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TECHNICAL MEMORANDUM NO. 08-027.02

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DATE: June 30, 2023

SUBJECT: Dublin Watershed Protection Plan, 2022 Annual Progress
 Report for the Dublin Water Pollution Control Plant,
 NPDES permit No. GA0025569

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1.0 INTRODUCTION

The city of Dublin is in Laurens County and located in the Coastal Plain physiographic region of central Georgia, within the Altamaha River Basin (HUC 030701; Figure 1). The jurisdictional city limits of Dublin encompass an area of approximately 16.1 square miles. The Dublin Water Pollution Control Plant (WPCP) service area covers approximately 44.5 square miles and includes the entirety of the city and surrounding area located outside the city limits. The Dublin WPCP is currently permitted to discharge up to 6.0 million gallons per day (MGD) into the Oconee River, in the Lower Oconee sub-basin (HUC 03070102), under National Pollution Discharge Elimination System (NPDES) permit GA0025569.

Pursuant to the NPDES permit requirements, a Watershed Assessment (WA) was completed for the Dublin WPCP in 2012, revised in 2013, and a Watershed Protection Plan (WPP) based on the results of the WA was developed in 2013. Updates to the 2013 WPP have occurred in 2016 and in 2019. The most recent Dublin WPP was approved by the Georgia Environmental Protection Division (EPD) in February 2020. WPP implementation began in January 2021. This annual status report presents the results of WPP implementation completed between January 1 and December 31, 2022, including best management practices (BMPs), water quality monitoring results, and any emerging long-term water quality monitoring trends.

2.0 WATERSHED PROTECTION PLAN IMPLEMENTATION

2.1 Water Resource Management and Best Management Practices

The city of Dublin, in conjunction with Nutter & Associates, Inc. (NAI) and Thomas and Hutton, coordinated the implementation of the WPP. Specifically, meetings between city representatives and NAI were conducted in 2019 to begin planning the implementation of the WPP. Implementation of both structural and non-structural best management practices (BMPs), as identified in the January 2020 WPP, and routine water quality monitoring began in January 2021 and will continue to be conducted on an annual basis. As specified in Sections 4.0 and 7.0 of the updated WPP, several structural and non-structural BMPs were developed by the City of Dublin. City personnel and resources are being allocated to manage several of the BMP measures outlined in the WPP. The details of the on-going implementation measures are summarized below.

2.1.1 Structural BMPs

The city has contracted with engineering firm Thomas and Hutton to develop a stormwater ordinance. Thomas and Hutton is finishing up the work on the new storm drain ordinance, and the city hopes to have it approved by City Council soon. Additionally, the city is currently evaluating the feasibility of implementing a city-wide stormwater utility but has not yet made a decision to move forward. The city continues to monitor and assess the need for sanitary and stormwater infrastructure maintenance, inspection, and rehabilitation. Several reaches of existing sanitary sewer line are being replaced and rehabilitated on an “as needed” basis. As a part of the rehabilitation, the city is actively conducting an inventory of the existing stormwater and wastewater infrastructure and, as time permits, geolocating existing sewer and storm infrastructure and adding them to a new mapping platform. Any new sewer and storm infrastructure installed is surveyed and placed on the geothinQ GIS mapping system. Existing sewer and storm infrastructure is mapped by an as-needed and time-available process. Several sewer line projects to eliminate inflow and infiltration have been added to the proposed SPLOST project list.

A sewer main extension has been completed for the new RaceTrac convenience store located at the corner of US 441 South and Pinehill Road. A new sewer main was also extended to the True North apartment complex at the corner of Hillcrest Parkway and Claxton Dairy. These improvements account for the addition of several manholes and several hundred feet of 8-inch diameter PVC main. The city is in the process of designing a sewer line replacement project that is funded through a U.S. Economic Development Administration grant with matching funds provided by a Georgia Environmental Finance Authority loan. The project will involve the replacement of 1970s-era 12-inch terra cotta sewer line and brick manholes with new 18-inch PVC sewer pipe and precast concrete manholes.

As part of its litter reduction initiative, the city currently offers sanitary waste service, recycling, and bulk item disposal for all commercial and residential areas within the city. The Dublin Sanitation Department offers curbside recycling. Keep Dublin-Laurens Beautiful (KDLB) is an affiliate group of Keep America Beautiful, which focuses on litter reduction, beautification, and recycling. KDLB exists to educate the community about the importance of recycling and the benefits of living in a litter-free area. The KDLB committee is no longer funded by the city but continues to coordinate annual neighborhood as well as Oconee River clean up events.

2.1.2 Non-structural BMPs

Dublin currently operates as a Local Issuing Authority (LIA), with one person each certified as either Level 1A, 1B, and II. The Dublin LIA ensures that land disturbing activities do not result in excessive soil erosion and sedimentation and that the general provisions, minimum requirements, and BMPs required by the NPDES General Permit(s) for construction activities are met. The LIA is also responsible for ensuring developments undergoing land-disturbing activities have acquired the proper permits and have met the minimum erosion, sediment, and pollution control plan requirements. The LIA reviews erosion control plans to ensure they are properly designed in accordance with the provisions and requirements of the General Permit(s) and the *Georgia Manual for Erosion and Sediment Control*. Additionally, the LIA conducts regular site inspections and permit enforcement in accordance with the local municipal code and the NPDES General Permit(s).

2.1.3 Community Outreach

The city of Dublin currently has an established public outreach and education program that publishes fliers, information, and materials on environmentally related topics. Publicly distributed information includes septic system maintenance, importance of stream buffers, litter reduction, importance of recycling, water conservation methods and tips, natural resource protection, and education. Free materials are available to residents that promote water use efficiency. As a part of the WPP, the city of Dublin will continue to provide environmental education and public outreach to City and County residents. Finally, the city also advertises its recycling program as part of its public outreach and education program.

2.2 Long-term Water Quality Monitoring

Six monitoring stations are located on primary stream drainages within the Dublin WPCP service area as part of the long-term monitoring requirements outlined in the 2020 WPP (Table 1; Figure 2). However, following the 2021 monitoring period, station UTS01 was removed from the WPP long-term monitoring requirements, because the station is located within a swampy, braided portion of the stream that may be affected by beaver activity. The stream is in close proximity to the Oconee River floodplain and is surrounded by private property, and an alternative sampling location on this tributary is not available. Based on this change, long-term water quality monitoring is now conducted at five stations within the Dublin WPCP service area.

Water quality, bacteriological, and bioassessment monitoring was conducted at these five stations by Nutter & Associates, Inc (NAI) in 2022. Specifically, three dry weather and one wet

weather water quality monitoring events are to be conducted annually. Two series of bacteriological sampling, to constitute two annual geometric determinations for *Escherichia coli* bacteria, are to be conducted between May and October. Biological monitoring (bioassessments) of the benthic macroinvertebrate and fish communities shall be conducted at least twice within every five-year period and shall not be performed in consecutive years.

The long-term monitoring stations for the Dublin WPP are located in the Atlantic Southern loam plains (65I) Level IV ecoregion and the Altamaha River drainage basin (HUC 030701). Monitoring station location details and WPP long-term monitoring requirements at each station are summarized in Table 1 below.

Table 1. Location information and monitoring requirements for each long-term monitoring station for the Dublin WPP.

Station ID	Site description	Latitude	Longitude	Watershed area	Monitoring parameters
		DD		sq. mi.	
DC01	Dublin Creek at South Decatur Street	32.537804	-82.898086	1.51	Water Quality only
FC01	Fords Creek at US 80	32.544133	-82.962409	9.50	Water Quality and Biology
HHC02	Hunger and Hardship Creek at East Mary Street	32.554264	-82.901653	26.3	Water Quality only
LC01	Long Branch at Riverview Park Drive	32.517863	-82.891951	5.31	Water Quality and Biology
UTN01	Unnamed Tributary at Bainbridge Street	32.544555	-82.900095	0.81	Water Quality only

2.2.1 2022 Water Quality Monitoring

During the 2022 monitoring period, three dry weather events, one wet weather event, and two bacteriological series events were completed by NAI personnel (Table 2). All laboratory sample analysis followed EPD guidance and U.S. Environmental Protection Agency (EPA) testing methods (Table 3). Dry weather events for 2022 were conducted on March 29th, June 23rd, and October 10th. The wet weather event was conducted on October 12th, when 2.00 inches of rain

were recorded on the day of sampling at the Dublin Water Pollution Control Plant, the closest location with reliable daily precipitation data (Table 4). The two bacteriological geometric mean determinations were completed between May 19th and June 9th and between June 16th and July 7th. Macroinvertebrate and fish community bioassessments were last completed in 2021 and are next scheduled to be completed in 2023. Photos of the sampling location conditions during each sampling event are included on a USB drive submitted with this report. The following sections detail the results of 2022 water quality and biological monitoring.

2.2.1.1 *In situ* Water Quality

During 2022 monitoring, water and air temperature, specific conductivity, salinity, dissolved oxygen (DO), pH, and turbidity were measured *in situ* at all stations during the dry weather, wet weather, and bacteriological sampling events (Table 5). Eight events occurred between May and September, when critical conditions such as high water temperature and low DO typically happen more frequently. Air and water temperatures, salinity, and pH throughout 2022 were similar at all stations and met applicable Georgia water quality standards (Table 3). Specific conductivity measurements were slightly higher at stations DC01 and UTN01, where the majority of land cover is classified as medium-high or low intensity developed land. Average DO measurements were slightly lower at station FC01, but DO concentrations were above the Georgia water quality standard of 4.0 mg/L for all 2022 events. Turbidity was higher at station UTN01 when compared to all other stations. The increased turbidity at this station is most likely due to increased stormwater runoff from the impervious surfaces within the UTN01 watershed during the October wet weather event.

2.2.1.2 Analytical Water Quality

During 2022 monitoring, water samples collected during dry and wet weather events were analyzed for five-day biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH₃), nitrate-nitrogen (NO₃), nitrite-nitrogen (NO₂), total phosphorus, orthophosphate, total suspended solids (TSS), and total hardness (Table 6). Throughout this report, when any sample result was below the minimum laboratory detection limits (MDL), the detection limit is reported with an appropriate qualifier.

BOD₅ was measured to be consistently higher during the wet weather event at all stations while most other BOD₅ concentrations were below detection limits. COD was also highest at each station during the wet weather event, while the COD measurements during dry weather events show some variability but were typically below or near the laboratory MDL. During the wet weather event, COD at station UTN01 was markedly higher than other stations. Elevated COD in

surface waters during wet weather is often associated with stormwater runoff, and common sources of elevated COD from stormwater include antifreeze and emulsified oils from roadways.

TKN concentrations were highest at each station during the wet weather event, and concentrations were highest overall at station UTN01. Nitrate concentrations were variable and tended to be lowest during the wet weather event, but the samples were out of hold time. All nitrite measurements were below detection limits except for two during the third dry weather event at stations LC01 and UTN01. Total phosphorus was highest at each station during the wet weather event, and highest at station UTN01, which is likely due to transported sediments. Soil erosion is a major contributor of phosphorus in streams, while other sources could include fertilizers, animal wastes, and wastewater from sewage or industrial facilities.

TSS was higher at each station during the wet weather event and highest at station UTN01. High COD concentrations coupled with high TSS and turbidity during the wet weather event at UTN01 may indicate the presence of hydrocarbons and/or other pollutants, including excess sediments, flushing into the stream in stormwater runoff. The watershed of station UTN01 is highly urbanized, and potential sources of nonpoint source sediment and nutrient pollution in urbanized watersheds (with their corresponding high percentages of impervious surfaces) include erosion of the stream channel from high stormwater volumes, additions of oil, grease, and chemicals from motor vehicles, and influx of pesticides and fertilizers from lawns and gardens.

2.2.1.3 Total Recoverable and Calculated Dissolved Metals

Total recoverable cadmium, copper, lead, and zinc were measured in samples collected during the three dry weather events as well as the wet weather event (Table 7). Dissolved metals were calculated from total recoverable concentrations using formulas developed by EPA. Total recoverable cadmium, copper, and lead were near or below the laboratory method detection limits, except for total copper and lead during the third dry weather event at stations DC01, FC01, and UTN01. Among all the stations, total recoverable zinc was highest during the third 2022 dry weather event. When above MDLs, total recoverable metal concentrations were typically higher among all stations during the 2022 wet weather event compared to the dry weather events.

Calculated dissolved concentrations were compared to hardness-based acute and chronic criteria specified in GA Code 391-3-6-03 Water Use Classifications and water quality standards (Table 8). Calculated dissolved cadmium and copper exceeded EPD acute and chronic criteria at

station FC01 during the first dry weather event, but neither are not considered an exceedance, as the total recoverable result was below the laboratory MDL. Similarly, the calculated dissolved cadmium exceeded EPD acute and chronic criteria at stations LC01 and UTN01 during the wet weather event, but these are not considered exceedances, since the total recoverable cadmium was below the laboratory MDL. Lastly, dissolved lead concentrations exceeded EPD chronic criteria at stations DC01 and UTN01 during the wet weather event. Detectable lead wet weather concentrations at stations DC01 and UTN01 were likely the result of metals being transported with sediment particles, as evidenced by the high TSS concentration and turbidity collected during the same sampling event. Potential sources of heavy metals from nonpoint sources in urban watersheds include sediment, roof shingles, motor vehicles, and improperly disposed appliances and other waste.

2.2.1.4 Bacteriological Sampling

Two bacteriological geomean sampling events consisting of four individual samples each were conducted in 2022, and each sample was analyzed for *E. coli* bacteria concentrations. The first 2022 geomean was calculated from four individual samples collected by NAI between May 19 and June 9, 2022, and the second geomean was calculated from four samples collected between June 16 and July 7, 2022 (Table 9). The Georgia State Water Quality Standards (approved August 2022) specify that *E. coli* concentrations, calculated as a geometric mean of four independent samples, shall not exceed 126 counts per 100 mL for May to October and 630 counts per 100 mL for November to April, as based on a 30-day geomean. (Note that EPD standards and laboratory reporting inconsistently use units of MPN or CFU, and these are treated as interchangeable herein).

The Georgia water quality standard of 126 counts per 100 mL was exceeded during the first 2022 geometric mean event at stations DC01 (452 counts per 100 mL), FC01 (133 counts per 100 mL), LC01 (578 counts per 100 mL), and UTN01 (973 counts per 100 mL). Significant precipitation occurred in the seven days preceding three of the sample events during the first series, which could have impacted *E. coli* concentrations. The Georgia water quality standard was exceeded during the second geometric mean sampling event at stations DC01 (759 counts per 100 mL), FC01 (172 counts per 100 mL), HHC02 (163 counts per 100 mL), and UTN01 (592 counts per 100 mL). Significant precipitation occurred preceding the last sampling event in the second series, which could have impacted *E. coli* concentrations in the second geomean. Stations DC01 and UTN01 exhibit higher 2022 geomeans than other stations, and this can be attributed to the large percentage of impervious and developed land cover in their contributing watersheds. The most common potential sources of excess *E. coli* in urban areas include stormwater runoff, leaking sewer infrastructure, pet waste, urban wildlife feces, or the

resuspension of *E. coli* bacteria into the water column that is attached to sediments. Bacteria geomeans for Dublin monitoring stations suggest nonpoint source runoff of bacteria is a significant water quality concern for service area streams.

3.0 LONG-TERM WATER QUALITY TRENDS

Since the WA was completed in 2011, two years of long-term monitoring have been completed at stations in the Dublin service area. The following sections provide information on the climate, land use, and water quality conditions in the service area based on the available monitoring data and the 2022 monitoring data. Data evaluations are provided in order to identify any persistent and/or emerging water quality trends.

3.1 Precipitation Trends

The closest climate station with sufficient data to calculate a recent 30-year average annual precipitation total is located approximately one mile north of the city center of Dublin. Climate and NRCS WETS data were acquired from the NOAA Applied Climate Information System (ACIS) for the Dublin 1 monitoring station (GHCN #USC00092839). Average annual precipitation at this station between 1991 and 2020 was 47.27 inches. WETS information for the same time period indicates there is a 30 percent chance the station will receive less than 30.38 inches or more than 59.94 inches of rainfall annually (Table 10). Precipitation during the 2022 monitoring period totaled 47.05 inches, which is similar to the long-term annual average. During the 2011 WA, observed rainfall was almost 10 inches below the long-term average whereas a surplus of rainfall occurred in the Dublin area during the 2021 monitoring period.

3.2 Land Use Data

The 2019 National Land Cover Database (NLCD), produced by the Multi-Resolution Land Characteristics Consortium, represents the most recently published land use classification for the U.S. The 2019 NLCD was used to characterize land use and impervious surface coverage in the Dublin WPCP service area, as well as within the watersheds of the long-term water quality monitoring stations (which include some areas outside of the Dublin WPCP service area; Figure 3). Land use within the watershed of each water quality station was evaluated to better understand all areas that may affect water quality at each station. For this characterization, NLCD land use classes were grouped into six categories: medium to high intensity developed, low intensity to open space developed, forest, pasture/hayland, cultivated cropland, and wetland/water.

Current land use/land cover in Dublin’s service area is predominantly low intensity/open space developed and forest, covering approximately 26% and 25% of the service area, respectively (Table 14; Figure 3). Medium to high intensity developed space (9%), pasture/hayland (12%), cultivated cropland (14%), and wetland/water (14%) compose a relatively equal proportion of the rest of the land coverage in the Dublin service area. Overall, the 2019 NLCD impervious cover estimate for the service area is 12%, which is a minor increase from 2011, when impervious surfaces covered approximately 11% of the service area; therefore, an increase in development is not expected to have caused substantial impacts to water quality in the service area.

The watersheds for stations UTN01 and DC01 contain the highest percentages of developed land (85% and 90%, respectively), with approximately 29% and 33% impervious surface cover. The watershed for FC01 is the least developed, containing 18% developed land and 5% impervious surfaces. In addition to being the least developed, the watersheds for HHC02 and FC01 also contain the highest proportion of forested land in the service area, ranging from 30 to 32%. Based on land use, stations UTN01 and DC01 may be at highest risk for nonpoint source runoff of nutrients, metals, and bacteria from urban land use, and stations FC01 and LC01 could be at a relatively higher risk for nonpoint source runoff of nutrients from agricultural land use.

3.3 Water Quality Trends

The evaluation of water quality trends between years can be challenging, considering natural interannual variability and the limited annual data set required by the WPP. Year-to-year water quality parameter variability may be influenced by several natural and anthropogenic factors, including seasonal climatic variability (temperature, precipitation, groundwater discharge rates and quality, etc.), antecedent climatic variables and dynamics (precipitation and associated stormwater flow to receiving waters), and watershed characteristics (tidal influence, geology, soils, land use, etc.). Additionally, the number and timing of samples collected, consistency in annual and diurnal sample collection timing, and laboratory method detection limits can also affect sample results. Due to the multitude of factors that influence water quality, conclusive identification of water quality trends and their causes is inherently problematic, unless obvious drivers (e.g., changes in predominant land uses or point source pollution) can be identified. The following sections present observed water quality trends and possible drivers only when sufficient data is available and/or when identifiable watershed changes are present.

For the Dublin service area, water quality samples have only been collected in 2011 to 2012, 2021, and 2022, and inferences cannot be made about water quality trends until additional water quality data is collected. Only water quality anomalies and differences between the three

monitoring years are discussed in the following sections. The WA dry weather monitoring events all occurred in 2011, whereas the wet weather event occurred in May of 2012. For simplicity, the WA monitoring year is hereafter referred to as 2011 only.

3.3.1 *In situ* Water Quality Trends

Average physiochemical parameter values from the current long-term monitoring period (2011 and 2021) were calculated for each station, for comparison with 2022 monitoring results (Tables 12 and 13). It is important to note that parameter averages are calculated from a limited set of observations, which does not likely represent actual intra-annual variability. During the 2022 monitoring period, a total of 11 dry weather, wet weather, or bacteriological water quality sampling events at DC01, FC01, HHC01, LC01, UTN01 stations included collection of *in situ* parameters. *In situ* data is available from between 14 and 17 events (depending on the station) over the long-term monitoring period (the individual years 2011 and 2021) for each station, as a basis for comparison.

Specific conductivities were slightly lower in 2022 and 2021 compared to 2011, possibly as a result of low water levels from the 2011 drought, and pH values were also slightly lower in 2022 and 2021 than 2011. Turbidity values were higher in 2022 and 2021, possibly due to the higher rainfall compared to 2011 (Table 12). Overall, measurements of specific conductivity, pH, and turbidity in 2022 closely resemble the measurements taken in 2021.

DO concentrations are typically negatively correlated with water temperatures. Therefore, average water temperature and DO were calculated for samples collected during the summer months (May to October) and winter months (November to April) for each monitoring period (Table 13). Winter temperatures in 2022 at station DC01, HHC02, and UTN01 were higher than winter temperatures in 2021 and resemble those taken in 2011. Winter DO concentrations did not show much change in any years at any stations. A few of the winter DO measurements in 2022 were higher than 2021 despite temperatures also being higher (stations LC01 and UTN01). In 2011 measurements, there were multiple exceedances of the state DO standards at stations FC01, HHC02, CC01, and LC01. In 2021 and 2022, no exceedances of DO standards occurred at any active monitoring stations. Low DO concentrations during 2011 were likely partially attributable to low water levels and warm temperatures.

3.3.2 Analytical Water Quality Trends

Analytical water quality monitoring results from dry and wet weather events in 2022 were compared to results from the WA in 2011 and the single-year 2021 long-term monitoring

period, in order to identify any persisting and/or emerging water quality trends. Analytical results for all years are shown in Figures 4 through 28 (note that when a parameter was not detected in a sample, the laboratory MDL or RL is shown in the figures). Only those parameters that appear to show substantial differences or anomalies are discussed in the section that follows.

Dry weather concentrations of ammonia-nitrogen have varied across all stations during the monitoring years, although concentrations were slightly lower in 2011 and 2022 when compared with 2021. For the wet weather events, ammonia-nitrogen concentrations have generally been highest for stations DC01, LC01, and UTN01, but have been lower in 2021 and 2022 than in 2011 at stations DC01 and LC01. Conversely, the 2022 wet weather ammonia-nitrogen concentrations for stations HHC02 and UTN01 were the highest during 2021-2022 than in 2011. Similarly, nitrate-nitrogen has also varied across all stations, but has generally been highest at DC01, LC01, and UTN01 during dry weather events throughout the monitoring years. The highest wet weather nitrate-nitrogen concentration occurred during the 2022 wet weather event at station HHC02, whereas all other 2022 wet weather nitrate-nitrogen concentrations were similar among all stations from 2011, 2021, and 2022. Since the 2011 WA, dry weather TKN concentrations have declined at all stations, but have been generally increasing after the 2011 monitoring year for all stations during the wet weather sampling. This was also the case for total phosphorus concentrations, which have generally decreased from 2011 to 2022 during the dry weather sampling, but have increased from 2011 to 2022 during the wet weather sampling. Among all stations, the highest total phosphorus concentrations for all dry weather sampling have typically been for station HHC02 whereas the highest wet weather concentrations have been measured for stations DC01 and UTN01.

Since 2011, TSS, BOD₅, and COD wet weather concentrations were higher at all stations compared to the dry weather events (Figures 16 through 21). Wet weather TSS concentrations have generally increased among all the stations, and were highest for stations DC01 and UTN01 in both 2021 and 2022. The wet weather BOD₅ concentrations increased at all stations from 2011 to 2021, and excluding stations LC01 and UTN01, the same trend continued for the 2022 wet weather events. COD concentrations have only been measured for 2021 and 2022 wet weather events, and were highest at station UTN01 during both the 2021 and 2022 wet weather events. As discussed in section 2.2.1 above, stations UTN01 and DC01 have urbanized watersheds with high potential for nonpoint source nutrient runoff, and higher TSS at stations DC01 and UTN01 during wet weather events in 2021 and 2022 were noted (Figure 17). TSS concentrations are likely related to the watershed land uses for the stations as previously discussed.

Total recoverable concentrations of cadmium, copper, lead, and zinc concentrations were all higher during wet weather sampling than dry weather sampling at all stations in 2011, 2021, and 2022 (Figures 22 through 29). However, higher method detection limits were utilized by the analysis laboratory during the 2021 and 2022 wet weather events than the dry weather events. Despite the higher MDLs, wet weather concentrations of total recoverable lead and zinc have been slightly increasing at stations DC01 and UTN01 since the 2011 wet weather sampling event. If this trend continues in subsequent monitoring years, it may indicate a persistent problem with nonpoint source runoff from urban land uses in those watersheds.

3.3.3 Bacteriological Trends

E. coli geomeans calculated for 2011 and 2021 monitoring periods were plotted for comparison to the 2022 geomeans (Figures 30 through 34). *E. coli* geomeans during 2022 were within the ranges of historical measurements for all stations. 2022 geomeans were generally lower than the 2021 geomeans. Bacteria are often detected in stormwater runoff, from various sources, and the lower bacteria geomeans in 2022 compared to 2021 may be attributable to the lower rainfall totals during the 2022 monitoring year. DC01 and UTN01 had the highest average values for *E. coli* during all monitoring periods, which may be related to the relatively high percentage of developed land use and impervious surfaces within their contributing watersheds. Urban runoff, septic/sewage leaks, and stormwater overflows are common contributing factors to bacteria loading in freshwater systems.

3.4 Summary of Long-term Water Quality Trends

Continued annual monitoring is required to detect meaningful water quality trends. Stations with higher proportions of development, especially DC01 and UTN01, had higher concentrations of nutrients, metals, and bacteria during 2022 monitoring, particularly during the 2022 wet weather events. Additionally, wet weather nitrate concentrations and dry weather concentrations for total phosphorus have been higher for station HHC02 during 2021 and 2022 compared to 2011. The HHC02 watershed has mixed land use, with forest and low intensity developed land use interspersed with agricultural lands. Continued monitoring at this station will assist the city in determining if increases in instream nutrient concentrations are attributed to recent land use changes in the watershed, and/or if additional BMP measures are needed.

BMPs that reduce surface runoff to streams in urban and agricultural areas should improve water quality conditions in the Dublin service area. The DC01 and UTN01 watersheds should be considered high priority watersheds for implementation of BMPs that address runoff from

urban areas, whereas the HHC02 watershed should be considered a high priority watershed for implementation of BMPs that address urban and agricultural land use. If forestry operations are actively underway in the HHC02 watershed, the city could also ensure these operations are utilizing appropriate BMPs as detailed in the Georgia Forestry Commission's *Best Management Practices for Forestry*, and that landowners have developed a Forest Management Plan. Additional resources and measures for forestry BMPs could also be attained by establishing a partnership between the city and the Georgia Forestry Commission.

4.0 FUTURE SAMPLING AND PROPOSED WPP CHANGES

The 2023 monitoring period for the Dublin WPP long-term monitoring began in January 2023. Three dry weather events, one wet weather event, two bacteriological geometric mean determinations, and biological monitoring are scheduled for completion prior to December 31, 2023 (Table 14).

In accordance with the WPP guidance, dry weather monitoring events should occur at least 60 days apart. When possible, wet weather events should be conducted during summer months (May to October) in order to assess water quality during "critical conditions" (low flow, high temperature). However, due to unpredictable timing, duration, and intensity associated with convection storms that are typical during summer months in Georgia, sampling during critical conditions may not be possible. Biological assessments shall be conducted at least twice during every five-year period and shall not be performed in consecutive years. Future macroinvertebrate and fish assessments will be conducted at stations FC01 and LC01 utilizing the most recent Georgia DNR biological monitoring Standard Operating Procedures (SOPs). As required by the WPP guidance during biological sampling years, dry weather monitoring events will be conducted concurrently with the macroinvertebrate community assessments. The Dublin WPP was first implemented in 2013 and most recently updated in 2020.

TABLES

Table 1. Location information and monitoring requirements for each long-term monitoring station for the Dublin Watershed Protection Plan.

Station ID	Site description	Latitude	Longitude	Watershed area	Monitoring parameters
		DD		sq. mi.	
DC01	Dublin Creek at South Decatur Street	32.537804	-82.898086	1.51	Water Quality only
FC01	Fords Creek at US 80	32.544133	-82.962409	9.50	Water Quality and Biology
HHC02	Hunger and Hardship Creek at East Mary Street	32.554264	-82.901653	26.3	Water Quality only
LC01	Long Branch at Riverview Park Drive	32.517863	-82.891951	5.31	Water Quality and Biology
UTN01	Unnamed Tributary at Bainbridge Street	32.544555	-82.900095	0.81	Water Quality only

Table 2. Sampling events for the Dublin 2022 Watershed Protection Plan long-term monitoring.

Sampling task	2022											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water Quality												
<i>In situ</i>			D		B	D,B				D,W		
Analytical			D			D				D,W		
Bacteria (<i>E. coli</i>)					B	B						

D = dry weather sampling event.
W = wet weather event sampling.
B = bacteriological sampling event.

Table 3. Required water quality parameters, test methods, and applicable Water Quality Standards for the Dublin Watershed Protection Plan long-term monitoring.

Parameter	Units	Method ¹⁻³	Water Quality Standard
Temperature (water and air)	°C		32.2° C (equivalent to 90° F)
pH	SU		Within the range 6.0 - 8.5
Dissolved oxygen	mg/L & % saturation		A daily average of 5.0 mg/L; no less than 4.0 mg/l at all times
Specific conductivity	µS/cm		
Turbidity	NTU		Refer to 391-3-6-.03(5)(d)
Biochemical oxygen demand, 5-day	mg/L	SM 5210B	
Chemical oxygen demand		EPA 410.4	
Total suspended solids		SM 2540D	
Total phosphorus		EPA 365.3	
Orthophosphate		EPA 300.0	
Total Kjeldahl nitrogen		EPA 351.2	
Ammonia nitrogen		EPA 350.1	
Nitrate, as nitrogen		EPA 300.0	
Nitrite, as nitrogen		EPA 300.0	1.0 (MCL)
Cd - Total and dissolved ^{4,5}		µg/L	EPA 200.8
	Acute criteria 0.94		
Cu - Total and dissolved ^{4,5}	Chronic criteria 5.0		
	Acute criteria 7.0		
Pb - Total and dissolved ^{4,5}	Chronic criteria 1.2		
	Acute criteria 30		
Zn - Total and dissolved ^{4,5}	Chronic criteria 65		
	Acute criteria 65		
Total hardness, as CaCO ₃	mg/L	EPA 200.7	
Calcium			
Magnesium			
Alkalinity, total		SM 2320B	
<i>Escherichia coli</i> (<i>E. coli</i>)	counts/ 100 mL	SM 9223B	May-Oct: 126 counts/100 mL
			Nov-Apr: 630 counts/100 mL

¹ Laboratory analyses will be in accordance with the approved test procedures set forth in 40 CFR 136.

² The method detection limit (MDL) and/or reporting limit (RL) listed for each standard method was provided by the analytical laboratory listed on the laboratory reports provided on the attached report USB drive.

³ The MDL and RL for each standard method will vary based on the sample matrix, environmental conditions at the time of sampling, and laboratory sample preparation steps, instrumentation, and technology.

⁴ Total recoverable metal concentrations are converted to dissolved using TSS concentrations and translator equations developed by the EPA (EPA 823-B-96-007), and then compared to hardness-based acute and chronic criteria specified in O.C.G.A 391-3-6-03.

⁵ The in-stream criterion for metals are expressed as chronic and acute criteria in terms of the dissolved fraction in the water column for freshwater streams.

Table 4. Observed precipitation at the Dublin Water Pollution Control Plant during and prior to each 2022 sampling event.

Sampling event type	Date	Day of event	3 days preceding	7 days preceding
		inches		
Dry 1	3/29/2022	0.00	0.00	0.00
Bacteria 1-1	5/19/2022	0.00	0.00	0.00
Bacteria 1-2	5/26/2022	1.00	1.10	1.40
Bacteria 1-3	6/2/2022	0.00	0.10	1.10
Bacteria 1-4	6/9/2022	0.00	0.20	0.85
Bacteria 2-1	6/16/2022	0.00	0.00	0.00
Dry 2 & Bacteria 2-2	6/23/2022	0.00	0.00	0.20
Bacteria 2-3	6/30/2022	0.01	0.10	0.10
Bacteria 2-4	7/7/2022	0.20	0.70	2.21
Dry 3	10/10/2022	0.00	0.00	0.00
Wet weather	10/12/2022	2.00	0.00	0.00

Table 5. Results of physicochemical water quality monitoring for the Dublin 2022 Watershed Protection Plan implementation.

Station	Sampling event type	Date	Temperature		Specific conductivity	Salinity	Dissolved oxygen		pH	Turbidity	Discharge
			Water	Air			mg/L	%			
			°C								
								SU	NTU	cfs	
DC01	Dry 1	3/29/2022	27.3	15.9	137	0.06	10.5	106	6.8	7.5	NM
	Bacteria 1-1	5/19/2022	22.7	30.6	137	0.06	7.3	85.1	7.1	5.5	NM
	Bacteria 1-2	5/26/2022	22.8	24.6	142	0.07	7.0	81.4	6.9	6.6	NM
	Bacteria 1-3	6/2/2022	23.8	30.5	150	0.07	7.7	91.2	6.7	4.7	NM
	Bacteria 1-4	6/9/2022	23.6	28.6	147	0.07	7.6	90	6.7	3.2	NM
	Bacteria 2-1	6/16/2022	25.8	30.8	140	0.07	7.6	92.4	7.2	3.3	NM
	Dry 2 & Bacteria 2-2	6/23/2022	24.3	27.8	136	0.06	6.4	76.6	7.0	2.5	NM
	Bacteria 2-3	6/30/2022	23.6	26.4	129	0.06	6.1	71.7	6.9	2.8	NM
	Bacteria 2-4	7/7/2022	25.5	27.2	149	0.07	6.6	80.9	7.0	9.5	NM
	Dry 3	10/10/2022	18.0	26.8	141	0.07	9.2	97.0	6.8	2.6	NM
	Wet weather	10/12/2022	21.4	21.3	30	0.01	8.4	95.4	6.7	115	NM
AVERAGE			23.5	26.4	131	0.06	7.7	87.9	6.9	15	NM
FC01	Dry 1	3/29/2022	14.9	20.3	63	0.03	8.0	79.0	6.5	12	4.040
	Bacteria 1-1	5/19/2022	22.7	23.8	94	0.04	6.6	77.1	6.7	10	NM
	Bacteria 1-2	5/26/2022	23.6	25.4	87	0.04	7.6	90.1	6.6	11	NM
	Bacteria 1-3	6/2/2022	24.0	24.6	97	0.05	5.8	69.8	6.6	10	NM
	Bacteria 1-4	6/9/2022	23.8	24.7	104	0.05	5.8	69.1	6.0	12	NM
	Bacteria 2-1	6/16/2022	25.5	25.2	116	0.05	4.4	54.1	6.6	12	NM
	Dry 2 & Bacteria 2-2	6/23/2022	24.0	25.6	119	0.06	4.7	55.7	6.5	6.7	NM
	Bacteria 2-3	6/30/2022	23.8	26.2	96	0.05	4.3	50.6	6.4	7.7	NM
	Bacteria 2-4	7/7/2022	25.0	25.5	101	0.05	5.7	68.8	6.9	13	NM
	Dry 3	10/10/2022	18.6	22.2	97	0.05	7.2	77.3	6.0	6.0	NM
	Wet weather	10/12/2022	21.3	24.0	48	0.02	7.3	82.5	6.2	43	NM
AVERAGE			22.5	24.3	93	0.04	6.1	70.4	6.5	13	4.040

Table 5. Results of physicochemical water quality monitoring for the Dublin 2022 Watershed Protection Plan implementation.
(Continued)

Station	Sampling event type	Date	Temperature		Specific conductivity	Salinity	Dissolved oxygen		pH	Turbidity	Discharge
			Water	Air			mg/L	%			
			°C		µS/cm	PPT			SU	NTU	cfs
HHC02	Dry 1	3/29/2022	17.3	26.2	79	0.04	8.7	90.1	6.8	14	NM
	Bacteria 1-1	5/19/2022	24.0	30.3	97	0.05	6.8	74.2	7.1	15	NM
	Bacteria 1-2	5/26/2022	23.8	24.4	84	0.04	6.3	74.8	6.9	11	NM
	Bacteria 1-3	6/2/2022	25.4	32.1	99	0.05	6.4	78.6	7.0	11	NM
	Bacteria 1-4	6/9/2022	NM	24.5	95	0.04	6.5	78.9	6.8	11	NM
	Bacteria 2-1	6/16/2022	27.0	31.1	112	0.05	5.9	74.2	7.2	13	NM
	Dry 2 & Bacteria 2-2	6/23/2022	25.1	29.6	117	0.06	5.1	62.2	7.1	14	NM
	Bacteria 2-3	6/30/2022	24.9	29.5	129	0.06	6.2	74.8	6.9	12	NM
	Bacteria 2-4	7/7/2022	25.5	27.6	99	0.05	6.9	84.6	7.2	8.5	NM
	Dry 3	10/10/2022	18.7	24.6	73	0.07	9.4	101	6.7	7.0	NM
	Wet weather	10/12/2022	20.5	21.2	86	0.04	6.5	72.8	6.5	76	NM
AVERAGE			23.2	27.4	97	0.05	6.8	78.7	6.9	18	NM
LC01	Dry 1	3/29/2022	15.3	23.5	68	0.03	9.5	93.7	6.5	11	2.068
	Bacteria 1-1	5/19/2022	22.7	29.3	106	0.05	5.8	66.4	6.8	8.5	NM
	Bacteria 1-2	5/26/2022	22.8	24.7	66	0.03	8.5	98.1	6.8	12	NM
	Bacteria 1-3	6/2/2022	24.0	29.6	84	0.04	7.0	83.9	6.8	10	NM
	Bacteria 1-4	6/9/2022	23.7	27.1	97	0.05	6.7	79.1	6.6	7.8	NM
	Bacteria 2-1	6/16/2022	25.4	30.2	110	0.05	4.1	49.9	6.8	7.3	NM
	Dry 2 & Bacteria 2-2	6/23/2022	24.4	27.4	120	0.06	4.1	48.1	6.7	13	NM
	Bacteria 2-3	6/30/2022	23.4	25.5	128	0.06	3.7	44.7	6.8	7.3	NM
	Bacteria 2-4	7/7/2022	25.2	27.7	72	0.03	6.6	80.1	7.1	19	NM
	Dry 3	10/10/2022	17.9	24.6	114	0.05	7.2	75.9	6.4	3.6	NM
	Wet weather	10/12/2022	20.4	21.1	80	0.04	7.2	79.8	6.4	88	NM
AVERAGE			22.3	26.4	95	0.04	6.4	72.7	6.7	17	2.068

Table 5. Results of physicochemical water quality monitoring for the Dublin 2022 Watershed Protection Plan implementation.
(Continued)

Station	Sampling event type	Date	Temperature		Specific conductivity	Salinity	Dissolved oxygen		pH	Turbidity	Discharge
			Water	Air			mg/L	%			
			°C								
UTN01	Dry 1	3/29/2022	16.0	27.3	122	0.06	12.0	121	7.0	5.0	0.462
	Bacteria 1-1	5/19/2022	22.5	29.7	167	0.08	7.7	89.2	7.2	4.8	NM
	Bacteria 1-2	5/26/2022	22.9	25.0	149	NM	8.2	95.6	7.5	12	NM
	Bacteria 1-3	6/2/2022	23.9	30.7	157	0.07	8.8	105	7.0	4.7	NM
	Bacteria 1-4	6/9/2022	23.2	28.5	162	0.08	8.2	97	6.9	2.9	NM
	Bacteria 2-1	6/16/2022	26.1	31.9	174	0.08	8.6	106	7.4	2.6	NM
	Dry 2 & Bacteria 2-2	6/23/2022	23.9	28.8	191	0.09	7.5	89.4	7.3	2.1	NM
	Bacteria 2-3	6/30/2022	24.3	28.6	171	0.08	4.6	54.8	7.0	1.9	NM
	Bacteria 2-4	7/7/2022	25.4	27.5	149	0.07	7.1	87.1	7.2	6.7	NM
	Dry 3	10/10/2022	18.2	25.7	179	0.09	10.1	107	6.7	1.8	NM
	Wet weather	10/12/2022	21.3	21.7	34	0.01	8.5	96.0	6.4	702	NM
	AVERAGE			22.5	27.8	150	0.07	8.3	95.3	7.0	68

Table 6. Results of analytical water quality monitoring for the Dublin 2022 Watershed Protection Plan long-term monitoring.

Station	Sampling event type	Date	BOD ₅	COD	TKN	NH ₃	Nitrate	Nitrite	Total P	Ortho-P	TSS	Hardness	Alkalinity
			mg/L										mg/L CaCO ₃
DC01	Dry 1	3/29/2022	<2.0	<10	<0.20	0.050	0.79 I	<0.20	0.020	<0.20	<2.0	51	42
	Dry 2	6/23/2022	<2.0	20 I	<0.20	0.03 I	0.50 I	<0.20	<0.005	<0.20	<2.0	50	NM
	Dry 3	10/10/2022	<2.0	25	0.202 I	0.052	0.79	<0.10	0.017	<0.10	<2.0	47	50
	Wet	10/12/2022	12	59	1.18	0.083	<0.20 Q	<0.20 Q	0.434	<0.20 J4,Q	191	19	11I
FC01	Dry 1	3/29/2022	5.0	20 I	0.398 I	0.03 I	0.24 I	<0.20	0.026	<0.20	2.5	21	17I
	Dry 2	6/23/2022	<2.0	28	0.621	0.090	0.60 I	<0.20	0.010 I	<0.20	2.7	40	NM
	Dry 3	10/10/2022	<2.0	31	0.269 I	0.029 I	0.15 I	<0.10	<0.005	<0.10	2.3	32	29
	Wet	10/12/2022	13	54	1.01	0.050	<0.20 Q	<0.20 Q	0.228	<0.20 Q	35	18	12I
HHC02	Dry 1	3/29/2022	<2.0	20 I	0.511	0.050	0.26 I	<0.20	0.060	<0.20	<2.0	25	21
	Dry 2	6/23/2022	<2.0	20 I	0.279 I	0.060	0.20 I	<0.20	0.034	<0.20	3.0	44	NM
	Dry 3	10/10/2022	<2.0	29	<0.20	0.021 I	<0.10	<0.10	0.084	<0.10	<2.0	32	30
	Wet	10/12/2022	22	48	1.19	0.091	0.82 Q	<0.20 Q	0.105	<0.20 Q	125	31	23

Table 6. Results of analytical water quality monitoring for the Dublin 2022 Watershed Protection Plan long-term monitoring.
(Continued)

Station	Sampling event type	Date	BOD ₅	COD	TKN	NH ₃	Nitrate	Nitrite	Total P	Ortho-P	TSS	Hardness	Alkalinity
			mg/L										mg/L CaCO ₃
LC01	Dry 1	3/29/2022	<2.0	18 I	0.400 I	0.04I	0.28 I	<0.20	0.020	<0.20	3.8	26	21
	Dry 2	6/23/2022	<2.0	24	0.329 I	0.100	<0.20	<0.20	0.065	<0.20	7.9	49	NM
	Dry 3	10/10/2022	<2.0	33	0.204 I	0.035 I	0.67	0.11	0.014	<0.012	<2.0	43	36
	Wet	10/12/2022	25	69	1.15	0.056	<0.20 Q	<0.20 Q	0.268	<0.20 Q	153	30	26
UTN01	Dry 1	3/29/2022	<2.0	<10	0.209 I	0.02 I	0.62 I	<0.20	0.015	<0.20	2.2	42	36
	Dry 2	6/23/2022	<2.0	14 I	0.227 I	0.060	0.80	<0.20	<0.005	<0.20	<2.0	67	NM
	Dry 3	10/10/2022	<2.0	25	<0.20	<0.017	0.51	0.11	<0.005	<0.012	<2.0	61	60
	Wet	10/12/2022	27	110	2.21	0.180	0.38 I,Q	<0.20 Q	0.632	<0.20 Q	315	19	7.3 I

NM = Not measured

< = Compound was analyzed for but was not detected (ND). MDL is shown

I = The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit

J4 = Estimated result

Q = Missed hold time

Table 7. Results of total recoverable and calculated dissolved metals analyses for the Dublin 2022 Watershed Protection Plan long-term monitoring.¹⁻⁵

Station	Sampling event type	Date	Cd, Total	Cd, Dissolved	Cu, Total	Cu, Dissolved	Pb, Total	Pb, Dissolved	Zn, Total	Zn, Dissolved
			µg/L							
DC01	Dry 1	3/29/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	20 l	7.9
	Dry 2	6/23/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	10 l	3.9
	Dry 3	10/10/2022	<0.25	0.08	8.0	1.6	17	1.9	76	11
	Wet	10/12/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	13 l	5.1
FC01	Dry 1	3/29/2022	<2.5	0.55	<10	4.3	<0.50	0.11	<60	23
	Dry 2	6/23/2022	<0.25	0.06	<1.0	0.43	<0.50	0.11	10 l	3.7
	Dry 3	10/10/2022	<0.25	0.07	2.6 l	0.72	2.1	0.31	31	6.8
	Wet	10/12/2022	<0.25	0.05	<1.0	0.44	<0.50	0.12	11 l	4.2
HHC02	Dry 1	3/29/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	<6.0	2.4
	Dry 2	6/23/2022	<0.25	0.06	<1.0	0.42	<0.50	0.11	12 l	4.4
	Dry 3	10/10/2022	<2.5	0.80	<10	2.2	<5.0	0.60	68 l	11
	Wet	10/12/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	11 l	4.3
LC01	Dry 1	3/29/2022	<0.25	0.06	<1.0	0.41	<0.50	0.11	9.1 l	3.2
	Dry 2	6/23/2022	<0.25	0.06	<1.0	0.36	<0.50	0.10	9.7 l	2.9
	Dry 3	10/10/2022	<2.5	0.81	<10	2.1	<5.0	0.58	100 l	15
	Wet	10/12/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	11 l	4.3
UTN01	Dry 1	3/29/2022	<0.25	0.05	1.0 l	0.44	<0.50	0.12	17 l	6.6
	Dry 2	6/23/2022	<0.25	0.05	1.2 l	0.54	<0.50	0.12	18 l	7.1
	Dry 3	10/10/2022	<2.5	0.87	11 l	2.0	28	2.8	140 l	18
	Wet	10/12/2022	<0.25	0.05	<1.0	0.45	<0.50	0.12	18 l	7.1

¹ When total metal or TSS concentrations were not detected, estimated laboratory values were used to calculate dissolved metal concentrations.

² Dissolved metal concentrations were calculated using total recoverable metal, TSS, and hardness concentrations using EPD provided calculations.

³ Cd = cadmium, Cu = copper, Pb = lead, Zn = zinc.

⁴ < Compound was analyzed for but was not detected. MDL is shown.

⁵ l = result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 8. Calculated dissolved metals concentrations for the Dublin 2022 Watershed Protection Plan long-term monitoring compared to EPD chronic and acute life use criteria for cadmium, copper, lead, and zinc.

	DC01	FC01	HHC02	LC01	UTN01
	µg/L				
Dry Weather #1					
Cadmium Concentration ¹	< 0.05	< 0.55*	< 0.05	< 0.06	< 0.05
Acute Criterion	0.96	0.42	0.49	0.51	0.80
Chronic Criterion	0.43	0.22	0.25	0.26	0.37
Copper Concentration ²	< 0.45	< 4.3*	< 0.45	< 0.41	0.44
Acute Criterion	7.1	3.1	3.6	3.8	5.93
Chronic Criterion	1.2	2.4	2.7	2.8	4.27
Lead Concentration ³	< 0.12	< 0.11	< 0.12	< 0.11	< 0.12
Acute Criterion	31	11	14	15	25
Chronic Criterion	1.2	0.44	0.54	0.57	0.97
Zinc Concentration ⁴	7.9	< 23	< 2.4	3.2	6.6
Acute Criterion	66	31	36	37	56
Chronic Criterion	67	31	36	38	57
Dry Weather #2					
Cadmium Concentration ¹	< 0.05	< 0.06	< 0.06	< 0.06	< 0.05
Acute Criterion	0.94	0.76	0.83	0.92	1.23
Chronic Criterion	0.43	0.36	0.39	0.42	410
Copper Concentration ²	< 0.45	< 0.43	< 0.42	< 0.36	0.54
Acute Criterion	7.0	5.7	6.2	6.9	9.2
Chronic Criterion	5.0	4.1	4.4	4.9	6.4
Lead Concentration ³	< 0.12	< 0.11	< 0.11	< 0.10	< 0.12
Acute Criterion	30	24	26	29	42
Chronic Criterion	1.2	0.92	1.0	1.1	1.6
Zinc Concentration ⁴	3.9	3.7	4.4	2.9	7.1
Acute Criterion	65	54	58	64	83
Chronic Criterion	66	54	59	65	84

Table 8. Calculated dissolved metals concentrations for the Dublin 2022 Watershed Protection Plan long-term monitoring compared to EPD chronic and acute life use criteria for cadmium, copper, lead, and zinc. (Continued)

	DC01	FC01	HHC02	LC01	UTN01
	µg/L				
Dry Weather #3					
Cadmium Concentration ¹	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acute Criterion	0.89	0.62	0.62	0.81	1.1
Chronic Criterion	0.41	0.30	0.30	0.38	0.50
Copper Concentration ²	< 0.45	< 0.44	< 0.45	< 0.45	< 0.45
Acute Criterion	6.6	4.6	4.6	6.1	8.4
Chronic Criterion	4.7	3.4	3.4	4.4	5.9
Lead Concentration ³	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12
Acute Criterion	28	18	18	25	38
Chronic Criterion	1.1	0.71	0.71	0.99	1.5
Zinc Concentration ⁴	I 5.1	I 4.2	I 4.3	I 4.3	I 7.1
Acute Criterion	62	45	45	57	77
Chronic Criterion	62	45	45	58	78
Wet Weather					
Cadmium Concentration ¹	< 0.08	< 0.07	< 0.80*	< 0.81*	< 0.87*
Acute Criterion	0.38	0.36	0.60	0.58	0.38
Chronic Criterion	0.21	0.20	0.30	0.29	0.21
Copper Concentration ²	1.6	I 0.72	< 2.2	< 2.1	I 2.0
Acute Criterion	2.8	2.7	4.5	4.3	2.8
Chronic Criterion	2.2	2.1	3.3	3.2	2.2
Lead Concentration ³	1.9**	0.31	< 0.60	< 0.58	2.8**
Acute Criterion	10	9.6	18	17	10
Chronic Criterion	0.40	0.37	0.69	0.66	0.40
Zinc Concentration ⁴	11	6.8	I 11	I 15	I 18
Acute Criterion	29	27	43	42	29
Chronic Criterion	29	28	44	43	29

*The dissolved concentration was calculated using the laboratory MDL and is above the criterion, but is not considered an exceedance.

< = Compound was analyzed for but was not detected (ND). MDL is shown.

I = result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

¹ Cadmium aquatic life criteria standard correction to measured hardness. Acute criteria = $(e^{1.0166[\ln(\text{hardness})]-3.924}) * CF$; CF: $(1.136672 - [(\ln(\text{hardness}))(0.041838)]) \mu\text{g/L}$. Chronic criteria = $(e^{(0.7409[\ln(\text{hardness})]-4.719)}) * CF$; CF: $(1.101672 - [(\ln(\text{hardness}))(0.041838)]) \mu\text{g/L}$.

² Copper aquatic life criteria standard correction to measured hardness. Acute criteria = $(e^{(0.9422[\ln(\text{hardness})]-1.700)}) * CF$; CF: 0.960 µg/L. Chronic criteria = $(e^{(0.8545[\ln(\text{hardness})]-1.702)}) * CF$; CF: 0.960 µg/L.

³ Lead aquatic life criteria standard correction to measured hardness. Acute criteria = $(e^{(1.273[\ln(\text{hardness})]-1.460)}) * CF$; CF: $(1.46203 - [(\ln(\text{hardness}))(0.145712)]) \mu\text{g/L}$. Chronic criteria = $(e^{(1.273[\ln(\text{hardness})]-4.705)}) * CF$; CF: $(1.46203 - [(\ln(\text{hardness}))(0.145712)]) \mu\text{g/L}$.

⁴ Zinc aquatic life criteria standard correction to measured hardness. Acute criteria = $(e^{(0.8473[(\ln(\text{hardness}))+0.884]}) * CF$; CF: 0.978 µg/L. Chronic criteria = $(e^{(0.8473[(\ln(\text{hardness}))+0.884]}) * CF$; CF: 0.986 µg/L.

Table 9. Results of individual bacteriological samples and geometric mean determinations of *E. coli* for Dublin 2022 Watershed Protection Plan long-term monitoring.

	Sample date	<i>E. coli</i>		Sample date	<i>E. coli</i>
		counts/100 mL			counts/100 mL
DC01	5/19/2022	399	FC01	5/19/2022	121
	5/26/2022	471		5/26/2022	160
	6/2/2022	528		6/2/2022	110
	6/9/2022	419		6/9/2022	146
	Geomean 1	452		Geomean 1	133
	6/16/2022	481		6/16/2022	30
	6/23/2022	862		6/23/2022	185
	6/30/2022	766		6/30/2022	836
	7/7/2022	1,046		7/7/2022	189
	Geomean 2	759		Geomean 2	172
	HHC02	5/19/2022		74	LC01
5/26/2022		122	5/26/2022	836	
6/2/2022		86	6/2/2022	404	
6/9/2022		97	6/9/2022	345	
Geomean 1		93	Geomean 1	578	
6/16/2022		109	6/16/2022	146	
6/23/2022		120	6/23/2022	41	
6/30/2022		292	6/30/2022	10	
7/7/2022		185	7/7/2022	601	
Geomean 2		163	Geomean 2	77	
UTN01	5/19/2022	545			
	5/26/2022	1,259			
	6/2/2022	1,607			
	6/9/2022	813			
	Geomean 1	973			
	6/16/2022	591			
	6/23/2022	706			
	6/30/2022	399			
	7/7/2022	739			
	Geomean 2	592			

Table 10. Thirty-year average annual precipitation and annual precipitation totals observed at Dublin 1 station (GHCN #USC00092839) during the long-term monitoring period for the Dublin Watershed Protection Plan.

Monitoring year	Observed precipitation	Departure from normal
	inches	
1991 – 2020 average	47.27	n/a
(± 25% exceedance chance)	(30.38 – 59.94)	
2011	37.62	-9.65
2021	53.86	6.59
2022	47.05	-0.22

Table 11. National Land Cover Database (NLCD) land cover classifications and percent imperviousness within the Dublin Water Pollution Control Plant service area and long-term water quality monitoring station watersheds.

Land cover	Service area				DC01		FC01		HHC02		LC01		UTN01	
	2011		2019		2019									
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Developed - med to high intensity	2,403	8.4	2,647	9.3	282	28	190	3.1	618	7.3	585	17	108	22
Developed low intensity/open space	7,422	26	7,452	26	622	62	889	15	2414	29	859	25	307	63
Forest	7,590	27	7,081	25	77	7.7	1,931	32	2,507	30	615	18	37	7.6
Pasture/hayland	2,734	10	3,331	12	9.5	0.94	681	11	856	10	389	11	11	2.2
Cultivated cropland	4,258	15	3,922	14	0.88	0.09	1,335	22	890	11	564	16	7.8	1.6
Wetland/water	4,094	14	4,069	14	9.5	0.94	1,026	17	1,135	13	466	13	18	3.7
Imperviousness														
Impervious surfaces*	3,097	11	3,282	12	334	33	280	4.6	862	10	334	33	140	29

*Impervious surfaces are estimated separately from land cover and may overlap with land cover classifications.

Table 12. Comparison of average physicochemical water quality results for Dublin Watershed Protection Plan long-term monitoring.

Station	Sample Period	No. Samples (range)	Specific Conductivity	pH	Turbidity
			μS/cm	SU	NTU
DC01	2011	3	258	7.9	1.5
	2021	11	132	6.7	18
	2022	11	131	6.9	15
FC01	2011	5-6	84	6.6	2.8
	2021	11	65	6.3	9.8
	2022	11	93	6.5	13
HHC02	2011	5-6	110	6.9	15
	2021	10-11	73	6.8	13
	2022	11	97	6.9	18
LC01	2011	5-6	114	6.9	9.5
	2021	11	89	6.5	11
	2022	11	95	6.7	17
UTN01	2011	5-6	119	6.5	11
	2021	11	77	6.1	40
	2022	11	150	7.0	68

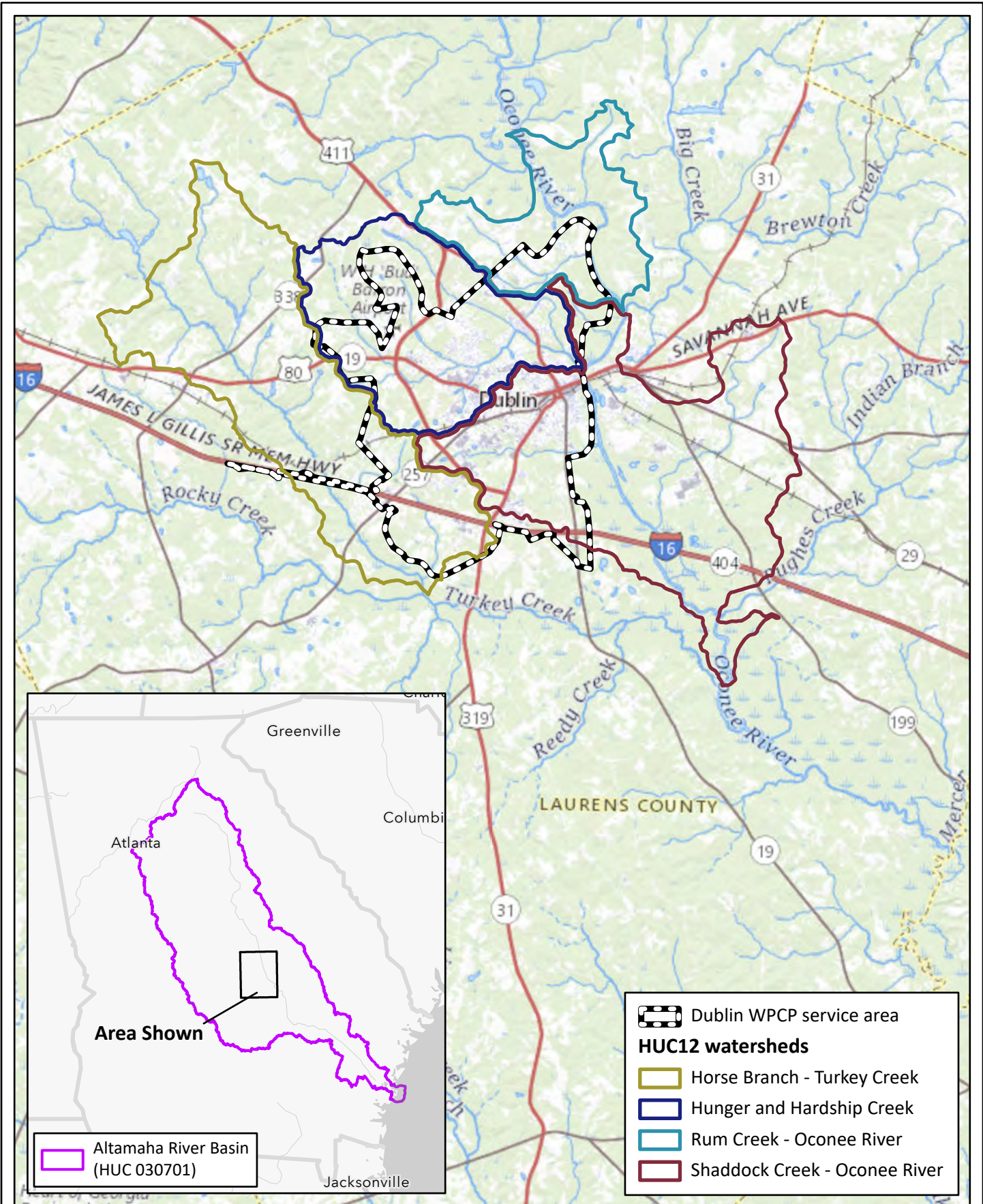
Table 13. Comparison of average summer and winter water temperatures and dissolved oxygen concentrations for Dublin Watershed Protection Plan long-term monitoring.

Station	Season	Sample Period	No. Samples	Water Temp	Dissolved Oxygen
				°C	mg/L
DC01	Summer	2011	3	26.1	6.2
		2021	10	23.7	7.3
		2022	10	23.1	7.4
	Winter	2011	0	NM	NM
		2021	1	10.6	10.9
		2022	1	27.3	10.5
FC01	Summer	2011	5	26.8	4.2
		2021	10	23.0	6.3
		2022	10	23.2	6.0
	Winter	2011	1	17.7	10.5
		2021	1	11.2	8.8
		2022	1	14.9	8.0
HHC02	Summer	2011	5	26.6	3.4
		2021	10	23.7	6.7
		2022	10	23.9	6.6
	Winter	2011	1	17.2	3.3
		2021	1	10.2	9.8
		2022	1	17.3	8.7
LC01	Summer	2011	5	25.6	3.4
		2021	10	22.8	7.0
		2022	10	23.0	6.1
	Winter	2011	1	15.5	7.3
		2021	1	12.0	9.2
		2022	1	15.3	9.5
UTN01	Summer	2011	5	27.7	6.0
		2021	10	23.5	7.8
		2022	10	23.2	7.9
	Winter	2011	1	17.5	12.1
		2021	1	9.8	11.2
		2022	1	16.0	12.0

Table 14. Future long-term monitoring schedule for the Dublin Watershed Protection Plan.

Watershed Protection Plan monitoring requirement	Monitoring period		
	2023	2024	2025
Water quality monitoring (5 stations)			
3 dry weather events & 1 wet weather event	✓	✓	✓
2 bacteriological geometric mean determinations (8 individual sample events)	✓	✓	✓
Biological monitoring (2 stations)			
Benthic macroinvertebrate communities	✓		
Fish community assessment	✓		
Annual report (due June 30)	✓	✓	✓

FIGURES



Data Source: USGS National Map, NHD Created: Wednesday, June 22, 2022






Path: G:\08\08-027 Dublin WA\GISFILES\Dublin_Status_Report_figs_2022.aprx

Figure 1. Dublin Water Pollution Control Plant service area and vicinity, Dublin, Laurens County, Georgia.

0 1 2 4 Miles



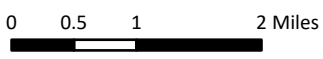


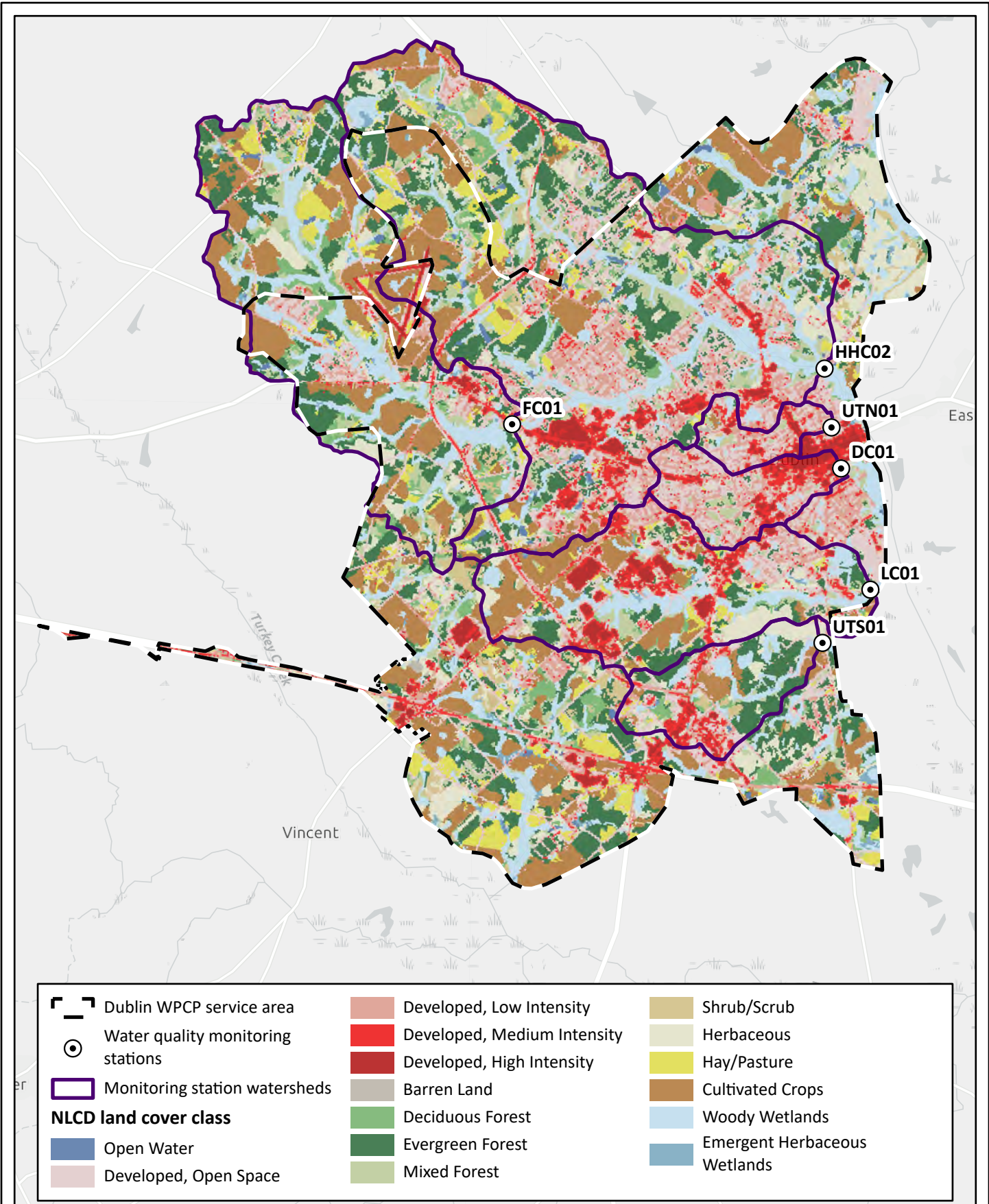
 Dublin Service Area
 Monitoring station watersheds
 USGS Streams
Water Quality Monitoring Stations
 Water Quality and Biological
 Water Quality Only

Data Source: ESRI World Imagery, USGS NHD, Created: Thursday, June 23, 2022

Path: G:\08\08-027 Dublin WA\GISFILES\Dublin_Status_Report_figs_2022.aprx

Figure 2. Long-term water quality monitoring stations and drainage basins for the Dublin Watershed Protection Plan, revised July 2022.





Data Sources: ESRI Light Grey Basemap, USGS, MRLC NLCD 2019

G:\08\08-027 Dublin WA\GISFILES\Land Cover Analysis\Dubline Land Use Analysis

Figure 3. 2019 National Land Cover Database classification for the Dublin WPCP service area and long-term monitoring station watersheds.



Figure 4. Ammonia-nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

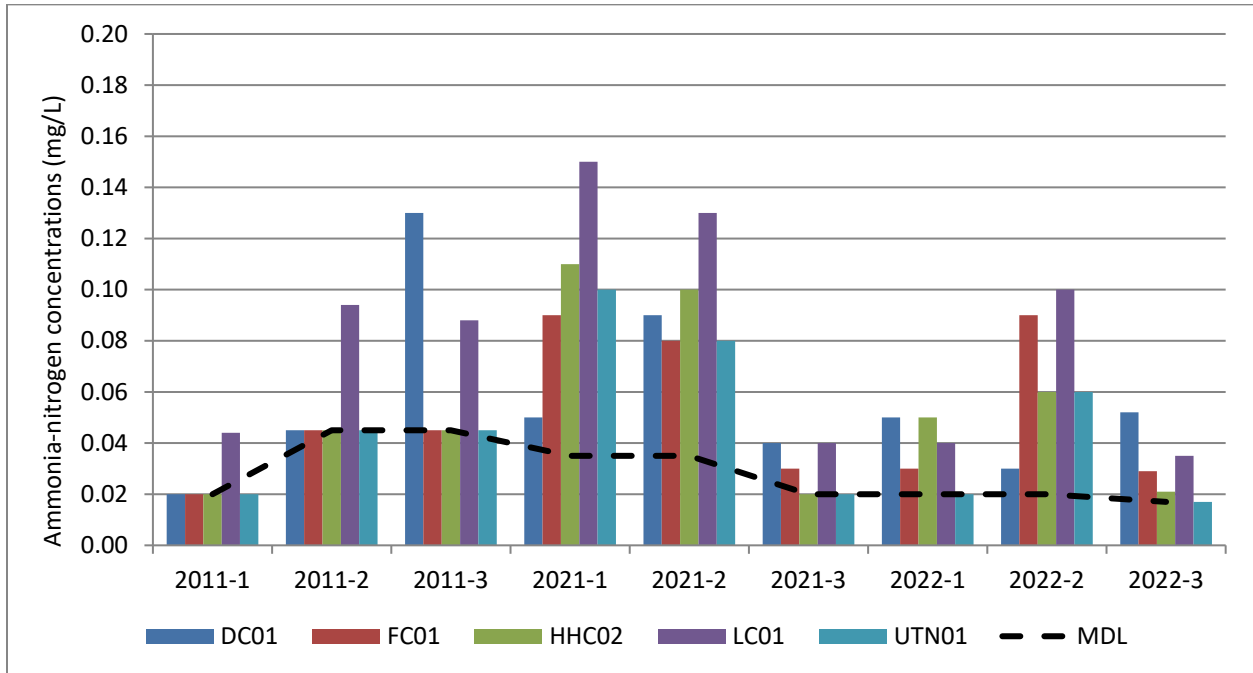


Figure 5. Ammonia-nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

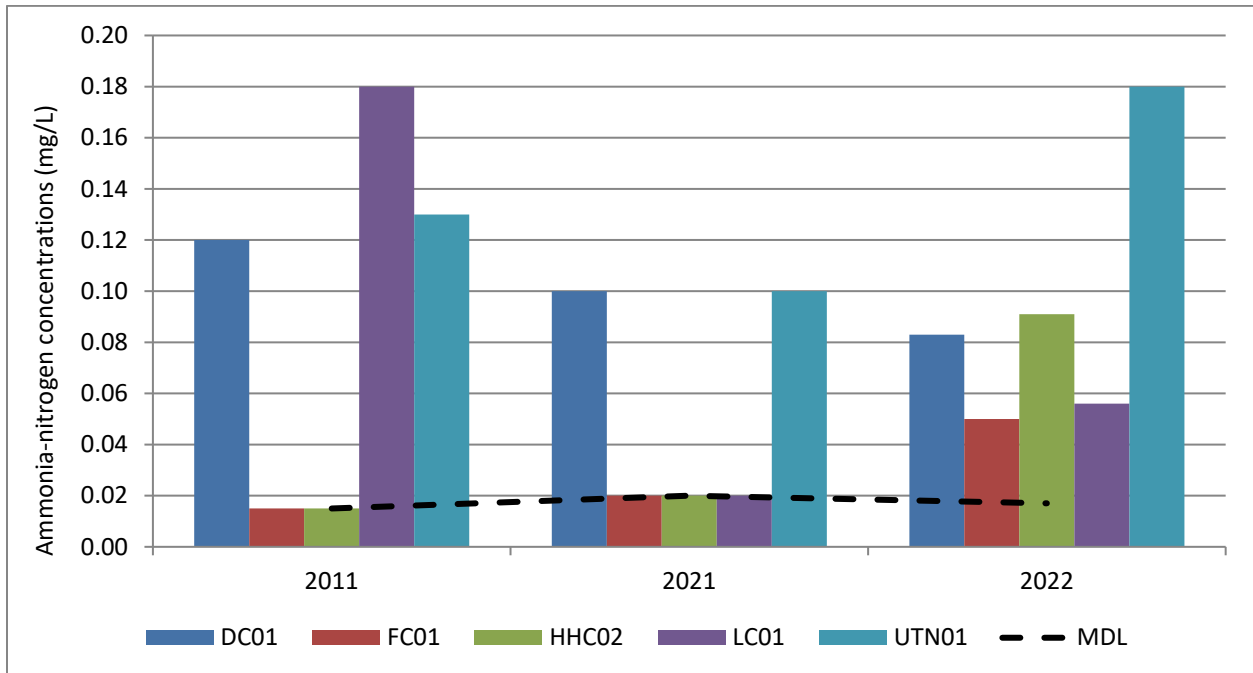
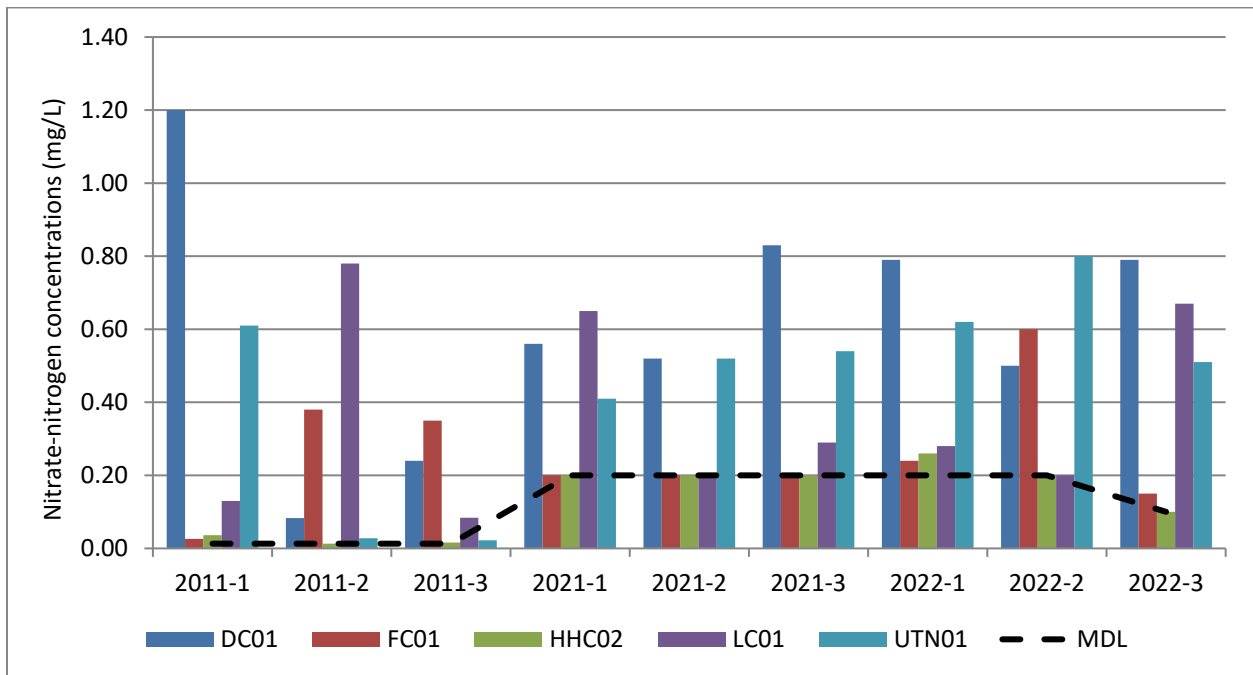


Figure 6. Nitrate-nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 3 event. The highest MDL used is shown on the graph.

Figure 7. Nitrate-nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

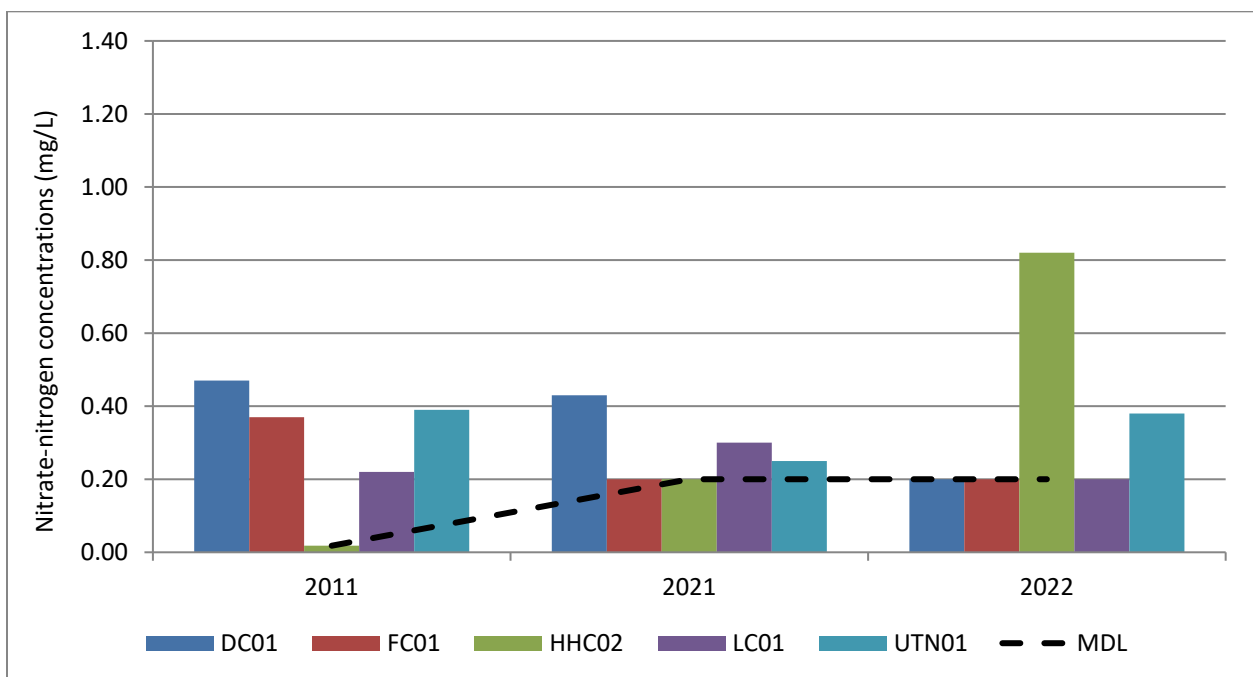
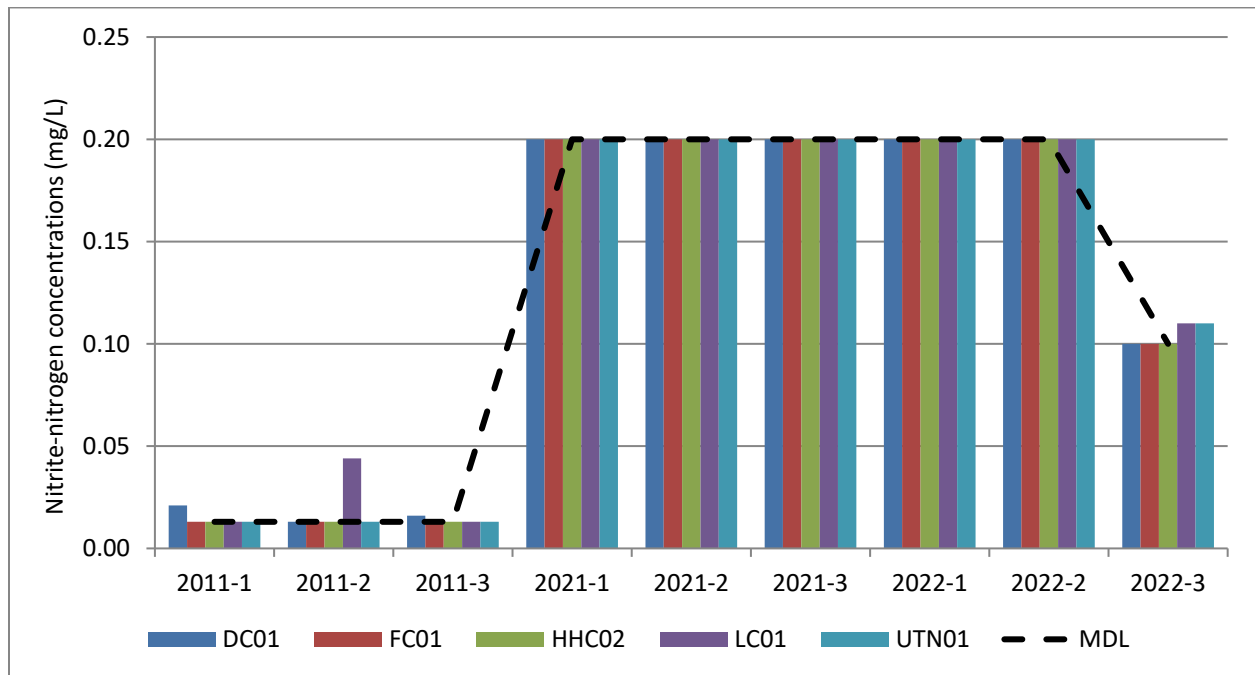


Figure 8. Nitrite-nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 3 event. The highest MDL used is shown on the graph.

Figure 9. Nitrite-nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

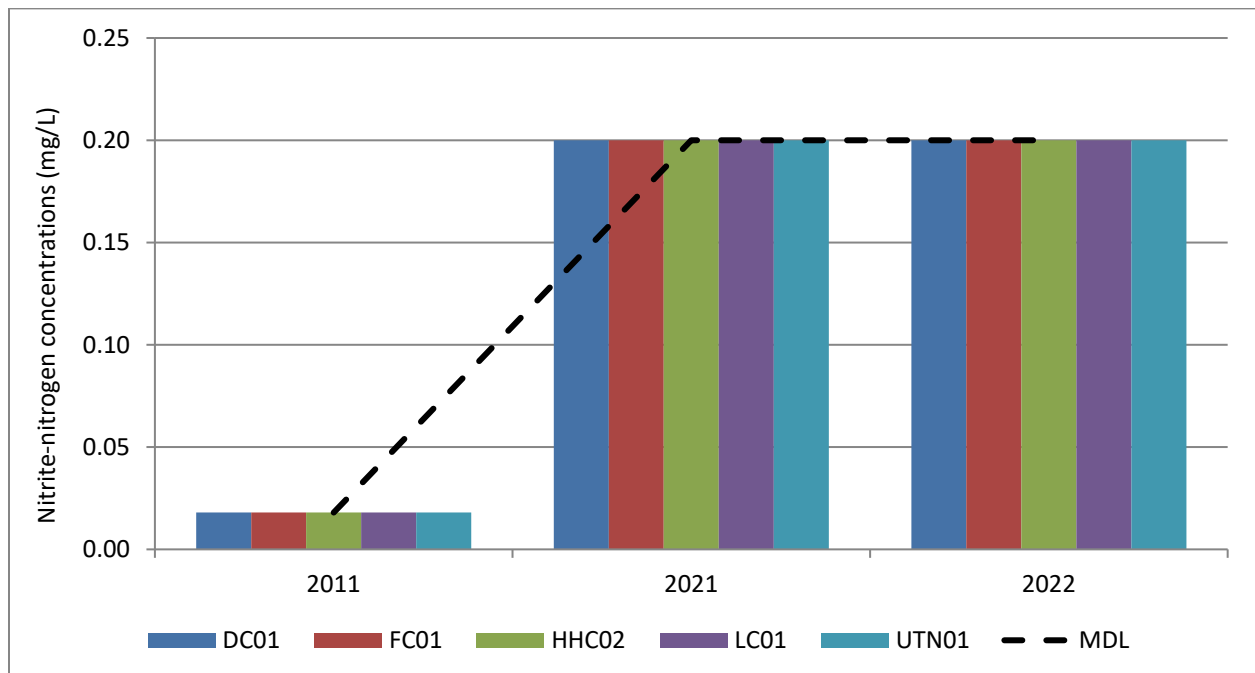


Figure 10. Total Kjeldahl nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

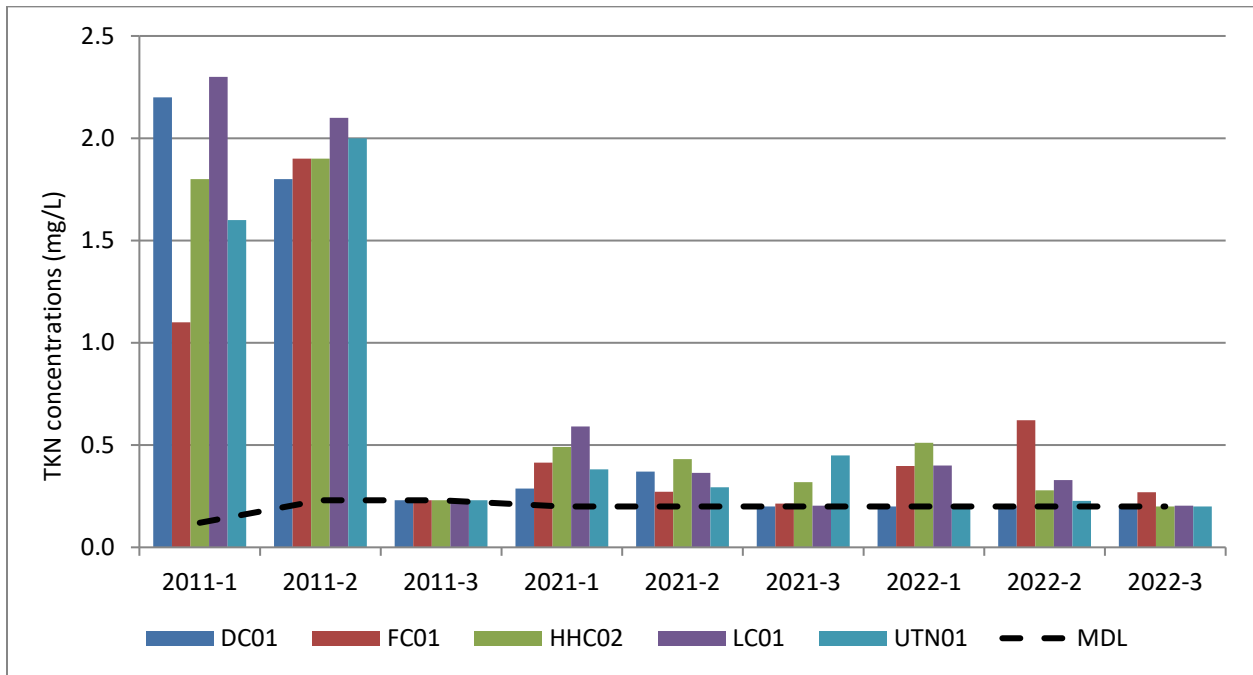


Figure 11. Total Kjeldahl nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

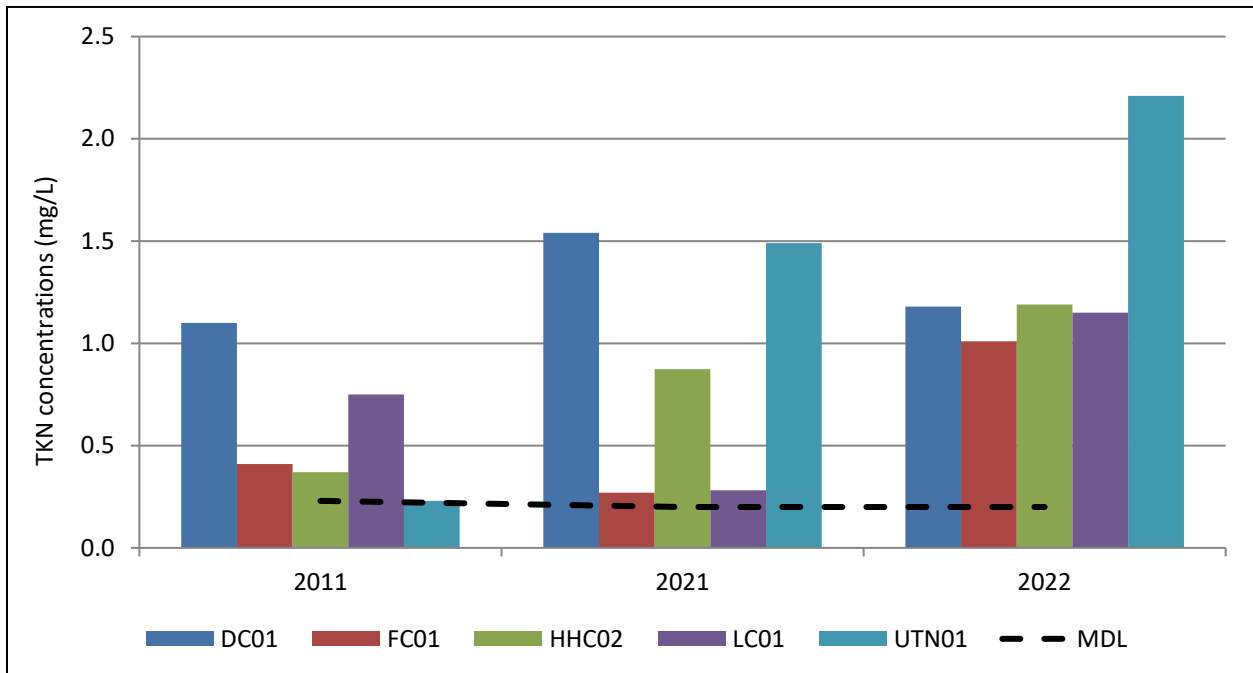


Figure 12. Total phosphorus concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

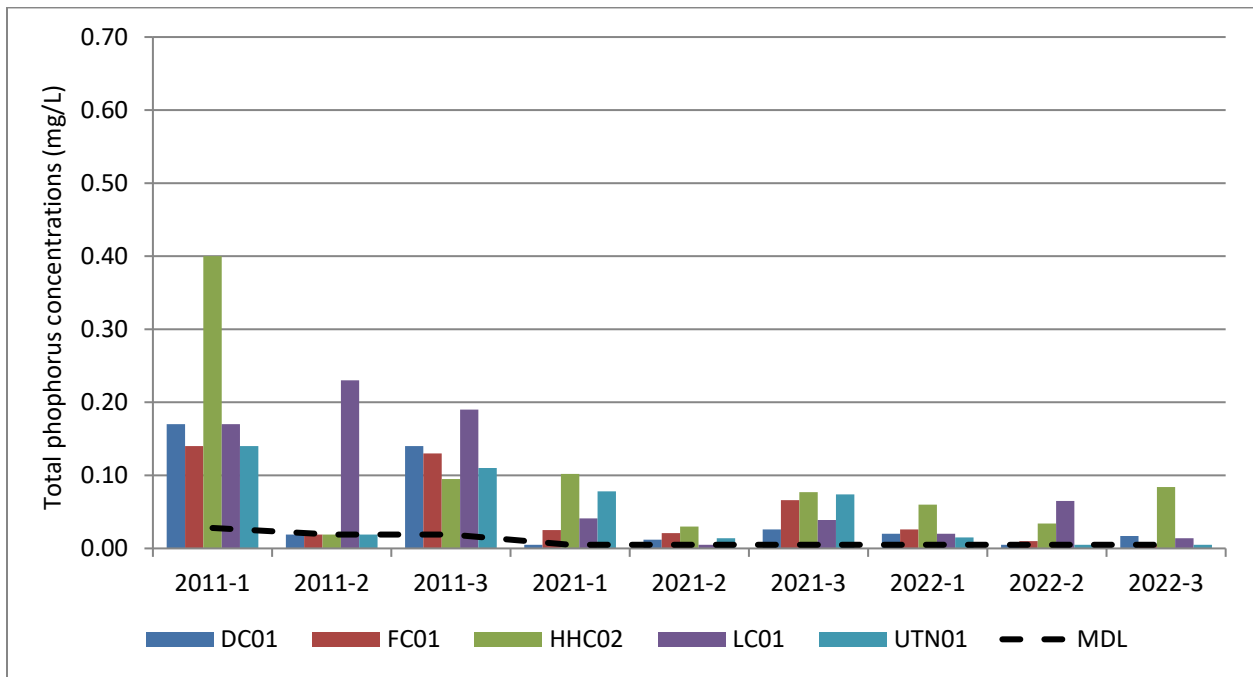


Figure 13. Total phosphorus concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

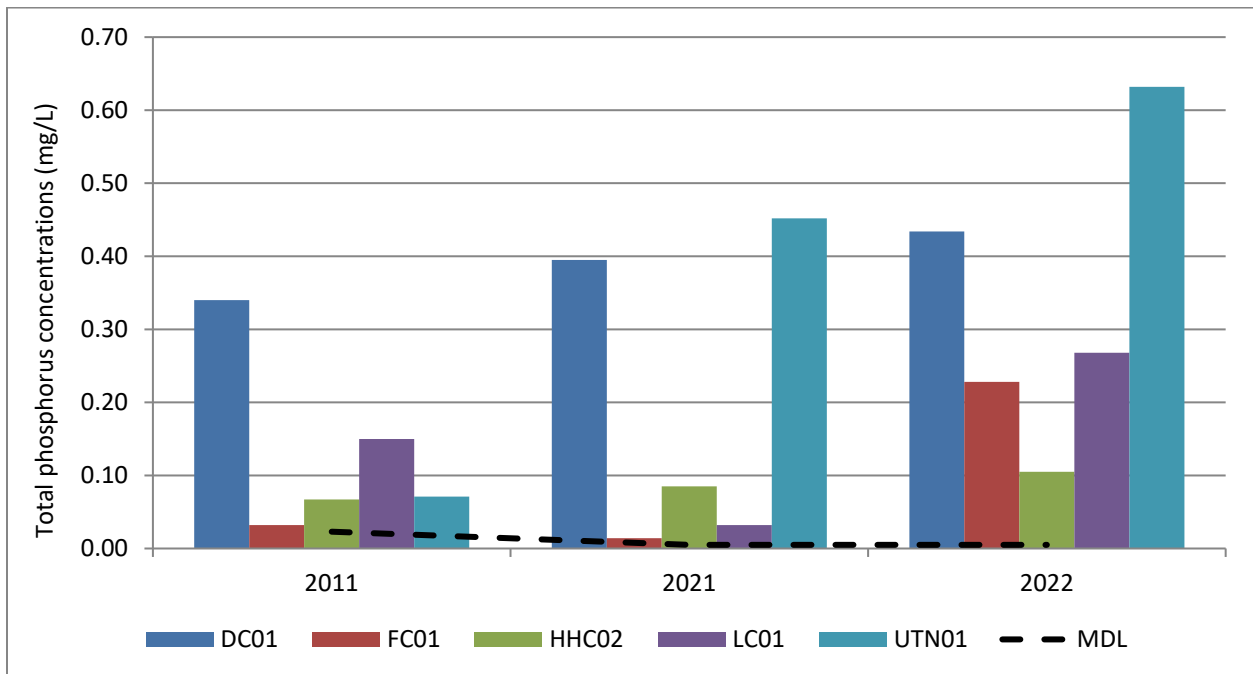
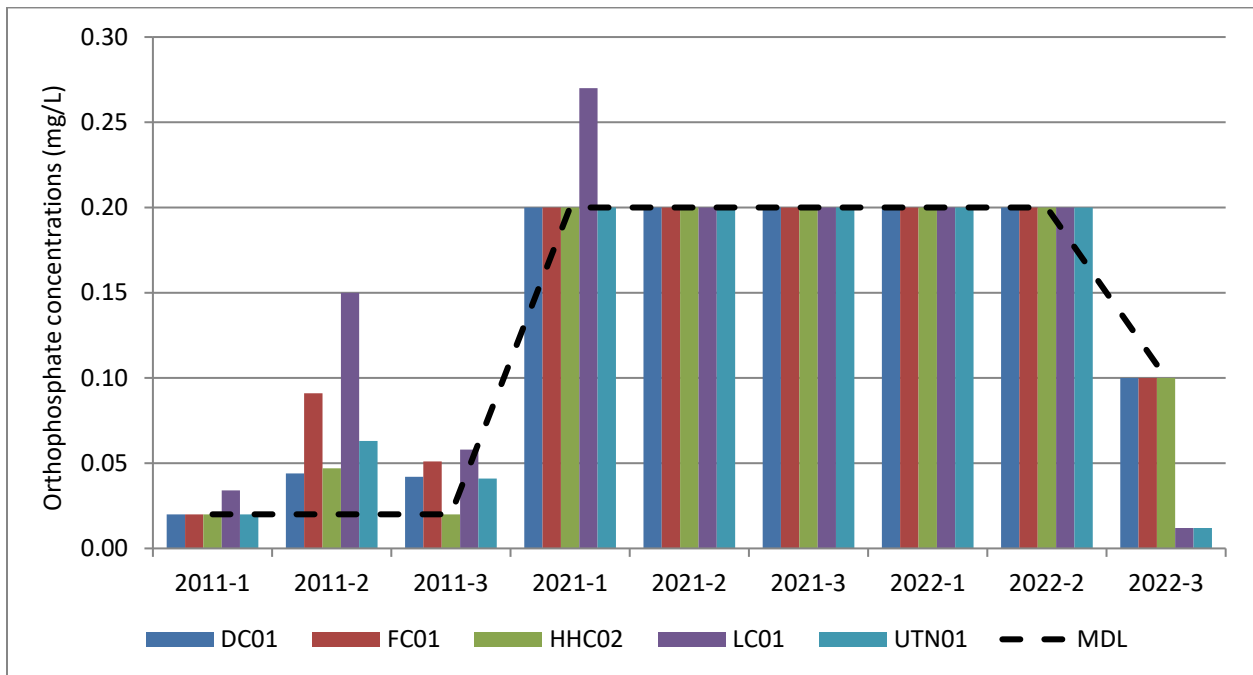


Figure 14. Orthophosphate concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 3 event. The highest MDL used is shown on the graph.

Figure 15. Orthophosphate concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

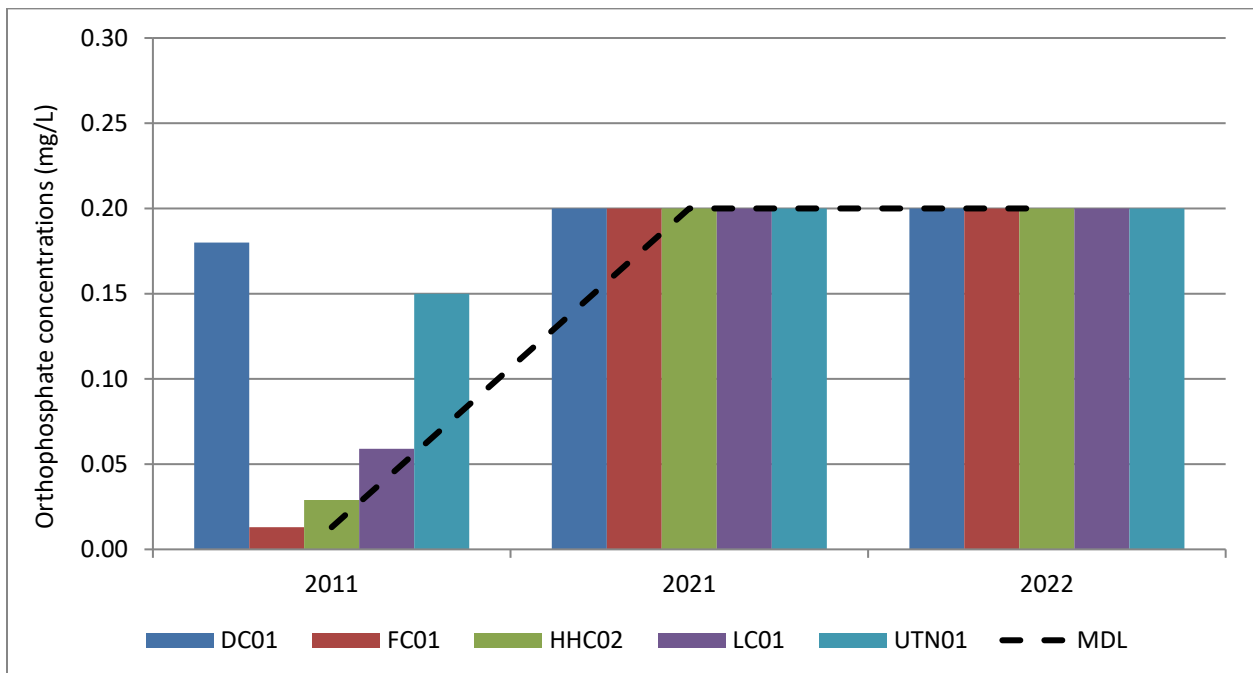
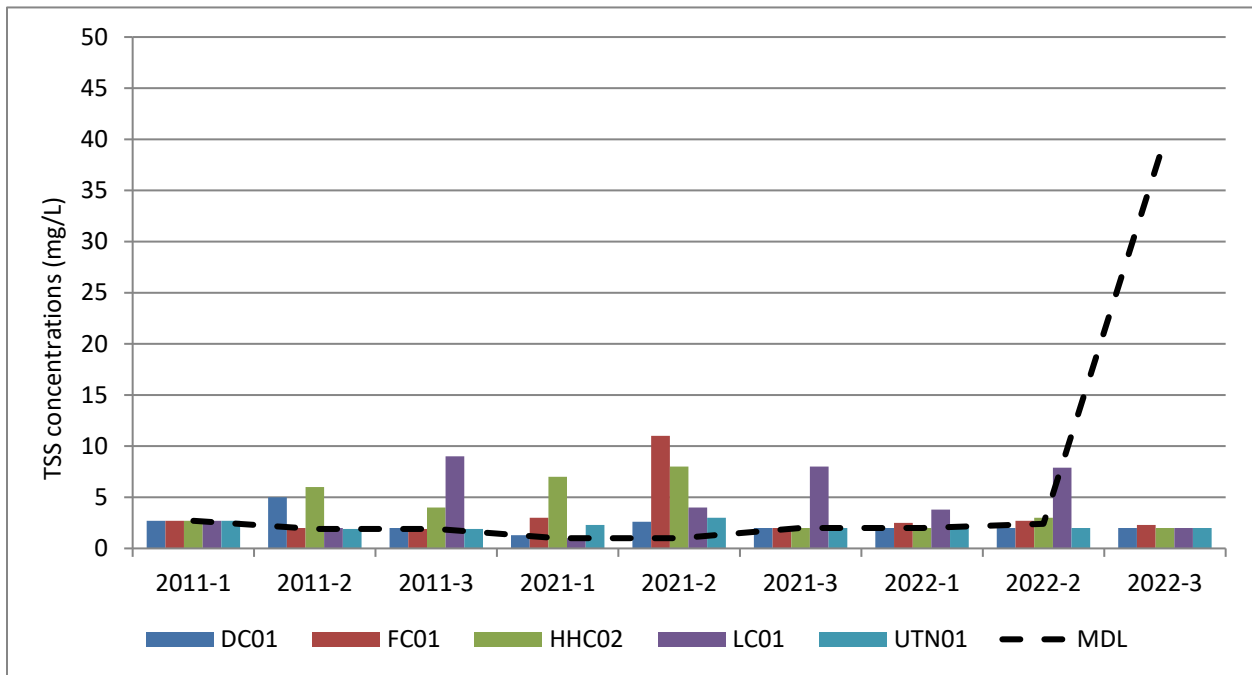
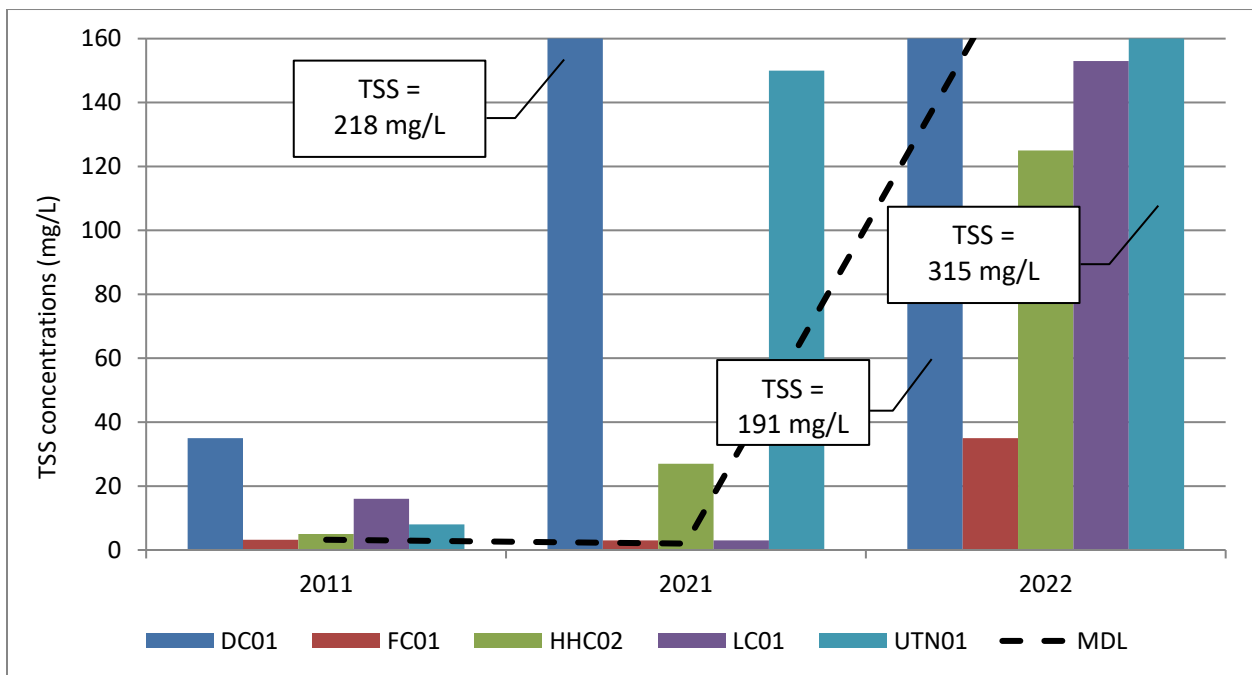


Figure 16. Total suspended solids concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather events. The highest MDL used is shown on the graph.

Figure 17. Total suspended solids concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 3 event. The highest MDL used is shown on the graph.

Figure 18. Five-day biochemical oxygen demand concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

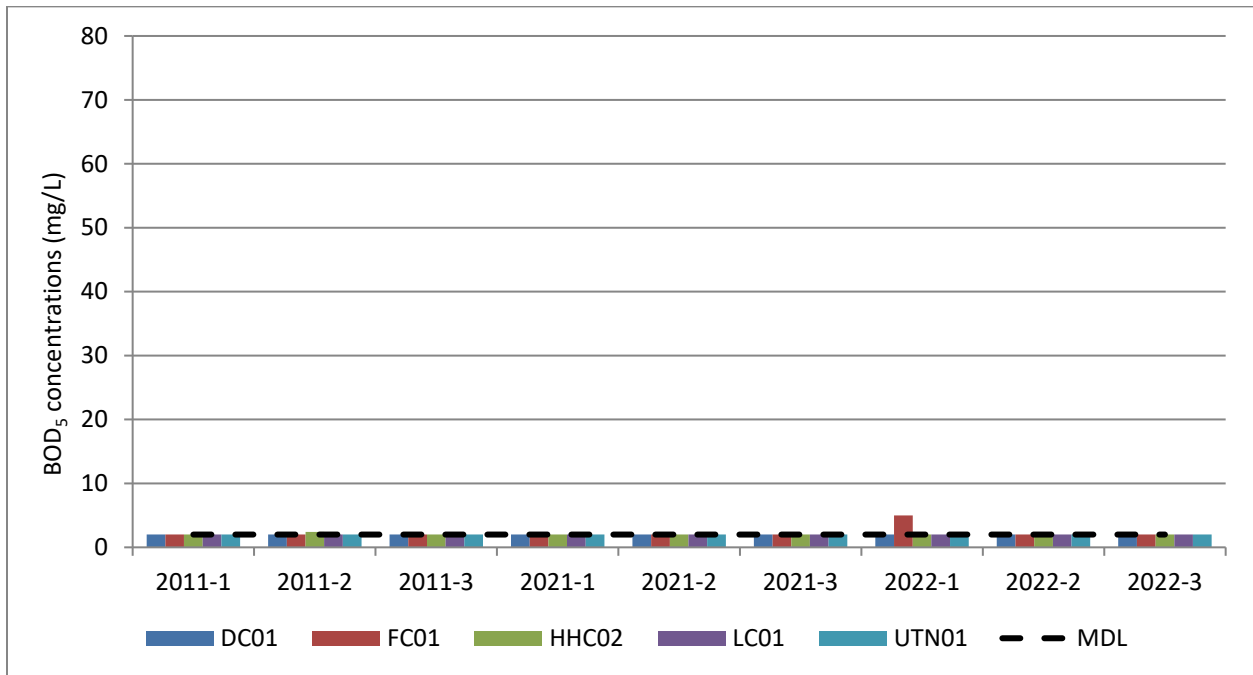


Figure 19. Five-day biochemical oxygen demand concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

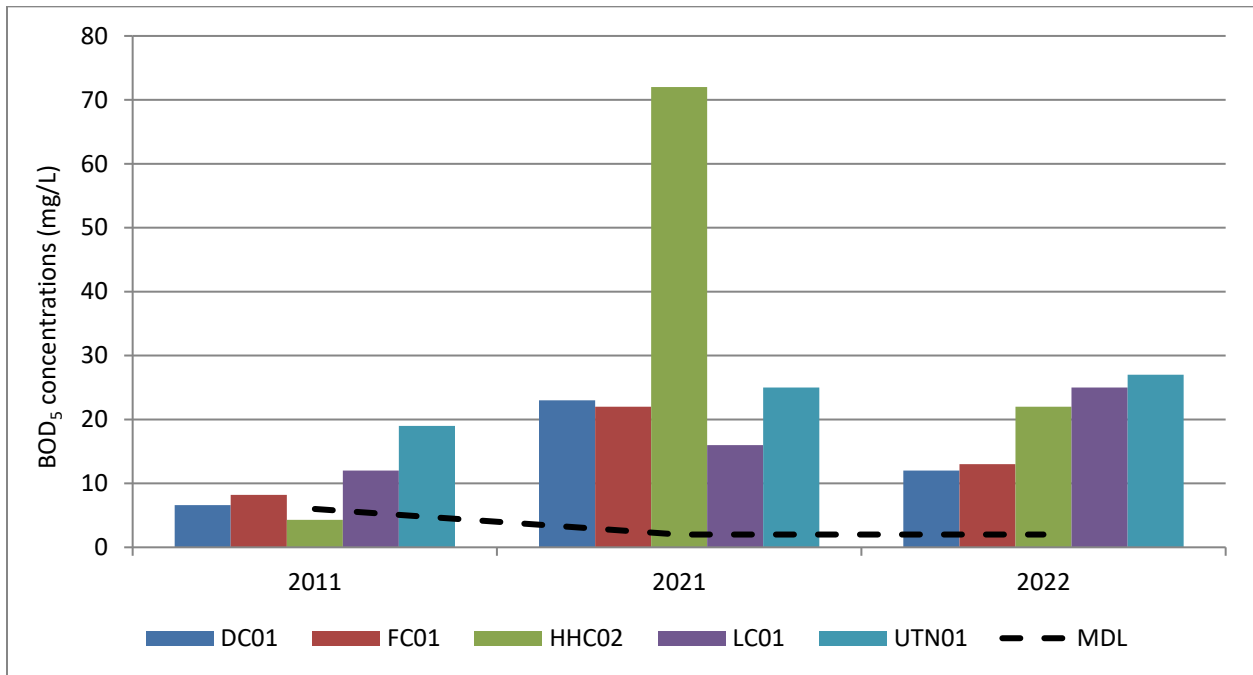


Figure 20. Chemical oxygen demand concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

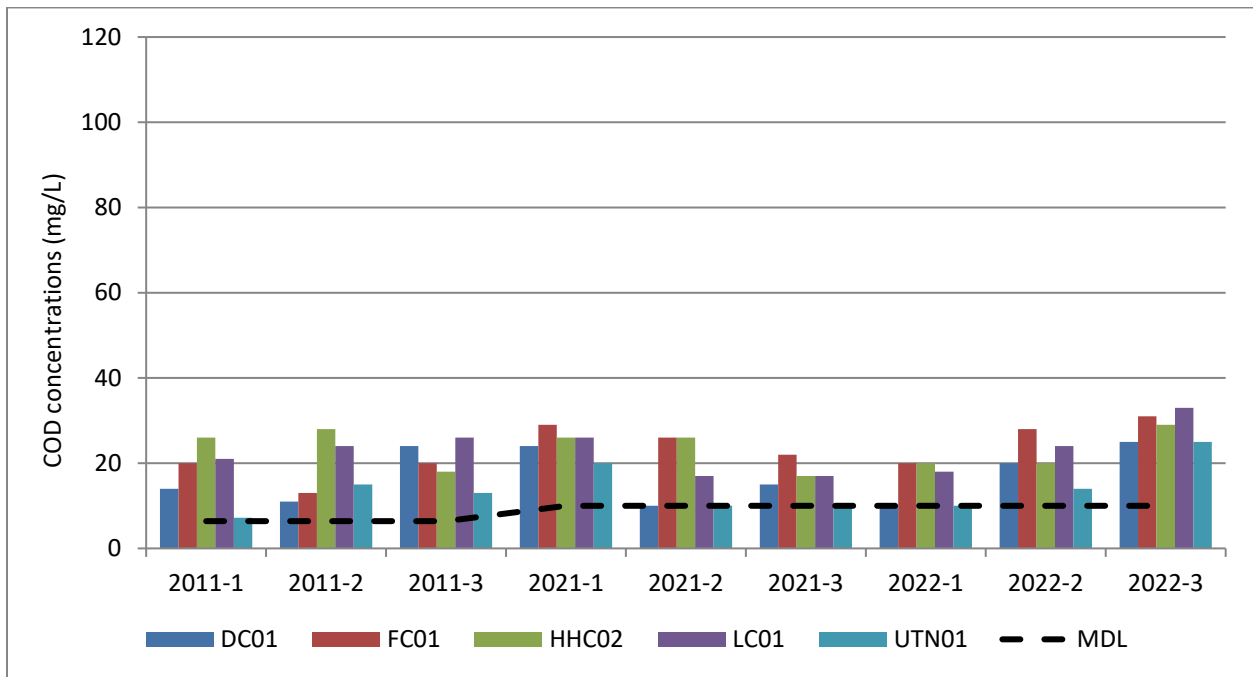


Figure 21. Chemical oxygen demand concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

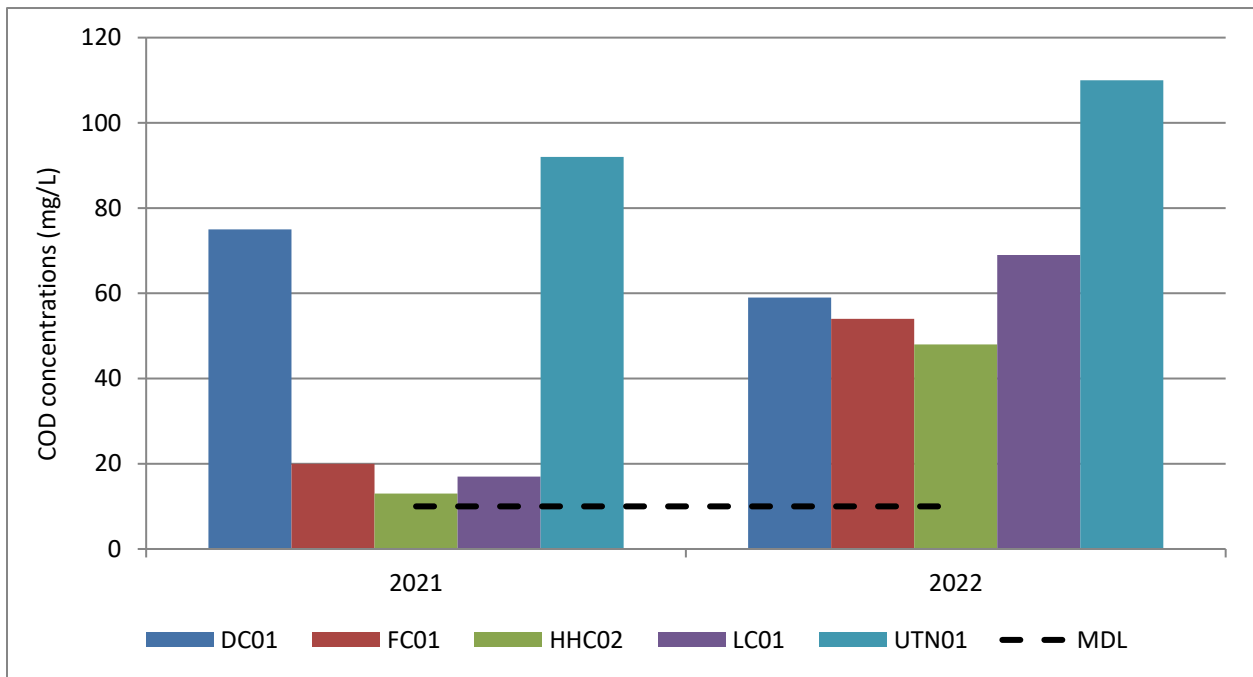
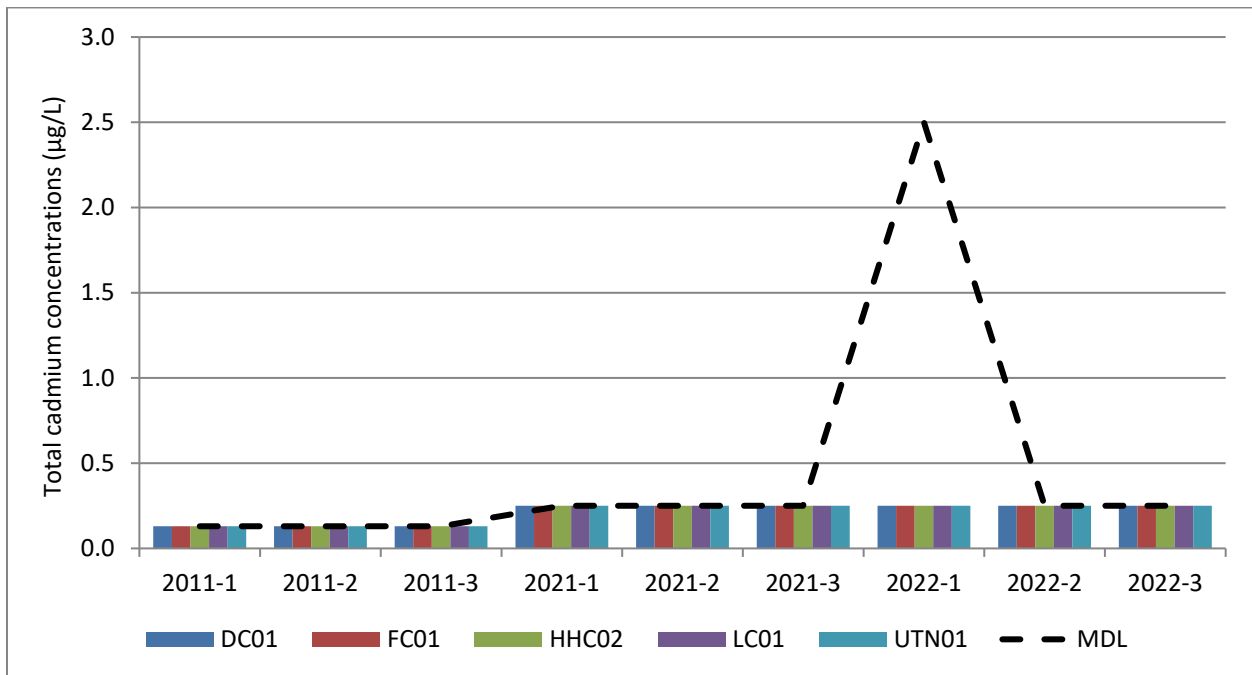
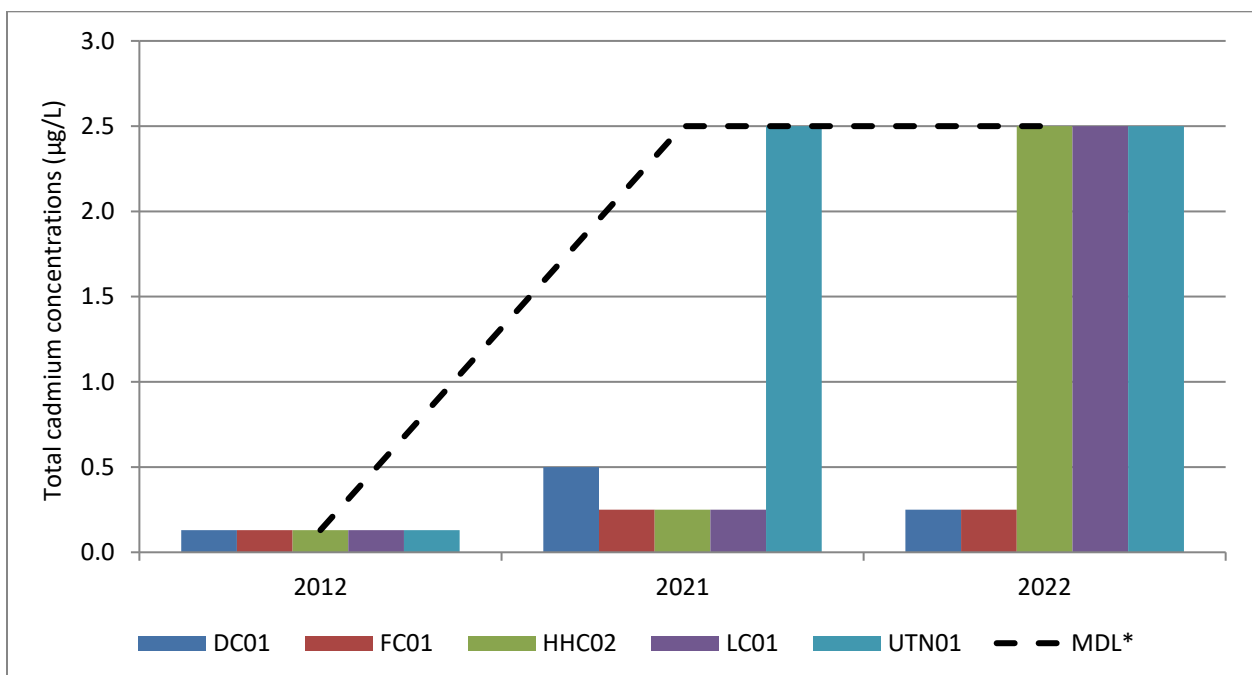


Figure 22. Total recoverable cadmium concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



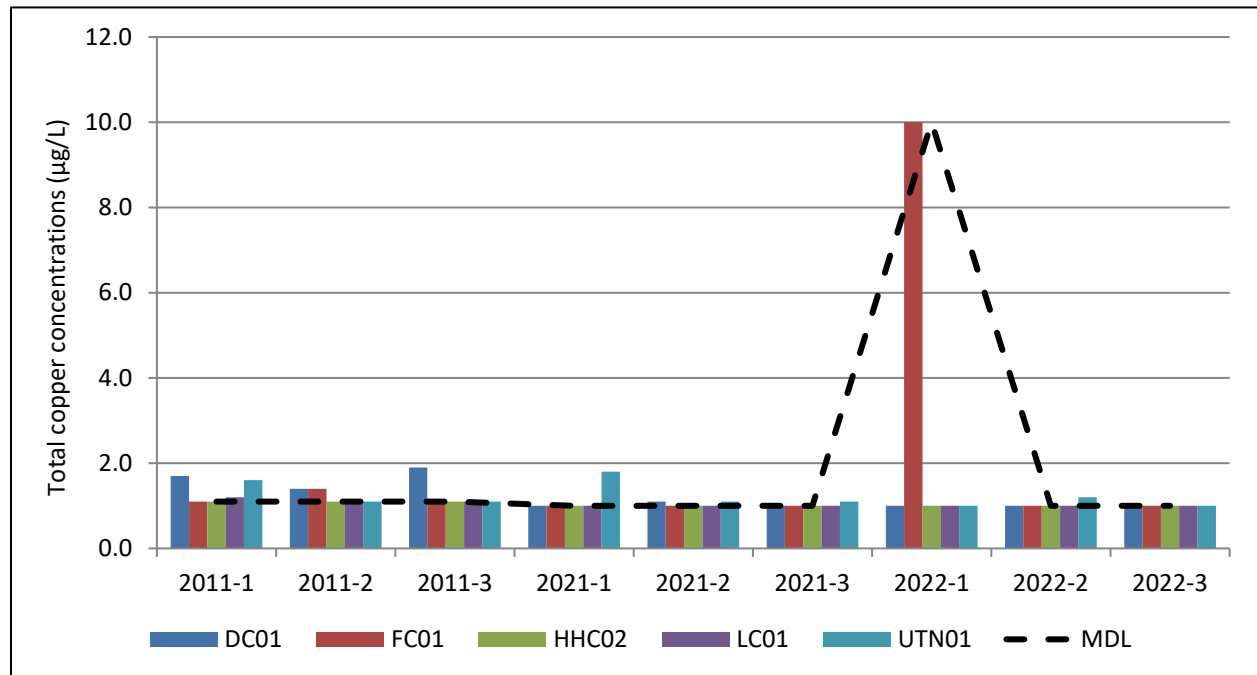
*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 1 event. The highest MDL used is shown on the graph.

Figure 23. Total recoverable cadmium concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



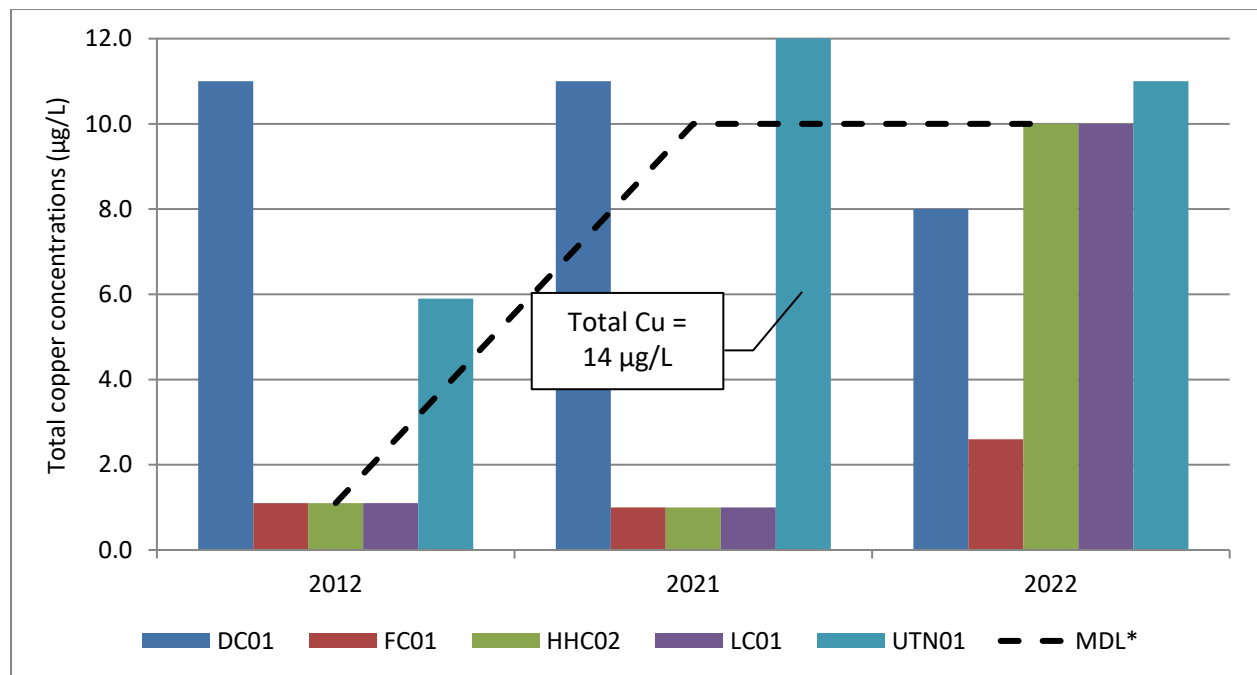
*Variable MDLs were used for each sample by the analysis laboratory for the 2022 wet weather event. The highest MDL used is shown on the graph.

Figure 24. Total recoverable copper concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 1 event. The highest MDL used is shown on the graph.

Figure 25. Total recoverable copper concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 wet weather events. The highest MDL used is shown on the graph.

Figure 26. Total recoverable lead concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

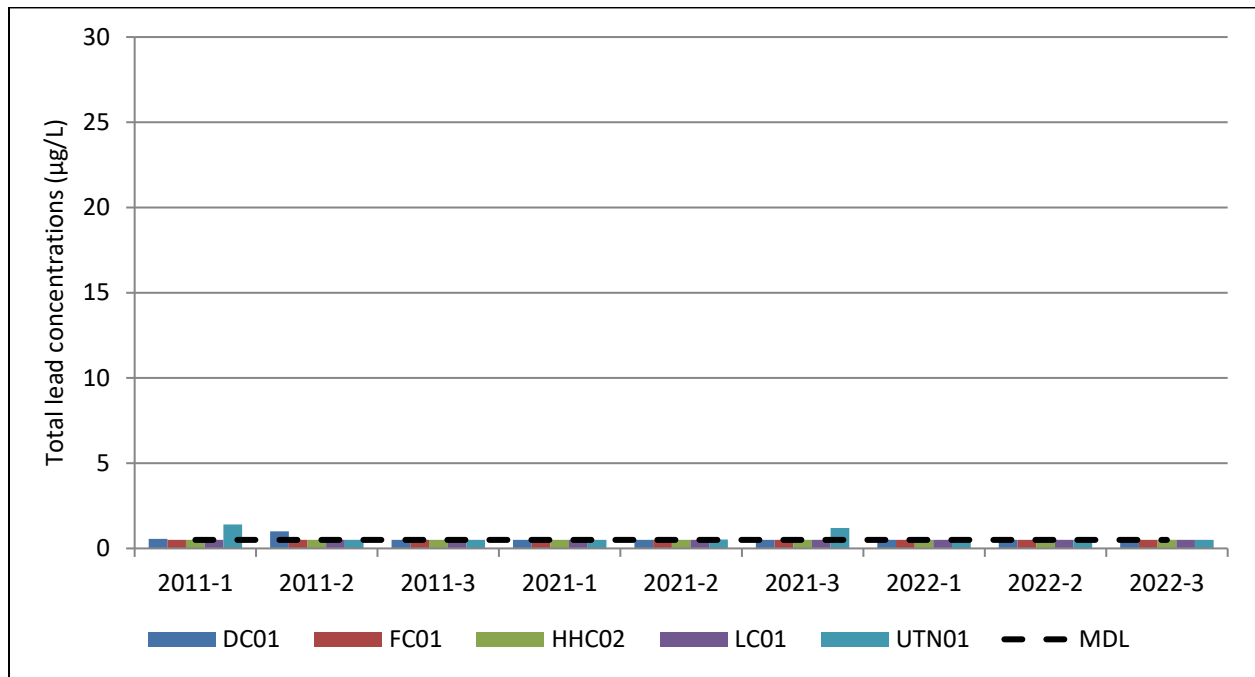
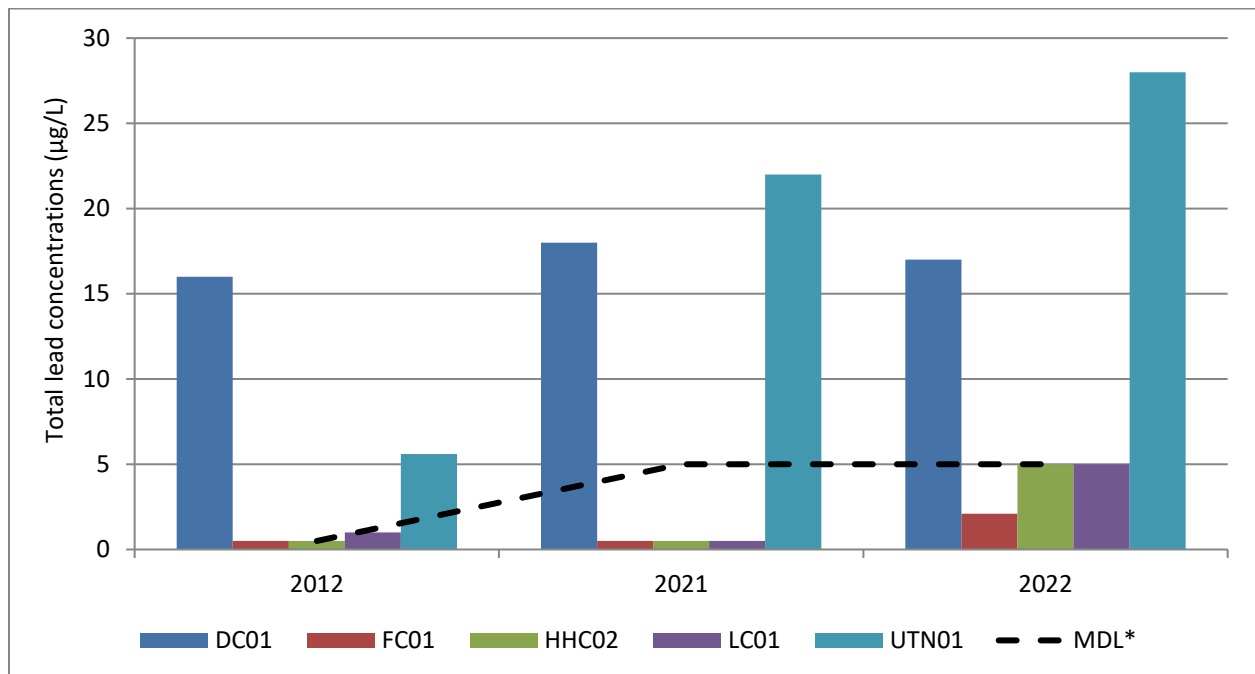
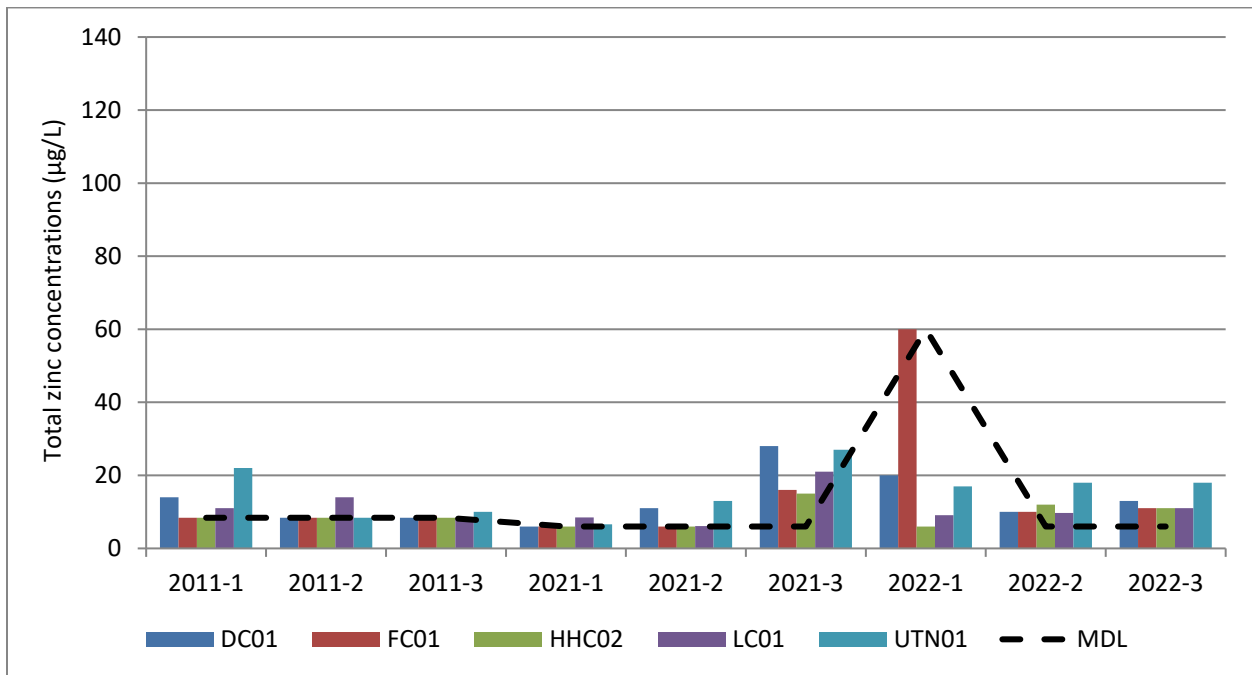


Figure 27. Total recoverable lead concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



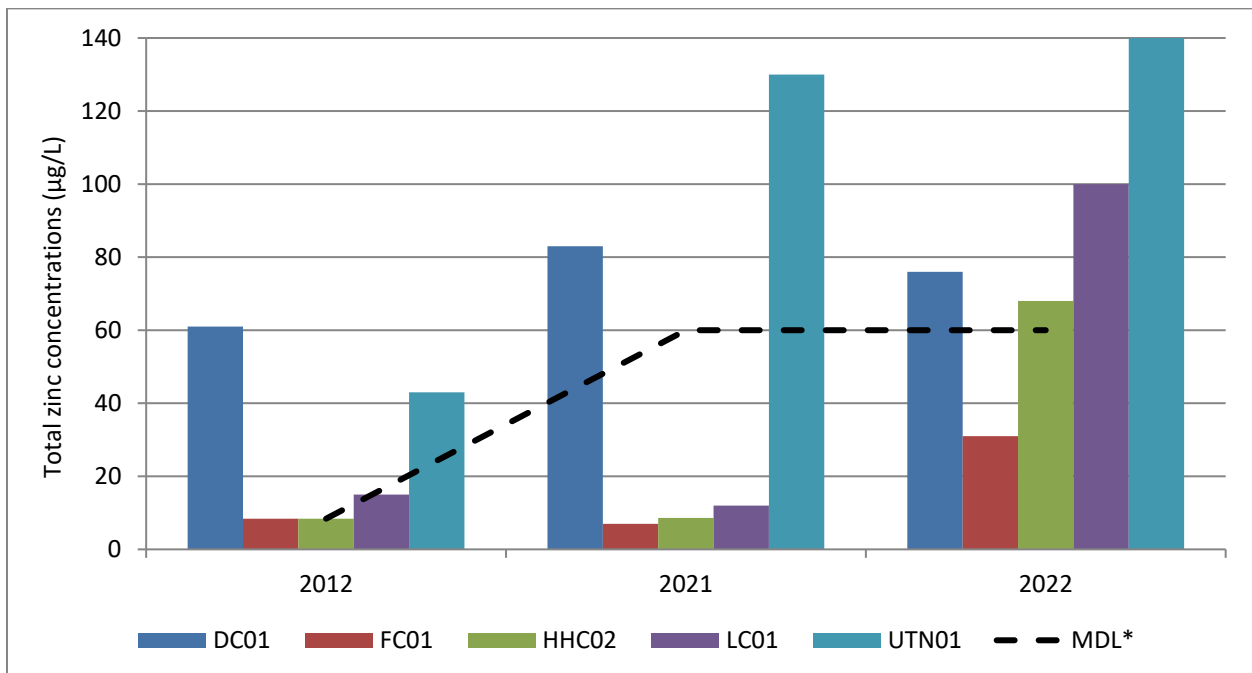
*Variable MDLs were used for each sample by the analysis laboratory for the 2021 and 2022 wet weather events. The highest MDL used is shown on the graph.

Figure 28. Total recoverable zinc concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2022 dry weather 1 event. The highest MDL used is shown on the graph.

Figure 29. Total recoverable zinc concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



*Variable MDLs were used for each sample by the analysis laboratory for the 2021 and 2022 wet weather event. The highest MDL used is shown on the graph.

Figure 30. Geometric means of *E. coli* calculated for station DC01 during the watershed assessment and long-term monitoring.

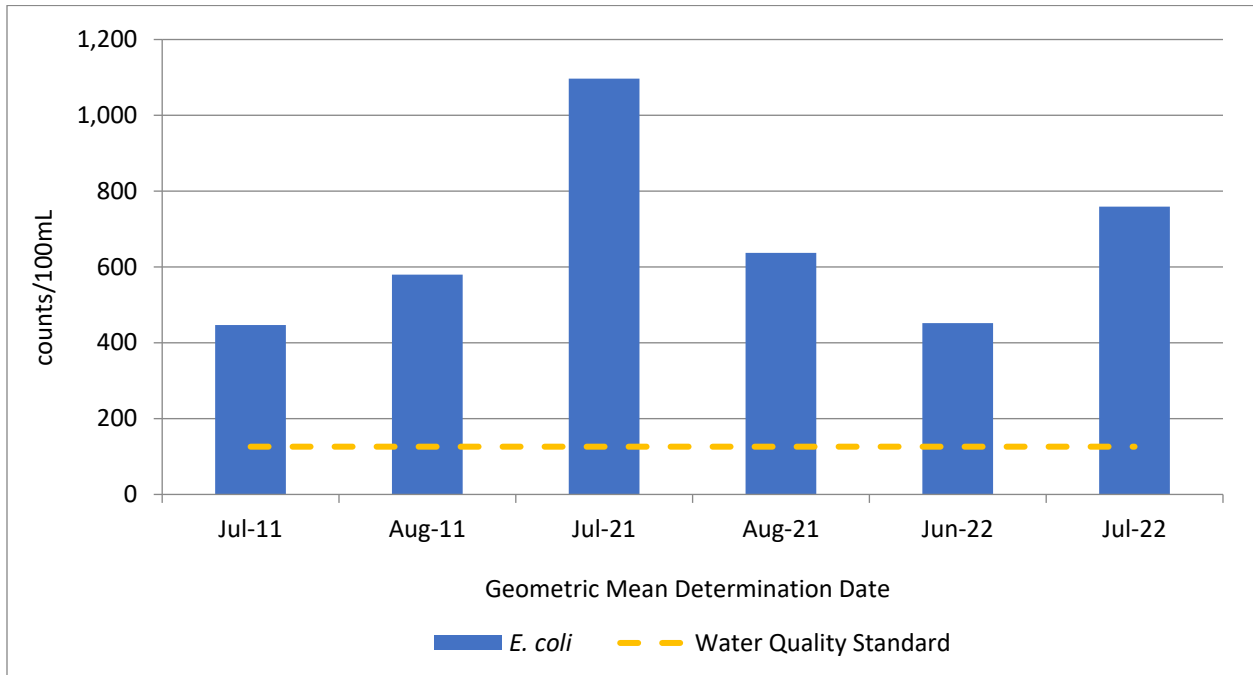


Figure 31. Geometric means of *E. coli* calculated for station FC01 during the watershed assessment and long-term monitoring.

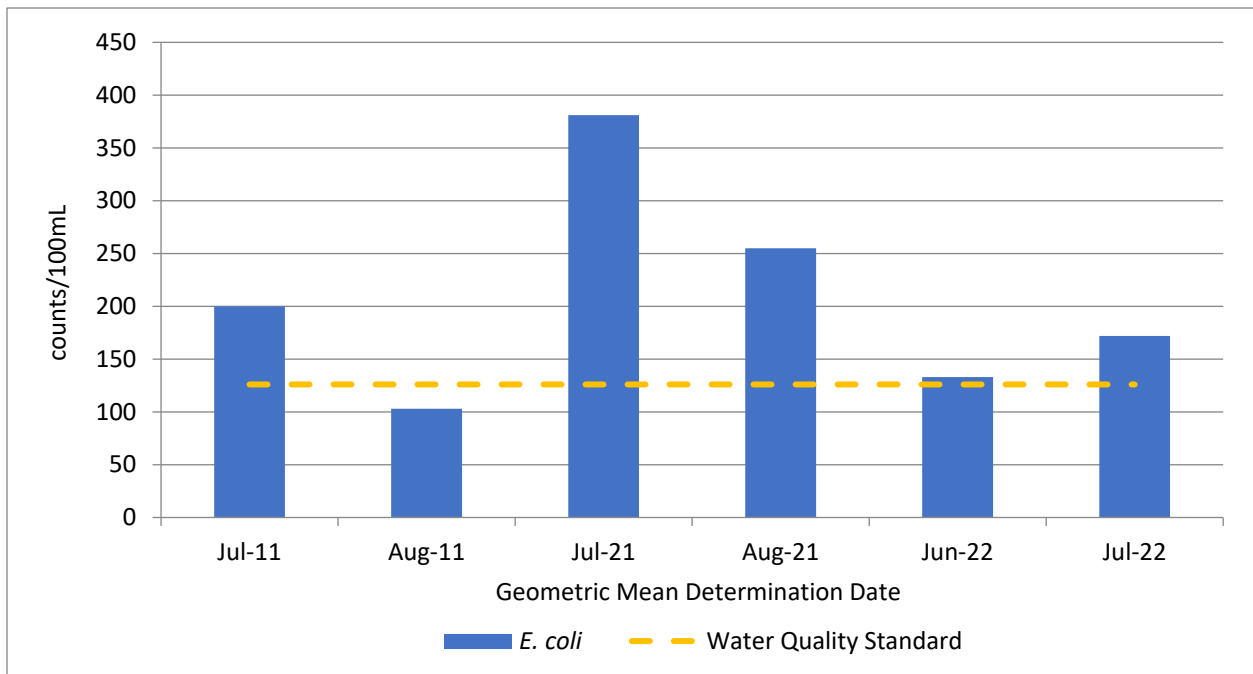


Figure 32. Geometric means of *E. coli* calculated for station HHC02 during the watershed assessment and long-term monitoring.

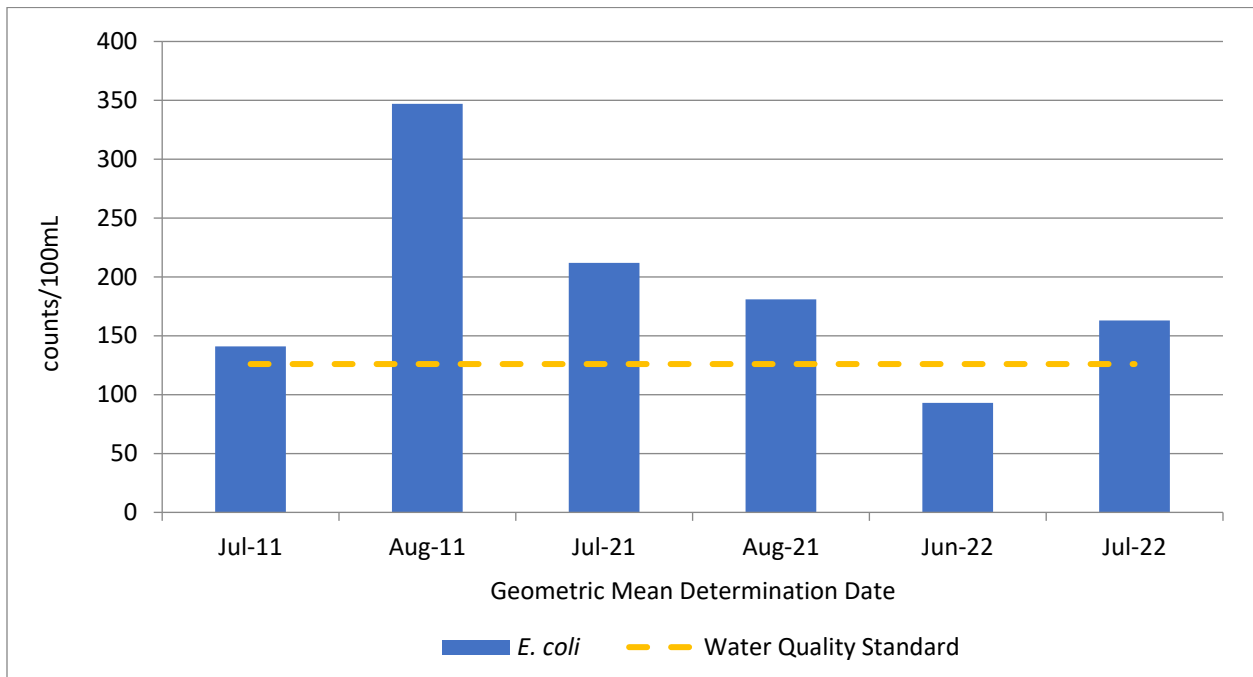


Figure 33. Geometric means of *E. coli* calculated for station LC01 during the watershed assessment and long-term monitoring.

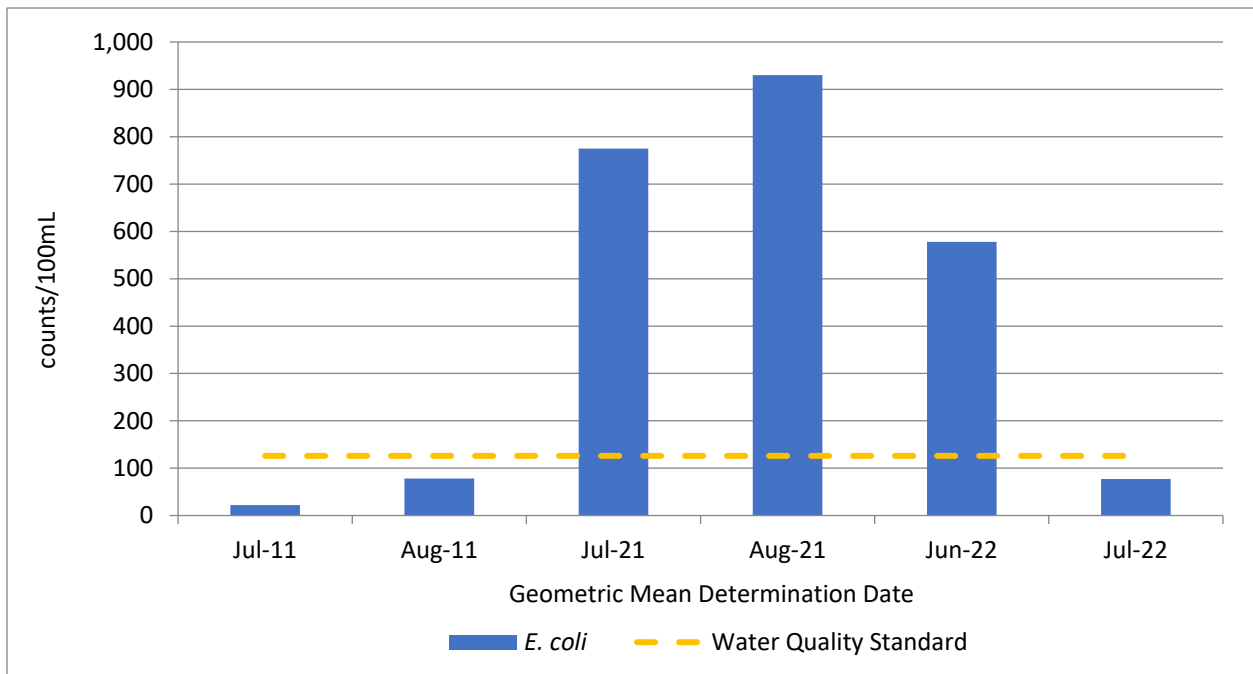


Figure 34. Geometric means of *E. coli* calculated for station UTN01 during the watershed assessment and long-term monitoring.

