

**Fecal Coliform Bacteria Monitoring for the
Sleepy Creek Watershed
319 Project Water Monitoring
15 Months at 7 sites**

Draft Report

Prepared for: West Virginia Conservation Agency

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Participating Agencies and Organizations

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Project Summary

Cacapon Institute (CI) under contract with the WV Conservation Agency and subject to review by the 319 project team, monitored Sleepy Creek and certain tributaries for fecal coliform bacteria as outlined below.

Background

Sleepy Creek (WVP-9, TMDL SWS 9001 – 9063) watershed is located in Morgan County, West Virginia (87%) and Fredrick County, Virginia (13%) that flows 42 miles north into the Potomac River. Within the watershed two streams have a TMDL, Total Maximum Daily Load. These streams are Sleepy Creek and Indian Run (WVP-9-G). Both Sleepy Creek and Indian Run are impaired “relative to numeric water quality criteria for fecal coliform bacteria.” TMDL, 2007.

According to the TMDL, non-point source accounted for the majority of the fecal coliform bacteria. The WVDEP source tracker identified areas of high population density without access to public sewers in the watershed. The TMDL estimates 6,400 homes were not connected to a publicly owned treatment facility. Of all the homes in the entire watershed 14.18% are estimated to have failing individual sewer systems.

West Virginia Department of Environmental Protection set pre-TMDL sample sites in areas of Sleepy Creek where previous sampling efforts (targeted sampling based on their 5-year rotating plan) show even a single 'hit' for fecal. A single sample (out of 11 pre-TMDL samples) had a result of 560 cfu/100ml. The pre-TMDL data was deemed sufficient to list the stream for the first time on the 2006 303(d) list. Data collected for the purpose of supporting TMDL development was put into the WVDEP 'decision database' that is used to track assessment decisions. This decision database produced the following description: *List for fecal from mouth to RM 18.0 and again from RM 26.7 to headwaters 2003/2004 TMDL data had 1/11 violations near mouth, 2/11 at RM 8.0, 0/12 at RM 18, 1/12 at RM 26.7, and 2/11 at RM 36.8.* (John Wirts, WVDEP, personal communication).

Cacapon Institute conducted 'implementation plan monitoring' for fecal coliform bacteria between March 2012 and September 2011. The purpose of this monitoring was to gather the additional data that is necessary to identify “hot spots” and possible sources of fecal pollution entering the main stem of Sleepy Creek. Sampling was done at nine sites monthly selected by the Sleepy Creek 319 Team. The study found that, as with the pre-TMDL monitoring, exceedences of the 400 cfu/100ml fecal coliform standard were infrequent and occurred during rainy periods. Indian Run was monitored because it had the greatest number of exceedences during the pre-TMDL monitoring period (3 out of 13 samples in excess of 400 cfu/100ml); Indian Run had zero exceedences during the implementation plan monitoring' study, which implies that the cause of fecal coliform bacteria impairment during the pre-TMDL period has been addressed. As a result, Indian Run is in the first stages of being delisted by WVDEP for fecal coliform impairment.

Four sites had more than one 400 cfu/100ml exceedence: Sleepy Creek (SC) at Shades Road, SC at Middle Fork, SC at Ruffed Grouse Road, and SC at Morgan Road. The Sleepy Creek 319 Team

selected these sites for additional monitoring; with additional sites to aid in the goal of identifying tributaries that contribute to the fecal coliform problem in the Sleepy Creek mainstem.

- SC at Morgan Road, just upstream of West Virginia in Virginia, identifies the out-of-state fecal bacteria contribution.
- SC at Ruffed Grouse Road is located a short distance downstream of an area identified in the TMDL as having a high probability of septic failures.
- SC at Morgan Road will continue to be monitored as well as two of its feeder streams: the Middle Fork and South Forks of Sleepy Creek.
- SC at Shades Road will continue to be monitored as well as one of its feeder streams: Yellow Springs Run.

Monitoring Plan

CI sampled the seven (7) locations described above in an effort to locate sources of fecal coliform contamination. The original intent was for sampling to be done at these sites monthly for 15 months; however, field conditions (summer/autumn drought in 2014 and frozen streams in winter 2015) resulted in fewer samples being taken during those periods and twice monthly samples were taken to complete the work in the required time frame. As budgeted, a total of 17 sampling trips were accomplished. On two dates (8/19/2014 and 9/25/2014) only four sites were sampled because the other three sites were dry.

Field and Laboratory Methods

Cacapon Institute is a West Virginia Certified Laboratory, and performed field collections and laboratory analyses as laid out in the organization's approved SOPs.

Water samples were collected midstream 10-15 cm below the surface. When water levels precluded wading into the river, samples were collected from shore or bridges using an extension sampler. Sampling containers, storage conditions and holding times followed APHA (APHA, 1992). One daily duplicate sample was collected.

Fecal Coliform Bacteria were determined using the Membrane Filtration Method by filtering three known volumes of sample (3 ml, 10 ml, 30 ml) through three separate 0.45 micrometer filters, transferring the filters to petri dishes containing a selective growth medium (PourRite m-FC/Rosalic Acid Broth Ampules -Hach Cat# 24285-20), incubating the petri dish at a selective temperature of $44.5^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$ in a Millepore Dual Chamber Incubator (Cat# XX63 LK1 15), and counting the number of resulting colonies at 24 hours (± 2 hours). Results were expressed as number of colony forming units per 100 ml.

Statistical methods

The methods used to analyze data were statistical. Data distributions were displayed in tables of summary statistics. Non-parametric one-way analysis of variance (ANOVA) was run on rank transformed data for comparison of median concentration distributions and of the deviation from daily medians to compare sites and dates. An alpha value of 0.05 was used to determine the significance of test results. If a significant difference among group medians was detected, Tukey's multiple comparison test was used on the rank transformed data to determine where differences were located (Helsel and Hirsh, 1992). Statistics were calculated using JMP Statistical Discovery Software (version 4).

Results

The West Virginia standard for fecal coliform bacteria specifies that the maximum allowable level of fecal coliform for primary contact recreation shall not exceed 200 cfu/100 mL as a monthly geometric mean (based on not less than 5 samples per month). The fecal coliform count also shall not exceed 400 cfu/100 mL in more than 10 percent of all samples taken during any one month. The data collected during this study does not allow a direct comparison to the state standard of 200 cfu/100 mL as a monthly geometric mean because samples were only collected at each site once per month. When fewer than five samples are collected per month, the applicable standard becomes 400 cfu/100 mL. For that reason, the results of this study will be discussed in the context of the 400 cfu/100ml part of the fecal coliform bacteria standard. 200 cfu/100 ml is discussed as a "warning" level.

Table 1 (next page) provides descriptive statistics for each of the sampling sites; the last two columns provide the total number of samples that exceeded 400 and 200 cfu/100 ml, respectively. The table includes original summary data for the sites that were repeated for this study, as well as the new feeder stream data. Mean values varied much more widely than median values and tended to be higher, sometimes much higher. This is characteristic of non point source data that is skewed by a few high values recorded during precipitation events. The median is the preferred "measure of central tendency" for this parameter, while the mean and maximum values are more reflective of the tendency of each site towards high concentrations during runoff events. Sleepy Creek at Ruffed Grouse Road had the highest median and mean values in both the 2010-2011 study and the 2014-2015 study. However, no statistically significant differences were detected between sites.

During the later fifteen month study period, only the Yellow Springs and Sleepy Creek at Shades Rd. sites never exceeded the 400 cfu/100ml, Yellow Springs never exceeded 200 cfu/100ml. All of the other five sites had at least one exceedence of 400 cfu/100 ml. The Sleepy Creek at Ruffed Grouse had five bacteria counts greater than 400 cfu/100 ml, Sleepy Creek at Morgan Road had two, and Sleepy Creek below Middle Fork, Middle Fork, and South Fork each had one.

| Table 1. Fecal coliform bacteria at five sampling sites in the Sleepy Creek watershed from the 2010-2011 study repeated in 2014-2015. Results reported in colony forming units per 100 ml. | | | | | | | | | | | |
|--|-------------------|---------|---------------|--------|-------|---------------|---------|------------|------------|---|---|
| Sampling Site | Number of Samples | Minimum | 25th Quartile | Median | Mean | 75th Quartile | Maximum | No. >= 400 | No. >= 200 | | |
| SC at Shades Road 2010-2011 | 17 | 13 | 38.5 | 77.0 | 192.6 | 130.0 | 1067 | 3 | 3 | | |
| SC at Shades Road 2014-2015 | 17 | 1 | 16.5 | 50.0 | 79.4 | 95.0 | 350 | 0 | 2 | | |
| SC At Middle Fork 2010-2011 | 18 | 3 | 41.5 | 70.0 | 199.5 | 285.0 | 1000 | 3 | 6 | | |
| SC below Middle Fork 2014-2015 | 17 | 1 | 13.0 | 100.0 | 135.4 | 185.0 | 630 | 1 | 4 | | |
| SC at Ruffed Grouse Rd. 2010-2011 | 18 | 3 | 35.8 | 103.0 | 231.5 | 285.0 | 1033 | 3 | 5 | | |
| SC at Ruffed Grouse Rd. 2014-2015 | 17 | 1 | 20.0 | 130.0 | 224.5 | 455.0 | 666 | 5 | 7 | | |
| SC at Morgan Road 2010-2011 | 18 | 3 | 12.3 | 73.0 | 166.7 | 184.3 | 1333 | 2 | 4 | | |
| SC at Morgan Road 2014-2015 | 17 | 3 | 15.0 | 53.0 | 165.4 | 255.0 | 733 | 2 | 5 | | |
| Feeder streams added for the 2014-2015 sampling | | | | | | | | | | | |
| Middle Fork 2014-2015 | | | 15 | 1 | 7 | 80 | 129.5 | 140 | 733 | 1 | 2 |
| South Fork 2014-2015 | | | 15 | 1 | 3 | 46 | 125.5 | 110 | 1100 | 1 | 2 |
| Yellow Springs 2014-2015 | | | 15 | 1 | 3 | 10 | 42.8 | 63 | 193 | 0 | 0 |

Table 2 (below) provides descriptive statistics for all sites on each of the sampling dates; the last two columns provide the total number of samples that exceeded 400 and 200 cfu/100 ml, respectively.

The mean and media values generally varied much more narrowly on each sampling date than in Table 1, which provided statistics by site. This would seem to indicate that bacteria levels at all or most sites were responding to similar “drivers” on any given day. 9/25/2014 had the highest median and mean values (395 and 406 cfu/100 ml, respectively) of all the sampling days; but this period was abnormal because the feeder streams were not sampled because they were dry (as they also were on 8/19/2014). Weather Underground precipitation records indicate no significant precipitation during the week leading up to the 9/25/2014 sample collection.

<http://www.wunderground.com/personal-weather-station/dashboard?ID=KWVBERKE2#history/s20140918/e20140925/mweek>)

There were no 400 cfu/100 ml exceedances on eleven of the fifteen sampling days. Three dates stand out as having more than one sample exceeding the 400 cfu/100 ml standard: 9/25/2014, 6/18/2015, and 7/30/2015, with two, two and three exceedances, respectively. Field notes for those dates indicate it was dry, wet, and variable conditions on these dates, respectively.

Precipitation was often associated with dates on which any samples exceeded 400 cfu/ 100 ml, but not always. The lack of a particular pattern does not help in determining possible sources of the higher counts. Bacteria counts were extremely low throughout the winter sampling period, which

was also true for the previous study.

| Sampling Site | Number of Samples | Minimum | 25th Quartile | Median | Mean | 75th Quartile | Maximum | No. >= 400 | No. >= 200 |
|---------------|-------------------|---------|---------------|--------|---------|---------------|---------|------------|------------|
| 6/30/2014 | 7 | 47 | 50 | 80 | 99.571 | 157 | 210 | 0 | 1 |
| 8/19/2014 | 4 | 73 | 77.25 | 125 | 124.75 | 172 | 176 | 0 | 0 |
| 9/25/2014 | 4 | 100 | 162.5 | 395 | 405.75 | 659.75 | 733 | 2 | 3 |
| 10/27/2014 | 7 | 7 | 10.0 | 23.0 | 62.7 | 43.0 | 300 | 0 | 1 |
| 12/4/2014 | 7 | 3 | 10 | 20 | 19.857 | 33 | 36 | 0 | 0 |
| 12/19/2014 | 7 | 3 | 3 | 7 | 13.714 | 13 | 50 | 0 | 0 |
| 1/19/2015 | 7 | 1 | 3 | 3 | 6.571 | 10 | 23 | 0 | 0 |
| 3/16/2015 | 7 | 1 | 1 | 3 | 2.429 | 3 | 3 | 0 | 0 |
| 3/26/2015 | 7 | 1 | 1 | 1 | 4.429 | 7 | 13 | 0 | 0 |
| 4/21/2015 | 7 | 46 | 110 | 136 | 143.429 | 166 | 260 | 0 | 1 |
| 4/30/2015 | 7 | 13 | 20 | 37 | 37 | 56 | 63 | 0 | 0 |
| 5/18/2015 | 7 | 43 | 50 | 77 | 280.429 | 370 | 1100 | 1 | 3 |
| 5/29/2015 | 7 | 10 | 17 | 110 | 143.857 | 147 | 550 | 1 | 1 |
| 6/4/2015 | 7 | 60 | 80 | 113 | 141.857 | 250 | 270 | 0 | 2 |
| 6/18/2015 | 7 | 73 | 130 | 193 | 306.429 | 666 | 700 | 2 | 3 |
| 7/13/2015 | 7 | 73 | 110 | 137 | 209 | 350 | 470 | 1 | 3 |
| 7/30/2015 | 7 | 10 | 73 | 260 | 332.286 | 630 | 733 | 3 | 4 |

Discussion and Conclusions

Exceedences of the 400 cfu/100ml fecal coliform standard during the pre-TMDL monitoring period in Sleepy Creek were infrequent and occurred during rainy periods. The same pattern was also the case during the 2010-2011 study. It is less certain that rain was a driver of high fecal bacteria counts during the 2014-2015 study.

South Fork, Middle Fork, and Yellow Springs were monitored to determine if those tributaries were notable contributors of fecal bacteria to the Sleepy Creek mainstem sites that that frequent violations during the 2010-2011 study. South Fork and Middle Fork both had occasional exceedences of the standard (see Table 1 above) but not frequently. Yellow Spring had no exceedences.

Acknowledgments

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Citations

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