WATERSHED TREND REPORT

NORTH STUDY BASIN

2012 - 2019

Report Version 1: 6/21/24

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Introduction

Sanitation District No. 1 (SD1), a clean-water agency which serves over 30 communities in Campbell, Kenton, and Boone Counties, Kentucky, as both a wastewater and a storm water utility, is implementing an adaptive watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program, Municipal Separate Storm Sewer System (MS4) Program, Total Maximum Daily Load (TMDL) Program, etc.) to address environmental impacts associated with sewer overflows and storm water runoff in the communities it serves. In complying with these regulatory requirements, SD1 is applying a comprehensive approach for identifying impairments. In 2009, SD1 developed Watershed Characterization Reports for 16 watersheds to relate instream conditions to watershed characteristics. The results of these Watershed Characterization Reports were used to identify impaired watersheds and prioritize them for consideration of control alternatives associated with sewer overflow mitigation[1].

SD1 is undertaking a long-term effort to collect and compile data that describes the water quality conditions of Northern Kentucky (NKY) streams. This information is compiled at a basin scale and a watershed scale to relate instream conditions to watershed characteristics. Figure 1 shows the four study basins (East, Central, North and West) that are used to group NKY watersheds into logical reporting units.

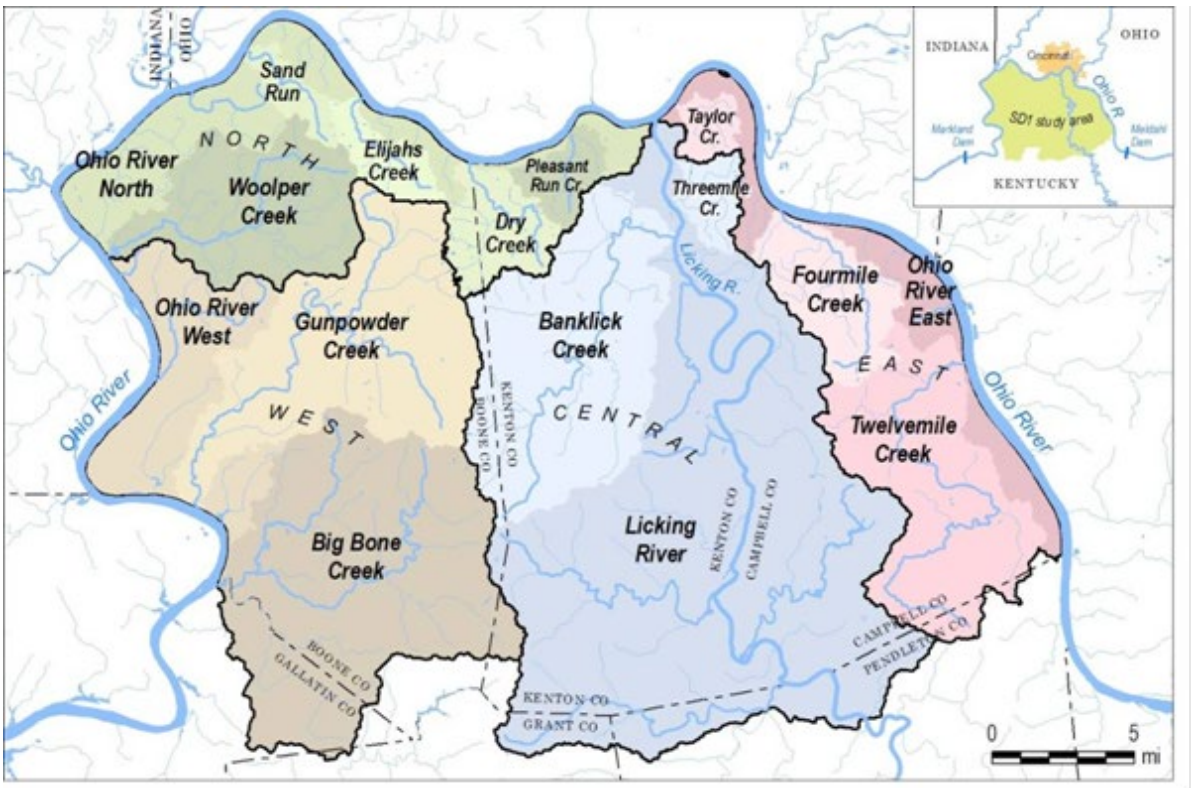


Figure 1. Study Basins and Watersheds

[1] SD1 entered into a Consent Decree with state and federal environmental regulators in 2007.

Background

The watersheds depicted in Figure 1 represent varying conditions with respect to the amount of development, as well as sources of stream pollution. The variation in the stream conditions can range from undeveloped watersheds that have been categorized as "exceptional" waters by the State, while other watersheds are more highly developed and are identified as "impaired" by the State.

As a result of the vast differences between these watersheds, SD1 initiated a comprehensive monitoring program in 2006 to collect instream water quality, biology, physical habitat, and stream stability data to establish current conditions and long-term datasets for model development and trend analysis.

This monitoring program is being implemented in a phased approach which is designed to achieve the following objectives:

- Characterize watershed conditions during baseflow/dry weather and storm flow/wet weather;
- Provide datasets for calibrating detailed watershed and water quality models;
- Provide datasets for assessment tools, such as a Stream Condition Index;
- Meet regulatory requirements for the Nine Minimum Controls as defined within the Long-term Control Plan requirements of the CSO Policy;
- Meet regulatory requirements for the Six Minimum Control Measures as defined within the Storm Water Quality Management Plan requirements of the Phase II MS4 Program;
- Characterize physical stream channel responses from urbanized storm water runoff (i.e., hydromodification);
- Establish a baseline for evaluating improvements from implementing controls; and,
- Respond to regulatory initiatives such as 305(b) assessments, 303(d) listings, TMDLs, etc.

Prior to 2006, limited water quality monitoring and biological assessments had been conducted in the watersheds of Northern Kentucky, thus the monitoring program has evolved over time based on the relative timetable associated with the objectives identified above. SD1 initiated a watershed wide monitoring program in 2006 to establish baseline conditions (base flow and storm flow) and datasets for model development - Period 1 (2006-2011). Period 2 spanned from 2012-2015 which established the basin rotation approach (e.g., 2012 - East Basin; 2013 - Central Basin; 2014 - North Basin; 2015 - West Basin). Period 3 spanned from 2016-2019 and was a continuation of the Period 2 basin rotation approach and established the ambient water quality monitoring approach to focus on spatial and temporal changes within the watersheds. After a temporary suspension of monitoring and assessment activities in 2020, Period 4 (2021-2024) data collection activities are in progress.

This report will focus on the North Basin watersheds and each of the four monitoring components of SD1's monitoring program to assess stream condition trends for Periods 2 and 3.

Ambient Water Quality Monitoring

Water Quality Sampling

The objective of the ambient monitoring program is to characterize instream water quality under a wide range of environmental conditions in Northern Kentucky streams. By monitoring instream water quality, the condition of watersheds can be assessed along with the impact of land-based activities on the local waterways. Specific or emerging water quality issues may also be identified by monitoring and gathering information on the various waterbodies.

Although watershed wide water quality monitoring was initiated in 2006, the development of an ambient monitoring program component began in 2015 (i.e., the last year of Period 2). During Period 3, the ambient monitoring was further enhanced to meet program objectives. In 2021 (the beginning of Period 4), additional sites will be added to each watershed's rotational basin schedule to increase spatial resolution of the monitoring.

Biological Assessments

Biological Assessment

The objective of the biological assessment program is to characterize the biological diversity and habitat quality in Northern Kentucky streams. By assessing the biological community to determine pollutant tolerant and pollutant intolerant species, the overall integrity of a waterbody can be determined along with both present and past effects of stressors of the biological integrity on the aquatic ecosystem.

Watershed wide biological assessments were conducted from 2006 through 2011 (Period 1) in order to record baseline data on the current condition of the streams and to develop subsequent monitoring and assessment strategies. With respect to the Basin Trend Reports, results and analysis of biological assessments began with the Period 2 datasets.

Stream Stability Assessments

Stream Stability Assessment

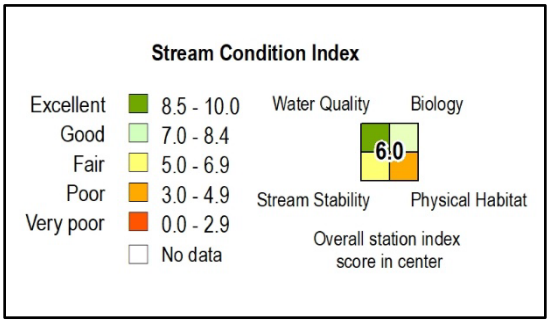
The objective of the stream stability assessment program is to characterize the rate of streambed and streambank movement in Northern Kentucky streams. By measuring physical stream channel responses over time, that are primarily attributable to land-use conversion from undeveloped to developed, a stream site can be designated as stable or unstable. The altered flow regime associated with conventional urban development leads to hydromodification – flashier streams, larger flow, excessive stream erosion and overall channel instability. Accelerated bank erosion,

channel deepening/widening, and overall enlargement pose risks to adjacent public infrastructure (i.e., sewers, roads and bridges), as well as private property losses. These same actions also cause water quality impairments (i.e., high TSS and sedimentation/siltation) and have adverse effects on aquatic biota, such as fish and macroinvertebrate populations.

Limited stream stability assessments began in 2008 after sampling crews documented significant stream erosion while conducting water quality monitoring and biological assessments. Throughout Periods 1 and 2, additional sites were added to meet program objectives. Beginning in 2019, rapid stream stability assessments were conducted at all biological assessment sites.

Stream Condition Index

To better evaluate, summarize, and communicate the results of the monitoring program, SD1 has utilized data collected from local streams and watersheds to develop a regionally based Stream Condition Index (SCI)[2]. Appropriate indicators of stream condition were researched and selected in four key categories: water quality, biology, physical habitat, and stream stability. A scoring system for each indicator and a method to aggregate indicator scores at each site was established, creating a sub-index score for each of the four categories. At each site, the four sub-index scores are averaged to create a single Stream Condition Index (SCI) score. The SCI scores allow for a general comparison of stream conditions across the Northern Kentucky area.



Stream Condition Index

These types of environmental indices are commonly used by resource managers and scientists to summarize large amounts of complex data but are rarely calibrated to reflect conditions of such a localized area. The local focus of the SCI will allow its use in resource monitoring, potentially diagnosing problem areas, predicting relative resource condition, setting benchmarks for management targets, and (perhaps most importantly) streamlining complex data in terms that can be understood by a non-technical audience.[3]

The objectives for the SD1's SCI were to:

- Summarize large amounts of complex data from Northern Kentucky streams;
- Use existing monitoring programs and indices to the extent possible;
- Incorporate and reflect broader conditions beyond water quality;
- Balance scientific rigor with the timely development of an index; and,
- Communicate information on monitoring data to a lay audience.

[2] *A Stream Condition Index for Water Utility Resource Management in Northern Kentucky*, 2015.
[3] *A Manager's Guide to Indicator Selection*. U.S. EPA, 2006.

North Basin

The North Basin study area is located in northern Kenton and northern Boone Counties, KY (Figure 2). This basin includes (from east to west): Pleasant Run Creek, Dry Creek, Elijahs Creek, Sand Run, and Woolper Creek, along with smaller tributaries that discharge directly to the Ohio River (collectively depicted as Ohio River North).

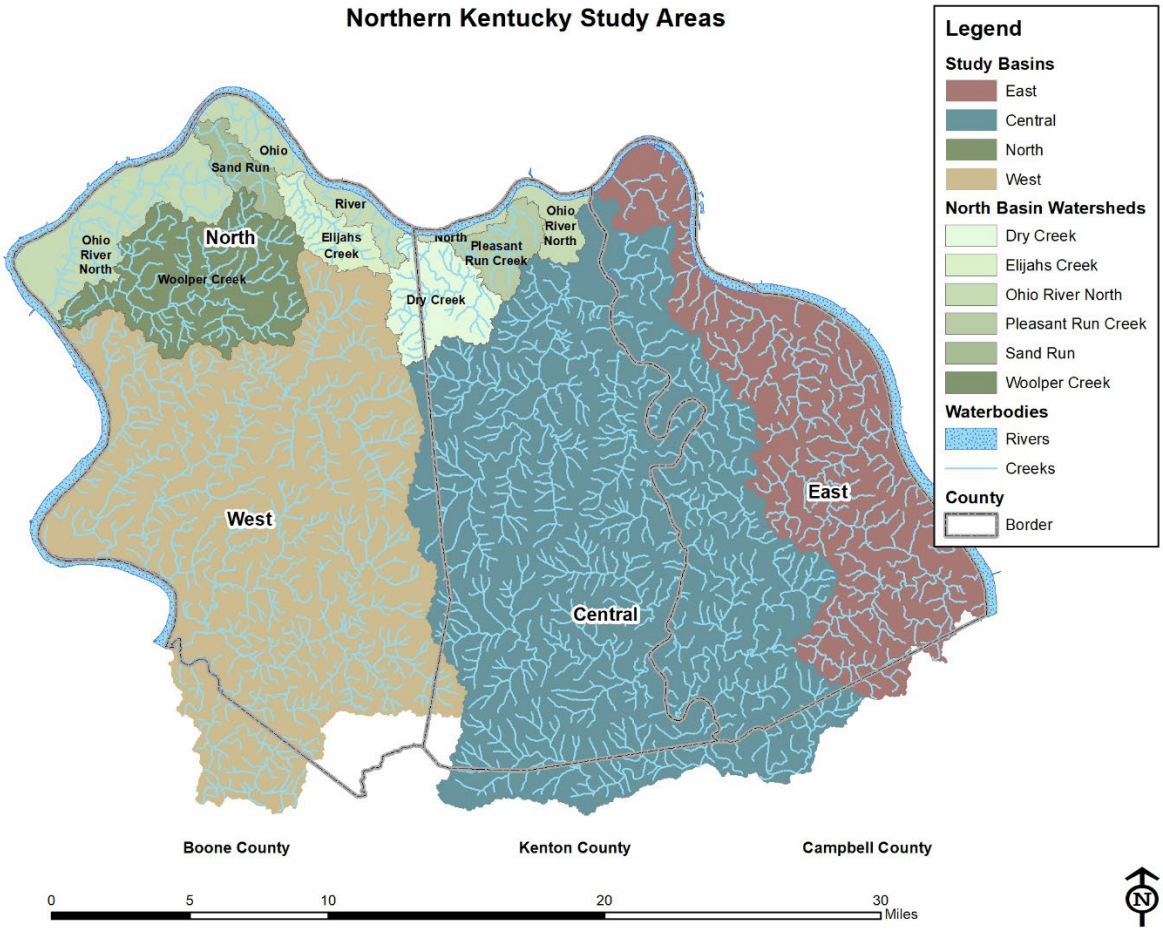


Figure 2. North Basin Study Area Map

The Basin Trend monitoring and assessment sites within the North Basin are located in five primary watersheds: Dry Creek, Elijahs Creek, Pleasant Run Creek, Sand Run, and Woolper Creek. Each watershed has multiple sites located throughout its drainage area, representing varying conditions with respect to the amount of development (i.e., impervious surface), as well as potential sources of stream pollution. Table 1 identifies the individual sites contained in each watershed.

Table 1. North Basin Site Locations

Dry Creek	Elijahs Creek	Pleasant Run Creek	Sand Run	Woolper Creek
DRC1.4	EJC0.3	PRC0.4	SDR0.6	WPC5.0
DRC3.0-WFD1.5	EJC2.8	PRC2.0	SDR4.0	ALF0.1
DRC4.4				WPC8.8

Sampling site locations were selected using several criteria including, but not limited to, drainage area, accessibility, stream heterogeneity, adjacent land use, past studies, and available resources.

Land cover and sewer system areas each play an important role in the quantity and quality of runoff into receiving waters. Each watershed overview section includes a series of maps that depict watershed conditions, as follows:

1) General watershed characteristics displayed as follows:
    a. Waterbodies include rivers and creeks that are designated as perennial, intermittent or piped, as well as reservoirs and impoundments, such as lakes and ponds.
    b. Constructed features include buildings, pavement, such as roads, parking lots, etc., as well as other impervious surfaces.

2) National Land Cover Database (NLCD) modified and displayed as follows:
    a. Initial dataset included agriculture, barren land, developed, forest, grassland, shrubland, water and wetlands categories representing 2019 conditions.
    b. Modified dataset to Circa 2023 with local GIS and imagery data including parcel information, buildings, pavement surfaces and waterbodies to correct and refine the agriculture, developed, grassland and water land cover categories.

3) SD1 service area boundaries and the active sewer overflow locations displayed as follows:
    a. Storm Water and Wastewater Service Area boundaries depicted as of December 2019.
    b. Modeled Sewer Overflow Locations[4] include model predicted sanitary sewer overflows[5] and combined sewer overflows[6], based on 2020 sewer system conditions.

[4] Refer to SD1's Amended Consent Decree, Appendix A, filed 3/17/09.
[5] Design storm modeling based on a 2-year, 6-hour rainfall event (2.29") for the Eastern Region of KY.
[6] Typical year modeling based on 1970 rainfall events recorded at the Cincinnati-NKY International Airport.

Dry Creek

Located in both Kenton County and Boone County, the Dry Creek watershed originates in the city of Crestview Hills, KY and flows approximately 7.1 miles in a northwesterly direction to the Ohio River (Figure 3). West Fork Dry Creek is a significant tributary that contributes drainage to Dry Creek. The overall watershed provides drainage to many political jurisdictions including the cities of Crescent Springs, Crestview Hills, Edgewood, Erlanger, Florence, Fort Mitchell, Lakeside Park, and Villa Hills, as well as portions of unincorporated Boone County. The Dry Creek watershed has a drainage area of approximately 12.8 square miles with 29.0% estimated as impervious surface. Monitoring is conducted at two sites on the main-stem of Dry Creek, as well as one site within the West Fork Dry Creek sub-watershed.

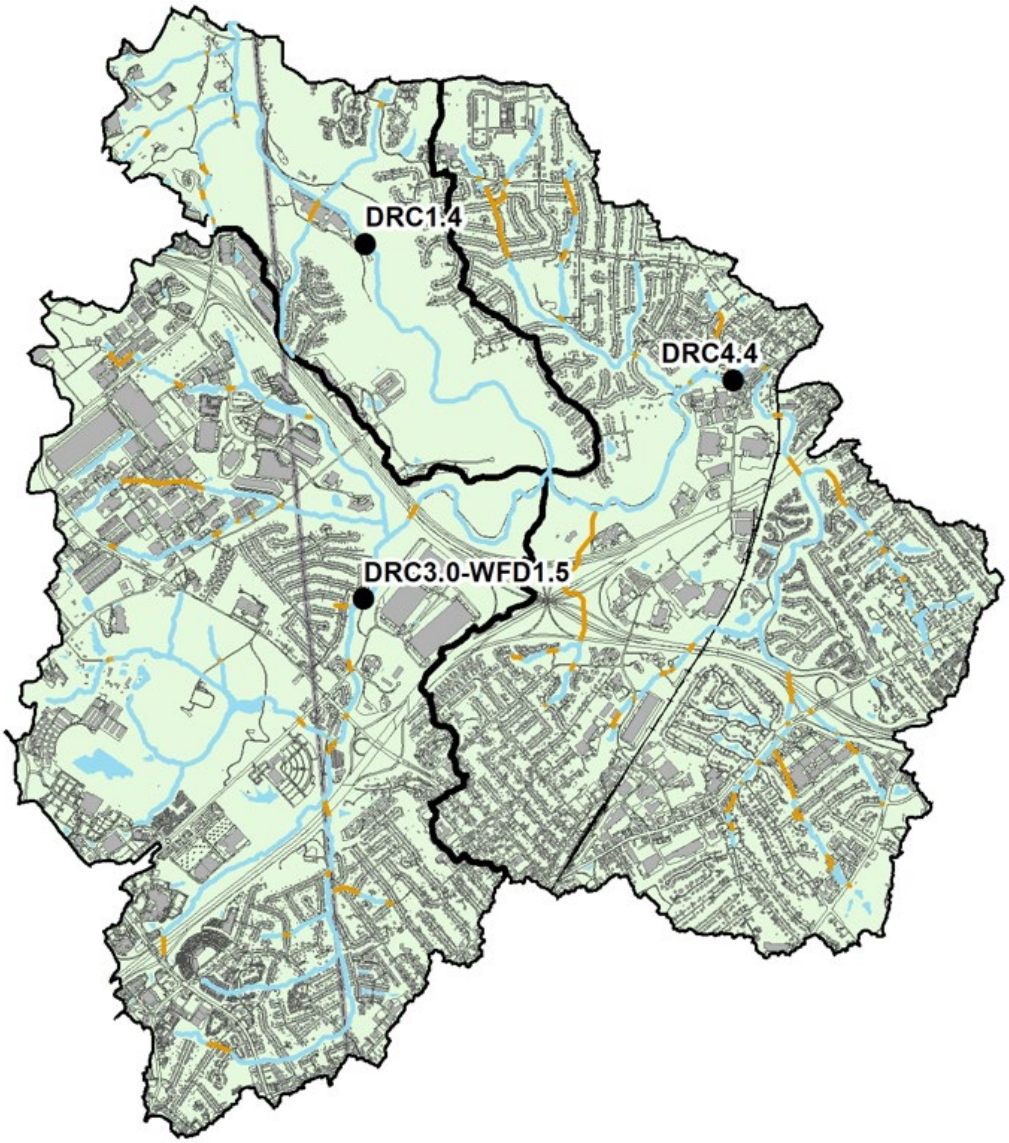


Figure 3. Dry Creek Watershed

Dry Creek watershed is highly urbanized and the most developed watershed in the Central Basin (Figure 4). Land cover consists of predominately developed land (~77%), followed by forested land (~17%). Interstate highways I-71/75 and I-275, significant transportation routes, traverse sizable areas of the watershed.

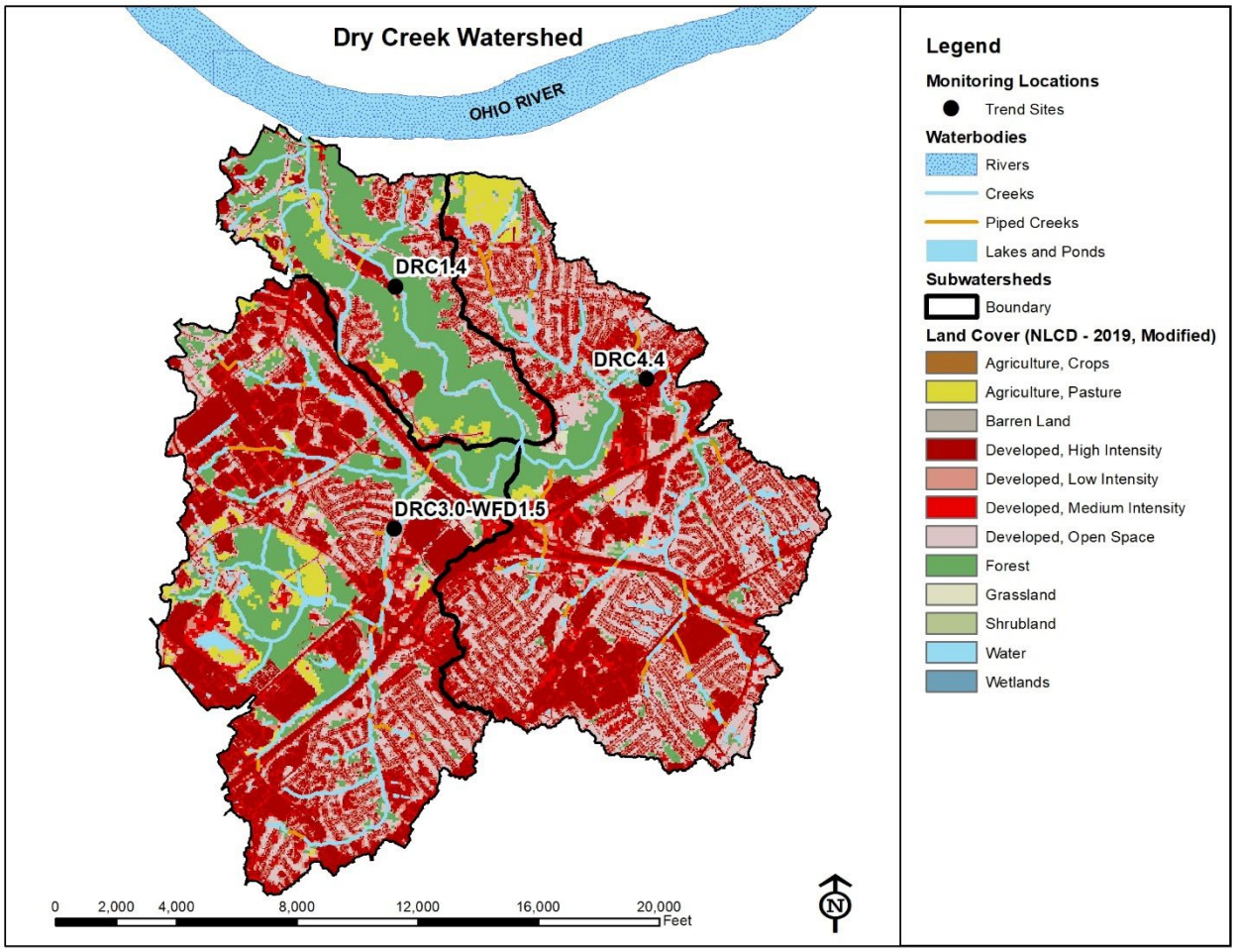


Figure 4. Dry Creek Land Cover

Areas within the Dry Creek watershed that are managed by SD1 with respect to centralized sanitary sewers and regional storm water systems, are depicted in Figure 5. Currently within the wastewater system eight modeled overflow locations, consisting of only sanitary sewer overflows (SSOs), discharge during various wet weather conditions. The overflow locations occur throughout the watershed with three overflows located in the upper portion of the West Fork Dry Creek sub-watershed. Although SD1's Dry Creek Wastewater Treatment Plant is located in the lower portion of the watershed, the treated effluent discharges directly to the Ohio River. The entire watershed is subject to Kentucky's Phase II MS4 program. The majority of the MS4 program area is encompassed within SD1's storm water service area, representing the NKY Regional Storm Water Program, while area within the city limits of Florence is subject to the city's storm water program. KYTC rights-of-way within the MS4 program area are subject to the Transportation Cabinet's storm water program.

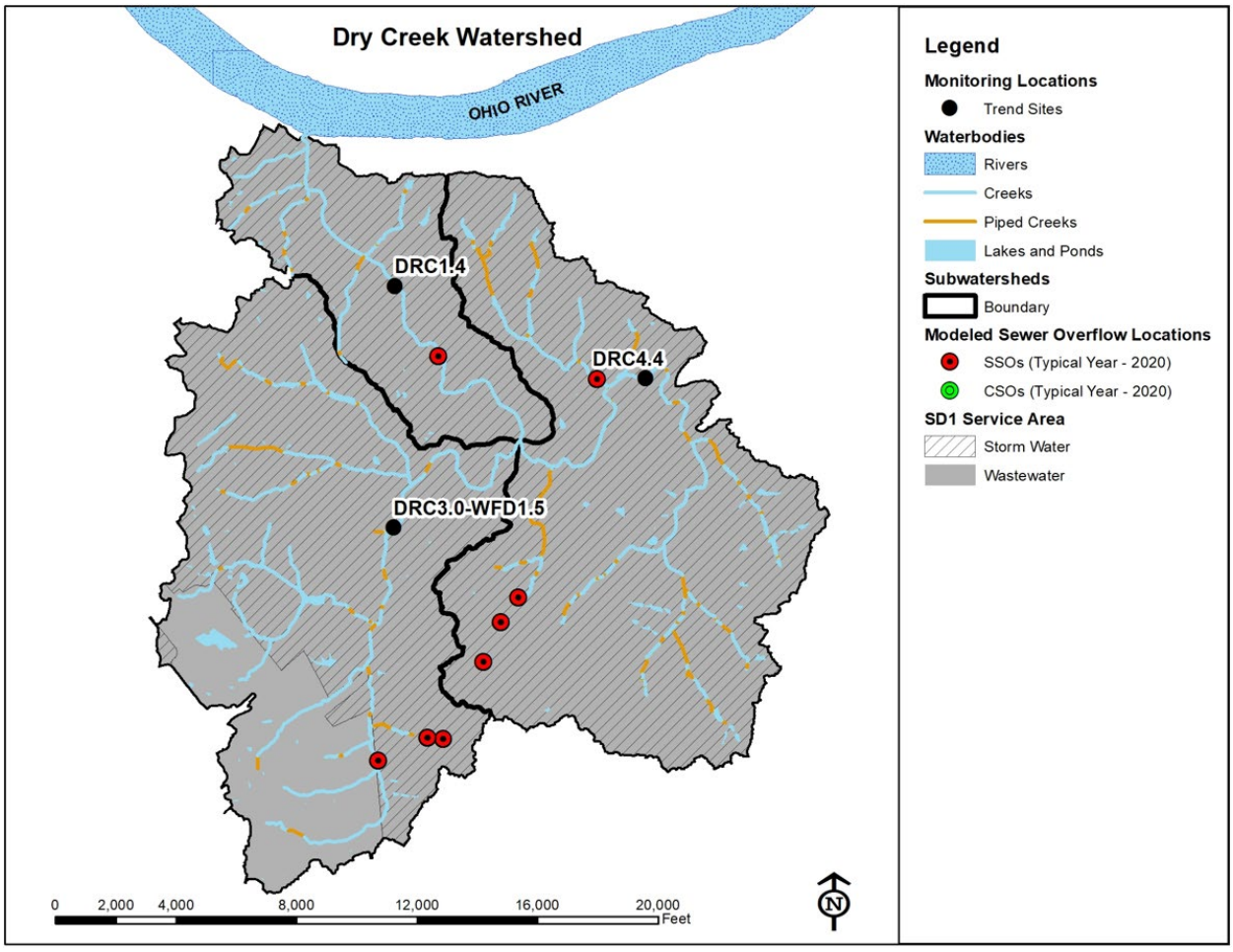


Figure 5. Dry Creek Modeled Sewer Overflows and Service Areas

Elijahs Creek

Located entirely within Boone County, the Elijahs Creek watershed originates on the north end of the Cincinnati/Northern Kentucky International Airport and flows approximately 5.4 miles in a north westerly direction to the Ohio River (Figure 6). The overall watershed provides drainage to portions of unincorporated Boone County. The Elijahs Creek watershed has a drainage area of approximately 6.6 square miles with 26.3% estimated as impervious surface. Monitoring is conducted at two sites on the main-stem of Elijahs Creek.

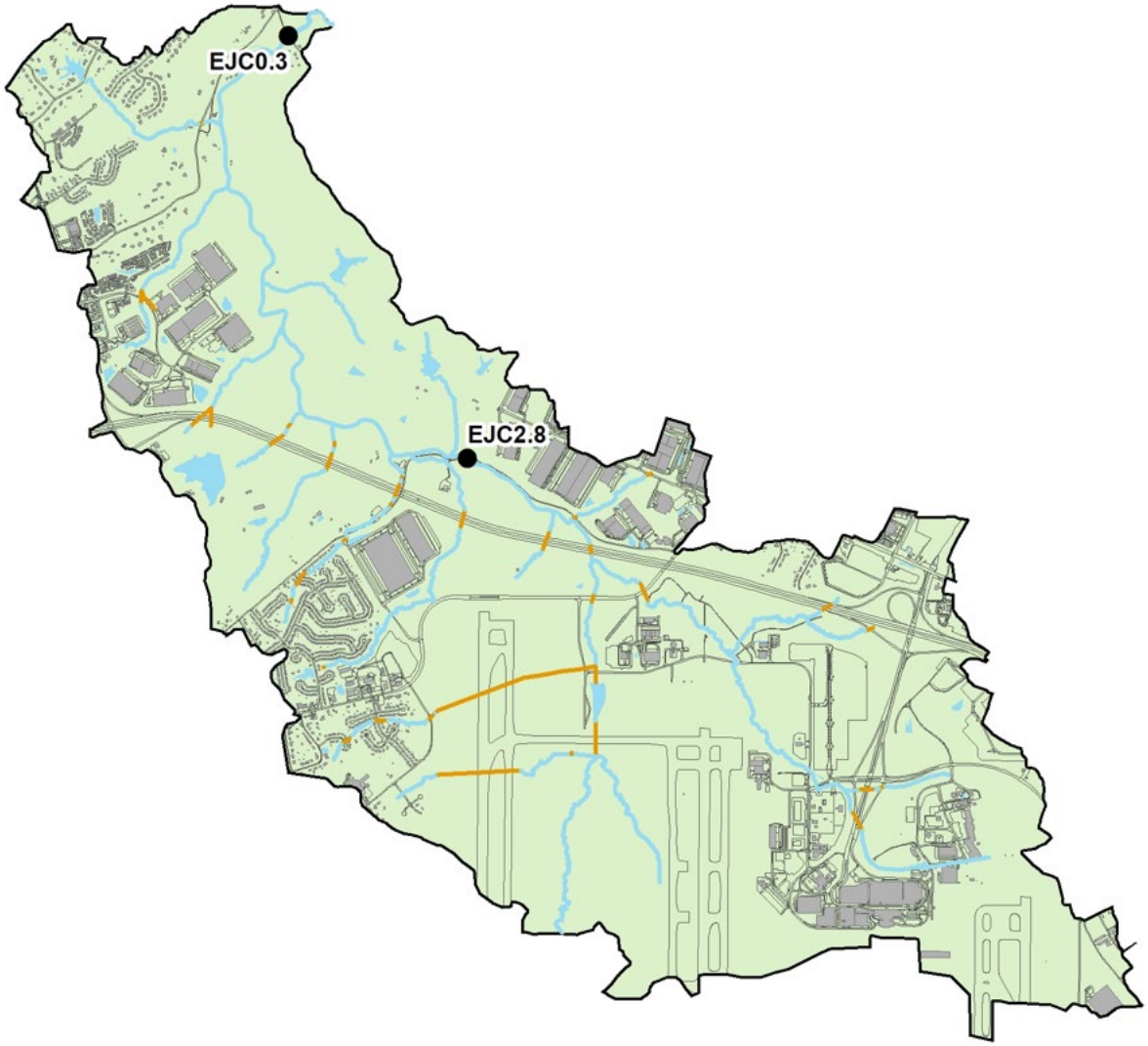


Figure 6. Elijahs Creek Watershed

Elijahs Creek watershed is highly urbanized with the Cincinnati/Northern Kentucky International Airport located in the headwaters area (Figure 7). Land cover consists of predominately developed land (~67%), followed by forested land (~23%). Interstate highway I-275, a significant transportation route, traverses the watershed.

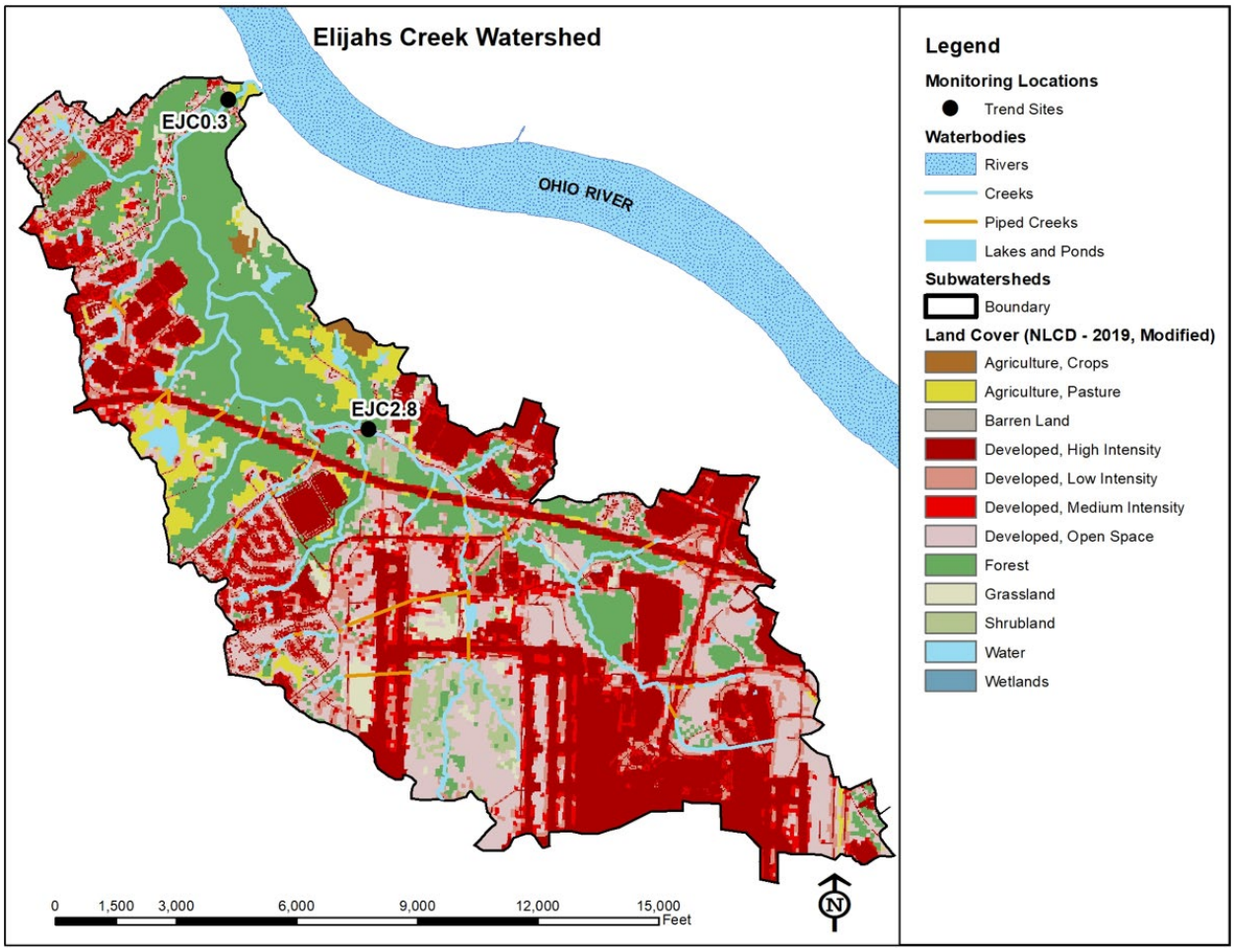


Figure 7. Elijahs Creek Land Cover

Areas within the Elijahs Creek watershed that are managed by SD1 with respect to centralized sanitary sewers and regional storm water systems are depicted in Figure 8. There are no modeled overflow locations in the watershed, which is completely within the wastewater service area. The entire watershed is subject to Kentucky's Phase II MS4 program and is encompassed within SD1's storm water service area, representing the NKY Regional Storm Water Program, while area within KYTC rights-of-way is subject to the Transportation Cabinet's storm water program.

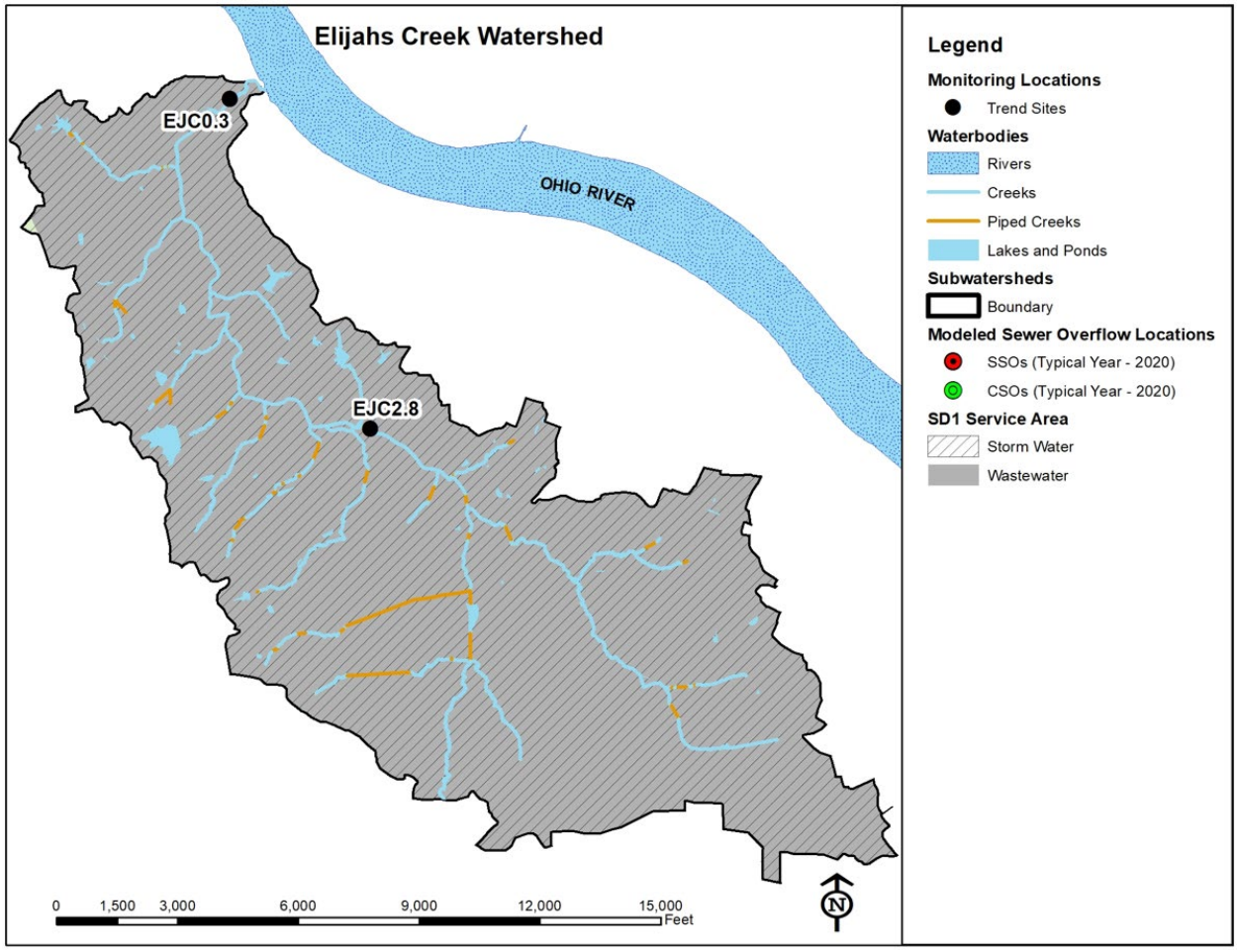


Figure 8. Elijahs Creek Modeled Sewer Overflows and Service Areas

Pleasant Run Creek

Located entirely in Kenton County, the Pleasant Run Creek watershed originates in the city of Fort Mitchell, KY and flows approximately 3.6 miles in a northly direction to the Ohio River (Figure 9). West Fork Pleasant Run Creek is a significant tributary that contributes drainage to Pleasant Run Creek. The overall watershed provides drainage to many political jurisdictions including the cities of Bromley, Covington, Crescent Springs, Fort Mitchell, Fort Wright, Ludlow, Park Hills, and Villa Hills, as well as portions of unincorporated Kenton County. The Pleasant Run Creek watershed has a drainage area of approximately 6.4 square miles with 19.5% estimated as impervious surface. Monitoring is conducted at two sites on the main-stem of Pleasant Run Creek.

Figure 9. Pleasant Run Creek Watershed

Land cover consists of predominately developed land (~70%), followed by forested land (~27%) (Figure 10). Interstate highway I-71/75, a significant transportation route, traverses the upper portion of the watershed.

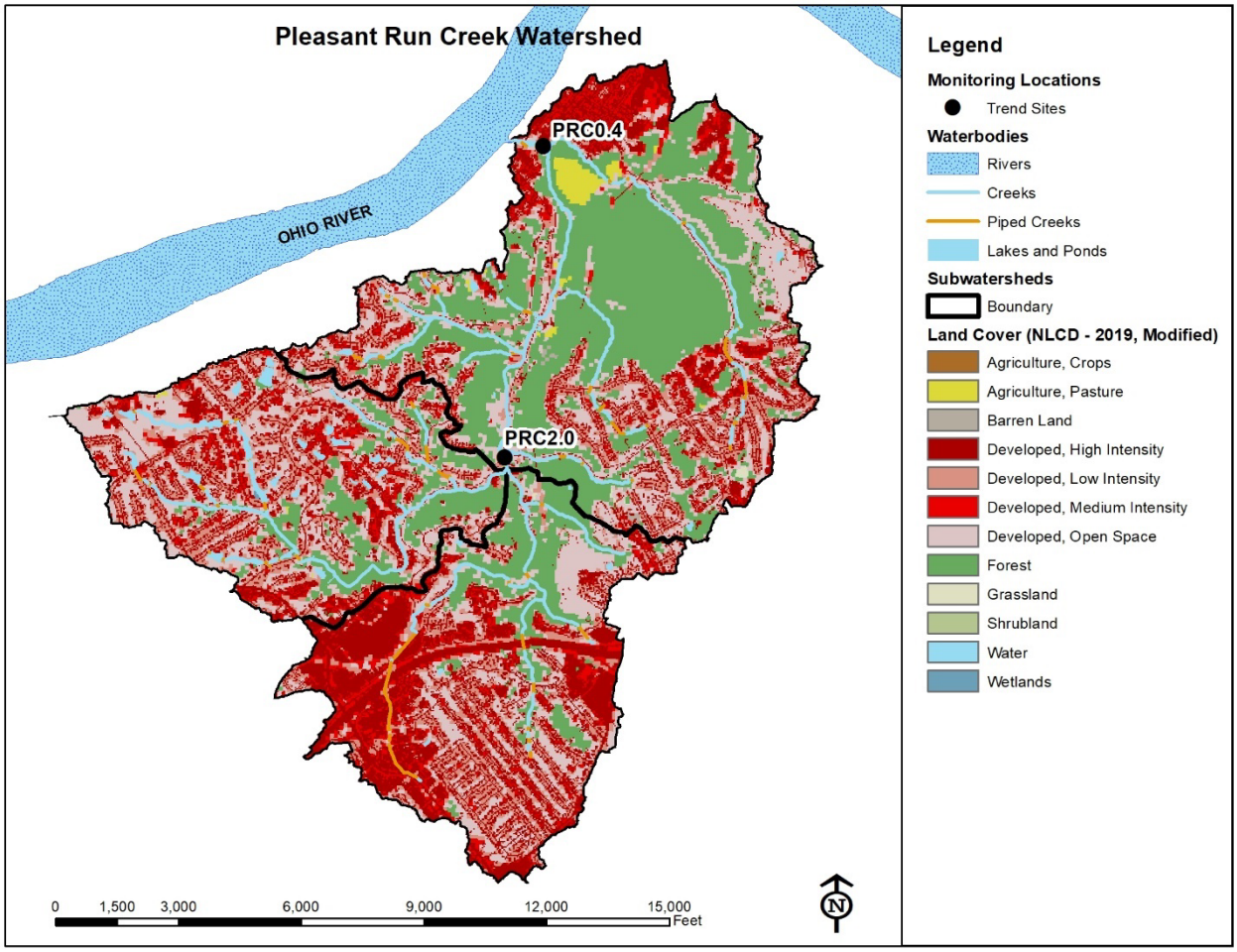


Figure 10. Pleasant Run Creek Land Cover

Areas within the Pleasant Run Creek watershed that are managed by SD1 with respect to centralized sanitary sewers and regional storm water systems are depicted in Figure 11. Currently within the wastewater system 11 modeled overflow locations, consisting of 9 sanitary sewer overflows (SSOs) and two combined sewer overflows (CSO), discharge during various wet weather conditions. CSO locations occur in the lower portion of the watershed near the Ohio River, while SSO locations occur throughout other portions of the watershed. The entire watershed is subject to Kentucky's Phase II MS4 program and is encompassed within SD1's storm water service area, representing the NKY Regional Storm Water Program, while area within KYTC rights-of-way is subject to the Transportation Cabinet's storm water program.

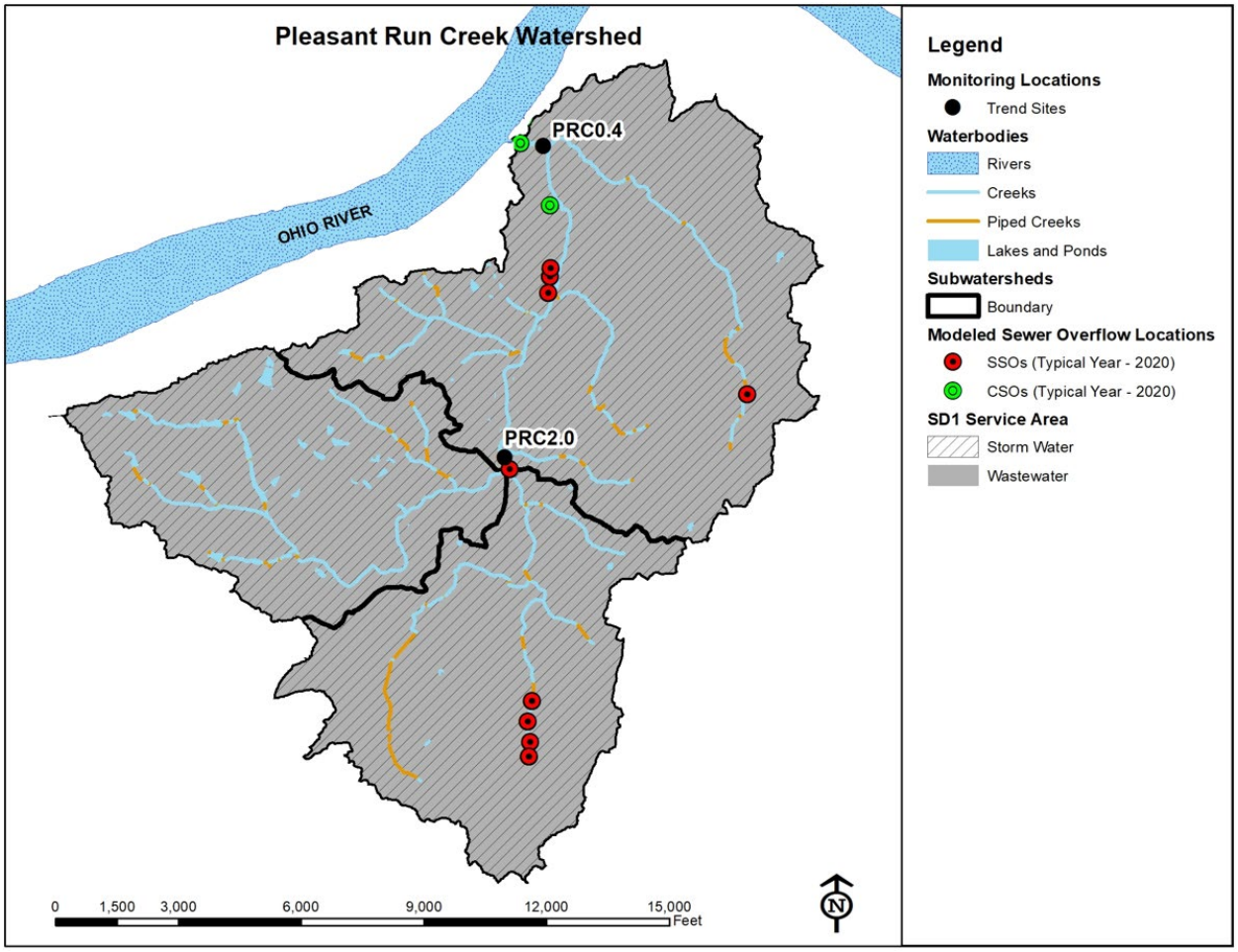


Figure 11. Pleasant Run Creek Modeled Sewer Overflows and Service Areas

Note: The city of Covington withdrew from the Regional Storm Water Program on March 1, 2021, establishing its own storm water program separate from SD1.

Sand Run

Located entirely within Boone County, the Sand Run watershed originates north of Hebron, KY and flows approximately 5.6 miles in a northwesterly direction to the Ohio River (Figure 12). The overall watershed provides drainage to portions of unincorporated Boone County. The Sand Run watershed has a drainage area of approximately 5.0 square miles with 19.1% estimated as impervious surface. Monitoring is conducted at two sites on the main-stem of Sand Run.

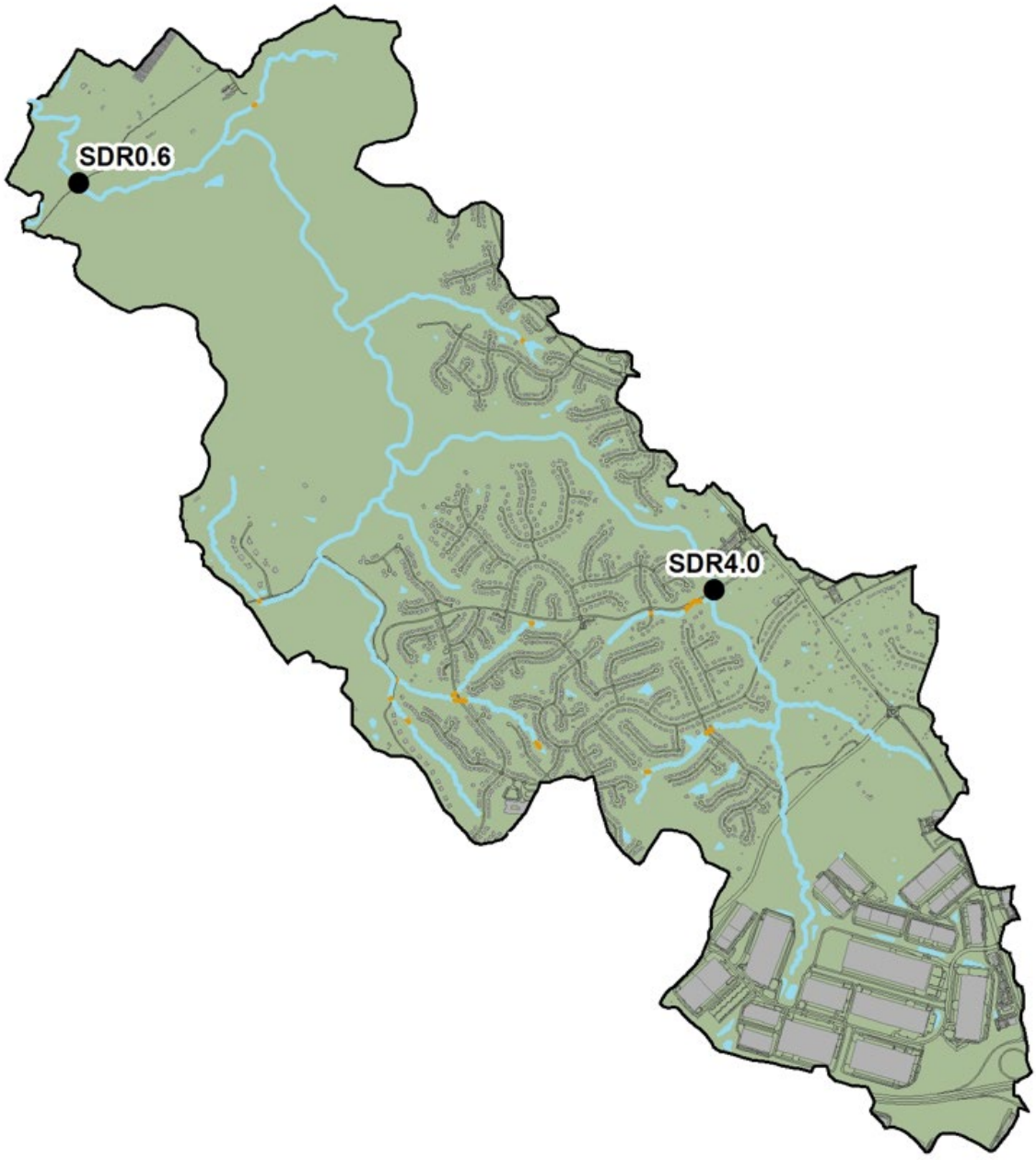


Figure 12. Sand Run Watershed

Sand Run watershed is mostly a mix of rural and suburban areas, with intensive commercial development in the headwaters area (Figure 13). Land cover consists of predominately developed land (~46%) and forested land (~41%). Interstate highway I-275, a significant transportation route, traverses a small area of the upper portion of the watershed.

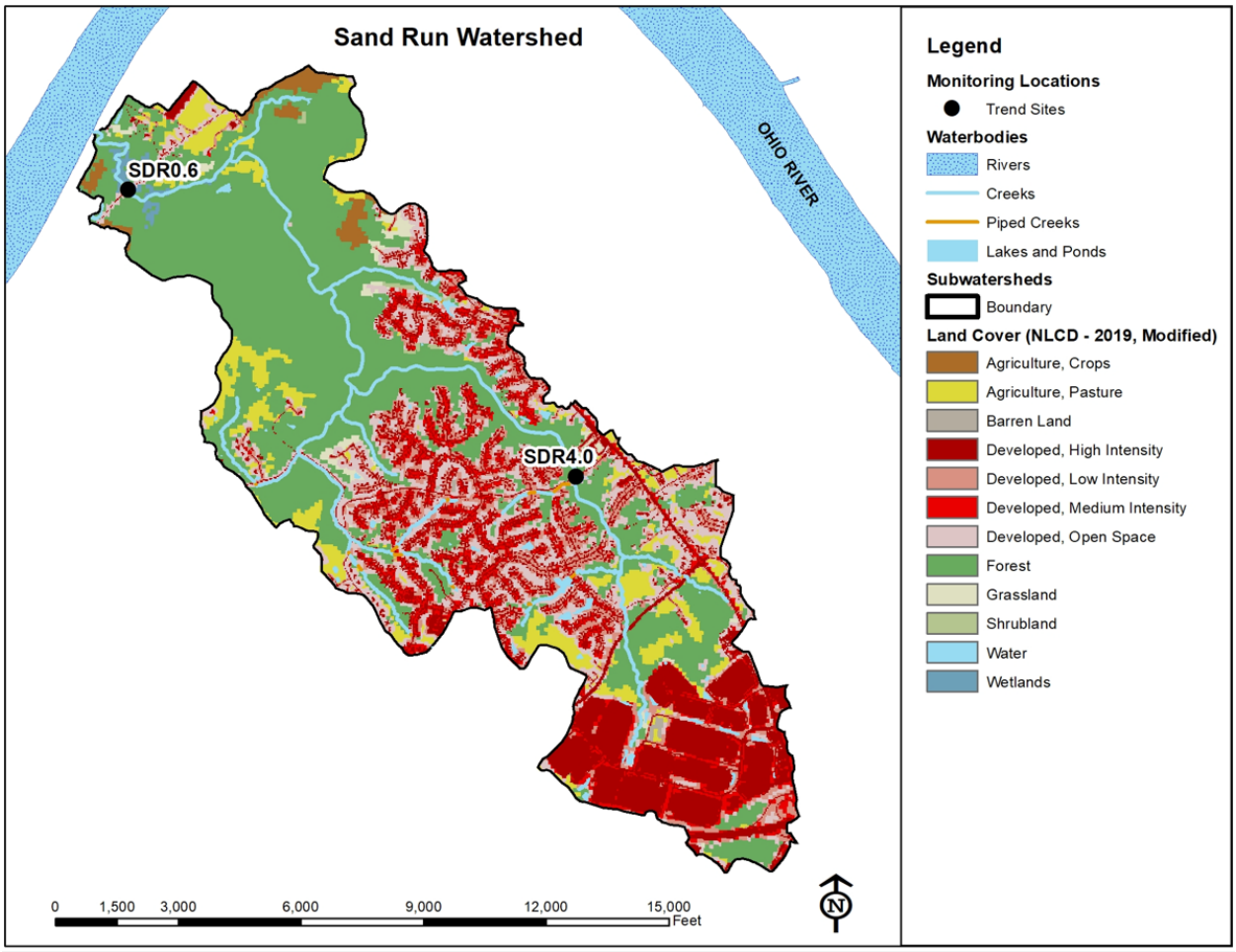


Figure 13. Sand Run Land Cover

Areas within the Sand Run watershed that are managed by SD1 with respect to centralized sanitary sewers and regional storm water systems are depicted in Figure 14. There are no modeled overflow locations in the watershed, which is not entirely within the wastewater service area. Most of the watershed is subject to Kentucky's Phase II MS4 program, which is encompassed within SD1's storm water service area, representing the NKY Regional Storm Water Program, while area within KYTC rights-of-way is subject to the Transportation Cabinet's storm water program.

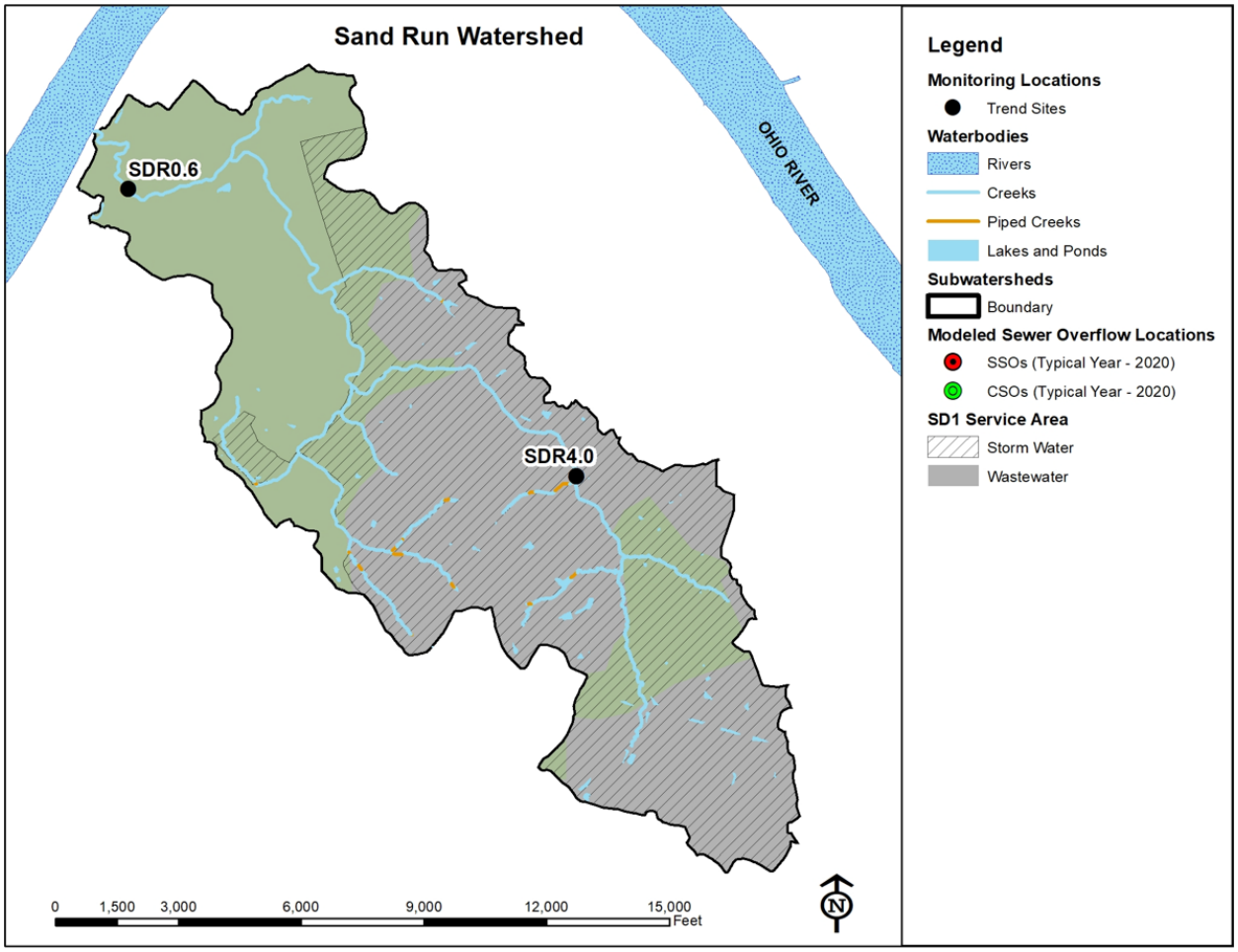


Figure 14. Sand Run Modeled Sewer Overflows and Service Areas

Woolper Creek

Located entirely in Boone County, the Woolper Creek watershed originates near Hebron, KY and flows approximately 14.2 miles in a south westerly direction to the Ohio River (Figure 15). Allen Fork (southeast), Double Lick Creek (north central) and Ashbys Fork (northwest) are three significant tributaries that contribute drainage to Woolper Creek. The overall watershed provides drainage to portions of unincorporated Boone County. The Woolper Creek watershed has a drainage area of approximately 33.0 square miles with 8.5% estimated as impervious surface. Monitoring is conducted at two sites on the main-stem of Woolper Creek, as well as one site within the Allen Fork sub-watershed.

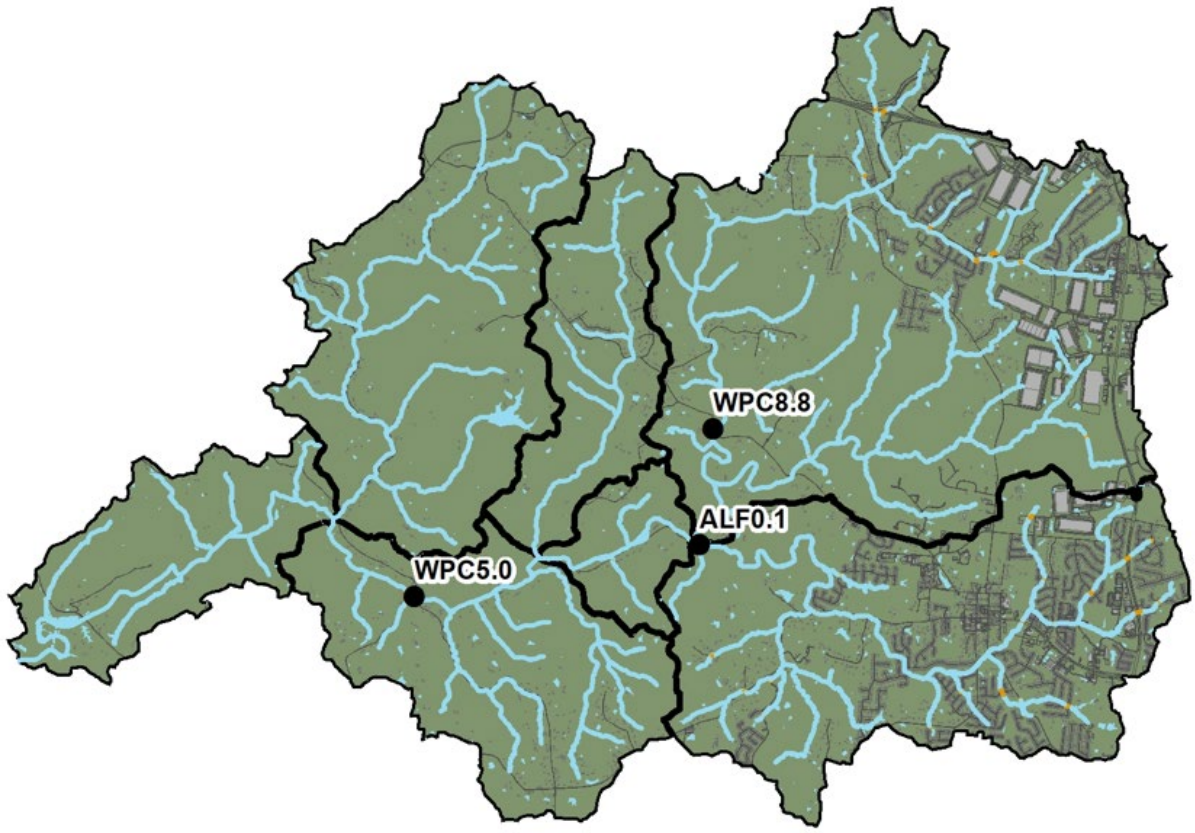


Figure 15. Woolper Creek Watershed

Woolper Creek watershed is mostly rural with suburban and urban areas in the upper portions of the watershed (Figure 16). Land cover consists of predominately forested land (~48%), with lesser amounts of developed land (~28%) and pastureland (~19%). Interstate highway I-275, a significant transportation route, traverses a small area of the upper portion of the watershed.

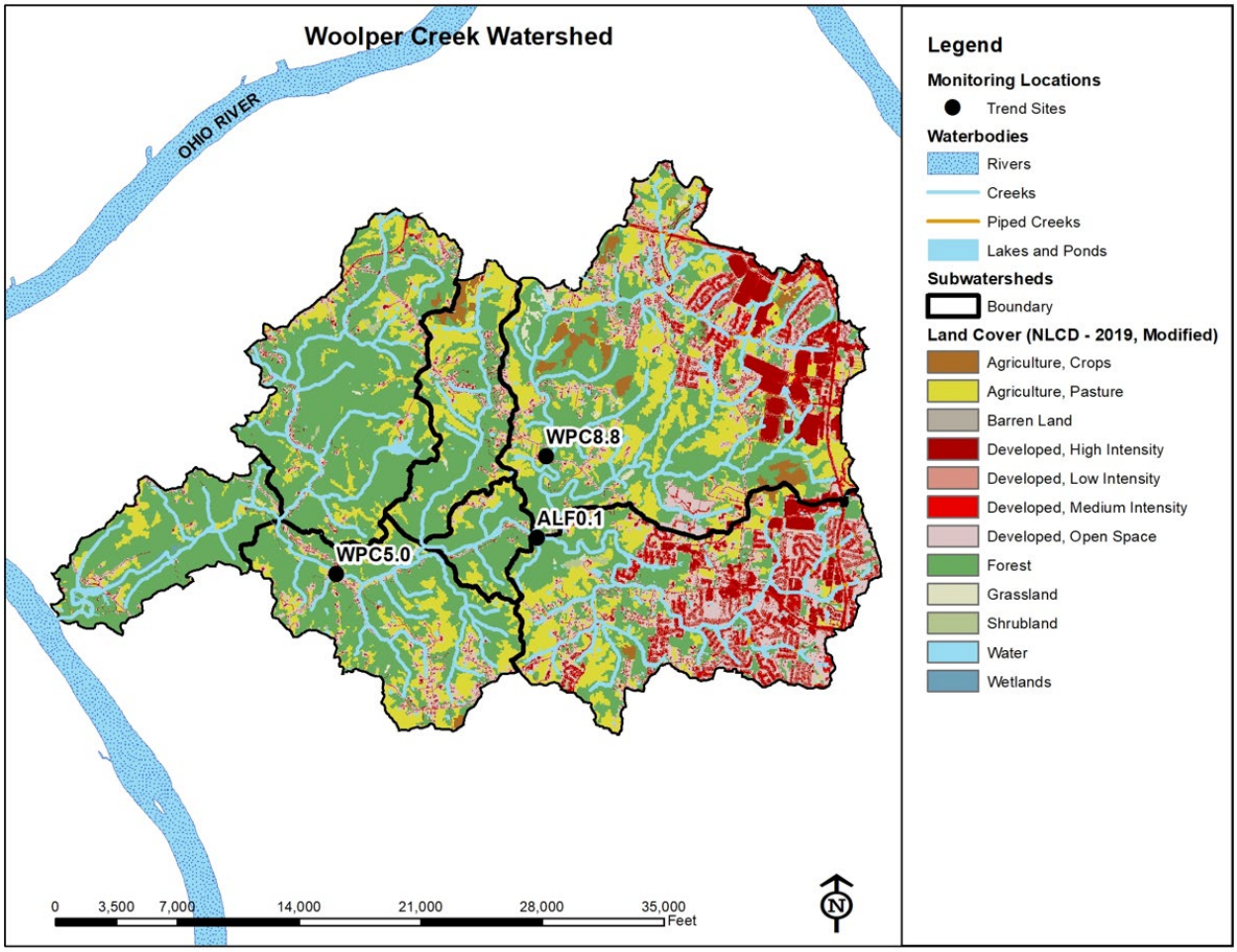


Figure 16. Woolper Creek Land Cover

Areas within the Woolper Creek watershed that are managed by SD1 with respect to centralized sanitary sewers and regional storm water systems, are depicted in Figure 17. Currently within the wastewater system one modeled overflow location, a sanitary sewer overflow (SSO), discharges during various wet weather conditions. The overflow location occurs in the upper portion of Woolper Creek. Less than half of the watershed is subject to Kentucky's Phase II MS4 program, which is encompassed within SD1's storm water service area, representing the NKY Regional Storm Water Program, while area within KYTC rights-of-way is subject to the Transportation Cabinet's storm water program.

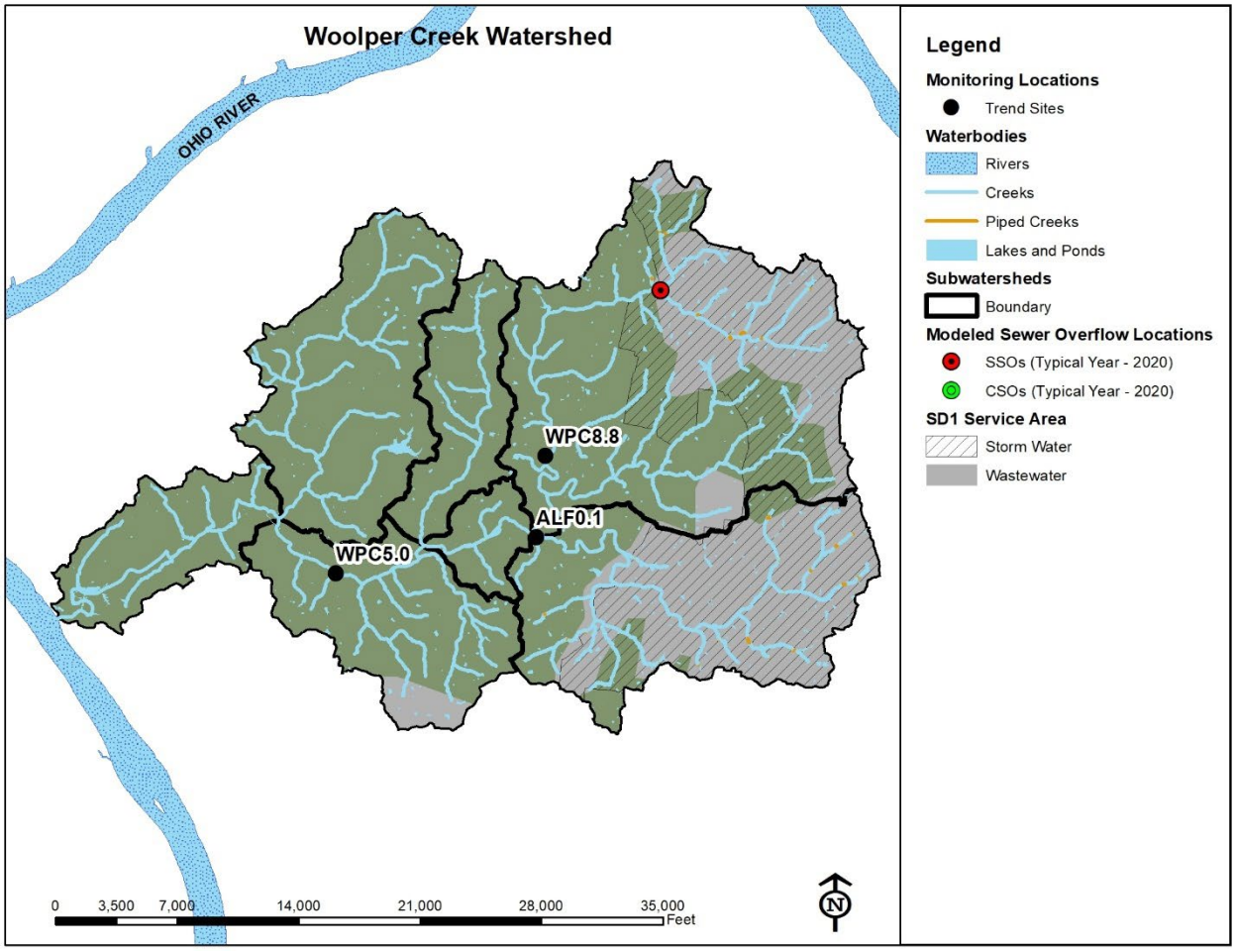


Figure 17. Woolper Creek Modeled Sewer Overflows and Service Areas

Further detailed characteristics of each watershed can be found on the SD1 website, https://www.sd1.org/233/Watershed-Characterization-Reports.

Ambient Water Quality Monitoring Results

SD1's ambient water quality monitoring consists of surface water grab samples collected from March through November on a set schedule (10 – 16 events per year) to "capture" varying flow regimes during the spring, summer and fall seasons. All sampling events were conducted following the appropriate Field Monitoring and Sampling Plan (FMSP) and the associated Quality Assurance Program Plan (QAPP) utilizing approved sampling protocols[7]. The FMSP and QAPP were designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled. Samples collected were analyzed in a laboratory for bacteria (*Escherichia coli - E. coli*), solids (total suspended solids - TSS), and nutrients (total phosphorus - TP and total nitrogen - TN) per the associated QAPP following approved analytical protocols[8].

- Bacteria are utilized as pathogen indicators and can range widely based on failing or undersized infrastructure and host source (e.g., human, livestock, pets, wildlife).
- TSS can rise significantly during and immediately after rainfall events due to land surface erosion and/or streambank erosion caused by runoff.
- Background phosphorus is typically higher in NKY area watersheds, primarily due to creek beds composed of limestone bedrock, however excess values are often attributed to point source and nonpoint source pollution.
- Nitrogen is found naturally in the environment; however excess values are often attributed to point source and nonpoint source pollution.

Ambient results for each site were compiled by parameter and represented in Box-and-Whisker plots. The whiskers for each plot represent the minimum and maximum values, while the box represents the 25th and 75th percentile range of the data. The "heavy" short black line represents the median value of the data. These plots are used to compare time periods within the watershed by site for each parameter. Additionally, either the water quality criteria or benchmark values are also shown in the figures. The water quality standard was derived from Section 401 of the Kentucky Administrative Regulations *401 KAR 10:031. Surface water standards*. The benchmarks were developed by Kentucky Division of Water as a guideline since there are no current standards developed for those parameters yet.

Table 2. Water Quality Criteria Type

Parameter	Water Quality Criteria Type	Value	Units	Applies
E. coli	KDOW Standard - Max	240	mpn/100 mL	May-Oct
TSS	KDOW Benchmark	7.25	mg/L	Apr-Oct
TP	KDOW Benchmark	0.08	mg/L	Jan-Dec
TN	KDOW Benchmark	0.6	mg/L	Jan-Dec

Refer to Appendix A for results from individual sites within the North Basin study area.

[7]EPA Guidance for Quality Assurance Project Plans, 2002.
[8] Standard Methods for the Examination of Water and Wastewater, 2017.

Dry Creek

Dry Creek watershed monitoring site DRC 1.4 was sampled during Period 2 and all four years of Period 3. Monitoring sites DRC 3.0-WFD1.5 and DRC 4.4 were added to the ambient monitoring program in 2021, with all three sites scheduled for sampling during Period 4 per the basin rotation cycle.

Table 3. Dry Creek Number of Samples Collected

Dry Creek	Period 2 No. of Samples	Period 3 No. of Samples			
Site	**2015**	**2016**	**2017**	**2018**	**2019**
DRC1.4	10	16	13	12	12
DRC3.0 – WFD1.5	NS	NS	NS	NS	NS
DRC4.4	NS	NS	NS	NS	NS

Columns displaying "NS" do not currently have results available but will in subsequent years (i.e., Period 4).

Photo 1. Dry Creek 1.4

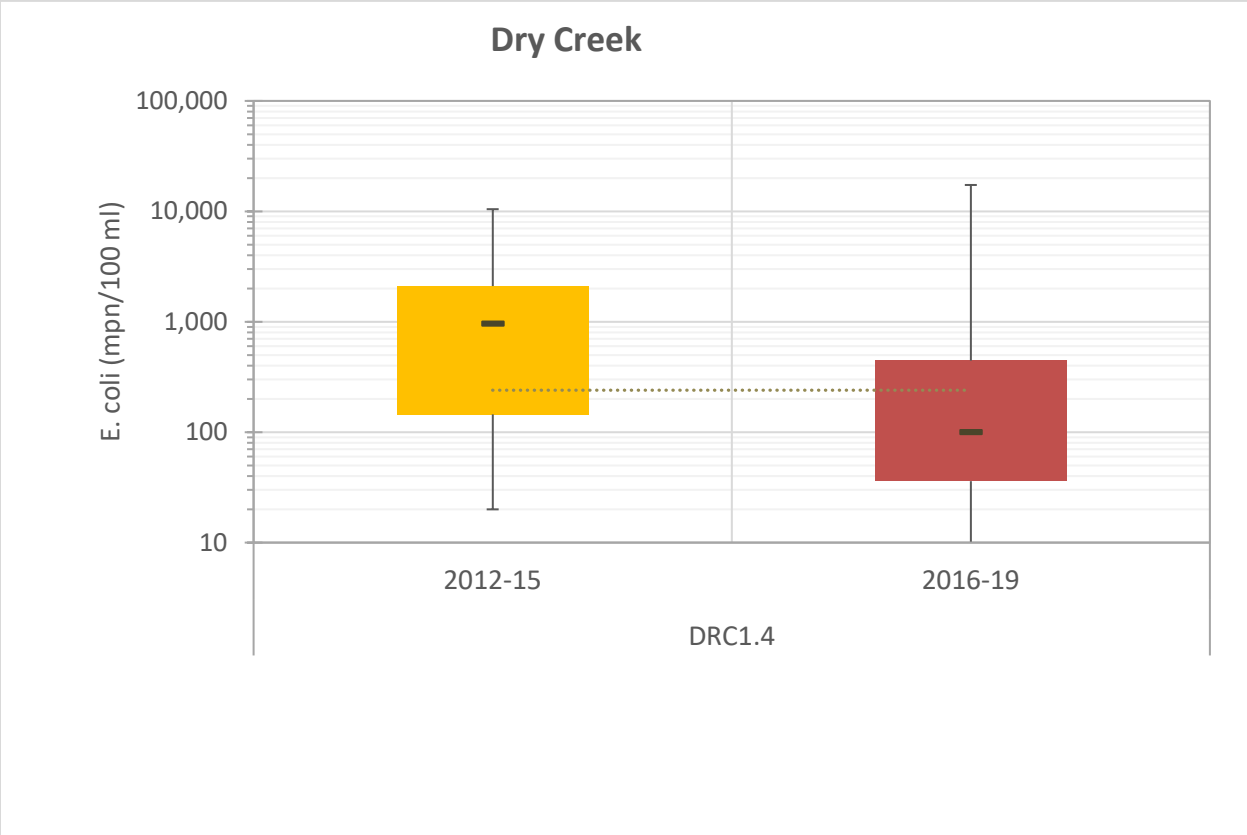
Photo 2. West Fork Dry Creek 1.5

Dry Creek *E. coli*

E. coli values ranged from 20 mpn/100ml to 10,460 mpn/100ml during Period 2 and ranged from 8 mpn/100ml to 17,300 mpn/100ml during Period 3 at DRC1.4. The median value during Period 2 was above the 240 mpn/100ml criteria, 956 mpn/100ml, while the median was below the criteria in Period 3, 100 mpn/100ml.

Suspected sources of elevated *E. coli* values within the Dry Creek watershed primarily includes sewer overflows and storm water runoff.

Photo 3. Dry Creek 4.4



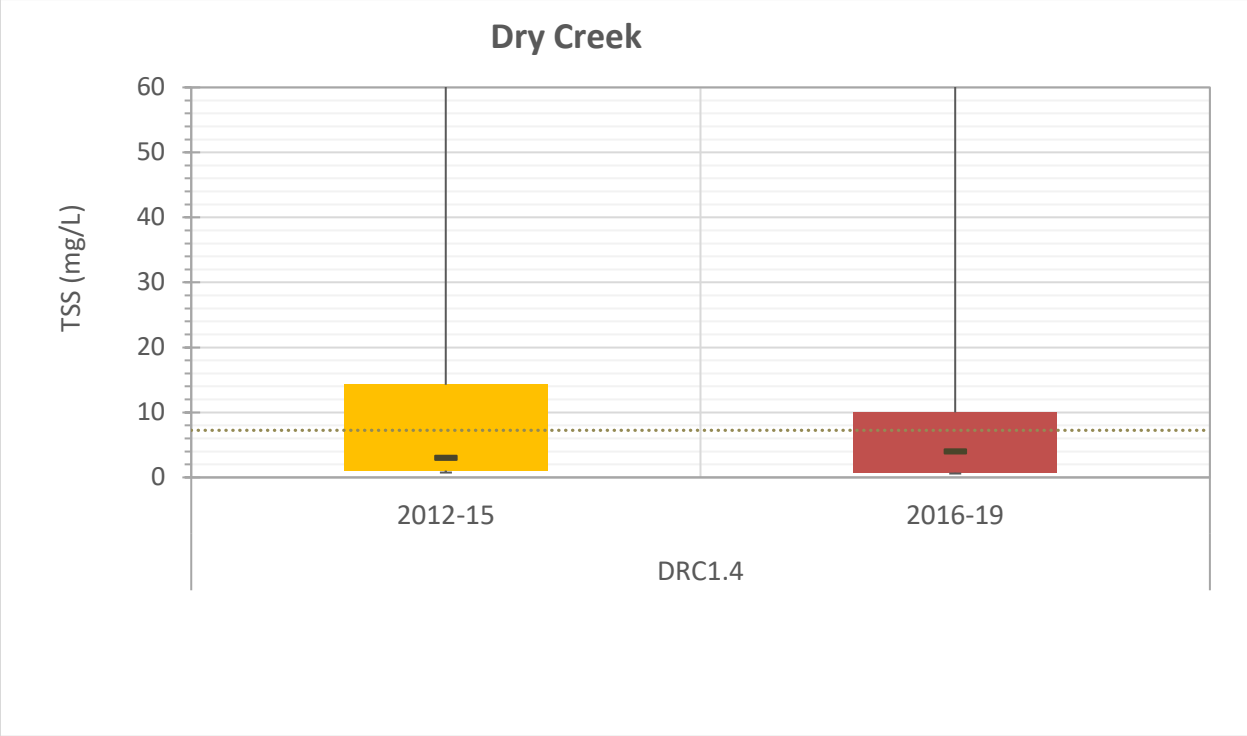
The dashed line in the graph represents the single sample maximum criteria of 240 mpn/100ml.

Figure 18. Dry Creek E. coli Results

Dry Creek Total Suspended Solids

TSS values ranged from <1.2 mg/L to 81 mg/L during Period 2 and ranged from <1.2 mg/L to 220 mg/L during Period 3 at DRC1.4. The median values during both periods were below the 7.25 mg/L benchmark, 3 mg/L and 4 mg/L.

Suspected sources of elevated TSS values within the Dry Creek watershed primarily includes storm water runoff and streambank erosion due to hydromodification.



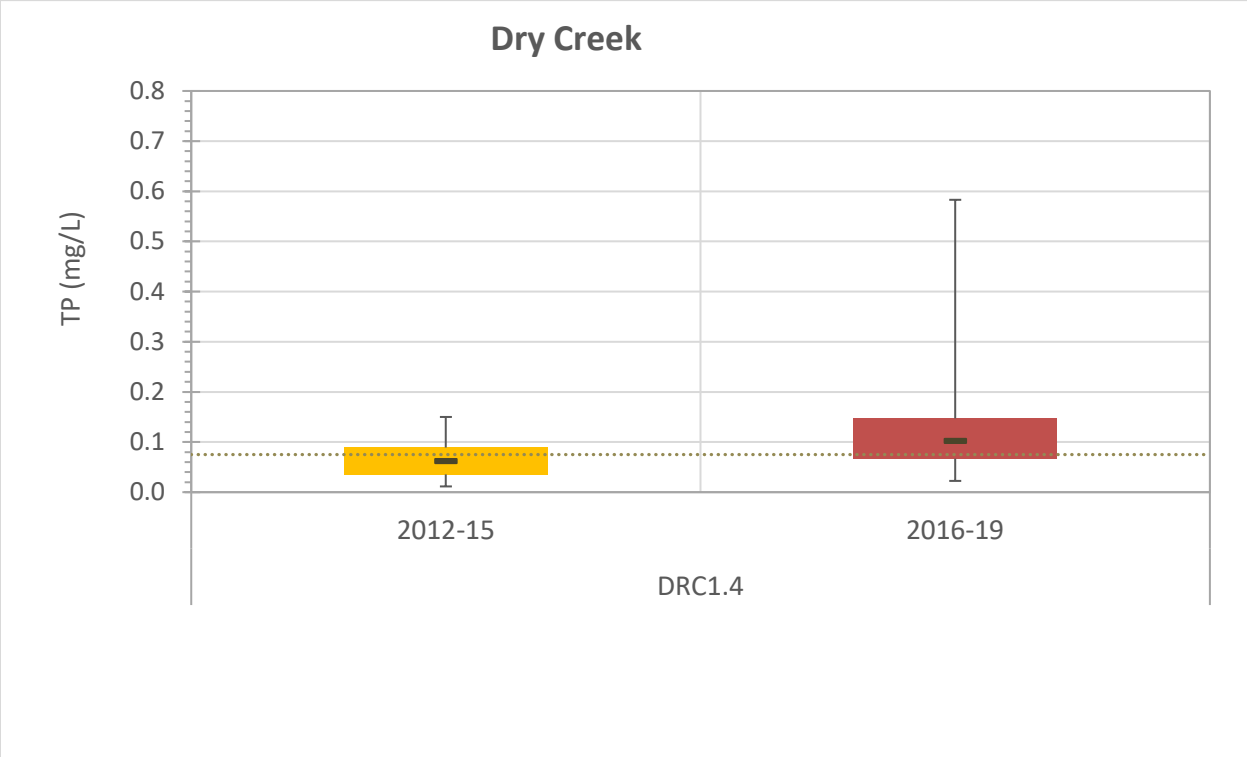
The dashed line in the graph represents the benchmark value established by KDOW of 7.25 mg/L.

Figure 19. Dry Creek TSS Results

Dry Creek Total Phosphorous

TP values ranged from <0.023 mg/L to 0.15 mg/L during Period 2 and ranged from <0.045 mg/L to 0.583 mg/L during Period 3 at DRC1.4. The median value during Period 2 was below the 0.08 mg/L benchmark, 0.062 mg/L, while the median value during Period 3 was above the benchmark, 0.102 mg/L.

Suspected sources of elevated phosphorus values within the Dry Creek watershed primarily include storm water runoff.



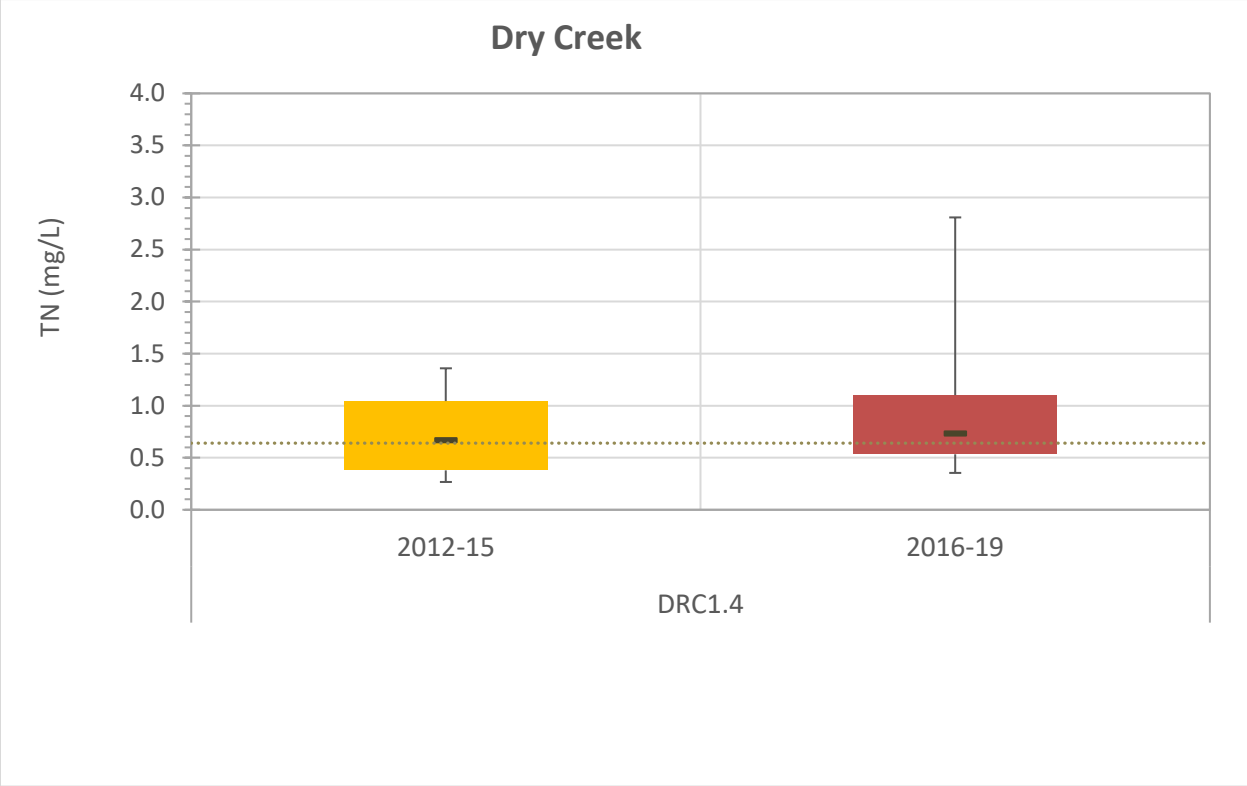
The dashed line in the graph represents the benchmark value established by KDOW of 0.08 mg/L.

Figure 20. Dry Creek TP Results

Dry Creek Total Nitrogen

TN values ranged from 0.27 mg/L to 1.36 mg/L during Period 2 and 0.35 mg/L to 2.81 mg/L during Period 3 at DRC1.4. The median values during both periods were above the 0.6 mg/L benchmark, 0.67 mg/L and 0.73 mg/L.

Suspected sources of excess nitrogen values within the Dry Creek watershed primarily include storm water runoff.



The dashed line in the graph represents the benchmark value established by KDOW of 0.6 mg/L.

Figure 21. Dry Creek TN Results

Elijahs Creek

Elijahs Creek watershed monitoring site EJC2.8 was sampled during Period 2 and all four of Period 3. Monitoring site EJC0.3 was added to the ambient monitoring program in 2021, with both sites scheduled for sampling during Period 4 per the basin rotation cycle.

Table 4. Elijahs Creek Number of Samples Collected

Elijahs Creek	Period 2 No. of Samples	Period 3 No. of Samples			
Site	**2015**	**2016**	**2017**	**2018**	**2019**
EJC0.3	NS	NS	NS	NS	NS
EJC2.8	10	16	13	12	12

Columns displaying "NS" do not currently have results available but will in subsequent years (i.e., Period 4).

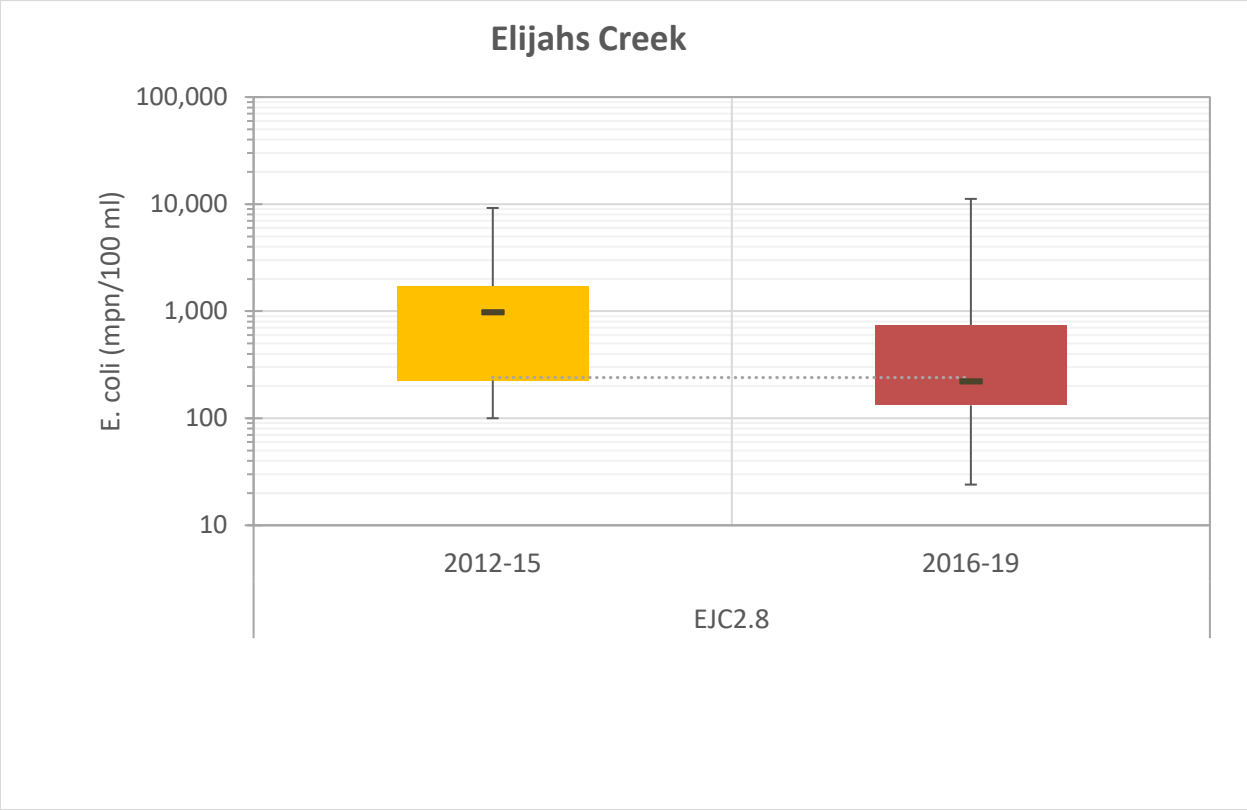
Photo 4. Elijahs Creek 0.3

Photo 5. Elijahs Creek 2.8

Elijahs Creek *E. coli*

E. coli values ranged from 100 mpn/100ml to 9,210 mpn/100ml during Period 2 and ranged from 24 mpn/100ml to 11,200 mpn/100ml during Period 3 at EJC2.8. The median value during Period 2 was above the 240 mpn/100ml criteria, 976 mpn/100 ml, while it was below the median in Period 3, 220 mpn/100ml.

Suspected sources of elevated *E. coli* values within the Elijahs Creek watershed primarily include storm water runoff.



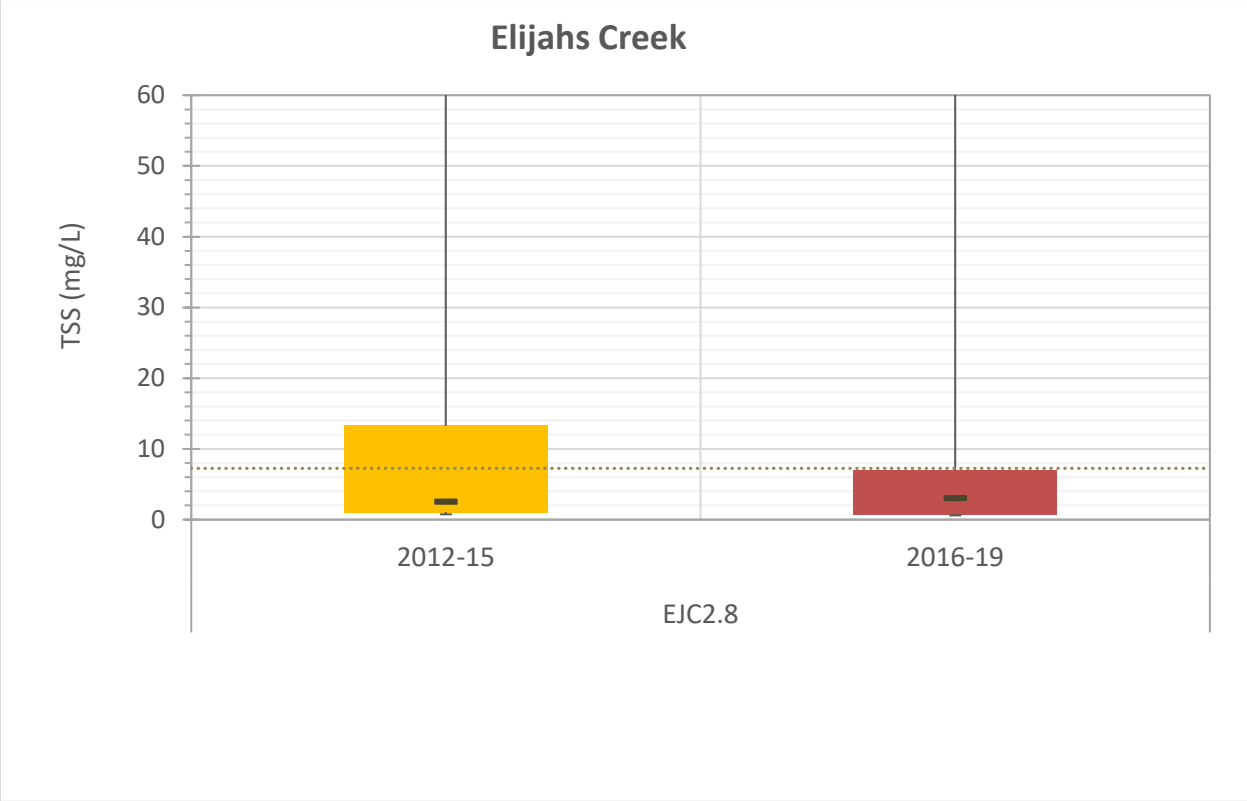
The dashed line in the graph represents the single sample maximum criteria of 240 mpn/100ml.

Figure 22. Elijahs Creek E. coli Results

Elijah Creek Total Suspended Solids

TSS values ranged from <1.5 mg/L to 68 mg/L during Period 2 and ranged from <1.2 mg/L to 110 mg/L during Period 3 at EJC2.8. The median values during both periods were below the 7.25 mg/L benchmark, 3 mg/L and 3 mg/L.

Suspected sources of elevated TSS values within the Elijahs Creek watershed primarily includes storm water runoff and streambank erosion due to hydromodification.



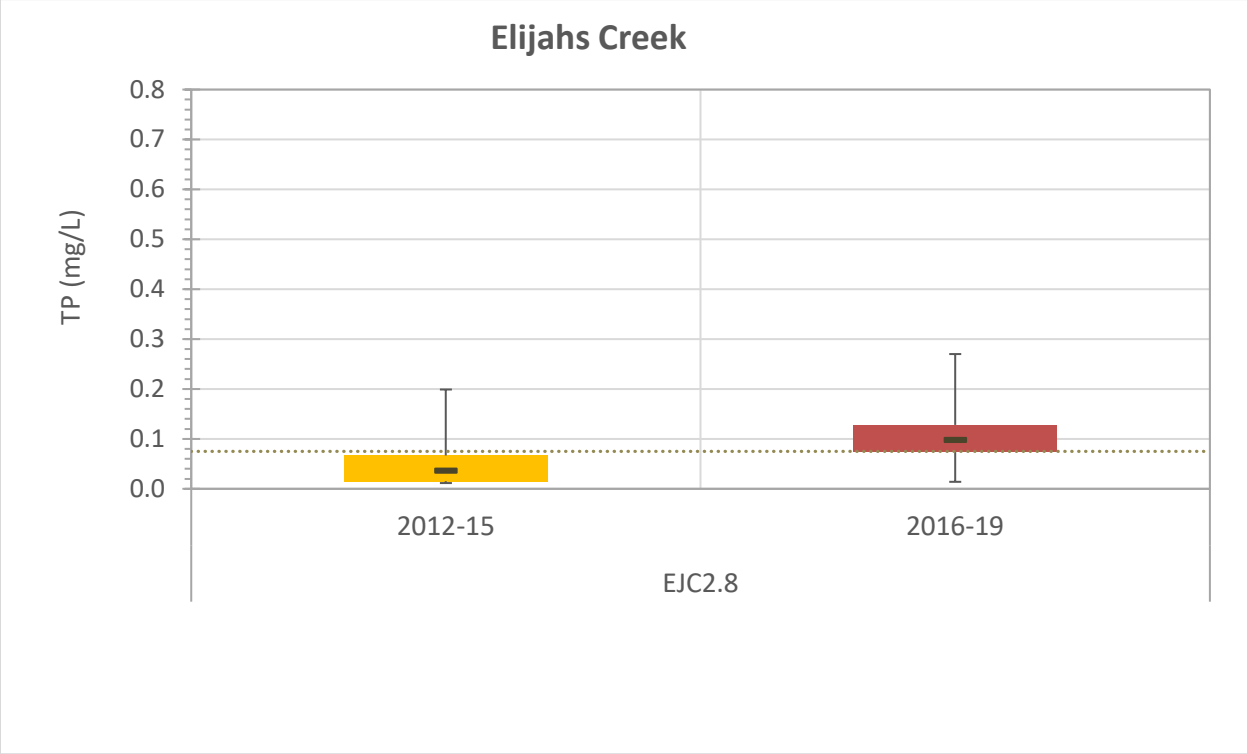
The dashed line in the graph represents the benchmark value established by KDOW of 7.25 mg/L.

Figure 23. Elijah Creek TSS Results

Elijahs Creek Total Phosphorous

TP values ranged from <0.023 mg/L to 0.199 mg/L during Period 2 and ranged from <0.045 mg/L to 0.270 mg/L during Period 3 at EJC2.8. The median value during Period 2 was below the benchmark (0.036 mg/L) and the median value was above the benchmark during Period 3 (0.075 mg/L).

The median phosphorus values for each reporting period was the lowest for the Elijahs Creek watershed when compared to the other four North Basin watersheds. Suspected sources of excess phosphorus values within the Elijahs Creek watershed primarily include storm water runoff.



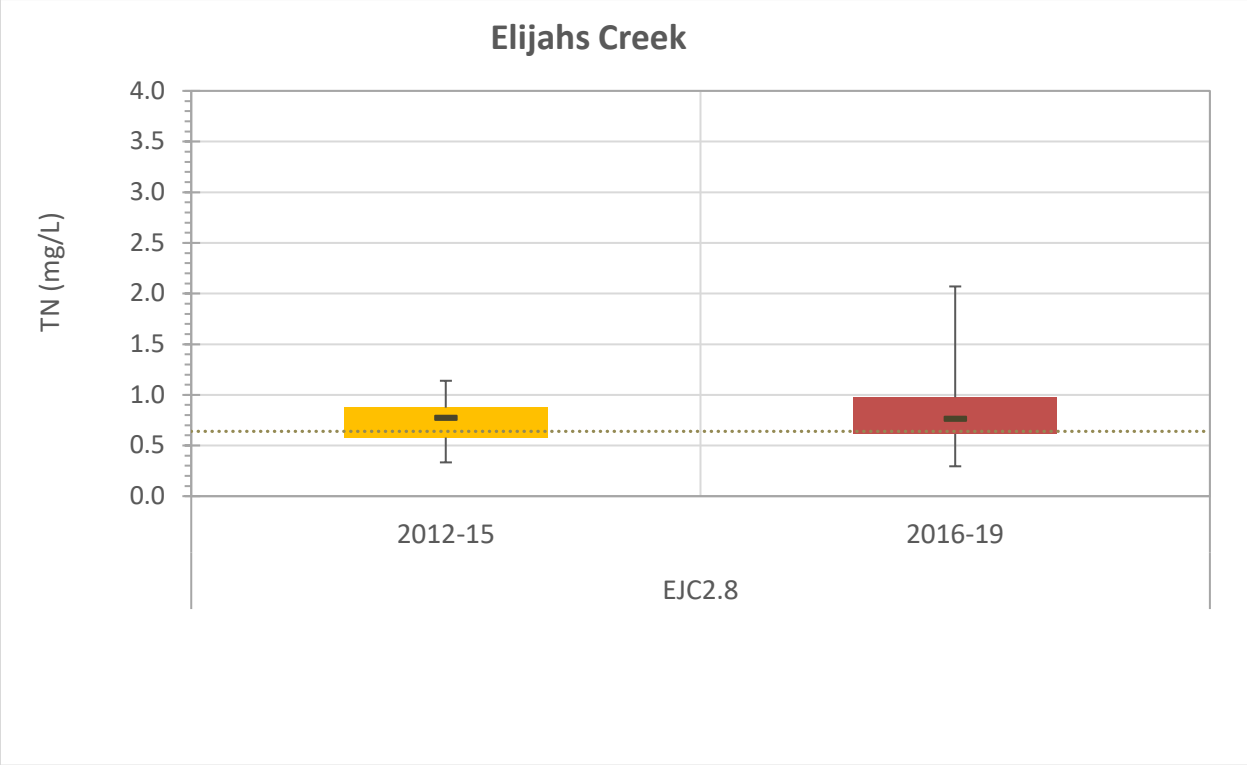
The dashed line in the graph represents the benchmark value established by KDOW of 0.08 mg/L.

Figure 24. Elijahs Creek TP Results

Elijahs Creek Total Nitrogen

TN values ranged from 0.33 mg/L to 1.14 mg/L during Period 2 and 0.30 mg/L to 2.07 mg/L during Period 3 at EJC2.8. The median values during both periods were above the 0.6 mg/L benchmark, 0.77 mg/L and 0.76 mg/L.

Suspected sources of excess nitrogen values within the Elijahs Creek watershed primarily include storm water runoff.



The dashed line in the graph represents the benchmark value established by KDOW of 0.6 mg/L.

Figure 25. Elijahs Creek TN Results

Pleasant Run Creek

Pleasant Run Creek watershed monitoring site PRC0.4 was sampled during Period 2 and all four years of Period 3. Monitoring site PRC0.4 was added to the ambient monitoring program in 2021, with both sites being scheduled for sampling during Period 4 per the basin rotation cycle.

Table 5. Pleasant Run Creek Number of Samples Collected

Pleasant Run Creek	Period 2 No. of Samples	Period 3 No. of Samples			
Site	**2015**	**2016**	**2017**	**2018**	**2019**
PRC0.4	10	16	13	12	12
PRC2.0	NS	NS	NS	NS	NS

Columns displaying "NS" do not currently have results available but will in subsequent years (i.e., Period 4).

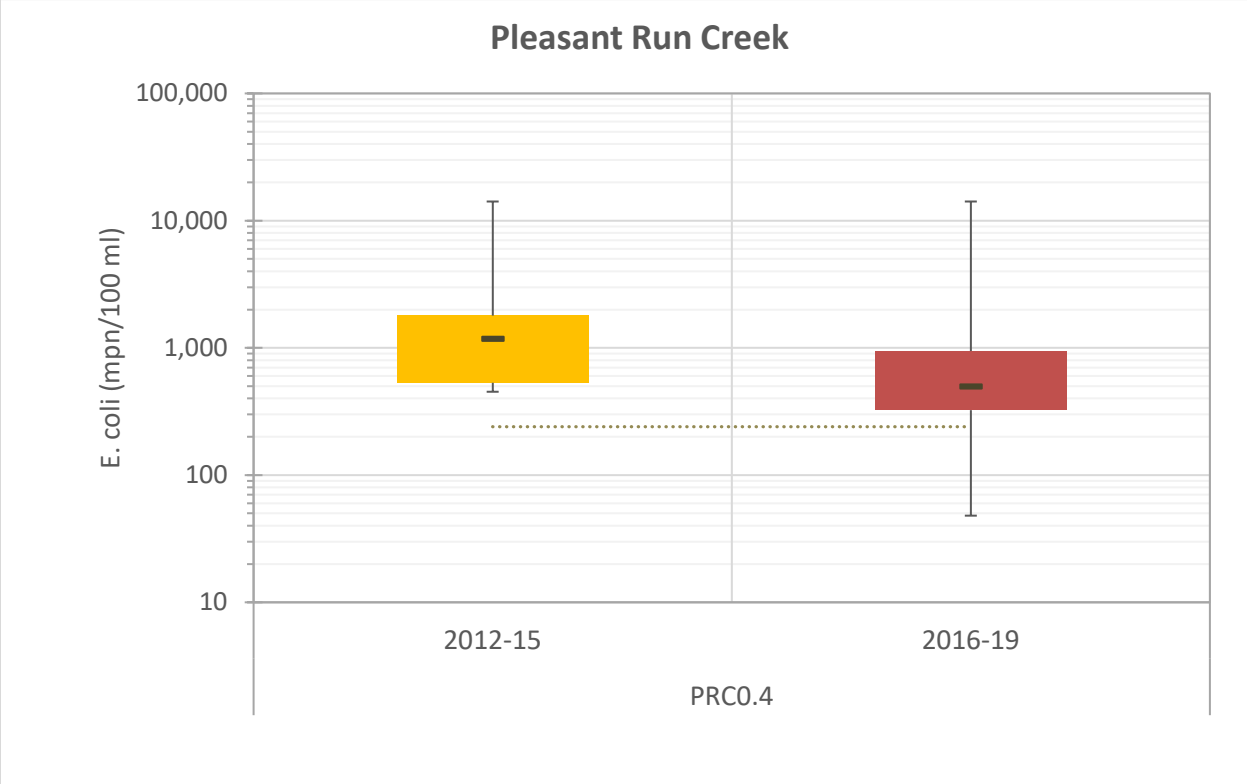
Photo 6. Pleasant Run Creek 0.4

Photo 7. Pleasant Run Creek 2.0

Pleasant Run Creek *E. coli*

E. coli values ranged from 452 mpn/100ml to 14,140 mpn/100ml during Period 2 and ranged from 48 mpn/100ml to 14,140 mpn/100ml during Period 3 at PRC0.4. The median values during both periods were above the 240 mpn/100ml criteria, 1,178 mpn/100 ml and 496 mpn/100ml.

The median bacteria value for each reporting period was highest within the Pleasant Run Creek watershed when compared to the other four North Basin watersheds. Suspected sources of elevated *E. coli* values within the Pleasant Run Creek watershed primarily includes sewer overflows and storm water runoff.



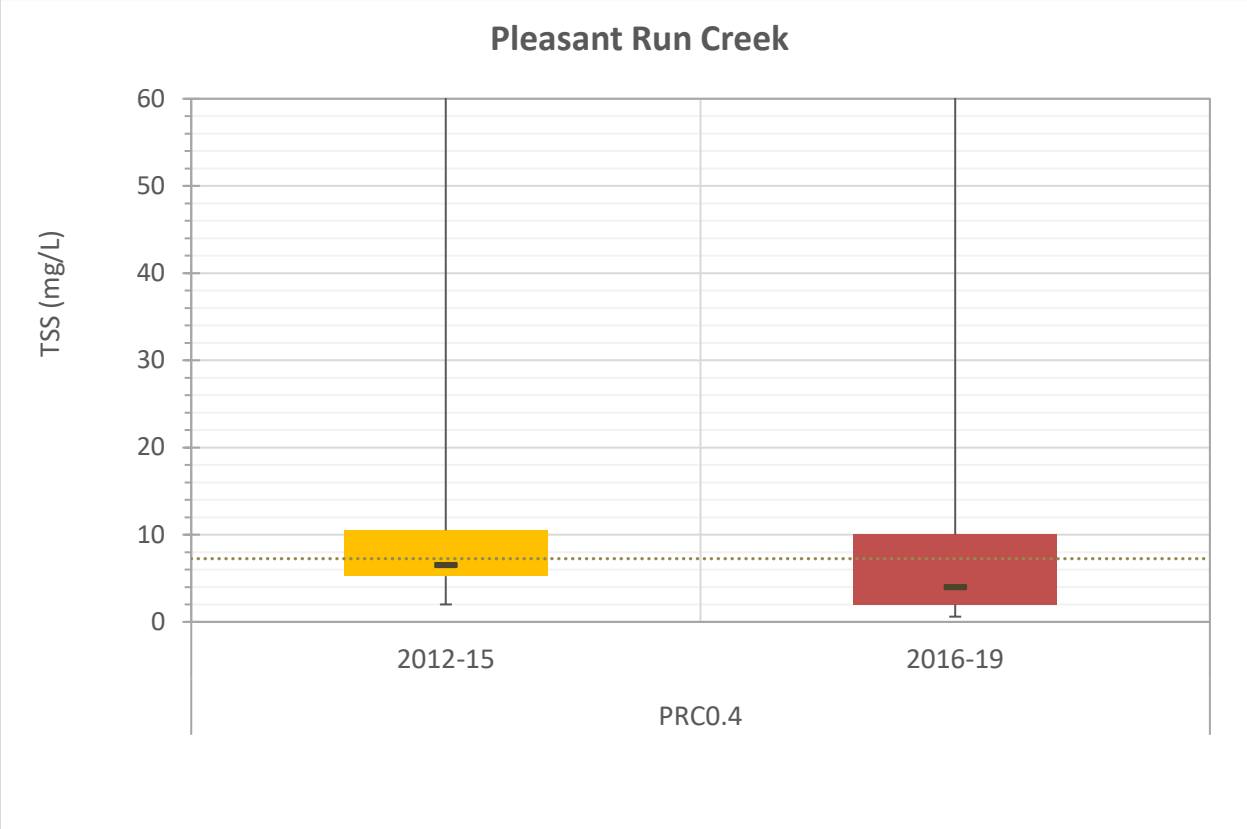
The dashed line in the graph represents the single sample maximum criteria of 240 mpn/100ml.

Figure 26. Pleasant Run Creek E. coli Results

Pleasant Run Creek Total Suspended Solids

TSS values ranged from 2 mg/L to 502 mg/L during Period 2 and ranged from <1.2 mg/L to 170 mg/L during Period 3 at PRC0.4. The median values during both periods were below the 7.25 mg/L benchmark, 7 mg/L and 4 mg/L.

The median TSS value for each reporting period was highest within the Pleasant Run Creek watershed when compared to the other four North Basin watersheds. Suspected sources of elevated TSS values within Pleasant Run watershed primarily includes storm water runoff and streambank erosion due to hydromodification.



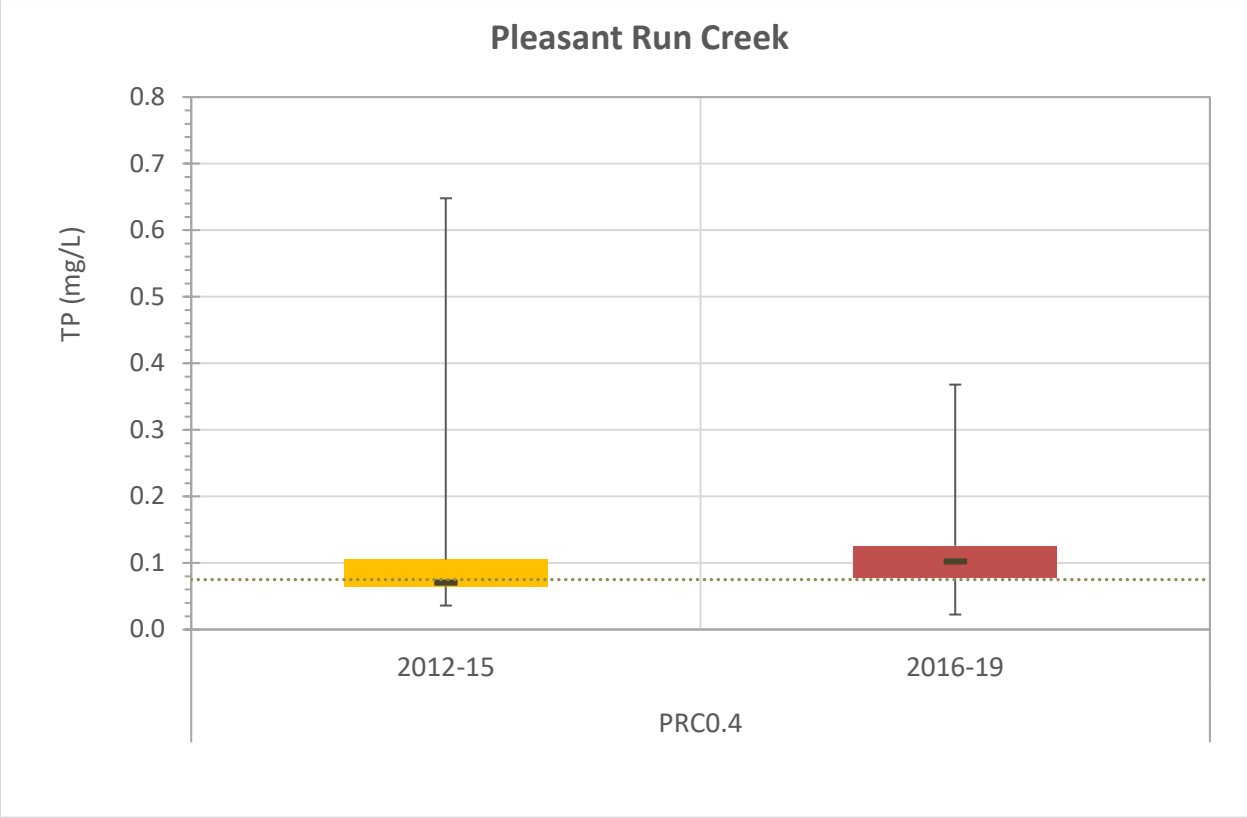
The dashed line in the graph represents the benchmark value established by KDOW of 7.25 mg/L.

Figure 27. Pleasant Run Creek TSS Results

Pleasant Run Creek Total Phosphorous

TP values ranged from 0.036 mg/L to 0.648 mg/L during Period 2 and ranged from <0.045 mg/L to 0.368 mg/L during Period 3 at PRC0.4. The median value during both periods was above the 0.08 mg/L benchmark, 0.071 mg/L and 0.102 mg/L.

The suspected sources of elevated phosphorus values within Pleasant Run Creek watershed primarily includes sewer overflows and storm water runoff.



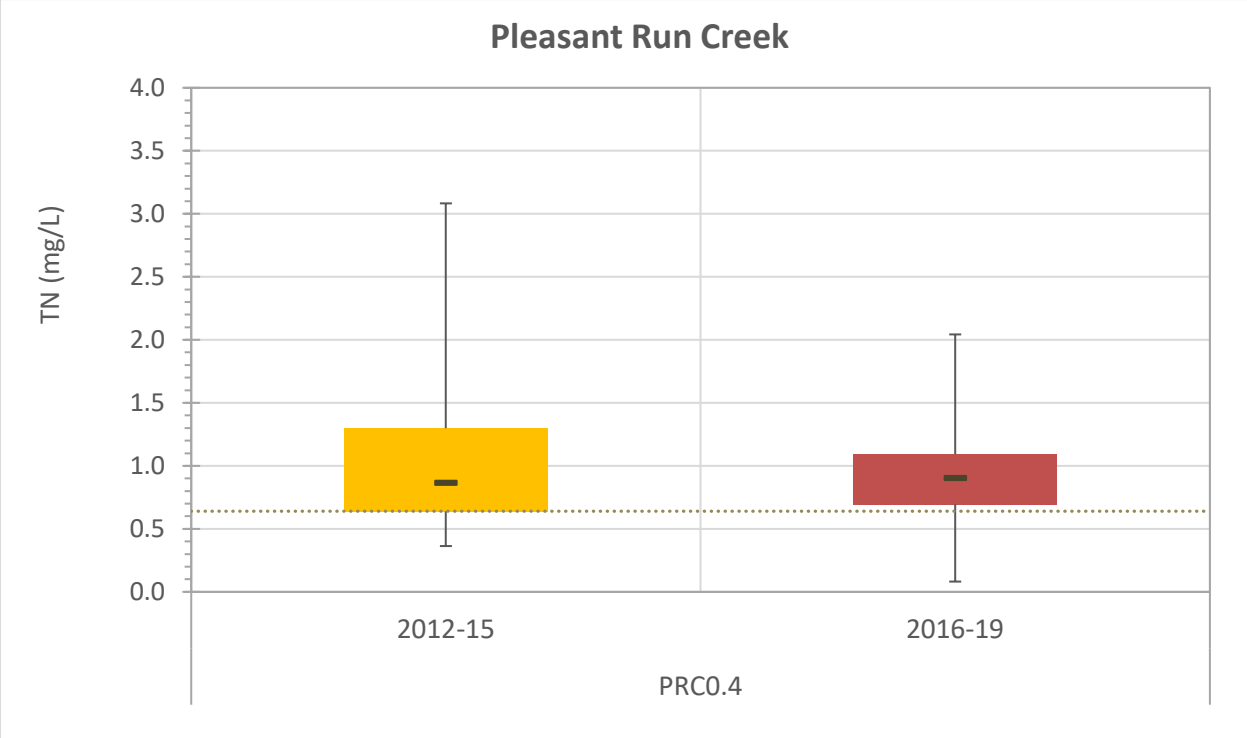
The dashed line in the graph represents the benchmark value established by KDOW of 0.08 mg/L.

Figure 28. Pleasant Run Creek TP Results

Pleasant Run Creek Total Nitrogen

TN values ranged from 0.36 mg/L to 3.08 mg/L during Period 2 and 0.08 mg/L to 2.04 mg/L during Period 3 at PRC0.4. The median values during both periods were above the 0.6 mg/L benchmark, 0.86 mg/L and 0.90 mg/L.

The median phosphorus value for each reporting period was highest within the Pleasant Run Creek watershed when compared to the other four North Basin watersheds. Suspected sources of excess nitrogen values within Pleasant Run Creek watershed primarily include storm water runoff.



The dashed line in the graph represents the benchmark value established by KDOW of 0.6 mg/L.

Figure 29. Pleasant Run Creek TN Results

Sand Run

Sand Run watershed monitoring site SDR4.0 was sampled during Period 2 and all four years of Period 3. Monitoring site SDR0.6 was added to the ambient monitoring program in 2021, with both sites scheduled for sampling during Period 4 per the basin rotation cycle.

Table 6. Sand Run Number of Samples Collected

Sand Run	Period 2 No. of Samples	Period 3 No. of Samples			
Site	**2015**	**2016**	**2017**	**2018**	**2019**
SDR0.6	NS	NS	NS	NS	NS
SDR4.0	10	16	13	12	12

Columns displaying "NS" do not currently have results available but will in subsequent years (i.e., Period 4).

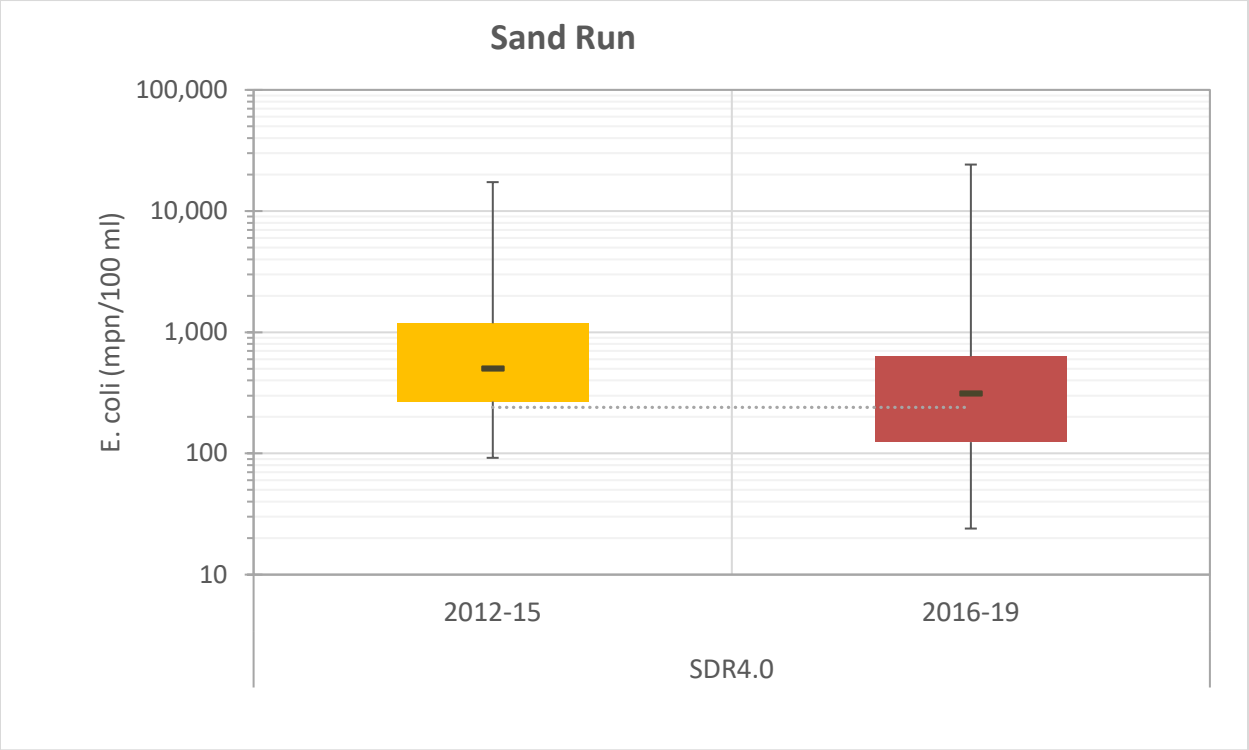
Photo 8. Sand Run 0.6

Photo 9. Sand Run 4.0

Sand Run *E. coli*

E. coli values ranged from 92 mpn/100ml to 17,330 mpn/100ml during Period 2 and ranged from 24 mpn/100ml to 24,200 mpn/100ml during Period 3 at SDR4.0. The median values during both periods were above the 240 mpn/100ml criteria, 502 mpn/100 ml and 312 mpn/100ml.

Suspected sources of elevated *E. coli* values within Sand Run Creek watershed primarily includes failing septic systems and storm water runoff.



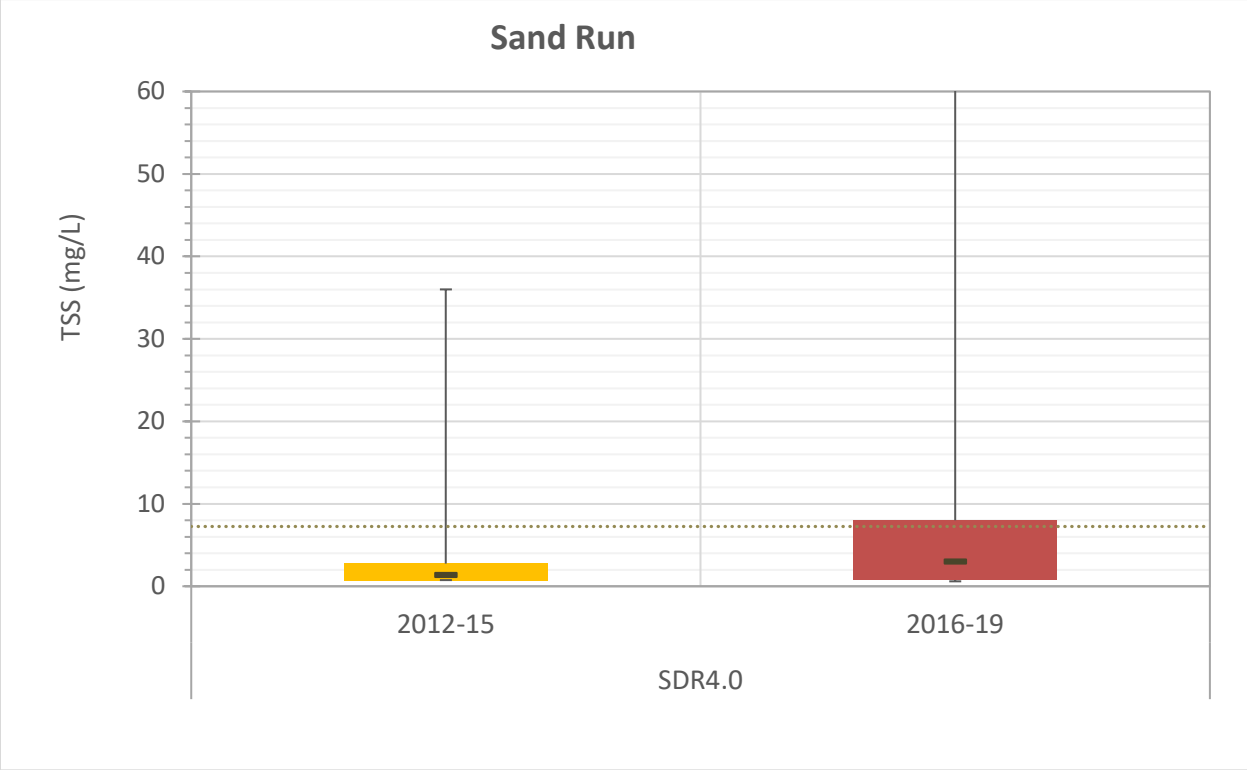
The dashed line in the graph represents the single sample maximum criteria of 240 mpn/100ml.

Figure 30. Sand Run E. coli Results

Sand Run Total Suspended Solids

TSS values ranged from <1.5 mg/L to 36 mg/L during Period 2 and ranged from <1.2 mg/L to 142 mg/L during Period 3 at SDR4.0. The median values during both periods were below the 7.25 mg/L benchmark, 1.4 mg/L and 3 mg/L.

The median TSS value for each reporting period was lowest within the Sand Run watershed when compared to the other four North Basin watersheds. Suspected sources of elevated TSS values within the Sand Run watershed primarily includes storm water runoff and streambank erosion due to hydromodification.



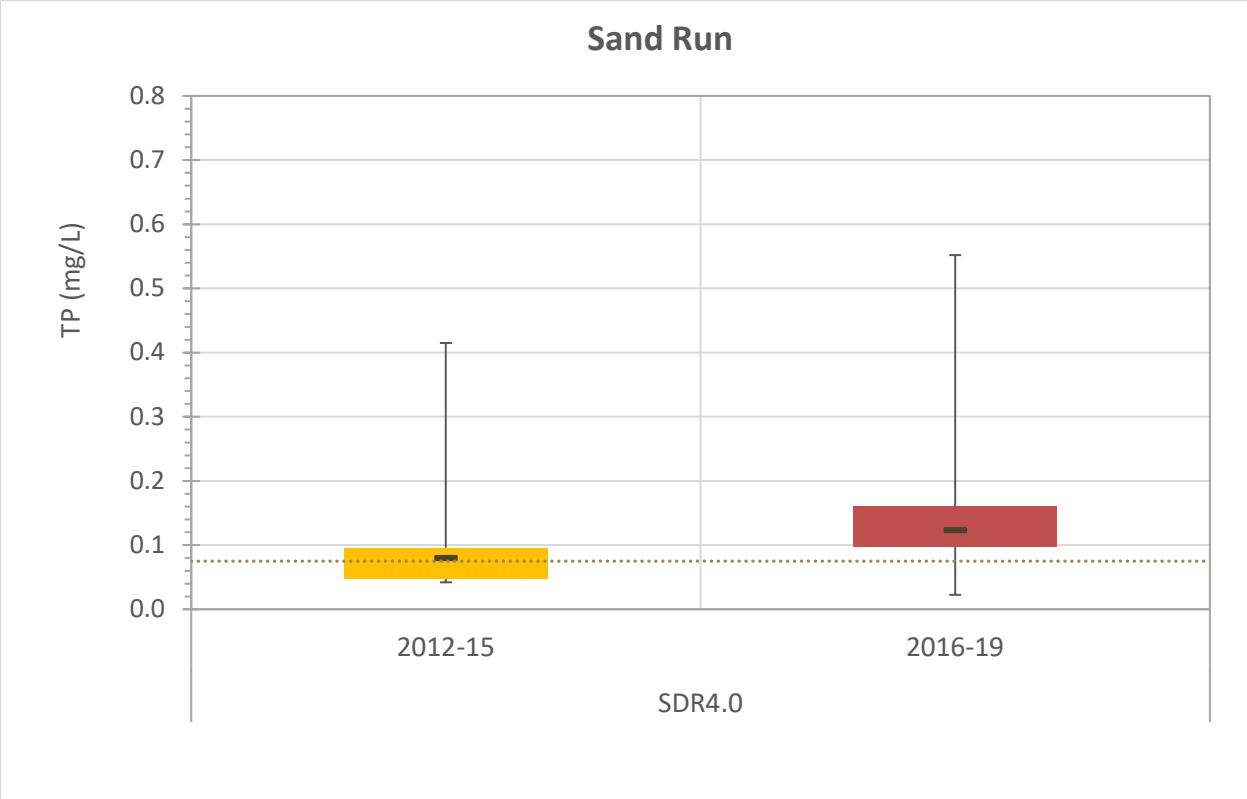
The dashed line in the graph represents the benchmark value established by KDOW of 7.25 mg/L.

Figure 31. Sand Run TSS Results

Sand Run Total Phosphorous

TP values ranged from 0.042 mg/L to 0.415 mg/L during Period 2 and ranged from <0.045 mg/L to 0.552 mg/L during Period 3 at SDR4.0. The median value was near the benchmark during Period 2 (0.075 mg/L) and above the 0.08 mg/L benchmark during Period 3 (0.123 mg/L).

The median phosphorus value for each reporting period was the highest within the Sand Run watershed when compared to the other four North Basin watersheds. The suspected sources of elevated phosphorus values within the Sand Run watershed primarily include storm water runoff.



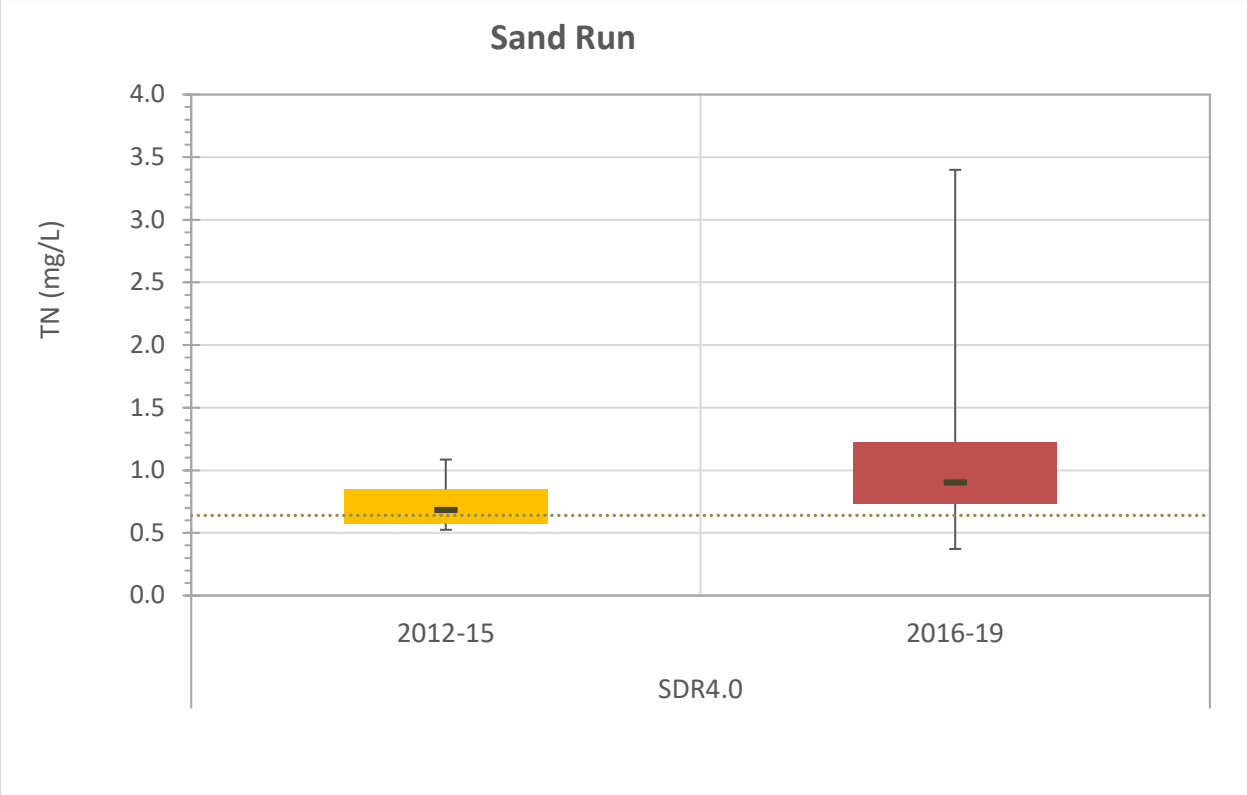
The dashed line in the graph represents the benchmark value established by KDOW of 0.08 mg/L.

Figure 32. Sand Run TP Results

Sand Run Total Nitrogen

TN values ranged from 0.53 mg/L to 1.09 mg/L during Period 2 and 0.37 mg/L to 3.40 mg/L during Period 3 at SDR4.0. The median values during both periods were above the 0.6 mg/L benchmark, 0.68 mg/L and 0.90 mg/L.

Suspected sources of excess nitrogen values with Sand Run watershed primarily include storm water runoff.



The dashed line in the graph represents the benchmark value established by KDOW of 0.6 mg/L.

Figure 33. Sand Run TN Results

Woolper Creek

Woolper Creek watershed monitoring site WPC5.0 was sampled during Period 2 and all four years of Period 3. Monitoring sites WPC8.8 and ALF0.1 were added to the ambient monitoring program in 2021, with all three sites scheduled for sampling during Period 4 per the basin rotation cycle.

Table 7. Woolper Creek Number of Samples Collected

Woolper Creek	Period 2 No. of Samples	Period 3 No. of Samples			
Site	**2015**	**2016**	**2017**	**2018**	**2019**
WPC5.0	10	16	13	12	12
WPC8.8	NS	NS	NS	NS	NS
ALF0.1	NS	NS	NS	NS	NS

Columns displaying "NS" do not currently have results available but will in subsequent years (i.e., Period 4).

Photo 10. Woolper Creek 5.0

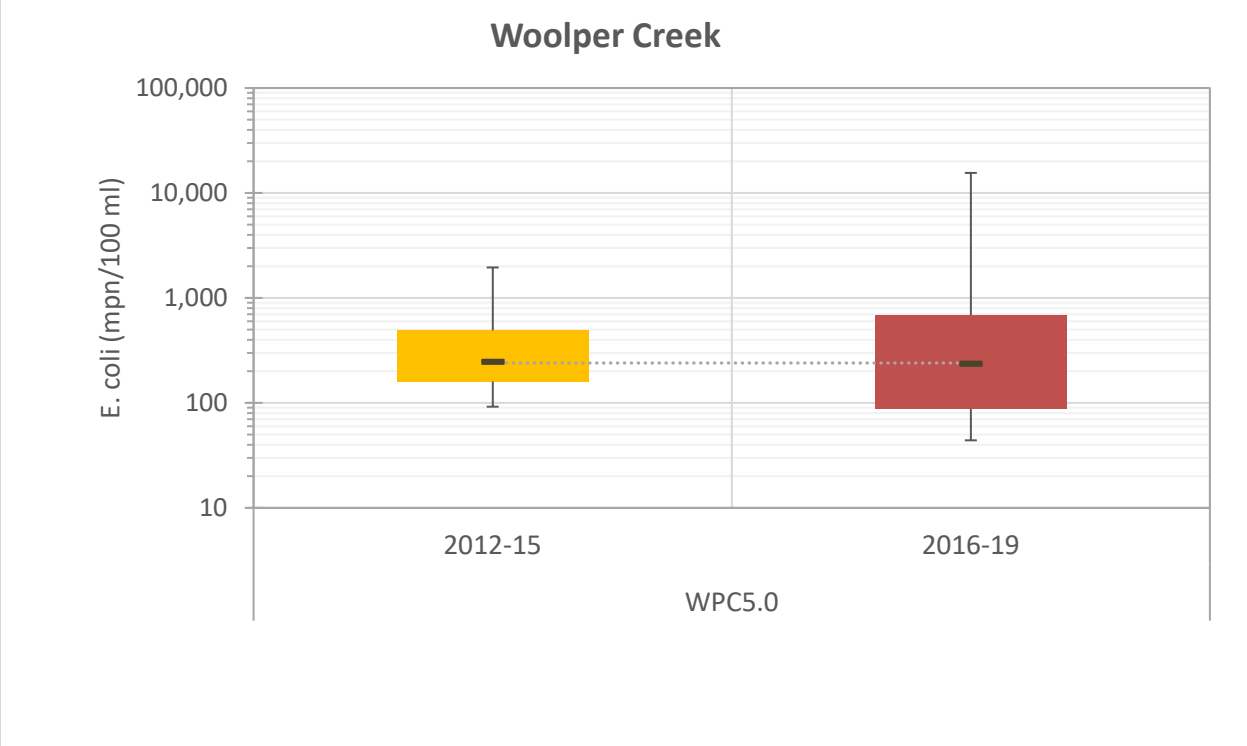
Photo 11. Allen Fork 0.1

Woolper Creek *E. coli*

E. coli values ranged from 92 mpn/100ml to 1,952 mpn/100ml during Period 2 and ranged from 44 mpn/100ml to 15,530 mpn/100ml during Period 3 at WPC5.0. The median values during both periods were above the 240 mpn/100ml criteria, 246 mpn/100 ml and 236 mpn/100ml.

The median bacteria value for each reporting period was lowest within the Woolper Creek watershed when compared to the other four North Basin watersheds. Suspected sources of elevated *E. coli* values within the Woolper Creek watershed primarily includes failing septic systems and storm water runoff.

Photo 12. Woolper Creek 8.8



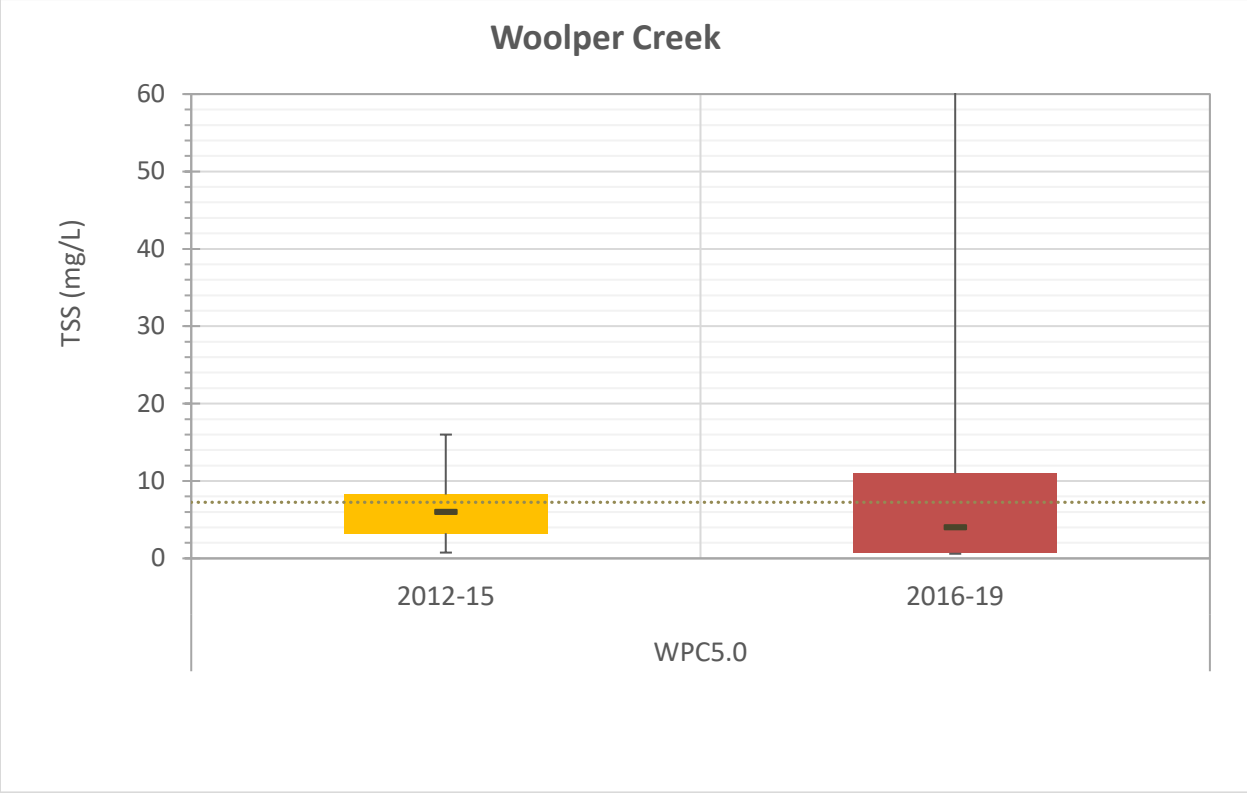
The dashed line in the graph represents the single sample maximum criteria of 240 mpn/100ml.

Figure 34. Woolper Creek E. coli Results

Woolper Creek Total Suspended Solids

TSS values ranged from <1.5 mg/L to 16 mg/L during Period 2 and ranged from <1.2 mg/L to 352 mg/L during Period 3 at WPC5.0. The median values during both periods were below the 7.25 mg/L benchmark, 6 mg/L and 4 mg/L.

Suspected sources of elevated TSS values within the Woolper Creek watershed primarily includes storm water runoff and streambank erosion due to hydromodification.



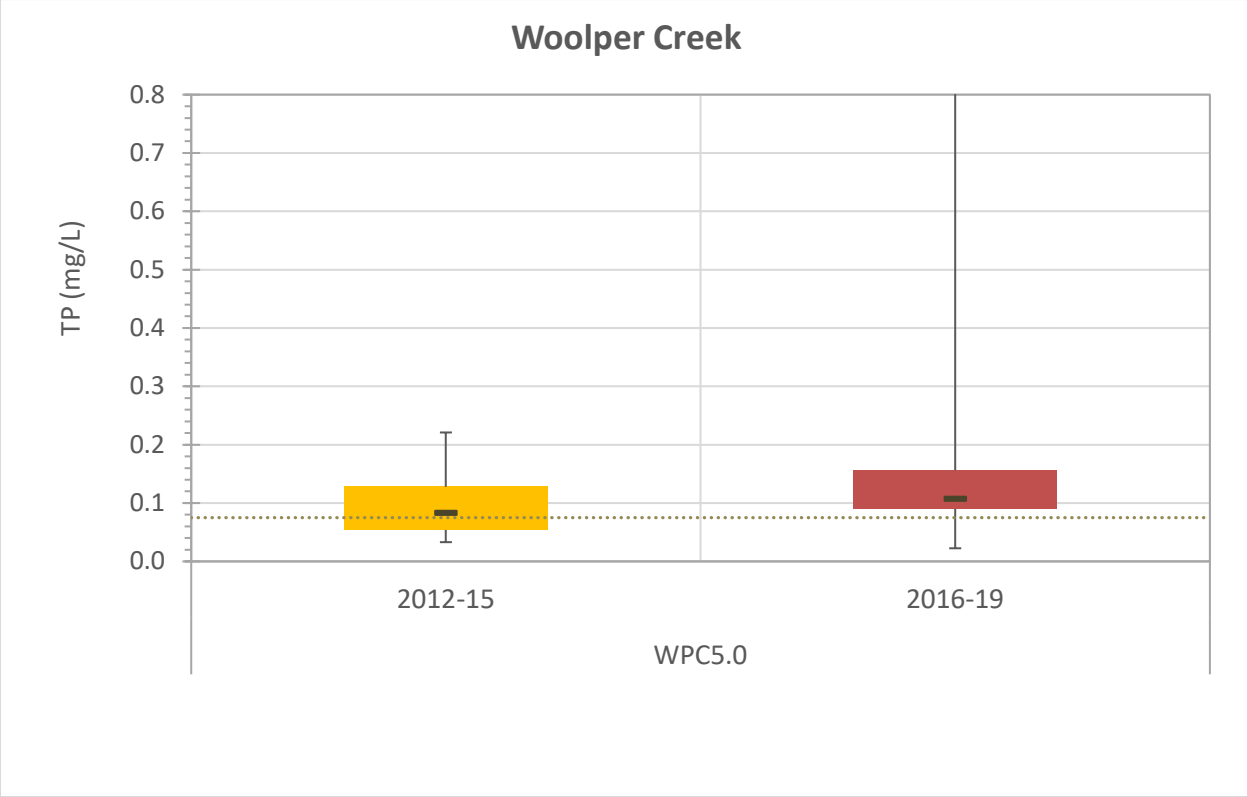
The dashed line in the graph represents the benchmark value established by KDOW of 7.25 mg/L.

Figure 35. Woolper Creek TSS Results

Woolper Creek Total Phosphorous

TP values ranged from 0.033 mg/L to 0.221 mg/L during Period 2 and ranged from <0.045 mg/L to 2.23 mg/L during Period 3 at WPC5.0. The median values during both periods were above the 0.08 mg/L benchmark, 0.083 mg/l and 0.103 mg/L.

The suspected sources of elevated phosphorous values within Woolper Creek watershed primarily include storm water runoff.



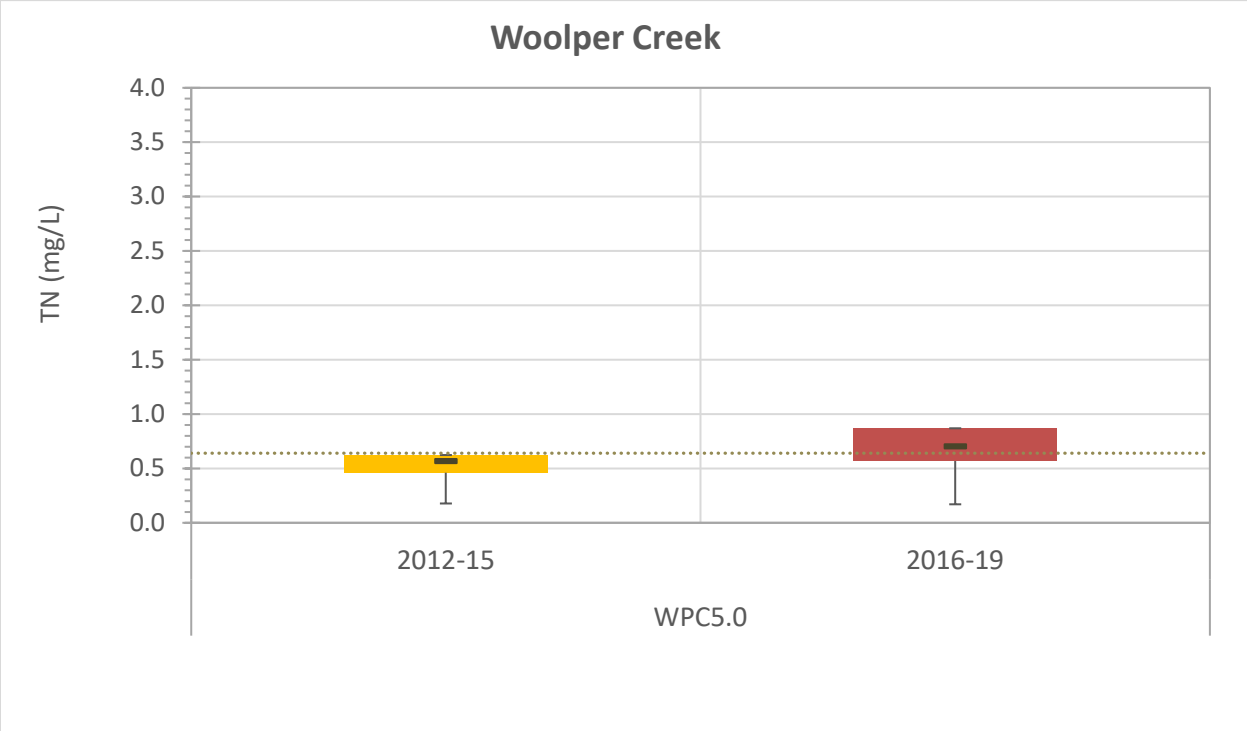
The dashed line in the graph represents the benchmark value established by KDOW of 0.08 mg/L.

Figure 36. Woolper Creek TP Results

Woolper Creek Total Nitrogen

TN values ranged from 0.18 mg/L to 0.836 mg/L during Period 2 and 0.17 mg/L to 12.87 mg/L during Period 3 at WPC5.0. The median values during both periods were near the 0.6 mg/L benchmark, 0.57 mg/L and 0.70 mg/L.

The median TN value for each reporting period was the lowest within the Woolper Creek watershed when compared to the other four North Basin watersheds. Suspected sources of excess nitrogen values within the Woolper Creek watershed primarily include storm water runoff.



The dashed line in the graph represents the benchmark value established by KDOW of 0.6 mg/L.

Figure 37. Woolper Creek TN Results

Biological Assessment Results

SD1's biological assessments consist of macroinvertebrate specimen collection and habitat characterization conducted at multiple sites in each watershed. During the Period 2 basin rotation, North Basin sites were collected in 2014; during Period 3 basin rotation, North Basin sites were collected in 2018. All assessments were conducted following the appropriate Field Monitoring and Sampling Plan (FMSP) and the associated Quality Assurance Program Plan (QAPP) utilizing approved bioassessment protocols[9].

Macroinvertebrate specimen samples were analyzed using the Kentucky Division of Water Macroinvertebrate Biologic Index (MBI), as well as statistical analyses that examine community structure. The MBI is a multi-metric index that uses various attributes to assign a score (0-100, scaled temporally and spatially) and a rating (Excellent, Good, Fair, Poor, Very Poor) to a given stream reach, with higher scores corresponding to higher quality streams. Key metrics that affect overall index scores (refer to Appendix B1 for additional details) are as follows:

- Abundance of genera (i.e., taxa richness) - increasing total number of genera generally indicates improving water quality and habitat conditions (see example photos below).

Photo 13. Hellgrammite Larvae (Megaloptera)

Photo 14. Crane Fly Larvae (Diptera)

- Abundance of pollution sensitive organisms (specifically insect orders of Ephemeroptera, Plecoptera and Trichoptera) - increasing total pollutant sensitive organisms generally indicate improving water quality and habitat conditions (see example photos below).

Photo 15. Mayfly Nymph (Ephemeroptera)

Photo 16. Stonefly (Plecoptera)

[9] Kentucky Division of Water/U.S. Environmental Protection Agency criteria (Barbour et al. 1999, KDOW 2001)

- Abundance of pollution tolerant organisms - increasing total pollutant tolerant organisms generally indicate declining water quality conditions (see example photos below).

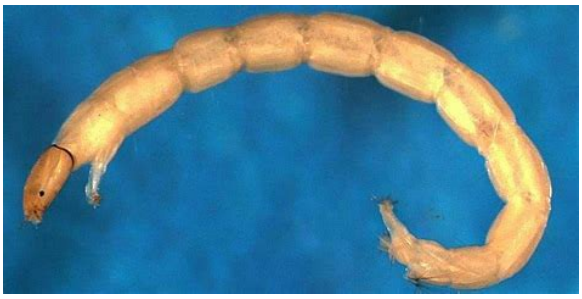


Photo 17. Chironomid Larvae (Chironomidae) [10]

Photo 18. Aquatic Worm (Oligochaete)

Habitat assessments were determined using Rapid Bioassessment Protocols (RBP). This protocol evaluates instream metrics – such as embeddedness, and velocity, as well as the surrounding riparian buffer metrics – such as bank stability, vegetative protection, and channel alteration. In combination, these metrics give an overall evaluation of the stream reach. In total there are ten metrics that are evaluated (refer to Appendix B2 for additional details). Each metric is assigned a score (0-20) by the field crew for each site. A final score is calculated, and a rating (Good, Fair, Poor) is given to the stream reach, with higher scores corresponding to higher quality streams.

Habitat and macroinvertebrate data were collected at sampling sites as defined in the FMSP. Sites were separated into two types and categorized as either headwater or wadeable. Headwater sites have 5 miles^2 or less drainage area, while wadeable sites have greater than 5 miles^2 of drainage area.

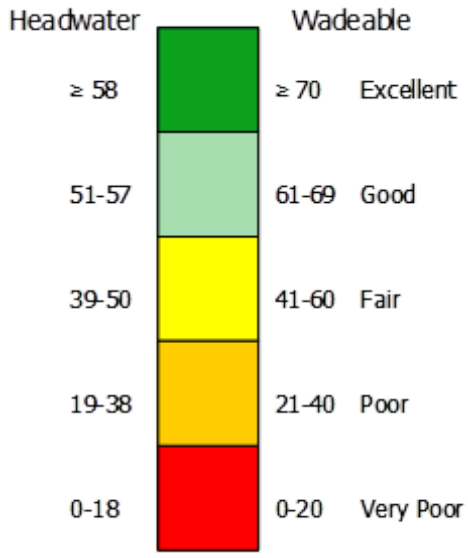


Figure 38. MBI Ratings

Table 8. RBP Ratings

Headwater		Wadeable	
Good	>156	Good	>130
Fair	142-155	Fair	114-129
Poor	<141	Poor	<113

Refer to Appendices B1 and B2 for results from individual sites within the North Basin study area.

[10] Photo taken from the North Carolina Department of Environmental Quality website.

Dry Creek

Dry Creek is a high gradient stream (elevation change of approximately 490 feet from headwaters to Ohio River confluence), with a streambed dominated by cobble/boulder substrates. Riparian zone habitat varies throughout the stream length, dependent primarily on the surrounding land use. The current state of development has resulted in a watershed with a total impervious surface area of 29.0%. Assessments were performed at all three monitoring sites during Period 2 and Period 3.

Table 9. Dry Creek MBI Scores

Dry Creek	Site Type	Period 2 MBI Scores	Period 3 MBI Scores
Site	**Category**	**2014**	**2018**
DRC1.4	Wadeable	61.88 (Good)	63.16 (Good)
DRC4.4	Headwater	22.17 (Poor)	28.6 (Poor)
DRC3.0-WFD1.5	Headwater	37.21 (Poor)	59.08 (Excellent)

The Dry Creek MBI scores ranged from poor to excellent at all three sites. While DRC1.4 and DRC4.4 increased in score, remaining within the same rating, DRC3.0-WFD1.5 increased almost 22 points, elevating the rating from poor to excellent. This change in rating was the result of increases in taxa richness and pollutant sensitive organisms, along with a significant decrease in pollutant tolerant organisms.

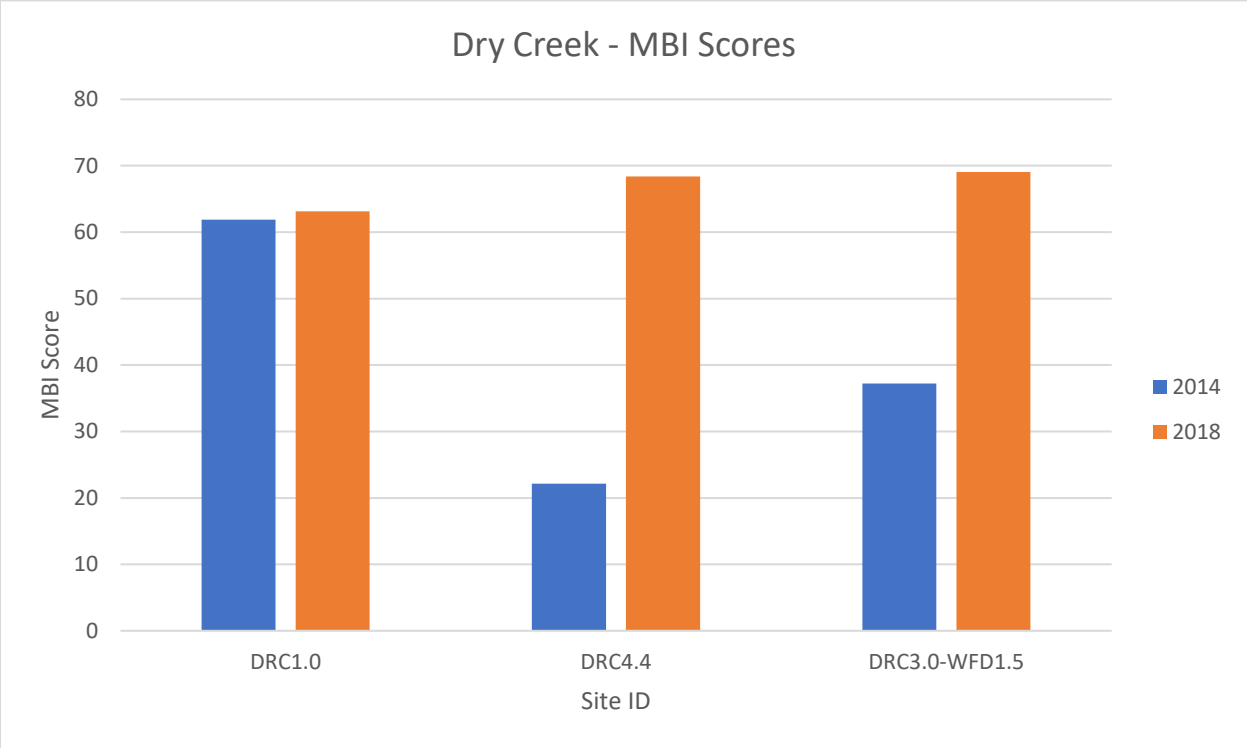


Figure 39. Dry Creek MBI Scores

Table 10. Dry Creek RBP Scores

Dry Creek	Site Type	Period 2 RBP Scores	Period 3 RBP Scores
Site	**Category**	**2014**	**2018**
DRC1.4	Wadeable	83 (Poor)	102 (Poor)
DRC4.4	Headwater	103 (Poor)	107 (Poor)
DRC3.0-WFD1.5	Headwater	88 (Poor)	116 (Poor)

The Dry Creek habitat scores increased at all three sites from 2014 to 2018, however scores remained within the poor rating. Site DRC3.0-WFD1.5 had a marked increase due to improvement within bank stability and vegetation protection, as well as higher channel flow status. Site DRC1.4 and DRC4.4 marginally increased in scores, with improvements in riffle frequency and velocity/depth regime.

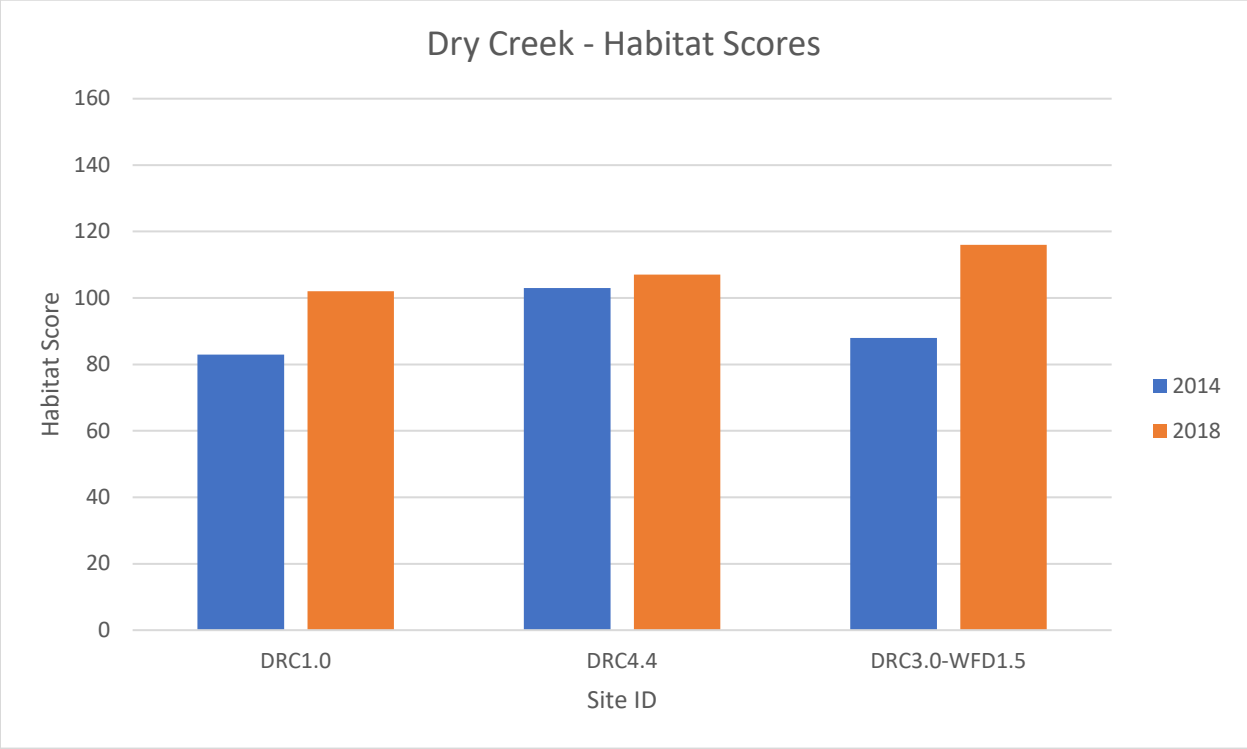


Figure 40. Dry Creek Habitat Scores

Elijahs Creek

Elijahs Creek is a moderate to steep gradient stream, with streambeds usually dominated by exposed bedrock and fine sediment substrates. Riparian zone habitat varies throughout the stream length, dependent primarily on the surrounding land use. The current state of development has resulted in a watershed total impervious surface area of 26.3%. Assessments were performed at both monitoring sites during Period 2 and Period 3.

Table 11. Elijahs Creek MBI Scores

Elijahs Creek	Site Type	Period 2 MBI Scores	Period 3 MBI Scores
Site	**Category**	**2014**	**2018**
EJC0.3	Wadeable	54.34 (Fair)	35.24 (Poor)
EJC2.8	Headwater	30.25 (Poor)	35.78 (Poor)

The Elijahs Creek MBI scores were rated as poor at both sites. The overall score at site EJC0.3 decreased, changing rating from fair in 2014 to poor in 2018, based on increased percentages of pollutant tolerant organisms, as well as decreased abundance of pollutant sensitive organisms. The MBI score for site EJC2.8 increased from 2014 to 2018 due to increased taxa richness and percentage decrease in pollutant tolerant organisms.

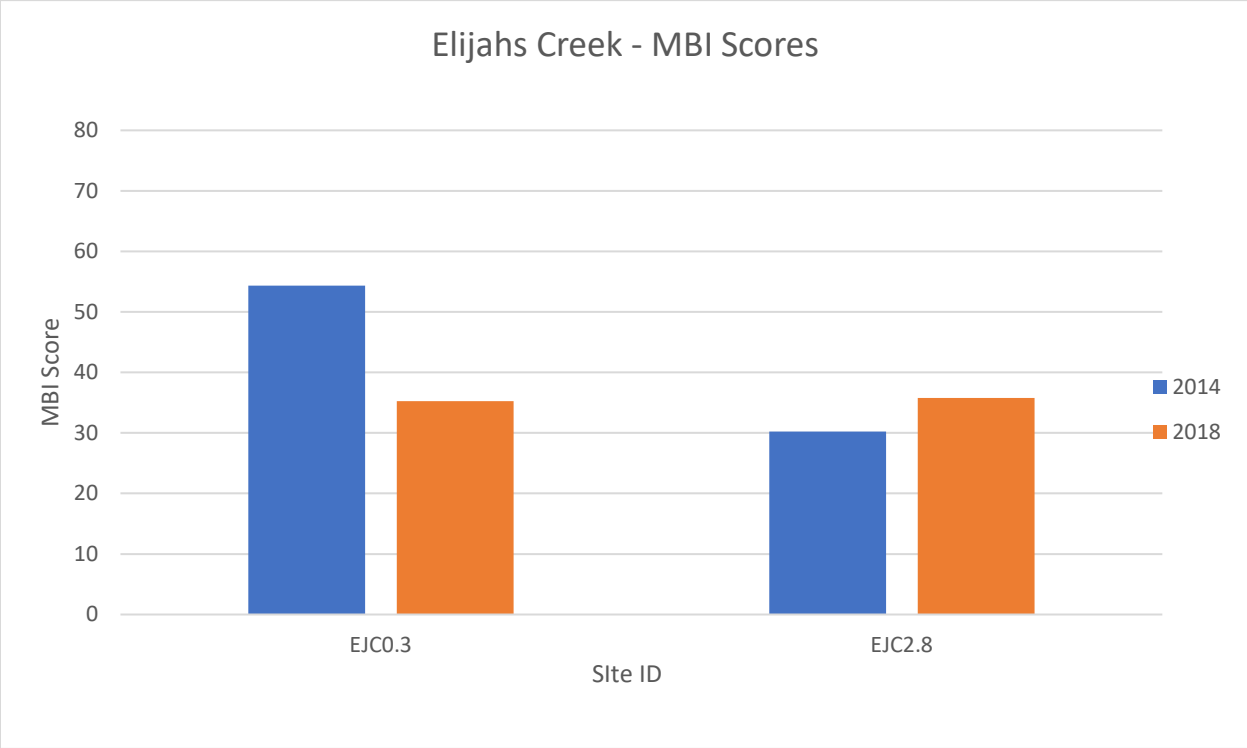


Figure 41. Elijahs Creek MBI Scores

Table 12. Elijahs Creek RBP Scores

Elijahs Creek	Category	Period 2 RBP Scores	Period 3 RBP Scores
Sites		**2014**	**2018**
EJC0.3	Wadeable	98 (Poor)	113 (Poor)
EJC2.8	Headwater	89 (Poor)	85 (Poor)

The Elijahs Creek habitat scores fluctuated from 2014 to 2018, however scores remained within the poor rating. Site EJC0.3 scores increased due to improvements in riparian vegetation and channel alteration, while site EJC2.8 scores decreased slightly.

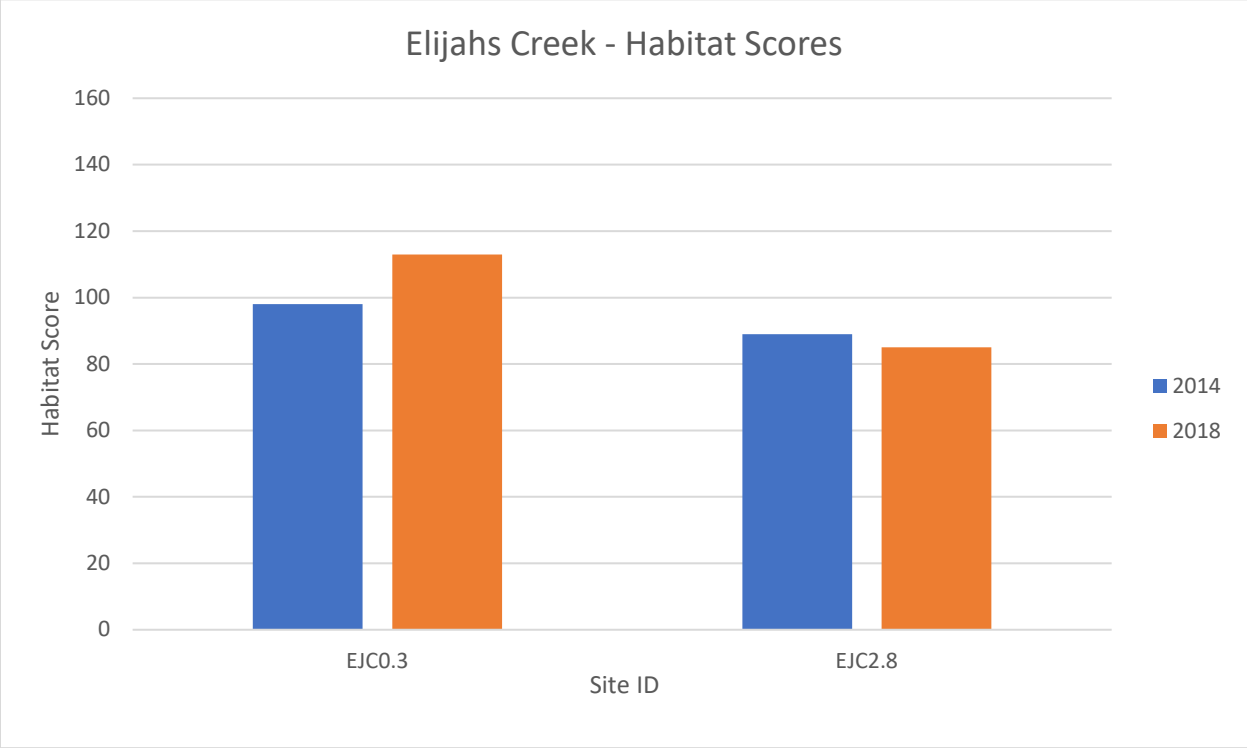


Figure 42. Elijahs Creek Habitat Scores

Pleasant Run Creek

Pleasant Run Creek is a shallow stream with large cobble substrate and erodible soils. Riparian zone habitat varies throughout the stream length, dependent primarily on the surrounding land use. The current state of development has resulted in a watershed total impervious surface area of 19.5%. Assessments were performed at site PRC2.0 during Period 2 and Period 3. Biological monitoring will be added to site PRC0.4 for assessment during Period 4 per the basin rotation cycle.

Table 13. Pleasant Run Creek MBI Scores

Pleasant Run Creek	Site Type	Period 2 MBI Scores	Period 3 MBI Scores
Site	**Category**	**2014**	**2018**
PRC0.4	Wadeable	NA	NA
PRC2.0	Headwater	39.31 (Fair)	27.59 (Poor)

Columns displaying "NA" do not currently have results available but will in subsequent years (i.e., Period 4).

The MBI score for site PRC2.0 decreased from fair in 2014 to poor in 2018 due to a percentage loss in Ephemoroptera and an increase in pollutant toleratant organisms.

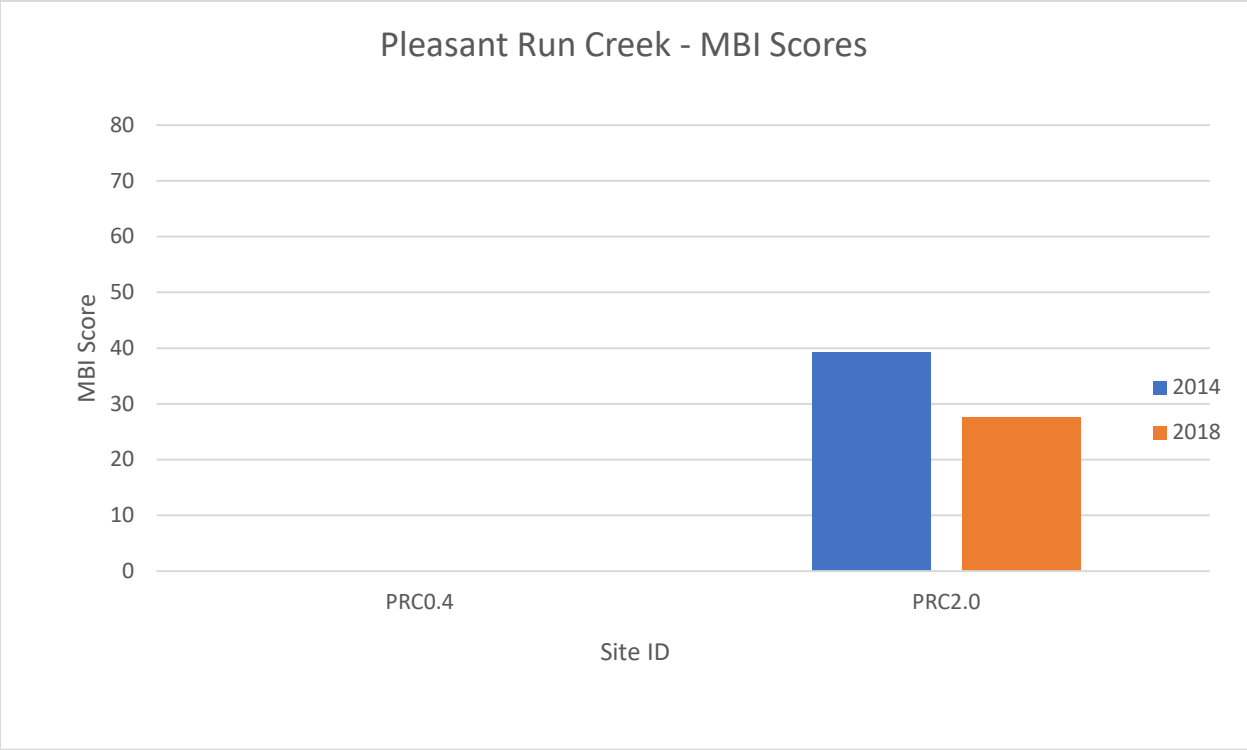


Figure 43. Pleasant Run Creek MBI Scores

Table 14. Pleasant Run Creek RBP Scores

Pleasant Run Creek	Site Type	Period 2 RBP Scores	Period 3 RBP Scores
Site	**Category**	**2014**	**2018**
PRC0.4	Wadeable	NA	NA
PRC2.0	Headwater	88 (Poor)	105 (Poor)

Columns displaying "NA" do not currently have results available but will in subsequent years (i.e., Period 4).

The habitat scores at site PRC2.0 increased from 2014 to 2018, mainly due to increases in bank stability and vegetative protection metrics, however the site rating remained poor.

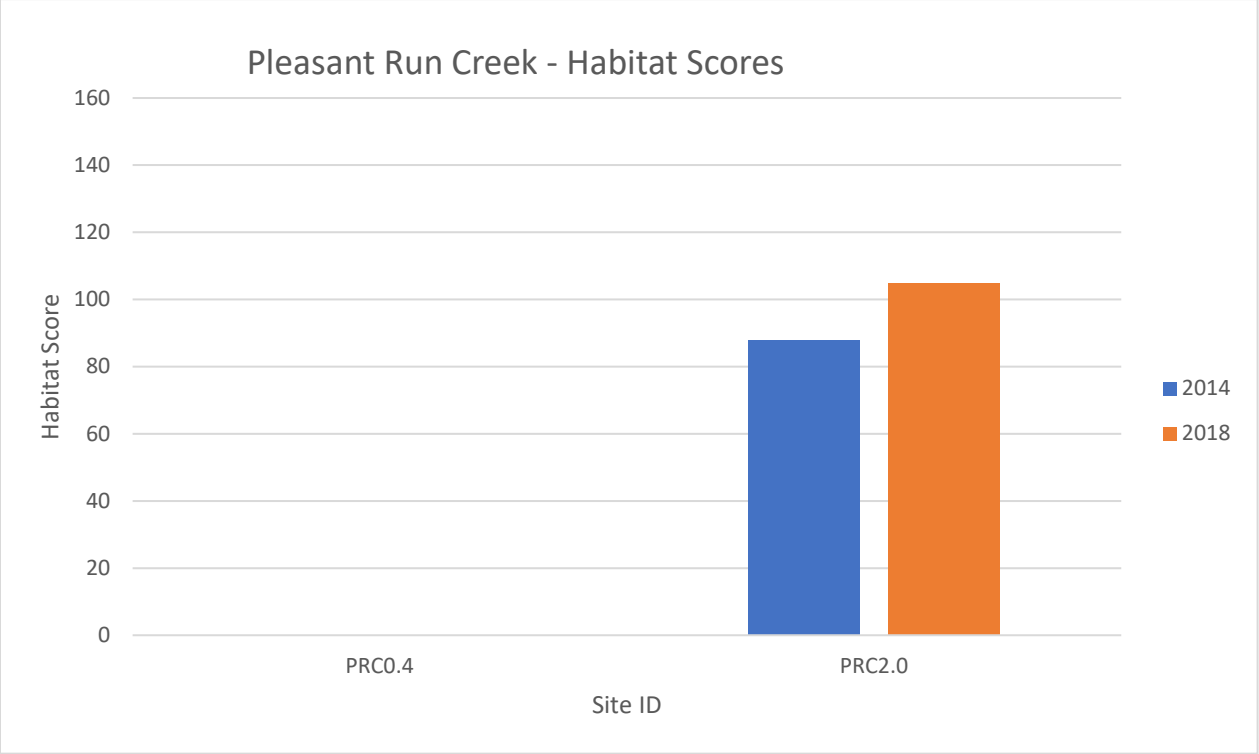


Figure 44. Pleasant Run Creek Habitat Scores

Sand Run

Sand Run is a moderately steep stream with the upper portions dominated by bedrock and large cobble, while the lower half is mainly sand with minimal cobble substrates. Riparian zone habitat varies throughout the upper stream length, dependent primarily on the surrounding land use, while the lower stream length is mainly undisturbed and provides a contiguous forest canopy. The current state of development has resulted in a watershed total impervious surface area of 19.1%. Assessments were performed at one of the two monitoring sites during Period 2 and Period 3 (SDR0.6 was not assessed during either period due to Ohio River backwater influence).

Table 15. Sand Run MBI Scores

Sand Run	Site Type	Period 2 MBI Scores	Period 3 MBI Scores
Site	**Category**	**2014**	**2018**
SDR0.6	Headwater	NA	NA
SDR4.0	Headwater	44.09 (Fair)	31.01 (Poor)

Columns displaying "NA" were not assessed during the monitoring period.

The MBI score at site SDR4.0 decreased from fair in 2014 to poor in 2018, due to a loss in percentage of Ephemoroptera and an increase in pollutant tolerant organisms.

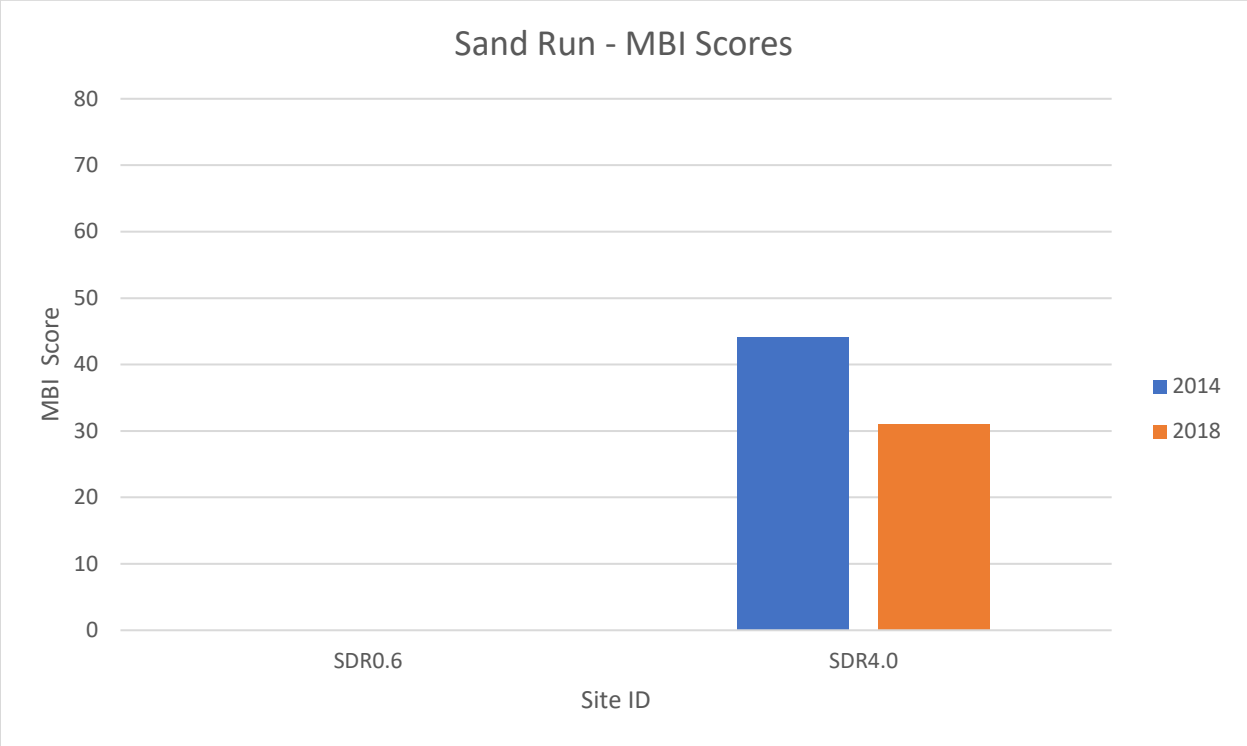


Figure 45. Sand Run MBI Scores

Table 16. Sand Run RBP Scores

Sand Run	Site Type	Period 2 RBP Scores	Period 3 RBP Scores
Site	**Category**	**2014**	**2018**
SDR0.6	Headwater	NA	NA
SDR4.0	Headwater	102 (Poor)	98 (Poor)

Columns displaying "NA" were not assessed during the monitoring period.

The habitat scores at site SDR4.0 decreased slightly from 2014 to 2018 due to a slight increase in embedded material and loss of available substrate cover.

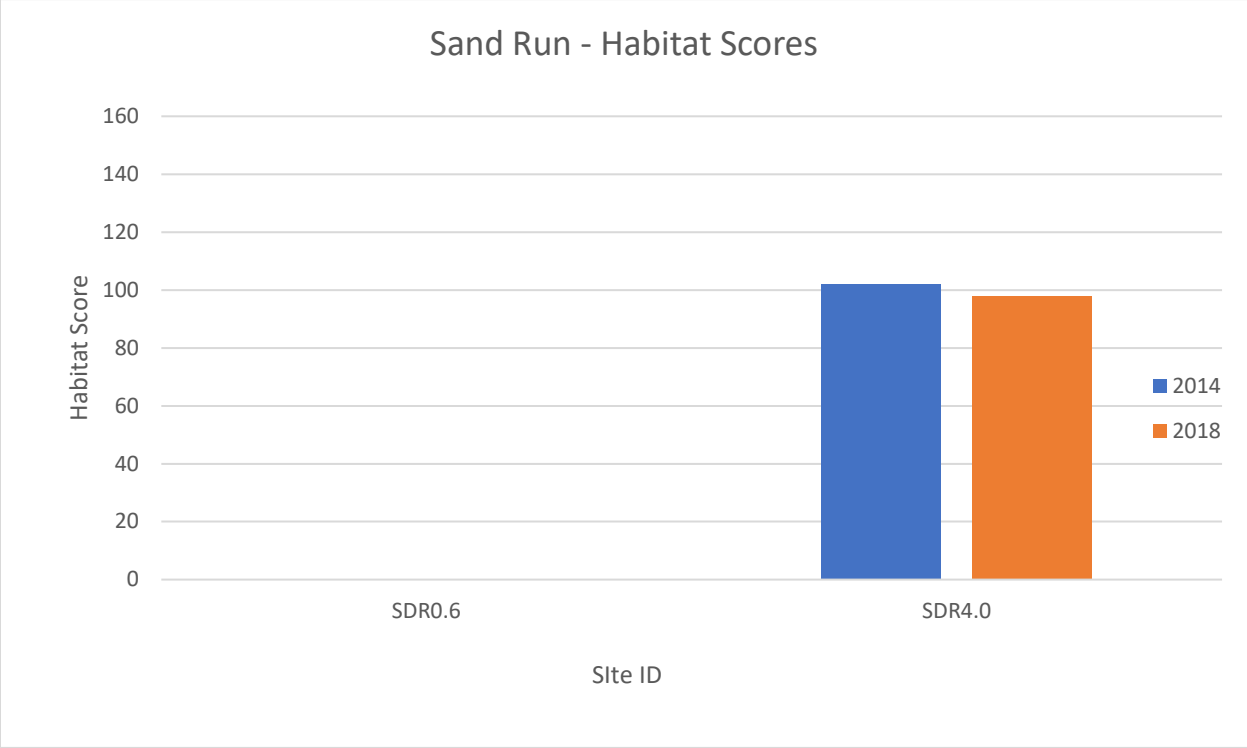


Figure 46. Sand Run Habitat Scores

Woolper Creek

Woolper Creek streams have moderate to steep gradients with highly erodible shale substrates. Riparian zone habitat varies throughout the stream length, dependent primarily on the surrounding land use. The current state of development has resulted in a watershed total impervious surface area of 8.5%. Assessments were performed at all three monitoring sites during Period 2 and Period 3.

Table 17. Woolper Creek MBI Scores

Woolper Creek	Site Type	Period 2 MBI Scores	Period 3 MBI Scores
Site	**Category**	**2014**	**2018**
WPC5.0	Wadeable	62.22 (Good)	56.07 (Fair)
WPC8.8	Wadeable	60.85 (Good)	68.10 (Good)
ALF0.1	Wadeable	52.03 (Fair)	51.47 (Fair)

The Woolper Creek MBI scores ranged from fair to good at all three sites. At sites WPC5.0 and ALF0.1 the scores decreased from 2014 to 2018 due to fluctuations in individual metrics (i.e., increase in pollutant tolerant species and decrease in taxa richness), while the MBI score increased at site WPC8.8 due to improvements in taxa richness and percentage of Ephemoroptera.

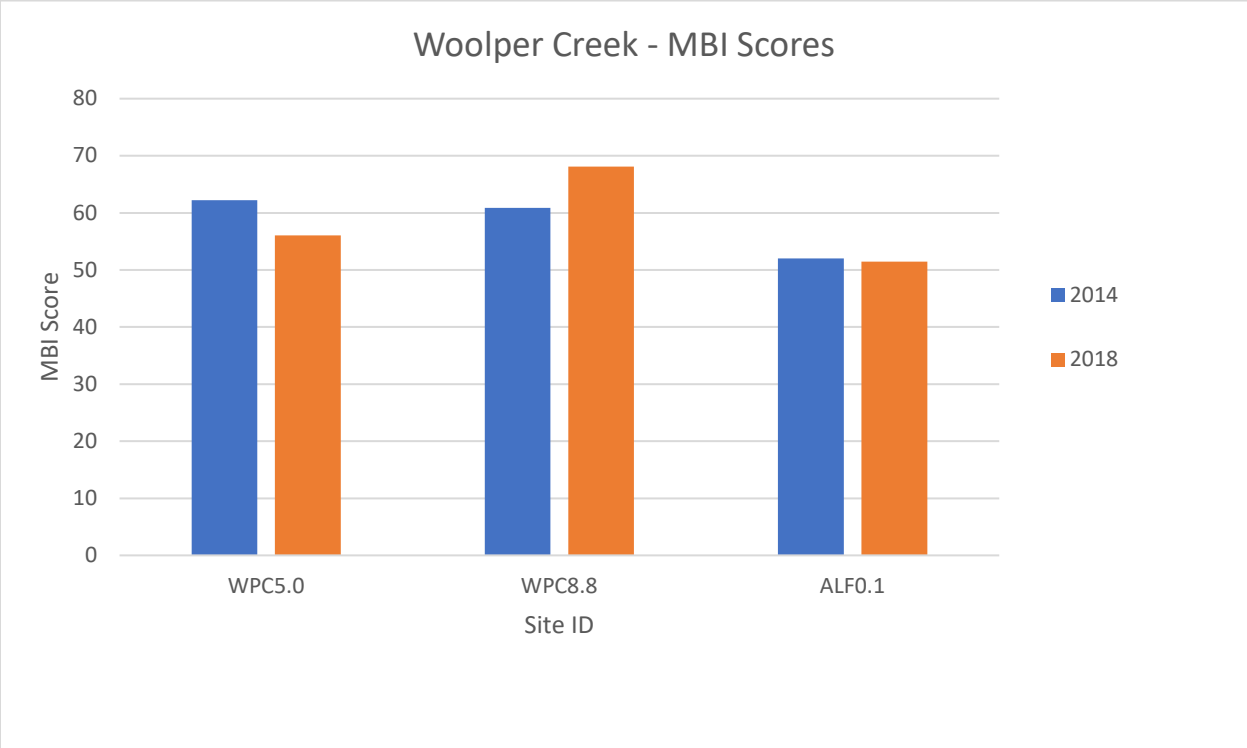


Figure 47.Woolper Creek MBI Scores

Table 18. Woolper Creek RBP Scores

Woolper Creek	Site Type	Period 2 RBP Scores	Period 3 RBP Scores
Site	**Category**	**2014**	**2018**
WPC5.0	Wadeable	127 (Fair)	125 (Fair)
WPC8.8	Wadeable	115 (Fair)	130 (Good)
ALF0.1	Wadeable	96 (Poor)	116 (Fair)

The Woolper Creek habitat scores ranged from fair to good at all three sites. Sites WPC8.8 and ALF0.1 scores increased from 2014 to 2018, while site WPC5.0 declined slightly. The rating for site WPC8.8 changed from fair to good due to improvements in bank stability, riparian vegetation, as well as embeddedness of stream substrate. The rating for site ALF0.1 changed from poor to fair, mainly due to improvements in frequency of riffles and riparian buffer width.

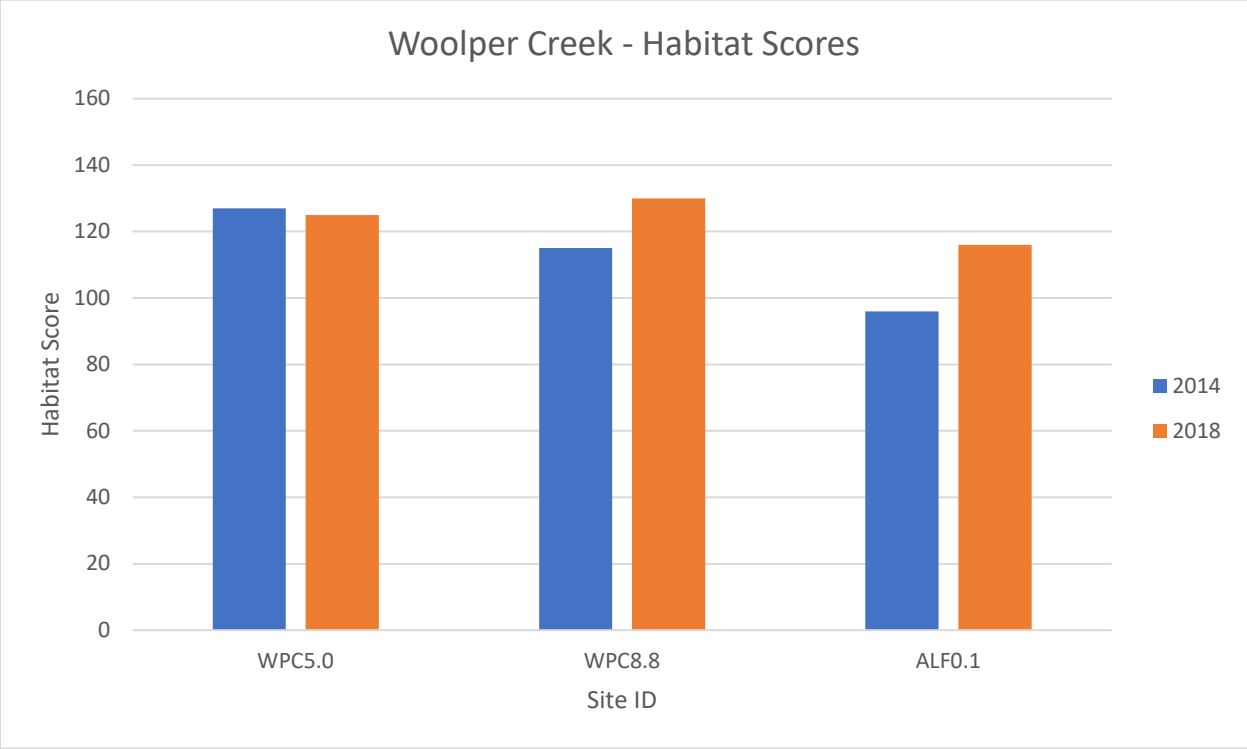


Figure 48. Woolper Creek Habitat Scores

Stream Stability Assessment Results

The stream stability monitoring program collects dimensions of stream geomorphology across NKY to develop a regional stream stability index, which consists of full surveys (i.e., channel cross-sections and longitudinal profiles, along with bed material particle counts), as well as rapid stability assessments[11] (i.e., bank height/angle, channel shape, bedrock, and pool depth indexes). The rapid stability assessment was developed to supplement the labor-intensive data collection of full surveys to enable the generation of a numerical score immediately upon data collection. For efficient data collection, rapid stream stability assessments were conducted during the biological assessments.

Rapid Stability Scores measure rates of channel change, as seen in Figure 28 (figure shows the channel evolution model – illustration of how a stream can deepen, then widen, and reestablish new banks, over time), in conjunction with field indicators, failure mechanisms, and sediment transport analyses to develop a regionally calibrated channel stability index. The index scale (i.e., 0 – 10 scale) is designed to have built-in flexibility to score sites without detailed stream stability surveys on the same scale as those with multiple years of data using simple but significant metrics. There is not a definitive separation between scores, as in the MBI, however, as a guideline, Table 10 shows stability rankings (i.e., Stable, Transition and Unstable) with respect to assessment scores.

Table 19. Rapid Stability Scores

Rapid Stability Scores	
Stable (relative equilibrium)	>7
Transition (intermediate)	>4 to <7
Unstable (actively adjusting in multiple dimensions)	<4

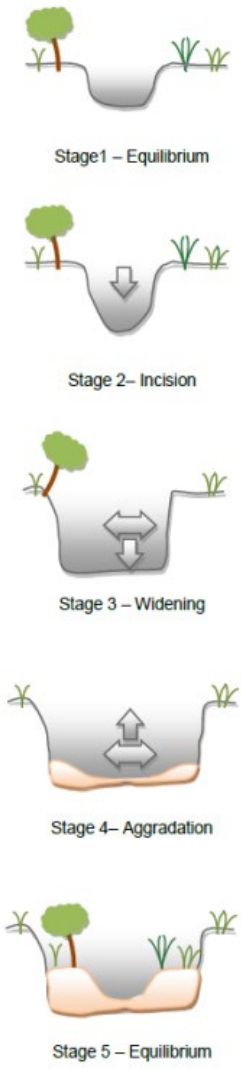


Figure 49. Channel Evolution Model[12]

Refer to Appendix C for results from individual sites within the North Basin study area.

[11] *Regionally-Calibrated Channel Stability Index for Northern Kentucky Streams*, July 2012 Memorandum
[12] *Incised Channels: Morphology Dynamics and Control*, Schumm et al. 1984

Dry Creek

Dry Creek watershed monitoring sites were assessed during Period 2 (DRC3.0-WFD1.5 and DRC4.4 in 2012 and DRC1.4 in 2014). Although only DRC1.4 was assessed during Period 3, all three sites are scheduled for assessment during Period 4, per the basin rotation cycle.

Table 20. Dry Creek Rapid Stability Scores

Dry Creek	Period 2		Period 3
Site	**2012**	**2014**	**2018**
DRC1.4	NA	2.95	0.80
DRC3.0-WFD1.5	2.35	NA	NA
DRC4.4	6.1	NA	NA

Columns displaying "NA" do not currently have results available but will in subsequent years (i.e., Period 4).

The monitoring sites in the Dry Creek watershed were all below the stable threshold score of 7, with only one site (DRC4.4) within the transition zone, as represented by the area between the solid and dashed blue lines in Figure 50. The site photo of DRC1.4 illustrates an unstable area, exhibiting stream channel movement and channel widening.

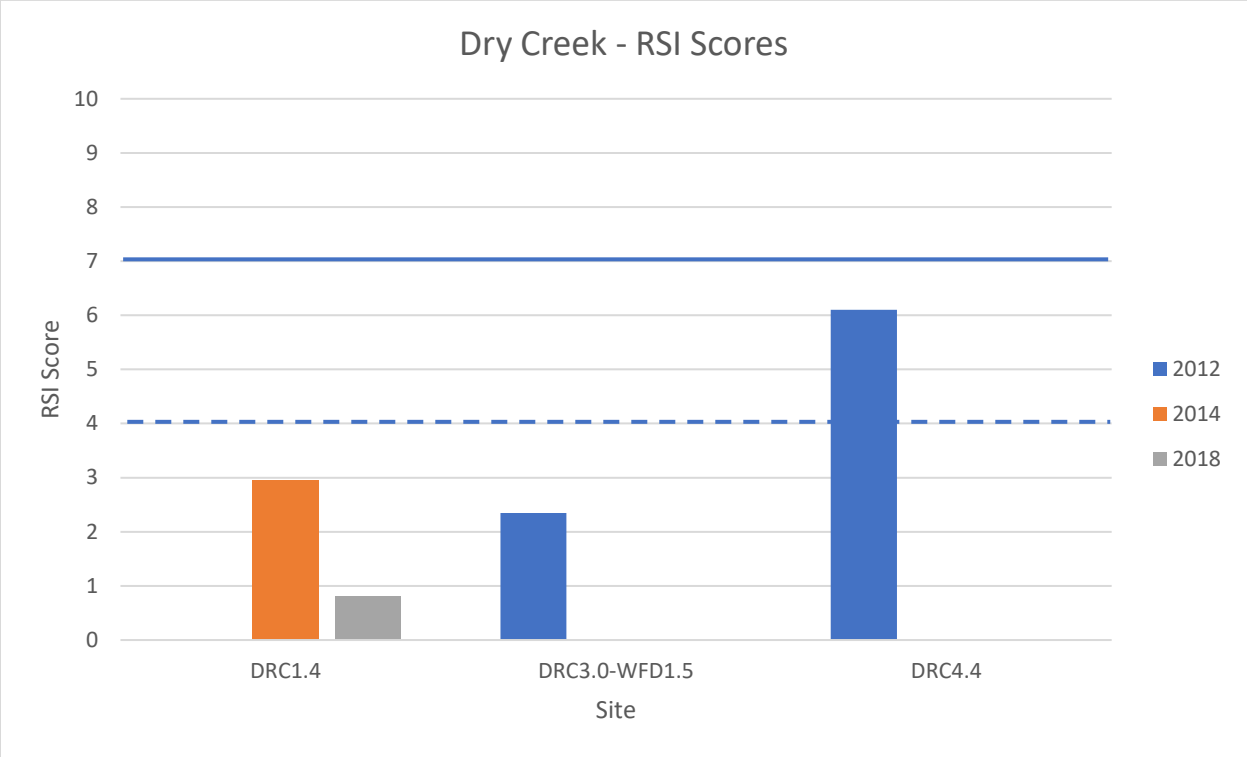


Figure 50. Dry Creek Rapid Stability Scores

Photo 19. Dry Creek 1.4

Photo 20. Dry Creek 4.4

Elijahs Creek

Elijahs Creek watershed monitoring sites were assessed in 2012 during Period 2. Although neither site was assessed during Period 3, both sites are scheduled for assessment during Period 4, per the basin rotation cycle.

Table 21. Elijahs Creek Rapid Stability Scores

Elijahs Creek	Period 2	Period 3
Site	**2012**	**2018**
EJC0.3	4.85	NA
EJC2.8	2.70	NA

Columns displaying "NA" do not currently have results available but will in subsequent years (i.e., Period 4).

The monitoring sites in the Elijahs Creek watershed were both below the stable threshold score of 7, with only one site (EJC0.3) within the transition zone, as represented by the area between the solid and dashed blue lines in Figure 51. EJC2.8 is dominated by bedrock with minimal substrate and portions of the bank upstream of the site have been armored.

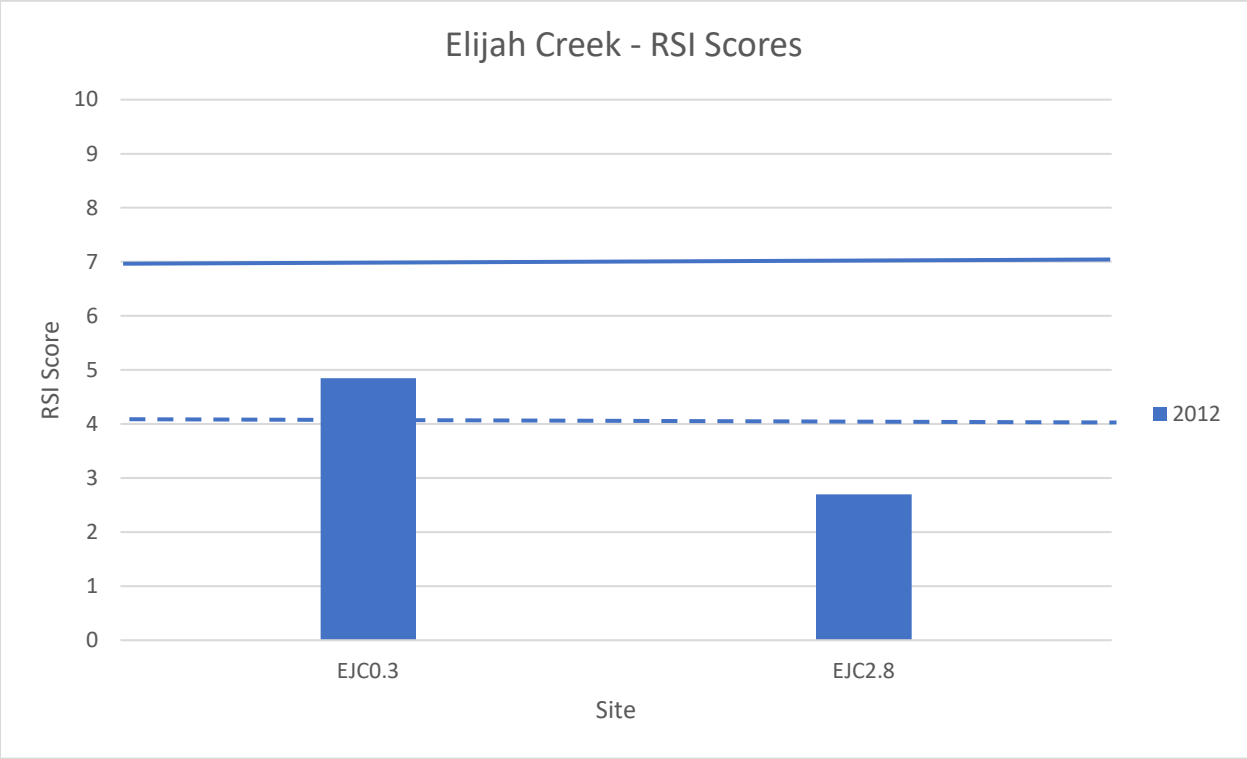


***Figure 51. Elijahs* Creek Rapid Stability Scores**

Photo 21. Elijahs Creek 0.3

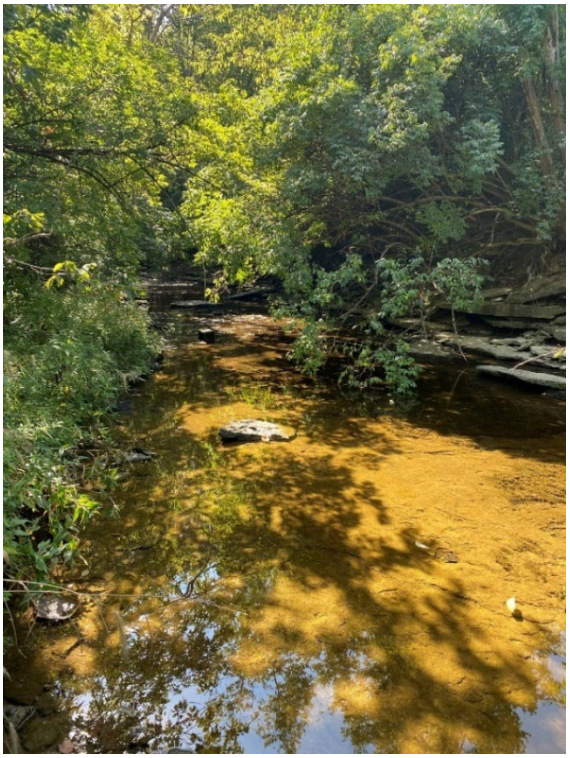


Photo 22. Elijahs Creek 2.8

Pleasant Run Creek

Pleasant Run Creek watershed monitoring site PRC2.0 was the only site assessed in 2012 during Period 2. Although neither site was assessed during Period 3, both sites are scheduled for assessment during Period 4, per the basin rotation cycle.

Table 22. Pleasant Run Creek Rapid Stability Scores

Pleasant Run Creek	Period 2	Period 3
Site	**2012**	**2018**
PRC0.4	NA	NA
PRC2.0	-0.60	NA

Columns displaying "NA" do not currently have results available but will in subsequent years (i.e., Period 4).

Pleasant Run Creek watershed monitoring site photo of PRC2.0 illustrates the high steep banks, embedded substrate and large deep pools, which are indicators of a highly unstable area resulting in a zero score.

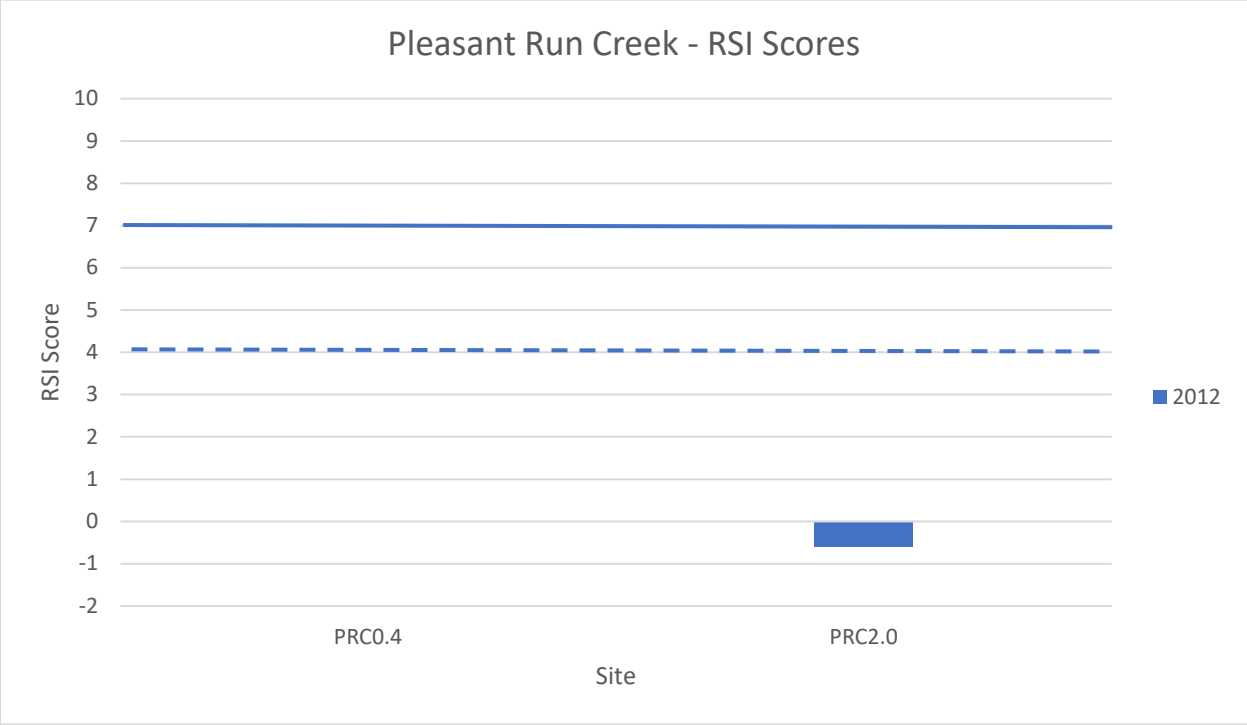


Figure 52. Pleasant Run Creek Rapid Stability Scores

Photo 23. Pleasant Run Creek 0.4

Photo 24. Pleasant Run Creek 2.0

Sand Run

Sand Run watershed monitoring sites were assessed in 2012 during Period 2. Although neither site was assessed during Period 3, both sites are scheduled for assessment during Period 4, per the basin rotation cycle.

Table 23. Sand Run Rapid Stability Scores

Sand Run	Period 2	Period 3
Site	**2012**	**2018**
SDR0.6	1.25	NA
SDR4.0	2.95	NA

The sites labeled "NA" do not currently have results available but will in subsequent years (i.e., Period 4).

The monitoring sites in the Sand Run watershed were both below the unstable threshold score of 4, as represented by the dashed blue line in Figure 53. The site photo of SDR0.6, near the confluence with the Ohio River, illustrates the sandy/silty substrate, with high banks, decreased connection to flood plain and low riffle frequency, while the site photo of SDR4.0 illustrates low sloped banks, dominated by bedrock in the upper reaches, and minimal bed irregularity.

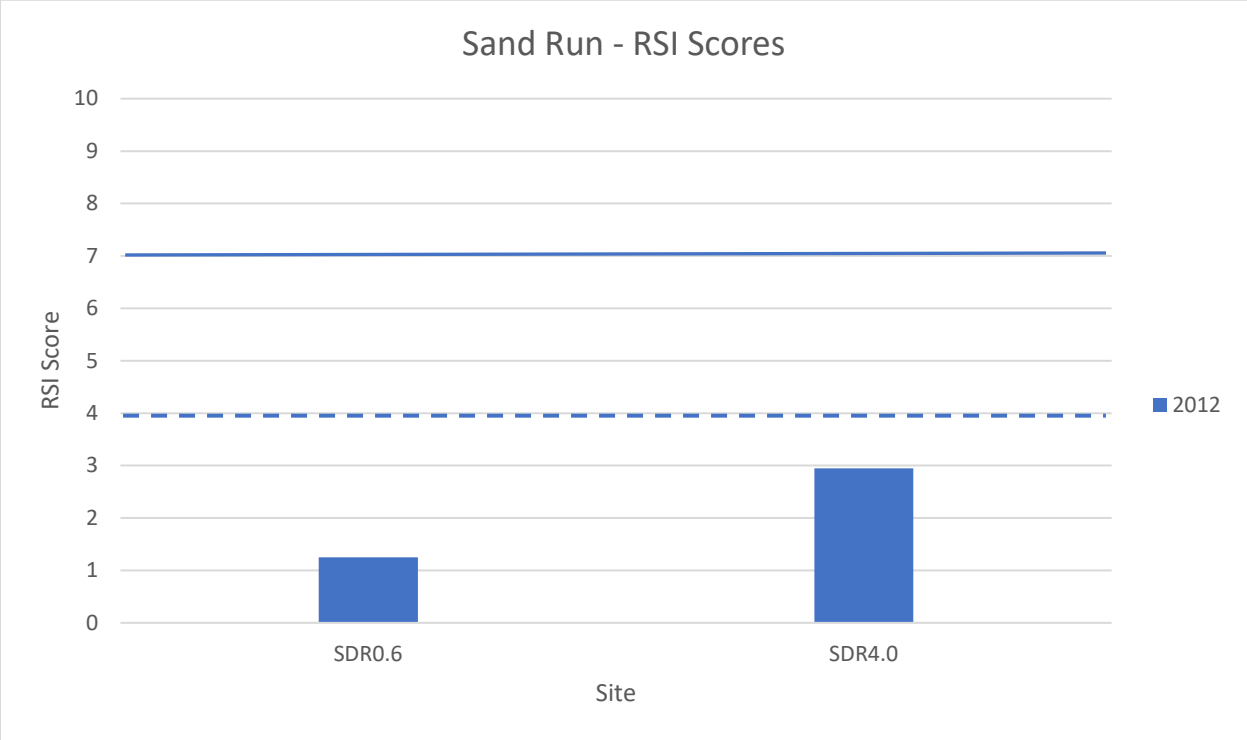


Figure 53. Sand Run Creek Rapid Stability Scores

Photo 25. Sand Run 0.6

Photo 26. Sand Run 4.0

Woolper Creek

Two Woolper Creek watershed monitoring sites were assessed during Period 2. Although only WPC5.0 was assessed during Period 3, all three sites are scheduled for assessment during Period 4, per the basin rotation cycle.

Table 24. Woolper Creek Rapid Stability Scores

Woolper Creek	Period 2		Period 3
Site	**2012**	**2014**	**2018**
WPC5.0	NA	3.25*	2.80
WPC8.8	2.20	NA	NA
ALF0.1	3.00	NA	NA

Columns displaying "NA" do not currently have results available but will in subsequent years (i.e., Period 4).
*Site WPC5.0 was assessed in 2013.

The monitoring sites in the Woolper Creek watershed were all below the unstable threshold score of 4, as represented by the dashed blue line in Figure 54. WPC5.0 experienced a bit of instability, most likely due to an increase in pool depth within the survey area. WPC8.8 has large pools, large areas of mixture of bedrock and large cobble, and deep pools. ALF0.1 has large amounts of bedrock and an unstable bank.

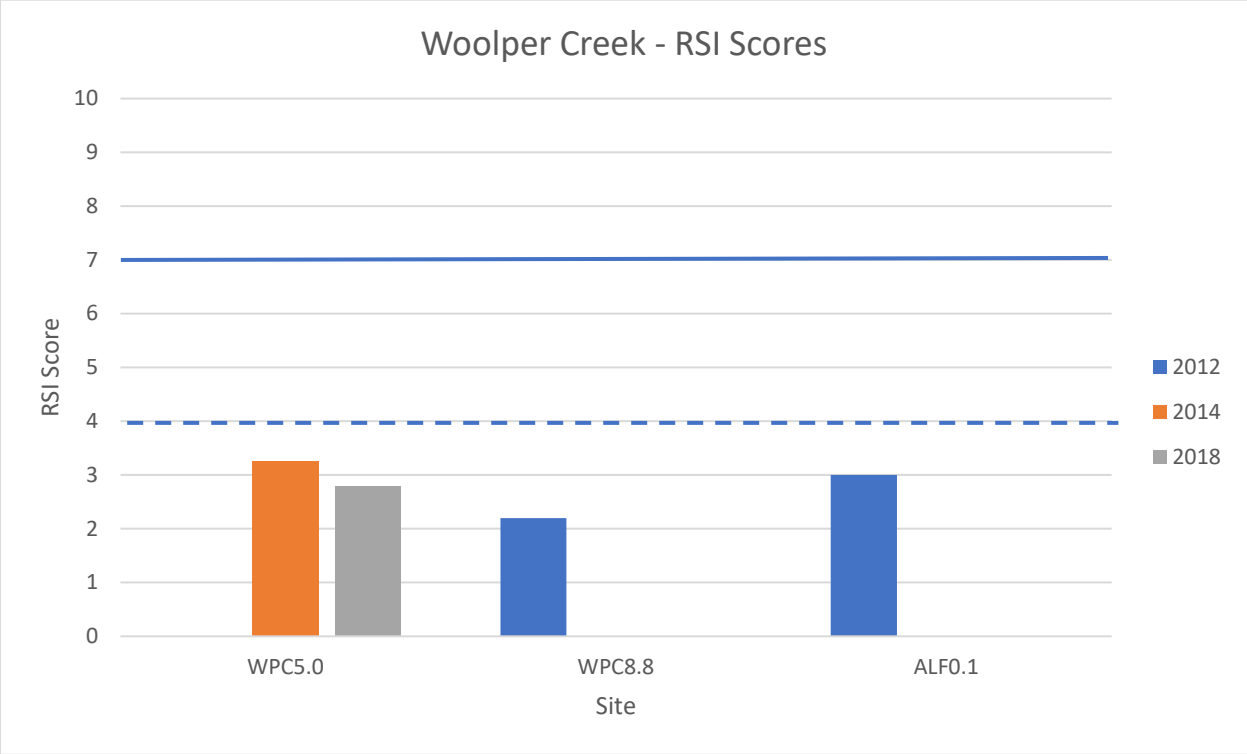


Figure 54. Woolper Creek Rapid Stability Scores

Photo 27. Woolper Creek 5.0

Photo 28. Woolper Creek 8.8

Stream Condition Index Basin Trends

The Stream Condition Index (SCI) is a visual representation (Figure 54) of four key components of SD1's watershed assessment program: water quality, biology, physical habitat, and stream stability[13]. Originally developed for a tool to summarize large amounts of complex information that can be easily understood by the general public, the SCI was updated in 2020 for trend analysis[14]. Each of these four components is essential to fully understand the ecological functions and relative health of the individual streams. Relying on a single parameter could be problematic since some streams may rate well in one category, but poor in others. Each of the four indicators used in the Stream Condition Index are given sub-scores. The four sub-scores are then averaged to generate a single overall Stream Condition Index score. These scores are updated as additional data is collected and as the characterization of the watersheds are refined. The overall score for a monitoring site is only calculated if 3 out of the 4 indicators are populated with a sub-score.

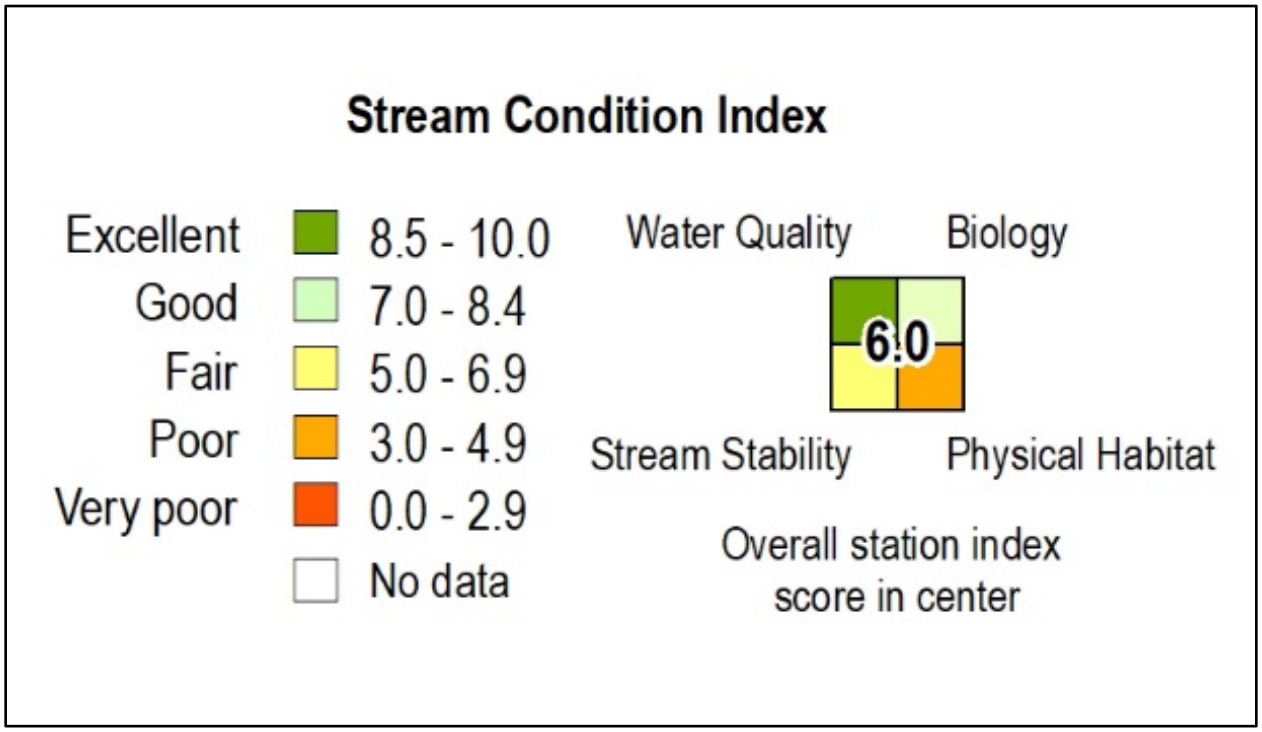


Figure 55. Stream Condition Index Visual Representation

An overall watershed SCI score is calculated if at least 50% of the monitoring sites within the watershed contain data and, if at minimum, sub-scores are calculated for water quality, biology and physical habitat. Watershed scores for Periods 2 and 3 are displayed in the preceding graphs and tables. These scores are out of a total rating of 10, which would be the highest score possible. Appendix D contains tables for Individual site scores for Periods 2 and 3.

[13] A Stream Condition Index for Water Utility Resource Management in Northern Kentucky Document, June 2013
[14] Basin Trend Stream Condition Index Water Quality Sub-Indice Development, October 2020 Memorandum

The overall SCI scores for the North Basin watersheds from 2012 - 2015 range from 3.34 to 5.92. Woolper Creek had the highest score of 5.92 (Fair), while Pleasant Run Creek had the lowest score of 3.34 (Poor). Elijahs Creek, Dry Creek and Sand Run all rated as Poor with scores of 4.70, 4.68 and 4.60, respectively (Table 25 and Figure 56).

Table 25. Stream Condition Index Basin Trend Scores by Watershed for Period 2 (2012 - 2015)

Watershed	Water Quality Score	Biology Score	Habitat Score	Stream Stability Score	Score
Dry Creek	6.18	5.25	3.47	3.80	4.68
Elijahs Creek	5.90	5.38	3.73	3.78	4.70
Pleasant Run Creek	5.18	5.06	3.12	0.00	3.34
Sand Run	6.60	6.06	3.62	2.10	4.60
Woolper Creek	7.25	7.42	6.20	2.82	5.92

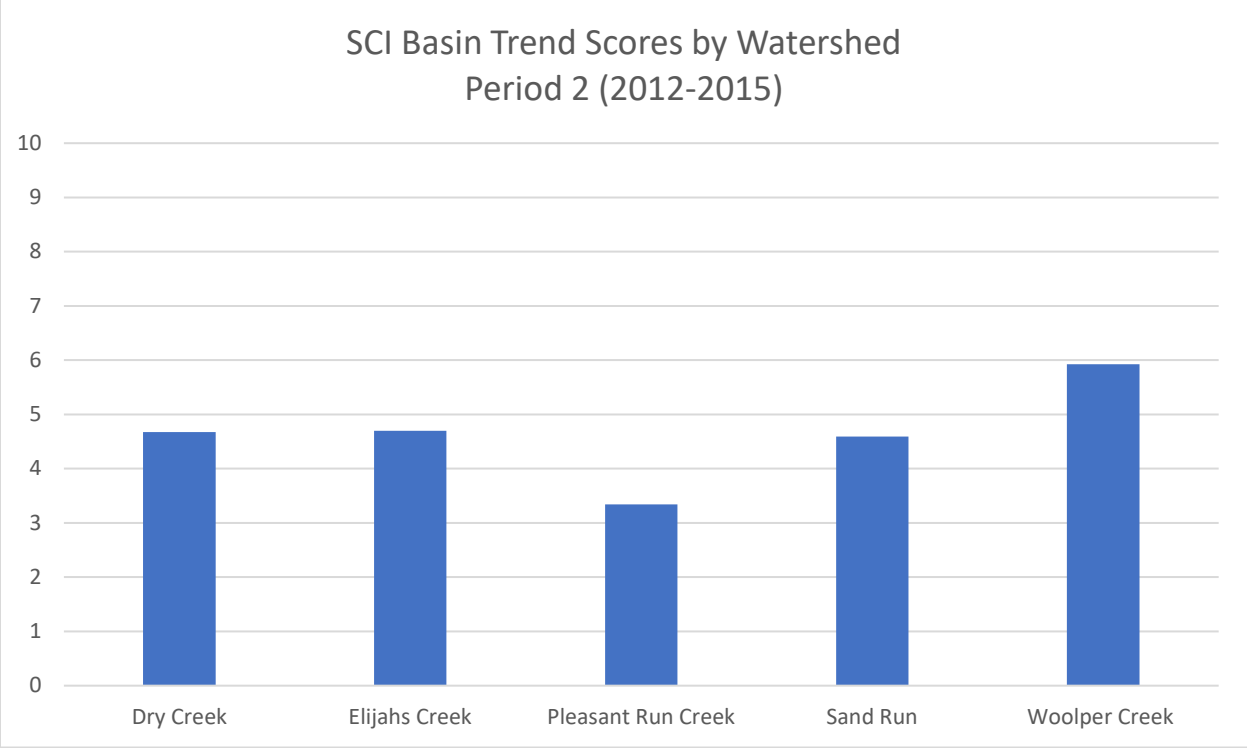


Figure 56. Stream Condition Index Basin Trend Scores by Watershed for Period 2

The overall SCI scores for the North Basin watersheds from 2016 - 2019 range from 4.79 to 6.43. Woolper Creek had the highest score of 6.43 (Fair), while Pleasant Run Creek had the lowest score of 4.79 (Poor). Elijahs Creek, Dry Creek and Sand Run all rated from Fair to Poor with scores of 5.26, 5.05 and 4.92, respectively (Table 26 and Figure 57).

Table 26. Stream Condition Index Basin Trend Scores by Watershed for Period 3 (2016 - 2019)

Watershed	Water Quality Score	Biology Score	Habitat Score	Stream Stability Score	Score
Dry Creek	7.93	7.35	4.13	0.80	5.05
Elijahs Creek	7.28	4.51	3.99	NA	5.26
Pleasant Run Creek	7.02	3.64	3.72	NA	4.79
Sand Run	7.24	4.05	3.48	NA	4.92
Woolper Creek	7.22	7.66	8.02	2.80	6.43

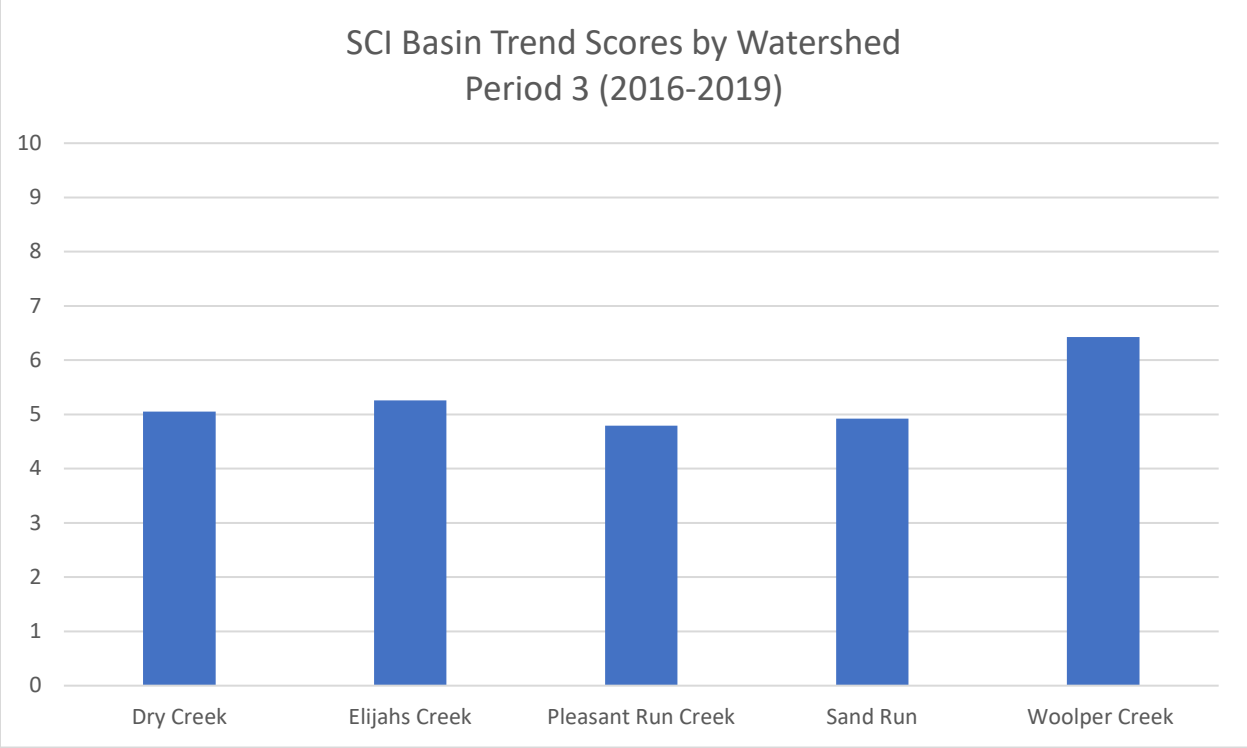


Figure 57. Stream Condition Index Basin Trend Scores by Watershed for Period 3

Conclusion

Table 27 and Figure 58 depict the initial points of a trend line representing SD1's Stream Condition Index for the five watersheds in the North Basin. Although data was limited at some monitoring sites within the watersheds during Periods 2 and 3, a more complete dataset starting with Period 4 will increase the accuracy of the analysis.

Over time as the watersheds are sampled and assessed, the trend line representing each watersheds rating will extend. Currently, the lines between periods for all five watersheds are trending upward (i.e., positive improvement).

Table 27. Stream Condition Index Basin Trend Scores

Watershed	Period 2 (2012-2015)	Period 3 (2016-2019)
Dry Creek	4.68	5.05
Elijahs Creek	4.70	5.26
Pleasant Run Creek	3.34	4.79
Sand Run	4.60	4.92
Woolper Creek	5.92	6.43

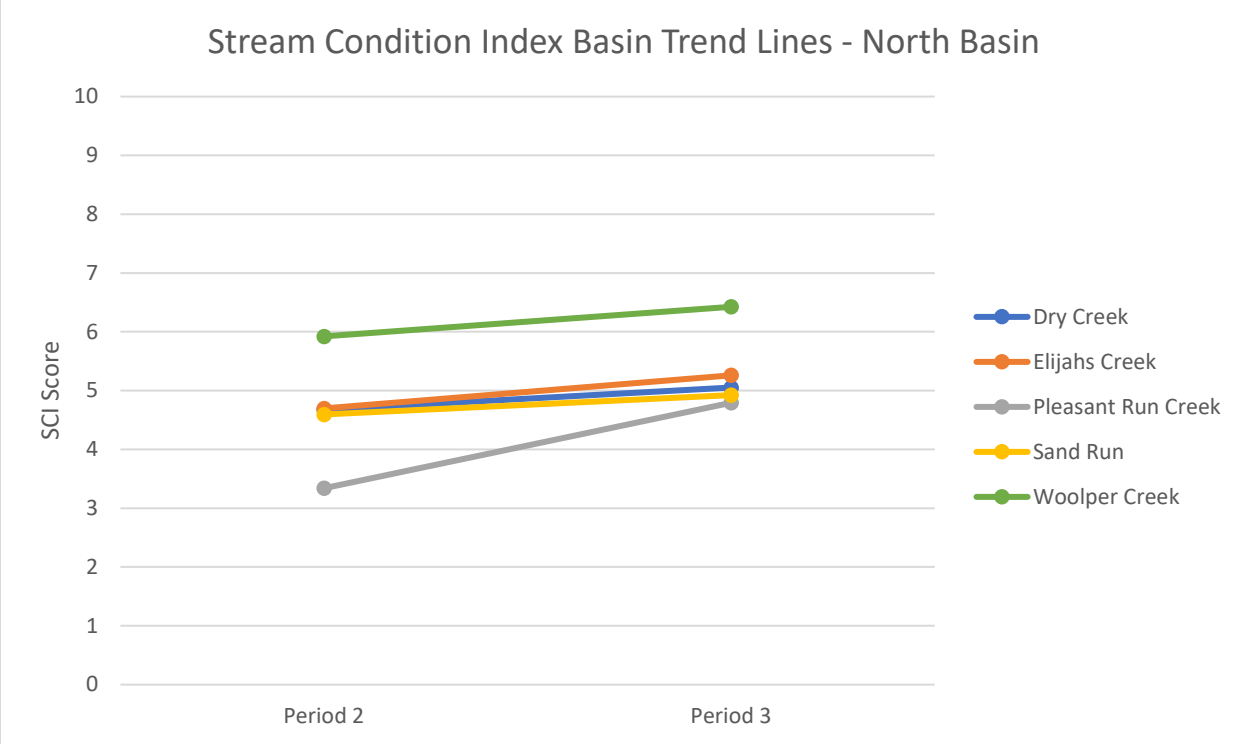


Figure 58. Stream Condition Index Basin Trend Scores

As stated in the beginning objectives, there are numerous reasons why SD1 continues to collect instream water quality, biology, physical habitat, and stream stability data. These monitoring program components together not only characterize the state of Northern Kentucky watersheds, but they also provide locally relevant data as to how to better manage the impacts to the watersheds by implementing effective regulatory requirements and improvement projects.

This data has been used to inform local storm water management policies and regulations that are effective in protecting the region's water quality. Additionally, the monitoring data collected by SD1 has been used by local partners (e.g., conservation districts and citizen watershed groups) to obtain 319 (h) grants from Kentucky to inform additional watershed plans and implementation projects that compliment SD1 initiatives.

SD1 is committed to balance the need to keep local waterways clean and safe with the need to provide affordable wastewater and storm water services in Northern Kentucky. Clean H_2O40 is SD1's commitment to increasing our capacity to better manage the flow of wastewater and storm water in Northern Kentucky. Through a number of strategic projects specifically designed to address sewer overflows, SD1 will meet the requirements of Northern Kentucky's consent decree and improve the quality of life in our community. By the year 2040, SD1 will completely eliminate typical-year sanitary sewer overflows and recapture at least 85 percent of all typical-year combined sewer overflows.

Additional information on SD1's monitoring programs and Clean H_2O40 initiative can be found at https://www.sd1.org.

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Appendix A – Water Quality Data

Instream water quality results are listed in tables beginning with the Dry Creek watershed, followed by the Elijahs Creek, Pleasant Run Creek, Sand Run and Woolper Creek watersheds. Along with the individual parameter results, the precipitation condition in which the samples were collected is also included in the tables as follows:

- Baseflow (Dry) – flow in the stream is comprised primarily of groundwater and/or the hydrograph is stable (typical example: no precipitation within 72 hours prior to sampling).
- Storm Flow (Wet) – flow in the stream is dominated by runoff and/or the hydrograph is rising or falling (typical example: greater than 0.25" of precipitation within 24 hours prior to sampling).

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Dry Creek Water Quality Data

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	7/23/15 13:30	144	36	0.066	0.267	0.151	0.116
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	8/6/15 13:10	10,460	81	0.150	1.184	0.867	0.317
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	9/3/15 13:15	148	<1.5	0.030	0.368	0.255	0.113
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	9/17/15 13:30	20	<1.5	<0.023	0.410	0.281	0.129
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	10/1/15 13:40	452	3	0.058	0.698	0.443	0.255
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	10/15/15 13:30	116	<1.5	0.052	0.294	0.230	0.064
Dry Creek	Dry Creek	1.4	DRC1.4	2	Dry	10/29/15 11:50	2,908	2	0.091	1.359	0.591	0.768
Dry Creek	Dry Creek	1.4	DRC1.4	2	Wet	7/9/15 13:40	1,844	15	0.083	1.047	0.822	0.225
Dry Creek	Dry Creek	1.4	DRC1.4	2	Wet	8/20/15 14:05	2,192	12	0.102	1.035	0.534	0.501
Dry Creek	Dry Creek	1.4	DRC1.4	2	Wet	11/12/15 13:50	1,460	3	0.024	0.634	0.402	0.232
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	5/26/16 13:05	8	<1.2	0.105	0.424	0.394	0.030
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	6/9/16 12:35	32	<1.2	0.099	0.445	0.428	0.017
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	7/21/16 12:15	92	<1.2	0.124	0.503	0.434	0.069
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	8/4/16 14:20	76	3	0.118	0.589	0.506	0.083
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/1/16 13:20	96	3	<0.045	1.101	0.435	0.666
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/15/16 13:45	48	<1.2	<0.045	1.106	0.767	0.339
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	10/13/16 13:00	8	7	0.067	0.800	0.583	0.217
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	10/27/16 13:00	92	<1.2	0.117	0.774	0.593	0.181
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	11/10/16 11:20	16	<1.2	0.065	0.467	0.421	0.046
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	4/13/17 13:15	24	<1.4	0.172	0.533	0.504	0.029
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	4/27/17 12:50	324	18	0.072	0.997	0.638	0.359
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	6/8/17 12:20	100	3	0.082	0.595	0.401	0.194
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	7/13/17 11:30	160	<1.4	0.106	0.709	0.493	0.216
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/7/17 11:45	20	<1.4	0.105	0.673	0.436	0.237

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/21/17 11:40	48	<1.4	0.102	0.643	0.524	0.119
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	10/19/17 11:25	16	<1.4	0.094	0.407	0.339	0.068
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	11/16/17 11:40	524	6	0.134	1.051	0.700	0.351
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	4/19/18 11:45	264	2	0.064	0.501	0.434	0.067
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	6/14/18 11:35	300	4	0.085	0.584	0.461	0.123
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	7/12/18 11:00	444	13	0.188	0.830	0.411	0.419
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	7/26/18 11:55	52	7	0.054	0.478	0.384	0.094
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/13/18 11:00	276	14	0.157	1.175	0.492	0.683
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/27/18 10:40	420	220	0.437	1.560	0.997	0.563
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	10/18/18 11:45	120	116	0.402	0.974	0.786	0.188
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	3/21/19 10:35	28	3	0.064	0.488	0.455	0.033
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	4/25/19 11:25	1,380	6	0.076	0.549	0.399	0.150
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	5/9/19 11:20	64	9	0.096	0.875	0.313	0.562
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	6/13/19 11:15	168	3	0.064	0.474	0.334	0.140
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	7/11/19 11:25	40	6	0.058	0.422	0.281	0.141
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	7/25/19 10:50	76	4	0.071	0.559	0.357	0.202
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	8/15/19 12:12	36	5	0.046	0.671	0.545	0.126
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/12/19 11:30	20	<1.4	0.089	0.662	0.482	0.180
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	9/26/19 11:15	16	<1.4	0.054	0.513	0.397	0.116
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	10/24/19 11:25	12	<1.4	0.065	0.354	0.330	0.024
Dry Creek	Dry Creek	1.4	DRC1.4	3	Dry	11/14/19 11:10	56	3	0.083	0.665	0.456	0.209
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	4/14/16 13:45	24	3	0.062	0.775	0.745	0.030
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	4/28/16 12:10	5,170	15	0.182	1.386	0.991	0.395
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	5/12/16 13:30	156	2	0.111	0.731	0.602	0.129
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	6/23/16 14:30	7,270	16	0.193	1.295	0.984	0.311
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	7/7/16 13:45	112	10	0.133	0.523	0.486	0.037

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	8/18/16 12:45	770	4	0.148	1.300	0.807	0.493
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	9/29/16 11:40	1,376	3	0.049	0.975	0.609	0.366
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	5/11/17 11:55	460	6	0.128	1.226	0.787	0.439
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	5/25/17 12:20	9,800	39	0.158	1.411	1.090	0.321
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	6/22/17 13:10	92	<1.4	0.129	0.968	0.671	0.297
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	7/27/17 11:05	17,330	10	0.228	1.471	0.988	0.483
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	8/17/17 11:20	12	<1.4	0.098	2.809	<0.097	2.760
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	3/29/18 11:15	796	19	0.147	1.231	0.783	0.448
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	5/10/18 11:30	1,952	14	0.089	0.931	0.616	0.315
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	5/24/18 11:10	180	7	0.117	0.721	0.309	0.412
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	8/23/18 10:40	128	39	0.172	0.813	0.497	0.316
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	11/15/18 10:50	12,030	45	0.311	1.418	0.883	0.535
Dry Creek	Dry Creek	1.4	DRC1.4	3	Wet	5/23/19 11:35	12,030	194	0.583	2.808	2.140	0.668

Elijahs Creek Water Quality Data

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Dry	7/21/15 12:30	648	2	0.042	0.334	<0.139	0.264
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Dry	8/4/15 11:15	1,304	23	0.029	0.888	0.574	0.314
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Dry	8/18/15 11:25	232	<1.5	0.067	0.831	0.346	0.485
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Dry	9/1/15 11:50	144	3	<0.023	0.554	0.473	0.081
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Dry	9/15/15 11:40	100	<1.5	0.027	0.542	0.390	0.152
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Wet	7/9/15 13:10	1,644	5	0.120	0.773	0.594	0.179
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Wet	9/29/15 11:40	8,660	68	0.199	1.100	0.854	0.246
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Wet	10/13/15 11:15	9,210	2	0.066	1.139	0.754	0.385
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Wet	10/27/15 12:15	1,740	16	<0.023	0.654	0.360	0.294
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2	Wet	11/10/15 11:35	224	<1.5	<0.023	0.770	0.411	0.359
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	5/24/16 11:55	80	<1.2	0.056	0.602	0.564	0.038
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	6/7/16 11:25	132	2	0.088	0.762	0.668	0.094
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	6/21/16 11:30	1,460	<1.2	0.134	0.833	0.782	0.051
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	7/19/16 13:10	744	5	0.108	0.757	0.647	0.110
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	8/30/16 11:35	500	3	<0.045	1.112	0.913	0.199
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	9/13/16 12:25	144	<1.2	0.045	0.872	0.712	0.160
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	9/27/16 11:20	2,452	5	<0.045	1.045	0.922	0.123
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	10/11/16 11:10	44	<1.2	0.099	0.671	0.660	0.011
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	10/25/16 12:45	148	<1.2	0.194	0.857	0.775	0.082
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	11/8/16 12:00	68	2	0.171	0.614	0.609	<0.01
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	4/25/17 12:00	44	2	0.169	0.726	0.699	0.027
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	5/23/17 12:25	100	2	<0.061	1.016	0.784	0.232
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	6/6/17 11:45	132	2	0.095	1.264	0.990	0.274
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	6/20/17 11:55	312	3	0.123	0.876	0.642	0.234

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	7/25/17 11:05	140	<1.4	0.093	0.708	0.570	0.138
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	8/15/17 10:55	60	<1.4	0.082	0.567	0.547	0.020
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	9/5/17 11:20	188	<1.4	0.100	0.492	0.409	0.083
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	10/17/17 11:30	92	3	0.098	0.402	0.397	<0.01
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	11/14/17 12:10	92	3	0.111	0.950	0.732	0.218
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	4/17/18 11:25	568	77	0.233	0.926	0.843	0.083
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	5/8/18 11:30	68	<1.4	0.051	0.514	0.456	0.058
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	7/10/18 10:45	292	7	0.119	1.033	0.871	0.162
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	7/24/18 10:50	248	7	0.080	0.679	0.508	0.171
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	9/11/18 11:25	208	10	0.097	0.824	0.535	0.289
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	10/16/18 11:20	180	<1.4	0.056	0.295	0.254	0.041
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	11/13/18 11:00	80	<1.4	0.088	1.267	0.783	0.484
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	3/19/19 10:35	28	4	0.044	0.504	0.425	0.079
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	4/23/19 11:10	140	4	0.082	0.807	0.674	0.133
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	5/7/19 11:05	220	5	0.085	0.569	0.385	0.184
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	5/21/19 11:30	228	9	0.074	0.699	0.546	0.153
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	6/11/19 12:20	384	6	0.144	1.196	0.953	0.243
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	7/9/19 11:25	180	2	0.036	0.555	0.425	0.130
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	7/23/19 11:30	3,080	6	0.089	0.780	0.463	0.317
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	8/13/19 11:15	1,740	2	<0.028	0.647	0.587	0.060
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	9/10/19 10:20	180	<1.4	0.057	0.497	0.418	0.079
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	9/24/19 11:25	552	<1.4	0.097	0.677	0.618	0.059
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	10/22/19 11:45	200	2	0.078	0.498	0.482	0.016
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Dry	11/12/19 11:15	712	8	0.115	1.017	0.657	0.360
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	4/12/16 11:50	384	18	0.128	0.919	0.803	0.116
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	4/26/16 12:00	24	7	0.106	0.701	0.668	0.033

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	5/10/16 11:40	912	34	0.109	0.961	0.698	0.263
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	7/5/16 11:45	4,610	10	0.146	0.799	0.633	0.166
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	8/2/16 12:45	912	4	0.110	0.749	0.637	0.112
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	8/16/16 11:35	3,264	2	0.133	2.070	1.040	1.030
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	4/11/17 12:00	876	16	0.193	0.976	0.876	0.100
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	5/9/17 11:45	2,596	110	0.270	1.745	1.640	0.105
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	7/11/17 11:15	568	<1.4	0.092	0.738	0.612	0.126
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	9/19/17 11:30	212	2	0.126	0.653	0.631	0.022
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	3/27/18 10:40	112	2	<0.061	0.577	0.564	0.013
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	5/22/18 10:40	6,870	28	0.217	1.046	0.885	0.161
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	6/12/18 10:55	11,200	34	0.138	1.323	0.890	0.433
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	8/21/18 11:12	344	3	0.068	0.561	0.421	0.140
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	3	Wet	9/25/18 10:50	2,068	11	0.162	0.982	0.640	0.342

Pleasant Run Creek Water Quality Data

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	7/23/15 13:10	592	3	0.036	0.364	<0.139	0.294
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	8/6/15 11:45	14,140	502	0.648	2.121	1.660	0.461
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	9/3/15 12:45	496	14	0.071	0.579	0.414	0.165
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	9/17/15 13:00	512	9	0.041	0.760	0.528	0.232
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	10/1/15 13:10	1,044	6	0.067	0.599	0.417	0.182
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	10/15/15 13:00	452	2	0.184	3.083	3.010	0.073
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Dry	10/29/15 11:25	1,312	5	0.106	1.358	0.539	0.819
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Wet	7/9/15 12:45	1,312	11	0.064	0.897	0.575	0.322
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Wet	8/20/15 13:40	5,790	7	0.103	1.119	0.487	0.632
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2	Wet	11/12/15 13:25	1,952	6	0.070	0.832	0.463	0.369
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	5/26/16 12:35	496	<1.2	0.107	0.886	0.559	0.327
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	6/9/16 11:20	876	11	0.114	0.716	0.589	0.127
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	7/21/16 11:20	688	2	0.113	0.584	0.453	0.131
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	8/4/16 0:00	1,952	2	0.113	0.600	0.514	0.086
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/1/16 12:55	280	4	<0.045	1.127	0.680	0.447
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/15/16 13:15	560	<1.2	<0.045	1.067	0.857	0.210

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	10/13/16 12:35	344	<1.2	0.062	1.010	0.822	0.188
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	10/27/16 12:40	124	3	0.132	0.729	0.526	0.203
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	11/10/16 10:50	64	4	0.093	0.665	0.564	0.101
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	4/13/17 12:50	60	<1.4	0.175	0.669	0.606	0.063
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	4/27/17 12:25	420	3	0.092	1.003	0.691	0.312
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	6/8/17 11:25	1,044	5	0.087	0.696	0.365	0.331
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	7/13/17 11:10	776	3	0.109	0.855	0.568	0.287
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/7/17 11:20	112	<1.4	0.105	0.741	0.469	0.272
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/21/17 11:15	324	<1.4	0.102	0.959	0.783	0.176
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	10/19/17 11:00	152	3	0.093	0.591	0.451	0.140
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	11/16/17 11:20	944	7	0.130	1.616	1.110	0.506
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	4/19/18 11:20	740	29	0.103	1.065	0.650	0.415
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	6/14/18 11:15	1,844	11	0.073	0.939	0.602	0.337
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	7/12/18 10:35	316	8	0.059	0.825	0.651	0.174
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	7/26/18 11:20	644	4	0.062	0.612	0.455	0.157
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/13/18 10:35	344	36	0.151	1.479	0.703	0.776
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/27/18 10:15	496	6	0.077	0.907	0.426	0.481

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	10/18/18 11:20	84	2	0.062	0.561	0.308	0.253
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	3/21/19 10:10	120	3	0.058	0.658	0.311	0.347
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	4/25/19 11:00	1,164	4	0.060	0.796	0.457	0.339
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	5/9/19 10:30	384	6	0.081	0.874	0.276	0.598
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	6/13/19 10:50	3,260	16	0.098	0.903	0.414	0.489
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	7/11/19 11:00	796	7	0.061	0.801	0.445	0.356
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	7/25/19 10:30	460	3	0.077	0.914	0.258	0.656
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	8/15/19 11:50	992	7	0.118	2.043	0.553	1.490
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/12/19 11:05	372	2	0.107	1.002	0.628	0.374
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	9/26/19 10:50	128	<1.4	0.083	0.619	0.403	0.216
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	10/24/19 11:00	124	<1.4	0.083	0.652	0.547	0.105
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Dry	11/14/19 10:30	116	<1.4	0.089	0.749	0.465	0.284
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	4/14/16 13:20	48	4	0.089	0.537	0.492	0.045
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	4/28/16 11:40	3,464	15	0.166	1.410	1.010	0.400
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	5/12/16 13:00	428	<1.2	0.077	0.913	0.657	0.256
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	6/23/16 13:55	8,660	12	0.193	1.536	1.040	0.496
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	7/7/16 13:20	580	5	0.136	0.635	0.443	0.192

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	8/18/16 12:15	400	<1.2	0.106	1.632	1.010	0.622
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	9/29/16 11:20	944	4	<0.045	0.082	<0.153	<0.01
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	5/11/17 11:30	776	3	0.126	1.276	0.573	0.703
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	5/25/17 11:55	14,140	110	0.217	1.601	1.280	0.321
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	6/22/17 10:40	592	2	0.133	1.092	0.710	0.382
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	7/27/17 0:00	12,030	112	0.316	1.702	1.210	0.492
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	8/17/17 10:55	592	<1.4	0.111	0.875	0.596	0.279
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	3/29/18 10:55	420	13	0.123	1.227	0.753	0.474
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	5/10/18 11:00	420	10	0.084	0.719	0.457	0.262
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	5/24/18 10:50	856	10	0.139	1.078	0.504	0.574
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	8/23/18 10:15	356	2	0.091	0.911	0.437	0.474
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	11/15/18 10:25	3,870	26	0.235	1.434	0.814	0.620
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	3	Wet	5/23/19 11:10	12,030	170	0.368	1.825	1.150	0.675

Sand Run Water Quality Data

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Sand Run	Sand Run	4.0	SDR4.0	2	Dry	7/7/15 11:30	448	11	0.100	0.626	0.258	0.368
Sand Run	Sand Run	4.0	SDR4.0	2	Dry	7/21/15 11:30	1,304	2	0.047	0.573	<0.139	0.503
Sand Run	Sand Run	4.0	SDR4.0	2	Dry	8/4/15 11:35	540	<1.5	0.045	0.864	0.493	0.371
Sand Run	Sand Run	4.0	SDR4.0	2	Dry	8/18/15 11:45	464	<1.5	0.096	1.086	0.456	0.630
Sand Run	Sand Run	4.0	SDR4.0	2	Dry	9/1/15 12:15	180	2	0.065	0.525	0.380	0.145
Sand Run	Sand Run	4.0	SDR4.0	2	Dry	9/15/15 12:05	92	<1.5	0.047	0.583	0.365	0.218
Sand Run	Sand Run	4.0	SDR4.0	2	Wet	9/29/15 11:11	17,330	36	0.415	0.815	0.674	0.141
Sand Run	Sand Run	4.0	SDR4.0	2	Wet	10/13/15 10:55	1,044	<1.5	0.095	0.536	0.326	0.210
Sand Run	Sand Run	4.0	SDR4.0	2	Wet	10/27/15 11:55	1,232	3	0.094	0.737	0.359	0.378
Sand Run	Sand Run	4.0	SDR4.0	2	Wet	11/10/15 11:10	208	<1.5	0.042	0.857	0.410	0.447
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	5/24/16 12:20	264	<1.2	0.101	0.996	0.581	0.415
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	6/7/16 11:00	180	3	0.106	0.837	0.578	0.259
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	6/21/16 11:45	364	9	0.142	0.693	0.688	<0.01
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	7/19/16 0:00	336	<1.2	0.128	0.868	0.655	0.213
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	8/30/16 11:55	116	<1.2	<0.045	0.994	0.747	0.247
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	9/13/16 12:45	72	<1.2	0.058	0.828	0.606	0.222
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	9/27/16 11:40	712	<1.2	0.057	0.980	0.772	0.208
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	10/11/16 11:30	32	<1.2	0.114	0.587	0.556	0.031
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	10/25/16 13:05	96	<1.2	0.168	0.607	0.510	0.097
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	11/8/16 12:30	24	9	0.140	0.659	0.654	<0.01
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	4/25/17 12:20	148	3	0.166	0.744	0.552	0.192
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	5/23/17 12:45	384	3	<0.061	0.994	0.466	0.528
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	6/6/17 12:25	1,952	2	0.086	1.639	0.940	0.699
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	6/20/17 12:12	236	<1.4	0.129	0.821	0.456	0.365
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	7/25/17 11:25	312	<1.4	0.108	1.058	0.580	0.478

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	8/15/17 11:15	96	<1.4	0.107	0.667	0.470	0.197
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	9/5/17 11:35	364	<1.4	0.187	3.399	0.649	2.750
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	10/17/17 11:50	80	4	0.196	2.030	0.460	1.570
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	11/14/17 12:30	92	5	0.125	0.876	0.355	0.521
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	4/17/18 11:45	416	3	0.062	0.712	0.427	0.285
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	5/8/18 11:50	332	3	0.048	0.372	0.323	0.049
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	7/10/18 11:05	100	10	0.099	0.746	0.551	0.195
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	7/24/18 11:10	228	7	0.115	2.942	2.570	0.372
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	9/11/18 11:45	420	8	0.138	1.434	0.532	0.902
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	10/16/18 11:40	192	15	0.123	0.724	0.339	0.385
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	11/13/18 11:20	104	<1.4	0.073	0.992	0.368	0.624
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	3/19/19 10:55	88	2	0.083	0.833	0.458	0.375
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	4/23/19 11:30	124	2	0.073	0.680	0.493	0.187
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	5/7/19 11:25	184	3	0.125	0.903	0.399	0.504
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	5/21/19 11:50	632	13	0.116	1.016	0.521	0.495
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	6/11/19 12:40	944	5	0.131	1.086	0.428	0.658
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	7/9/19 11:45	408	5	0.076	0.637	0.424	0.213
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	7/23/19 11:35	1,304	30	0.097	0.798	0.357	0.441
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	8/13/19 11:30	100	11	0.189	0.901	0.696	0.205
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	9/10/19 10:40	6,870	2	0.130	0.732	0.594	0.138
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	9/24/19 11:45	148	<1.4	0.211	0.528	0.500	0.028
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	10/22/19 12:10	232	7	0.167	0.620	0.612	<0.016
Sand Run	Sand Run	4.0	SDR4.0	3	Dry	11/12/19 11:30	308	8	0.169	1.753	1.380	0.373
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	4/12/16 12:15	524	7	0.128	1.051	0.738	0.313
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	4/26/16 12:15	112	<1.2	0.097	0.943	0.771	0.172
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	5/10/16 12:00	5,480	142	0.299	2.024	1.550	0.474

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	7/5/16 12:10	1,460	4	0.153	0.885	0.608	0.277
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	8/2/16 13:05	292	2	0.117	0.852	0.556	0.296
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	8/16/16 12:00	408	<1.2	0.179	1.456	1.120	0.336
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	4/11/17 12:20	788	7	0.178	1.227	0.845	0.382
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	5/9/17 12:10	7,270	110	0.329	1.523	1.280	0.243
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	7/11/17 11:35	452	34	0.119	0.954	0.544	0.410
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	9/19/17 11:55	24,200	45	0.552	2.872	1.920	0.952
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	3/27/18 11:00	176	7	0.102	0.682	0.532	0.150
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	5/22/18 11:00	2,748	15	0.160	1.270	0.640	0.630
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	6/12/18 11:20	6,130	16	0.130	1.248	0.673	0.575
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	8/21/18 11:30	344	<1.4	0.094	0.815	0.435	0.380
Sand Run	Sand Run	4.0	SDR4.0	3	Wet	9/25/18 11:10	1,196	6	0.122	1.337	0.624	0.713

Woolper Creek Water Quality Data

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Dry	7/7/15 10:25	344	6	0.071	0.452	0.283	0.169
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Dry	7/21/15 10:35	224	12	0.053	0.178	<0.139	0.108
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Dry	8/4/15 10:20	1,952	16	0.057	0.636	0.392	0.244
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Dry	8/18/15 10:15	152	6	0.095	0.836	0.317	0.519
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Dry	9/1/15 10:55	92	4	0.033	0.487	0.407	0.080
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Dry	9/15/15 10:45	184	3	0.041	0.560	0.476	0.084
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Wet	9/29/15 10:20	268	6	0.136	0.691	0.585	0.106
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Wet	10/13/15 10:10	1,952	9	0.140	0.584	0.521	0.063
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Wet	10/27/15 11:10	112	<1.5	0.221	0.340	0.287	0.053
Woolper Creek	Woolper Creek	5.0	WPC5.0	2	Wet	11/10/15 10:15	540	2	0.103	0.576	0.381	0.195
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	5/24/16 10:50	124	<1.2	0.092	0.616	0.598	0.018
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	6/7/16 10:05	76	8	0.481	0.589	0.521	0.068
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	6/21/16 10:35	180	2	0.226	0.694	0.689	<0.01
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	7/19/16 11:20	532	5	0.136	0.703	0.617	0.086
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	8/30/16 10:35	256	3	<0.045	0.741	0.670	0.071
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	9/13/16 11:20	364	3	0.055	0.786	0.723	0.063
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	9/27/16 10:35	2,068	4	0.127	0.721	0.694	0.027
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	10/11/16 10:30	136	<1.2	0.070	0.354	0.349	<0.01
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	10/25/16 11:00	212	<1.2	0.181	0.891	0.859	0.032
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	11/8/16 11:20	48	4	0.103	0.647	0.642	<0.01
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	4/25/17 10:55	100	2	0.163	0.547	0.542	<0.01
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	5/23/17 11:10	364	3	<0.061	0.838	0.680	0.158
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	6/6/17 10:50	364	11	0.121	0.869	0.798	0.071
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	6/20/17 10:45	1,304	14	0.156	1.165	0.788	0.377
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	7/25/17 10:25	80	<1.4	0.106	0.736	0.626	0.110

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	8/15/17 10:20	76	<1.4	0.099	0.581	0.459	0.122
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	9/5/17 10:40	152	<1.4	0.107	0.487	0.437	0.050
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	10/17/17 10:42	44	2	0.125	0.170	0.165	<0.01
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	11/14/17 11:30	236	<1.4	0.142	0.996	0.636	0.360
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	4/17/18 10:10	688	4	0.083	0.692	0.470	0.222
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	5/8/18 10:40	668	<1.4	0.058	0.286	0.278	<0.016
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	7/10/18 10:10	640	6	0.045	0.548	0.491	0.057
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	7/24/18 10:15	200	13	0.105	0.743	0.565	0.178
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	9/11/18 10:35	520	9	0.140	1.219	0.509	0.710
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	10/16/18 10:35	92	2	0.146	0.318	0.310	<0.016
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	11/13/18 10:20	116	<1.4	0.090	0.704	0.281	0.423
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	3/19/19 9:55	56	2	0.074	0.670	0.349	0.321
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	4/23/19 10:30	236	<1.4	0.065	0.437	0.406	0.031
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	5/7/19 10:25	144	2	0.083	0.517	0.295	0.222
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	5/21/19 10:45	520	12	0.101	0.808	0.540	0.268
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	6/11/19 11:31	1,164	11	0.160	1.083	0.615	0.468
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	7/9/19 10:35	372	14	0.075	0.451	0.413	0.038
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	7/23/19 10:30	1,104	19	0.125	0.887	0.489	0.398
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	8/13/19 10:30	56	6	0.098	0.779	0.722	0.057
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	9/10/19 9:55	116	<1.4	0.072	0.516	0.424	0.092
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	9/24/19 10:20	48	4	0.107	0.627	0.562	0.065
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	10/22/19 11:10	52	<1.4	0.099	0.576	0.568	<0.016
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Dry	11/12/19 10:40	48	<1.4	0.096	0.785	0.758	0.027
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	wet	4/12/16 11:00	1,952	28	0.162	1.118	0.760	0.358
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	wet	4/26/16 11:00	80	<1.2	0.112	0.531	0.501	0.030
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	5/10/16 10:45	200	9	0.090	0.568	0.545	0.023

Watershed	Stream	RM	LocID	Period	Precip Condition	Date	E. coli (mpn/100 ml)	TSS (mg/L)	TP (mg/L)	TN (mg/L)	TKN (mg/L)	N/N (mg/L)
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	7/5/16 10:30	2,068	65	0.219	1.188	0.877	0.311
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	8/2/16 11:20	4,610	67	0.216	1.149	0.866	0.283
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	8/16/16 10:50	2,910	41	2.230	12.866	12.500	0.366
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	4/11/17 11:18	88	7	0.178	0.588	0.567	0.021
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	5/9/17 10:55	8,660	352	0.731	2.208	1.900	0.308
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	7/11/17 10:25	72	12	0.112	0.588	0.546	0.042
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	9/19/17 10:55	4,350	11	0.112	0.626	0.600	0.026
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	3/27/18 10:00	48	<1.4	<0.061	0.482	0.454	0.028
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	5/22/18 10:00	15,530	79	0.309	1.856	1.200	0.656
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	6/12/18 10:20	992	17	0.090	0.821	0.587	0.234
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	8/21/18 10:20	304	3	0.109	0.754	0.484	0.270
Woolper Creek	Woolper Creek	5.0	WPC5.0	3	Wet	9/25/18 10:00	5,170	11	0.201	1.797	0.841	0.956

Appendix B1 – Biological Data

Macroinvertebrate assessment results are listed in tables beginning with the Dry Creek watershed, followed by the Elijahs Creek, Pleasant Run Creek, Sand Run and Woolper Creek watersheds. The MBI metrics included in the tables are as follows:

- Percent Chironomidae+Oligochaeta (%Chir+%Olig) – calculates the relative abundance of pollution tolerant organisms; increasing metric values generally indicate declining water quality conditions.

- Percent Primary Clingers (%ClngP) – calculates the relative abundance of organisms that require hard/silt-free substrates; increasing metric values generally indicate improving substrate stability.

- Percent Ephemeroptera (%Ephem) – calculates the abundance of mayfly species (insect order Ephemeroptera), which are pollution sensitive; metric is only utilized for assessing headwater streams.

- Modified Percent EPT Abundance (m%EPT) – calculates the abundance of pollution sensitive organisms (specifically insect orders of Ephemeroptera, Plecoptera and Trichoptera); increasing metric values generally indicate improving water quality and habitat conditions.

- Genus Ephemeroptera, Plecoptera, Trichoptera Richness (G-EPT) – calculates the total number of distinct genera of pollution sensitive organisms in a composite sample; increasing metric values generally indicate improving water quality and habitat conditions.

- Genus Taxa Richness (G-TR) – calculates the total number of genera in a composite sample; increasing metric values generally indicate improving water quality and habitat conditions.

- Modified Hilsenhoff Biotic Index (mHBI) – calculates the overall pollution tolerance of the benthic macroinvertebrate community (including arthropods) (Lenat 1993); increasing metric values generally indicate decreasing water quality conditions.

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Dry Creek Macroinvertebrate Index Scores

Watershed	Stream	RM	LocID	Year	Site Type	%Chir+ %Olig	%ClngP	%Ephem	G-EPT	G-TR	m%EPT	mHBI	MBI_ Genus	MBI_Genus Rating
Dry Creek	Dry Creek	4.4	DRC4.4	2014	H	74.58	4.75	14.24	2	22	14.24	6.73	22.17	Poor
Dry Creek	Dry Creek	4.4	DRC4.4	2018	H	63.48	17.73	9.57	4	30	10.28	6.09	28.60	Poor
Dry Creek	Dry Creek	1.4	DRC1.4	2014	W	7.21	49.55	N/A	8	29	52.55	5.29	61.88	Good
Dry Creek	Dry Creek	1.4	DRC1.4	2018	W	13.53	45.87	N/A	5	33	72.61	5.56	63.16	Good
Dry Creek	West Fork Dry Creek	1.5	WFD1.5	2014	H	53.63	8.83	36.91	3	25	39.43	6.16	37.21	Poor
Dry Creek	West Fork Dry Creek	1.5	WFD1.5	2018	H	9.12	25.41	58.31	5	33	65.47	5.83	59.08	Excellent

Elijahs Creek Macroinvertebrate Index Scores

Watershed	Stream	RM	LocID	Year	Site Type	%Chir+ %Olig	%ClngP	%Ephem	G-EPT	G-TR	m%EPT	mHBI	MBI_ Genus	MBI_Genus Rating
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2014	H	67.92	26.28	11.60	5	26	16.38	6.23	30.25	Poor
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2018	H	29.71	23.64	10.54	4	35	15.34	6.67	35.78	Poor
Elijahs Creek	Elijahs Creek	0.3	EJC0.3	2014	W	1.34	39.60	N/A	10	29	24.83	5.75	54.34	Fair
Elijahs Creek	Elijahs Creek	0.3	EJC0.3	2018	W	38.80	21.07	N/A	4	26	21.74	6.48	35.24	Poor

Pleasant Run Creek Macroinvertebrate Index Scores

Watershed	Stream	RM	LocID	Year	Site Type	%Chir+ %Olig	%ClngP	%Ephem	G-EPT	G-TR	m%EPT	mHBI	MBI_ Genus	MBI_Genus Rating
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2014	W									Not Data
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2018	W									No Data
Pleasant Run Creek	Pleasant Run Creek	2	PRC2.0	2014	H	37.92	11.41	39.60	4	20	40.94	6.55	39.31	Fair
Pleasant Run Creek	Pleasant Run Creek	2	PRC2.0	2018	H	57.91	17.51	11.11	3	25	11.45	6.43	27.59	Poor

Sand Run Creek Macroinvertebrate Index Scores

Watershed	Stream	RM	LocID	Year	Site Type	%Chir+ %Olig	%ClngP	%Ephem	G-EPT	G-TR	m%EPT	mHBI	MBI_ Genus	MBI_Genus Rating
Sand Run	Sand Run	0.6	SDR0.6	2014	H									No Data
Sand Run	Sand Run	0.6	SDR0.6	2018	H									No Data
Sand Run	Sand Run	4	SDR4.0	2014	H	30.36	33.00	25.08	5	30	31.02	5.75	44.09	Fair
Sand Run	Sand Run	4	SDR4.0	2018	H	67.12	20.89	12.33	6	33	13.01	6.28	31.01	Poor

Woolper Creek Macroinvertebrate Index Scores

Watershed	Stream	RM	LocID	Year	Site Type	%Chir+%Olig	%ClngP	G-EPT	G-TR	m%EPT	mHBI	MBI_Genus	MBI_Genus Rating
Woolper Creek	Woolper Creek	8.8	WPC8.8	2014	W	4.18	47.74	12	36	39.37	6.17	60.85	Good
Woolper Creek	Woolper Creek	8.8	WPC8.8	2018	W	5.83	59.22	10	43	53.72	5.72	68.10	Good
Woolper Creek	Woolper Creek	5	WPC5.0	2014	W	18.79	66.31	15	52	8.87	5.77	62.22	Good
Woolper Creek	Woolper Creek	5	WPC5.0	2018	W	36.33	49.48	9	35	41.18	5.43	56.07	Fair
Woolper Creek	Allen Fork	0.1	ALF0.1	2014	W	32.70	56.29	7	29	30.82	5.92	52.03	Fair
Woolper Creek	Allen Fork	0.1	ALF0.1	2018	W	37.93	39.81	7	33	42.01	5.72	51.47	Fair

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Appendix B2 – Biological Data

Habitat assessment results are listed in tables beginning with the Dry Creek watershed, followed by the Elijahs Creek, Pleasant Run Creek, Sand Run and Woolper Creek watersheds. The RBP metrics included in the tables are as follows:

- Bank Stability (BankSta) – estimates actual or potential streambank erosion; eroded banks indicate sediment movement and deposition issues.
- Bank Vegetative Protection (BankVegP) – estimates the vegetative protection adjacent to the stream; differing vegetative types provide various abilities to resist erosion.
- Channel Flow Status (ChaFlowS) – estimates the degree to which the stream channel is filled with water; relates to the amount of substrate that is suitable for aquatic organisms.
- Channel Alteration (ChanAlter) – characterizes large scale or direct changes to the shape of the stream channel; relates to the amount of natural habitat with meandering streams having greater potential and straightened or deepened channels have less potential and subject to scouring.
- Embeddedness – estimates the extent of stream bottom substrate covered by silt, sand, or mud due to sedimentation; greater embeddedness decreases habitat diversity.
- Epifaunal Substrate/Available Cover (EpiFauSub) – estimates the relative quantity and variety of natural structures (e.g., boulders, logs, aquatic vegetation, etc.) in the stream that provide habitat; greater habitat opportunities provide greater potential for aquatic organism colonization.
- Frequency of Riffles (FreqOfRiffles) – determines the sequence of riffles occurring in the stream system; higher frequencies typically provide better habitat opportunities.
- Riparian Vegetative Zone Width (RipVegZW) – estimates the width of the vegetation from the edge of the streambank to the edge of the riparian zone; larger undisturbed riparian zones support more robust stream systems.
- Sediment Deposition (SedDep) – estimates the amount of stream bed sediment accumulation in pools; deposition signifies an unstable regime that is not suitable from many organisms.
- Velocity/Depth Regime (Vel/Dep Regime) – determines the occurrence pattern of stream velocity and stream depth regimes (i.e., slow-deep, slow-shallow, fast-deep and fast-shallow); the number of patterns present relates to the stability of the aquatic environment.

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Dry Creek Habitat Scores

Watershed	Stream	RM	LocID	Year	Site Type	BankSta-LB	BankSta-RB	BankVegP-LB	BankVegP-RB	ChaFlowS	ChanAlter	Embeddedness	EpiFauSub	FreqOfRiffles	RipVegZW-LB	RipVegZW-RB	SedDep	Vel/Dep Regime	RBP_HA	RBP_HA Rating
Dry Creek	Dry Creek	4.4	DRC4.4	2014	H	2	6	5	4	13	10	12	11	6	7	3	12	12	103	Poor
Dry Creek	Dry Creek	4.4	DRC4.4	2018	H	6	5	6	4	11	10	7	10	14	5	3	12	14	107	Poor
Dry Creek	Dry Creek	1.4	DRC1.4	2014	W	1	0	3	3	7	12	12	4	10	1	7	10	13	83	Poor
Dry Creek	Dry Creek	1.4	DRC1.4	2018	W	3	5	5	6	7	7	11	11	16	3	6	8	14	102	Poor
Dry Creek	West Fork Dry Creek	1.5	WFD1.5	2014	H	2	4	3	3	12	11	8	7	7	5	5	9	12	88	Poor
Dry Creek	West Fork Dry Creek	1.5	WFD1.5	2018	H	6	6	7	6	16	9	12	11	8	7	6	10	12	116	Poor

Elijahs Creek Habitat Scores

Watershed	Stream	RM	LocID	Year	Site Type	BankSta-LB	BankSta-RB	BankVegP-LB	BankVegP-RB	ChaFlowS	ChanAlter	Embeddedness	EpiFauSub	FreqOfRiffles	RipVegZW-LB	RipVegZW-RB	SedDep	Vel/Dep Regime	RBP_HA	RBP_HA Rating
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2014	H	4	5	4	3	13	7	9	8	4	6	4	14	8	89	Poor
Elijahs Creek	Elijahs Creek	2.8	EJC2.8	2018	H	4	8	2	4	17	7	5	11	11	2	2	5	7	85	Poor
Elijahs Creek	Elijahs Creek	0.3	EJC0.3	2014	W	1	2	5	5	7	7	11	11	17	4	7	10	11	98	Poor
Elijahs Creek	Elijahs Creek	0.3	EJC0.3	2018	W	3	2	6	6	7	13	13	11	16	8	9	6	13	113	Poor

Pleasant Run Creek Habitat Scores

Watershed	Stream	RM	LocID	Year	Site Type	BankSta-LB	BankSta-RB	BankVegP-LB	BankVegP-RB	ChaFlowS	ChanAlter	Embeddedness	EpiFauSub	FreqOfRiffles	RipVegZW-LB	RipVegZW-RB	SedDep	Vel/Dep Regime	RBP_HA	RBP_HA Rating
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2014	W															No Data
Pleasant Run Creek	Pleasant Run Creek	0.4	PRC0.4	2018	W															No Data
Pleasant Run Creek	Pleasant Run Creek	2	PRC2.0	2014	H	1	0	3	3	8	9	13	8	17	1	5	7	13	88	Poor
Pleasant Run Creek	Pleasant Run Creek	2	PRC2.0	2018	H	4	5	4	4	10	12	13	9	14	5	1	11	13	105	Poor

Sand Run Habitat Scores

Watershed	Stream	RM	LocID	Year	Site Type	BankSta-LB	BankSta-RB	BankVegP-LB	BankVegP-RB	ChaFlowS	ChanAlter	Embeddedness	EpiFauSub	FreqOfRiffles	RipVegZW-LB	RipVegZW-RB	SedDep	Vel/Dep Regime	RBP_HA	RBP_HA Rating
Sand Run	Sand Run	0.6	SDR0.6	2014	H															No Data
Sand Run	Sand Run	0.6	SDR0.6	2018	H															No Data
Sand Run	Sand Run	4	SDR4.0	2014	H	6	4	5	5	11	10	11	12	6	7	7	9	9	102	Poor
Sand Run	Sand Run	4	SDR4.0	2018	H	5	3	7	8	11	13	3	7	7	8	8	7	11	98	Poor

Woolper Creek Habitat Scores

Watershed	Stream	RM	LocID	Year	Site Type	BankSta-LB	BankSta-RB	BankVegP-LB	BankVegP-RB	ChaFlowS	ChanAlter	Embeddedness	EpiFauSub	FreqORiffles	RipVegZW-LB	RipVegZW-RB	SedDep	Vel/Dep Regime	RBP_HA	RBP_HA Rating
Woolper Creek	Woolper Creek	8.8	WPC8.8	2014	W	6	6	5	7	10	11	13	12	14	2	8	10	11	115	Fair
Woolper Creek	Woolper Creek	8.8	WPC8.8	2018	W	7	8	7	8	9	14	11	14	17	7	9	11	8	130	Good
Woolper Creek	Woolper Creek	5	WPC5.0	2014	W	9	3	7	7	12	13	12	14	16	2	3	14	15	127	Fair
Woolper Creek	Woolper Creek	5	WPC5.0	2018	W	4	7	5	6	9	13	13	15	17	4	8	12	12	125	Fair
Woolper Creek	Allen Fork	0.1	ALF0.1	2014	W	1	7	5	6	10	12	11	7	7	9	1	8	12	96	Poor
Woolper Creek	Allen Fork	0.1	ALF0.1	2018	W	1	7	6	5	7	14	13	10	14	9	6	10	14	116	Fair

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Appendix C – Stream Stability Data

Rapid stability assessment results are listed in tables beginning with the Dry Creek watershed, followed by the Elijahs Creek, Pleasant Run Creek, Sand Run and Woolper Creek watersheds. The stability metrics included in the tables are as follows:

- Bank (LEFT_BANK and RIGHT_BANK) – Bank height and bank angle are utilized to calculate the risk of bank failure score for each stream bank (i.e., left bank and right bank) based on logistic regression thresholds developed from NKY stream systems. Each stream bank is assessed separately with scores ranging from 0 (stable) to 10 (unstable).

- Shape (SHAPE) – Floodplain connectivity and stream bed irregularity are utilized to determine the channel shape score. Each parameter is assessed separately (a score of 5 is stable and a score of 0 is unstable) and then added together for a total score.

- Bedrock (BEDROCK) – Percent of bedrock is utilized to determine the bedrock score as follows: <2% receives a score of 10 (good), 2-10% receives a score of 4 (fair), and >10% receives a score of 0 (poor).

- Pool Depth (POOL) – Depth of the deepest pool in the assessment reach is used to determine the pool depth score as follows: <2.5' receives a score of 10 (good) and >2.5' receives a score of 0 (poor).

- Embeddedness (EMBEDD) – Percent of embeddedness in the assessment reach is utilized to determine the embeddedness score as follows: 0-25% receives a score between 20 and 16 (Optimal), 25-50% receives a score between 15 and 11 (Suboptimal), 50-75% receives a score between 10 and 6 (Marginal), and >75% receives a score between 5 and 0 (Poor).

- Frequency of Riffles (RIFFLE FREQ) – Number of riffles occurring in the assessment reach is used to determine the riffle frequency score as follows: "relatively frequent" receives a score between 20 and 16 (Optimal), "infrequent" receives a score between 15 and 11 (Suboptimal), "occasional" receives a score between 10 and 6 (Marginal), and "generally all flat water" receives a score between 5 and 0 (Poor).

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Dry Creek Stream Stability Index Scores

DATE	SITE	LEFT_BANK	RIGHT_BANK	SHAPE	BEDROCK	EMBEDD	POOL	RIFFLE FREQ	SITE SCORE
6/7/2012	DRC4.4	5	10	10	4	9	10	16	***6.10***
6/7/2012	WFD1.5	0	10	0	4	9	10	16	***2.35***
6/2/2014	DRC1.4	0	3	5	10	12	10	10	***2.95***
11/8/2018	DRC1.4	7	6	0	4	11	0	16	***0.80***

Elijahs Creek Stream Stability Index Scores

DATE	SITE	LEFT_BANK	RIGHT_BANK	SHAPE	BEDROCK	EMBEDD	POOL	RIFFLE FREQ	SITE SCORE
9/5/2012	EJC0.3	10	9	5	10	11	0	19	***4.85***
6/8/2012	EJC2.8	10	9	0	4	9	10	12	***2.70***

Pleasant Run Creek Stream Stability Index Scores

DATE	SITE	LEFT_BANK	RIGHT_BANK	SHAPE	BEDROCK	EMBEDD	POOL	RIFFLE FREQ	SITE SCORE
9/5/2012	PRC2.0	1	1	0	4	11	0	17	***-0.60***

Sand Run Stream Stability Index Scores

DATE	SITE	LEFT_BANK	RIGHT_BANK	SHAPE	BEDROCK	EMBEDD	POOL	RIFFLE FREQ	SITE SCORE
9/5/2012	SDR0.6	10	10	0	10	13	0	8	***1.25***
6/8/2012	SDR4.0	9	9	0	0	11	10	14	***2.95***

Woolper Creek Stream Stability Index Scores

DATE	SITE	LEFT_BANK	RIGHT_BANK	SHAPE	BEDROCK	EMBEDD	POOL	RIFFLE FREQ	SITE SCORE
9/5/2012	WPC8.8	10	9	0	4	15	0	14	***2.20***
9/5/2012	ALF0.1	0	10	10	0	14	0	14	***3.00***
7/24/2013	WPC5.0	0	1	5	4	12	10	16	***3.25***
10/22/2018	WPC5.0	0	3	10	4	14	0	15	***2.80***

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Appendix D – Stream Condition Index Scores

Stream Condition Index Basin Trend Scores by Site – Period 2 (2012 - 2015)

Watershed	Site	Water Quality Score	Biology Score	Habitat Score	Stream Stability Score	Score
Dry Creek	1.4	6.18	7.97	3.64	2.95	5.18
	4.4	NA	3.00	3.65	6.10	4.25
	WFD1.5	NA	4.79	3.12	2.35	3.42
Elijahs Creek	0.3	NA	6.79	4.30	4.85	5.31
	2.8	5.90	3.96	3.16	2.70	3.93
Pleasant Run Creek	0.4	5.18	NA	NA	NA	NA
	2.0	NA	5.06	3.12	0.00	2.73
Sand Run	0.6	NA	NA	NA	1.25	NA
	4.0	6.60	6.06	3.62	2.95	4.81
Woolper Creek	5.0	7.25	8.06	9.06	3.25	6.90
	8.8	NA	7.71	5.31	2.20	5.08
	ALF0.1	NA	6.50	4.21	3.00	4.57

Note: An overall monitoring site score is only calculated if 3 out of the 4 categories are populated.

Stream Condition Index Basin Trend Scores by Site – Period 3 (2016 - 2019)

Watershed	Site	Water Quality Score	Biology Score	Habitat Score	Stream Stability Score	Score
Dry Creek	1.4	7.93	8.29	4.47	0.80	5.37
	4.4	NA	3.76	3.79	NA	NA
	WFD1.5	NA	10.00	4.11	NA	NA
Elijahs Creek	0.3	NA	4.41	4.96	NA	NA
	2.8	7.28	4.62	3.01	NA	4.97
Pleasant Run Creek	0.4	7.02	NA	NA	NA	NA
	2.0	NA	3.64	3.72	NA	NA
Sand Run	0.6	NA	NA	NA	NA	NA
	4.0	7.24	4.05	3.48	NA	4.92
Woolper Creek	5.0	7.22	7.01	8.44	2.80	6.37
	8.8	NA	9.53	10.00	NA	NA
	ALF0.1	NA	6.43	5.63	NA	NA

Note: An overall monitoring site score is only calculated if 3 out of the 4 categories are populated.

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