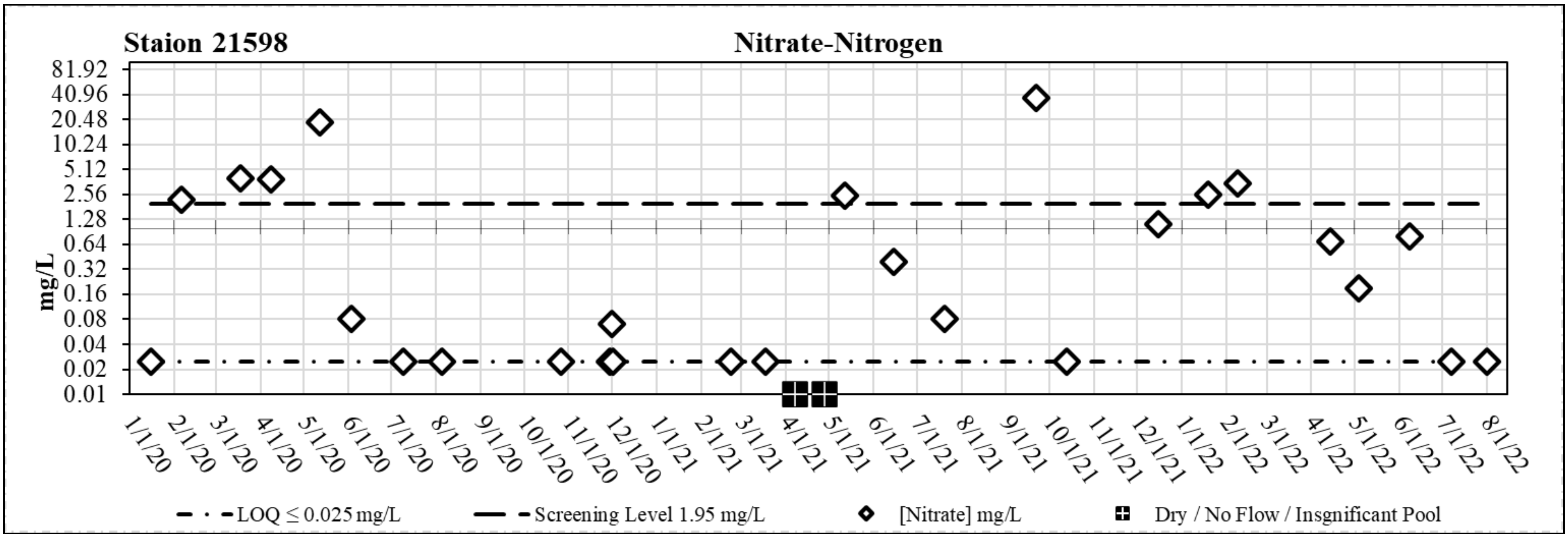


Figure 27. [Nitrate-Nitrogen] at Tributary Station 21598

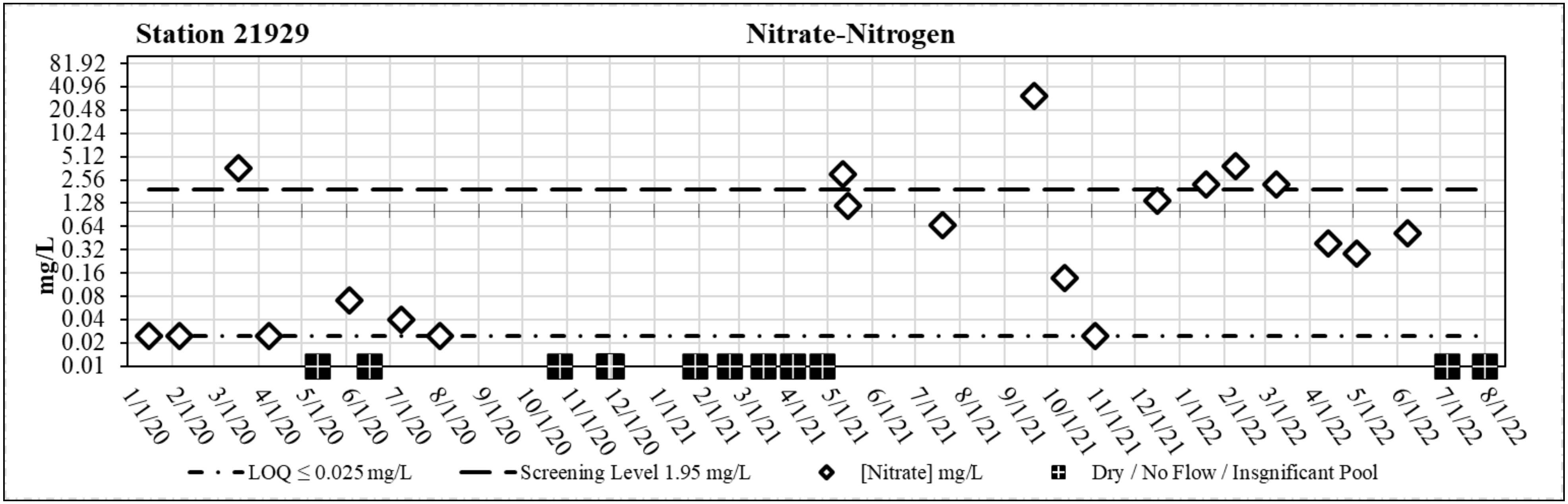


Figure 28. [Nitrate-Nitrogen] at Tributary Station 21929

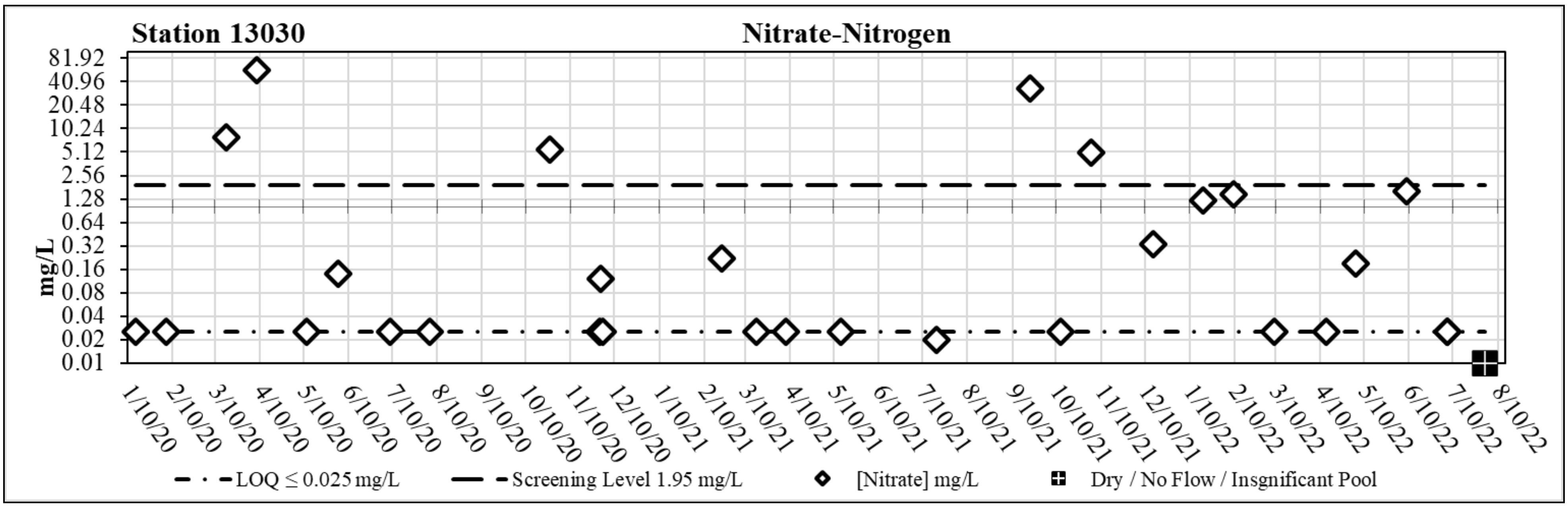


Figure 29. [Nitrate-Nitrogen] at Tributary Station 13030

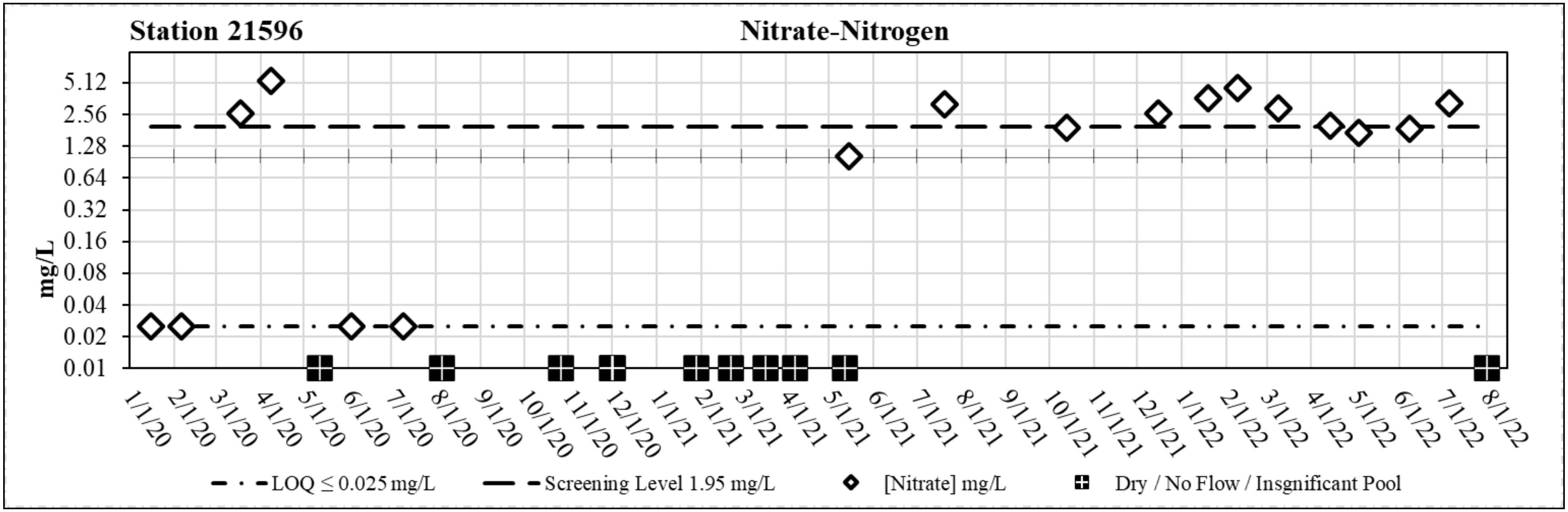
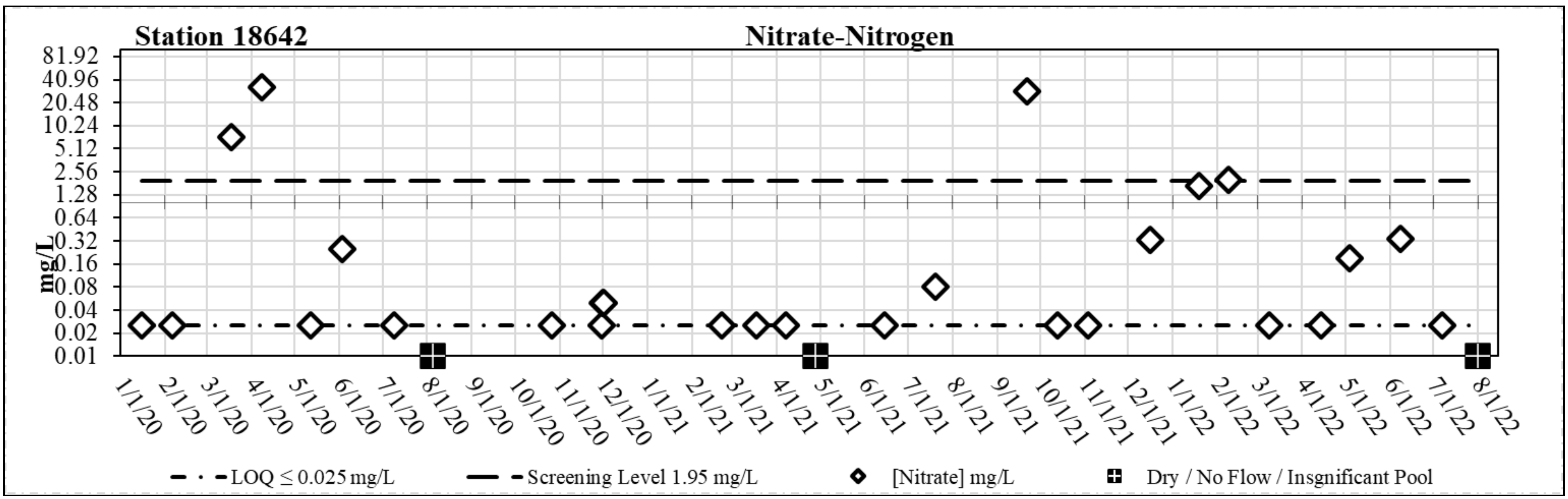


Figure 30. [Nitrate-Nitrogen] at Tributary Station 21596



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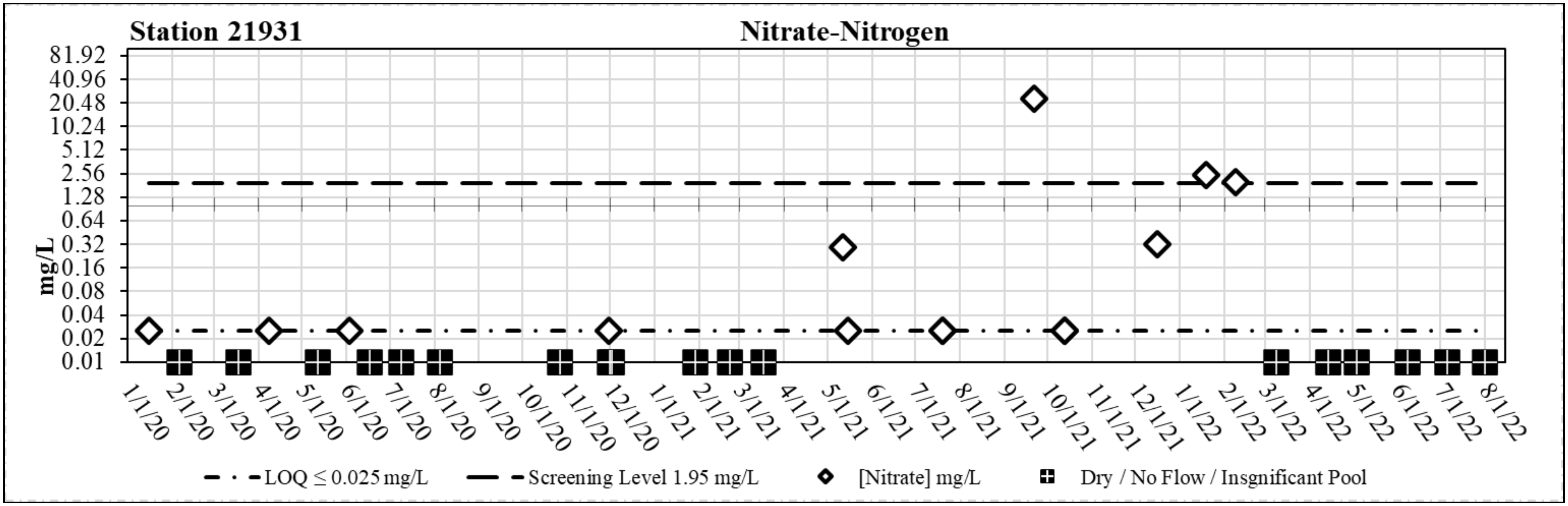


Figure 32. [Nitrate-Nitrogen] at Tributary Station 21931

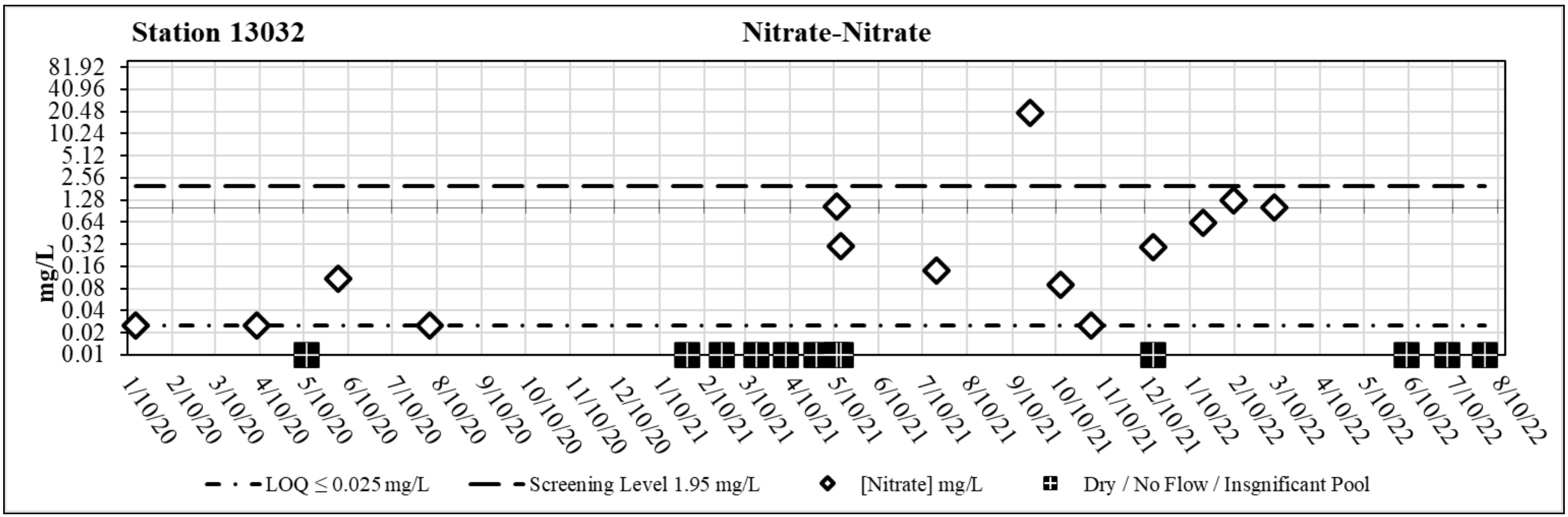


Figure 33. [Nitrate-Nitrogen] at Tributary Station 13032

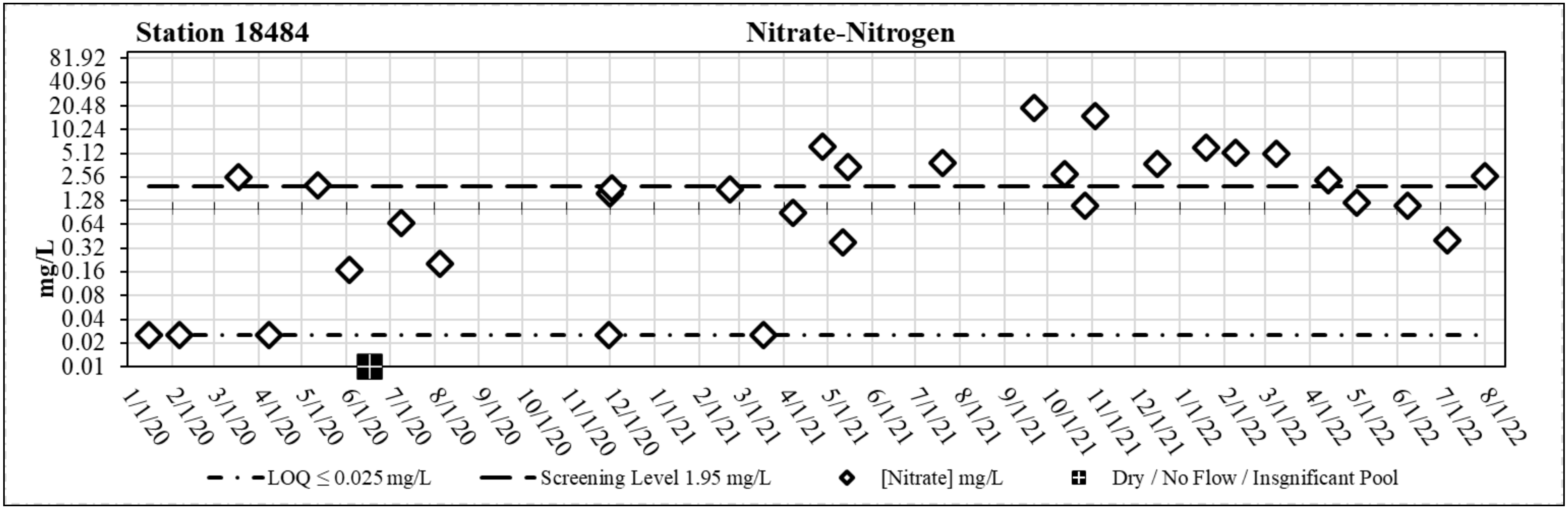
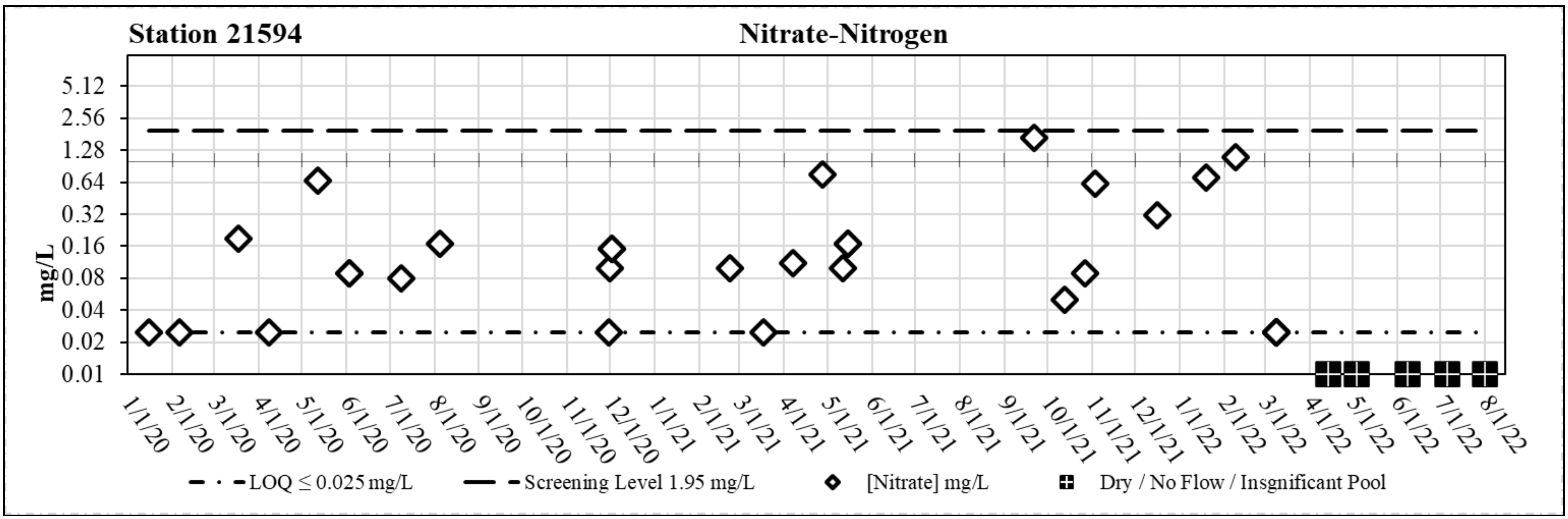


Figure 34. [Nitrate-Nitrogen] at Tributary Station 18484



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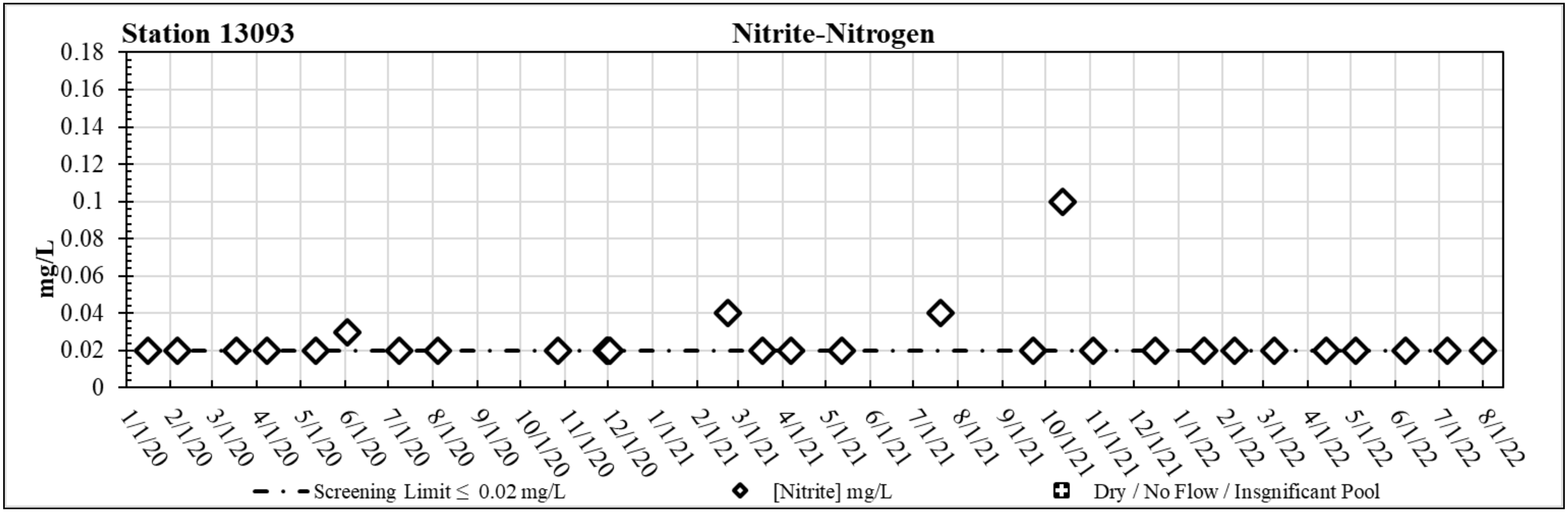
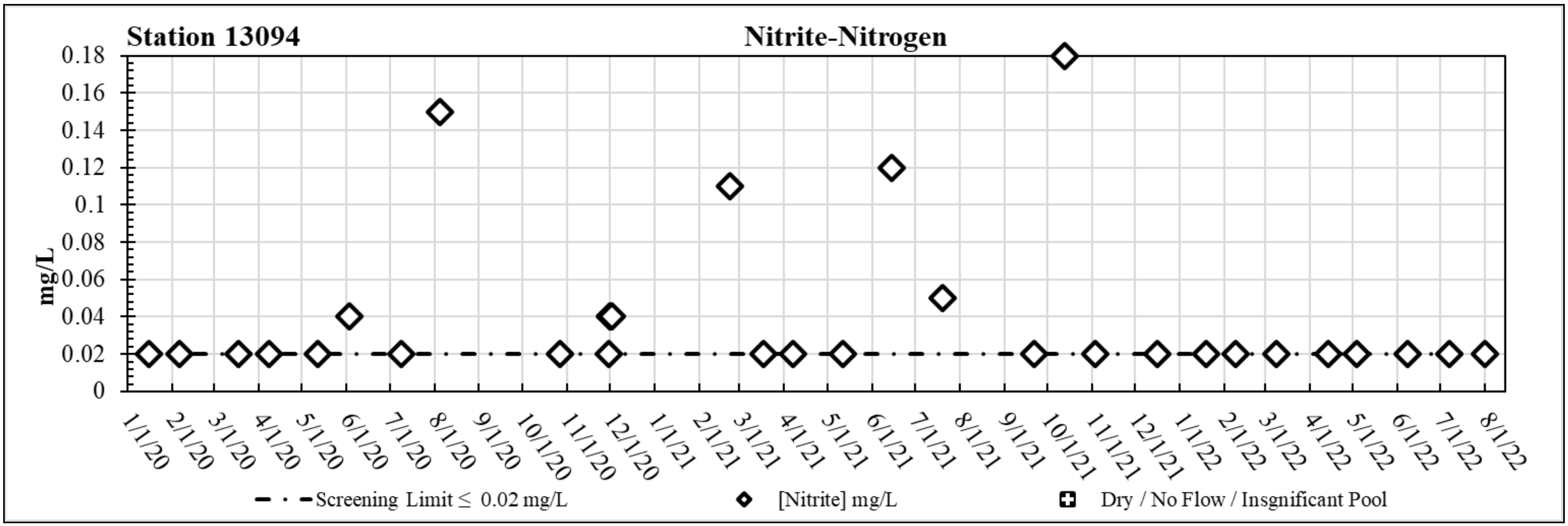


Figure 36. [Nitrite-Nitrogen] at Main Stem Station 13093



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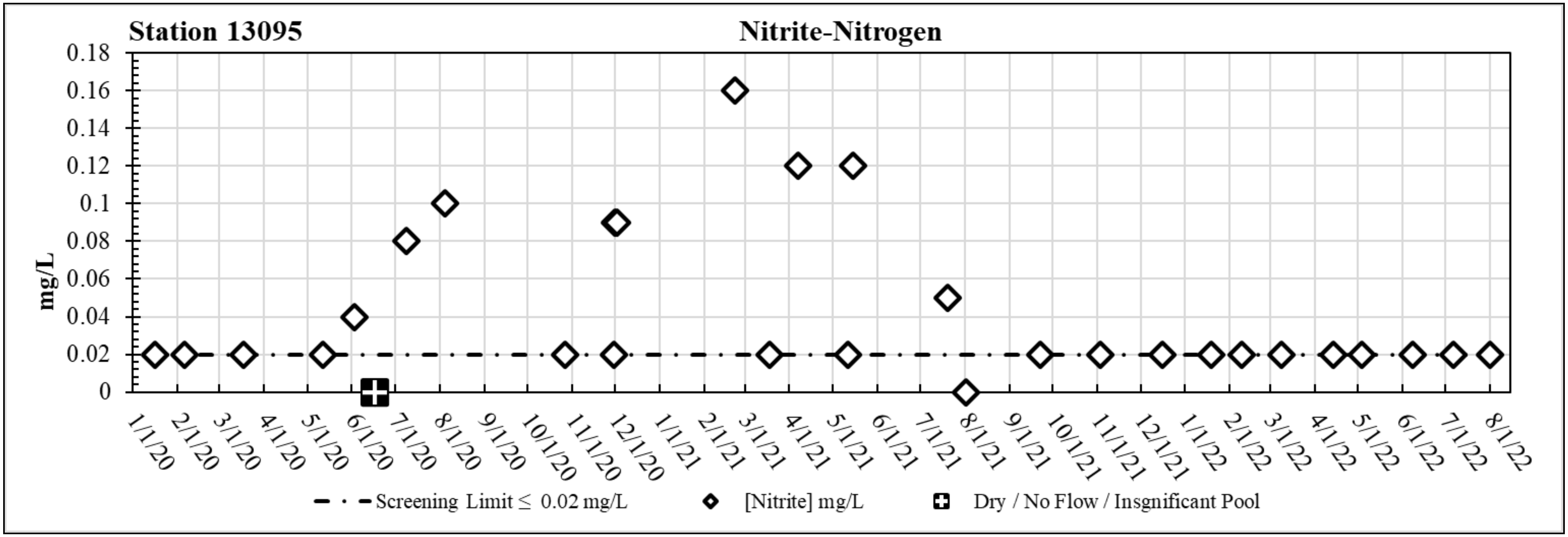

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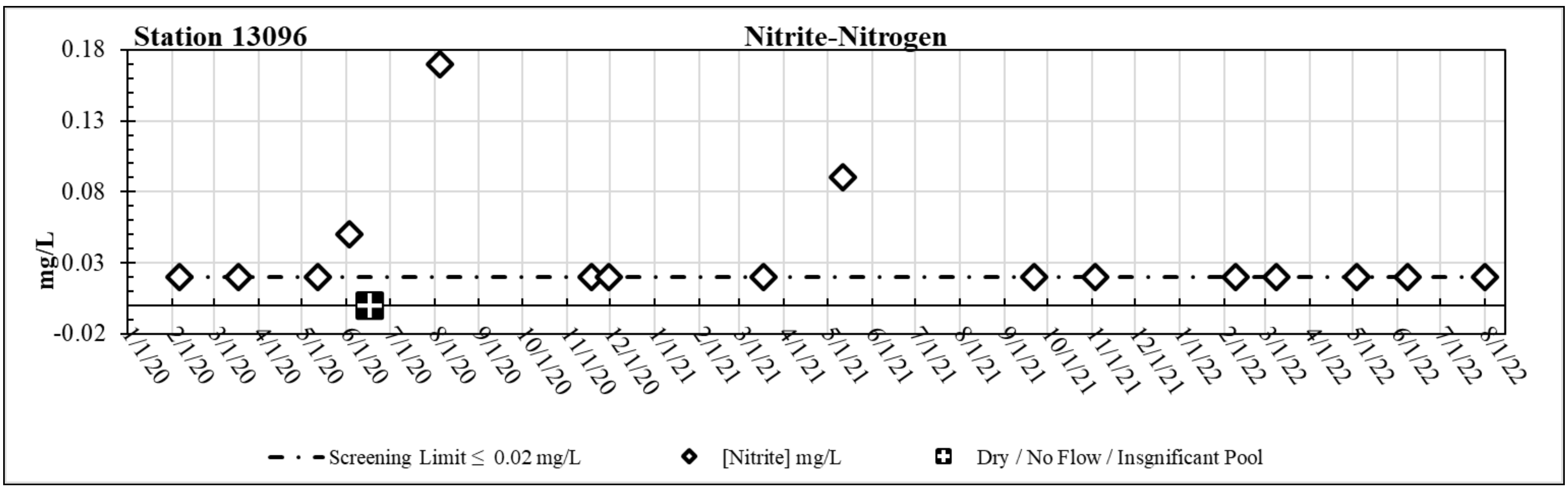

Figure 39. [Nitrite-Nitrogen] at Main Stem Station 13096

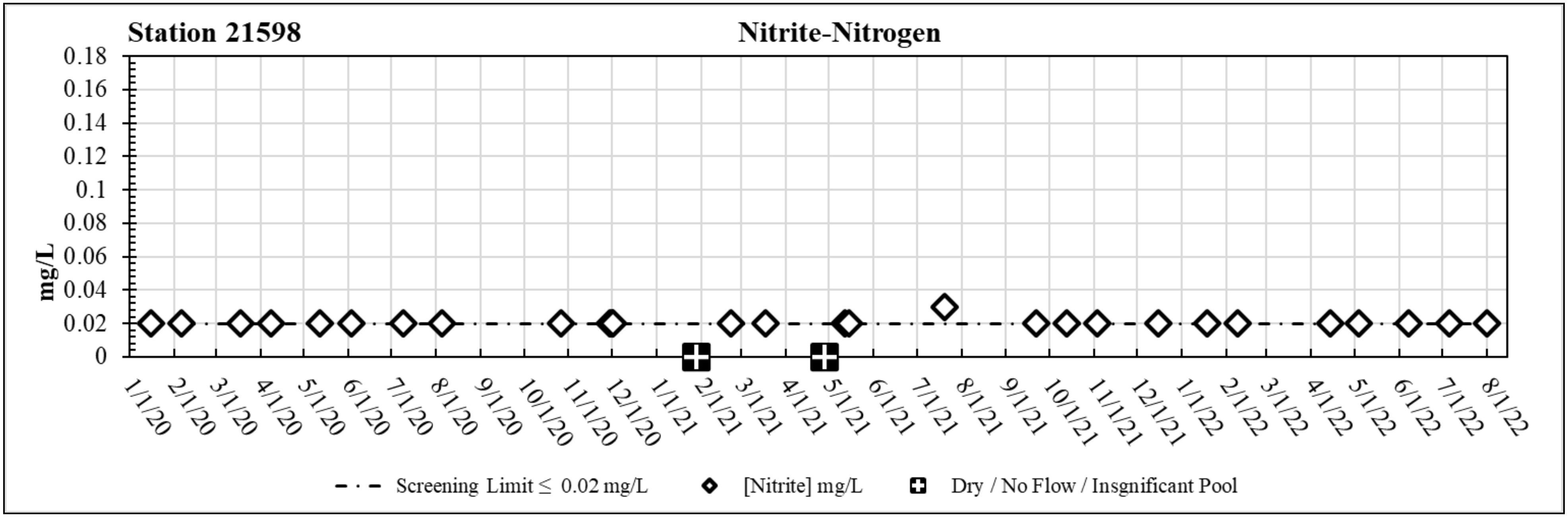

Figure 40. [Nitrite-Nitrogen] at Tributary Station 21598

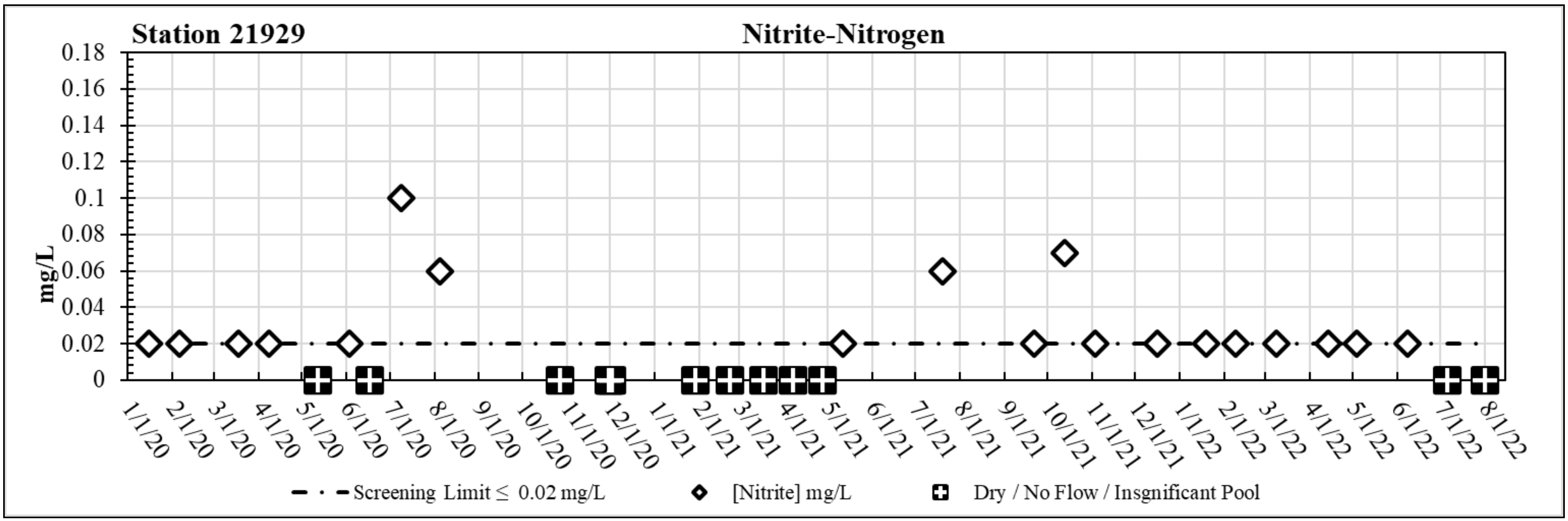

Figure 41. [Nitrite-Nitrogen] at Tributary Station 21929

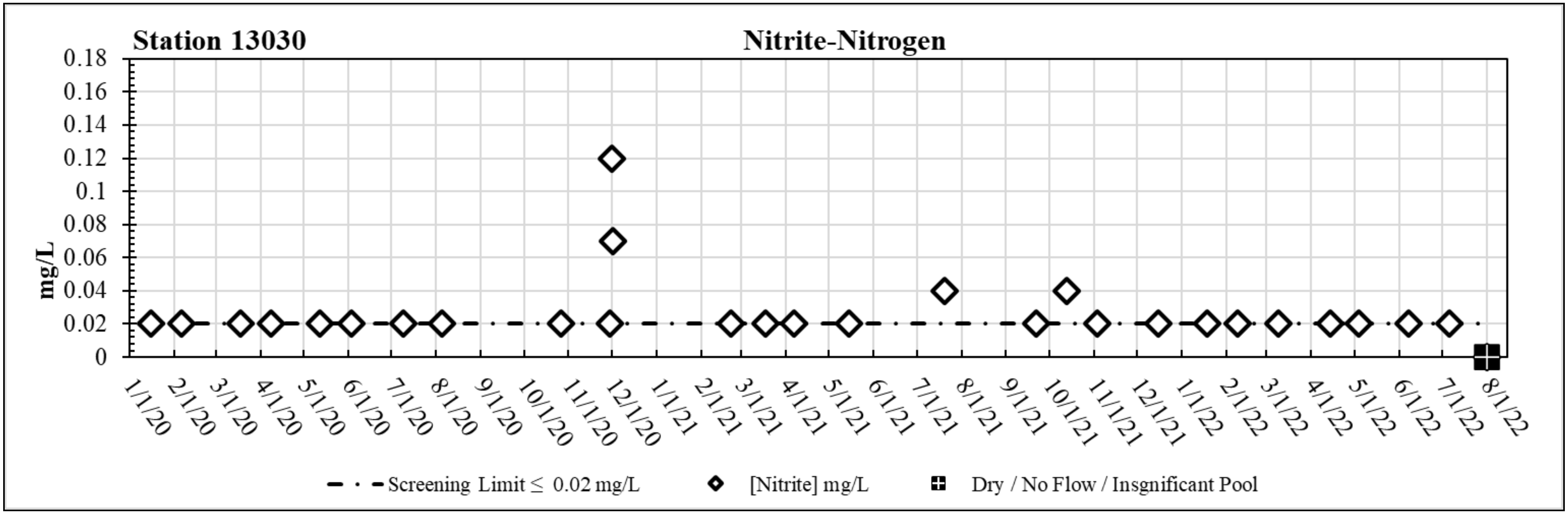

Figure 42. [Nitrite-Nitrogen] at Tributary Station 13030

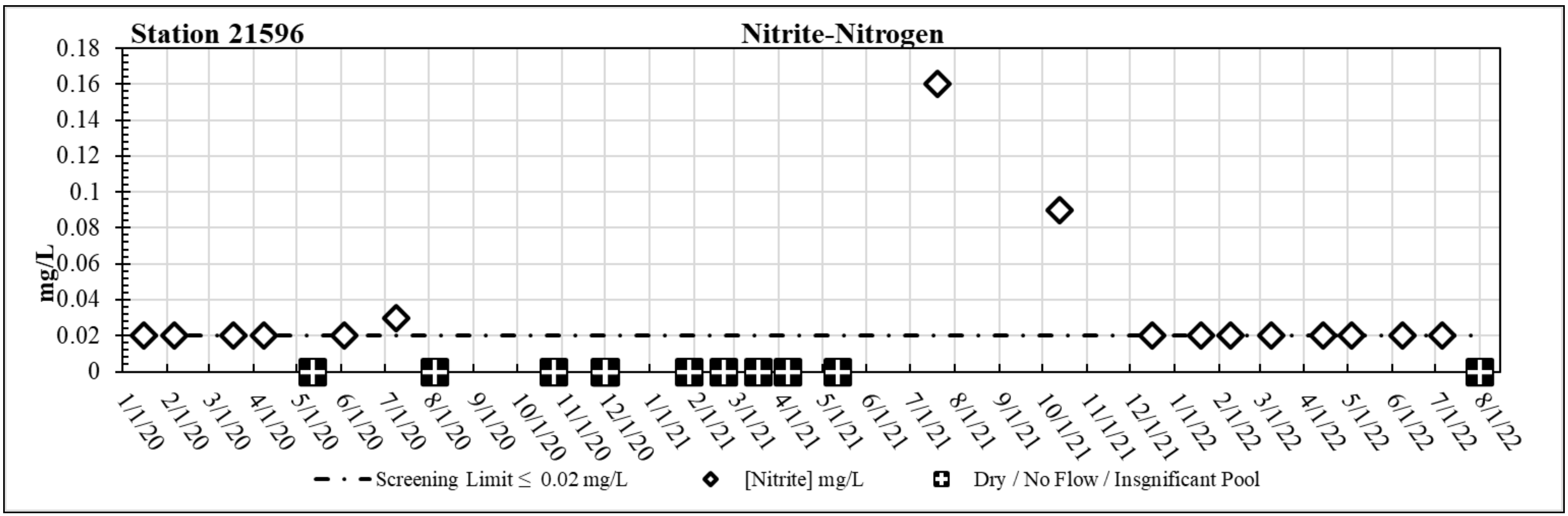

Figure 43. [Nitrite-Nitrogen] at Tributary Station 21596

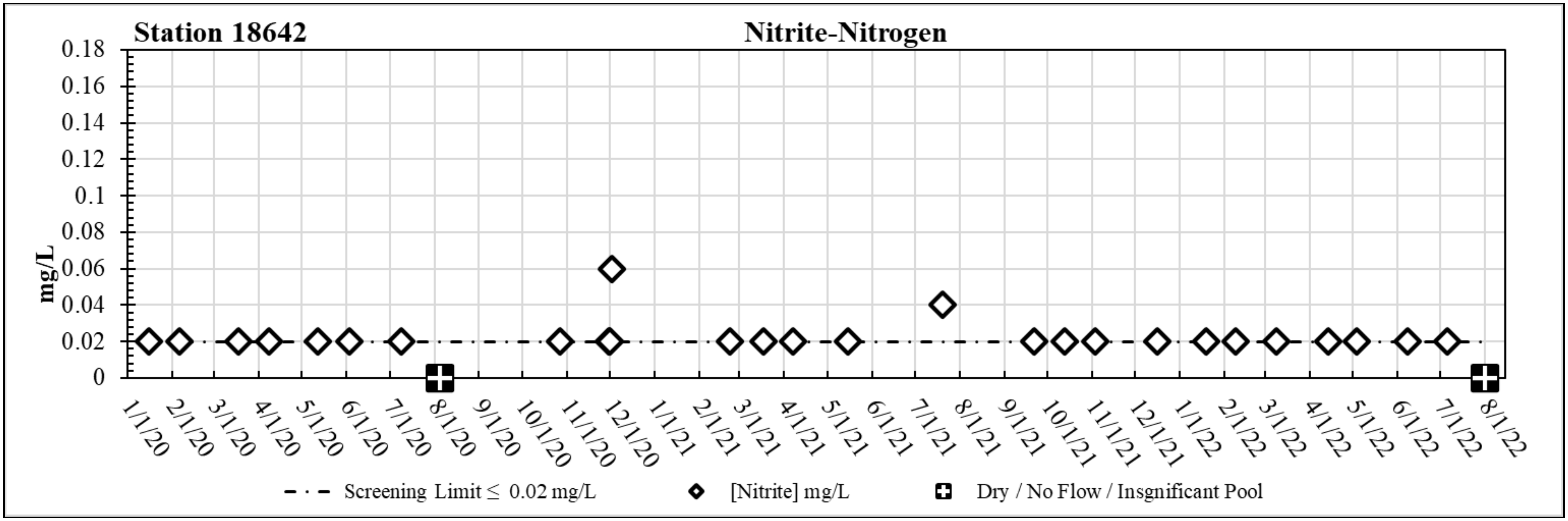

Figure 44. [Nitrite-Nitrogen] at Tributary Station 18642

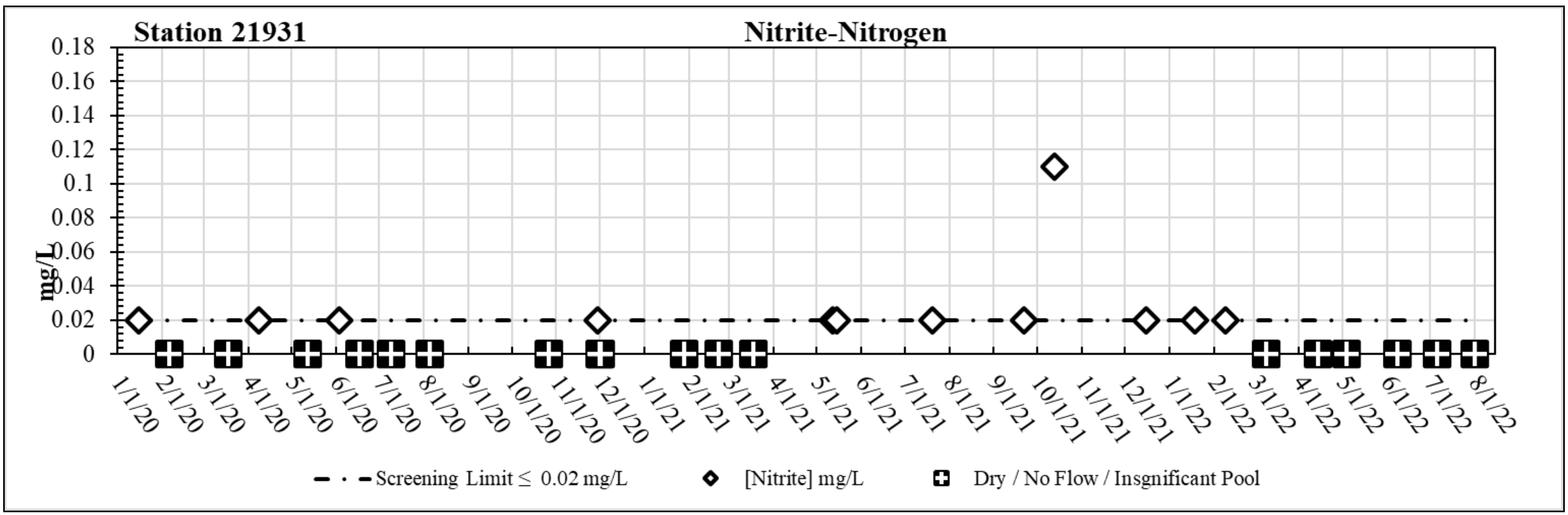

Figure 45. [Nitrite-Nitrogen] at Tributary Station 21931

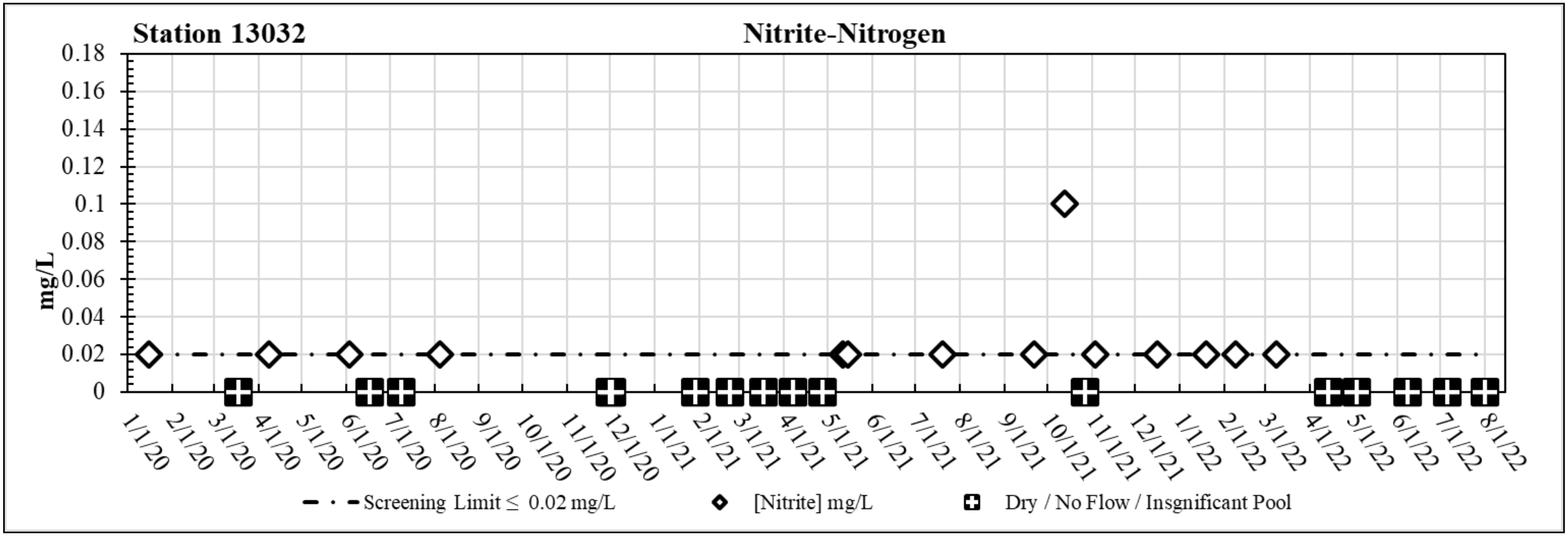

Figure 46. [Nitrite-Nitrogen] at Tributary Station 13032

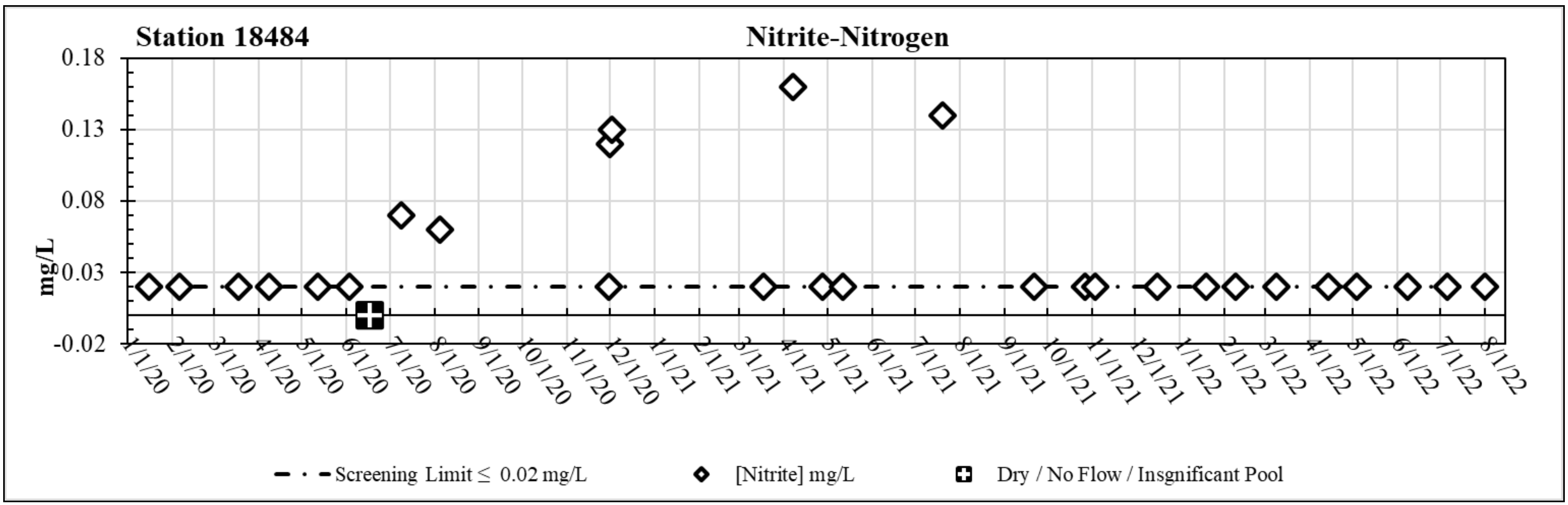

Figure 47. [Nitrite-Nitrogen] at Tributary Station 18484

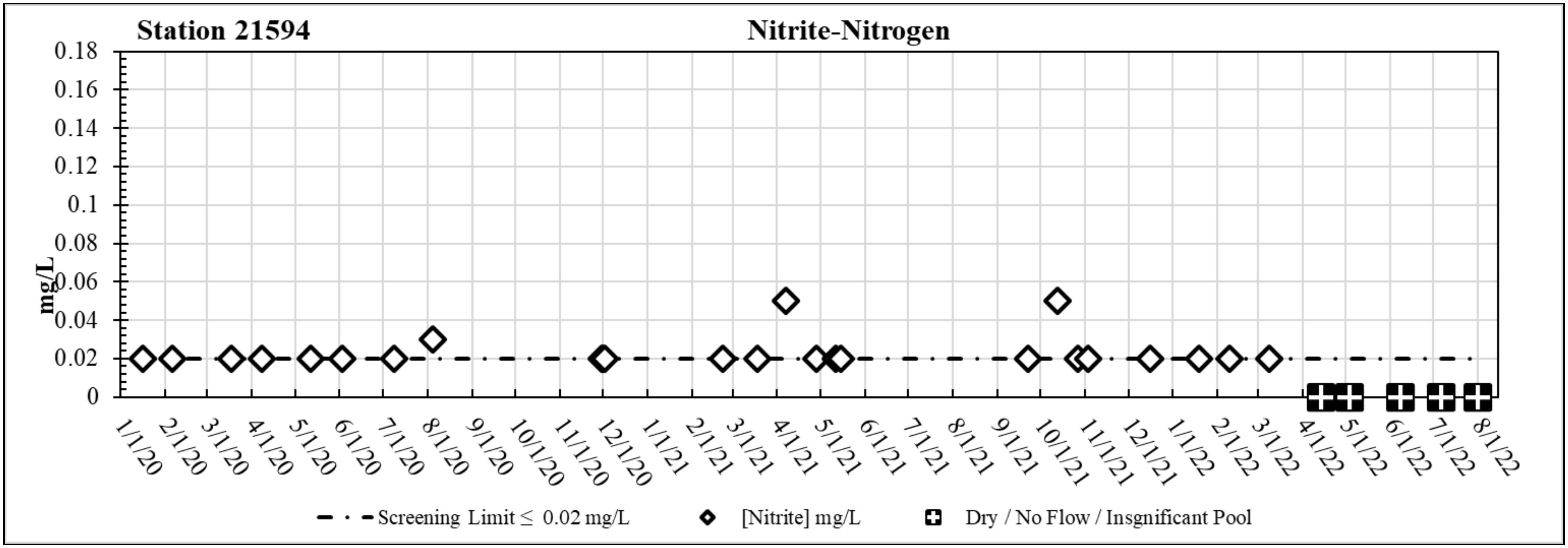

Figure 48. [Nitrite-Nitrogen] at Tributary Station 21594

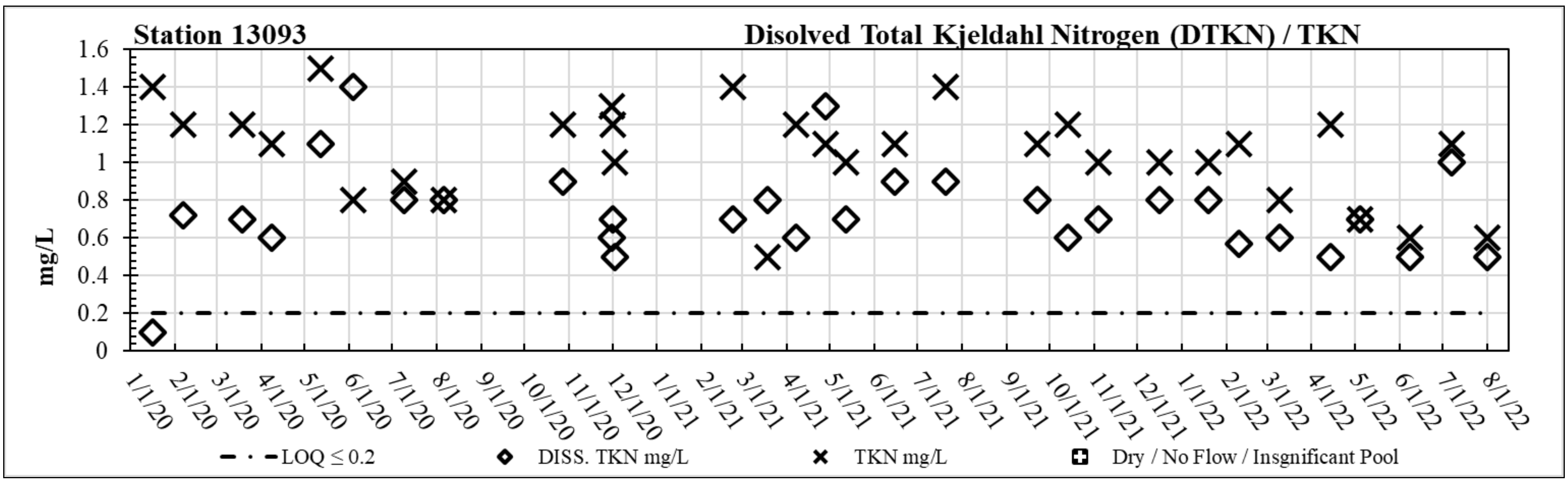

Figure 49. [DTKN] and [TKN] at Main Stem Station 13093

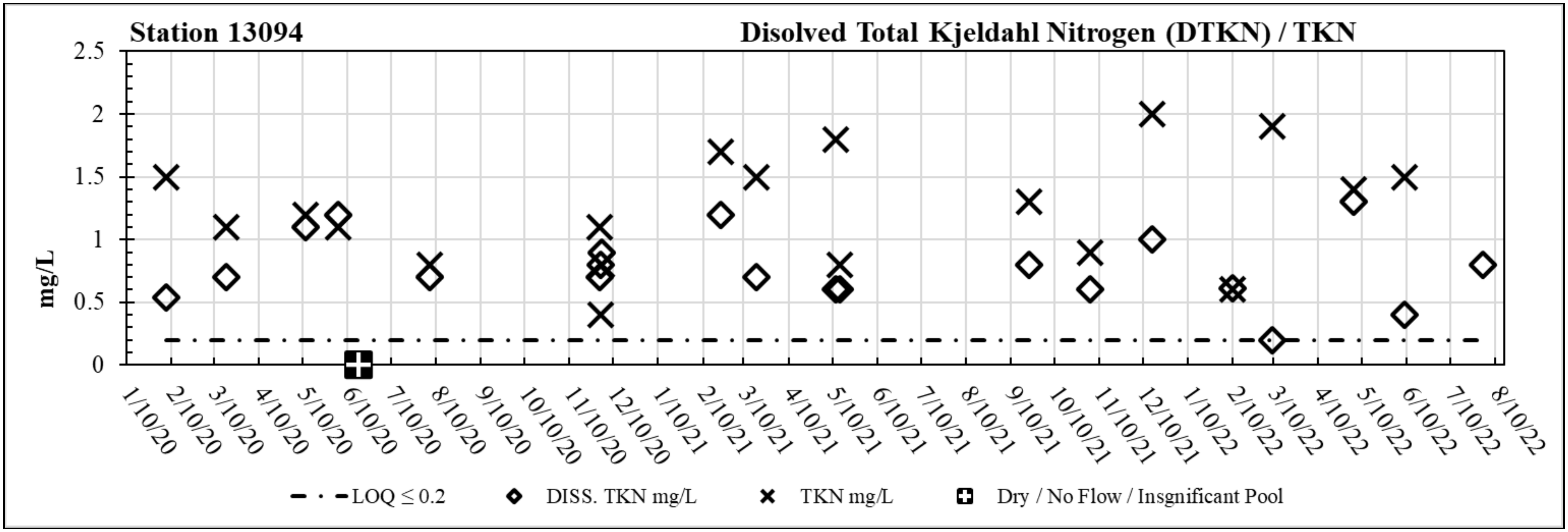

Figure 50. [DTKN] and [TKN] at Main Stem Station 13094

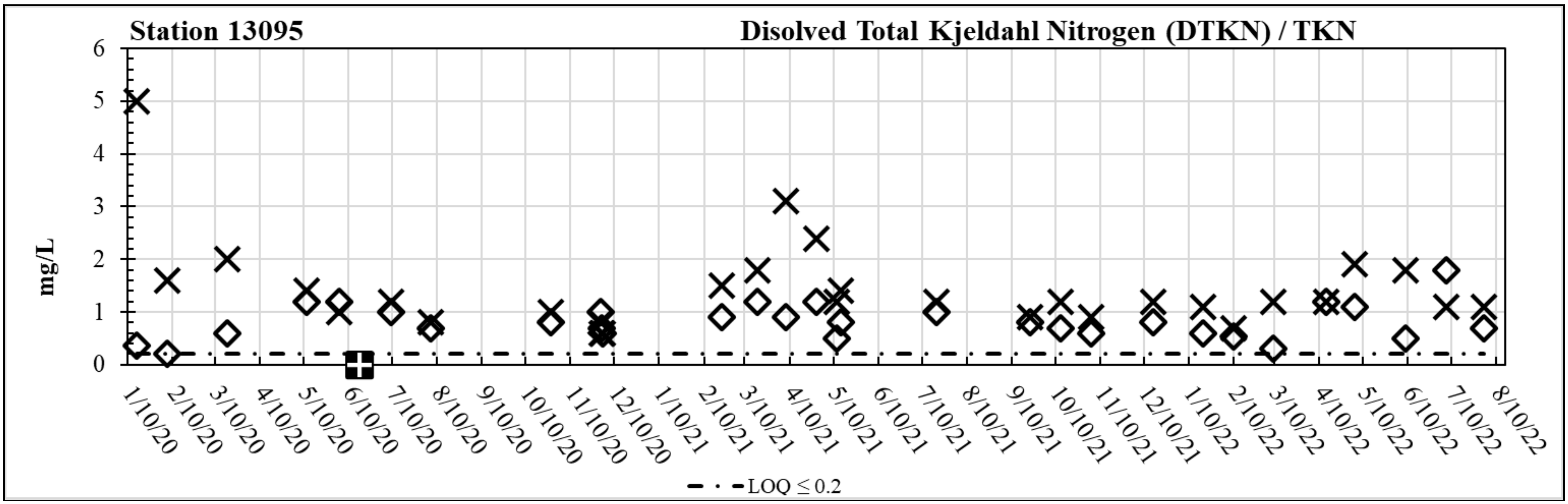

Figure 51. [DTKN] and [TKN] at Main Stem Station 13095

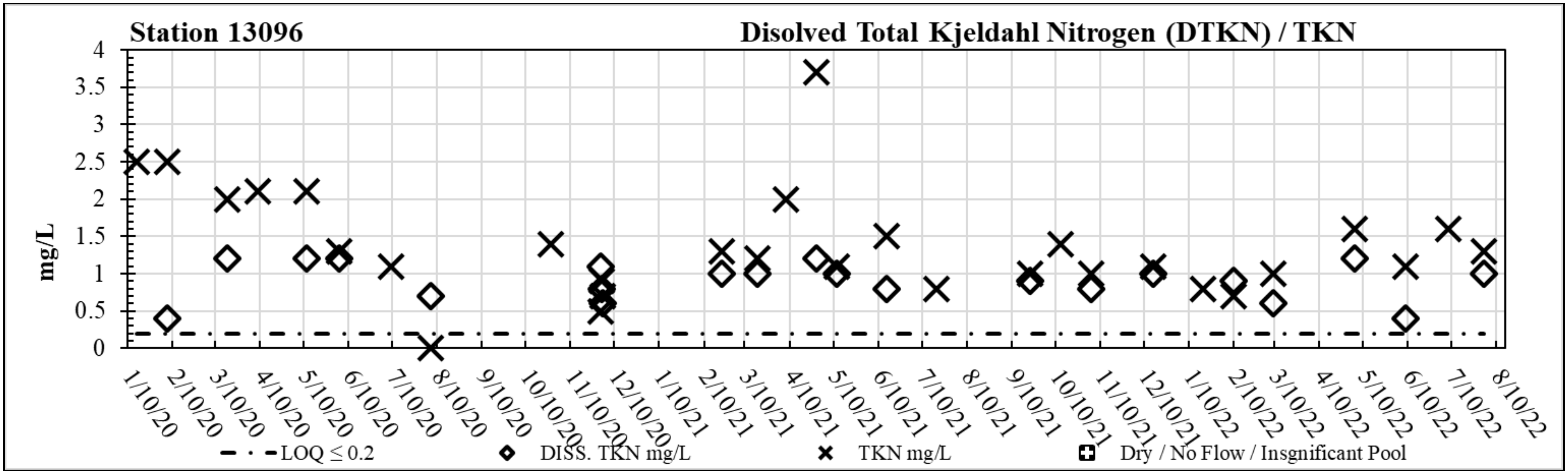

Figure 52. [DTKN] and [TKN] at Main Stem Station 13096

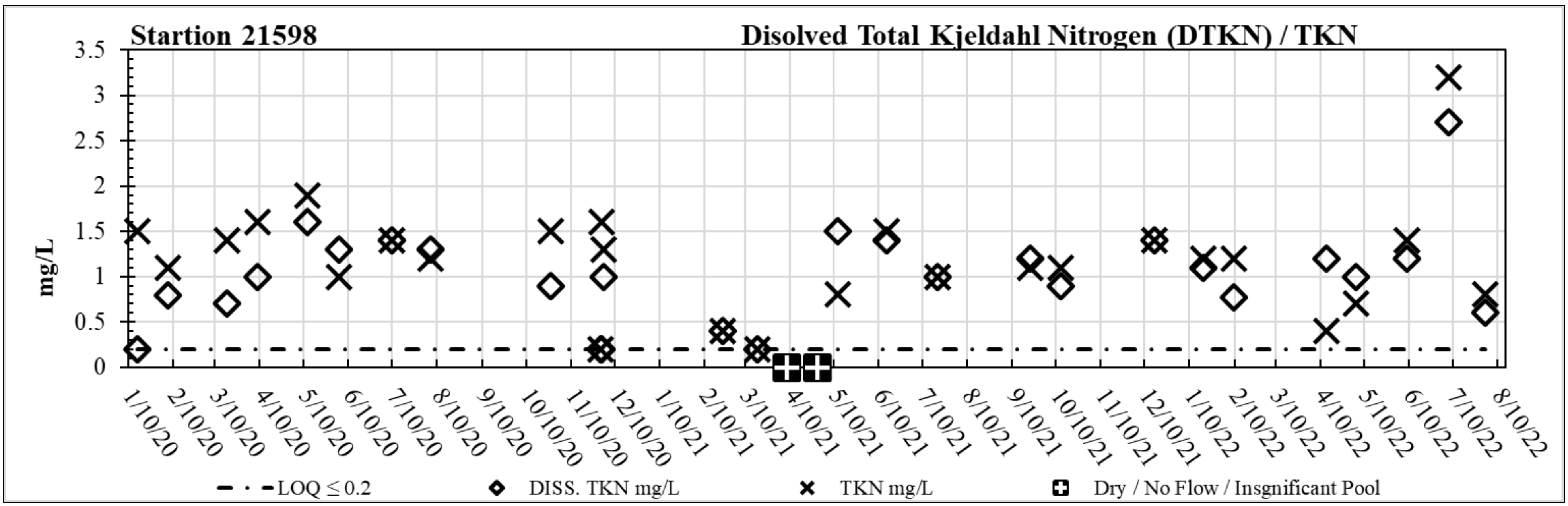

Figure 53. [DTKN] and [TKN] at Tributary Station 21598

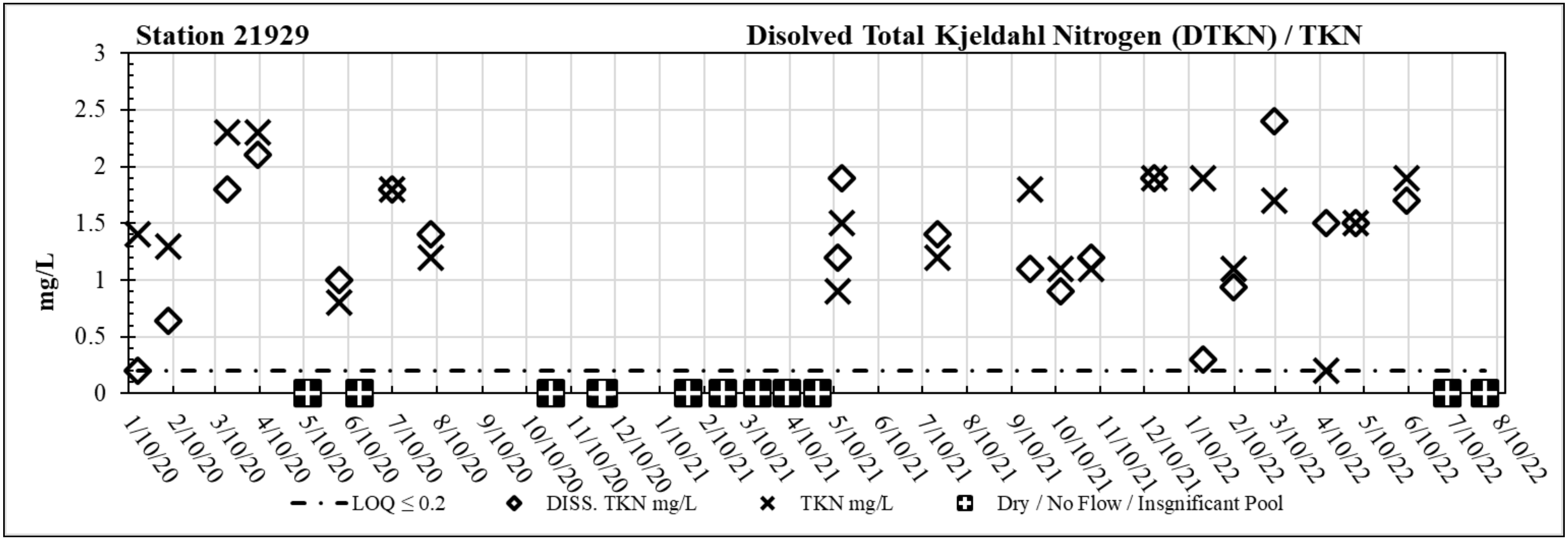

Figure 54. [DTKN] and [TKN] at Tributary Station 21929

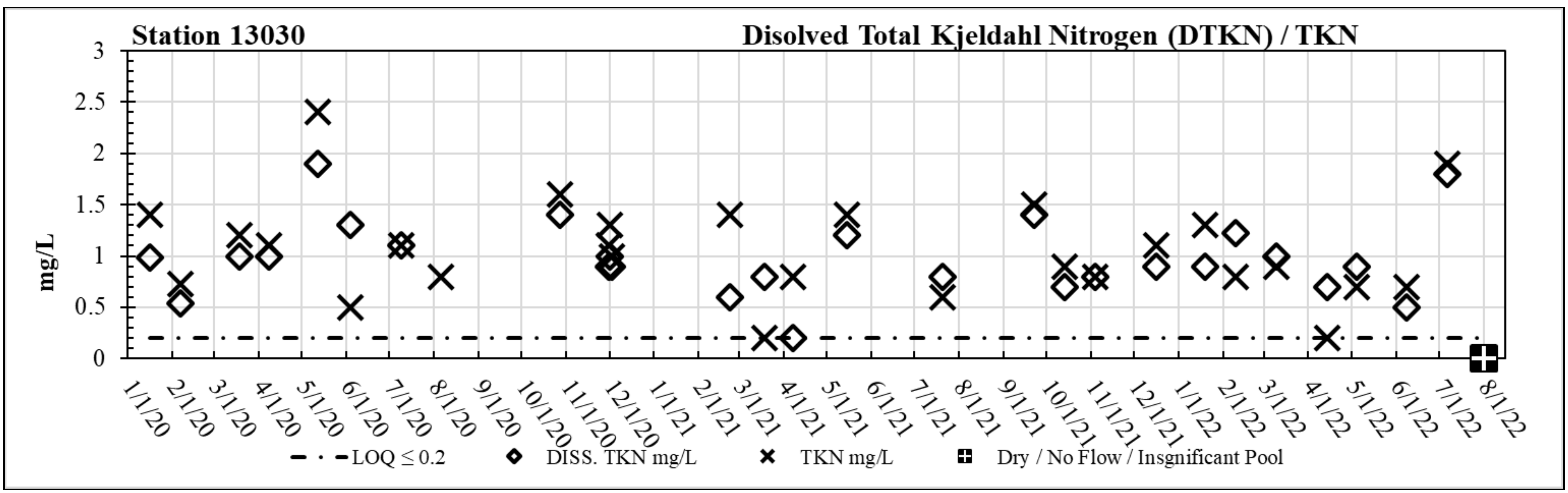

Figure 55. [DTKN] and [TKN] at Tributary Station 13030

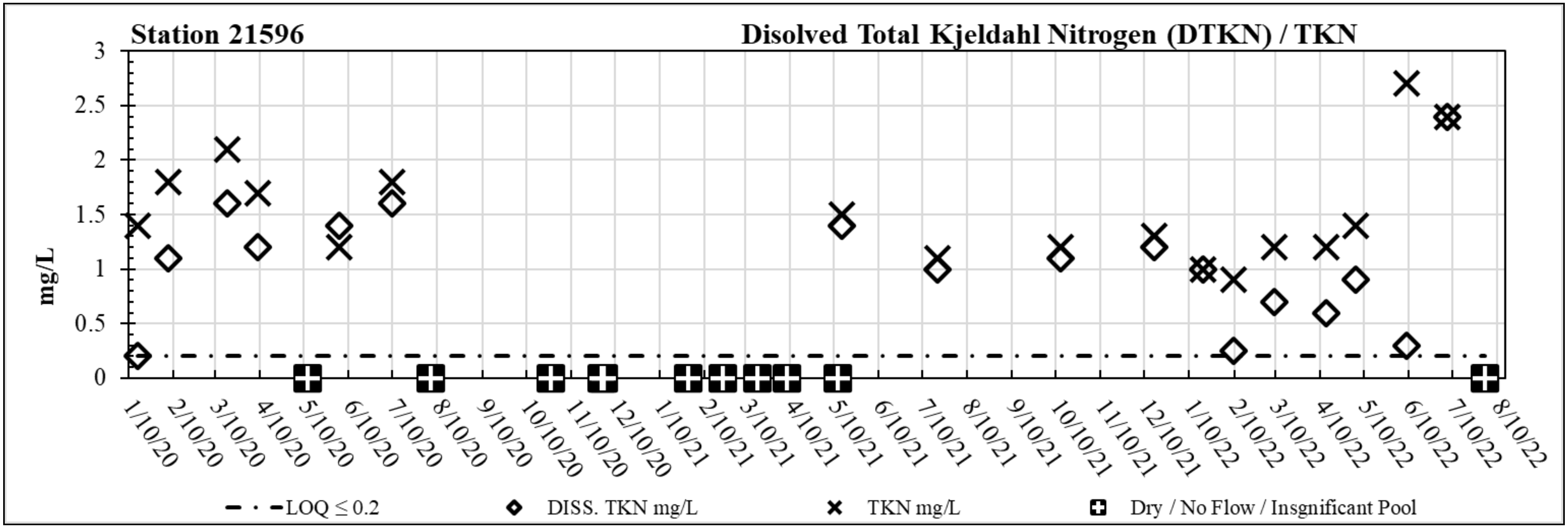

Figure 56. [DTKN] and [TKN] at Tributary Station 21596

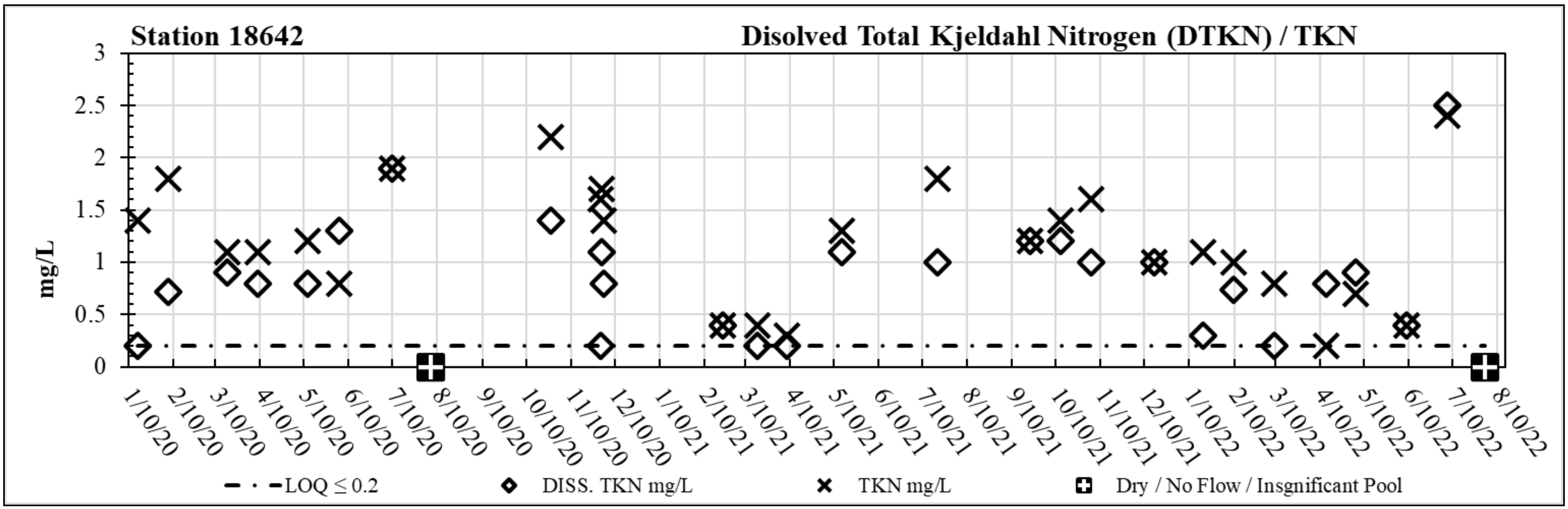

Figure 57. [DTKN] and [TKN] at Tributary Station 18642

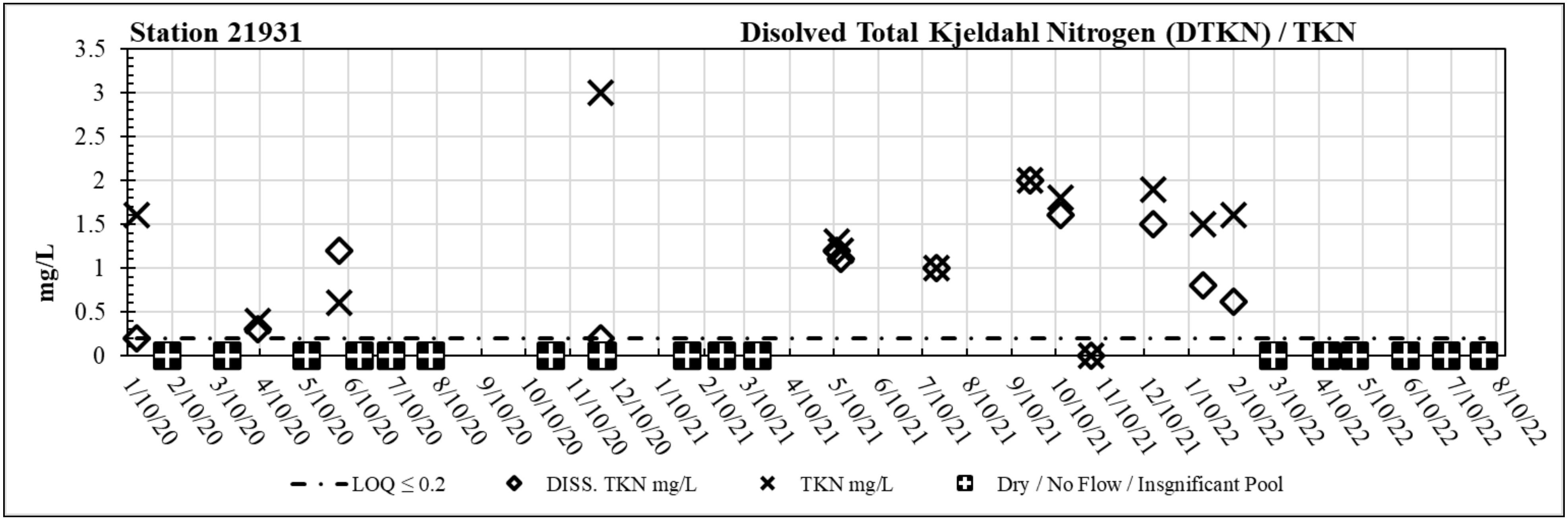

Figure 58. [DTKN] and [TKN] at Tributary Station 21931

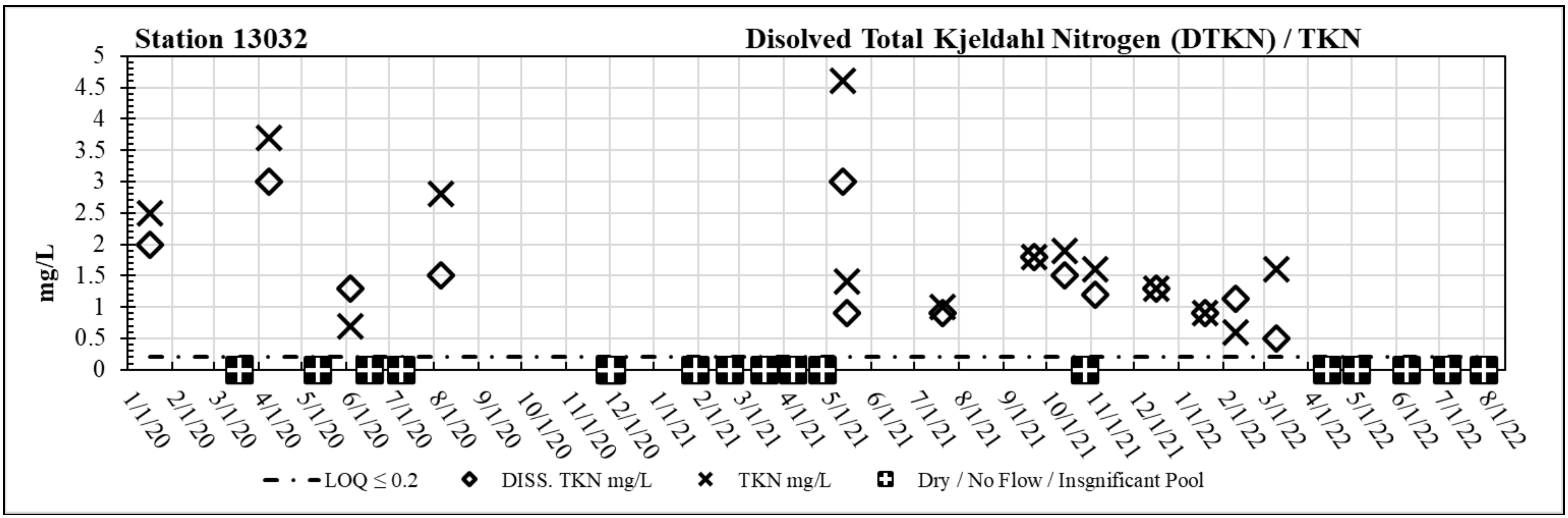

Figure 59. [DTKN] and [TKN] at Tributary Station 13032

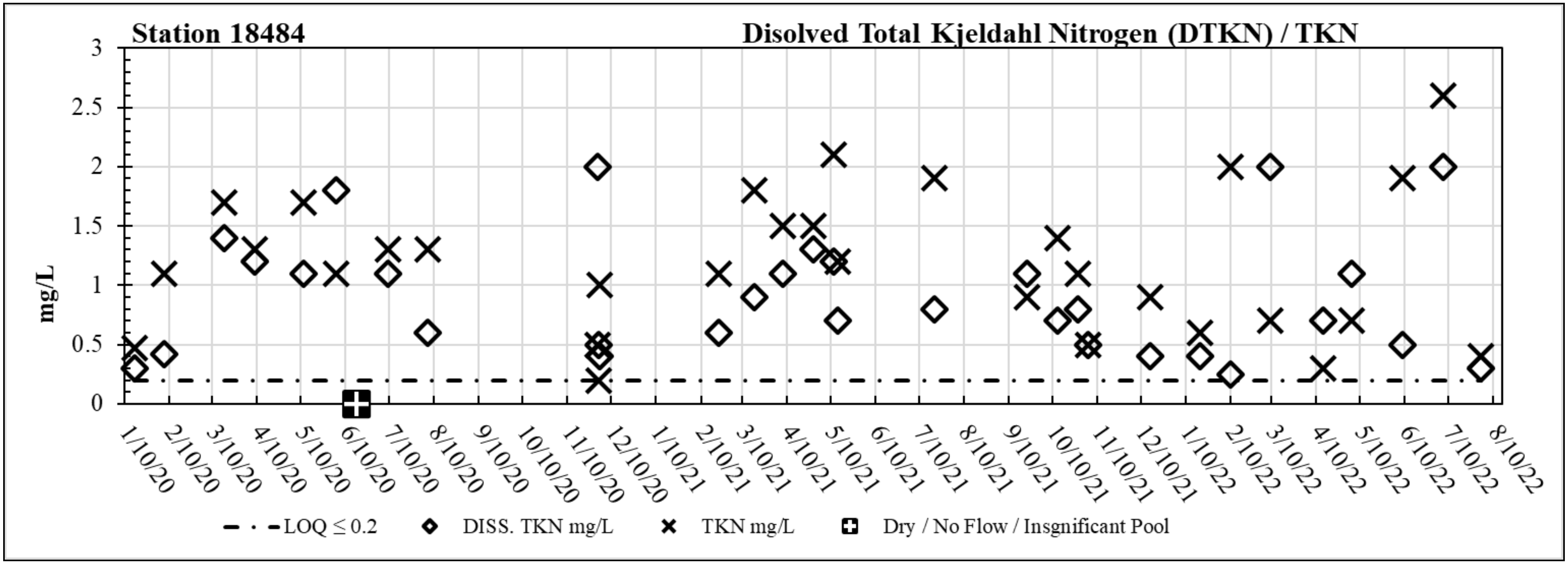

Figure 60. [DTKN] and [TKN] at Tributary Station 18484

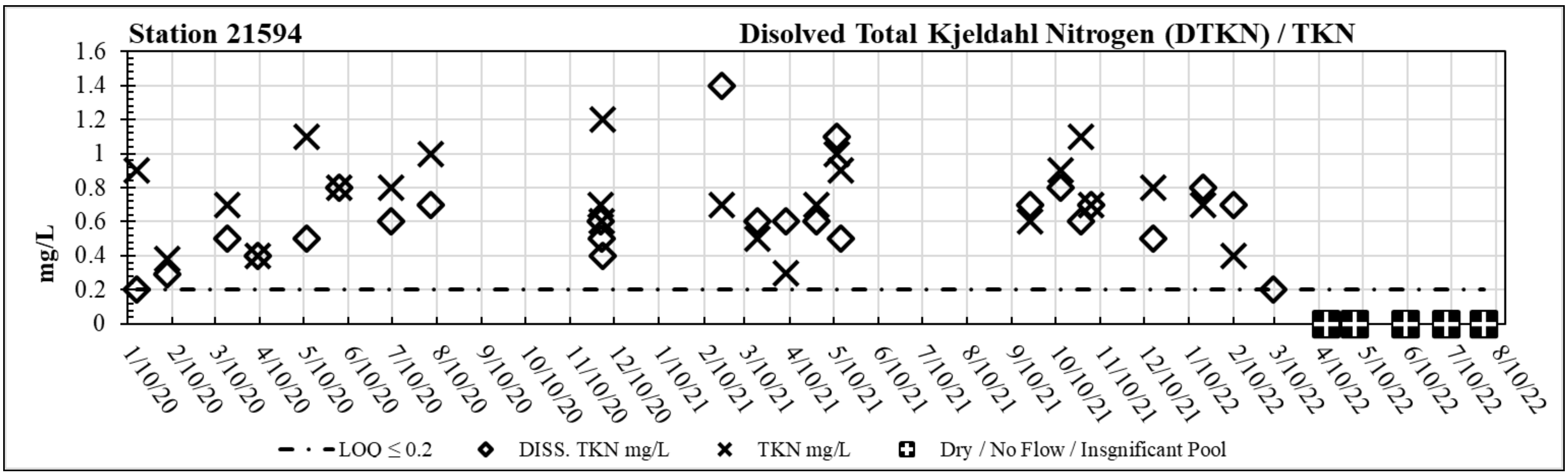

Figure 61. [DTKN] and [TKN] at Tributary Station 21594

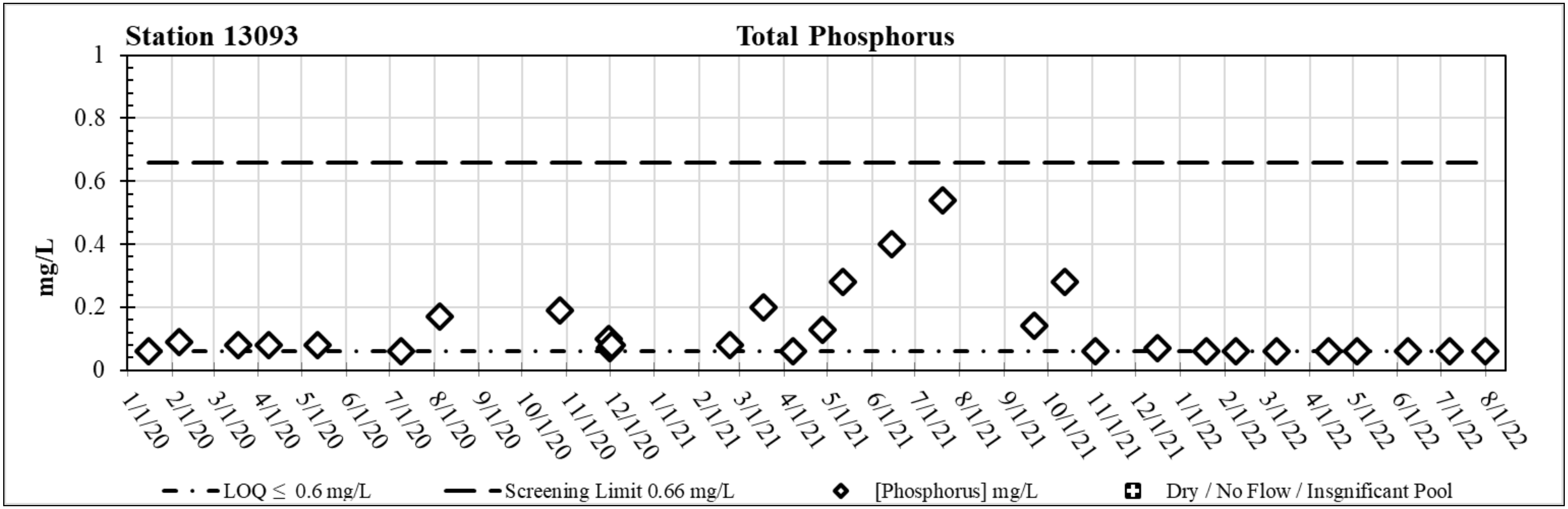

Figure 62. [Total Phosphorus] at Main Stem Station 13093

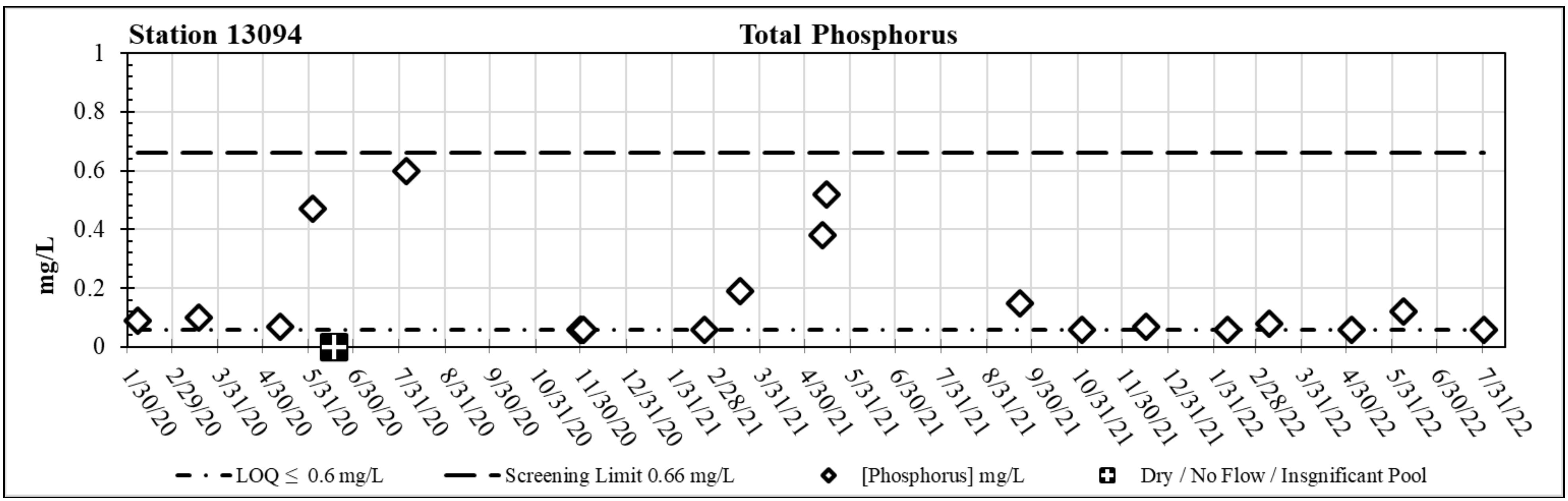

Figure 63. [Total Phosphorus] at Main Stem Station 13094

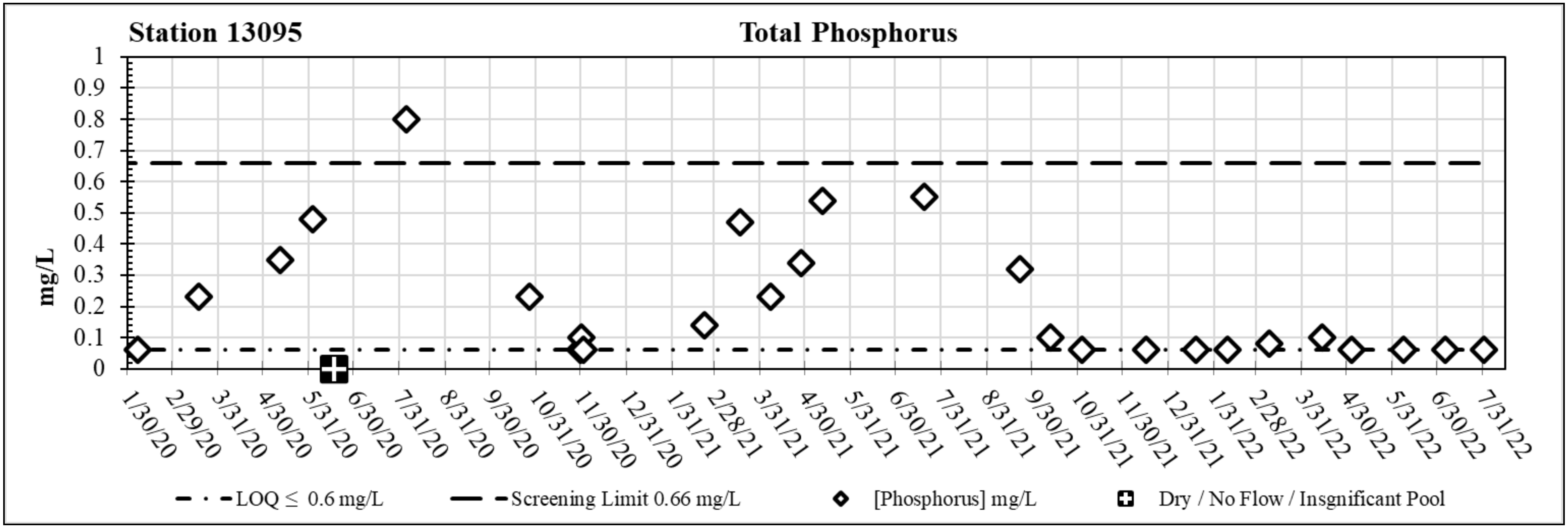

Figure 64. [Total Phosphorus] at Main Stem Station 13095

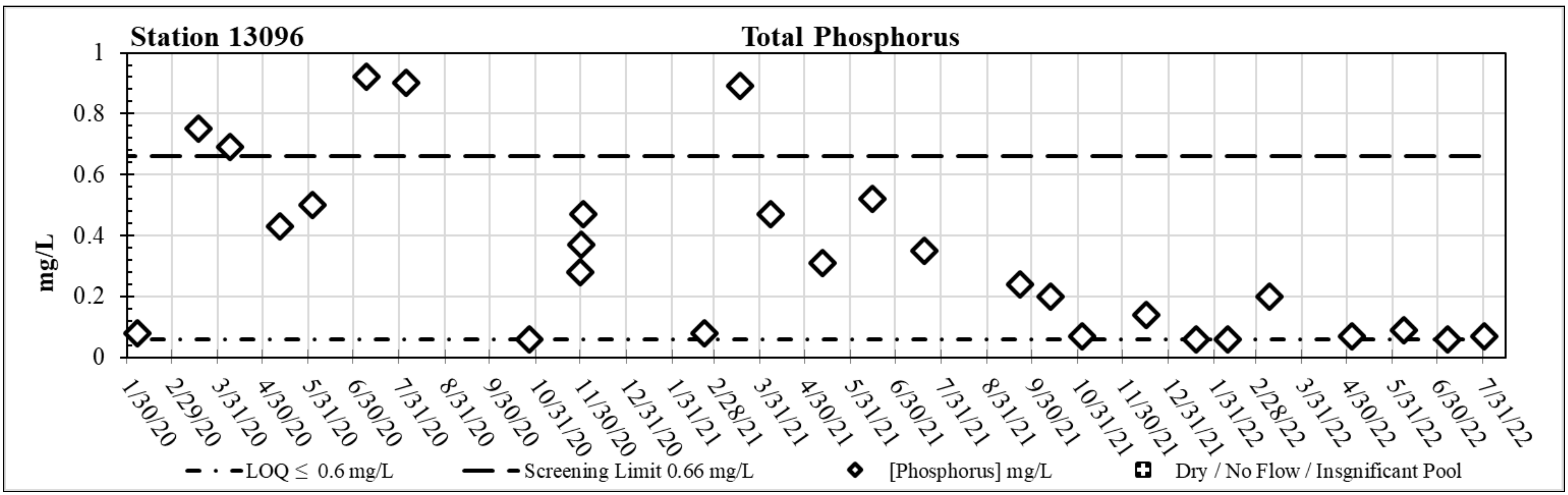

Figure 65. [Total Phosphorus] at Main Stem Station 13096

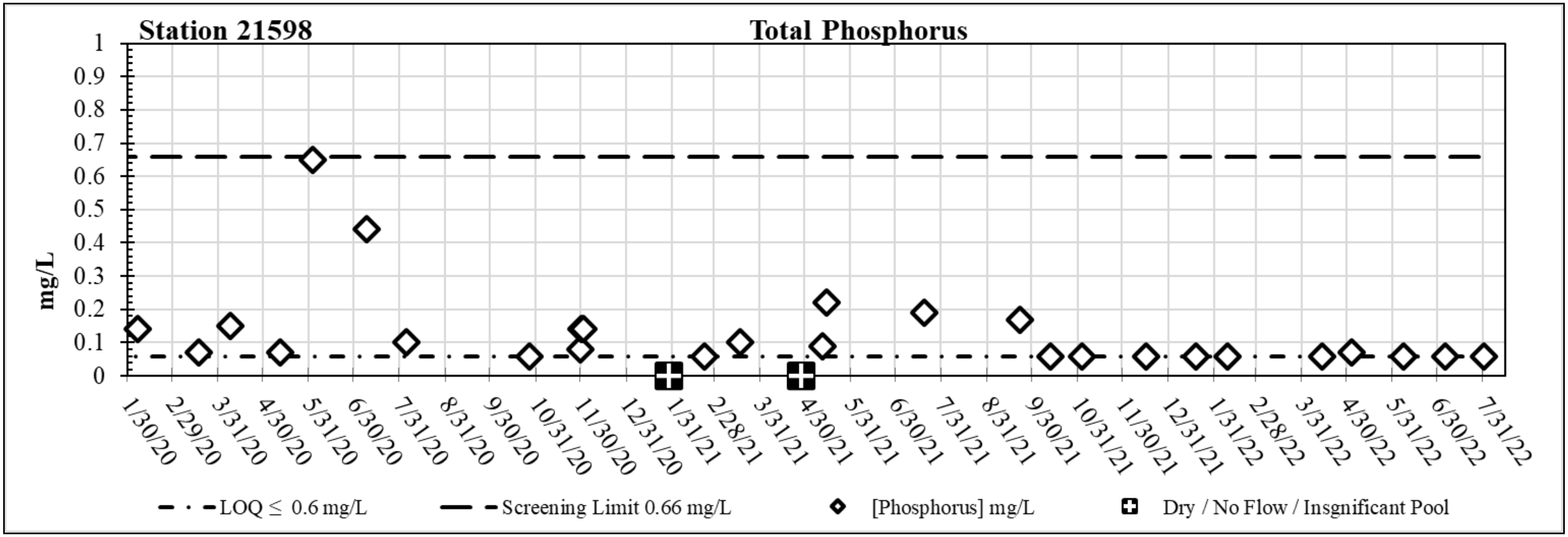

Figure 66. [Total Phosphorus] at Tributary Station 21598

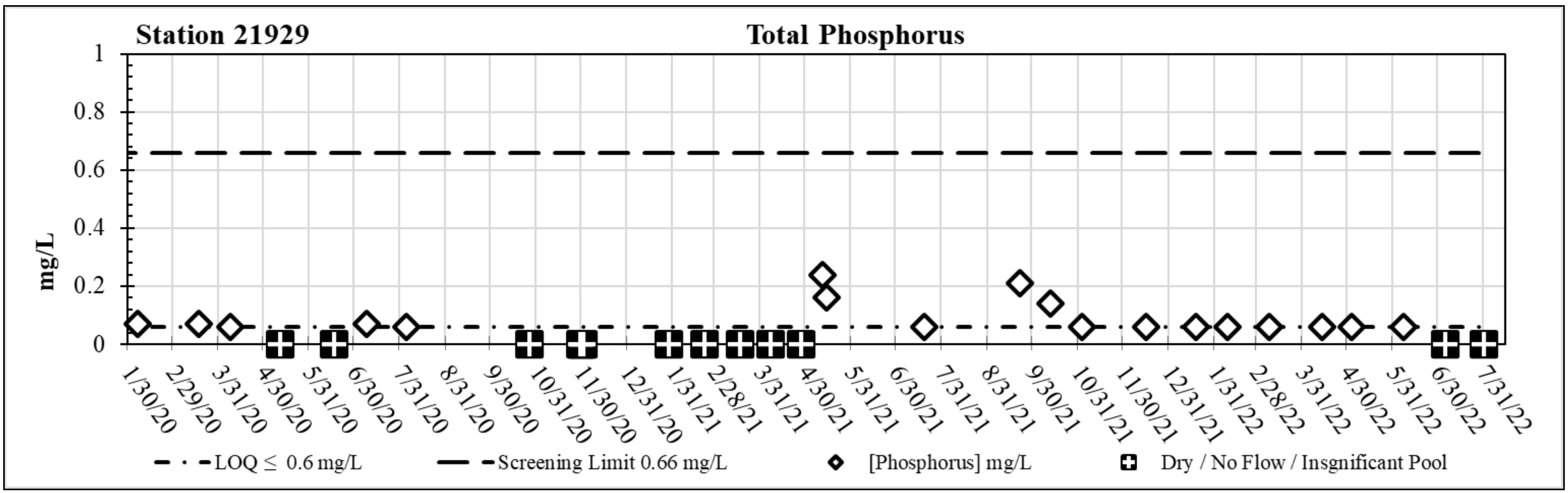

Figure 67. [Total Phosphorus] at Tributary Station 21929

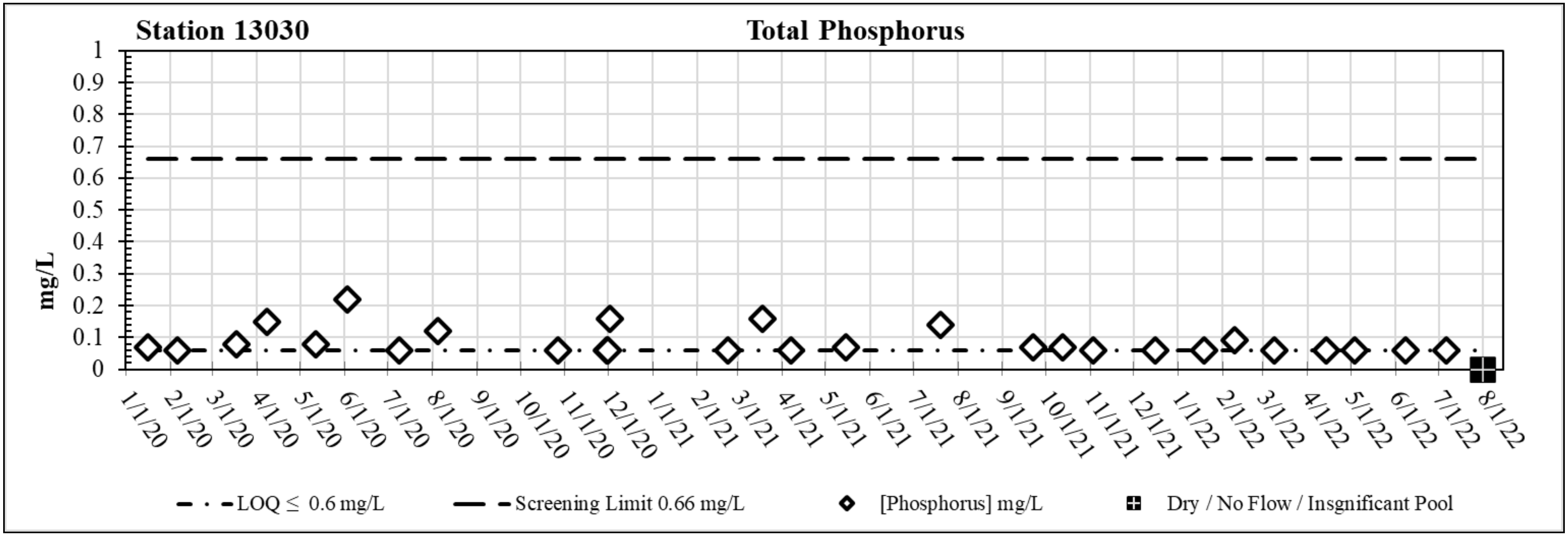

Figure 68. [Total Phosphorus] at Tributary Station 13030

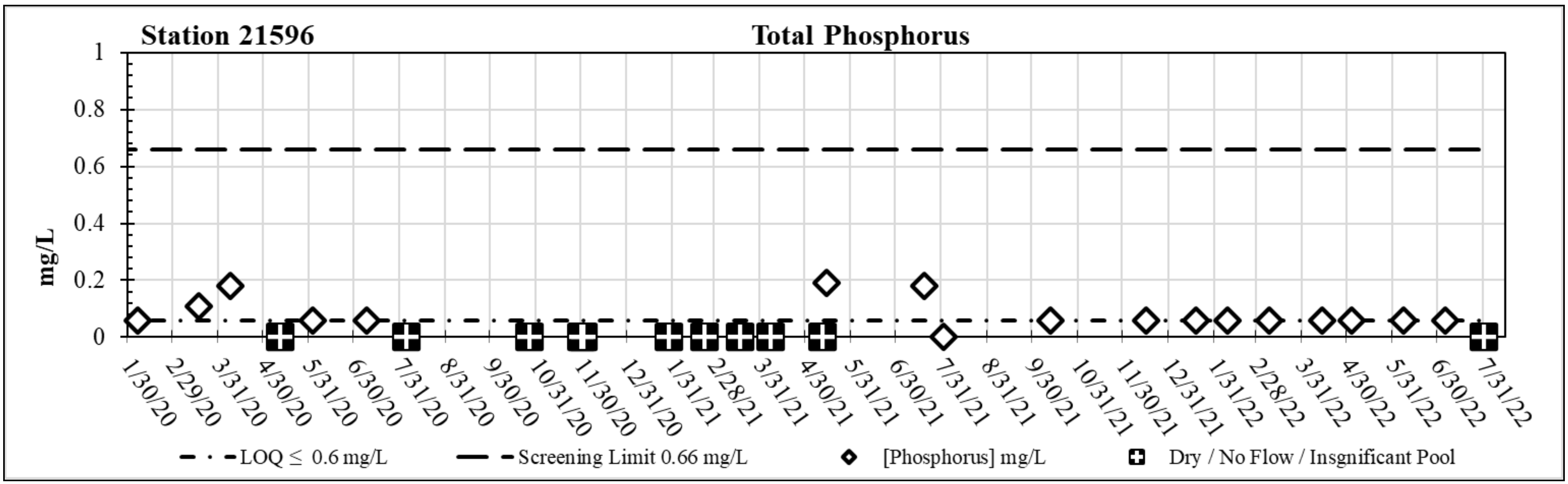

Figure 69. [Total Phosphorus] at Tributary Station 21596

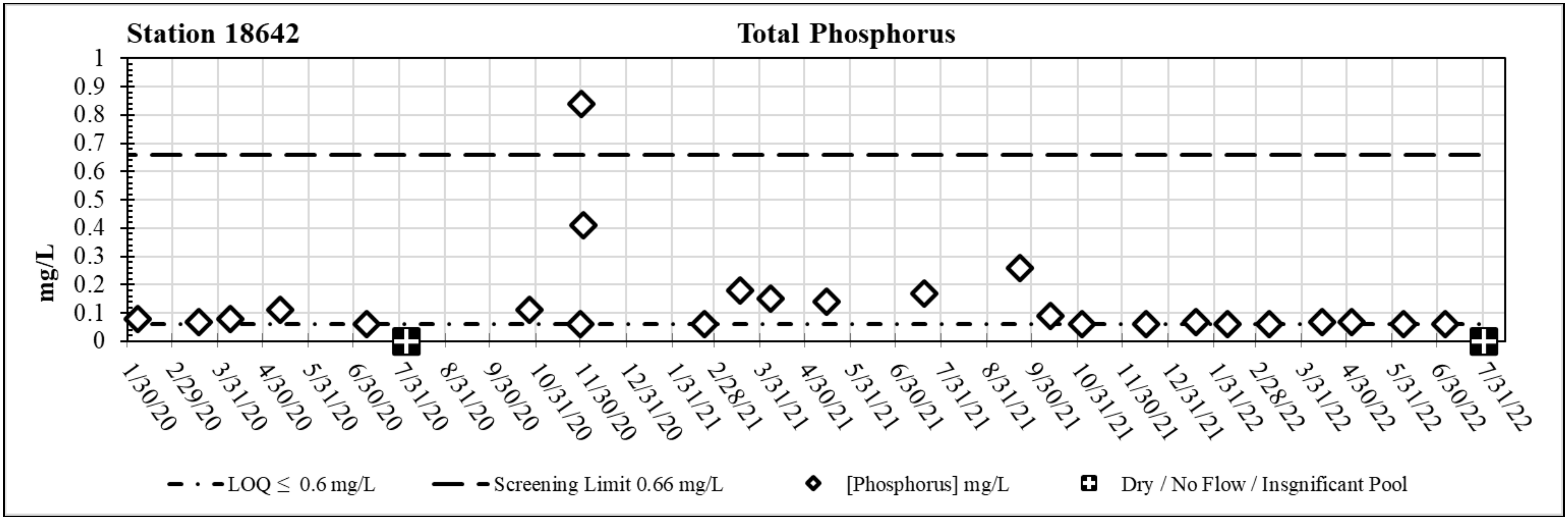

Figure 70. [Total Phosphorus] at Tributary Station 18642

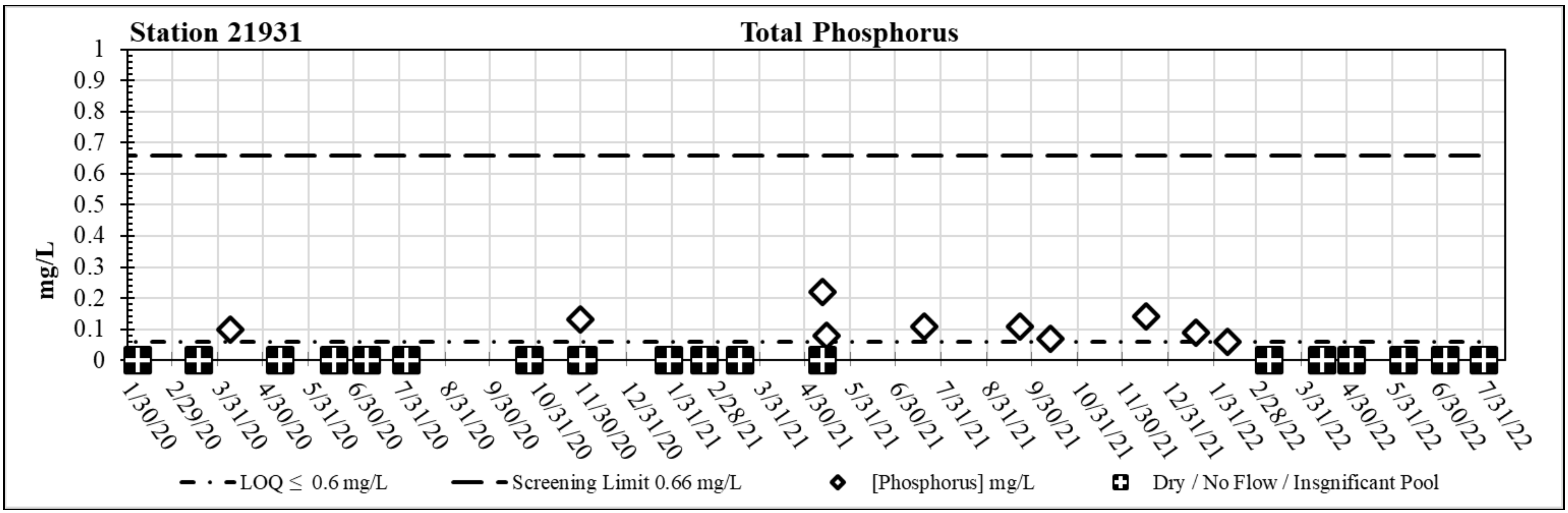

Figure 71. [Total Phosphorus] at Tributary Station 21931

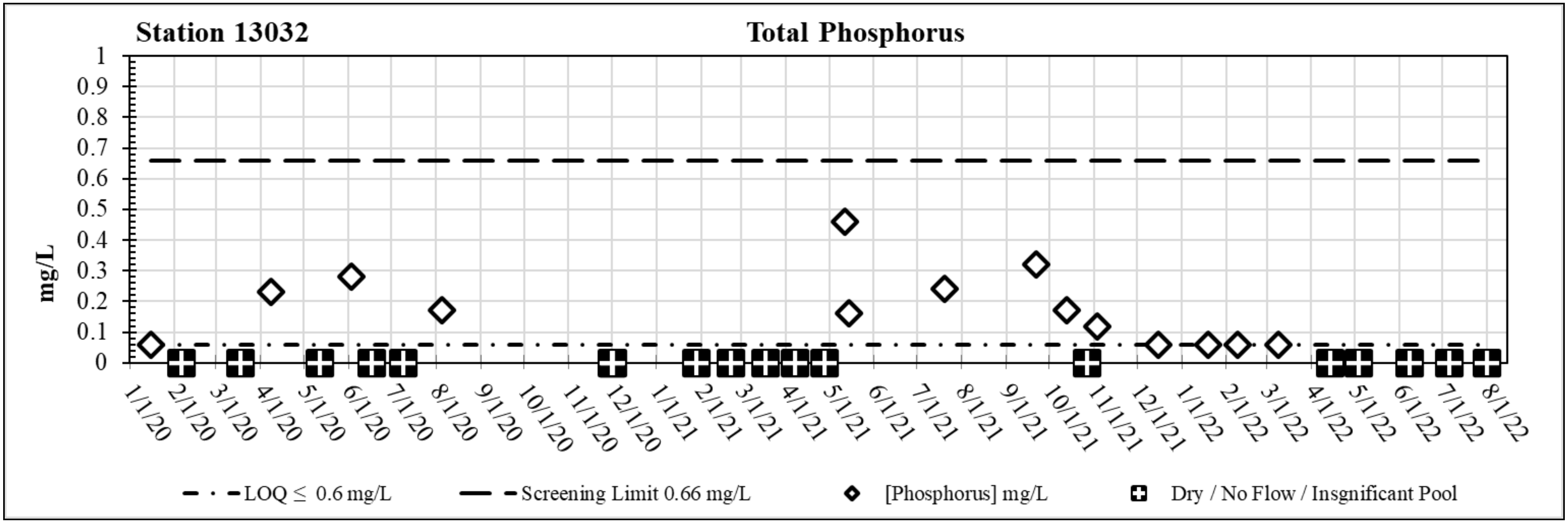

Figure 72. [Total Phosphorus] at Tributary Station 13032

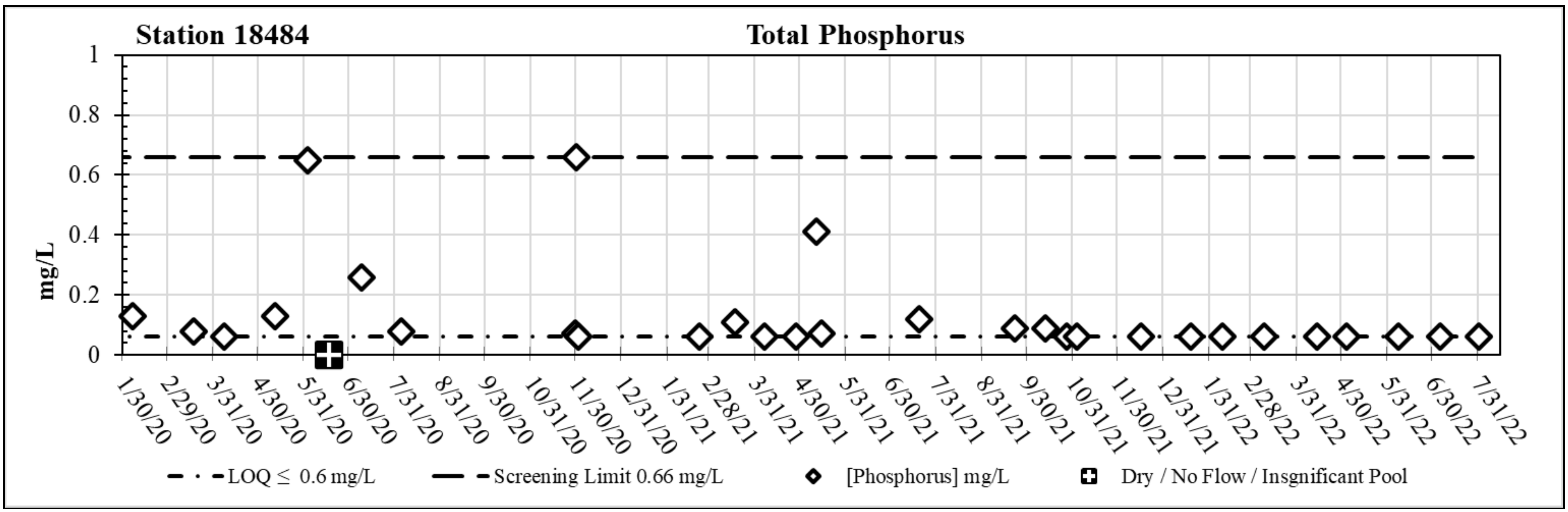

Figure 73. [Total Phosphorus] at Tributary Station 18484

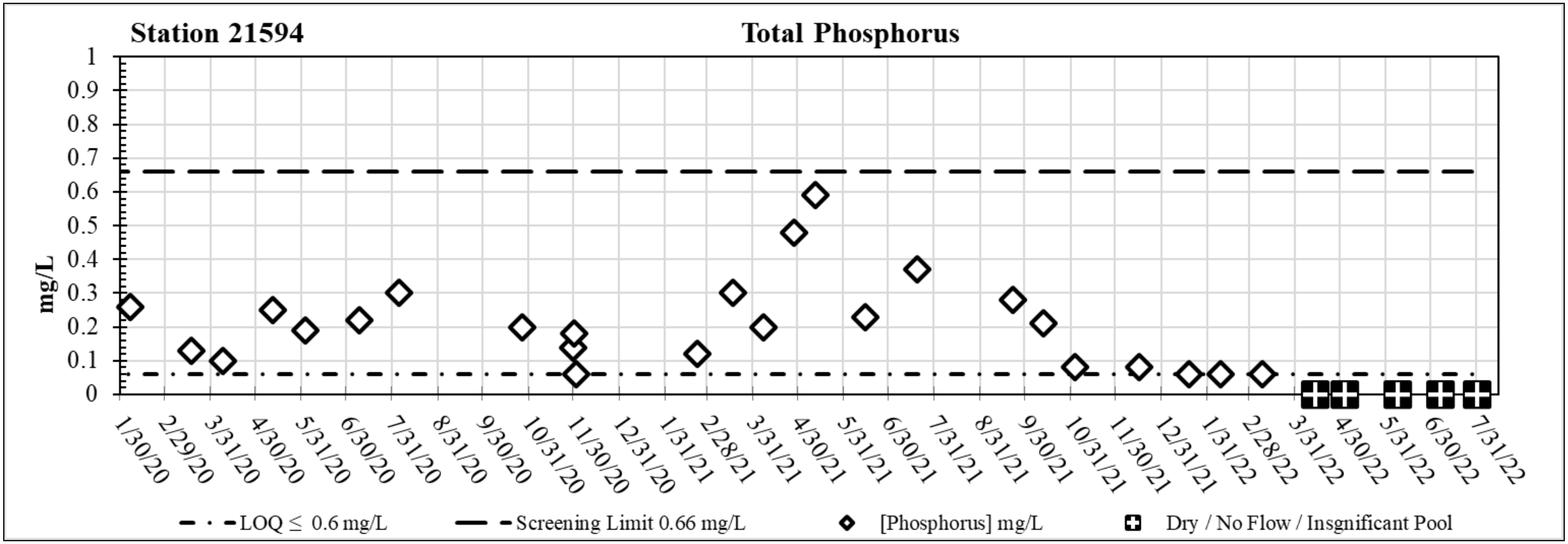

Figure 74. [Total Phosphorus] at Tributary Station 21594

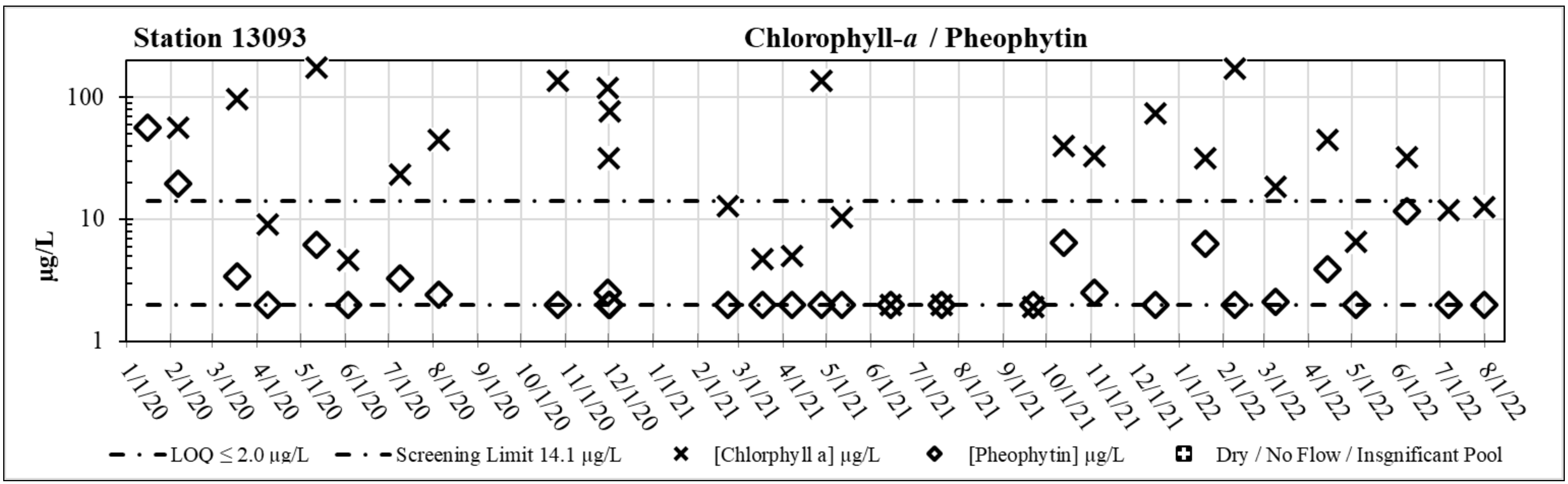

Figure 75. [Chlorophyll-*a*] and [Pheophytin] at Main Stem Station 13093

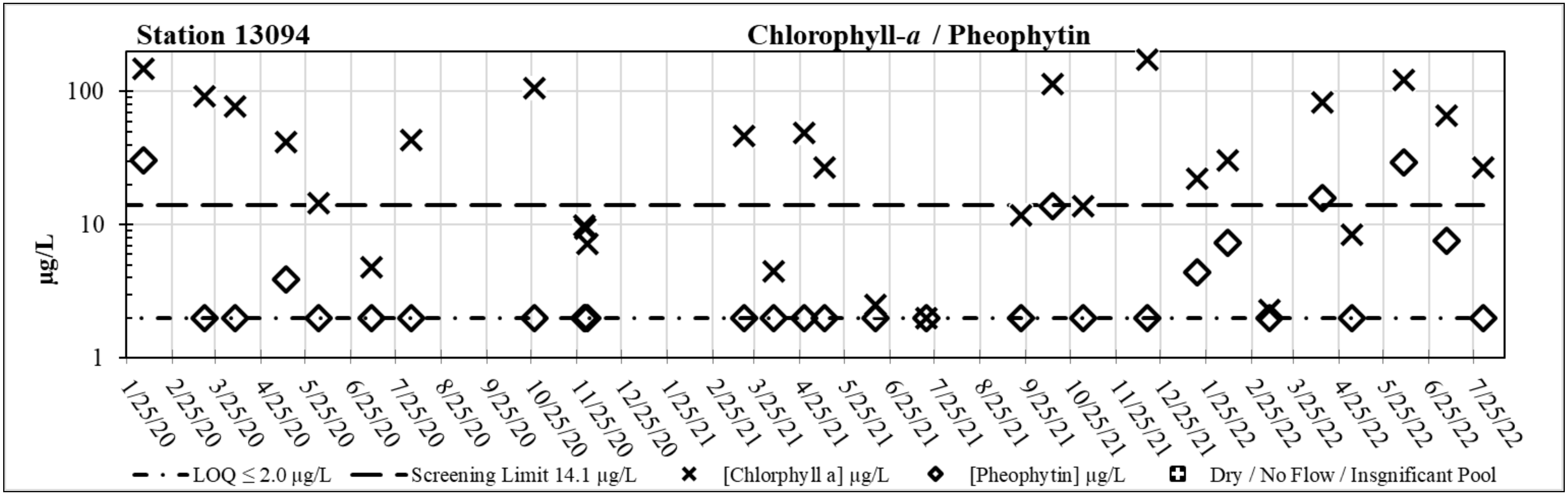

Figure 76. [Chlorophyll-*a*] and [Pheophytin] at Main Stem Station 13094

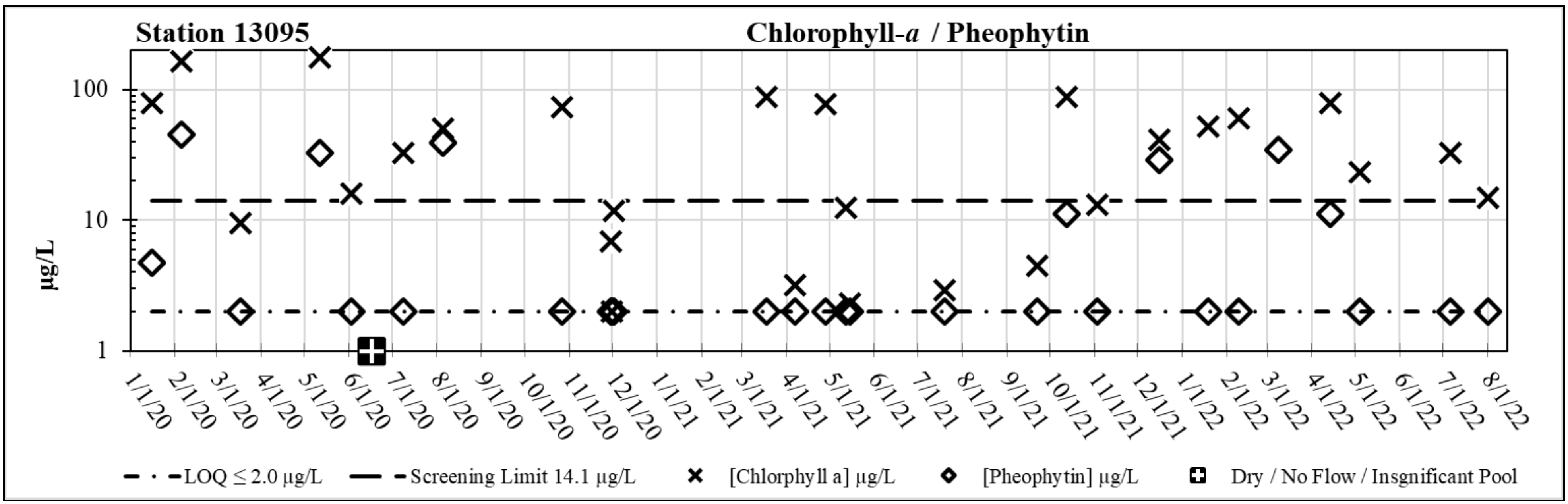

Figure 77. [Chlorophyll-*a*] and [Pheophytin] at Main Stem Station 13095

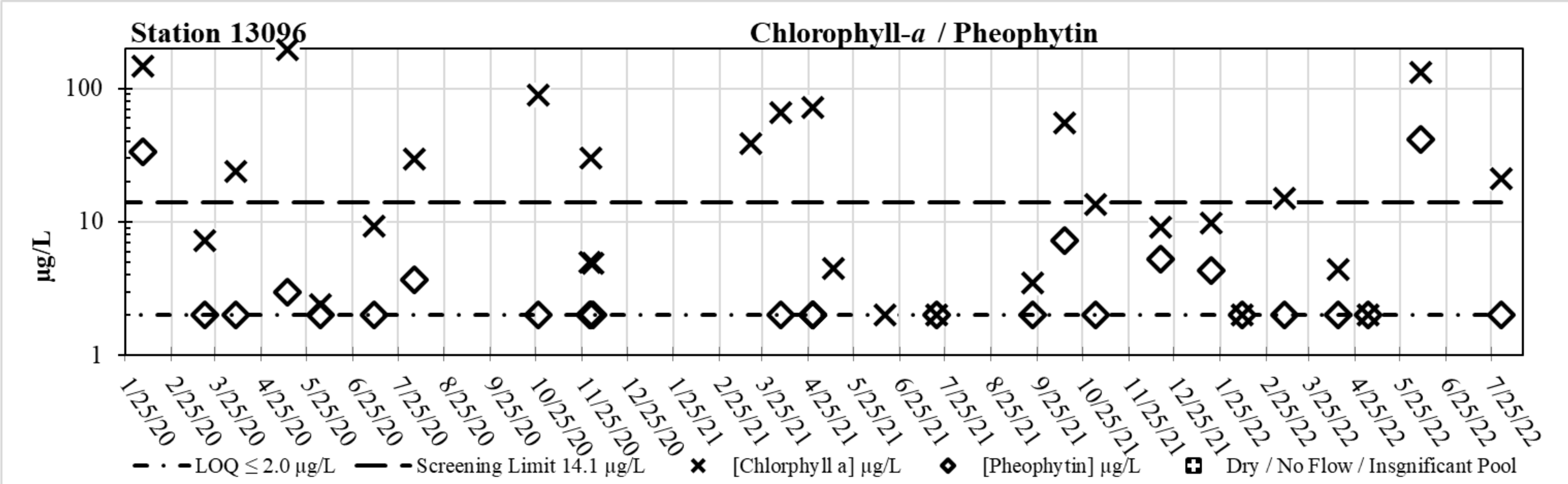

Figure 78. [Chlorophyll-*a*] and [Pheophytin] at Main Stem Station 13096

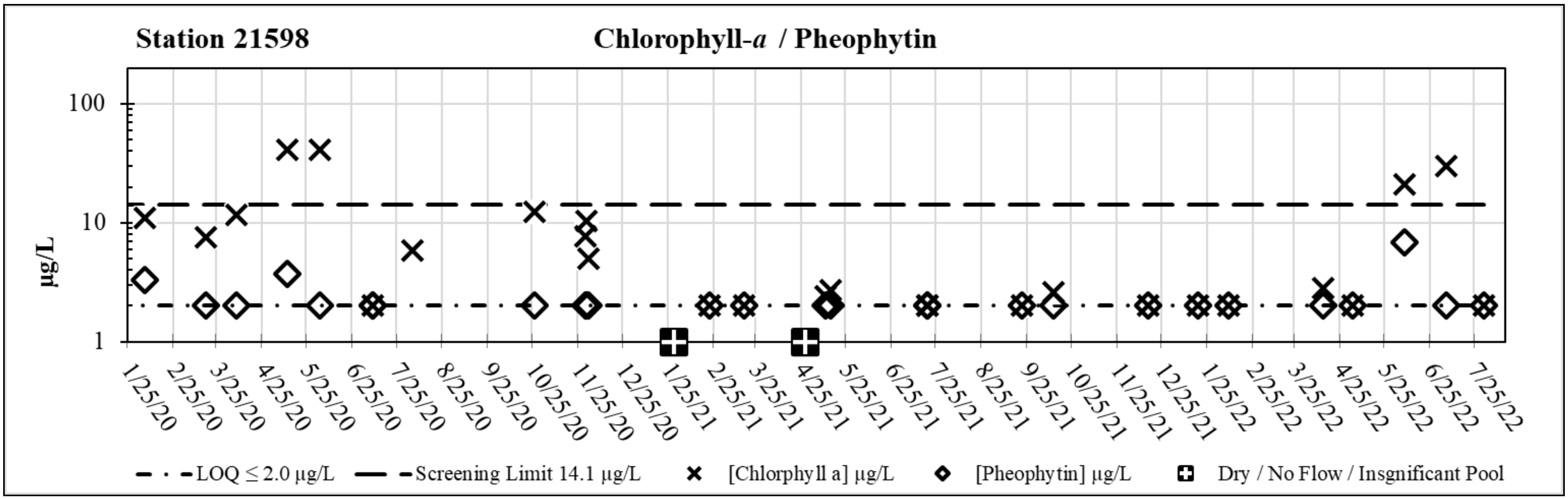

Figure 79. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 21598

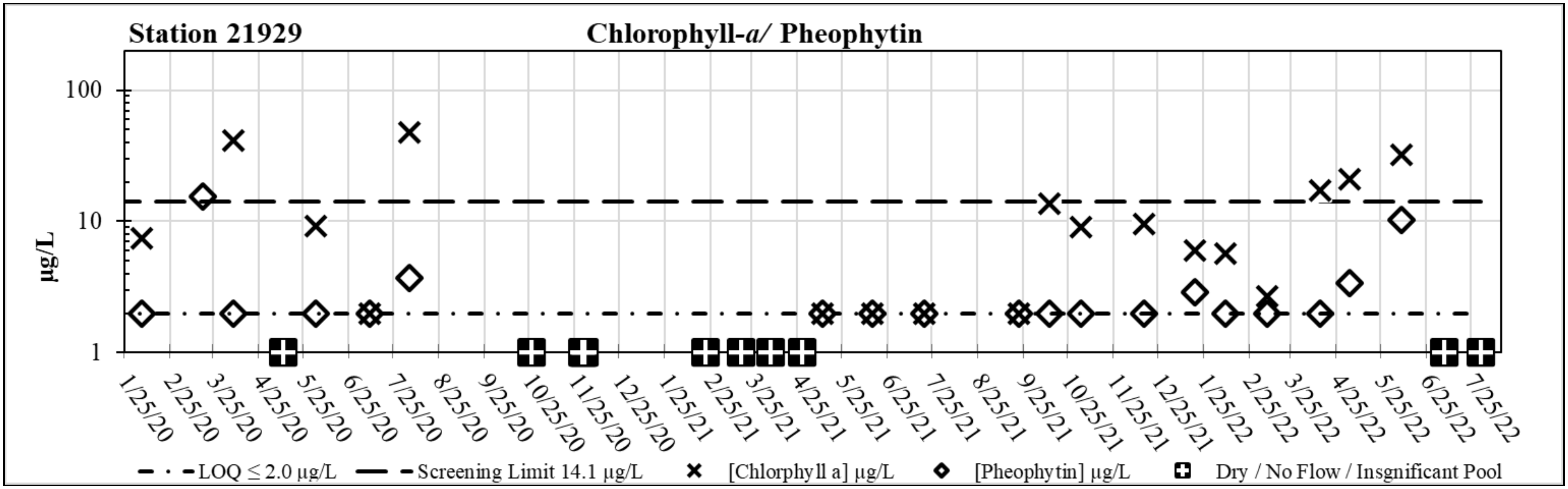

Figure 80. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 21929

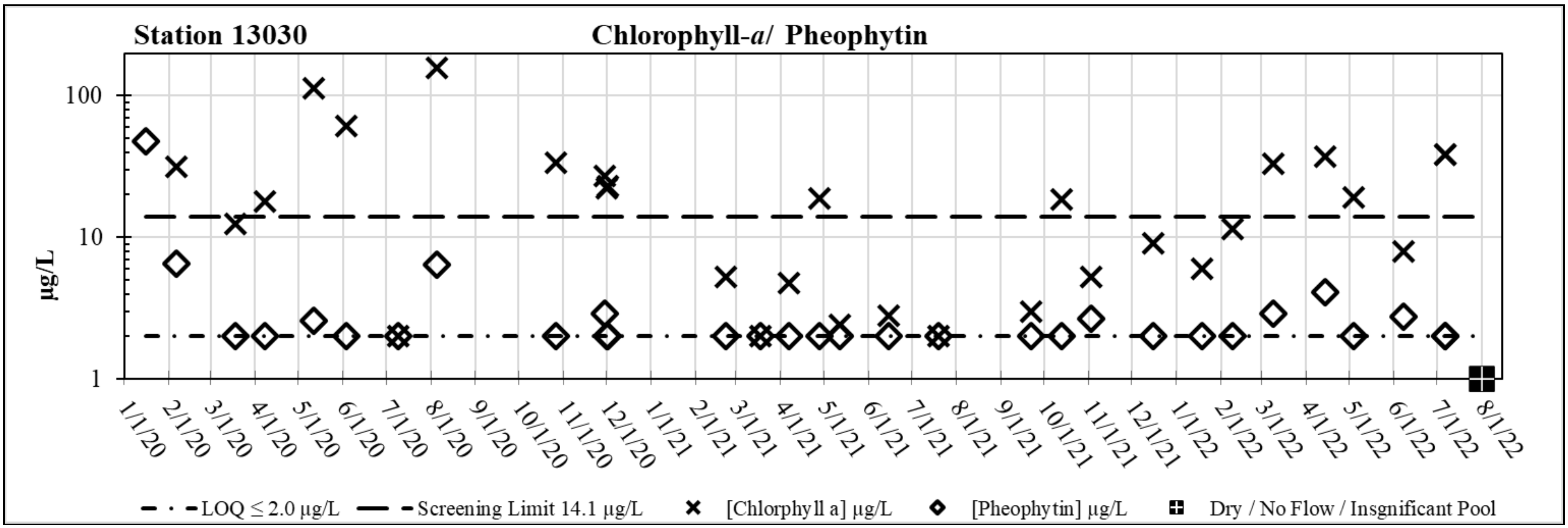

Figure 81. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 13030

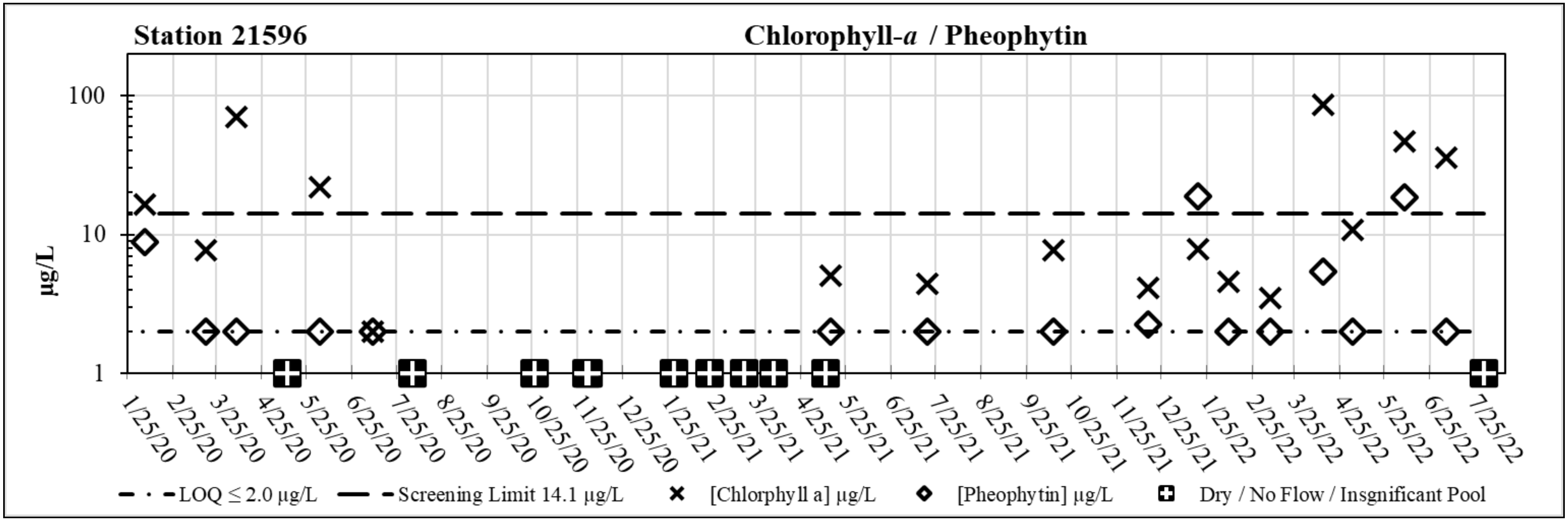

Figure 82. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 21596

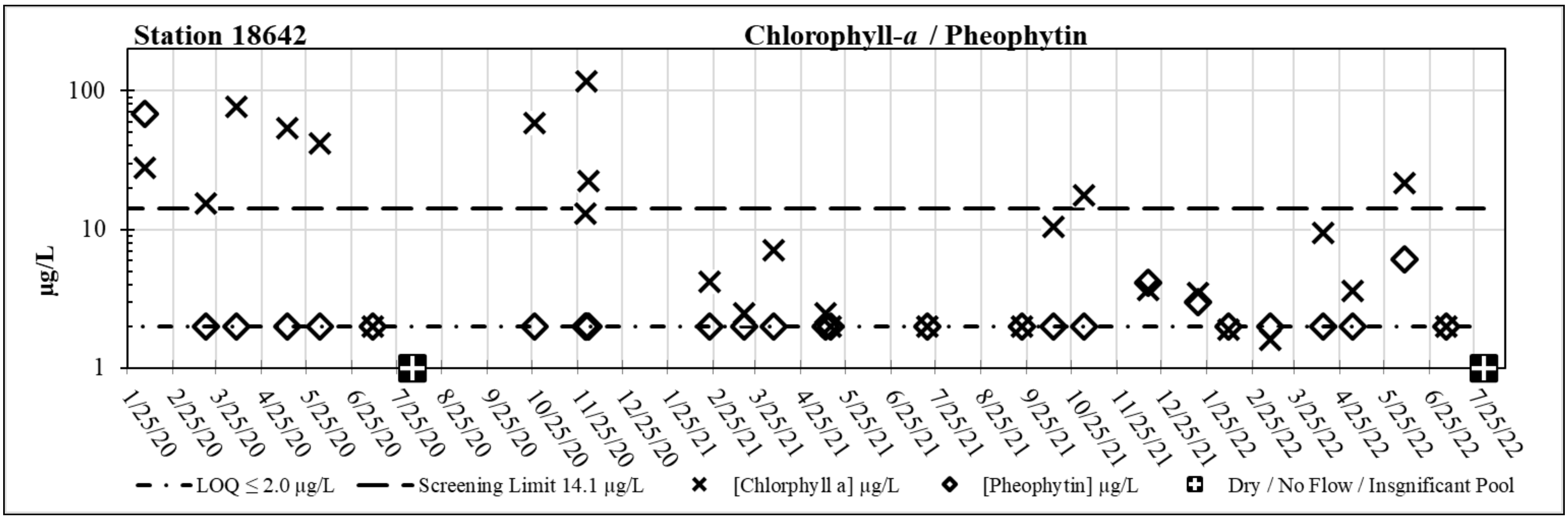

Figure 83. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 18642

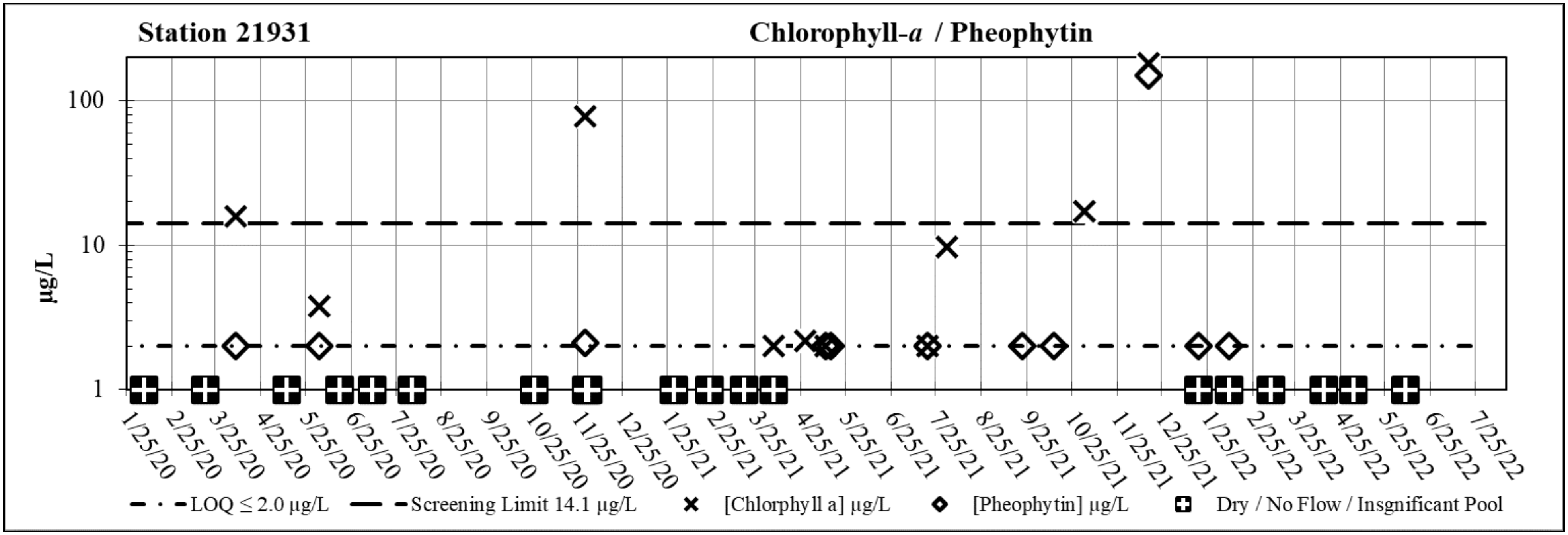

Figure 84. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 21931

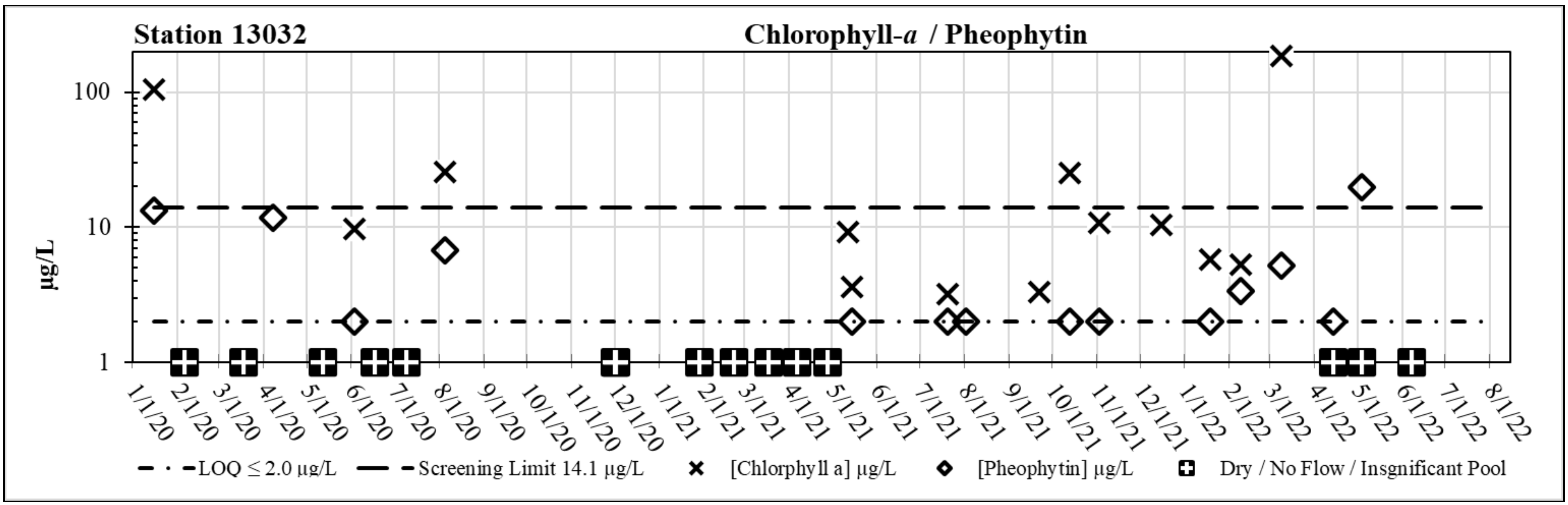

Figure 85. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 13032

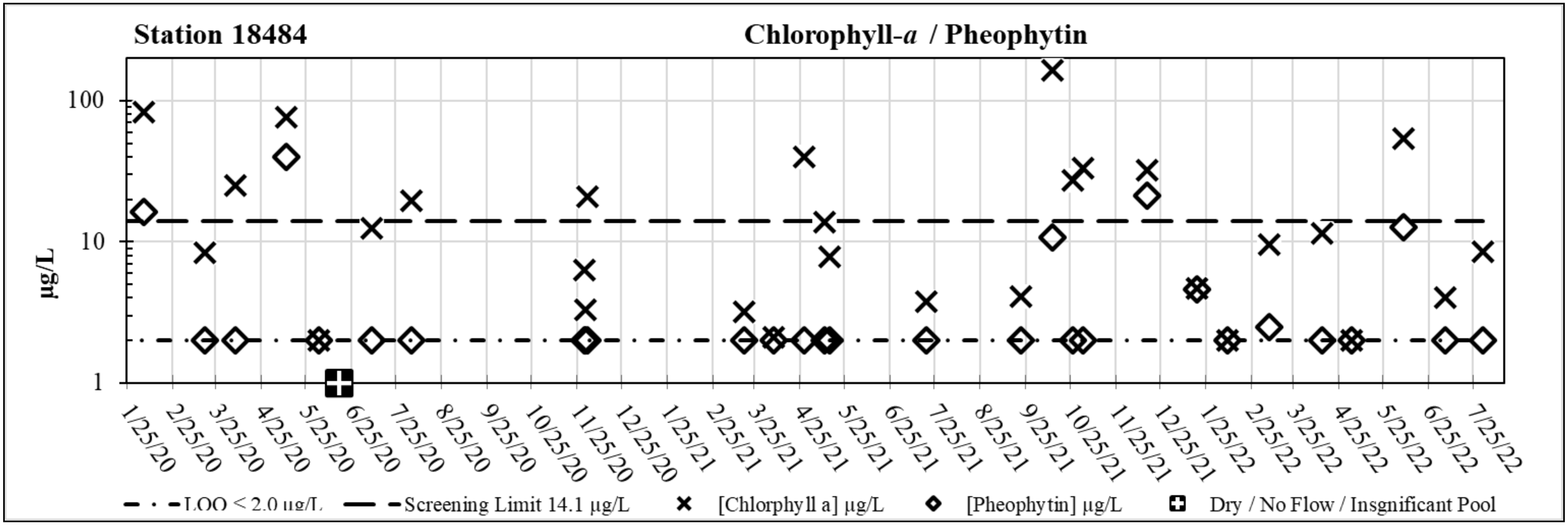

Figure 86. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 18484

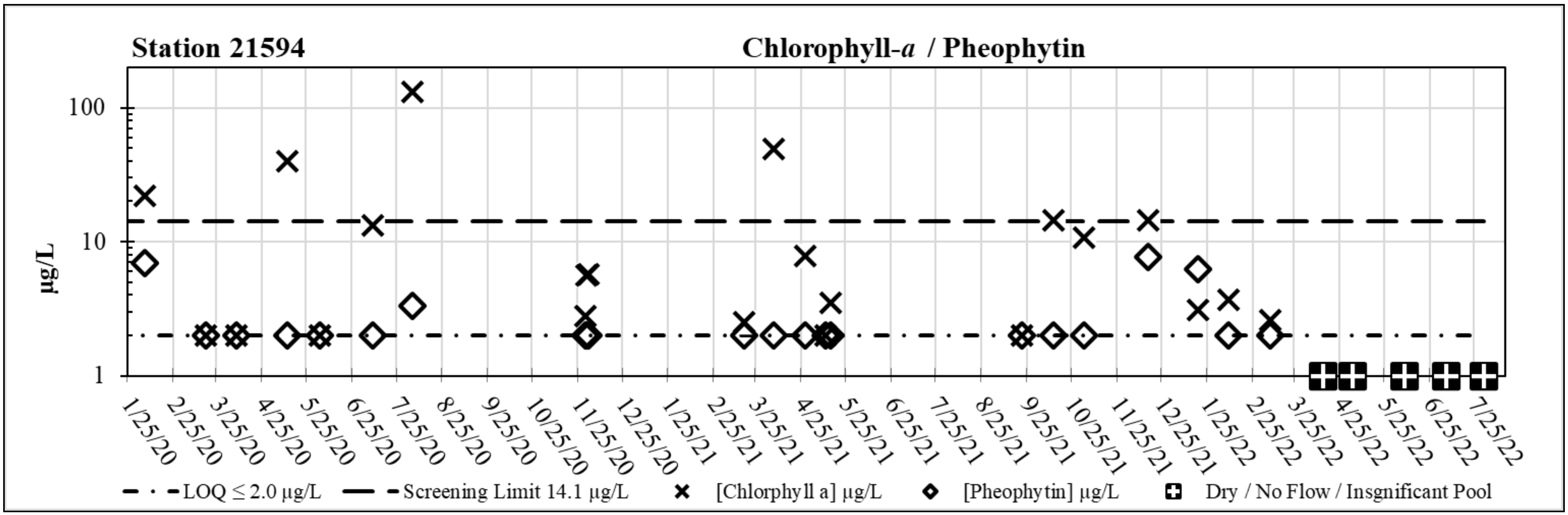

Figure 87. [Chlorophyll-*a*] and [Pheophytin] at Tributary Station 21594

Conclusions

Nutrient inputs to Petronila Creek Above Tidal (TCEQ Segment 2204) come from a variety of permitted and non-permitted sources including wastewater treatment plants (WWTPs), non-point source (NPS) runoff from cropland, groundwater interactions, wildlife and other natural sources.

Permitted sources include eight WWTPs that contribute treated domestic wastewater to Petronila Creek Above Tidal or its tributaries, one of which contributes measurable flow to the study area. The City of Driscoll is permitted to release up to 100,000 gpd of treated effluent upstream of station 13096. A ninth source, US Ecology, is permitted for stormwater effluent only (Appendix B).

Water quality monitoring was typically conducted at base flow conditions for much of the study period. Many of the nutrient parameters analyzed in this report show an extremely wide range of concentrations with results spanning from the limits of quantification to values significantly above their respective screening levels. Episodes of highly elevated nutrient concentrations as well as periods of very low concentrations show varying degrees of seasonality and are summarized below:

Ammonia – Ammonia concentrations were typically very low in the segment ranging from < 0.1 to 0.5 mg/L with 84% of samples being below the LOQ of laboratory equipment. The highest concentrations were often in the spring (March-June). Ammonia concentrations from main stem stations and the tributary stations were very similar with regard to maximum, minimum, and mean concentrations.

The LOQ for ammonia is 0.1 mg/L. The TCEQ screening level is 0.33 mg/L.

Ammonia	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	< 0.1 mg/L	0.4 mg/L	0.116 mg/L
Tributary Stations	< 0.1 mg/L	0.5 mg/L	0.121 mg/L

Nitrate-Nitrogen – Nitrate-Nitrogen concentrations showed significant variability in the segment ranging from < 0.025 to 57.0 mg/L with 32% of samples being below the LOQ of laboratory equipment and 26% of results being above the TCEQ screening level of 1.95 mg/L. The highest concentrations were often in April, September, and November. Nitrate-Nitrogen concentrations from main stem stations and the tributary stations were very similar with regard to maximum, minimum, and mean concentrations.

LOQ for nitrate-nitrogen is 0.025 mg/L. The TCEQ screening level is 1.95 mg/L.

Nitrate - Nitrogen	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	< 0.025 mg/L	22.8 mg/L	2.27 mg/L
Tributary Stations	< 0.025 mg/L	57.0 mg/L	2.69 mg/L

Nitrite-Nitrogen - Nitrite-Nitrogen concentrations showed significant variability in the segment ranging from < 0.02 to 8.64 mg/L with 79% of samples being below the LOQ of laboratory equipment. The four highest concentrations were in April 2021 under low flow conditions (0.5 feet^3/sec) on the main stem of the creek at stations 13093 (8.64 mg/L), 13094 (6.06 mg/L), 13095 (5.3 mg/L), and 13096 (5.12 mg/L). Elevated nitrite-nitrogen concentrations from the April 2021 sampling event were likely attributed to effluent sources from the Driscoll WWTP.

The LOQ for [nitrite-nitrogen] is 0.02 mg/L, however no TCEQ screening level exists for this parameter.

Nitrite-Nitrogen	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	<0.02 mg/L	8.64 mg/L	0.263 mg/L
Tributary Stations	<0.02 mg/L	0.52 mg/L	0.037 mg/L

Dissolved Total Kjedahl Nitrogen (Dissolved TKN) - DTKN concentrations showed significant variability in the segment ranging from < 0.2 to 3.0 mg/L with 4% of samples being below the LOQ of laboratory equipment. The highest concentrations were recorded during the spring (March – June) on the main stem on the tributary stations (0.5 feet^3/sec).

The LOQ for dissolved TKN is 0.2 mg/L, however no TCEQ screening levels exist for this nutrient parameter.

DTKN	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	< 0.2 mg/L	1.8 mg/L	0.808 mg/L
Tributary Stations	< 0.2 mg/L	3.0 mg/L	0.97 mg/L

Total Kjedahl Nitrogen (TKN) – TKN concentrations showed moderate variablility in the segment ranging from < 0.2 to 5.0 mg/L with only 1% of samples being below the LOQ of laboratory equipment. The highest concentrations were often in the spring (March-June). TKN concentrations from main stem stations and the tributary stations were very similar with regard to maximum, minimum, and mean concentrations.

The LOQ for TKN is 0.2 mg/L, however no TCEQ screening levels exist for this nutrient parameter.

TKN	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	0.4 mg/L	5.0 mg/L	1.26 mg/L
Tributary Stations	< 0.2 mg/L	4.6 mg/L	1.23 mg/L

Total Phosphorus (TP) - TP concentrations were typically very low in the segment ranging from < 0.2 to 5.0 mg/L with 40% of samples being below the LOQ of laboratory equipment. The highest concentrations were often in the summer (June-Aug). TP concentrations from main stem stations and the tributary stations were very similar with regard to maximum, minimum, and mean concentrations.

The LOQ for TP is 0.06 mg/L. The TCEQ screening level is 0.69 mg/L.

Total Phosphorus	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	< 0.06 mg/L	4.75 mg/L	0.302 mg/L
Tributary Stations	< 0.06 mg/L	3.21 mg/L	0.283 mg/L

Chlorophyll-*a* – Chlorophyll-*a* concentrations were highly variable in the segment ranging from < 2.0 to 800.8 µg/L with 12% of samples being below the LOQ of laboratory equipment. The highest concentrations were in the winter (January - March). Chlorophyll-*a* concentrations from main stem stations and the tributary stations were very similar with regard to maximum, minimum, and mean concentrations.

The LOQ for Chlorophyl-*a* is 2.0 µg/L. The TCEQ screening level is 14.1 µg/L.

Chlorophyll-*a*	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	< 2.0 µg/L	385.3 µg/L	52.0 µg/L
Tributary Stations	< 2.0 µg/L	800.8 µg/L	46.2 µg/L

Pheophytin - Pheophytin concentrations were typically in the segment ranging from < 2.0 to 67.8 µg/L with 55% of samples being below the LOQ of laboratory equipment. The highest concentrations were in the winter (January - March). Pheophytin concentrations from main stem stations and the tributary stations were similar with regard to maximum, minimum, and mean concentrations.

The LOQ for Pheophytin is 2.0 µg/L, however no TCEQ screening levels exist for this nutrient parameter.

Pheophytin	**[Minimum]**	**[Maximum]**	**[Mean]**
Main Stem Stations	< 2.0 µg/L	56.5 µg/L	18.5 µg/L
Tributary Stations	< 2.0 µg/L	67.8 µg/L	13.7 µg/L

Recommendations

To adequately quantify the spacial and temporal contribution of nutrient inputs to Petronila Creek Above Tidal (TCEQ Segment 2204), nutrient data collection in the watershed is recommended to continue to further assess hydrologic and climactic variability effects on water quality.

Appendix A

Photographs of Monitoring Stations

Station 21929 – Unnamed Tributary @ FM 70

Downstream view at Station 21929

Station 21958 – Unnamed Tributary @ FM 70

Upstream view at Station 21958

Widgeon grass (*Ruppia maritima)* at Station 21598

Station 13030 – Unnamed Tributary @ FM 70

Upstream view at Station 13030

Downstream view at Station 13030

Station 13093 – Petronila Creek @ FM 70

Upstream view at Station 13093

Downstream view at Station 13093

Station 21596 – Unnamed Tributary @ FM 892

Upstream view at Station 21596

Downstream view at Station 21596

Station 18642 – Unnamed Tributary @ FM 892

Upstream view at Station 18642

Downstream view at Station 18642

Station 13094 – Petronila Creek @ FM 892

Upstream view at Station 13094

Downstream view at Station 13094

Station 21931 – Unnamed Tributary @ FM 3354

Upstream view at Station 21931

Downstream view at Station 21931

Station 13095 - Petronila Creek @ CR 232


Upstream view at Station 13095


Downstream view at Station 13095

Station 13032 – Unnamed Tributary @ CR 18 & CR 75

Water clarity measurement at Station 13032

Downstream view at Station 13032

Station 13096 – Petronila Creek @ FM 665

Downstream view at Station 13096

Station 18484 – Petronila Creek @ CR 24

Upstream view at Station 18484

Downstream view at Station 18484

Station 21594 – Petronila Creek @ CR 233

Upstream view at Station 21594

Downstream view at Station 21594

Appendix B

Wastewater Discharge Permit Information

2204 Petronila Creek Above Tidal

#1. WQ0010592-001 – City of Orange Grove: <200,000 gpd treated domestic wastewater via Agua Dulce Creek

#2. WQ0010140-001 – City of Agua Dulce: <160,000 gpd treated domestic wastewater via Agua Dulce Creek

#3. WQ0011583-002 – Nueces County WCID #5: <100,000 gpd treated domestic wastewater via Banquete Creek

#4. WQ0014802-001 – Geo Group: <150,000 gpd treated domestic wastewater via drainage ditch

#5. WQ0014981-001 – International Education Services: <9,000 gpd treated domestic wastewater via drainage ditch

#6. WQ0011541-001 – City of Driscoll: <100,000 gpd treated domestic wastewater via Petronila Creek

#7. WQ0002888-000 – US Ecology Texas: storm water via Nueces County drainage ditch

#8. WQ0011689-001 – Coastal Bend Youth City: <15,000 gpd treated domestic wastewater via unnamed ditch

#9. WQ0011754-001 – Bishop Consolidated ISD: <8,000 gpd treated domestic wastewater via drainage ditch