

# Chehalis Best Management Practices Evaluation Project-- 1996-97 Beaver/Allen Creek Water Quality Data Report

## Abstract

This interim report describes the water quality monitoring results during the third year of a six year project to evaluate the effectiveness of best management practices (BMPs). Post BMP monitoring was conducted on Beaver Creek and Allen Creek (a tributary to Beaver Creek). Beaver Creek drains to the Black River near Littlerock in Thurston County. During the 1996-97 wet season monitoring, fecal coliform levels exceeded water quality standards at four out of five stations and nitrogen loading was elevated at creek miles 2.5 and 0.9 as compared to upstream sites. Improvements were seen in fecal coliform levels downstream of the BMP site, which may be due to BMP implementation. No statistically significant differences in water quality were noted between creek miles 0.9 and 0.1. Recommendations include post-BMP monitoring for Beaver Creek and possible investigation of sources between creek mile 2.5 and 0.9.

## Introduction

This report presents the results for 1996-97 wet season water quality monitoring of Beaver and Allen Creeks. Monitoring was conducted as part of the Chehalis Best Management Practices Evaluation Project funded by the U. S. Fish & Wildlife Service's (USFWS) Chehalis Fisheries Restoration Program (CFRP). The purpose of the monitoring is to gather post-BMP data for a dairy operation adjacent to Beaver Creek between creek mile (CM) 4.2 and CM 2.7 and for riparian restoration on Allen Creek, and baseline data for the rest of the study area. Results are shown in Tables 1 and 2. Sampling sites are shown in Figure 1.

## Methods

All sampling was conducted as described by the Quality Assurance Project Plan (QAPP) and addenda (Sargeant; 1994, 1995, 1996a). An additional Beaver Creek monitoring station was added at CM 0.9 during the 1996-97 sample year. Monitoring results from 1994-96 showed high levels of bacteria and nitrogen at BeCM 0.1. Between BeCM 2.5 and the station at BeCM 0.1 are agricultural sources (closer to BeCM 2.5) and residential sources (just upstream of BeCM 0.1). In order to distinguish between the agricultural and residential sources a monitoring site just upstream of Littlerock and the residential sources was added. Ten winter sampling events were conducted in all.

Field measurements for temperature, pH, and conductivity were made during all surveys using the methods described in the QAPP. Flows were obtained using a velocity meter and top-set wading rod. During the winter season, flow discharge measurements for BeCM 2.5 can not be safely obtained. Flows for BeCM 2.5 were estimated by totaling flows from BeCM 4.2 and BeCM 2.6T. Allen Creek (BeCM 2.6T) is the only significant tributary between BeCM 4.2 and BeCM 2.5. If the discharge at BeCM 2.5

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(BeCM 2.6T) is the only significant tributary between BeCM 4.2 and BeCM 2.5. If the discharge at BeCM 2.5 was underestimated, then the loads calculated for BeCM 2.7e would be underestimates. Flows at BeCM 0.9 were estimated using discharge measurements from BeCM 0.1. No tributaries are present between BeCM 0.9 and 0.1. Additional flow along either stretch could come from ground water inputs and overland flow during heavy rain events. Therefore, the loads calculated for BeCM 0.9 may be overestimated.

Laboratory samples were collected at all sites for fecal coliform, nitrite/nitrate nitrogen, ammonia nitrogen, total persulfate nitrogen, and turbidity. Samples were collected from flowing water by subsurface grab. Immediately following collection, samples were placed in the dark, on ice, and shipped to Ecology's Manchester Environmental laboratory within 24 hours after collection. Samples were analyzed in accordance with the QAPP.

### ***Data Analysis***

In order to compare data between stations and years a statistical test for the significance of variations was done using SYSTAT (1991) statistical software. Comparisons were made for each parameter using a non-parametric test, the Kruskal-Wallis one-way analysis of variance. Where a statistically significant difference was noted individual site differences were evaluated using a non-parametric Tukey-type multiple comparison test (Zar, 1984). A statistical significance level of  $0.05 \geq P$  was used for both tests.

To compare watershed moisture conditions the Antecedent Precipitation Index (API) was calculated for each sample event. The API is calculated using precipitation data for the 14 days preceding the first day of sampling using the equation described by Linsley et al. (1975).

## **Results**

### ***Best Management Practices***

Several BMPs have been implemented at the large commercial dairy operation that is located between monitoring sites BeCM 4.2 and BeCM 2.5 on Beaver Creek. Thurston Conservation District developed a conservation plan for the site, and construction of a waste management system including a storage pond was completed in September 1996. The storage pond was in use during the 1996-97 sampling season. The field application system was completed in spring 1997.

In 1993, the CFRP funded litter clean up of Beaver Creek around CM 0.5.

The CFRP has funded BMPs at four sites on Allen Creek between CM 1.0 and 2.5. The BMPs include over a mile of stream fencing to exclude livestock, 130,000 square feet of stream corridor revegetation, placement of eleven large woody debris structures, and construction of limited access livestock watering sites. The BMPs were installed between 1994-97 by Thurston Conservation District, the Chehalis Basin Fisheries Task Force, and a private consultant (Kelly, 1998).

### **Precipitation and Flows**

Precipitation for the sampling period, November 1996 through March 1997, was 48.62 inches measured at the Olympia Airport NOAA Weather Station. This is higher than the normal average of 35.39 inches (Perrich, 1992) expected for November through March. The preceding 24 and 48 hour rainfall for each sampling day as of 4:00 a.m. is shown in Table 3.

**Table 3. Previous Rainfall for 1996-97 Beaver Creek Sample Trips.**

Date	Preceding 24 hour Rainfall in inches	Preceding 48 hour Rainfall in inches	Antecedent Precipitation Index in inches
11/13/96	0.42	0.59	1.02
11/25/96	0.40	1.14	1.94
12/03/96	0.66	0.80	2.37
12/09/96	0.18	0.71	2.91
01/07/97	1.04	1.05	4.49
01/28/97	0.60	0.60	1.67
02/12/97	0.72	0.72	1.27
02/19/97	1.09	1.33	1.36
03/03/97	0.54	1.84	2.50
03/10/97	0.20	0.84	2.58
Average	0.59	0.96	2.21

To compare the 1996-97 sample season with previous years, previous rainfall, the average API and stream discharge from each sample season is presented in Table 4. The table shows mean, median, minimum and maximum discharge for BeCM 0.1, the average 24 and 48 hour rainfall preceding sampling, and the average API for the sampling year.

**Table 4. Discharge statistics for each season at BeCM 0.1 and previous rainfall.**

Sample Season	n=	Mean Discharge cfs	Median Discharge cfs	Minimum Discharge cfs	Maximum Discharge cfs *	Average preceding 24 hr rainfall in inches	Average preceding 48 hr rainfall in inches	Average Antecedent Precipitation Index in inches
1994-95	10	122	102	18	254	0.41	0.67	2.06
1995-96	5	174	160	130	250	0.82	1.23	2.36
1996-97	10	178	163	43	393	0.59	0.86	2.21

\*Maximum discharge for all years is a field estimate\gauge reading extrapolated from a flow curve.

Sampling for the 1994-95 winter season occurred during lower flow events, less preceding rainfall, and a lower API than the 1995-96 and 1996-97 winter season sampling. Average discharge for 1995-96 and 1996-97 sampling is similar but preceding rainfall and average API for 1995-96 sampling was higher.

**Water Quality Characterization**

During all sample events, temperature, turbidity, ammonia, and pH met water quality standards for all sites.

Fecal coliform levels at four out of the five sites did not meet water quality standards. Compliance with fecal coliform criteria is summarized in Table 5.

**Table 5. Fecal Coliform Results for Beaver\Allen Creek.**

Site Location	Geometric mean (GM) below 100cfu/100 mL?	10% or less of all samples for calculating GM exceed 200 colonies/100 mL?
BeCM 4.2	YES (GM=31)	YES, 1 out of 10 samples exceeded 200
BeCM 2.6T	YES (GM=79)	NO, 2 out of 10 samples exceeded 200
BeCM 2.5	NO (GM=520)	NO, 6 out of 10 samples exceeded 200
BeCM 0.9	NO (GM=290)	NO, 4 out of 10 samples exceeded 200
BeCM 0.1	NO (GM=360)	NO, 7 out of 10 samples exceeded 200

Figure 2 presents notched boxplots of fecal coliform concentrations by station for the 1996-97 sampling season. The boxplot shows an increase in fecal coliform levels from upstream, BeCM 4.2 to downstream at BeCM 2.5. Figure 3 illustrates how to interpret a notched boxplot. As with previous years fecal coliform levels increase in a downstream direction with the highest levels found at BeCM 2.5.

Table 6 presents geometric mean (GM) fecal coliform levels for three sampling seasons. The fecal coliform geometric means were greater for all stations in 1995-96 than in 1994-95 and 1996-97. The fecal coliform GM was lowest in 1996-97 for stations BeCM 4.2, 2.5, and 0.1, while station BeCM 2.6T had its lowest GM in 1994-95 (Sargeant; 1996b, 1997).

**Table 6. Geometric Mean Fecal Coliform Levels by Station by Year (#/100mL).**

Year	Valid N	BeCM 4.2	BeCM 2.6T	BeCM 2.5	BeCM 0.9	BeCM 0.1
1994-95	10	32	47	1300	-	840
1995-96	5	110	240	7400	-	6200
1996-97	10	31	79	520	290	360

No statistically significant differences in fecal coliform concentration or load were seen between stations BeCM 0.9 and 0.1.

In the Black River wet season nonpoint source total maximum daily load (TMDL) study (Coots, 1994), a target fecal coliform (FC) load allocation for the mouth of Beaver Creek was set at  $1.31 \times 10^{11}$  FC per day. If loading were reduced to this level during critical conditions, the criteria for fecal coliform (the water quality standard) would be met at the mouth of Beaver Creek (critical conditions are defined as soil saturated conditions on a rising hydrograph with 0.5" of rainfall occurring within the preceding 48 hours). Table 7 presents geometric mean fecal coliform levels during critical conditions for four wet seasons and the average 48 hour rainfall before sampling. Fecal coliform loading has decreased this year from the previous two years. This decrease may be explained by the average 48 hour rainfall before sampling, but it may also be due to the implementation of BMPs. Loading was greater in 1994/1995 when average previous rainfall was less, which may suggest some improvement due to BMP implementation.

**Table 7. Geometric mean Fecal Coliform Critical Loading for the mouth of Beaver Creek**

Year/Study	n	GM Fecal Coliform Critical Load (#/day) at Beaver Creek Mouth	Average Previous 48 hour rainfall in inches
Target FC Load	-	$1.31 \times 10^{11}$	$\geq 0.50$
1992/1993 (Coots, 1994)	6	$1.58 \times 10^{12}$	0.62
1994/1995 (Sargeant, 1996b)	10	$2.60 \times 10^{12}$	0.62
1995/1996 (Sargeant, 1997)	5	$2.66 \times 10^{13}$	1.23
1996/1997	10	$1.73 \times 10^{12}$	0.86

Figure 4 shows an increase in nitrogen loads upstream to downstream between BeCM 4.2 and BeCM 2.7e, downstream of Allen Creek at BeCM 2.5, and between BeCM 2.5 and BeCM 0.9. Total nitrogen loads during the 1995-96 winter season were greater than in 1994-95 and 1996-97. This is probably due to 1995-96 sampling occurring during periods of higher flow. No statistically significant differences in nitrogen levels were seen between stations BeCM 0.9 and 0.1.

## Conclusions

Total nitrogen loading increased from upstream to downstream between BeCM 4.2 and BeCM 2.7e, downstream of Allen Creek at BeCM 2.5, and between BeCM 2.5 at the station immediately downstream during 7 out of 10 sample events. These patterns suggest continuing nitrogen sources in these reaches.

No significant differences in temperature, conductivity, pH, turbidity, nitrogen, or fecal coliform were noted between stations BeCM 0.9 and BeCM 0.1, indicating little wet season impact from residential sources.

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Downstream of the dairy BMP site, fecal coliform concentrations and loading decreased in 1996-97 as compared to 1995-96. This decrease may be explained by the average 48 hour rainfall before sampling, but it may also be due to the implementation of BMPs. Loading was greater in 1994/1995 when average previous rainfall was less, suggesting that BMPs may indeed be producing some improvement.

## **Recommendations**

- Continue post-BMP water quality monitoring in Beaver Creek in winter 1997-98.
- Investigate possible sources between BeCM 2.5 and BeCM 0.9, and correct any problems found.
- Track BMPs to ensure proper operation and maintenance.

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## References

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## **Contacts:**

Debby Sargeant/ Washington State Department of Ecology  
Paul Pickett Environmental Investigations and Laboratory Services Program  
(360) 407-6684/(360) 407-6685

If you have special accommodation needs, please contact Shirley Rollins (360) 407-6696 (voice). Ecology's telecommunication device for the deaf (TDD) number at Ecology Headquarters is (360) 407-6006.



**Table 1**  
**1996-97 Beaver\Allen Creek Wet Season Field Data.**

Site Location	Station Creek Mile	Date	Time	Temp. ° C	pH	Cond. µmho/cm	Discharge cfs
Beaver Ck. (Case Rd.)	BeCM 4.2	11/13/96	13:15	9.6	6.5	87	13
Beaver Ck. (Case Rd.)	BeCM 4.2	11/25/96	12:30	5.7	6.8	54	91
Beaver Ck. (Case Rd.)	BeCM 4.2	12/3/96	9:55	4.4	7.3	57	59
Beaver Ck. (Case Rd.)	BeCM 4.2	12/9/96	8:06	6.4	6.7	57	76
Beaver Ck. (Case Rd.)	BeCM 4.2	1/7/97	9:30	6.0	7.3	51	E 138
Beaver Ck. (Case Rd.)	BeCM 4.2	1/28/97	9:40	3.4	6.6	64	62
Beaver Ck. (Case Rd.)	BeCM 4.2	2/12/97	8:50	5.2	6.7	59	50
Beaver Ck. (Case Rd.)	BeCM 4.2	2/19/97	8:45	7.1	6.7	54	108
Beaver Ck. (Case Rd.)	BeCM 4.2	3/3/97	9:55	5.7	6.7	54	E 79
Beaver Ck. (Case Rd.)	BeCM 4.2	3/10/97	10:45	6.8	6.8	54	E 90
Allen Ck. (mouth)	BeCM 2.6T	11/13/96	14:45	10.2	6.7	87	15
Allen Ck. (mouth)	BeCM 2.6T	11/25/96	13:05	6.7	7.0	80	50
Allen Ck. (mouth)	BeCM 2.6T	12/3/96	9:30	4.5	7.4	77	52
Allen Ck. (mouth)	BeCM 2.6T	12/9/96	8:45	6.4	6.9	70	53
Allen Ck. (mouth)	BeCM 2.6T	1/7/97	9:50	6.0	7.0	57	E 96
Allen Ck. (mouth)	BeCM 2.6T	1/28/97	10:05	4.0	7.1	78	45
Allen Ck. (mouth)	BeCM 2.6T	2/12/97	9:15	5.6	6.7	68	46
Allen Ck. (mouth)	BeCM 2.6T	2/19/97	9:25	7.1	6.8	68	75
Allen Ck. (mouth)	BeCM 2.6T	3/3/97	10:15	6.2	6.8	55	E 48
Allen Ck. (mouth)	BeCM 2.6T	3/10/97	10:50	6.9	6.9	60	E 52
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	11/13/96	13:50	9.8	6.6	110	e 28
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	11/25/96	13:35	6.2	6.9	64	e 141
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	12/3/96	9:15	4.8	7.0	65	e 111
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	12/9/96	9:06	6.4	6.8	66	e 129
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	1/7/97	10:10	6.0	6.9	55	e 234
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	1/28/97	10:25	3.9	7.2	74	e 107
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	2/12/97	9:30	5.5	6.7	72	e 96
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	2/19/97	9:55	7.2	6.9	63	e 183
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	3/3/97	10:25	5.9	6.8	58	e 127
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	3/10/97	11:05	6.9	6.8	61	e 142
E: Field estimate\gauge reading.							
e: Flow estimated as sum of Allen Creek flow and Beaver Ck (Case Rd) flow.							
x: Flow assumed to be same as BeCM 0.1.							

**Table 1**  
**1996-97 Beaver\Allen Creek Wet Season Field Data.**

Site Location	Station Creek Mile	Date	Time	Temp. ° C	pH	Cond. µmho/cm	Discharge cfs
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	11/25/96	13:45	6.1	7.0	63	x 163
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	12/3/96	9:05	4.9	7.2	67	x 156
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	12/9/96	9:17	6.5	6.8	67	x 162
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	1/7/97	10:30	6.1	7.0	53	x 393
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	1/28/97	10:35	3.8	7.2	79	x 131
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	2/12/97	9:40	5.5	6.8	70	x 118
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	2/19/97	10:10	7.3	6.9	61	x 228
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	3/3/97	10:45	6.1	6.7	58	x 177
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	3/10/97	11:10	6.7	6.8	57	x 209
Beaver Ck. (Hwy 121)	BeCM 0.1	11/13/96	14:05	10.0	7.0	109	43
Beaver Ck. (Hwy 121)	BeCM 0.1	11/25/96	14:05	6.2	7.1	80	163
Beaver Ck. (Hwy 121)	BeCM 0.1	12/3/96	8:32	5	7.6	66	156
Beaver Ck. (Hwy 121)	BeCM 0.1	12/9/96	9:32	6.5	6.9	67	162
Beaver Ck. (Hwy 121)	BeCM 0.1	1/7/97	10:50	6.2	7.1	54	E 393
Beaver Ck. (Hwy 121)	BeCM 0.1	1/28/97	10:50	3.9	7.4	79	131
Beaver Ck. (Hwy 121)	BeCM 0.1	2/12/97	9:55	5.6	6.9	68	118
Beaver Ck. (Hwy 121)	BeCM 0.1	2/19/97	10:30	7.2	6.9	60	228
Beaver Ck. (Hwy 121)	BeCM 0.1	3/3/97	10:55	6.3	6.8	60	E 177
Beaver Ck. (Hwy 121)	BeCM 0.1	3/10/97	11:25	7.4	6.8	51	E 209

E: Field estimate\gauge reading.

e: Flow estimated as sum of Allen Creek flow and Beaver Ck (Case Rd) flow.

x: Flow assumed to be same as BeCM 0.1.

**Table 2**  
**1996-97 Beaver\Allen Creek Wet Season Laboratory Data**

Paired sample results indicate field duplicate

Site Location	Station Creek Mile	Date	Time	Turbidity NTU	NH3 mg/L	NO2/3 mg/L	Total* Organic Nitrogen mg/L	TPN mg/L	Fecal Coliform #/100 mL
Beaver Ck. (Case Rd.)	BeCM 4.2	11/13/96	13:15	3.5	U 0.010	0.150	0.349	0.509	320
Beaver Ck. (Case Rd.)	BeCM 4.2	11/25/96	12:30	4.0	U 0.010 U 0.010	0.470	0.365	0.848	110
Beaver Ck. (Case Rd.)	BeCM 4.2	12/3/96	9:55	1.4	U 0.010	0.404	0.312 J	0.726	9
Beaver Ck. (Case Rd.)	BeCM 4.2	12/9/96	8:06	1.2	U 0.010	0.422	0.172	0.604	23
Beaver Ck. (Case Rd.)	BeCM 4.2	1/7/97	9:30	1.6	U 0.010	0.397	0.162	0.569	13
Beaver Ck. (Case Rd.)	BeCM 4.2	1/28/97	9:40	1.5	1.3 U 0.010	0.303	0.159	0.472	11
Beaver Ck. (Case Rd.)	BeCM 4.2	2/12/97	8:50	3.8	U 0.010	0.230	0.193	0.433	44
Beaver Ck. (Case Rd.)	BeCM 4.2	2/19/97	8:45	2.3	U 0.010	0.231	0.185	0.426	65
Beaver Ck. (Case Rd.)	BeCM 4.2	3/3/97	9:55	1.4	U 0.010	0.237	0.206	0.453	20
Beaver Ck. (Case Rd.)	BeCM 4.2	3/10/97	10:45	1.7	U 0.010 U 0.010	0.229	0.200	0.441	14
Allen Ck. (mouth)	BeCM 2.6T	11/13/96	14:45	3.0	U 0.010 U 0.010	0.181	0.552	0.755	89
Allen Ck. (mouth)	BeCM 2.6T	11/25/96	13:05	4.2	0.013	0.601	0.616	1.23	1000 S
Allen Ck. (mouth)	BeCM 2.6T	12/3/96	9:30	2.6	0.015	0.417	0.464 J	0.896	40
Allen Ck. (mouth)	BeCM 2.6T	12/9/96	8:45	1.9	0.027	0.426	0.330	0.783	10
Allen Ck. (mouth)	BeCM 2.6T	1/7/97	9:50	2.4	U 0.010	0.346	0.315	0.671	320 S
Allen Ck. (mouth)	BeCM 2.6T	1/28/97	10:05	2.5	0.026	0.473	0.328	0.827	17
Allen Ck. (mouth)	BeCM 2.6T	2/12/97	9:15	4.8	0.011	0.412	0.303	0.726	71
Allen Ck. (mouth)	BeCM 2.6T	2/19/97	9:25	4.4	0.040	0.359	0.425	0.830	67
Allen Ck. (mouth)	BeCM 2.6T	3/3/97	10:15	3.4	U 0.010 U 0.010	0.388	0.426	0.786	190
Allen Ck. (mouth)	BeCM 2.6T	3/10/97	10:50	2.5	U 0.010	0.384	0.376	0.770	43 S
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	11/13/96	13:50	4.6	0.564	0.840	0.676	2.08	1300
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	11/25/96	13:35	3.2	0.035	0.717	0.498	1.25	480 S
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	12/3/96	9:15	2.1	0.026	0.667	0.407 J	1.10	120
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	12/9/96	9:06	1.6	0.020	0.669	0.246	0.935	46
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	1/7/97	10:10	2.4	0.014	0.588	0.229	0.831	220 S
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	1/28/97	10:25	2.4	0.028	0.667	0.285	0.984	84
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	2/12/97	9:30	5.2	0.216	0.612	0.432	1.26	5600 J
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	2/19/97	9:55	4.7	0.202	0.448	0.470	1.12	11000
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	3/3/97	10:25	3.4	0.065	0.467	0.392	0.924	3300
Beaver Ck. (Beaver Ck. Ranch)	BeCM 2.5	3/10/97	11:05	1.7	U 0.010	0.419	0.297	0.726	130

\* Total organic nitrogen is calculated by subtracting ammonia and nitrate/nitrite from total persulfate nitrogen.

S Other bacteria present, count may be an underestimate.

U Less than the reported result

J Analyte was positively identified. The associated numerical result is an estimate.

**Table 2**  
**1996-97 Beaver\Allen Creek Wet Season Laboratory Data**

Paired sample results indicate field duplicate

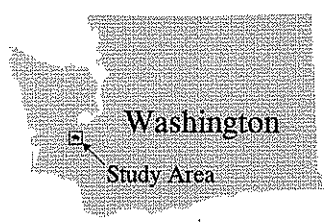
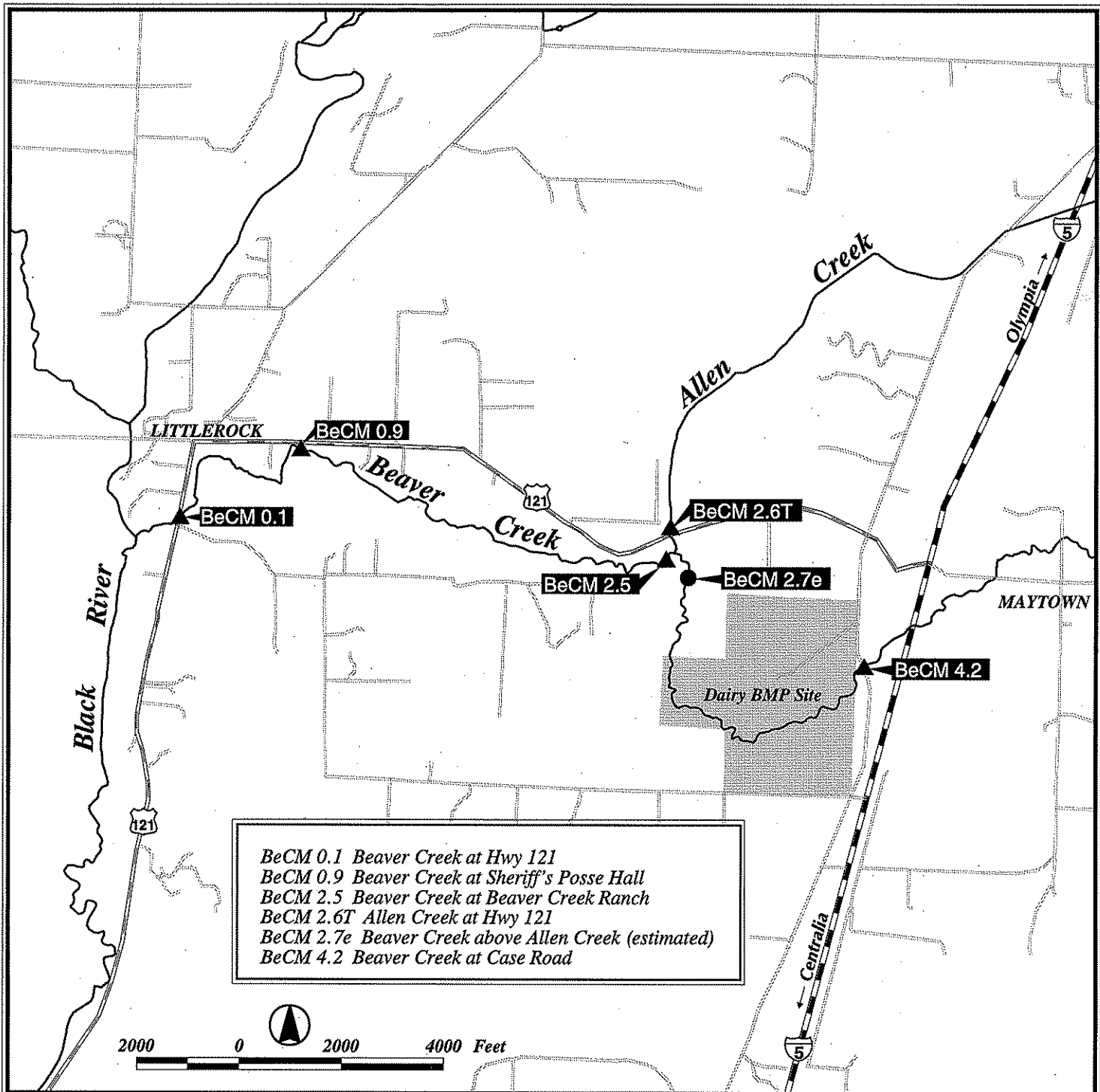
Site Location	Station Creek Mile	Date	Time	Turbidity NTU	NH3 mg/L	NO2/3 mg/L	Total* Organic Nitrogen mg/L	TPN mg/L	Fecal Coliform #/100 mL
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	11/25/96	13:45	4.5	0.035	0.734	0.194	0.963	S 570
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	12/3/96	9:05	2.4	0.020	0.650	0.370 J	1.04	71
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	12/9/96	9:17	1.8	0.016	0.667	0.261	0.944	25
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	1/7/97	10:30	2.2	0.025	0.584	0.312	0.942	S 120 S 195
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	1/28/97	10:35	2.2	0.026	0.694	0.266	0.986	47
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	2/12/97	9:40	3.4	0.075	0.673	0.262	1.01	J 2000
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	2/19/97	10:10	3.5	0.047	0.471	0.341	0.859	2900
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	3/3/97	10:45	2.8	0.074	1.00	0.496	1.57	2100
Beaver Ck. (Sheriff's Posse)	BeCM 0.9	3/10/97	11:10	1.7	0.010	0.464	0.277	0.751	140
Beaver Ck. (Hwy 121)	BeCM 0.1	11/13/96	14:05	5.0	0.355	1.03	0.605	1.99	930
Beaver Ck. (Hwy 121)	BeCM 0.1	11/25/96	14:05	6.0	0.030	0.746	0.534	1.31	S 530
Beaver Ck. (Hwy 121)	BeCM 0.1	12/3/96	8:32	2.6	0.020	0.65	0.400 J	1.07	170
Beaver Ck. (Hwy 121)	BeCM 0.1	12/9/96	9:32	1.8	0.017	0.647	0.257	0.921	26
Beaver Ck. (Hwy 121)	BeCM 0.1	1/7/97	10:50	2.6	0.012	0.586	0.291	0.889	S 240
Beaver Ck. (Hwy 121)	BeCM 0.1	1/28/97	10:50	2.2	0.028	0.702	0.257	0.987	57
Beaver Ck. (Hwy 121)	BeCM 0.1	2/12/97	9:55	4.1	0.049	0.679	0.270	0.998	J 2300
Beaver Ck. (Hwy 121)	BeCM 0.1	2/19/97	10:30	3.4	0.039	0.510	0.359	0.908	2800
Beaver Ck. (Hwy 121)	BeCM 0.1	3/3/97	10:55	2.8	0.070	0.496	0.444	1.01	2100
Beaver Ck. (Hwy 121)	BeCM 0.1	3/10/97	11:25	1.7	0.025	0.467	0.260	0.752	220

\* Total organic nitrogen is calculated by subtracting ammonia and nitrate/nitrite from total persulfate nitrogen.

S Other bacteria present, count may be an underestimate.

U Less than the reported result

J Analyte was positively identified. The associated numerical result is an estimate.



- Streams
- Highways
- Other Roads
- Dairy BMP Site
- Sampling Sites
- Estimated Site

**Figure 1. Beaver and Allen Creek Sample Sites**

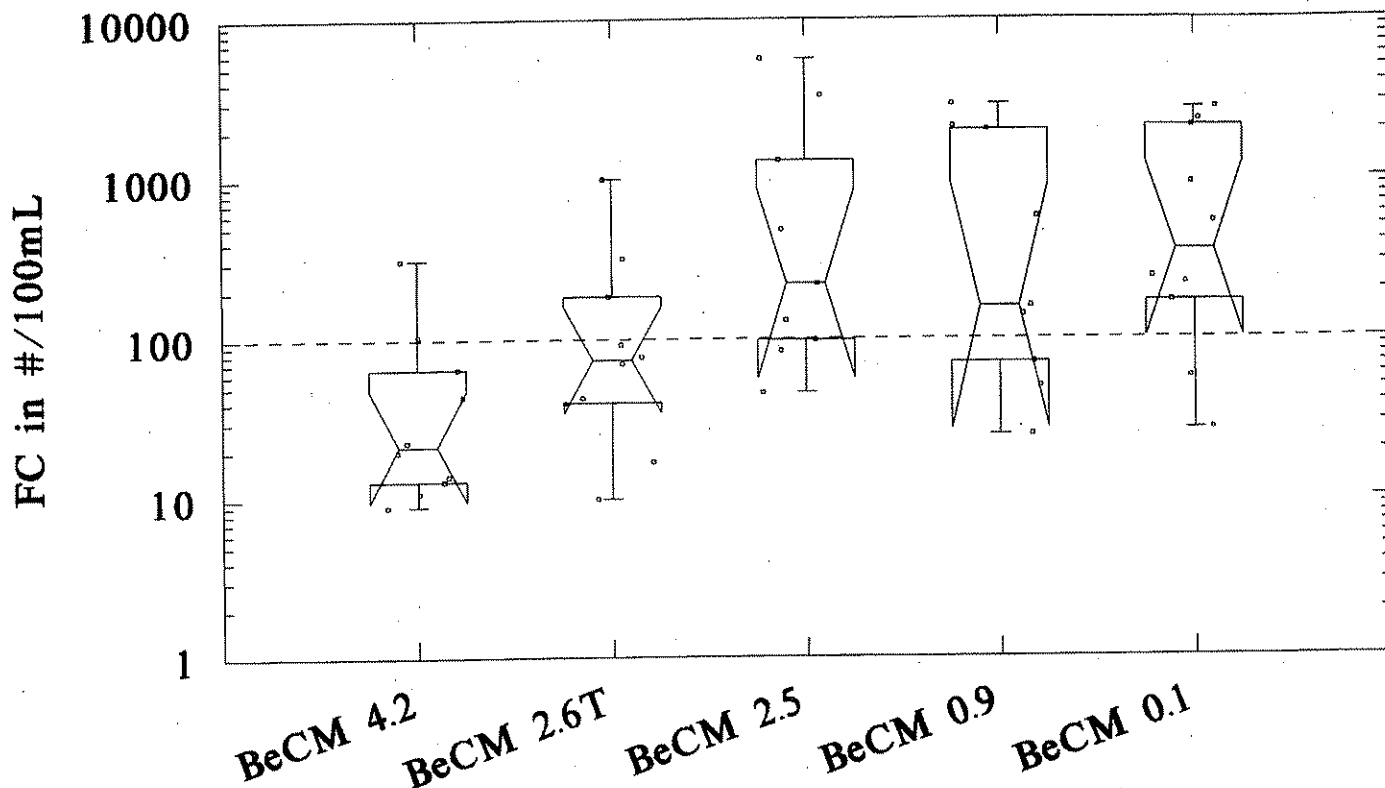


Figure 2 1996-97 Fecal Coliform Monitoring Results by Station.

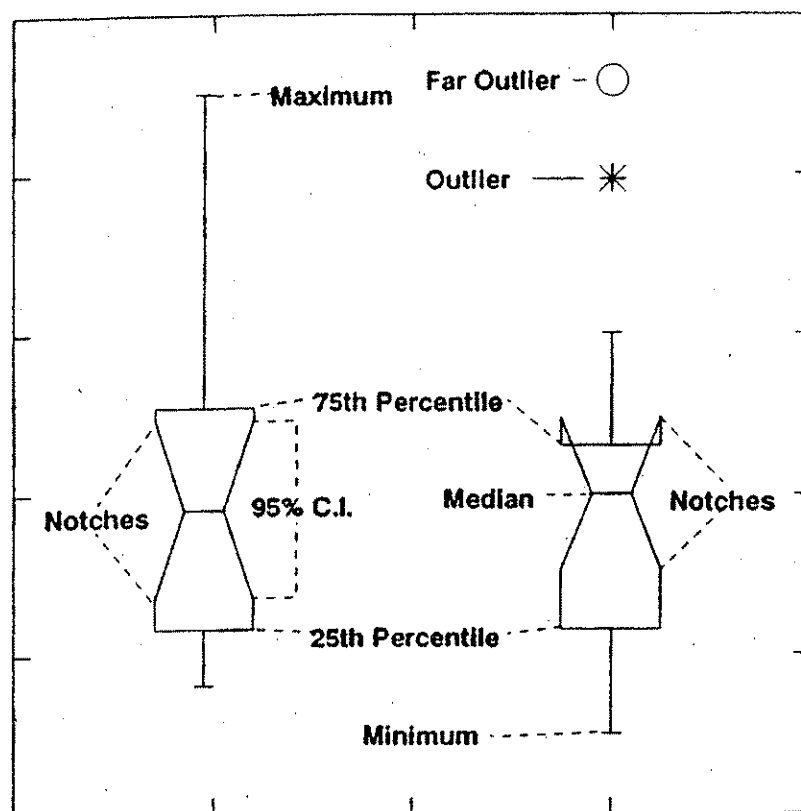


Figure 3 Example of Notched Boxplots.