Water Quality Assessment for the Development of Total Maximum Daily Loads for E. *coli* Bacteria in Cedar Creek, Dekalb and Allen Counties

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ATTACHMENTS

A) Sampling and Analysis Work Plan for Cedar Creek
B) Data Table from 1994-1995 305(b) Report
C) Quality Assurance/Quality Control Reports for E. *coli* Data
   i) QA/QC Review Report: IDEM/100/29/477/045/2000
   ii) QA/QC Review Report: IDEM/100/29/477/40/2000
   iii) QA/QC Review Report: IDEM/100/29/477/38/2000
   iv) QA/QC Review Report: IDEM/100/29/477/052/2000
   v) QA/QC Review Report: IDEM/100/29/477/053/2000

INTRODUCTION

Cedar Creek drains approximately 273 square miles of Dekalb and Allen counties in northeast Indiana. The headwaters for Cedar Creek begin in northwest Dekalb County, and the stream meanders over 31 miles south into Allen County before discharging into the St. Joseph River approximately one mile southwest of the Cedarville Reservoir. Major tributaries of Cedar Creek include Little Cedar Creek and Diehl Ditch.

Section 303 (d) of the Clean Water Act requires States to develop lists of impaired waters needing Total Maximum Daily Loads (TMDLs), and to establish priorities for their development. Streams are to be listed according to the severity of the pollution and the impact on designated uses. Data obtained for the 1994-1995 305(b) indicated unacceptable levels of *Escherichia coli* (*E. coli*) bacteria within Cedar Creek. As a result, Cedar Creek was placed on Indiana's 1996 and 1998 303 (d) lists.

According to 327 IAC 2-1.5-8 (e)(2), *E.coli* bacteria, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period. In addition, at least one wet weather and one dry weather event was included.

METHODS

Sampling Sites and Locations

As designated in the Cedar Creek Sampling and Analysis Work Plan (see attached), an initial water-quality assessment consisting of 10 sites, 5 along Cedar Creek, and 5 on its' tributaries, was conducted between August 23 and September 20, 2000 (Figure 1). One *E. coli* survey (5 samples spaced over a 30 day period) was used to determine if the water quality criteria for *E. coli* were still being violated.

Sample Collection

At each site, *E. coli* samples were collected in sterile 100ml plastic, narrow mouth bottles preserved with Sodium Thiosulfate ($Na_2S_2O_3$). *E. coli* pathogen analyses were performed by Environmental Health Laboratories (EHL) in South Bend, Indiana to meet the six (6) hour holding time requirement (Table 1). During transportation, all samples were stored on ice. Duplicates and blanks were also collected for Quality Assurance/Quality Control.

Field Measurements

Simultaneous with the *E. coli* sampling, standard field parameter measurements were taken with a YSI^{TM} multi-parameter water-chemistry analysis unit (Table 2). These parameters included pH, temperature, specific conductance, turbidity, chloride, chlorophyll, and dissolved oxygen and percent saturation. General field observations were also recorded on the IDEM "Stream Sampling Field Sheet".

Changes in Protocol

No significant deviations from the original sampling plan occurred. However, one *E. coli* sample had to be rejected due to a cracked sample bottle (site LEJ090-0017), and another because of problems with the analysis (site LEJ090-0021). Therefore, the geometric mean for these two sites was based on four samples instead of five, and can not be used to evaluate these stream segments.

RESULTS

E. coli

Of the 10 sites sampled, all ten sites violated the one time sample count for *E. coli* of 235 per 100 milliliters. Of these ten sites, eight violated the geometric mean of 125 per 100 milliliters consisting of five samples equally spaced over a thirty-day period (Table 1)*. As mentioned above, the geometric means for sites LEJ090-0017 and LEJ090-0021 were based on four samples instead of five because of problems with the samples, and can not be used to evaluate the associated stream segments. *E. coli* violations occurred both in dry and wet weather during this study indicating that both point and non-point sources of pollution may be contributing to the problem.

*When available, the geometric mean is the value used to make final judgements on stream quality and adherence to water quality standards. Any stream failing to meet this standard will require TMDL development.

Field Measurements

The majority of the field measurements taken during this survey were found to be within acceptable ranges. However, following a rain event, all sites sampled on 9/12/2000 showed elevations in turbidity (Table 2).

CONCLUSIONS

The following sites on Cedar Creek and several of its' tributaries are in violation of the *E. coli* standard as stated in 327 IAC 2-1.5-8, and will require TMDL development:

Map Number	Site Name	Description	Stream Name	Geometric Mean	One-day Exceedence
1	LEJ080-0005	Dekalb County Road 20	Cedar Creek	277	23000
2	LEJ080-0006	County Rd. 35 N.	Cedar Creek	290	2000
3	LEJ080-0007	County Rd. 32	Cedar Creek	768	25000

Table 2: Standard Field Data from the Cedar Creek TMDL Assessment

Map Number	Project ID	Site Name	Sample Number	Sample Date	Stream Name	Dissolved Oxygen	pH	Water Temp.	Specific Conductivity	Turbidity	Chloride	Chlorophyll	% Saturation Dissolved Oxygen
1	2000 Cedar Creek	LEJ080-0005	AA01637	8/23/00	Cedar Creek	11.11	7.99	24.36	663	12.2	72.18	16.7	133.10
	2000 Cedar Creek	LEJ080-0005	AA01829	8/31/00	Cedar Creek	18.63	7.99	24.78	1040	15.8	64.11	29.7	225.50
	2000 Cedar Creek	LEJ080-0005	AA01891	9/7/00	Cedar Creek	10.67	7.91	20.49	523	23.6	30.90	28.6	118.60
	2000 Cedar Creek	LEJ080-0005	AA01950	9/12/00	Cedar Creek	9.45	7.46	20.82	361	112.3	23.70	27.9	105.70
	2000 Cedar Creek	LEJ100-0005	AA02101	9/20/00	Cedar Creek	13.01	7.59	18.95	537	9.1	57.48	24.7	140.50
2	2000 Cedar Creek	LEJ080-0006	AA01639	8/23/00	Cedar Creek	7.69	7.87	22.48	704	7.0	104.90	3.4	89.00
	2000 Cedar Creek	LEJ080-0006	AA01828	8/31/00	Cedar Creek	11.46	7.81	23.18	1059	6.4	69.29	23.5	134.60
	2000 Cedar Creek	LEJ080-0006	AA01881	9/7/00	Cedar Creek	8.19	7.89	18.69	555	28.4	47.52	40.2	88.00
	2000 Cedar Creek	LEJ080-0006	AA01949	9/12/00	Cedar Creek	8.17	7.41	19.85	336	160.5	24.96	21.0	89.70
	2000 Cedar Creek	LEJ080-0006	AA02100	9/20/00	Cedar Creek	13.56	7.80	18.71	546	8.1	45.87	27.1	145.50
3	2000 Cedar Creek	LEJ080-0007	AA01640	8/23/00	Cedar Creek	8.58	7.89	22.14	763	13.5	130.90	3.0	98.70
	2000 Cedar Creek	LEJ080-0007	AA01826	8/31/00	Cedar Creek	10.96	7.80	21.70	1158	6.6	76.82	6.7	125.00
	2000 Cedar Creek	LEJ080-0007	AA01888	9/7/00	Cedar Creek	8.95	7.95	16.90	622	12.0	51.47	14.7	92.70
	2000 Cedar Creek	LEJ080-0007	AA01947	9/12/00	Cedar Creek	7.98	7.33	19.67	318	136.8	29.78	20.3	87.30
	2000 Cedar Creek	LEJ080-0007	AA02098	9/20/00	Cedar Creek	13.22	7.79	18.24	614	7.5	47.68	17.7	140.60
4	2000 Cedar Creek	LEJ080-0008	AA01641	8/23/00	Swartz Ditch	10.32	7.97	20.91	887	11.2	142.50	2.1	116.00
	2000 Cedar Creek	LEJ080-0008	AA01827	8/31/00	Swartz Ditch	12.32	7.77	20.45	1224	10.3	83.55	1.4	137.40
	2000 Cedar Creek	LEJ080-0008	AA01889	9/7/00	Swartz Ditch	10.28	8.01	15.70	687	13.6	48.27	8.8	103.70
	2000 Cedar Creek	LEJ080-0008	AA01948	9/12/00	Swartz Ditch	5.96	7.17	19.47	330	109.3	28.79	17.2	65.20
	2000 Cedar Creek	LEJ080-0008	AA02099	9/20/00	Swartz Ditch	13.54	7.69	18.06	662	29.7	48.56	16.2	143.50
5	2000 Cedar Creek	LEJ090-0017	AA01642	8/23/00	Little Cedar Creek	8.01	7.89	19.00	401	13.3	198.40	-5.4	87.20
	2000 Cedar Creek	LEJ090-0017	AA01820	8/31/00	Little Cedar Creek	10.07	7.88	21.09	1082	37.0	62.10	2.6	113.50
	2000 Cedar Creek	LEJ090-0017	AA01883	9/7/00	Little Cedar Creek	8.98	8.03	16.00	611	16.7	35.04	6.7	91.30
	2000 Cedar Creek	LEJ090-0017	AA01942	9/12/00	Little Cedar Creek	10.21	7.62	19.74	300	444.9	68.45	23.7	111.80
	2000 Cedar Creek	LEJ090-0017	AA02093	9/20/00	Little Cedar Creek	12.93	8.02	17.75	370	12.5	92.96	22.2	136.20
6	2000 Cedar Creek	LEJ090-0021	AA01643	8/23/00	Cedar Creek	8.19	7.90	19.42	770	19.4	155.90	-5.0	89.40
	2000 Cedar Creek	LEJ090-0021	AA01821	8/31/00	Cedar Creek	10.51	7.91	21.31	1093	24.4	60.76	3.0	119.00
	2000 Cedar Creek	LEJ090-0021	AA01884	9/7/00	Cedar Creek	9.34	8.04	16.03	616	14.9	30.09	9.1	94.90
	2000 Cedar Creek	LEJ090-0021	AA01943	9/12/00	Cedar Creek	9.41	7.52	19.51	297	386.2	56.57	22.7	102.60
	2000 Cedar Creek	LEJ090-0021	AA02094	9/20/00	Cedar Creek	13.27	8.04	17.71	705	11.9	109.50	25.5	139.60
7	2000 Cedar Creek	LEJ080-0009	AA01645	8/23/00	Cedar Creek	8.68	7.88	21.53	1008	4.0	234.50	-4.9	98.80
	2000 Cedar Creek	LEJ080-0009	AA01825	8/31/00	Cedar Creek	10.78	7.78	21.65	1143	14.8	81.68	9.7	123.00
	2000 Cedar Creek	LEJ080-0009	AA01887	9/7/00	Cedar Creek	8.69	7.98	17.18	771	5.5	78.09	8.8	90.50
	2000 Cedar Creek	LEJ080-0009	AA01946	9/12/00	Cedar Creek	8.30	7.42	19.64	274	233.3	31.28	16.9	90.70
	2000 Cedar Creek	LEJ080-0009	AA02097	9/20/00	Cedar Creek	13.18	7.76	18.07	651	28.3	66.77	17.5	139.70
8	2000 Cedar Creek	LEJ090-0018	AA01646	8/23/00	Diehl Ditch	7.66	7.97	22.43	419	3.9	115.70	-8.0	88.60
	2000 Cedar Creek	LEJ090-0018	AA01824	8/31/00	Diehl Ditch	11.38	7.77	21.68	977	18.3	76.73	18.0	129.80
	2000 Cedar Creek	LEJ090-0018	AA01886	9/7/00	Diehl Ditch	9.09	8.08	16.96	666	6.6	45.23	13.1	94.40
	2000 Cedar Creek	LEJ090-0018	AA01945	9/12/00	Diehl Ditch	8.47	7.39	19.50	237	204.3	34.08	16.3	92.30
	2000 Cedar Creek	LEJ090-0018	AA02096	9/20/00	Diehl Ditch	12.83	7.71	17.81	581	13.0	51.71	17.1	135.50
9	2000 Cedar Creek	LEJ090-0015	AA01647	8/23/00	Garrett City Ditch	9.08	8.01	23.59	1670	5.5	477.60	-4.4	107.60
	2000 Cedar Creek	LEJ090-0015	AA01823	8/31/00	Garrett City Ditch	11.52	7.81	23.00	2006	7.7	113.90	-1.5	135.20
	2000 Cedar Creek	LEJ090-0015	AA01885	9/7/00	Garrett City Ditch	9.86	7.99	17.94	1844	11.6	442.30	7.0	104.70
	2000 Cedar Creek	LEJ090-0015	AA01944	9/12/00	Garrett City Ditch	9.40	7.30	19.97	388	169.3	40.05	18.8	103.50
	2000 Cedar Creek	LEJ090-0015	AA02095	9/20/00	Garrett City Ditch	14.61	7.78	19.63	736	17.7	76.04	3.7	159.90
10	2000 Cedar Creek	LEJ090-0020	AA01648	8/23/00	Willow Creek	7.98	7.90	19.86	938	10.0	705.00	6.1	88.20
	2000 Cedar Creek	LEJ090-0020	AA01818	8/31/00	Willow Creek	10.59	7.88	21.68	1133	28.5	73.83	10.1	120.70
	2000 Cedar Creek	LEJ090-0020	AA01882	9/7/00	Willow Creek	8.56	8.00	16.38	399	13.7	92.13	7.7	88.20
	2000 Cedar Creek	LEJ090-0020	AA01940	9/12/00	Willow Creek	8.62	7.73	19.85	231	364.5	182.80	15.8	94.50
	2000 Cedar Creek	LEJ090-0020	AA02090	9/20/00	Willow Creek	12.62	7.88	18.18	338	22.9	65.27	15.4	134.00

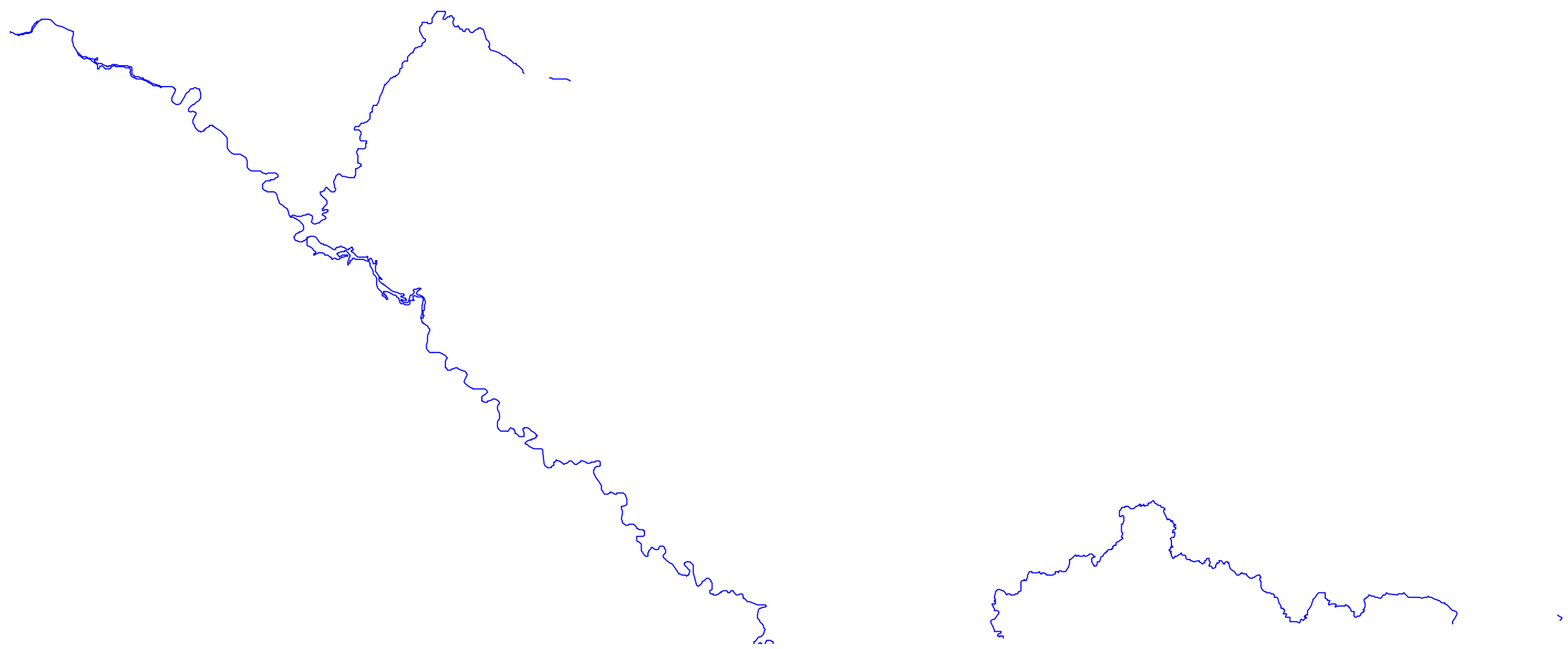

Table 1: E. coli values for Cedar Creek

Note: All non-detects for e-coli were assigned the detection limit of 10 counts for calculation of the geometric mean.

Map Number	ProjectID	Site Name	Sample Number	Sample Type	Duplicate ID Number	SampleDate	Parameter	Lab Test Result	Test Units	QA Flags	Stream Name	Geometric Mean
6	2000 Cedar Creek E. Coli	LEJ090-0021	AA01643	Normal	AA01644	8/23/00	E. Coli	100	CFU/100mL		Cedar Creek	256*
	2000 Cedar Creek E. Coli	LEJ090-0021	AA01644	Duplicate	AA01643	8/23/00	E. Coli	280	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ090-0021	AA01821	Normal	AA01822	8/31/00	E. Coli	400	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ090-0021	AA01822	Duplicate	AA01821	8/31/00	E. Coli	410	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ090-0021	AA01884	Normal		9/7/00	E. Coli	150	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ090-0021	AA01943	Normal		9/12/00	E. Coli	2000	CFU/100mL	R	Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ090-0021	AA02094	Normal		9/20/00	E. Coli	250	CFU/100mL		Cedar Creek	
7	2000 Cedar Creek E. Coli	LEJ080-0009	AA01645	Normal		8/23/00	E. Coli	100	CFU/100mL		Cedar Creek	270
	2000 Cedar Creek E. Coli	LEJ080-0009	AA01825	Normal		8/31/00	E. Coli	320	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ080-0009	AA01887	Normal		9/7/00	E. Coli	90	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ080-0009	AA01946	Normal		9/12/00	E. Coli	1500	CFU/100mL		Cedar Creek	
	2000 Cedar Creek E. Coli	LEJ080-0009	AA02097	Normal		9/20/00	E. Coli	330	CFU/100mL		Cedar Creek	
8	2000 Cedar Creek E. Coli	LEJ090-0018	AA01646	Normal		8/23/00	E. Coli	300	CFU/100mL		Diehl Ditch	609
	2000 Cedar Creek E. Coli	LEJ090-0018	AA01824	Normal		8/31/00	E. Coli	360	CFU/100mL		Diehl Ditch	
	2000 Cedar Creek E. Coli	LEJ090-0018	AA01886	Normal		9/7/00	E. Coli	320	CFU/100mL		Diehl Ditch	
	2000 Cedar Creek E. Coli	LEJ090-0018	AA01945	Normal		9/12/00	E. Coli	11000	CFU/100mL		Diehl Ditch	
	2000 Cedar Creek E. Coli	LEJ090-0018	AA02096	Normal		9/20/00	E. Coli	220	CFU/100mL		Diehl Ditch	
9	2000 Cedar Creek E. Coli	LEJ090-0015	AA01647	Normal		8/23/00	E. Coli	340	CFU/100mL		Garrett City Ditch	864
	2000 Cedar Creek E. Coli	LEJ090-0015	AA01823	Normal		8/31/00	E. Coli	1400	CFU/100mL		Garrett City Ditch	
	2000 Cedar Creek E. Coli	LEJ090-0015	AA01885	Normal		9/7/00	E. Coli	300	CFU/100mL		Garrett City Ditch	
	2000 Cedar Creek E. Coli	LEJ090-0015	AA01944	Normal		9/12/00	E. Coli	8200	CFU/100mL		Garrett City Ditch	
	2000 Cedar Creek E. Coli	LEJ090-0015	AA02095	Normal		9/20/00	E. Coli	410	CFU/100mL		Garrett City Ditch	
10	2000 Cedar Creek E. Coli	LEJ090-0020	AA01648	Normal		8/23/00	E. Coli	290	CFU/100mL		Willow Creek	799
	2000 Cedar Creek E. Coli	LEJ090-0020	AA01818	Normal		8/31/00	E. Coli	910	CFU/100mL		Willow Creek	
	2000 Cedar Creek E. Coli	LEJ090-0020	AA01882	Normal		9/7/00	E. Coli	260	CFU/100mL		Willow Creek	
	2000 Cedar Creek E. Coli	LEJ090-0020	AA01940	Normal		9/12/00	E. Coli	17000	CFU/100mL		Willow Creek	
	2000 Cedar Creek E. Coli	LEJ090-0020	AA02090	Normal		9/20/00	E. Coli	280	CFU/100mL		Willow Creek	
B	2000 Cedar Creek E. Coli	BLANK	AA01638	Field Blank		8/23/00	E. Coli	<10	CFU/100mL			10
	2000 Cedar Creek E. Coli	BLANK	AA01819	Field Blank		8/31/00	E. Coli	<10	CFU/100mL			
	2000 Cedar Creek E. Coli	BLANK	AA01880	Field Blank	24871	9/7/00	E. Coli	<10	CFU/100mL			
	2000 Cedar Creek E. Coli	BLANK	AA01941	Field Blank		9/12/00	E. Coli	<10	CFU/100mL			
	2000 Cedar Creek E. Coli	BLANK	AA02091	Field Blank		9/20/00	E. Coli	<10	CFU/100mL			

* This geometric mean was calculated based on four samples instead of five. Therefore this value cannot be used to evaluate the stream.