

TECHNICAL MEMORANDUM NO. 08-027.01

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1.0 INTRODUCTION

The City of Dublin is located in Laurens County, Georgia in the central part of the state (Figure 1). Pursuant to the City of Dublin Watershed Protection Plan (WPP), developed January 2020 and approved February 4, 2020, six water quality monitoring stations are located on the major stream drainages surrounding the city (Figure 2). The WPP was developed for the Dublin Water Pollution Control Plant (WPCP) (NPDES permit No. GA0025569). The Dublin WPCP is permitted to discharge up to 6.0 million gallons per day of treated wastewater into the Oconee River, in the Lower Oconee sub-basin (HUC 03070102). This report presents the WPP implementation measures and results of the first year (Year 1) of long-term water quality monitoring that occurred between January and December of 2021.

2.0 WATERSHED PROTECTION PLAN IMPLEMENTATION

2.1 Water Resource Management

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 5.0 and 7.0 of the 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.

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 National Pollutant Discharge Elimination System (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).

As of April 2022, the city has contracted with engineering firm Thomas and Hutton to develop a stormwater ordinance. Work on the new stormwater ordinance has commenced. The city is currently evaluating the feasibility of implementing a city-wide Stormwater Utility but has not yet made a decision to move forward. In 2020, as a part of WPP implementation, the city incorporated discussion on whether or not to proceed with the implementation of a Stormwater Utility. Quarterly discussion and status updates will be incorporated into the City Council meeting agendas.

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. All new sewer and storm line installations are geolocated and added into the utility mapping platform.

A sewer main extension has taken place recently 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 their 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 City’s Sanitation Department offers curbside recycling. As part of their public outreach program, the city advertises the recycling program on its website.

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.

Based upon community interest and involvement, the City of Dublin plans to facilitate the development of a local Georgia Adopt-A-Stream monitoring program to involve the community in water quality assessments within the City of Dublin. The Program will be utilized to promote education about non-point source pollution and ways to alleviate water quality stressor introduction.

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, which is funded mostly by the City of Dublin, coordinates annual neighborhood as well as Oconee River clean up events.

2.2 Long-term Water Quality Monitoring

Water quality and biological monitoring are to be conducted for the city as specified in the updated 2021 WPP. Specifically, three dry weather and one wet weather water quality monitoring events are to be conducted annually. Additionally, two bacteriological geometric mean determinations for both fecal coliform and *Escherichia coli* are to be conducted from May to October for a total of two annual events. Biological monitoring (bioassessments), which includes both fish and benthic macroinvertebrate community assessments shall be conducted at least twice out of every five years and shall not be performed in consecutive years.

Water quality monitoring is to be conducted at the six monitoring stations specified in the WPP (Figure 2). The designated use for all streams in the service area is fishing. The table below summarizes the locations and monitoring requirements for the six monitoring stations:

Station	Monitoring Requirement	Station Description	Latitude	Longitude
			Decimal Degrees	
HHC02	Water Quality only	Hunger and Hardship Creek at East Mary Street	32.55426	-82.90165
DC01	Water Quality only	Dublin Creek at South Decatur Street	32.53780	-82.89809
LC01	Water Quality and Biology	Long Branch at Riverview Park Drive	32.51786	-82.89195
FC01	Water Quality and Biology	Fords Creek at US 80	32.54413	-82.96241
UTN01	Water Quality only	Unnamed Tributary at Bainbridge Street	32.54456	-82.90010
UTS01	Water Quality only	Unnamed Tributary at SR 19	32.50892	-82.90110

2.2.1 Results of 2021 Water Quality Monitoring

For the 2021 monitoring period, three dry weather events, one wet weather event, and two individual bacteriological monitoring events were completed by NAI personnel (Table 1). The dry weather sampling events were completed in May 25, July 15, and November 30, 2021. The wet weather sampling event was completed during a rain event on October 28, 2021. The first bacteriological geometric mean sampling event was conducted in June and July 2021, and the second was conducted in July and August 2021. Fish community sampling was completed concurrently with the first dry weather event in 2021 at stations LC01 and FC01. Macroinvertebrate community sampling was conducted concurrently with the third dry weather event on November 30, 2021. Table 2 presents the required water quality parameters for each event and associated laboratory test method and reporting limits. Photos of each sampling station during each sampling event are included on the CD submitted with this report.

Total observed rainfall three and seven days prior to each water quality sampling event is summarized in Table 3. According to precipitation data from the University of Georgia Weather Network station in Dublin, approximately 0.72 inches of precipitation was observed for the Dublin area during the wet weather event on October 28.

2.2.1.1 *In situ* Water Quality

Most physiochemical parameters, including water temperature, pH, dissolved oxygen (DO), and turbidity were within ranges specified in Georgia Code 391-3-6-03 Water Use Classifications and

water quality standards (Tables 2 and 4). Water temperature measurements were below the water quality standard of 32.2°C during all sampling events. Most pH readings fell within the state standard range of 6.0 to 8.5 SU except during the wet weather event at stations UTN01 (5.6 SU) and UTS01 (5.7 SU) and during the third dry weather event at station FC01 (5.8 SU). DO concentrations were above the water quality standard of 4.0 mg/L for all sampling events at five out of six stations in 2021. Seven of the 11 DO measurements at station UTS01 were below 4.0 mg/L. A debris and/or beaver dam was present at many of the sampling events at UTS01 which likely affected the DO concentrations by creating stagnant water and hypoxic conditions. Relatively high average specific conductivities for freshwater streams were recorded at stations DC01 (132 µS/cm) and UTN01 (131 µS/cm). One measurement at station LC01 during the third dry weather event was far higher than other measurements at that station (229 µS/cm; see Table 4). Higher conductivities can occur during baseflow periods with little rainfall, and there was no precipitation recorded in the 7 days prior to the third dry weather event. Average turbidities were between 10 and 20 NTU for each station with the exception of UTS01, which had an average turbidity of 40 over all 11 measurements. The debris/beaver dam and stagnant water observed at UTS01 may have also caused flocculated iron to accumulate in the water column and increase turbidity readings. Stations DC01 and UTN01 had turbidities above 100 NTU during the wet weather event, which are much higher measurements than the dry weather readings at the same stations. High turbidity during wet weather could indicate excess sediment in stormwater running off of disturbed areas in those watersheds (Table 4).

2.2.1.2 Analytical Water Quality

During the 2021 monitoring period, water samples collected during dry weather events and the wet weather event were analyzed for 5-day biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH₃), nitrate plus nitrite-nitrogen (NO₃+NO₂), total phosphorus (TP), ortho-phosphate (OP), total suspended solids (TSS), and alkalinity (Tables 2 and 5).

Nutrient concentrations were variable in streams across the Dublin service area during 2021 monitoring. Concentrations of NH₃ were variable across all stations and events, ranging from below detection limits (<0.02 mg/L) to 0.20 mg/L, with similar NH₃ concentrations across all stations (Table 5). Nitrate concentrations were only recorded above method detection limits (>0.20 mg/L) at stations UTN01, LC01 and DC01, and ranged from below detection limits to 0.83 mg/L. TKN concentrations ranged from below detection limits (<0.20 mg/L) to 1.54 mg/L and were generally highest during the wet weather event at most stations. TKN for station UTS01 was consistently higher than other stations for the dry weather events. Orthophosphate was below detection limits in most samples, except during the first dry weather event at LC01 when

a value of 0.27 mg/L was reported. Total phosphorous ranged from below detection limits (<0.005 mg/L) to 0.45 mg/L. Most total phosphorous concentrations were within the Environmental Protection Agency (EPA) Nutrient Ecoregion IX reference range of 0.04 to 0.10 mg/L. Stations DC01 and UTN01 had phosphorus concentrations much higher than other stations during the wet weather event, and station UTS01 had relatively high concentrations during dry weather events, a possible indication of nonpoint source nutrient runoff in those watersheds.

Concentrations of BOD₅ were near or below detection limits during dry weather events but were much higher during the wet weather event at all stations, ranging from 16 to 72 mg/L. Elevated BOD₅ concentrations can often be elevated due to stormwater inputs carrying organic matter and/or nutrient runoff from impervious surfaces. Concentrations of COD were variable across events, and higher during the wet weather event at the same stations that showed elevated phosphorus during that event (DC01 and UTN01). COD concentrations ranged from below detection limits (10.0 mg/L) to 75 mg/L. Most TSS concentrations were near or below method detection limits during dry weather, except for an unusually high value of 180 mg/L at UTS01 during the second dry weather event. Concentrations of TSS were higher during the wet weather event for most stations, especially DC01 and UTN01. The high TSS at DC01 and UTN01 during the wet weather event indicates a large amount of sediment and/or organic particle runoff was present in the streams, and it is likely that the elevated phosphorus, TKN, and COD measured at those stations was associated to the solids suspended in the stream (Table 5). Stations DC01 and UTN01 are located on small tributaries in urbanized areas in Dublin, and both have small watersheds with close to 100% developed land use (see Figure 3 and Section 3.2 below). Potential sources of nonpoint source sediment and nutrient pollution in urbanized watersheds with high percentages of impervious surfaces include erosion of the stream channel from high stormwater volumes, oil, grease, and chemicals from motor vehicles, and pesticides and fertilizer 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 all dry and wet weather sampling events in 2021 (Table 6). Dissolved metals were calculated from total recoverable concentrations using hardness-based formulas developed by the EPA. Calculated dissolved concentrations were then compared to acute and chronic criteria specified in Georgia Code 391-3-6-03 Water Use Classifications and Water Quality Standards (Table 7). Total recoverable cadmium concentrations were below detection limits at each station during all 2021 sample events. The majority of the lead, copper, and zinc concentrations were also near or below detection limits in 2021, with the exception of the wet weather event at stations

DC01 and UTN01, the same stations that had elevated nutrient, TSS, and COD concentrations during the wet weather event. The elevated metals concentrations during the wet weather event resulted in exceedances of the chronic copper and lead criteria at station UTN01, and the chronic lead criterion at station DC01 (Table 7). As noted above, the watersheds of stations DC01 and UTN01 are highly urbanized. Potential sources of heavy metals from nonpoint sources in urban watersheds include sediment, roof shingles, motor vehicles, and improperly disposed appliances and other waste.

2.2.1.3 Bacteriological Sampling

The first bacteriological geometric mean (geomean) for the 2021 long-term monitoring period was calculated from four individual samples collected by NAI personnel between June 24 and July 15, 2021. Field sampling for the second round of bacteriological sampling for the 2021 long-term monitoring period was conducted by NAI personnel between July 22 and August 12, 2021 (Table 8).

During both geomean determinations, all stations exceeded the Georgia water quality standard for fecal coliform of 200 counts/100 mL for streams with a designated use of fishing during the months of May through October (Tables 2 and 8). A state water quality standard has been proposed for *E. coli* but is not yet EPA approved for freshwater streams with a designated use category of fishing. The proposed *E. coli* geometric mean standard for freshwater streams is 126 counts/100 mL during the months of May through October. The first *E. coli* geomean for station UTS01 was below the proposed water quality standard, and the second geomean was above the standard. All remaining stations had *E. coli* concentrations well above 126 counts/100mL during both determinations in the 2021 long-term monitoring period (Table 8). Stations UTN01, DC01, and LC01 had the highest concentrations of both fecal coliform and *E. coli* of the six stations for all geomean events. Potential sources of bacteria runoff from urbanized watersheds, such as the watersheds of UTN01 and DC01, include pet waste, leaking sewer pipes, and failing or improperly maintained septic systems.

2.2.2 Biological Monitoring 2021

2.2.2.1 Benthic Macroinvertebrate Community Assessment

Macroinvertebrate bioassessments were conducted at stations FC01 and LC01 on November 30, 2021 in accordance with Georgia Environmental Protection Division (EPD) Standard Operating Procedures and Watershed Assessment and Protection Plan Guidance documents (EPD, 2007). The macroinvertebrate community sample from Fords Branch at station FC01

contained 224 individuals from 30 different taxa (Table 9). Chironomid midges made up the majority of the sample (66%), with *Corynoneura* sp. (16%) and *Rheocricotopus robacki* (10%) being the most abundant taxa. Caddisflies in the genus *Chematopsyche* were also relatively abundant in the FC01 sample (9.8%). Ten different taxa from the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) were identified in the sample. The FC01 community sample received a Multi-metric Index (MMI) score of 75 for streams in the Atlantic Southern Loam Plains (65I) Level IV Ecoregion, with higher scores given for a high abundance of EPT taxa and lower scores given for the number of predator taxa in the sample (Table 10). The macroinvertebrate community sample from Long Branch at station LC01 contained 189 individuals from 24 different taxa (Table 9). Chironomid midges made up a larger percentage of the LC01 sample (80%) compared to the FC01 sample, with the most abundant taxa being *Polypedilum illinoense* (30%), *P. flavum* (19%), and *Tanytarsus* sp. (14%). Only four EPT taxa were identified in the FC01 sample. The LC01 sample received an MMI score of 52 (Table 10).

Both stations received similar average scores on the macroinvertebrate habitat assessments, with average scores of 147 and 150 out of 200 points for FC01 and LC01, respectively (Table 11).

2.2.2.2 Fish Community Assessment

NAI personnel completed fish sampling at stations FC01 and LC01 during the dry weather event on May 25, 2021 (Tables 3 and 4). A total of 104 individuals from 11 different taxa were collected at station FC01, and 72 individuals from 14 different taxa were collected from LC01 (Table 12). Sunfish (*Lepomis* spp.) dominated the species assemblage at FC01, whereas shiners (*Notropis* spp.) dominated the assemblage at LC01. The Georgia Department of Natural Resources (DNR) Index of Biotic Integrity (IBI) scores for FC01 and LC01 were 28 and 38, respectively. The IBI narrative score for FC01 is “Poor,” and for LC01 is “Fair.” Scores for habitat assessments completed during 2021 fish sampling for stations FC01 and LC01 averaged 138 and 137, respectively out of 200 possible points (Table 13).

3.0 LONG-TERM WATER QUALITY TRENDS

During the 2011 Watershed Assessment (WA) period, the most commonly identified water quality stressors within the Dublin service area were high fecal coliform from historic agricultural land use and urban stormwater runoff. However, the Dublin area experienced a significant drought in 2011, complicating conclusions about water quality stressors and trends between the WA year and the first year of long-term monitoring in 2021.

3.1 Precipitation Trends

The Dublin WPCP hosts a Global Historical Climatology Network (GHCN) monitoring station with a long-term precipitation record (Station No. USC00092844). Average annual precipitation totals at the Dublin GHCN station for the most recent 30-year period (1991 to 2020) was 49.31 inches. The table below summarizes the annual precipitation for the Dublin monitoring station from the WA year in 2011 and long-term monitoring year 2021.

Monitoring Year	Observed Precipitation (inches)	Departure from Normal (inches)
1991 – 2020 Average	49.31	n/a
WA 2011	37.62	-11.69
2021	53.86	+4.55

During WA monitoring in 2011, the Dublin area experienced an annual rainfall deficit of almost 12 inches. Annual precipitation for the first year of long-term monitoring in 2021 was 4.55 inches above the 30-year average. These differences in rainfall likely impacted water quality monitoring results.

3.2 Land Use Data

The 2019 National Land Cover Database (NLCD), produced by the Multi-Resolution Land Characteristics Consortium, represents the most recent 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 land use within the watersheds of the long-term water quality monitoring stations (which include some areas outside of the service area; see Figure 3). Land use within each water quality station’s watershed 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/open space developed, forest, pasture/hayland, cultivated cropland, and wetland/water (Table 14).

Current land use/land cover in the City of 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 11.5%, which is a minor increase from 2011, when impervious surfaces covered approximately 10.9% of the service area.

The watersheds for stations UTN01 and DC01 contain the highest percentage of developed land (85% and 90%, respectively), with approximately 29% and 33% impervious surface coverage. 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, UTS01 and FC01 also contain the highest proportion of forested land in the service area ranging from 30 to 32%.

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 (geology, soils, land use, etc.). Further, care should be taken when comparing water quality parameter summary statistics, as sampling methodology (e.g., number and annual and diurnal timing of sample collection), laboratory methods, and statistical approaches can substantially vary, potentially leading to spurious interpretations of trends. This is especially true when the dataset has a small sample size, as summary statistics (e.g., averages) can be skewed by outliers. Due to the multi-factorial nature of the conditions that influence water quality, conclusive identification of water quality trends and their causes is inherently problematic, without identifiable drivers such as major land use change or point sources of pollution.

For the Dublin service area, water quality samples have only been collected in 2011-2012 and 2021, and inferences cannot be made about water quality trends. Only water quality anomalies and differences between the two 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 annual values of physiochemical parameters from the WA year in 2011 were calculated for each station for comparison with the 2021 monitoring results (Tables 15 and 16). Specific conductivities were slightly lower in 2021 compared to 2011, possibly as a result of low water levels from the 2011 drought, and pH values were also slightly lower in 2021 than 2011. Turbidity values were higher in 2021, possibly due to the higher rainfall compared to 2011 (Table 15).

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 – October) and winter months (November – April) for each monitoring period. Overall, most DO values were higher and temperatures lower in both seasons in 2021 compared to 2011. A few of the winter DO measurements in 2011 were higher than 2021 despite temperatures also being higher (stations FC01, UTN01, and UTS01). In 2011 measurements, there were multiple exceedances of the state DO standards at stations FC01, HHC02, CC01, LC01, and UTS01. In 2021, only station UTS01 had DO concentrations below the standard, with a summer average DO of 3.6 mg/L, which was slightly higher than the summer average for that station in 2011 (1.8 mg/L). Low DO concentrations during 2011 were likely partially attributable to low water levels and warm temperatures.

3.3.2 Analytical Water Quality Trends

To assess any water quality trends between the 2011 WA and the first year of long-term monitoring, 2021 dry and wet weather analytical results were compared to the WA monitoring results. When an analytical parameter was not detected in a sample, the laboratory MDL is shown in Figures 4 through 28. Only those parameters that appear to show substantial differences or anomalies are discussed in the section that follows.

Nutrient parameter concentrations varied among years, stations, and event type. Compared to 2011 results, dry weather concentrations of nitrate-nitrogen, TKN, and total phosphorus at most stations were slightly lower in 2021, while ammonia was slightly higher (Figures 4 through 15). Station UTS01 had higher dry weather ammonia, TKN, and total phosphorus than the other stations in 2011. During 2021, a similar pattern emerged where station UTS01 had higher nutrient concentrations during most dry weather sampling events. Wet weather nutrients including TKN, total phosphorus, and orthophosphate were also relatively high at UTS01 during 2011 monitoring (Figures 10 through 15). Stations DC01 and UTN01 had higher concentrations of nitrate-nitrogen during dry weather events in 2021, as well as higher total phosphorus during

wet weather for both years. As discussed in section 2.2.1 above, stations UTN01 and DC01 have small, urbanized watersheds with high potential for nonpoint source nutrient runoff. The watershed above station UTS01 contains several agricultural fields and active silviculture properties, which may contribute nutrient runoff from fertilizers. TSS concentrations were noticeably higher at station UTS01 during dry weather events in 2021 and at two events in 2011 (Figure 16), and higher at station DC01 during wet weather events in both years (Figure 17). TSS concentrations are likely related to the watershed land uses for the stations as previously discussed.

Copper, lead, and zinc were all higher during wet weather than dry weather at stations DC01 and UTN01 in 2021 (see section 2.2.1). Higher values of these metals were also observed during wet weather than dry weather during the 2011-2012 WA sampling period (Figures 24, 26, and 28). 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 Monitoring Trends

Geomeans of *E. coli* and fecal coliform calculated for long-term monitoring in 2021 were plotted for comparison to WA monitoring in 2011 (Figures 29 through 34). Bacteria geomeans at stations LC01 and UTN01 were noticeably higher in 2021 compared to 2011, while UTS01 geomeans were slightly lower. The same stations with the highest bacteria geomeans in 2021 also had high geomeans in 2011 (UTN01 and DC01). Bacteria are often detected in stormwater runoff, from various sources, and the higher bacteria geomeans in 2021 compared to 2011-2012 may be attributable to the higher rainfall totals during. However, watershed land use and size appears to be associated with varying bacteria concentrations for most stations in the Dublin service area.

3.3.4 Long-term Water Quality Trend Conclusions

Differences between 2011 and 2021 water quality in the Dublin WPCP service area are likely related to the drought conditions during 2011, illustrated by the 16-inch difference in annual precipitation between the two years. Continued annual monitoring is required to detect meaningful water quality trends. Both years of observed data indicate a relationship between water quality and watershed land use with existing datasets show a spatial trend that is likely related to watershed land uses. Stations with higher proportions of development, especially DC01 and UTN01, had higher concentrations of nutrients, metals, and bacteria during 2021 monitoring. Low DO concentrations and relatively high nutrients and sediment concentrations

at station UTS01 are likely related to surrounding agricultural and forestry land use as well as the sampling location on a swampy, braided portion of the tributary.

The macroinvertebrate MMI scores at both FC01 and LC01 were higher in 2021 than 2011, despite both stations having slightly lower average habitat assessment scores in 2021 (Tables 9 through 11). The fish community IBI score at LC01 did improve over 2011 from 30 (Poor) to 38 (Fair) in 2021, although the score for station FC01 was slightly lower in 2021 (Table 12). Taxa richness increased at station FC01 from 11 in 2011 to 14 in 2021. In 2011, the IBI score for FC01 was 36 (Fair). The IBI score decreased slightly in 2021 to 28 (Poor; see Table 12). Additional monitoring is needed to determine if any trends in biological communities develop in streams in the Dublin service area.

3.4 Potential Management Measures

The results of the WA and the first year of long-term monitoring indicate that stormwater BMPs are a promising option to address nonpoint source pollution from urban land uses in the Dublin WPCP service area. Specific BMPs to target urban stormwater runoff include public education and outreach programs to educate citizens of Dublin regarding water quality transport mechanisms and pollution abatement. The city could inform the residents about the importance of reducing pollution in stormwater runoff through litter and waste reduction, the reduction of land and garden fertilizer application rates, and the importance of stream buffers and vegetation. The city could also host or sponsor community stream clean ups or add additional information on their website about the importance of protecting water resources in the Dublin area. Vegetated stream buffers are also an effective measure for improving stormwater quality, as they trap and filter common pollutants prior to entering the streams. The city could consider a stream buffer enhancement or establishment program or encourage citizens to restore or maintain stream buffers.

To address other potential sources of nonpoint source pollution within the service area, the city could conduct stream walks to detect illicit discharges, develop a plan to prevent illicit discharges, and/or develop a community hotline for residents to report illicit discharges. The City could also conduct regular inspections of the wastewater treatment system and establish a leak detection system. Signage could be installed along the waterways and within all City parks to educate citizens about the importance of cleaning up pet wastes and maintaining stream buffers.

4.0 FUTURE SAMPLING AND PROPOSED WPP CHANGES

The 2022 monitoring period began in January 2022 and will conclude on December 31, 2022. The annual status report for the 2022 monitoring period will be submitted no later than June 30, 2022, and will include data from three dry weather, one wet weather, and two bacteriological geometric mean determinations (Table 17). One dry weather event will be conducted during the winter months (January to February or November to December 2022). The other two dry weather events, the two rounds of bacteriological sampling, and the wet weather event will be conducted during the warm weather months between May and October 2022. Based on sampling results from station UTS01 from the watershed assessment and 2021 monitoring, it is recommended that this station be removed from long-term monitoring requirements. Water quality conditions at this station are not expected to improve due to the station's location within a swampy, braided portion of the stream that may be affected by beaver activity and surrounding active forestry and agriculture. 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.

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) 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 the Dublin area, sampling during critical conditions may not be possible.

TABLES

Table 1. Completed sampling events for City of Dublin 2021 Watershed Protection Plan monitoring.

Sampling Task	2021											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Water Quality												
<i>In situ</i>					D		D			W	D	
Analytical					D		D			W	D	
Bacteria							B	B				
Biological												
Benthic Macroinvertebrates											M	
Fish					F							

D = dry weather sampling event

W = wet weather sampling event

B = bacteriological sampling event

M = benthic macroinvertebrate assessment

F = fish sampling event

Table 2. Water quality parameters, test methods, and reporting limits.

Parameter	Units	Method	Method Detection Limit	Reporting Limit	Water Quality Standard
Temperature (water and air)	°C				32.2°C (equivalent to 90°F)
pH	S.U.				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 Conductance	µS/cm				
Turbidity	NTU				Refer to 391-3-6-.03(5)(d)
Biochemical oxygen demand, 5-day	mg/L	SM 5210B	2	2	
Chemical oxygen demand		410.4	10	20	
Total suspended solids		SM 2540D	1	2	
Total Phosphorus		365.4	.5	1	
Phosphate, ortho		300.0	0.2	0.8	
Total Kjeldahl Nitrogen		351.2	0.13	0.5	
Ammonia nitrogen		350.1	0.035	0.08	
Nitrate nitrogen		300.0	0.2	0.8	
Nitrite nitrogen		300.0	0.2	0.8	1.0 (MCL)
Cd - Total and dissolved ¹		µg/L	200.8	0.064	0.50
Cu - Total and dissolved ¹	200.8		0.35	0.8	Freshwater 5.0 (7.0) Coastal 3.1(4.8)
Pb - Total and dissolved ¹	200.8		0.24	0.7	Freshwater 1.2 (30) Coastal 8.1 (210)
Zn - Total and dissolved ¹	200.8		5.2	10	Freshwater 65 (65) Coastal 81 (90)
Total Hardness, Ca, Mg	mg/L		200.7	0.2	0.8
Fecal Coliform	mpn/ 100 ml	SM 9223B	2	2	May-Oct: 200 mpn/100mL Nov-Apr: 1,000 mpn/100ml
<i>E. Coli</i>		SM 9223B	2	2	
Total Hardness	mg/L	200.7	0.91	3.6	
Alkalinity	CaCO ₃	2320B	5	20	

¹Standards for metals are expressed as chronic or acute for freshwater streams. Acute criteria are in parentheses, chronic criteria without parentheses. Acute criteria will not be exceeded under 1Q10 or higher flow, chronic criteria will not be exceeded under 7Q10 minimum flow. The in-stream criterion for metals is expressed in terms of the dissolved fraction in the water column. Conversion factors used to calculate dissolved criteria are found in the EPA document National Recommended Water Quality Criteria - Correction, EPA 822-Z-99-001, April 1999. The in-stream criteria for Cu and Pb are lower than the EPD laboratory detection limits (the criterion may be higher than or lower than EPD laboratory detection limits depending upon the hardness of the water). The aquatic life criteria for these metals are expressed as a function of total hardness (mg/l) in a water body. Values in the table above assume a hardness of 50 mg/l CaCO₃. For other hardness values, the following equations from the EPA document: National Recommended Water Quality Criteria – Correction, EPA 822-Z-99-001, April 1999 should be used. The minimum hardness allowed for use in these equations shall not be less than 25 mg/l, as calcium carbonate and the maximum shall not be greater than 400 mg/l as calcium carbonate.

$$\text{Cadmium acute criteria} = (e^{1.0166[(\ln(\text{hardness})) - 3.924]})(1.136672 - [(\ln(\text{hardness}))(0.041838)]) \mu\text{g/l}$$

$$\text{Cadmium chronic criteria} = (e^{0.7409[(\ln(\text{hardness})) - 4.719]})(1.101672 - [(\ln(\text{hardness}))(0.041838)]) \mu\text{g/l}$$

$$\text{Copper acute criteria} = (e^{0.9422[(\ln(\text{hardness})) - 1.700]})(0.96) \mu\text{g/l}$$

$$\text{Copper chronic criteria} = (e^{0.8545[(\ln(\text{hardness})) - 1.702]})(0.96) \mu\text{g/l}$$

$$\text{Lead acute criteria} = (e^{1.273[(\ln(\text{hardness})) - 1.460]})(1.46203 - [(\ln(\text{hardness}))(0.145712)]) \mu\text{g/l}$$

$$\text{Lead chronic criteria} = (e^{1.273[(\ln(\text{hardness})) - 4.705]})(1.46203 - [(\ln(\text{hardness}))(0.145712)]) \mu\text{g/l}$$

$$\text{Zinc acute criteria} = (e^{0.8473[(\ln(\text{hardness})) + 0.884]})(0.978) \mu\text{g/l}$$

$$\text{Zinc chronic criteria} = (e^{0.8473[(\ln(\text{hardness})) + 0.884]})(0.986) \mu\text{g/l}$$

Table 3. Observed precipitation at the University of Georgia, Dublin, Laurens County, Georgia Weather Network station prior to each sampling event.

Sampling Event Type	Date	Observed Precipitation	
		7 days preceding	3 days preceding
		inches	
Dry 1 and Fish	5/25/2021	0.01	0.00
Bacteria 1-1	6/24/2021	1.44	0.13
Bacteria 1-2	7/1/2021	1.37	0.09
Bacteria 1-3	7/8/2021	0.40	0.35
Bacteria 1-4 and Dry 2	7/15/2021	2.21	0.44
Bacteria 2-1	7/22/2021	0.56	0.56
Bacteria 2-2	7/29/2021	3.76	3.59
Bacteria 2-3	8/5/2021	1.01	1.00
Bacteria 2-4	8/12/2021	0.30	0.02
Wet weather ¹	10/28/2021	0.00	0.00
Dry 3 and Macroinvertebrates	11/30/2021	0.00	0.00

¹ Approximately 0.72 inches of rain were recorded the day of the wet weather event.

Table 4. Results of the physiochemical water quality monitoring for the City of Dublin 2021 Watershed Protection Plan monitoring. (Continued on next page)

Station	Sampling Event Type	Date	Temperature		Specific Conductivity	Salinity	Dissolved Oxygen		pH	Turbidity
			Water	Air			mg/L	%		
			°C		µS/cm	PSU			S.U.	NTU
DC01	Dry 1 & Fish	5/25/2021	27.3	32.2	136	0.06	8.9	112	7.2	2.9
	Bacteria 1-1	6/24/2021	23.0	25.1	155	0.07	7.1	82.3	6.9	5.4
	Bacteria 1-2	7/1/2021	23.8	23.7	156	0.07	6.5	77.1	6.7	4.3
	Bacteria 1-3	7/8/2021	23.3	25.2	144	0.07	7.0	81.9	6.7	13.6
	Bacteria 1-4 & Dry 2	7/15/2021	24.0	25.1	146	0.07	7.0	83.3	6.9	5.2
	Bacteria 2-1	7/22/2021	25.4	24.7	108	0.05	6.4	77.6	6.7	15
	Bacteria 2-2	7/29/2021	24.7	26.5	118	0.06	7.2	87.1	6.6	19
	Bacteria 2-3	8/5/2021	23.5	25.9	144	0.07	7.2	84.8	6.8	4.6
	Bacteria 2-4	8/12/2021	24.0	24.8	152	0.07	7.1	84.4	6.9	3.1
	Wet weather	10/28/2021	18.0	16.6	53	0.02	8.3	NM	6.1	123
	Dry 3 & Macroinvertebrates	11/30/2021	10.6	19.3	135	0.06	10.9	97.4	6.5	3.5
	Average			22.5	24.5	132	0.06	7.6	86.8	6.7
FC01	Dry 1 & Fish	5/25/2021	23.0	35.4	90	0.04	6.1	71.0	6.1	8.0
	Bacteria 1-1	6/24/2021	23.0	23.0	69	0.03	6.7	77.3	6.4	8.6
	Bacteria 1-2	7/1/2021	24.1	26.4	69	0.03	6.6	77.7	6.6	8.7
	Bacteria 1-3	7/8/2021	23.1	24.9	50	0.02	6.9	79.7	6.3	14
	Bacteria 1-4 & Dry 2	7/15/2021	24.2	24.4	55	0.02	5.9	70.0	6.4	12
	Bacteria 2-1	7/22/2021	24.6	25.3	62	0.03	6.3	75.2	6.5	11
	Bacteria 2-2	7/29/2021	25.0	24.4	48	0.02	6.2	74.7	6.1	15
	Bacteria 2-3	8/5/2021	23.4	22.9	63	0.03	6.5	75.6	6.4	8.4
	Bacteria 2-4	8/12/2021	23.9	23.6	76	0.03	5.6	65.2	6.2	8.2
	Wet weather	10/28/2021	16.1	17.5	61	0.03	6.6	NM	6.1	9.0
	Dry 3 & Macroinvertebrates	11/30/2021	11.2	18.7	74	0.03	8.8	78.8	5.8	6.3
	AVERAGE			22.0	24.2	65	0.03	6.5	74.5	6.3

Table 4. Results of the physiochemical water quality monitoring for the City of Dublin 2021 Watershed Protection Plan monitoring.
(Continued)

Station	Sampling Event Type	Date	Temperature		Specific Conductivity	Salinity	Dissolved Oxygen		pH	Turbidity
			Water	Air			mg/L	%		
			°C		µS/cm	PSU			S.U.	NTU
HHC02	Dry 1 & Fish	5/25/2021	23.9	36.5	98	0.05	5.7	66.9	6.6	15
	Bacteria 1-1	6/24/2021	24.3	26.7	77	0.04	6.7	79.1	6.9	9.2
	Bacteria 1-2	7/1/2021	25.1	26.1	75	0.03	6.9	88.2	6.9	10
	Bacteria 1-3	7/8/2021	23.8	25.2	60	0.03	6.8	80.8	6.8	13
	Bacteria 1-4 & Dry 2	7/15/2021	25.4	25.9	63	0.03	6.7	80.7	6.8	15
	Bacteria 2-1	7/22/2021	25.0	24.9	72	0.03	6.7	80.8	6.9	18
	Bacteria 2-2	7/29/2021	25.2	26.7	56	0.03	6.2	78.6	6.6	15
	Bacteria 2-3	8/5/2021	24.0	26.2	75	0.03	6.3	74.8	6.8	23
	Bacteria 2-4	8/12/2021	24.1	24.7	69	0.04	6.4	76.4	7.0	10
	Wet weather	10/28/2021	16.7	18.0	73	0.03	8.5	NM	6.5	NM
	Dry 3 & Macroinvertebrates	11/30/2021	10.2	20.0	88	0.04	9.8	87.0	7.0	4.0
AVERAGE			22.5	25.5	73	0.03	7.0	79.3	6.8	13
LC01	Dry 1 & Fish	5/25/2021	21.8	31.9	98	0.05	6.2	70.2	6.3	5.6
	Bacteria 1-1	6/24/2021	22.7	24.7	66	0.03	7.5	86.9	6.5	11
	Bacteria 1-2	7/1/2021	23.6	23.3	67	0.03	6.7	79.0	6.4	9.1
	Bacteria 1-3	7/8/2021	23.2	27.0	56	0.03	7.6	89.6	6.5	13
	Bacteria 1-4 & Dry 2	7/15/2021	24.0	25.1	60	0.03	7.0	82.6	6.5	11
	Bacteria 2-1	7/22/2021	24.7	24.0	51	0.02	7.1	85.6	6.7	15
	Bacteria 2-2	7/29/2021	24.9	25.7	52	0.02	7.1	85.5	6.4	27
	Bacteria 2-3	8/5/2021	23.4	23.9	61	0.03	7.2	84.1	6.6	11
	Bacteria 2-4	8/12/2021	24.2	24.6	76	0.04	6.6	78.3	6.6	7.1
	Wet weather	10/28/2021	15.8	16.8	162	0.08	7.0	NM	6.2	6.7
	Dry 3 & Macroinvertebrates	11/30/2021	12.0	19.9	229	0.11	9.2	84.8	7.1	5.3
AVERAGE			21.8	24.3	89	0.04	7.2	82.7	6.5	11

Table 4. Results of the physiochemical water quality monitoring for the City of Dublin 2021 Watershed Protection Plan monitoring.
(Continued)

Station	Sampling Event Type	Date	Temperature		Specific Conductivity	Salinity	Dissolved Oxygen		pH	Turbidity
			Water	Air			mg/L	%		
			°C		µS/cm	PSU			S.U.	NTU
UTN01	Dry 1 & Fish	5/25/2021	25.0	NM	184	0.09	8.6	104	7.4	3.1
	Bacteria 1-1	6/24/2021	23.2	26.2	142	0.07	7.8	90.8	7.1	4.8
	Bacteria 1-2	7/1/2021	23.9	24.7	136	0.06	7.5	88.6	6.9	5.4
	Bacteria 1-3	7/8/2021	23.5	25.1	133	0.06	7.6	90.0	6.9	19
	Bacteria 1-4 & Dry 2	7/15/2021	24.2	25.2	129	0.06	7.6	90.3	7.0	6.8
	Bacteria 2-1	7/22/2021	24.8	25.1	107	0.05	7.7	92.9	6.9	20
	Bacteria 2-2	7/29/2021	24.7	26.6	119	0.06	7.8	93.4	6.8	15
	Bacteria 2-3	8/5/2021	23.7	26.8	133	0.06	7.8	91.4	7.0	4.7
	Bacteria 2-4	8/12/2021	24.0	24.9	142	0.07	7.7	91.6	7.1	6.0
	Wet weather	10/28/2021	18.0	16.5	19	0.01	8.0	NM	5.6	129
	Dry 3 & Macroinvertebrates	11/30/2021	9.8	19.9	201	0.10	11.2	98.3	6.7	4.0
AVERAGE			22.3	24.1	131	0.06	8.1	93.1	6.8	20
UTS01	Dry 1 & Fish	5/25/2021	26.2	NM	93	0.04	4.6	56.3	6.4	13
	Bacteria 1-1	6/24/2021	23.0	24.1	66	0.03	3.6	40.4	6.1	31
	Bacteria 1-2	7/1/2021	25.0	28.4	68	0.03	2.6	30.0	6.3	28
	Bacteria 1-3	7/8/2021	23.8	24.8	89	0.04	3.0	33.9	6.1	66
	Bacteria 1-4 & Dry 2	7/15/2021	24.3	24.0	61	0.03	2.5	27.3	6.1	60
	Bacteria 2-1	7/22/2021	25.0	24.8	89	0.04	2.8	32.2	6.1	64
	Bacteria 2-2	7/29/2021	24.4	25.6	48	0.02	7.1	85.3	6.1	36
	Bacteria 2-3	8/5/2021	23.6	26.1	58	0.03	4.5	53.0	6.2	76
	Bacteria 2-4	8/12/2021	23.7	24.4	98	0.05	1.7	19.7	6.2	14
	Wet weather	10/28/2021	16.1	16.1	78	0.04	3.9	NM	5.7	28
	Dry 3 & Macroinvertebrates	11/30/2021	11.1	20.3	95	0.04	4.8	57.8	6.2	21
AVERAGE			22.4	23.9	77	0.04	3.7	43.6	6.1	40

NM = Not measured

NA = Not applicable

NR = Result not reported due to sampling error

Table 5. Results of analytical water quality sampling as part of the City of Dublin 2021 Watershed Protection Plan long-term monitoring.

Station	Sampling Event Type	Date	Time	BOD ₅	COD	TKN	NH ₃	Nitrate	Nitrite	Total P	ortho-P	TSS	Hardness	Alkalinity
				mg/L										mg/L CaCO ₃
DC01	Dry 1	5/25/2021	16:10	<2.0	24	0.287	0.05	0.56	<0.20	<0.005	<0.20	1.3	51	46
	Dry 2	7/15/2021	8:30	<2.0	<10	0.37	0.09	0.52	<0.20	0.012	<0.20	2.6	61	53
	Wet	10/28/2021	12:10	23.0	75	1.54	0.10	0.43	<0.20	0.395	<0.20	218	29	18
	Dry 3	11/30/2021	11:30	<2.0	15	<0.20	0.04	0.83	<0.20	0.026	<0.20	<2.0	51	48
FC01	Dry 1	5/25/2021	13:00	<2.0	29	0.414	0.09	<0.20	<0.20	0.025	<0.20	3.0	35	32
	Dry 2	7/15/2021	7:30	<2.0	26	0.27	0.08	<0.20	<0.20	0.021	<0.20	11	16	14
	Wet	10/28/2021	10:50	22.0	20	0.27	<0.02	<0.20	<0.20	0.014	<0.20	3.0	26	22
	Dry 3	11/30/2021	10:50	<2.0	22	0.214	0.03	<0.20	<0.20	0.066	<0.20	<2.0	28	26
HHC02	Dry 1	5/25/2021	16:30	<2.0	26	0.491	0.11	<0.20	<0.20	0.102	<0.20	7.0	38	36
	Dry 2	7/15/2021	8:50	<2.0	26	0.431	0.10	<0.20	<0.20	0.030	<0.20	8.0	20	26
	Wet	10/28/2021	12:40	72.0	13	0.87	<0.02	<0.20	<0.20	0.085	<0.20	27	30	25
	Dry 3	11/30/2021	11:50	<2.0	17	0.319	0.02	<0.20	<0.20	0.077	<0.20	<2.0	29	27
LC01	Dry 1	5/25/2021	13:50	<2.0	26	0.59	0.15	0.65	<0.20	0.041	0.27	1.0	41	35
	Dry 2	7/15/2021	8:10	<2.0	17	0.364	0.13	<0.20	<0.20	0.005	<0.20	4.0	22	24
	Wet	10/28/2021	11:50	16.0	17	0.282	<0.02	0.3	<0.20	0.032	<0.20	3.0	39	29
	Dry 3	11/30/2021	12:45	<2.0	17	0.204	0.04	0.29	<0.20	0.039	<0.20	8.0	45	39
UTN01	Dry 1	5/25/2021	16:20	<2.0	20	0.381	0.10	0.41	<0.20	0.078	<0.20	2.3	57	56
	Dry 2	7/15/2021	8:40	<2.0	<10	0.294	0.08	0.52	<0.20	0.014	<0.20	3.0	48	40
	Wet	10/28/2021	12:20	25.0	92	1.49	0.10	0.25	<0.20	0.452	<0.20	150	15	7.0
	Dry 3	11/30/2021	11:45	<2.0	<10	0.449	<0.02	0.54	<0.20	0.074	<0.20	<2.0	62	57
UTS01	Dry 1	5/25/2021	15:50	3.0	43	1.01	0.20	<0.20	<0.20	0.127	<0.20	11	37	32
	Dry 2	7/15/2021	8:00	2.2	35	0.707	0.13	<0.20	<0.20	0.065	<0.20	180	22	21
	Wet	10/28/2021	11:40	25.0	30	0.579	<0.02	<0.20	<0.20	0.136	<0.20	27	36	30
	Dry 3	11/30/2021	11:50	2.1	56	0.965	0.10	<0.20	<0.20	0.348	<0.20	22	40	35

< = Compound was analyzed for but was not detected (ND)

| The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

Table 6. Results of total recoverable and calculated dissolved metals for the City of Dublin 2021 Watershed Protection Plan monitoring.¹⁻⁵

Station	Sampling Event Type	Date	Time	Cd, Total	Cd, Dissolved	Cu, Total	Cu, Dissolved	Pb, Total	Pb, Dissolved	Zn, Total	Zn, Dissolved
				µg/L							
DC01	Dry 1	5/25/2021	16:10	<0.25	0.051	<1.0	0.473	<0.50	0.127	<6.0	2.55
	Dry 2	7/15/2021	8:30	<0.25	0.055	1.1 l	0.472	<0.50	0.114	11 l	4.14
	Wet	10/28/2021	12:10	<0.50	0.168	11.0	2.14	18.0	1.95	83	11.6
	Dry 3	11/30/2021	11:30	<0.25	0.054	<1.0	0.446	<0.50	0.119	28	11.0
FC01	Dry 1	5/25/2021	13:00	<0.25	0.056	<1.0	0.420	<0.50	0.111	<6.0	2.20
	Dry 2	7/15/2021	7:30	<0.25	0.064	<1.0	0.342	<0.50	0.091	<6.0	1.69
	Wet	10/28/2021	10:50	<0.25	0.056	<1.0	0.420	<0.50	0.111	7.0 l	2.56
	Dry 3	11/30/2021	10:50	<0.25	0.054	<1.0	0.446	<0.50	0.119	16 l	6.31
HHC02	Dry 1	5/25/2021	16:30	<0.25	0.061	<1.0	0.369	<0.50	0.097	<6.0	1.86
	Dry 2	7/15/2021	8:50	<0.25	0.062	<1.0	0.361	<0.50	0.095	<6.0	1.81
	Wet	10/28/2021	12:40	<0.25	0.069	<1.0	0.292	<0.50	0.078	8.6 l	1.99
	Dry 3	11/30/2021	11:50	<0.25	0.054	<1.0	0.446	<0.50	0.119	15 l	5.92
LC01	Dry 1	5/25/2021	13:50	<0.25	0.050	<1.0	0.490	<0.50	0.132	8.5	3.78
	Dry 2	7/15/2021	8:10	<0.25	0.058	<1.0	0.403	<0.50	0.107	6.1 l	2.11
	Wet	10/28/2021	11:50	<0.25	0.056	<1.0	0.420	<0.50	0.111	12 l	4.39
	Dry 3	11/30/2021	12:45	<0.25	0.062	<1.0	0.361	<0.50	0.095	21 l	6.34
UTN01	Dry 1	5/25/2021	16:20	<0.25	0.054	1.8 l	0.787	<0.50	0.116	6.6	2.54
	Dry 2	7/15/2021	8:40	<0.25	0.056	1.1 l	0.463	0.52 l	0.116	13 l	4.76
	Wet	10/28/2021	12:20	<2.5	0.812	14 l	2.94	22.0	2.55	130 l	20.0
	Dry 3	11/30/2021	11:45	<0.25	0.054	1.1 l	0.491	1.2 l	0.285	27	10.7
UTS01	Dry 1	5/25/2021	15:50	<0.25	0.064	<1.0	0.342	1.90	0.344	<6.0	1.69
	Dry 2	7/15/2021	8:00	<0.25	0.083	1.6 l	0.324	2.20	0.247	<6.0	0.880
	Wet	10/28/2021	11:40	<0.25	0.069	<1.0	0.292	1.1 l	0.172	11 l	2.55
	Dry 3	11/30/2021	11:50	<0.25	0.068	1.1 l	0.334	3.60	0.581	19 l	4.61

¹ When total metal or TSS concentrations were not detected, laboratory detection limit 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 < = compound was analyzed for but was not detected.

⁴ Cd = cadmium, Cu = copper, Pb = lead, Zn = zinc

⁵ l = The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

Table 7. Calculated dissolved metals concentrations measured during the City of Dublin 2021 Watershed Protection Plan monitoring compared to EPD chronic and acute life use criteria for cadmium, copper, lead, zinc. (Continued on next page)

	DC01	FC01	HHC02	LC01	UTN01	UTS01
µg/L						
Dry Weather #1						
Cadmium Concentration ¹	< 0.051	< 0.056	< 0.061	< 0.050	< 0.054	< 0.064
Acute Criterion	1.05	0.725	0.785	0.846	1.17	0.765
Chronic Criterion	0.154	0.118	0.125	0.132	0.166	0.123
Copper Concentration ²	< 0.473	< 0.420	< 0.369	< 0.490	0.787	< 0.342
Acute Criterion	7.13	5.00	5.40	5.80	7.91	5.27
Chronic Criterion	1.20	3.65	3.92	4.18	5.54	21.6
Lead Concentration ³	< 0.127	< 0.111	< 0.097	< 0.132	< 0.116	0.344
Acute Criterion	30.8	20.3	22.2	24.2	34.8	21.6
Chronic Criterion	1.20	0.789	0.865	0.942	1.36	21.6
Zinc Concentration ⁴	< 2.55	< 2.20	< 1.86	3.78	2.54	< 1.69
Acute Criterion	66.2	48.1	51.6	55.1	72.8	50.5
Chronic Criterion	66.8	48.5	52.0	55.5	73.4	50.9
Dry Weather #2						
Cadmium Concentration ¹	< 0.055	< 0.064	< 0.062	< 0.058	< 0.056	< 0.083
Acute Criterion	1.245	0.338	0.420	0.461	0.99	62.9
Chronic Criterion	0.174	0.069	0.080	0.086	312	0.086
Copper Concentration ²	0.472	< 0.342	< 0.361	< 0.403	0.463	0.324
Acute Criterion	8.44	2.39	2.95	3.23	6.73	3.23
Chronic Criterion	5.87	1.87	2.26	2.46	4.78	2.46
Lead Concentration ³	< 0.114	< 0.091	< 0.095	< 0.107	0.116	0.247
Acute Criterion	37.6	8.38	10.8	12.0	28.8	12.0
Chronic Criterion	1.46	0.327	0.421	0.468	1.12	0.468
Zinc Concentration ⁴	4.14	< 1.69	< 1.81	2.11	4.76	< 0.880
Acute Criterion	77.1	24.8	30.0	32.5	62.9	32.5
Chronic Criterion	77.7	25.0	30.2	32.8	63.4	32.8

Table 7. Calculated dissolved metals concentrations measured during the City of Dublin 2021 Watershed Protection Plan monitoring compared to EPD chronic and acute life use criteria for cadmium, copper, lead, zinc. (Continued)

	DC01	FC01	HHC02	LC01	UTN01	UTS01
	µg/L					
Dry Weather #3						
Cadmium Concentration ¹	< 0.054	< 0.054	< 0.054	< 0.062	< 0.054	< 0.068
Acute Criterion	1.05	0.583	0.603	0.926	1.26	0.826
Chronic Criterion	0.154	0.101	0.104	0.141	0.176	0.130
Copper Concentration ²	< 0.446	< 0.446	< 0.446	< 0.361	I 0.491	I 0.334
Acute Criterion	7.13	4.05	4.19	6.33	8.57	5.67
Chronic Criterion	5.04	3.02	3.11	4.53	5.95	4.09
Lead Concentration ³	< 0.119	< 0.119	< 0.119	< 0.095	I 0.285	0.581
Acute Criterion	30.8	15.8	16.4	26.8	38.2	23.5
Chronic Criterion	1.20	0.615	0.639	1.04	1.49	0.916
Zinc Concentration ⁴	11.0	I 6.31	I 5.92	I 6.34	10.7	I 4.61
Acute Criterion	66.2	39.9	41.1	59.6	78.2	53.9
Chronic Criterion	66.8	40.2	41.4	60.1	78.8	54.4
Wet Weather						
Cadmium Concentration ¹	< 0.168	< 0.056	< 0.069	< 0.056	< 0.812	< 0.069
Acute Criterion	0.603	0.543	0.624	0.805	0.317	0.745
Chronic Criterion	0.104	0.096	0.106	0.128	0.066	0.121
Copper Concentration ²	2.14	< 0.420	< 0.292	< 0.420	I 2.94*	< 0.292
Acute Criterion	4.19	3.78	4.32	5.53	2.25	5.13
Chronic Criterion	3.11	2.83	3.20	4.01	1.77	3.74
Lead Concentration ³	1.95*	< 0.111	< 0.078	< 0.111	2.55*	I 0.172
Acute Criterion	16.4	14.5	17.0	22.9	7.79	20.9
Chronic Criterion	0.639	0.565	0.664	0.891	0.303	0.814
Zinc Concentration ⁴	11.6	I 2.56	I 1.99	I 4.39	I 20.0	I 2.55
Acute Criterion	41.1	37.4	42.2	52.8	23.5	49.3
Chronic Criterion	41.4	37.7	42.6	53.2	23.7	49.7

Notes:

* Chronic aquatic life criteria standard exceedance.

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

< Compound was analyzed for but was not detected (ND).

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: $0.960 \mu\text{g/L}$. Chronic criteria = $(e^{0.8545[\ln(\text{hardness})]-1.702}) * CF$; CF: $0.960 \mu\text{g/L}$.

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: $0.978 \mu\text{g/L}$. Chronic criteria = $(e^{0.8473[(\ln(\text{hardness}))+0.884]}) * CF$; CF: $0.986 \mu\text{g/L}$.

Table 8. Geometric means of bacteriological sampling events conducted for the City of Dublin 2021 Watershed Protection Plan monitoring.

Station	Geomean 1 June 24 - July 15		Geomean 2 July 22 - August 12	
	Fecal coliform	<i>E. coli</i>	Fecal coliform	<i>E. coli</i>
	MPN/100 mL			
DC01	4,401	1,097	2,466	637
FC01	777	381	305	255
HHC02	270	212	310	181
LC01	1,392	775	1,181	930
UTN01	4,959	1,587	6,817	1,644
UTS01	225	116	278	167

Table 9. Benthic macroinvertebrate sampling results for the City of Dublin WPP 2021 long-term monitoring. (Continued on next page)

Order	Family	Final ID (Taxon)	EPD Tolerance Value	FFG ¹	Habit ²	FC01	LC01
Ephemeroptera	Baetidae	<i>Baetis intercalaris</i>	5.8	OM	UN	1	10
		<i>Labiobaetis propinguus</i>	6.2	OM	UN	2	
	Heptageniidae	<i>Stenonema smithae</i>	3.4	OM	CN	7	
		<i>Stenonema</i> sp.	4.0	SC	CN	8	3
Plecoptera	Taeniopterygidae	<i>Taeniopteryx</i> sp.	6.3	SH	UN	8	
Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	6.6	CF	CN	22	1
		<i>Hydropsyche</i> sp.	4.0	CF	CN	2	
	Leptoceridae	<i>Triaenodes</i> sp.	3.7	SH	UN	1	
		<i>Triaenodes ignitus</i>	3.7	SH	UN	1	
	Philopotamidae	<i>Chimarra aterrima</i>	2.8	CF	CN	8	3
Coleoptera	Dytiscidae	<i>Neoporus</i> sp.	5.3	UN	UN		3
	Elmidae	<i>Ancyronyx variegatus</i>	6.9	OM	CN		2
		<i>Dubiraphia</i> sp.	6.4	CG	UN		1
		<i>Dubiraphia bivittata</i>	6.4	OM	UN		1
		<i>Microcyloepus pusillus</i>	2.1	CG	UN	2	
		<i>Stenelmis</i> sp.	5.4	SC	CN		2
	Gyrinidae	<i>Gyrinus</i> sp.	6.3	PR	SW	1	
Diptera	Chironomidae	<i>Microtendipes pedellus</i> group	6.2	CF	CN		1
		<i>Polypedilum aviceps</i>	4.0	UN	UN	15	
		<i>Polypedilum flavum</i>	6.7	UN	UN	5	35
		<i>Polypedilum laetum</i>	6.7	UN	UN	2	
		<i>Polypedilum illinoense</i> group	9.2	UN	UN	18	57
		<i>Stenochironomus</i> sp.	6.4	SH	BU		1
		<i>Tribelos jucundus</i>	6.6	CG	BU		1

Table 9. Benthic macroinvertebrate sampling results for the City of Dublin WPP 2021 long-term monitoring. (Continued)

Order	Family	Final ID (Taxon)	GA EPD Tolerance Value	FFG ¹	Habit ²	FC01	LC01
Diptera	Chironomidae	<i>Paratanytarsus dissimilis</i>	7.7	CG	UN		2
		<i>Rheotanytarsus exiguus</i> group	6.4	CF	UN	14	14
		<i>Rheotanytarsus pellucidus</i>	6.4	CF	CN	7	
		<i>Stempellinella fimbriata</i>	5.3	CG	SP	1	
		<i>Tanytarsus</i> sp.	6.7	CF	UN	13	27
		<i>Potthastia longimana</i>	7.4	CG	SP	1	1
		<i>Corynoneura</i> sp.	6.2	CG	SP	35	6
		<i>Eukiefferiella claripennis</i> group	5.7	CG	SP	1	
		<i>Nanocladius</i> sp.	7.2	CG	SP		1
		<i>Rheocricotopus robacki</i>	7.7	CG	SP	23	1
		<i>Rheocricotopus</i> sp.	7.3	CG	SP	1	
		<i>Thienemanniella xena</i>	6.0	CG	SP	5	
		<i>Conchapelopia</i> sp.	8.7	PR	SP		1
		<i>Labrundinia pilosella</i>	6.0	PR	SP	2	4
		<i>Labrundinia</i> sp.	5.3	PR	SP	1	
	<i>Nilotanypus fimbriatus</i>	4.0	PR	SP	3		
	Simuliidae	<i>Simulium</i> sp.	4.4	CF	CN	14	11
LTM Year 1 - 2021				Total individuals	224	189	
				Taxa richness	30	24	
				65I MMI	75	52	
WA - 2011				Total individuals	170	166	
				Taxa richness	45	21	
				65I MMI	44	28	

¹FFG = Functional Feeding Groups: CG Collector/Gatherer, SC Scraper, CF Collector/Filterer, OM Omnivore, PR Predator, UN Unidentified

²Habits: SW Swimmer, SH Shredder, BU Burrower, SP Sprawler, CB Climber, CN Clinger

Table 10. GA EPD Macroinvertebrate multi-metric index (MMI) scores for the City of Dublin 2021 WPP long-term monitoring.
 (Continued on next page)

GADNR/EPD MACROINVERTEBRATE MULTI-METRIC INDICES
SOUTHEASTERN PLAINS (65)
Atlantic Southern Loam Plains (65I) Metric Index

Macroinvertebrate Ranking of Subcoregion 65I (Atlantic Southern Loam Plains)		Site Name or Site Identification Number
Metrics	Standardized Metric Scores/Index Score/Site Ranking	FC01
EPT Taxa	100.00	
Diptera Taxa	53.57	
% EPT	100.00	
% Trichoptera	100.00	
HBI	72.06	
Predator Taxa	38.46	
Clinger Taxa	62.50	
Site Index Score	75	

Table 10. GA EPD Macroinvertebrate multi-metric index (MMI) scores for the City of Dublin 2021 WPP long-term monitoring.
(Continued)

GADNR/EPD MACROINVERTEBRATE MULTI-METRIC INDICES
SOUTHEASTERN PLAINS (65)
Atlantic Southern Loam Plains (65I) Metric Index

Macroinvertebrate Ranking of Subcoregion 65I (Atlantic Southern Loam Plains)		Site Name or Site Identification Number
Metrics	Standardized Metric Scores/Index Score/Site Ranking	LC01
EPT Taxa	51.28	
Diptera Taxa	44.64	
% EPT	100.00	
% Trichoptera	52.80	
HBI	35.60	
Predator Taxa	19.23	
Clinger Taxa	62.50	
Site Index Score	52	

Table 11. Average physical habitat assessment scores for macroinvertebrate habitats assessed during the City of Dublin 2021 WPP long-term monitoring.

Habitat parameter	FC01			LC01		
	Score 1	Score 2	Average	Score 1	Score 2	Average
Epifaunal substrate & available cover	15	15	15	13	12	13
Embeddedness/Pool substrate	16	16	16	9	11	10
Velocity& depth regime/pool variability	10	10	10	12	11	12
Sediment deposition	17	16	17	15	14	15
Channel flow status	16	15	16	16	15	16
Channel alteration	15	15	15	20	20	20
Frequency of riffles (or bends)	4	3	4	13	13	13
Bank stability	LB	7	8	8	7	8
	RB	7	8	8	8	7
Bank vegetative protection	LB	9	9	9	7	8
	RB	9	9	9	7	8
Riparian vegetative zone	LB	10	10	10	10	10
	RB	10	10	10	8	9
2021 Total score	145	144	147	145	146	150
Total average score 2011	172			156		

Table 12. Results of fish community sampling conducted on May 25, 2021.

Order	Family	Common name	Scientific name	Tolerance ranking ¹	Feeding guild ²	Species category ³	FC01	LC01
Anguilliformes	Anguillidae	American eel	<i>Anguilla rostrata</i>		CR		2	3
Cypriniformes	Cyprinidae	Yellowfin shiner	<i>Notropis lutipinnis</i>		IC		17	25
		Weed shiner	<i>Notropis texanus</i>		IC			4
		Bluehead chub	<i>Nocomis leptoccephalus</i>		OM		2	1
		Golden shiner	<i>Notemigonus crysoleucas</i>		GE			5
	Catostomidae	Eastern creek chubsucker	<i>Erimyzon oblongus</i>		IN	RBS	1	1
Esociformes	Esocidae	Redfin pickerel	<i>Esox americanus</i>		CR		2	3
Percopsiformes	Aphredoderidae	Pirate perch	<i>Aphredoderus sayanus</i>		IN		12	3
Perciformes	Centrarchidae	Flier	<i>Centrarchus macrochirus</i>		IN	SF		1
		Redbreast sunfish	<i>Lepomis auritus</i>		IN	SF	27	7
		Spotted sunfish	<i>Lepomis punctatus</i>		IN	SF	10	4
		Dollar sunfish	<i>Lepomis marginatus</i>		IN	SF	23	13
		Bluegill	<i>Lepomis macrochirus</i>		IN	SF		1
		Largemouth bass	<i>Micropterus salmoides</i>		CR	CENT		1
	Percidae	Christmas darter	<i>Etheostoma hopkinsi</i>	HWI	IN	BI	7	
		Blackbanded darter	<i>Percina nigrofasciata</i>		IN	BI	1	
Total Individuals							104	72
Total Taxa							11	14
GA DNR IBI Score							28	38
IBI Narrative Ranking							Poor	Fair
Shannon Weaver Diversity							1.95	2.1
Taxa Richness							11	14
2011 IBI Score							36 - Fair	30 - Poor

1 - HWI = headwaters intolerant.

2 - CR = top carnivore, IC = insectivorous cyprinid, OM = omnivore, GE = generalist, IN = insectivore/invertivore.

3 - RBS = round-bodies sucker species, SF = sunfish species, CENT = centrarchid species, BI = benthic invertivore.

Table 13. Average physical habitat assessment scores for each biological station assessed during fish sampling - Low Gradient Form.

Habitat Parameter	FC01				LC01			
	Score 1	Score 2	Score 3	Average	Score 1	Score 2	Score 3	Average
Bottom Substrate/Available Cover	14	15	15	15	14	14	14	14
Pool Substrate Characterization	5	5	5	5	5	5	5	5
Pool Variability	11	9	11	10	11	11	11	11
Channel Alteration	15	15	15	15	14	14	12	13
Sediment Deposition	14	12	14	13	9	9	11	10
Channel Sinuosity	18	18	18	18	16	17	16	16
Channel Flow Status	11	11	12	11	19	19	19	19
Bank Vegetative Protection	LB	8	9	8	8	7	8	8
	RB	8	9	8	8	7	8	8
Bank Stability	LB	8	7	7	7	7	6	7
	RB	8	7	7	7	7	6	7
Riparian Vegetative Zone	LB	9	9	9	9	10	10	10
	RB	10	10	10	10	10	10	10
Total Habitat Score 2021	139	136	139	138	136	137	138	137

Table 14. National Land Cover Database (NLCD) land cover classifications and impervious percentages within the City of Dublin service area and water quality monitoring station subwatersheds.

Land Cover	Dublin Service Area				FC01 Watershed		HHC02 Watershed		UTN01 Watershed		DC01 Watershed		LC01 Watershed		UTS01 Watershed	
	2011		2019		2019											
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Developed - med to high intensity	2,403	8	2,647	9.3	190	3	618	7.3	108	22	282	28	585	17	162	12
Developed low intensity/open space	7,422	26	7,452	26	889	15	2,414	29	307	63	622	62	859	25	288	22
Forest	7,590	27	7,081	25	1,931	32	2,507	30	37	8	77	8	615	18	421	32
Pasture/hayland	2,734	10	3,331	12	681	11	856	10	11	2.2	9.5	0.9	389	11	154	12
Cultivated cropland	4,258	15	3,922	14	1,335	22	890	11	7.8	1.6	0.9	0.09	564	16	122	9.2
Wetland/water	4,094	14	4,069	14	1,026	17	1,135	13	18	3.7	9.5	0.9	466	13	178	13
Imperviousness																
Impervious surfaces*	3,097	11	3,282	12	280	4.6	862	10	140	29	334	33	334	33	161	12

*Impervious surfaces are estimated separately from land cover and may or may not overlap with land cover classifications.

Table 15. Comparison of average physiochemical water quality parameters for all stations during 2011 watershed assessment monitoring and 2021 long term monitoring.

Station	Sample Period	No. Samples (range)	Specific Conductivity	pH	Turbidity
			μS/cm	S.U.	NTU
DC01	2011	3	258	7.9	1
	2021	11	132	6.7	18
FC01	2011	5-6	84	6.6	3
	2021	11	65	6.3	10
HHC02	2011	5-6	110	6.9	15
	2021	10-11	73	6.8	13
LC01	2011	5-6	114	6.9	9
	2021	11	89	6.5	11
UTN01	2011	5-6	154	7.4	2
	2021	11	131	6.8	20
UTS01	2011	5-6	119	6.5	11
	2021	11	77	6.1	40

Table 16. Comparison of summer and winter water temperatures and dissolved oxygen concentrations for all stations during 2011 watershed assessment monitoring and 2021 long term monitoring.

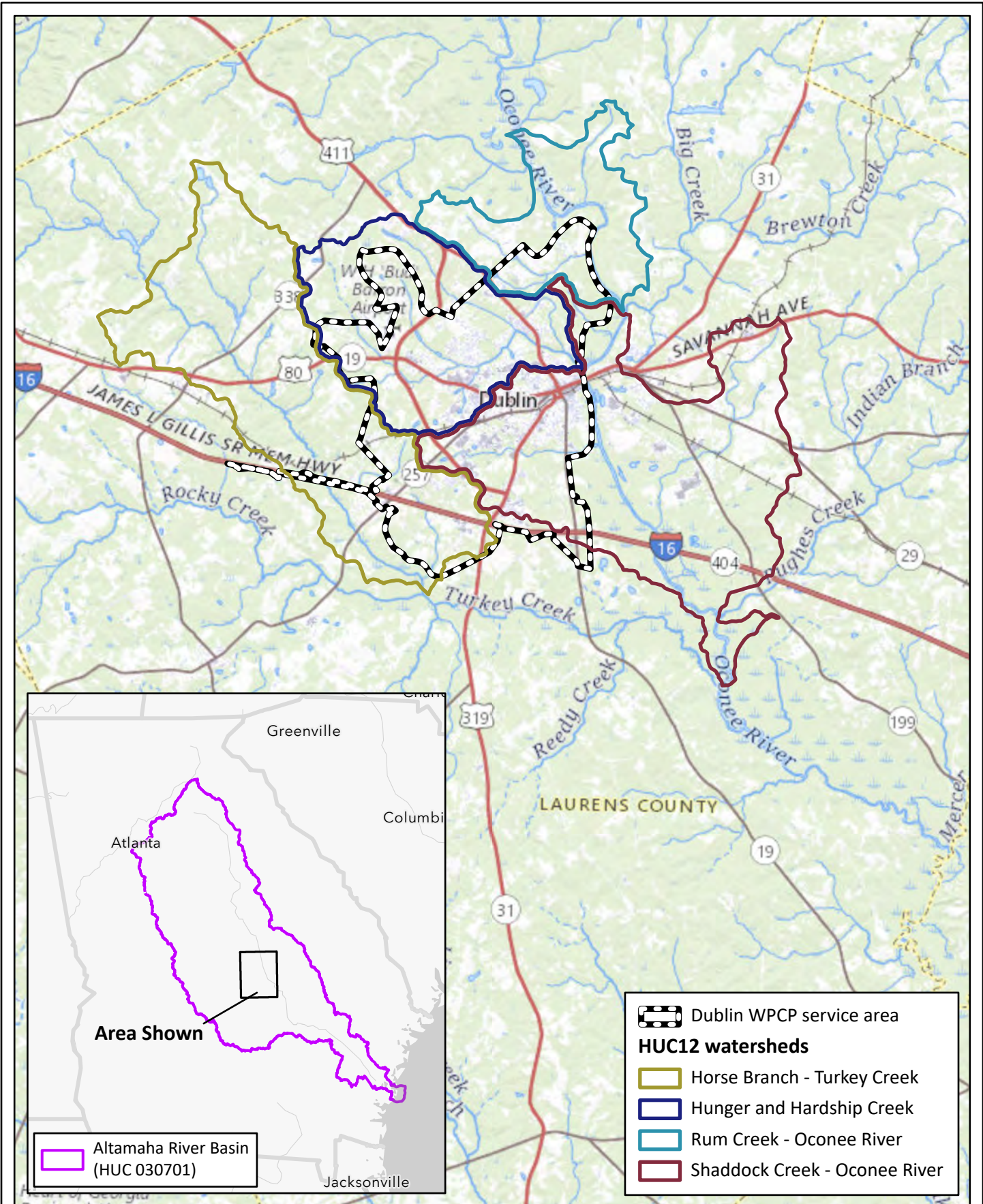
Station	Season	Sample Period	No. Samples	Water Temp	Dissolved Oxygen
				°C	mg/L
DC01	Summer	2011	3	26.1	6.2
		2021	10	23.7	7.3
	Winter	2011	0	NM	NM
		2021	1	10.6	10.9
FC01	Summer	2011	5	26.8	4.2
		2021	10	23.0	6.3
	Winter	2011	1	17.7	10.5
		2021	1	11.2	8.8
HHC02	Summer	2011	5	26.6	3.4
		2021	10	23.7	6.7
	Winter	2011	1	17.2	3.3
		2021	1	10.2	9.8
LC01	Summer	2011	5	25.6	3.4
		2021	10	22.8	7.0
	Winter	2011	1	15.5	7.3
		2021	1	12	9.2
UTN01	Summer	2011	5	27.7	6.0
		2021	10	23.5	7.8
	Winter	2011	1	17.5	12.1
		2021	1	9.8	11.2
UTS01	Summer	2011	5	25.1	1.8
		2021	10	23.5	3.6
	Winter	2011	1	14.9	9.0
		2021	1	11.1	4.8

NM = Not Measured

Table 17. Future long-term monitoring schedule for the City of Dublin Watershed Protection Plan.

Watershed Protection Plan Monitoring Requirement	2022	2023	2024
Water Quality Monitoring (6 Stations)			
3 dry weather & 1 wet weather events	✓	✓	✓
2 bacteriological geometric mean determinations (8 individual sample events)	✓	✓	✓
Biological Monitoring (4 Stations)			
Benthic macroinvertebrate communities		✓	
Fish Communities		✓	
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. City of Dublin Water Pollution Control Plant service area and vicinity, Laurens County, Georgia.

0 1 2 4 Miles



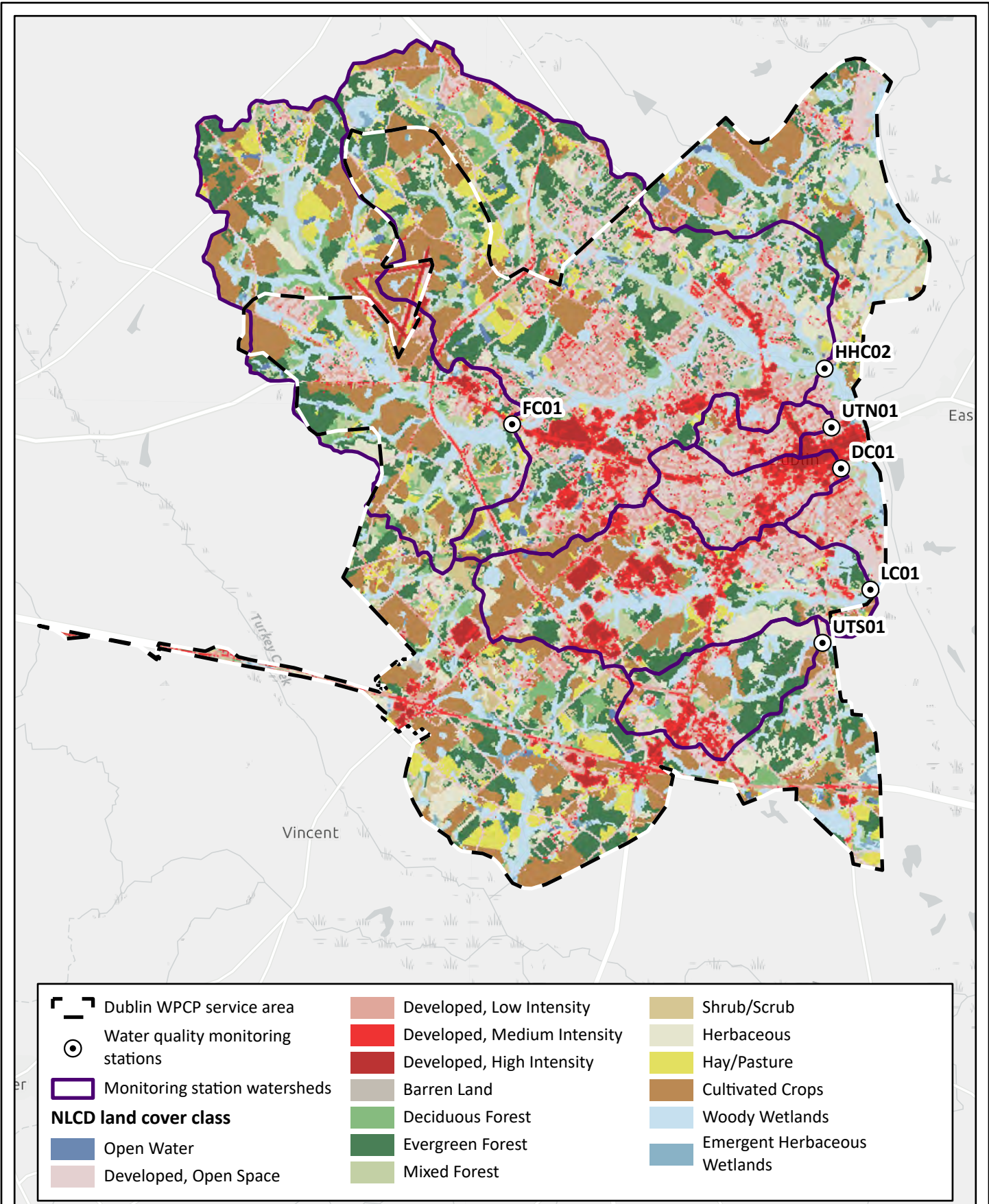


Data Source: ESRI World Imagery, USGS NHD, Created: Thursday, June 23, 2022

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

Figure 2. Long-term water quality monitoring stations for the Dublin Watershed Protection Plan.





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 and Land Use data for the Dublin WPCP service area and long-term monitoring station watersheds.

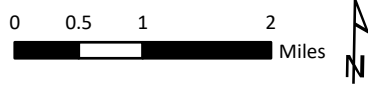


Figure 4. Ammonia-nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

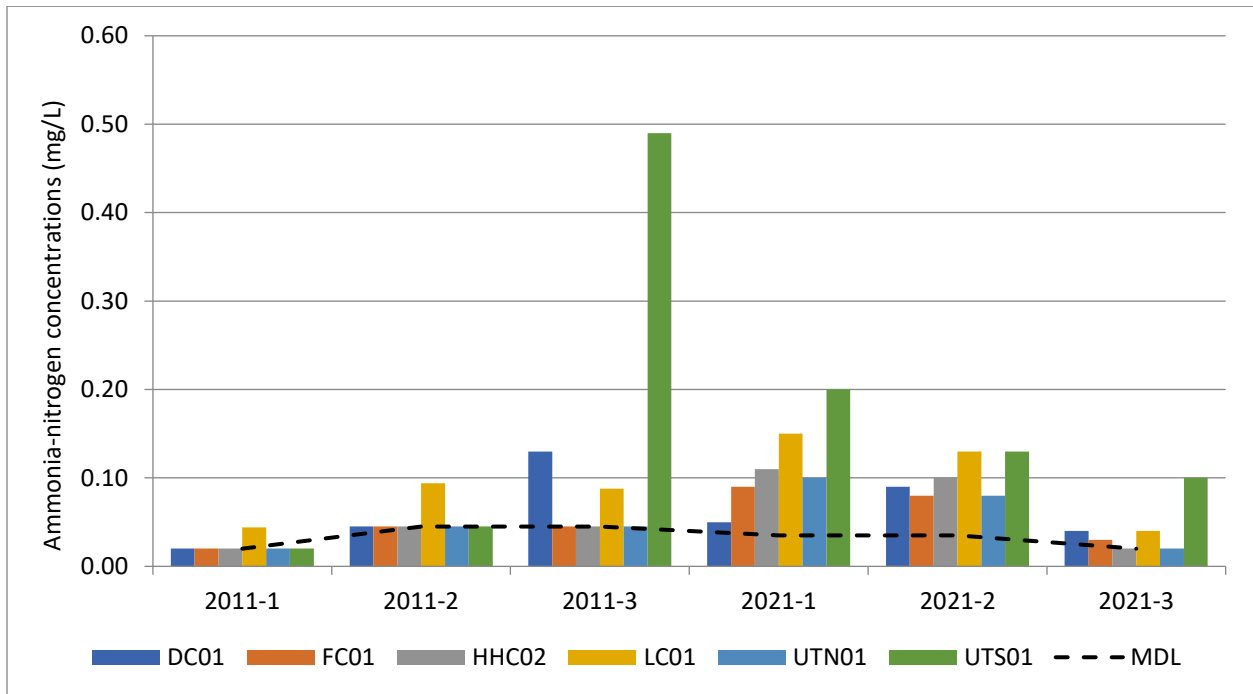


Figure 5. Ammonia-nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

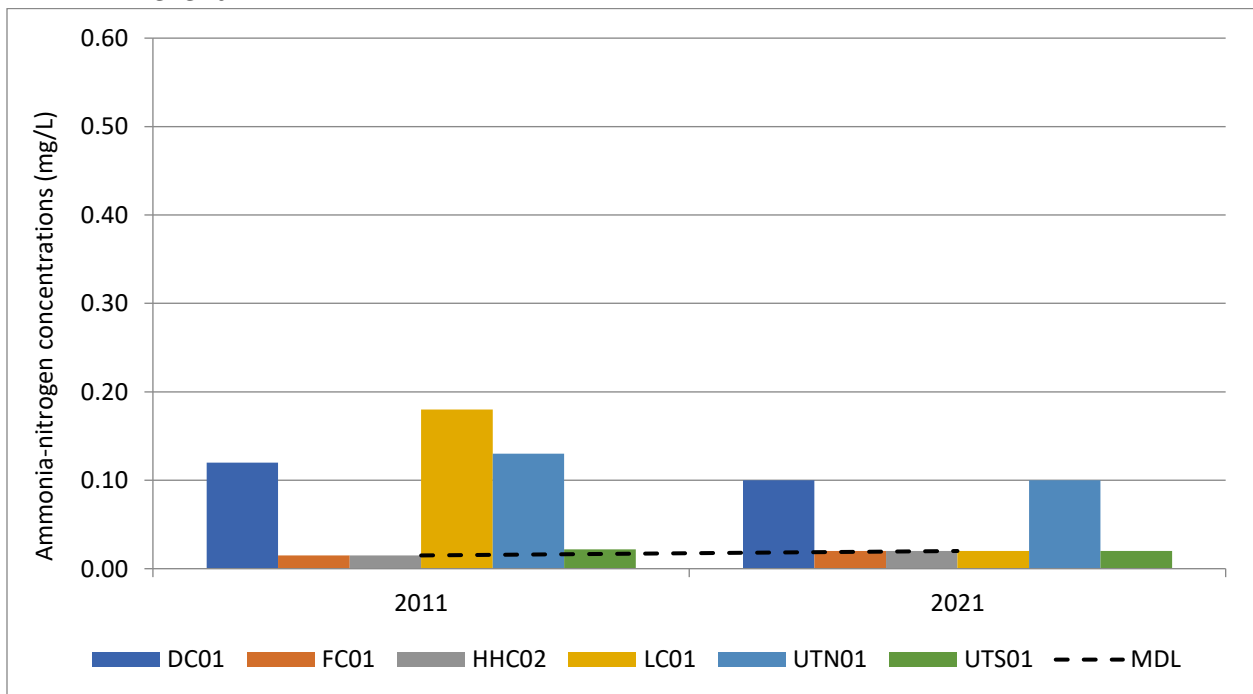


Figure 6. Nitrate-nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

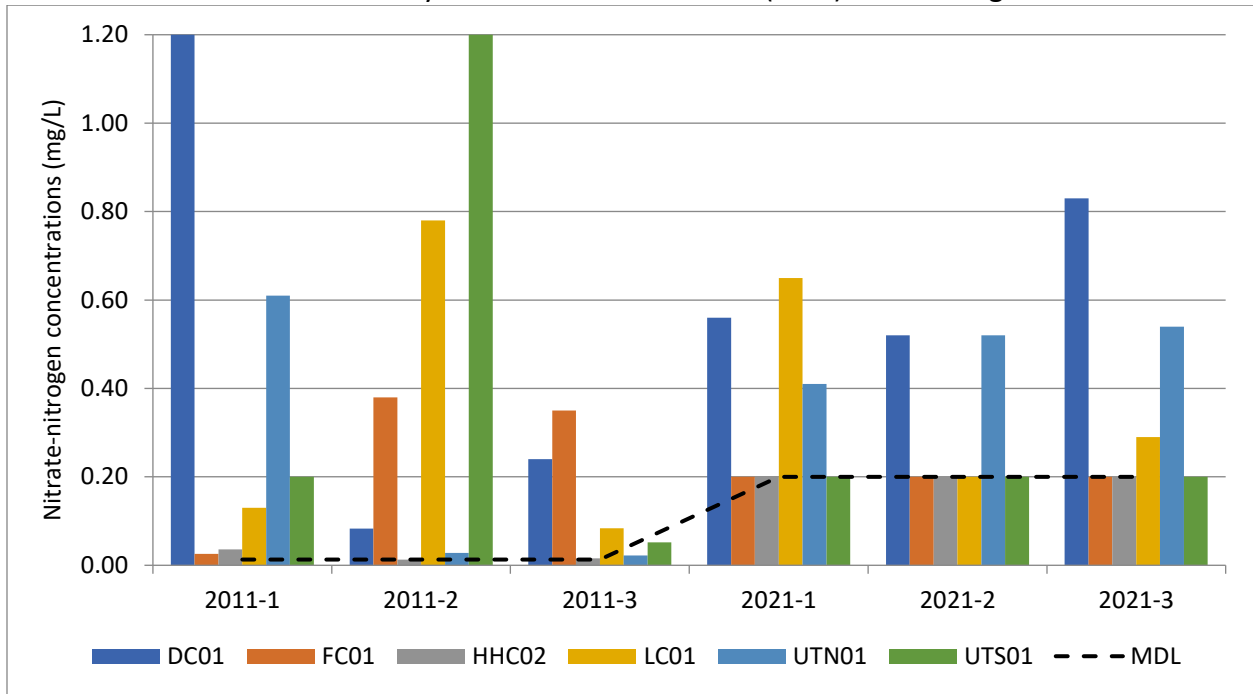


Figure 7. Nitrate-nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

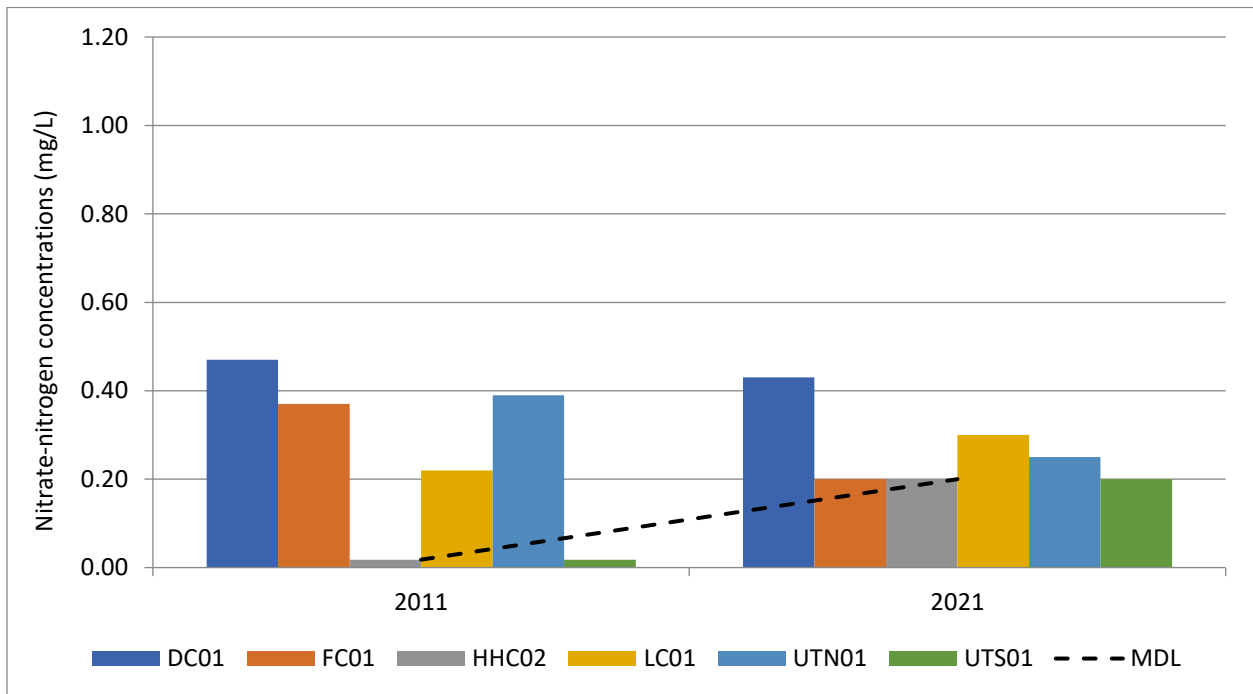


Figure 8. Nitrite-nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

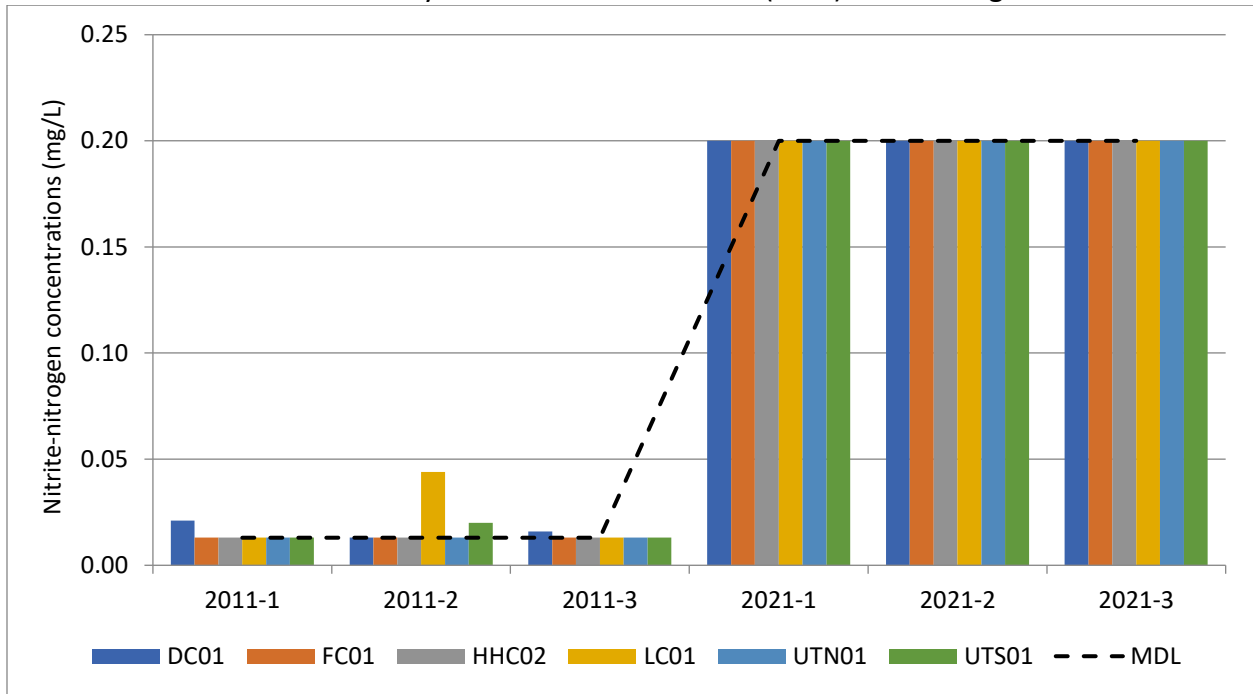


Figure 9. Nitrite-nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

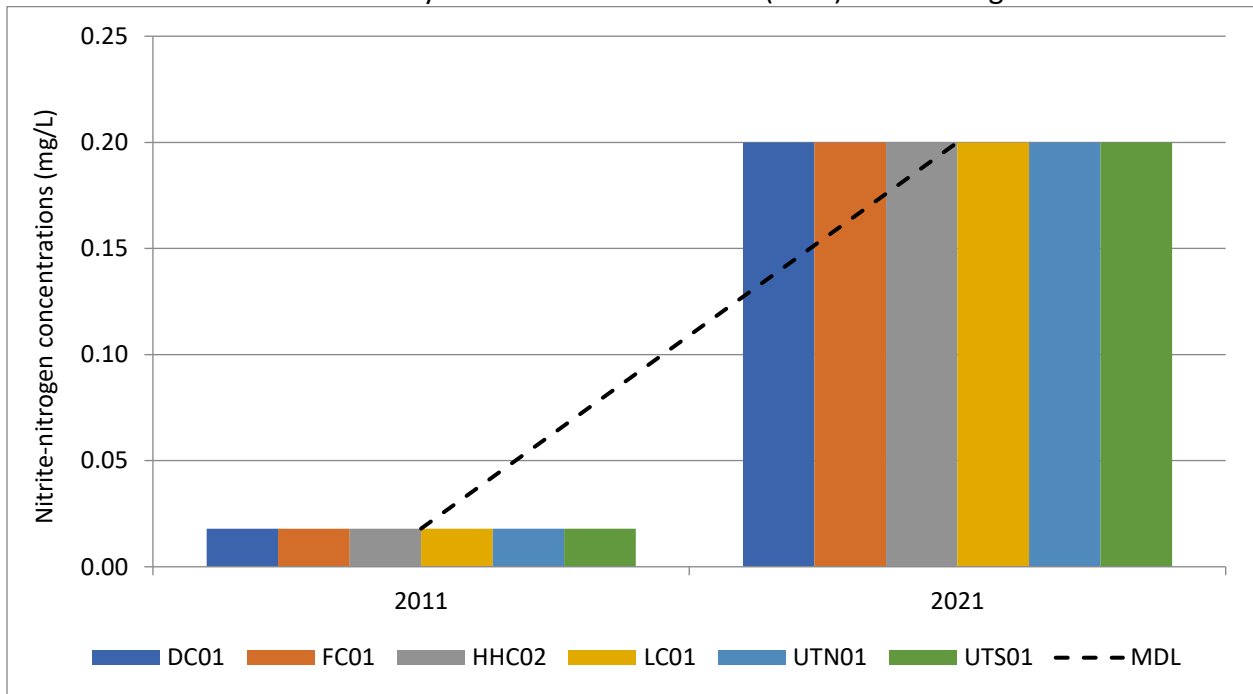


Figure 10. Total Kjeldahl nitrogen concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

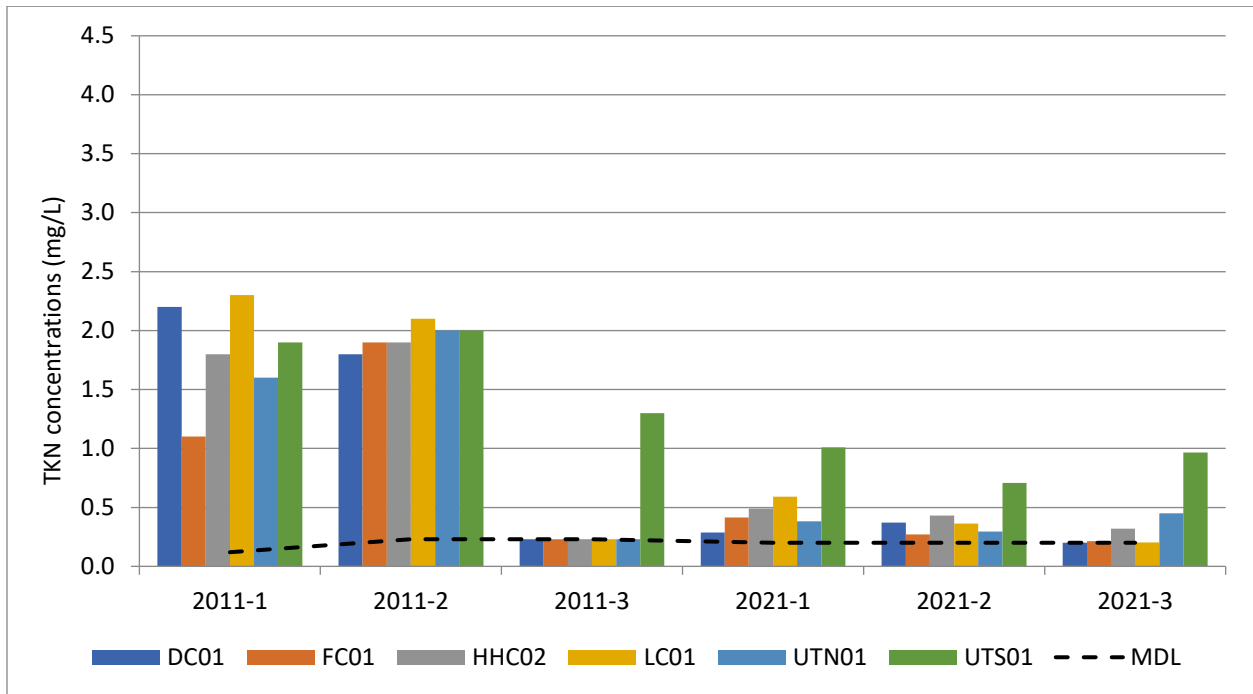


Figure 11. Total Kjeldahl nitrogen concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

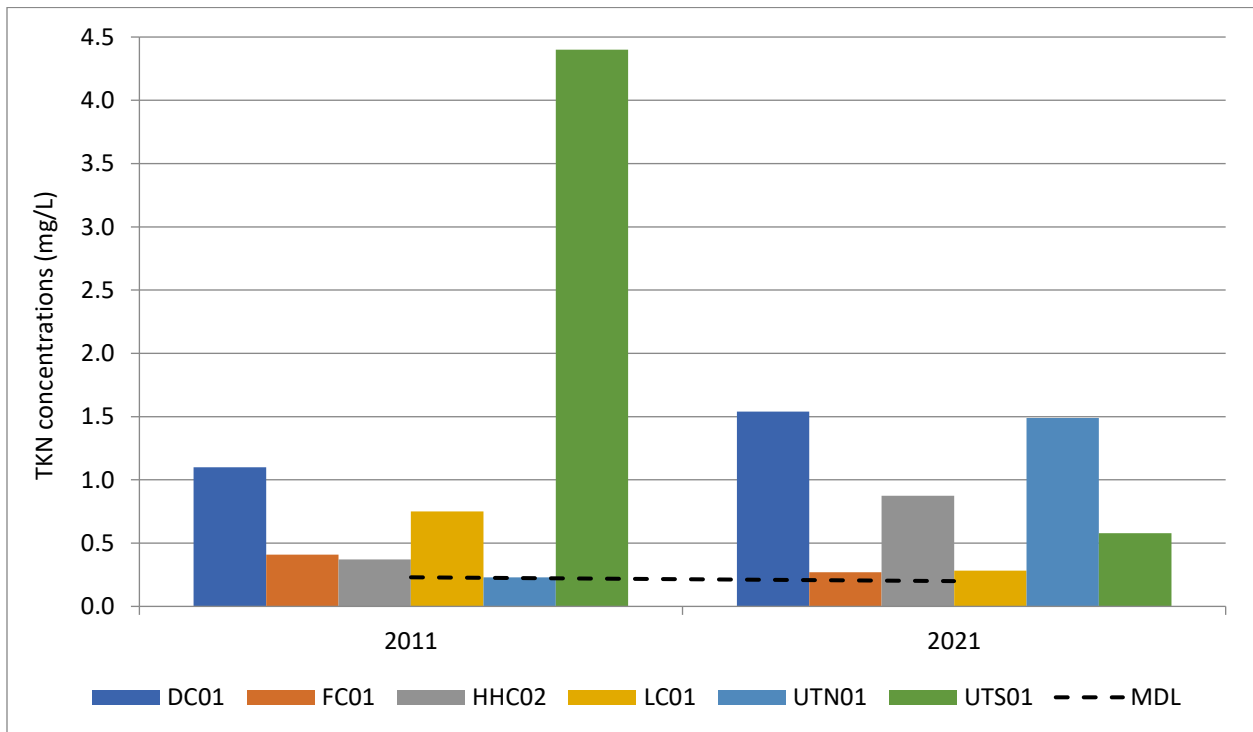


Figure 12. Total phosphorus concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

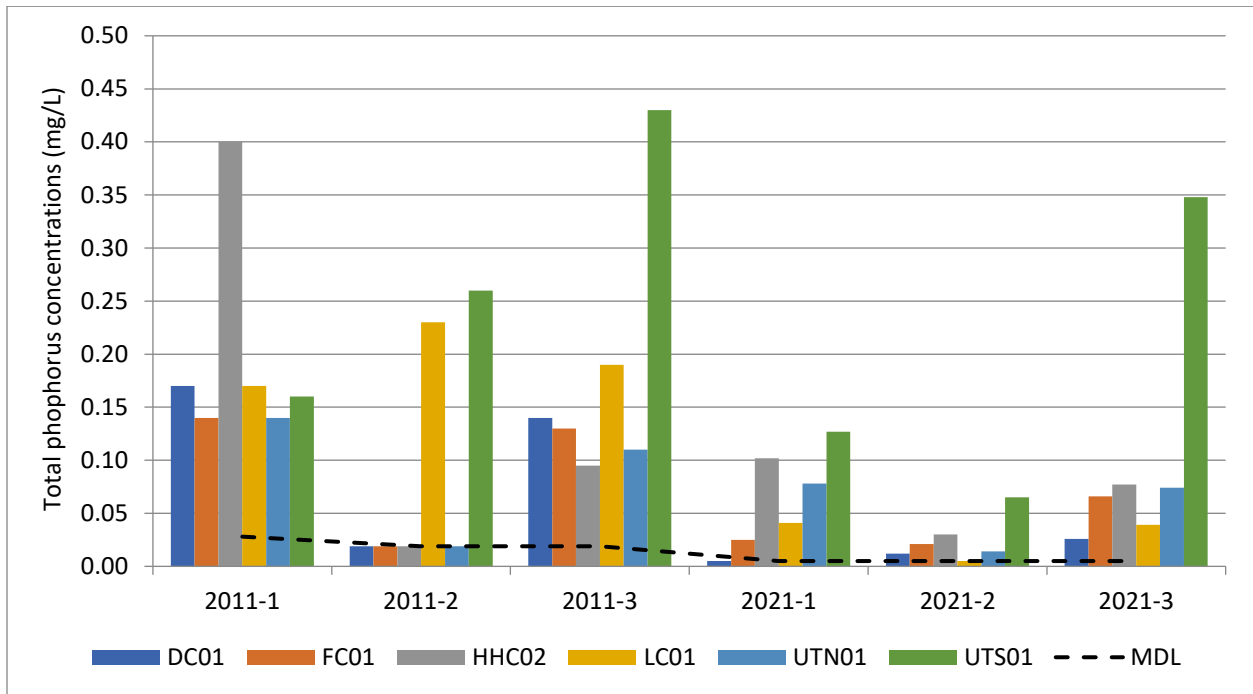


Figure 13. Total phosphorus concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

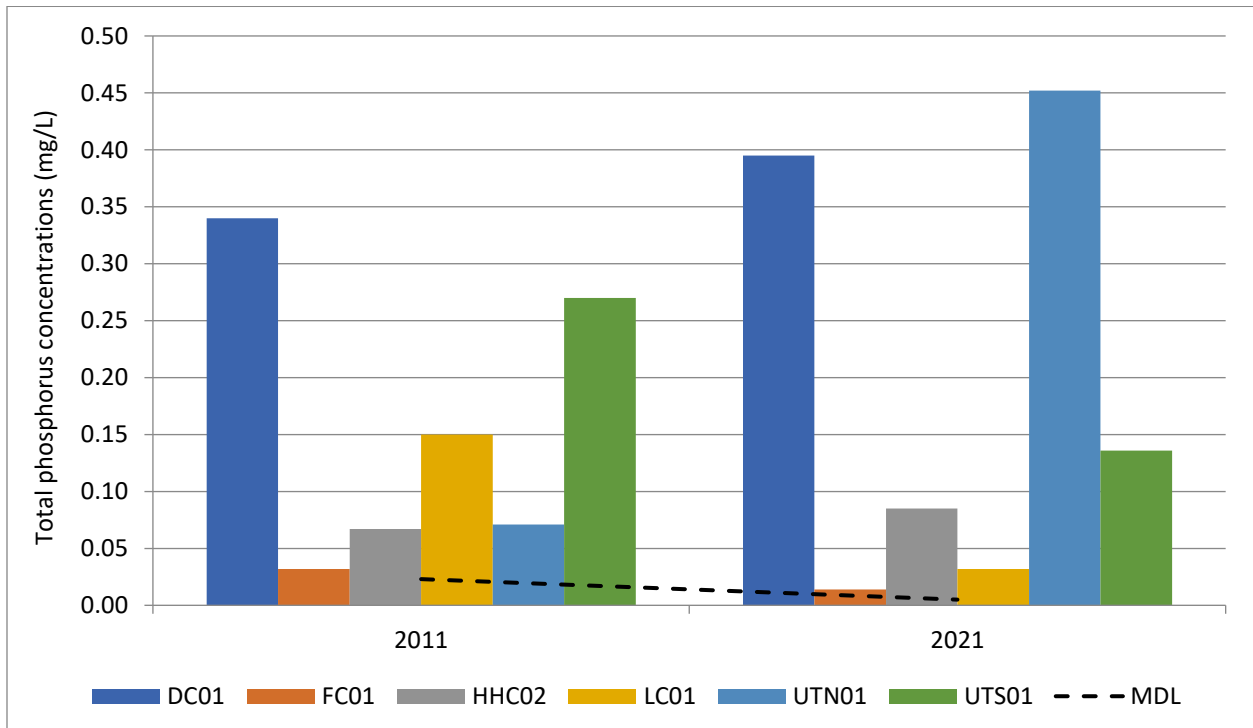


Figure 14. Orthophosphate concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

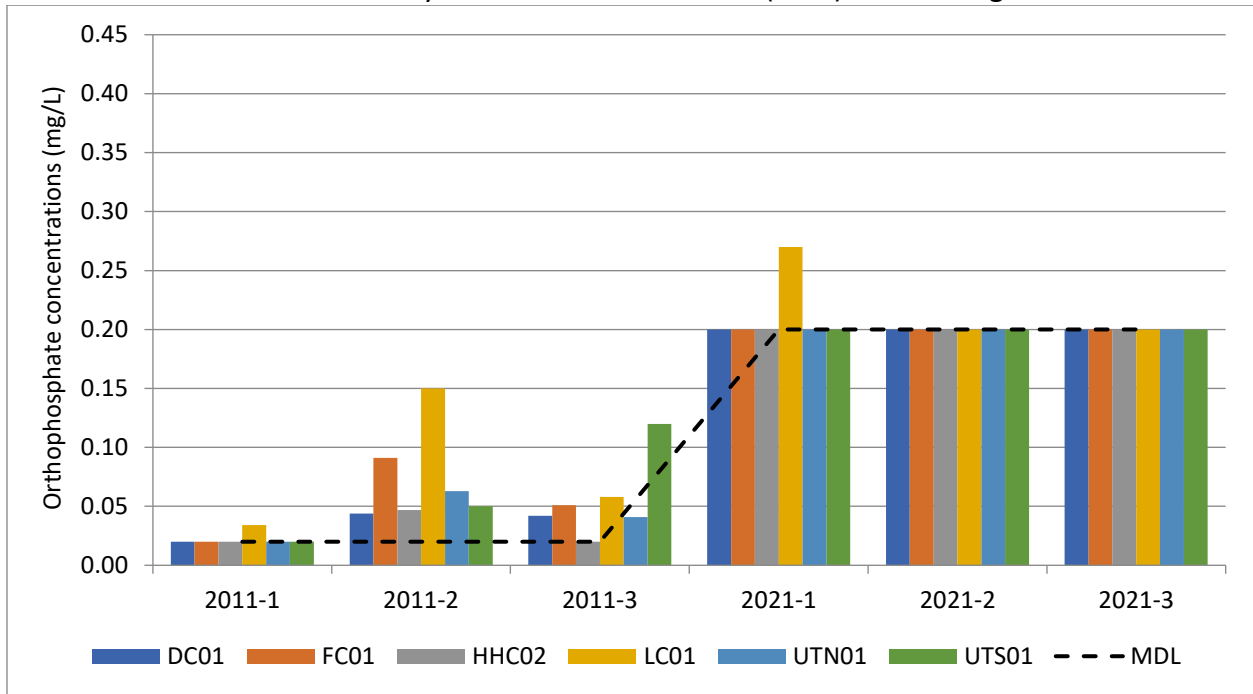


Figure 15. Orthophosphate concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

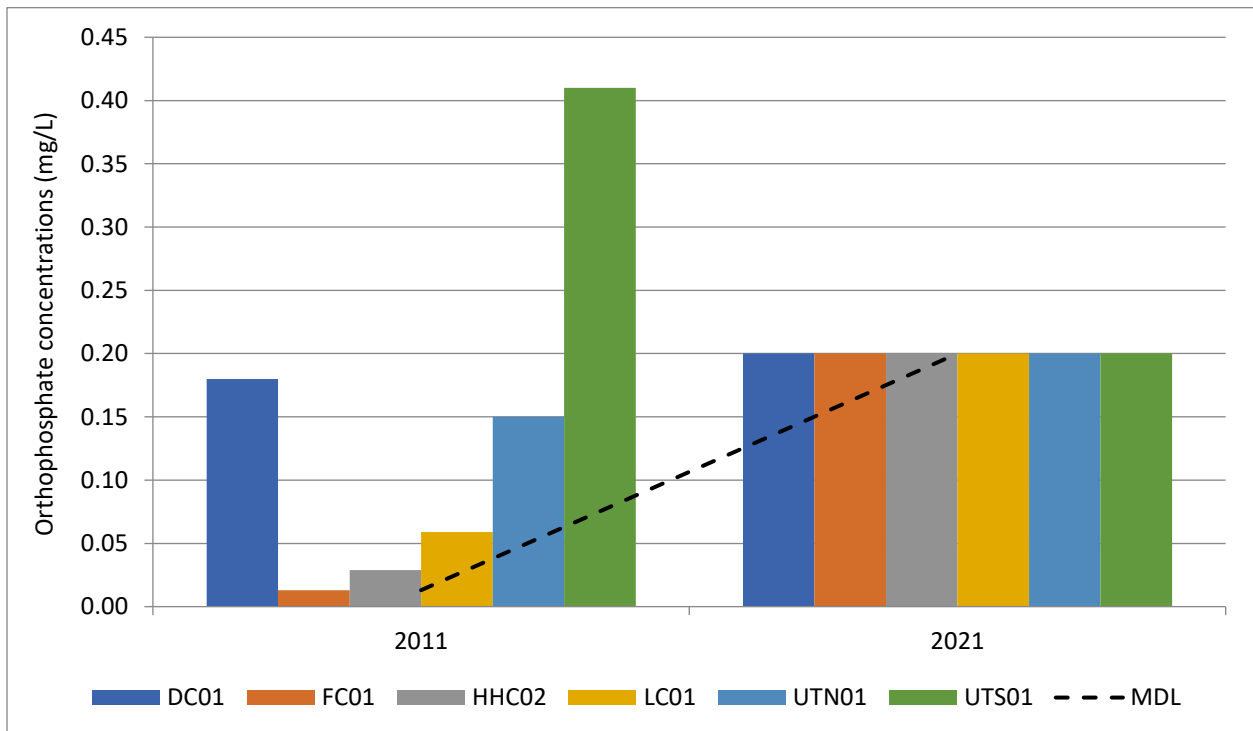


Figure 16. Total suspended solids concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

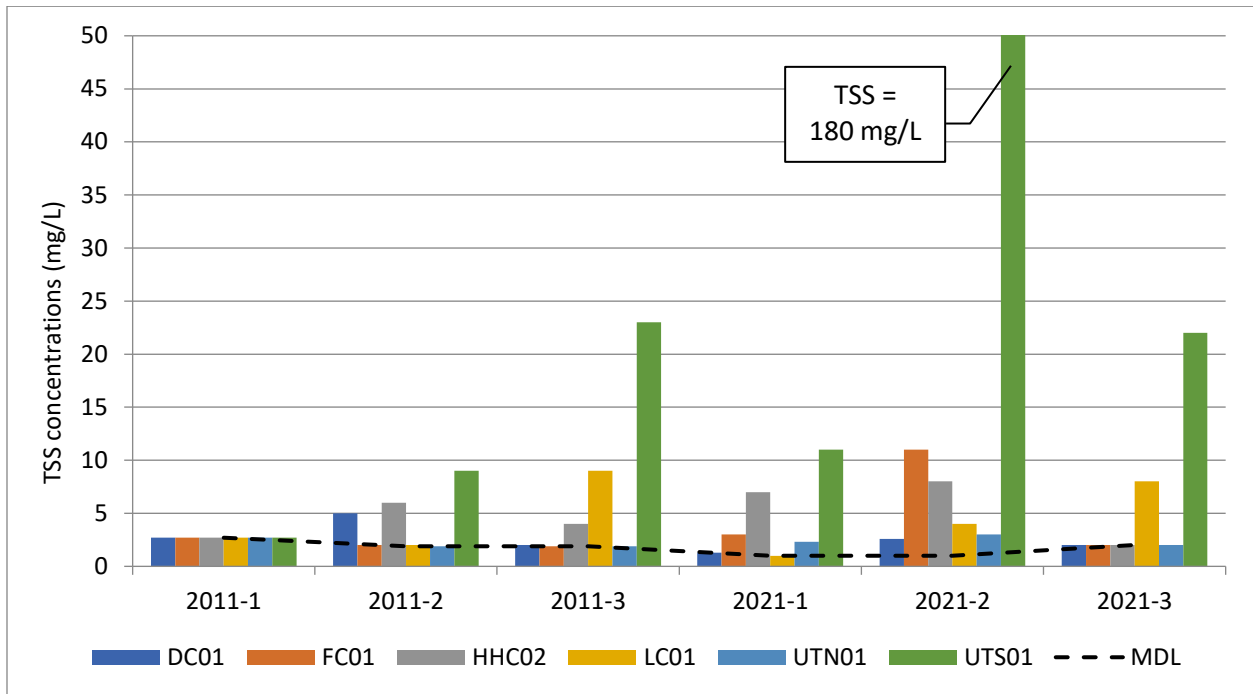


Figure 17. Total suspended solids concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

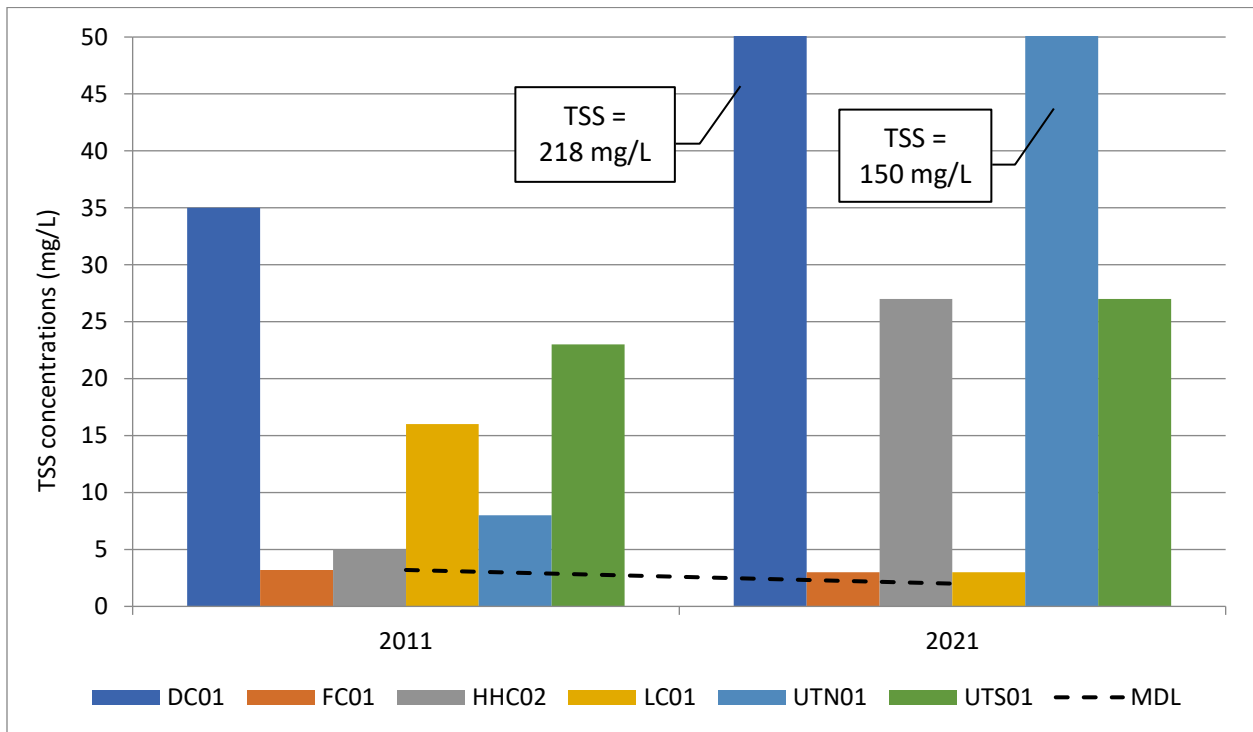


Figure 18. Five-day biochemical oxygen demand concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

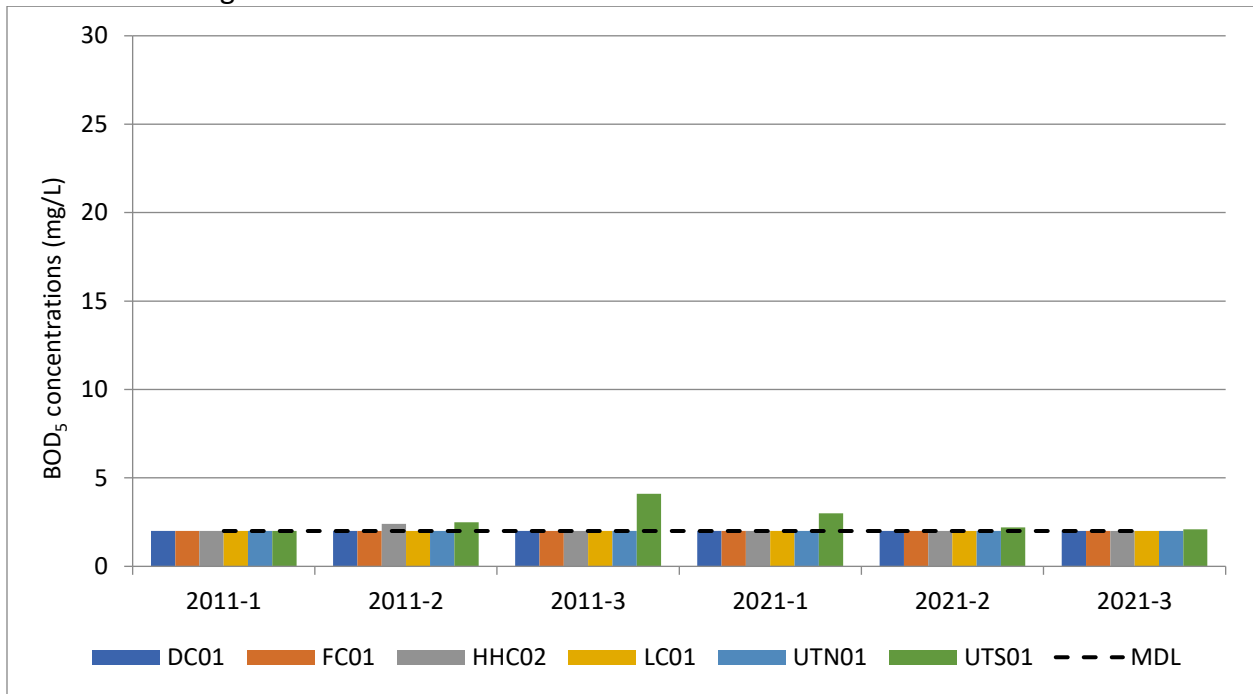


Figure 19. Five-day biochemical oxygen demand concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.

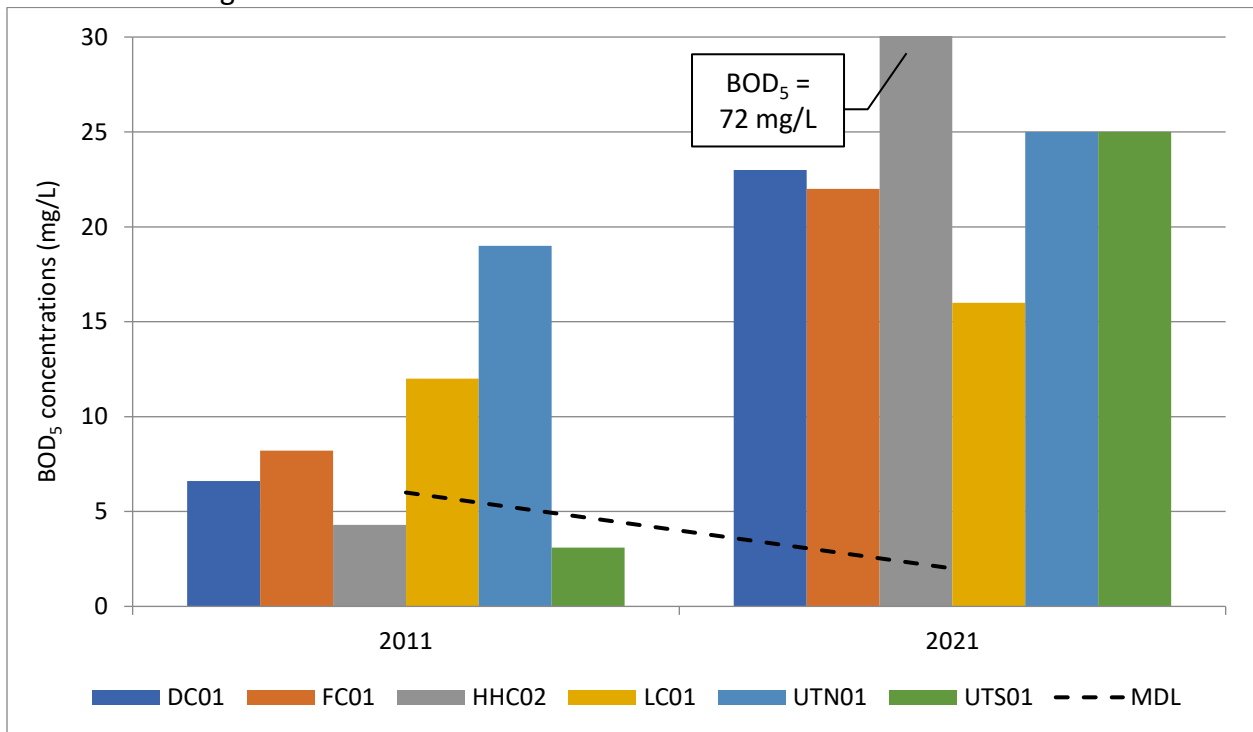


Figure 20. Chemical oxygen demand concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

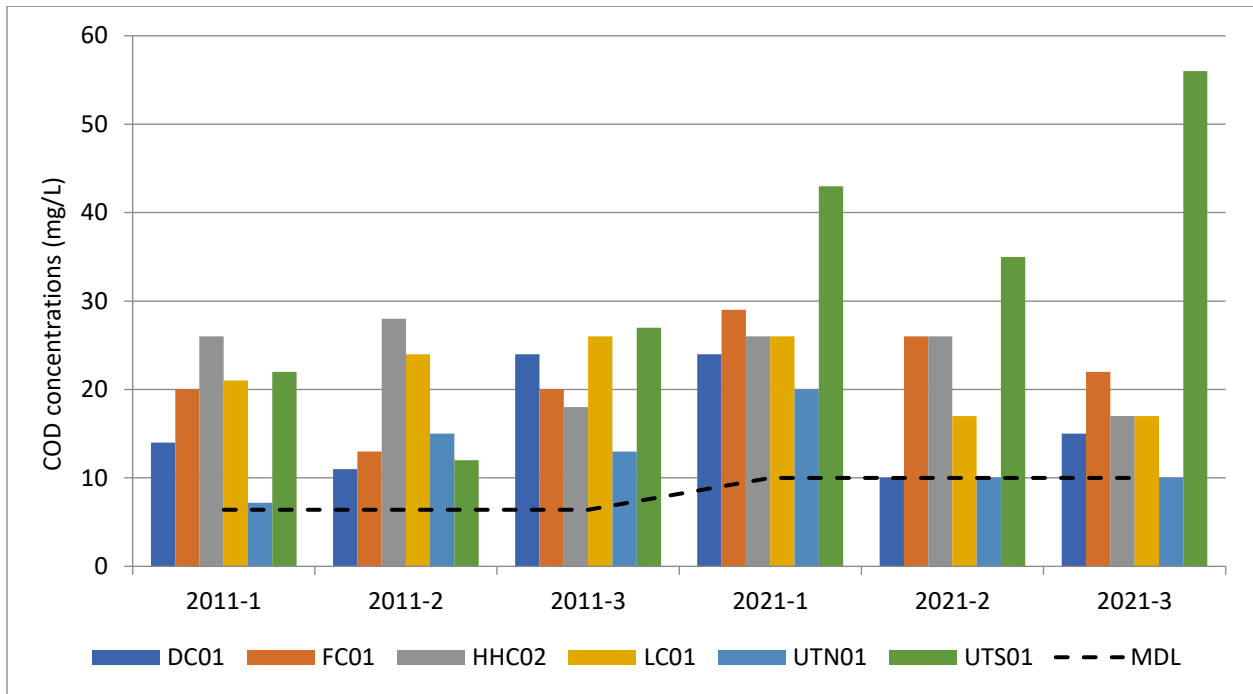


Figure 21. Total recoverable cadmium concentrations measured during long-term monitoring dry weather events and laboratory method detection limits (MDL) used during each event.

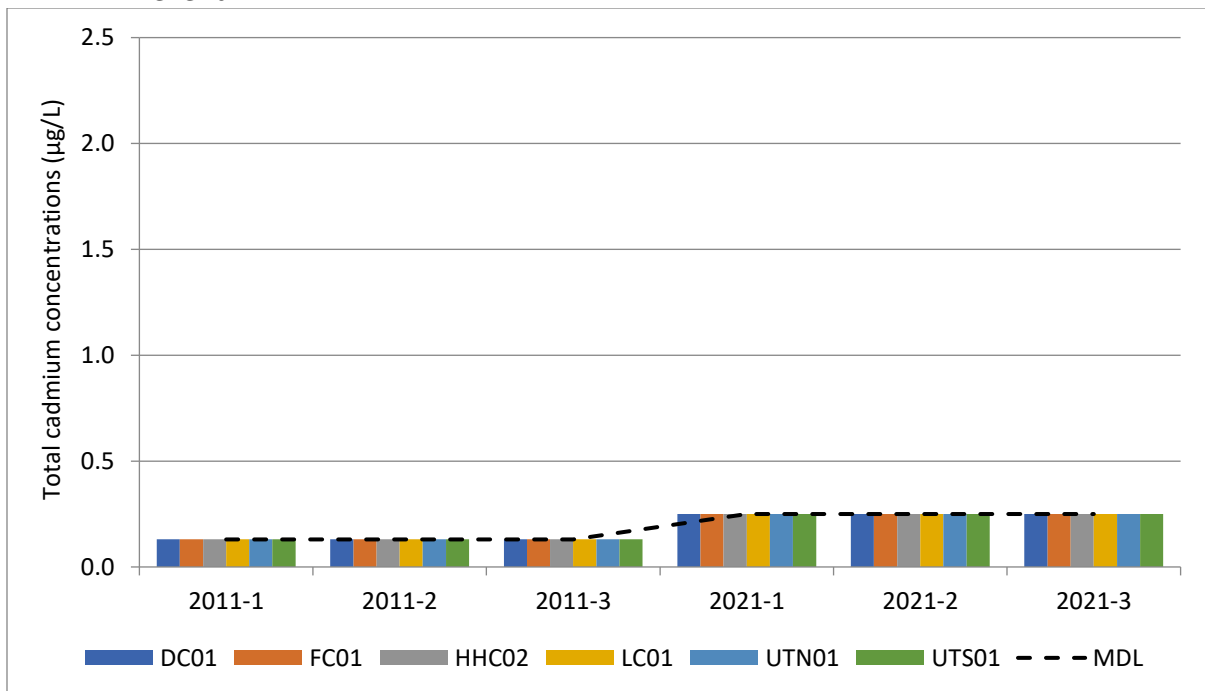
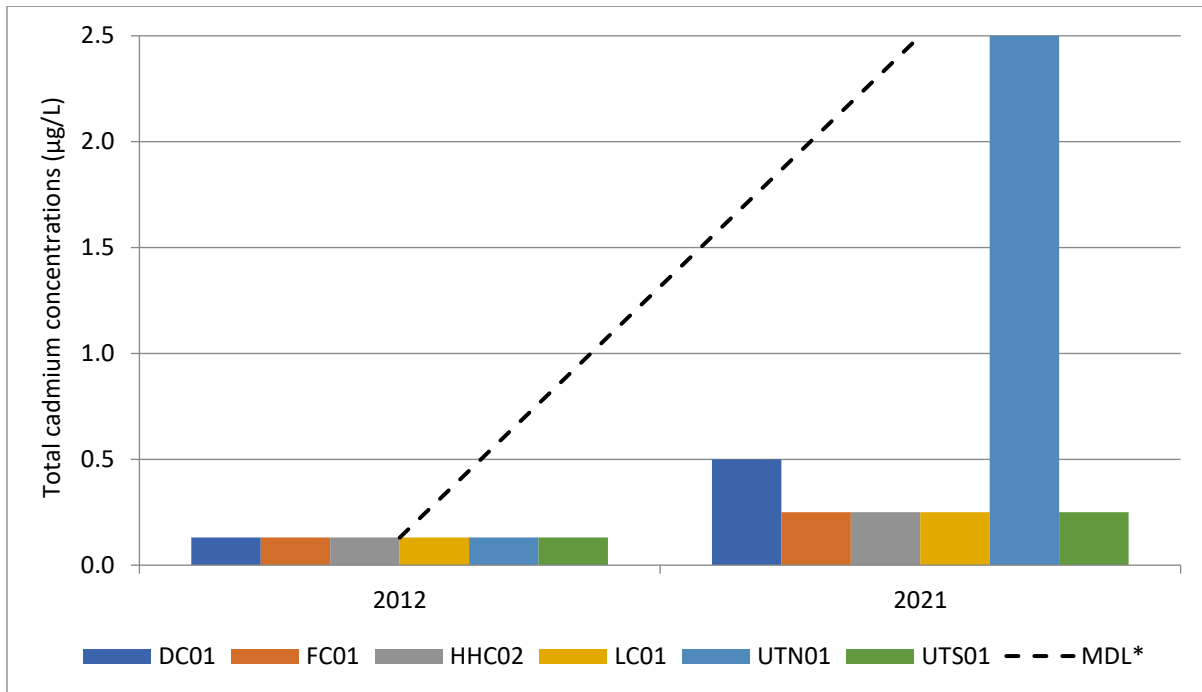


Figure 22. Total recoverable cadmium concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



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

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

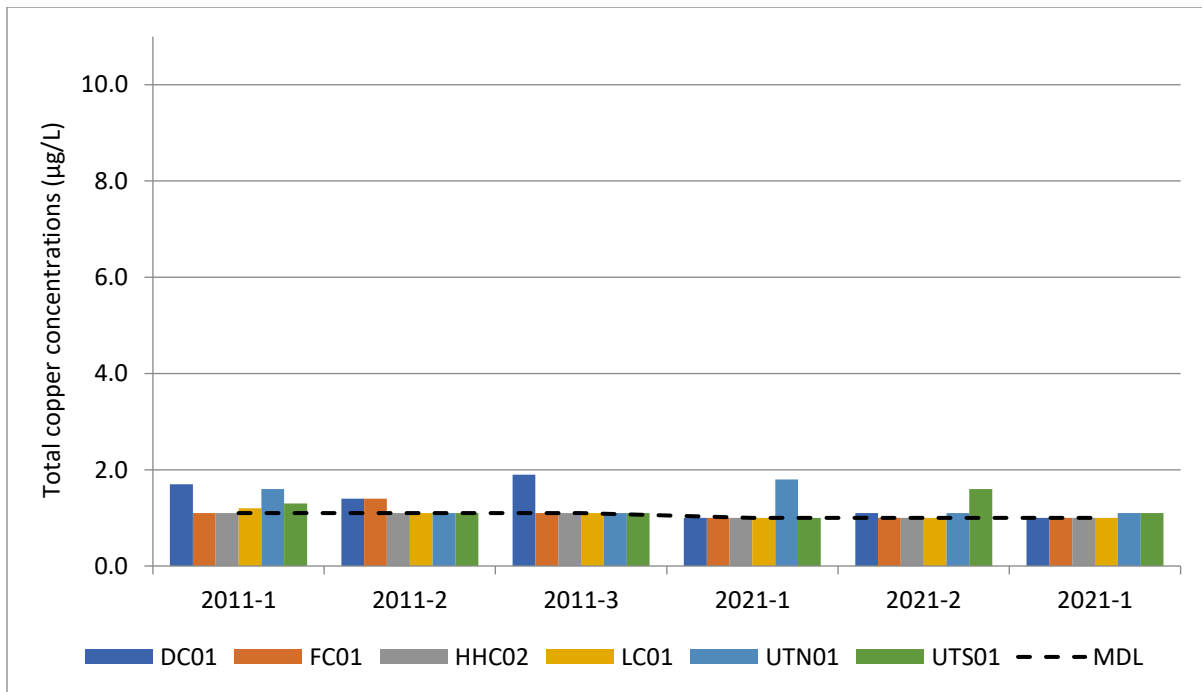
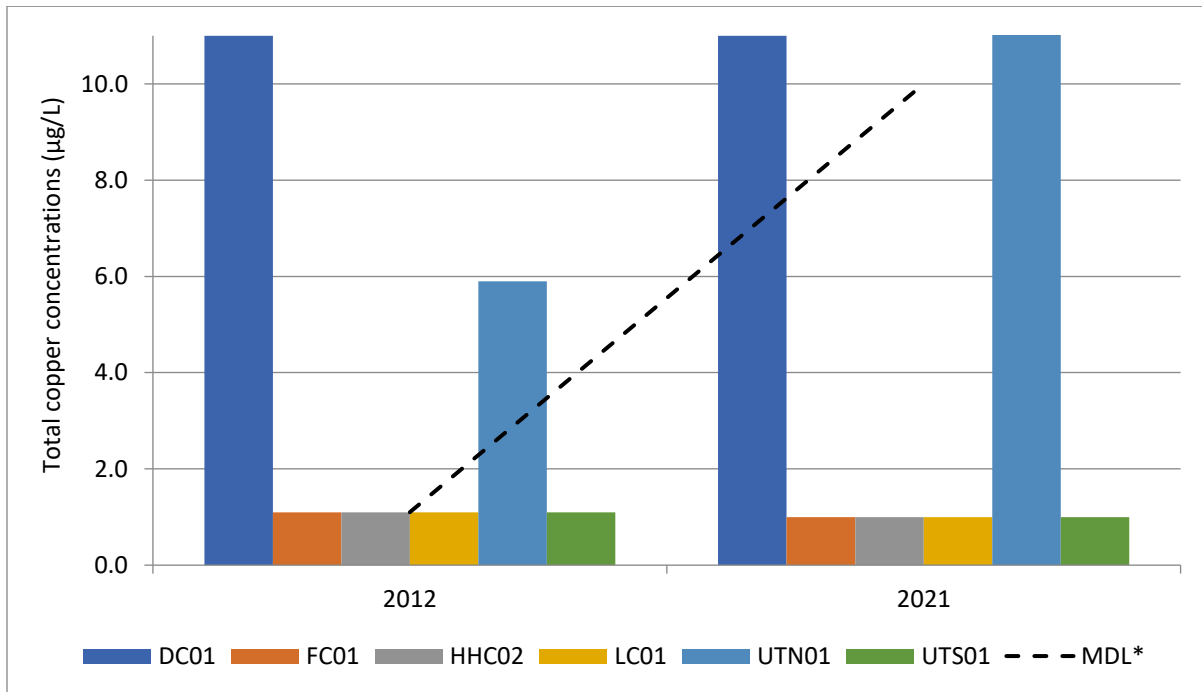


Figure 24. Total recoverable copper concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



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

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

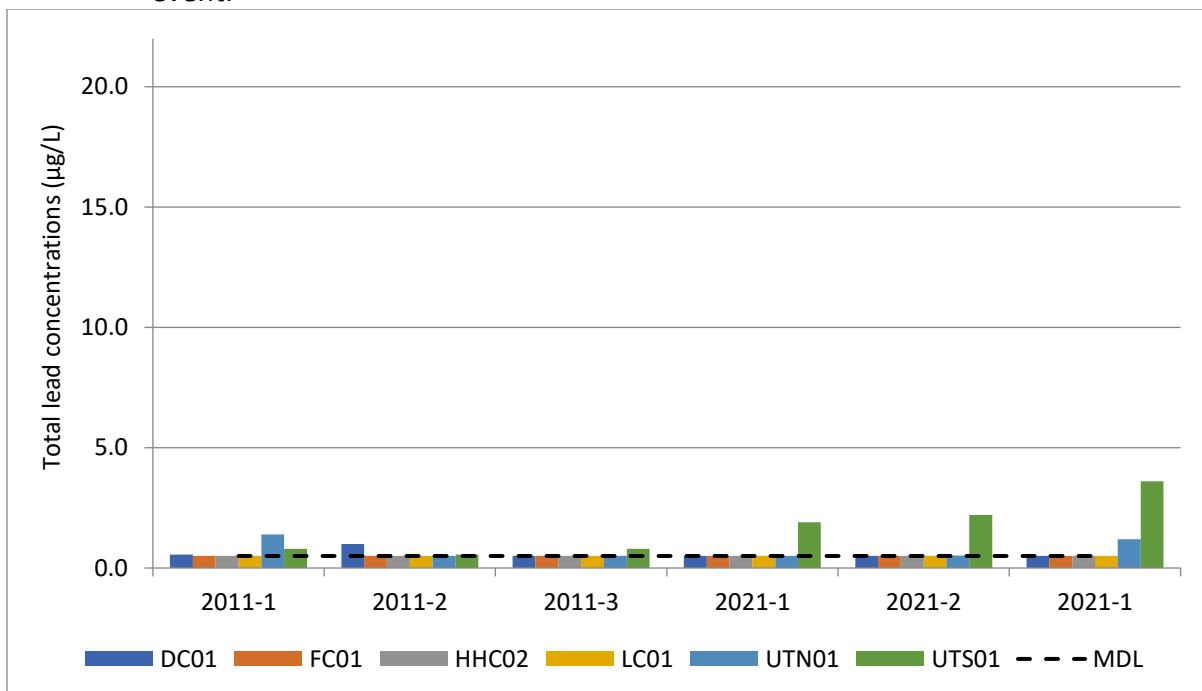
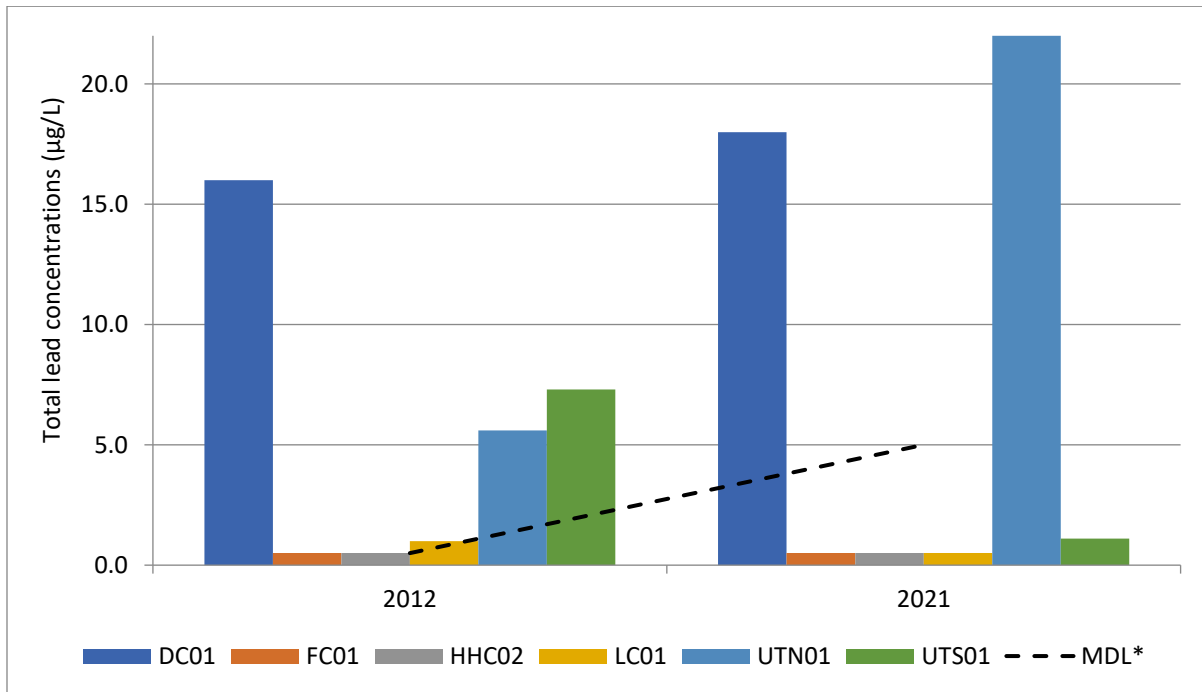


Figure 26. Total recoverable lead concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



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

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

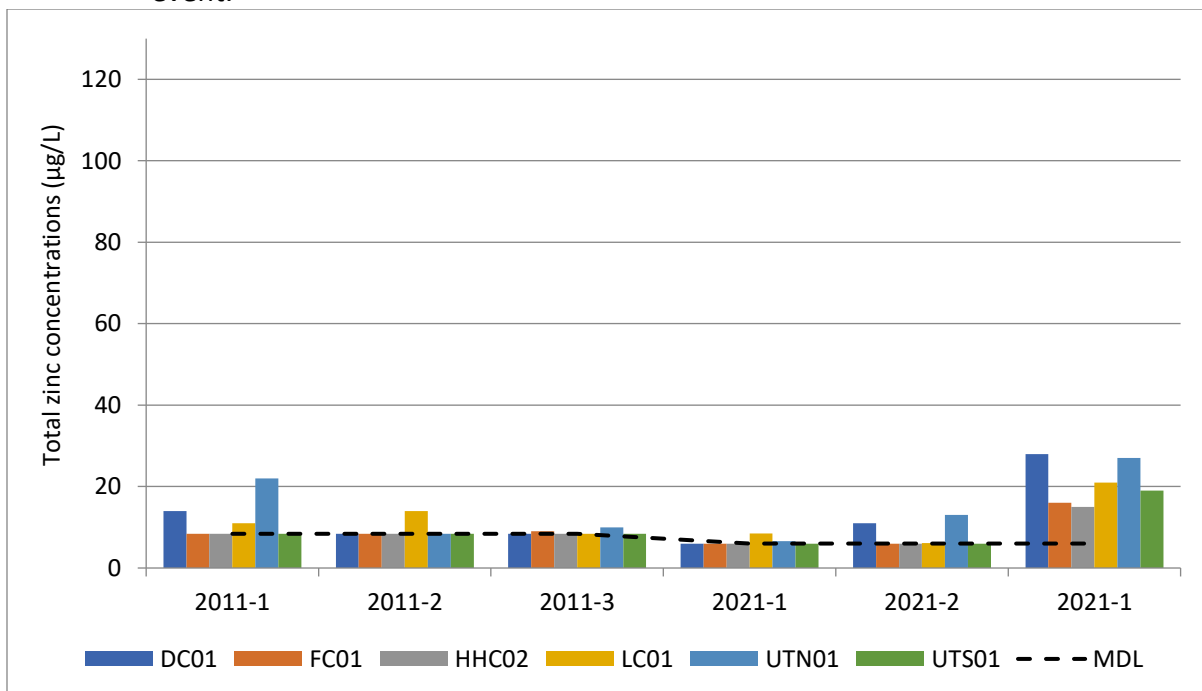
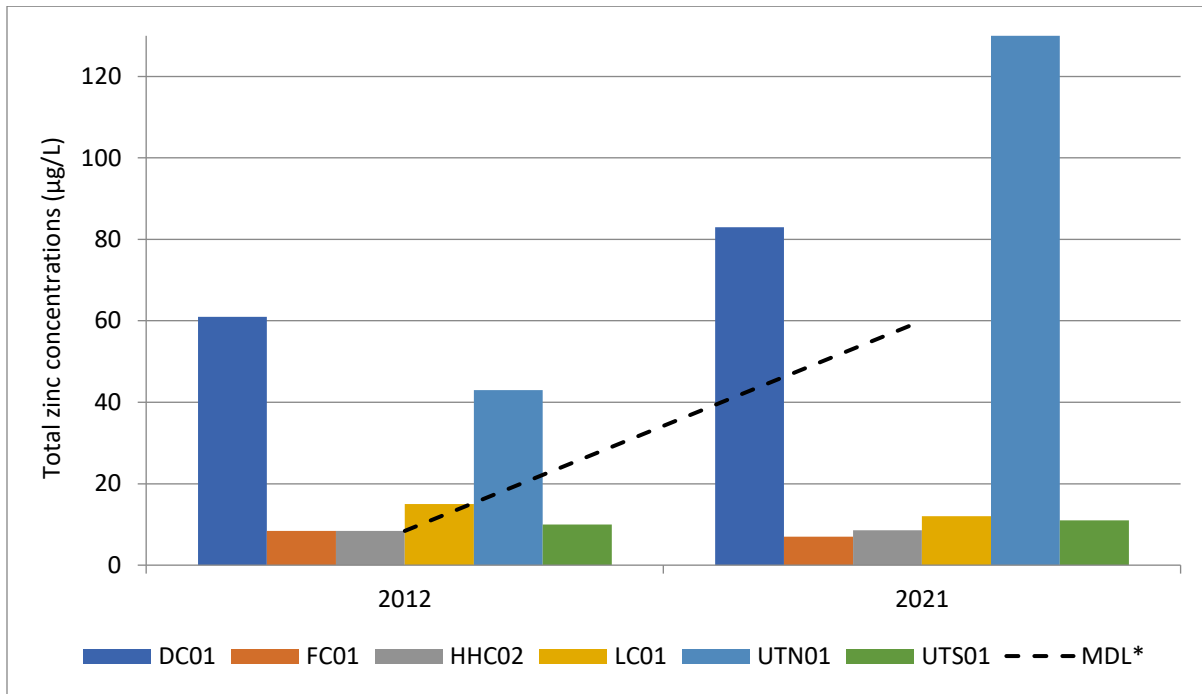


Figure 28. Total recoverable zinc concentrations measured during long-term monitoring wet weather events and laboratory method detection limits (MDL) used during each event.



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

Figure 29. Geometric means of fecal coliform and *E. coli* calculated for station DC01 during the watershed assessment and long-term monitoring.

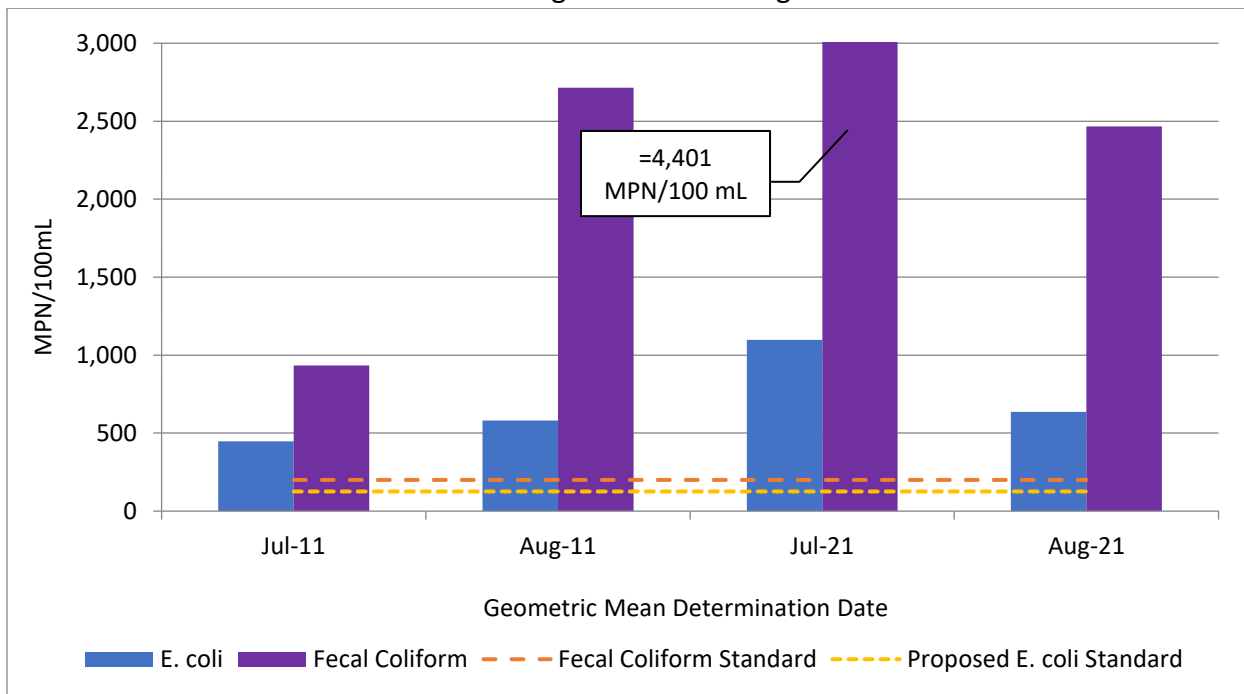


Figure 30. Geometric means of fecal coliform and *E. coli* calculated for station FC01 during the watershed assessment and long-term monitoring.

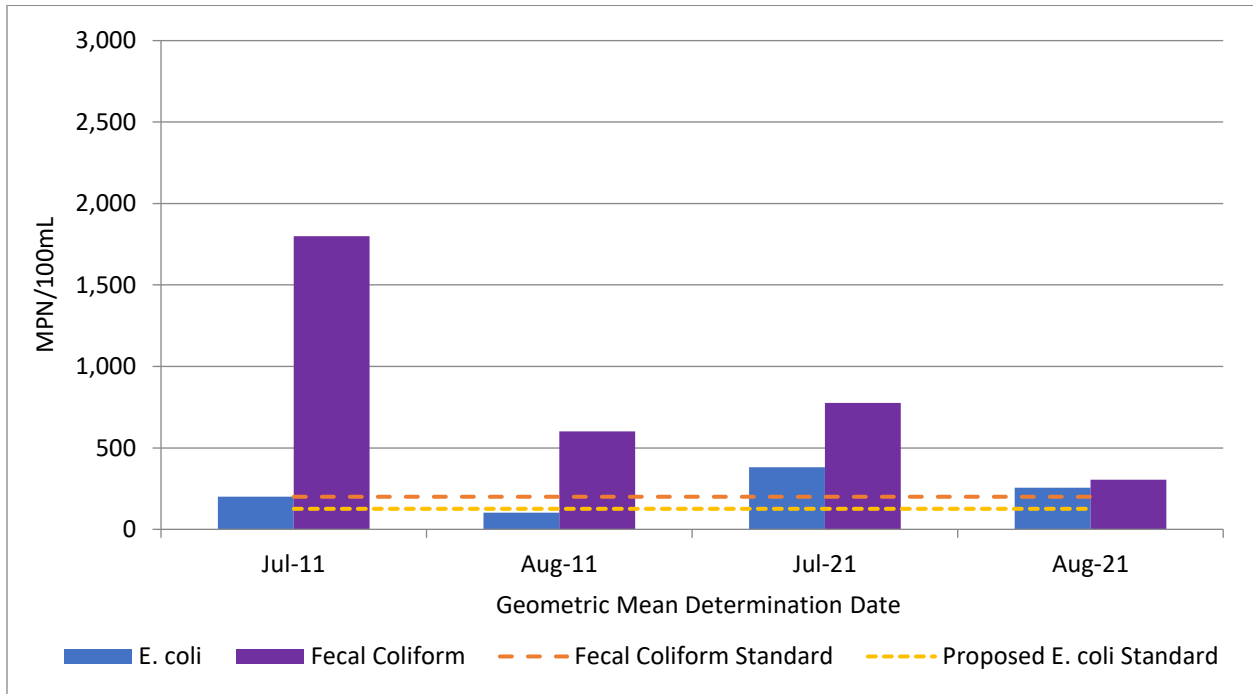


Figure 31. Geometric means of fecal coliform and *E. coli* calculated for station HHC02 during the watershed assessment and long-term monitoring.

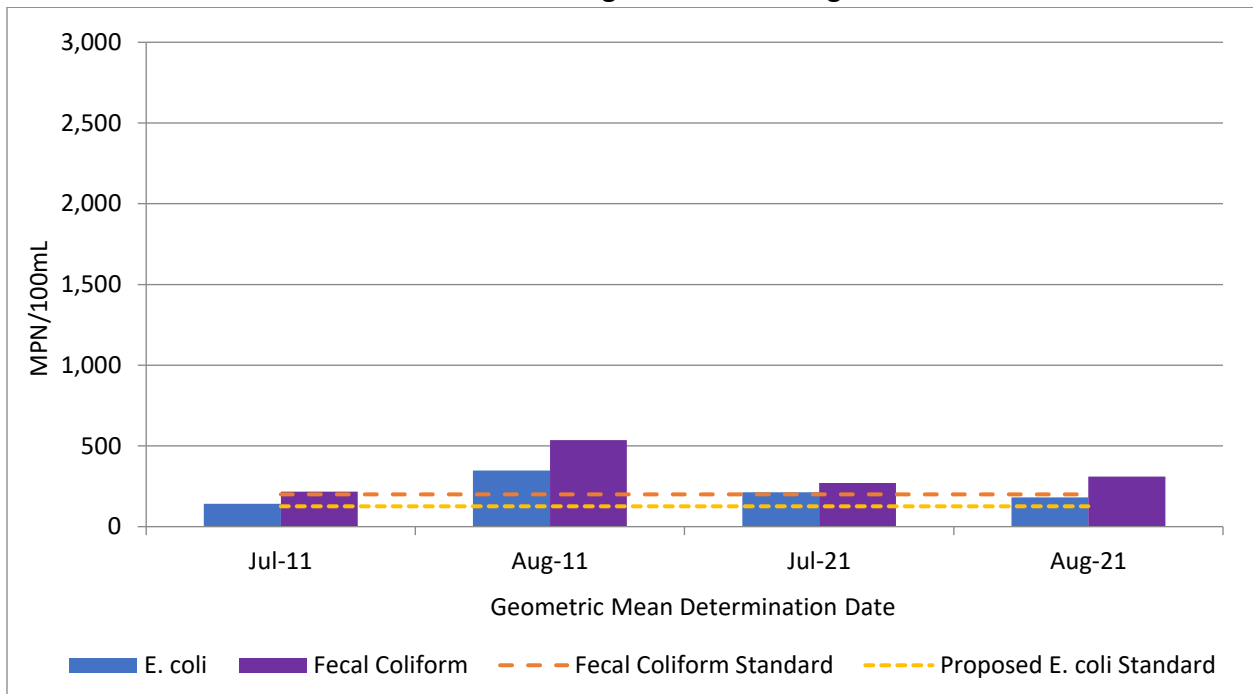


Figure 32. Geometric means of fecal coliform and *E. coli* calculated for station LC01 during the watershed assessment and long-term monitoring.

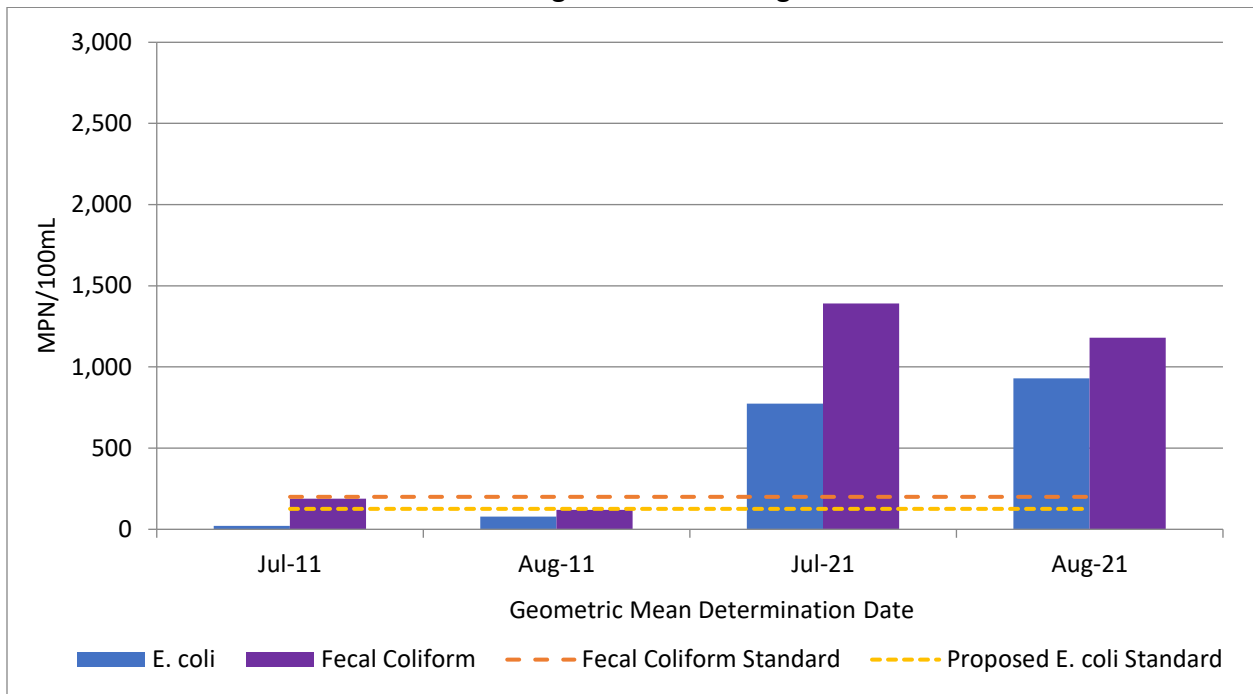


Figure 33. Geometric means of fecal coliform and *E. coli* calculated for station UTN01 during the watershed assessment and long-term monitoring.

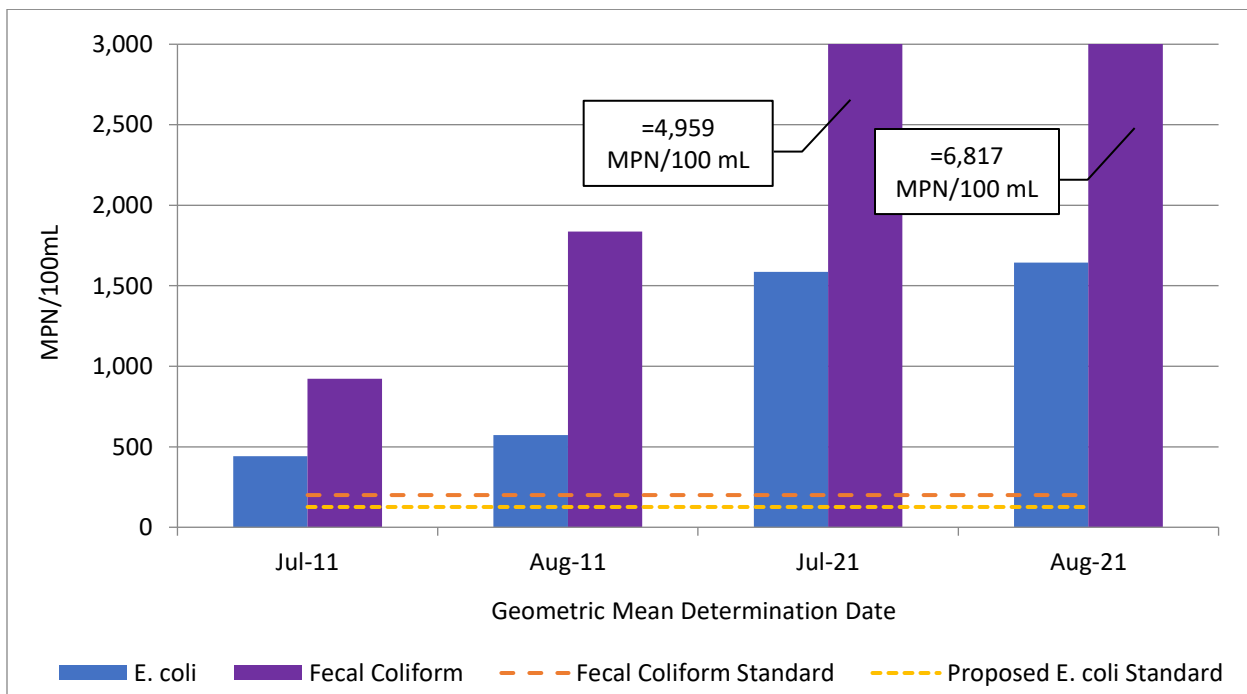


Figure 34. Geometric means of fecal coliform and *E. coli* calculated for station UTS01 during the watershed assessment and long-term monitoring.

