Fecal Coliform Bacteria Monitoring for the Sleepy Creek Watershed Incremental 319 Project Final Report

Prepared for: West Virginia Conservation Agency

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Participating Agencies and Organizations

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Introduction and Background

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

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) showed even a single 'hit' for fecal coliform bacteria. The result was that a single sample (out of 11 pre-TMDL samples) had 560 cfu/100ml. The pre-TMDL data was deemed sufficient to list the stream for the first time on West Virginia's 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).

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

The Sleepy Creek 319 Watershed Based Plan Development Team asked Cacapon Institute (CI) to conduct 'plan implementation monitoring' for fecal coliform bacteria. The purpose of monitoring was to gather additional data leading to a better understanding of the problem and more informed decisions on areas that require particular attention for remediation. The monitoring and sampling project will also be used to improve the accuracy of the watershed based plan.

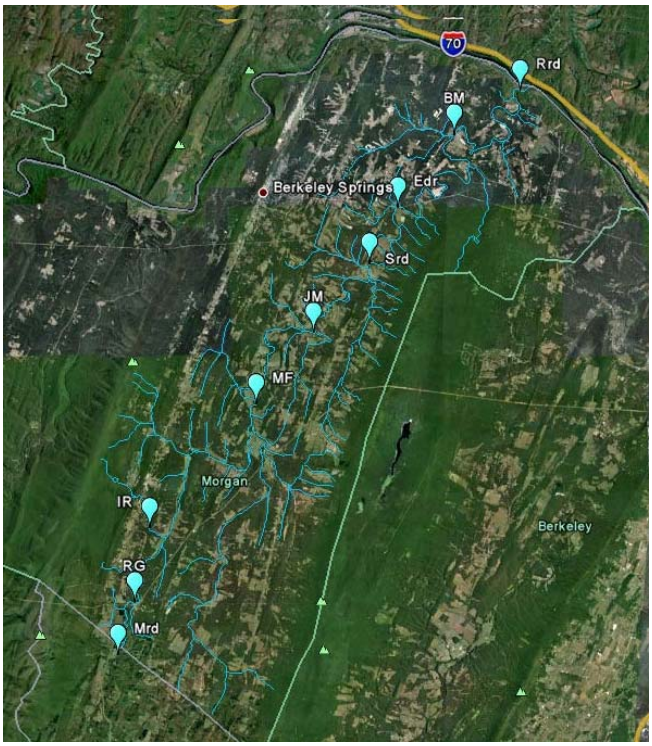
Sampling Design

As laid out in the approved Sleepy Creek Watershed Based Plan/319 funding proposal, CI, in consultation with the Sleepy Creek 319 Project Team, collected fecal coliform bacterial water quality data for Sleepy Creek in order to lead to a better understanding of the problem and allow the Sleepy Creek 319 Project Team to make more informed decisions.

Exceedences of the fecal coliform standard (400 cfu/100ml) during the pre-TMDL monitoring period in Sleepy Creek were infrequent. Weather data indicated that the exceedences occurred during rainy periods, making it likely that the specific locations of those exceedences provided little useful information as to likely sources of contamination.

Eight sampling locations were selected based on results of previous sampling and local knowledge of conditions on the ground. For example, 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).

Sampling Sites	Abbreviation
Sleepy Creek at River Road	Rrd
Sleepy Creek at Burnt Mill Road	Bm
Sleepy Creek at Eckert Drive	Edr
Sleepy Creek at Shades Road	Srd
Sleepy Creek at Johnsons Mill	JM
Sleepy Creek At Middle Fork	MF
Indian Run at Oakland Rd.	IR
Sleepy Creek at Ruffed Grouse Rd.	RG
Sleepy Creek at Morgan Road	Mrd



Sampling was done at these eight sites monthly for seven months (March to September 2010). Based on results from the initial seven months, the Sleepy Creek 319 Project Team decided to continue sampling the original eight sites, and add one additional site for the remaining twelve months (September 2010 to September 2011) effort: SC at Johnsons Mill. All sampling sites had either public access and/or landowner permission for access. There was no sampling in January 2011 due to a hard freeze. Also, Sleepy Creek at Shades Road was frozen in December 2010 and not sampled.

Samples were collected under a synoptic sampling schedule in which samples were collected at all sites within a three hour interval on the same day. No targeted storm sampling was conducted.

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 ^{o}C + 0.2 ^{o}C in a Millepore Dual Chamber Incubator (Cat# XX63 LK1 15), and counting the number of resulting colonies at 24 hours ($\pm$ 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 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. 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 (103 cfu/100 ml) and mean (231.5 cfu/100 ml) values. However, no statistically significant differences were detected between sites.

During the full eighteen month study period, only the Indian Run site never exceeded even 200 cfu/100ml; Johnsons Mill had no exceedences of the standard during its abbreviated sampling period. All of the other original seven sites had at least one exceedence of 400 cfu/100 ml. The Sleepy Creek at Middle Fork, Ruffed Grouse, and Shades Road sites each had three bacteria counts greater than 400 cfu/100 ml, and Sleepy Creek at Morgan Road had two.

Table 1. Fecal coliform bacteria at nine sampling sites in the Sleepy Creek watershed. 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 River Road	18	3	9.3	50	71.1	93.5	420	1	1
SC at Burnt Mill Road	18	3	10.0	50	149.2	124.0	1700	1	1
SC at Eckert Drive	18	3	18.3	57	174.8	107.8	1733	1	3
SC at Shades Road	17	13	38.5	77	192.6	130.0	1067	3	3
SC at Johnsons Mill	5	40	41.5	93	93.2	145.0	180	0	0
SC At Middle Fork	18	3	41.5	70	199.5	285.0	1000	3	6
Indian Run at Oakland Rd.	18	3	29.8	65	72.0	121.5	147	0	0
SC at Ruffed Grouse Rd.	18	3	35.8	103	231.5	285.0	1033	3	5
SC at Morgan Road	18	3	12.3	73	166.7	184.3	1333	2	4

Table 2 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. 9/28/2010 and 5/17/2010 had the highest median values (500 and 483.5 cfu/100 ml, respectively) and mean values (736.5 and 549.1 cfu/100 ml, respectively) of all the sampling days. Field notes for those dates indicate significant ongoing or recent precipitation and wet ground. Media fecal coliform bacteria levels on 9/28/2010 were significantly higher ($P < 0.0001$) than any date other than 5/17/2010. Media fecal coliform bacteria levels on 5/17/2010 were significantly higher ($P < 0.0001$) than any dates other than 9/28/2010, 8/16/2010, 7/15/2011, and 4/19/2011.

There were no 400 cfu/100 ml exceedences on twelve of the eighteen sampling days. Two dates stand out as having numerous samples exceeding the 400 cfu/100 ml standard: 5/17/2010 and 9/28/2010, with four and six exceedences, respectively. Field notes for those dates indicate significant ongoing or recent precipitation and wet ground.

Precipitation was associated with all of the dates on which any samples exceeded 400 cfu/ 100 ml

with the exception of 7/15/2011 – which was dry (however, one of the IFLOWS rain gages in Morgan County recorded 0.55" of rain at the "Cacapon" gage 36 hours previous to the 7/15/2011 sampling. IFLOWS, 2011).

Field notes for 4/19/2011 indicate "rain whole time, heavy from Middle Fork on"; the National Weather Service reported that April 2011 was the wettest April on record for the region. While there was only one exceedence of 400 cfu/100ml on 8/16/2010, described as "wet" on the field notes, four stations on that day exceeded the warning level of 200 cfu/100 ml. We do not have reliable precipitation data in the watershed and are unable to quantify the precipitation.

Table 2. Fecal coliform bacteria on 18 sampling dates in the Sleepy Creek watershed. Results reported in colony forming units per 100 ml.

Sampling Date	Number	Minimum	25%	Median	Mean	75%	Maximum	No. >= 400	No. >= 200
3/24/2010	8	3	4.0	8.5	10.4	17.5	23	0	0
4/16/2010	8	6	10.5	30.0	29.5	49.5	50	0	0
5/17/2010	8	87	130.0	483.5	549.1	952.5	1333	4	5
6/18/2010	8	47	58.3	78.0	121.8	126.0	420	1	1
7/16/2010	8	27	37.6	100.0	111.4	146.5	300	0	1
8/16/2010	8	10	94.5	183.5	295.3	367.5	1067	1	4
9/28/2010	8	119	310.0	500.0	736.5	1440.0	1733	6	7
10/20/2010	8	10	13.0	19.5	34.0	58.5	97	0	0
11/16/2010	8	13	34.0	45.0	58.3	77.5	143	0	0
12/20/2010	7	3	3.0	7.0	7.1	10.0	13	0	0
2/17/2011	8	3	3.0	5.0	6.1	9.3	13	0	0
3/16/2011	8	3	7.8	30.0	40.5	65.3	117	0	0
4/19/2011	9	47	50.0	77.0	181.6	173.5	900	1	2
5/20/2011	8	67	72.0	111.5	107.6	139.3	140	0	0
6/17/2011	9	63	81.5	137.0	151.1	212.5	270	0	2
7/15/2011	9	23	48.0	63.0	182.2	152.5	1000	1	1
8/18/2011	9	20	43.5	50.0	69.2	95.0	143	0	0
9/20/2011	9	33	52.0	73.0	88.6	130.0	180	0	0

Discussion and Conclusions

As noted in the introduction, 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. This was also the case during this study. However, it is notable that in 2011, March, April, May, and September were unusually rainy months and only one of those months (April) had any 400 cfu/100 ml exceedences.

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). This site had zero exceedences during this study, which implies that the cause of fecal coliform bacteria impairment during the pre-TMDL period has been addressed.

Acknowledgments

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Citations

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