

Attachment 4

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South Prairie Creek Monitoring Data Evaluation Technical Memorandum

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Limitations:

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1. EXECUTIVE SUMMARY

This memorandum describes Brown and Caldwell's (BC's) evaluation of water quality samples collected near the Inglin Dairy site in Pierce County, Washington. The primary purpose of the evaluation was to determine whether the recent elimination of the dairy operation has reduced fecal coliform bacteria concentrations in South Prairie Creek downstream of the dairy site. BC performed the evaluation in accordance with Task 7 in the Scope of Work for the Carbon River and Upper Puyallup Basin Plan Phase 2 (Pierce County Work Order No. DO10-016-2).

The Scope of Work for BC's evaluation specified three objectives:

1. Identify apparent water quality improvements that may be attributable to the County's recent acquisition and restoration of the Inglin Dairy site that supports attainment of the South Prairie Creek TMDL wasteload allocation.
2. Identify any South Prairie Creek stream reaches that may be eligible for removal from the state 303(d) list of "polluted" waters, based on recent water quality data.
3. Compare the observed load reductions to those previously estimated by BC using the Watershed Treatment Model (WTM).

BC found the following results for each objective:

1. The two mainstem monitoring sites just downstream of the Inglin Dairy site had significantly lower fecal coliform concentrations during 2005-2007, after the dairy was removed.
2. Based on sampling conducted during 2005-2007, both mainstem reaches downstream of the dairy site appear to have met the state standards for fecal coliform bacteria and are therefore eligible for removal from the state's list of "polluted" waters. Tributary T1 did not always meet standards during 2005-2007.
3. The fecal coliform load reductions observed after dairy closure are consistent with the WTM predictions.

2. BACKGROUND

The Inglin Dairy site is located on South Prairie Creek just downstream of the town of South Prairie (Figure 1). A small tributary (T1) flows through the dairy property and enters South Prairie Creek in the eastern part of the site. The T1 sub-basin encompasses approximately 400 acres of unincorporated land. Although Tributary T1 is not part of either Pierce County or Washington State Department of Transportation's (WSDOT) storm drainage system, it is the pathway by which stormwater covered by Pierce County and WSDOT's National Pollutant Discharge Elimination System (NPDES) permits reaches South Prairie Creek.

Water quality sampling conducted in the early 1990s indicated that South Prairie Creek often exceeded the state water quality standards for fecal coliform bacteria. Consequently, in 1996, the Washington State Department of Ecology (Ecology) listed South Prairie Creek as an "impaired" water body under Section 303(d) of the federal Clean Water Act. The Clean Water Act requires that a Total Maximum Daily Load (TMDL) must be established for each "impaired" water body on the 303(d) list when technology-based

controls are not sufficient. Ecology therefore issued a TMDL for fecal coliform bacteria in South Prairie Creek and Tributary T1 in 2003. The TMDL was based on monitoring data collected by Ecology during 2000-2001.

In April 2005, the Pierce County Department of Public Works and Utilities, Water Programs asked BC to estimate the potential fecal coliform load reductions associated with the elimination of the Inglin Dairy operation. BC used the Watershed Treatment Model (WTM) to estimate the potential load reductions (Caraco 2001). The WTM estimated that the annual fecal coliform bacteria load from the Inglin Dairy (when it was operating) ranged from roughly 112,000 billion to 1,500,000 billion colonies per year, or about 300 to 4,000 billion colonies per day. Based on these results, BC concluded that eliminating the dairy land use would cause substantial reductions in fecal coliform loads in the creek downstream of the dairy and in Tributary T1, which passes through the dairy site (Brown and Caldwell 2005). Ecology's TMDL submittal report (Ecology 2003) notes that Tributary T1 originates in the town of South Prairie and conveys groundwater and stormwater to South Prairie Creek. Land use in the upper portion of the T1 sub-basin is moderately dense residential development with some commercial, and land use in the lower portion is agricultural with limited rural residential (Ecology 2003).

Pierce County Water Programs helped purchase the Inglin Dairy in early 2005 to improve water quality in South Prairie Creek. All livestock were removed from the property at that time. The former Inglin Dairy site is now known as the South Prairie Creek Preserve and the County is restoring the site using native plants.

Ecology issued the Draft South Prairie Creek Bacteria and Temperature Total Maximum Daily Load Detailed Implementation Plan in March 2006. The Implementation Plan predicted that acquisition of the dairy would substantially reduce bacteria loads. The plan states:

This acquisition will undoubtedly be the single most important implementation action to affect the bacterial quality of South Prairie Creek and eliminates direct livestock access to South Prairie Creek. Fecal coliform inputs and loading between the Tributary 1 and Tributary 1-Inglin Dairy sampling locations will be significantly reduced as dairy livestock will no longer be grazing in the pastured area through which Tributary 1 flows.

It is assumed that the vast majority of fecal coliform pollution in South Prairie Creek will be eliminated by the removal of the Dairy herd from the former Inglin Dairy (September 2003), and that the creek, downstream of the former dairy, may now be meeting water quality standards for fecal coliform. Monthly fecal coliform monitoring beginning in May, 2005, will evaluate this assumption.

The Pierce Conservation District (PCD) led the "post-dairy" water quality monitoring program, which began in May 2005 and ended in October 2007. The "post-dairy" monitoring was conducted by PCD in accordance with an Ecology-approved Quality Assurance Project Plan (Ragland and Roberts 2005). As shown in Figure 1, the program included several locations near the Inglin Dairy site.

3. EVALUATION OBJECTIVES AND APPROACH

The Scope of Work for BC's evaluation specifies three objectives:

1. Identify apparent water quality improvements that may be attributable to the County's recent acquisition and restoration of the Inglin Dairy site that supports attainment of the South Prairie Creek TMDL wasteload allocation.
2. Identify any South Prairie Creek stream reaches that may be eligible for de-listing based on recent water quality data.

3. Compare the observed load reductions to those previously estimated by BC using the WTM.

To meet these objectives, BC completed the following steps:

- Selected monitoring locations to be included in the evaluation.
- Performed statistical analyses to determine whether the “post-dairy” fecal coliform bacteria concentrations were significantly lower than the concentrations observed while the dairy was still in operation.
- Compared the “post-dairy” fecal coliform bacteria concentrations to the state water quality standards.
- Compared the observed changes in fecal coliform bacteria loads to the changes estimated using the WTM.

3.1 Selection of Monitoring Locations

BC reviewed the Ecology and PCD monitoring programs to identify sampling locations that: 1) receive runoff from the Inglin Dairy site and 2) were sampled during both the 2000-2001 and the 2005-2007 studies.

The evaluation includes the following three sampling locations:

1. T1ID- Located at the mouth of the ditch (Tributary T1) from South Prairie
2. SPCID- Located at Inglin Dairy bridge
3. SPCB4- Located at the Route 162 bridge crossing just downstream of Inglin Dairy

T1ID and SPCID are located within the dairy site. Thus, they do not capture all drainage from the property. SPCB4 is located about 0.5 mile downstream of the dairy site. Any runoff from the property should flow past this location. However, SPCB4 also receives runoff from areas downstream of the dairy site.

3.2 Evaluation of Water Quality Trends over Time

BC first calculated the following basic statistics for monitoring data collected from the selected stations during 2000-2001 and 2005-2007:

- Geometric mean
- 90th percentile
- Coefficient of variation

The standard formulas for these statistics from Microsoft Excel were used.

The Wilcoxon Rank Sum (WRS) test was then used to evaluate whether apparent differences between the 2000-2001 and 2005-2007 fecal coliform bacteria concentrations at each location are statistically significant. The WRS test is a statistical test that compares two independent groups of data to determine if one group contains larger values than the other. The WRS test was used instead of the t-test because the WRS test is a nonparametric test, meaning (unlike the t-test) no data distribution is assumed for the groups of data being tested.

The rank sum test then checks for two hypotheses (the null versus the alternative). The hypotheses for these analyses are based on a one-tailed test being used. A one-tailed test looks for an increase or decrease in the parameter whereas a two-tailed test looks for any change in the parameter (which can be any change— increase or decrease). The null hypothesis for the test is “the median of the 2005-2007 fecal coliform data is

not significantly different than the median of the 2000-2001 fecal coliform data.” The alternative hypothesis is “the median of the 2005-2007 fecal coliform data is lower than the median of the 2000-2001 fecal coliform data.”

3.3 Evaluation of Potential “De-listing”

The federal Clean Water Act Section 303(d) requires that every 2 years Ecology must identify all water bodies that do not support their designated beneficial uses, as indicated by water quality standards excursions. The resulting list of “impaired” or “polluted” waters is called the “303(d) list.” Prior to 2002, all water bodies in Washington were either listed as “impaired” or not listed at all. In 2002, Ecology developed a more comprehensive system for classifying water bodies. The 2002 system involves five Water Quality Assessment Categories, which are defined below.

1. **Category 1: Meets tested standards for clean waters.** Placement in this category does not necessarily mean that a water body is free of all pollutants. Most water quality monitoring is designed to detect a specific array of pollutants, so placement in this category means that the water body met standards for all the pollutants for which it was tested. Specific information about the monitoring results may be found in the individual listings.
2. **Category 2: Waters of concern** is for waters where there is some evidence of a water quality problem, but not enough to require production of a TMDL at this time. There are several reasons why a water body would be placed in this category. A water body might have pollution levels that are not quite high enough to violate the water quality standards, or there may not have been enough violations to categorize it as impaired according to Ecology’s listing policy. There might be data showing water quality violations, but the data were not collected using proper scientific methods. In all of these situations, these are waters that will continue to be tested.
3. **Category 3: No data** is a category that will be largely empty. Water bodies that have not been tested will not be individually listed, but if they do not appear in one of the other categories, they are assumed to belong here.
4. **Category 4: Polluted waters that do not require a TMDL** is for waters that have pollution problems that are being solved in one of three ways.
 - a. **Category 4a** is for water bodies that have approved TMDLs in place that are actively being implemented.
 - b. **Category 4b** is for water bodies that have a plan in place that is expected to solve the pollution problems. While pollution control plans are not TMDLs, they must have many of the same features and there must be some legal or financial guarantee that they will be implemented.
 - c. **Category 4c** is for water bodies impaired by causes that cannot be addressed through a TMDL. These impairments include low water flow, stream channelization, and dams. These problems require complex solutions to help restore streams to more natural conditions.
5. **Category 5: Polluted waters that require a TMDL.** Placement in this category means that Ecology has data showing that the water quality standards have been violated for one or more pollutants, and there is no TMDL or pollution control plan in place; thus, TMDLs are required for the water bodies in this category. Category 5 is equivalent to the pre-2002 303 (d) lists.

South Prairie Creek was included on the state’s 303(d) list of “polluted” (Category 5) water bodies because it violated the state water quality standards. According to the state water quality standards (WAC 173-201A),

fecal coliform concentrations in South Prairie Creek must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

In 2006, Ecology issued a Detailed Implementation Plan for the South Prairie Creek bacteria TMDL. As noted above, Category 4a is for water bodies with approved TMDLs that are actively being implemented.

Ecology’s Water Quality Program Policy 1-11 (Ecology 2006b) indicates that a water body that had been listed as “impaired” or “polluted” (Category 5) can be removed from the list when at least 10 samples during a calendar year (or a shorter critical period if defined by Ecology) show no exceedances beyond the criteria. However, the data used for “de-listing” must be based on a sampling effort that is comparable to the sampling used to support the original listing, and the sampling effort must target the critical periods in which exceedances of the criteria are more likely to occur (Ecology 2006b).

Therefore, BC evaluated the 2005-2007 monitoring program to confirm its comparability to the monitoring used to support the listing. BC then calculated the geometric means and the percentages of samples exceeding 200 colonies/100mL, and compared these results to the water quality standards described above.

3.4 Comparison to WTM Predictions

The WTM analysis performed by BC in 2005 estimated the range of annual fecal coliform loads from the Inglin Dairy. Ecology’s 2000-2001 and PCD’s 2005-2007 sampling efforts included grab sampling and analysis to determine fecal coliform bacteria concentrations, but neither study included sufficient flow data to calculate loads that could be directly compared to the WTM load estimates.

Therefore, BC performed a qualitative comparison based on the average streamflow data from U.S. Geological Survey (USGS) gage 12095000 (South Prairie Creek at South Prairie, Washington) for the two monitoring periods. The USGS gage is about 2 miles upstream from the dairy site.

4. RESULTS

4.1 Water Quality Trends

BC used the sampling results to calculate the geometric mean, 90th percentile value, and coefficient of variation for these three stations. Table 1 lists the geometric mean and 90th percentile for both data sets and their percent changes as well as their statistical significance.

Monitoring Site	GeoMean			90th Percentile			Statistically Significant Change
	2000-2001	2005-2007	% Change	2000-2001	2005-2007	% Change	
SPCB4	71	30	-58%	411	135	-67%	Yes ¹
SPCID	65	31	-53%	245	136	-45%	Yes ²
T1ID	600	95	-84%	1843	474	-74%	Yes ²

¹ Based on 1-sided Wilcoxon Rank Sum test with a confidence interval (α) of 0.05

² Insufficient data from 2000-2001 to use the same Wilcoxon rank sum test so exact test was used.

As shown in Table 1, the geometric mean and 90th percentile appeared to drop substantially at all three monitoring stations. The largest apparent decreases were at Tributary T1.

The WRS test was then used to determine whether the apparent differences are statistically significant. There are two versions of the WRS test: the exact test and the large-sample approximation. If the size of the smaller sample of the two groups being compared does not exceed 20 and the size of the larger sample does not exceed 40, the exact version of the WRS test is used. Otherwise, the large-sample approximation version of the test is appropriate. SPCB4 was sampled 20 times during 2000-2001 and 30 times during 2005-2007, so the large-sample version of the test was used to analyze the data from that location. SPCID and T1ID were sampled only six times during 2000-2001 and 30 to 31 times during 2005-2007, so the exact test was used at those locations.

The null hypothesis for the large-sample test is “the median fecal coliform concentration from the 2005-2007 samples is not significantly different than the median from 2000-2001 samples.” The alternative hypothesis is “the median of the 2005-2007 samples is lower than the median of the 2000-2001 samples.” The samples from both data sets were then ranked together (any ties were accounted for). Using both the NORMSINV function from Microsoft Excel and Table A1- Cumulative Normal Distribution (Gilbert 1987), 1.645 was determined as the one-sided $Z_{1-\alpha}$ value. A confidence interval (α) of 0.05 was used. Two methods (Equation 18.9 [Gilbert 1987] and Statistica) were used to verify the value of Z_{rs} (the rank sum Z value). Both methods use the large sample approximation methods since both data sets have more than 10 samples. Both methods determined a Z_{rs} value of approximately -2.2. Because $Z_{rs} \leq Z_{1-\alpha}$, the null hypothesis is rejected and the alternative hypothesis is accepted. Thus, the statistical analysis found that the fecal coliform concentrations at SPCB4 were significantly higher in 2000-2001, when the Inglin Dairy was operational, than they were in 2005-2007, after the dairy had closed.

The null and alternative hypotheses for the exact test are the same as for the large-sample test described above. A confidence interval (α) of 0.05 was also used. The samples from both data sets were then ranked together (any ties were accounted for). The U' value is calculated using equation 8.45 (Zar 1999). The critical value, $U_{critical}$, was obtained from Table B-11 in Zar (1999). Because $U' \leq U_{critical}$ for both SPCID and T1ID, the null hypothesis is accepted at both monitoring locations. Thus, the statistical analysis found that the fecal coliform concentrations at SPCID and T1ID were significantly higher in 2000-2001, when the Inglin Dairy was operational, than they were in 2005-2007, after the dairy had closed.

4.2 Water Quality De-listing

Ecology's 2000-2001 sampling program, which was used to confirm the 303(d) listing and support development of the bacteria TMDL, involved 18 monthly grab samples at SPCB4 and 6 grab samples at SPCID and T1ID. PCD's 2005-2007 sampling program was conducted under a Quality Assurance Project Plan approved by Ecology. As shown in Table 2 below, the PCD program included 30 to 31 monthly grab sampling events at each of the three locations. Therefore, the 2005-2007 sampling results appear sufficient to help determine whether the reaches of South Prairie Creek and Tributary T1 met the applicable water quality standards.

The water quality standards applicable to South Prairie Creek and Tributary T1 state that fecal coliform concentrations must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 mL. The samples exceeding 100 colonies/ 100 mL are bolded in Table 2.

Table 2 shows that SPCB4 and SPCID had geometric mean fecal coliform concentrations less than the state standard of 100 colonies/100 mL, and less than 10 percent of the samples exceeded 200 colonies/100mL.

Thus, the reaches of South Prairie Creek associated with SPCB4 and SPCID met the state water quality standards for bacteria during the post-dairy sampling period. The geometric mean fecal coliform concentration at T1ID was less than the state standard of 100 colonies/100 mL; however, more than 10 percent of the samples collected at T1ID exceeded 200 colonies/100 mL, so Tributary 1 did not appear to meet the state standard during 2005-2007.

SBCB4		SBCID		T1ID	
Date	Fecal Coliform (colonies/100mL)	Date	Fecal Coliform (colonies/100mL)	Date	Fecal Coliform (colonies/100mL)
5/17/2005	5	5/16/2005	40	5/16/2005	1,000
		6/13/2005	21	6/13/2005	220
6/14/2005	31	6/14/2005	19	-	-
7/19/2005	23	7/18/2005	47	7/18/2005	320
8/29/2005	125	8/29/2005	103	8/29/2005	96
9/19/2005	55	9/19/2005	96.7	9/19/2005	145
10/18/2005	40	10/17/2005	51	10/17/2005	120
11/14/2005	14	11/14/2005	9	11/14/2005	29
12/12/2005	21	12/12/2005	19	12/12/2005	119
1/17/2006	6	1/17/2006	8	1/17/2006	46
2/13/2006	3	2/13/2006	12	2/13/2006	189
3/13/2006	<1*	3/13/2006	5	3/13/2006	95
4/17/2006	6	4/17/2006	4	4/17/2006	24
5/15/2006	23	5/15/2006	9	5/15/2006	40
6/12/2006	51	6/12/2006	28	6/12/2006	46
7/17/2006	40.5	7/17/2006	32	7/17/2006	26
8/14/2006	38	8/14/2006	40	8/14/2006	36
9/18/2006	172	9/18/2006	172	9/18/2006	18
10/16/2006	288	10/16/2006	244	10/16/2006	276
11/13/2006	37	11/13/2006	72.5	11/13/2006	25.5
12/11/2006	37	12/11/2006	11	12/11/2006	47
1/17/2007	7	1/17/2007	16	1/17/2007	38
2/12/2007	10	2/12/2007	15	2/12/2007	29
3/12/2007	45	3/12/2007	42	3/12/2007	248
4/16/2007	6	4/16/2007	6.5	4/16/2007	52
5/16/2007	12.5	5/16/2007	31	5/16/2007	61
6/11/2007	71	6/11/2007	61	6/11/2007	77
7/16/2007	108	7/16/2007	59	7/16/2007	2,360
8/13/2007	99	8/13/2007	71	8/13/2007	74
9/18/2007	162	9/17/2007	564	9/17/2007	2,020
10/16/2007	46	10/15/2007	45	10/15/2007	109
Number of Samples	30		31		30
Geometric Mean (colonies/100 mL)	30		31		95
% samples > 200 colonies/100 mL	3%		6%		23%

* This sample was below the detection limit of 1 colony/100 mL. A value of 1 was used for the statistical analysis.

4.3 Load Comparison

Calculating bacteria loads for a given time period (e.g., year or day) requires flow measurements for that time period. However, flows were measured at the sample locations during only a few of the 2000-2001 and 2005-2007 sampling events.

The USGS operates a flow gage (1209500) approximately 2 miles upstream of the Inglin Dairy site. BC used the flow data from this gage, together with the bacteria data listed in Table 2 above, to estimate “daily” bacteria loads at SPCB4 and SPCID. No loads could be computed for the T1ID sampling site due to lack of flow data. Table 3 lists the average daily streamflow on the monitoring dates.

Monitoring Dates 2000-2001	Streamflow (cfs)	Monitoring Dates 2005-2007	Streamflow (cfs)
7/19/2000	64	5/17/2005	538
8/1/2000	57	6/14/2005	179
8/21/2000	48	7/19/2005	80
9/5/2000	62	8/29/2005	55
9/19/2000	64	9/19/2005	34
10/24/2000	123	10/18/2005	88
1/29/2001	109	11/14/2005	399
2/27/2001	77	12/12/2005	147
3/26/2001	250	1/17/2006	995
4/16/2001	206	2/13/2006	217
5/22/2001	185	3/13/2006	141
6/18/2001	221	4/17/2006	267
7/9/2001	89	5/15/2006	144
8/20/2001	40	6/12/2006	179
9/17/2001	41	7/17/2006	60
10/15/2001	131	8/14/2006	36
11/29/2001	476	9/18/2006	40
12/18/2001	724	10/16/2006	126
		11/13/2006	829
		12/11/2006	338
		1/17/2007	193
		2/12/2007	166
		3/12/2007	1420
		4/16/2007	168
		5/16/2007	106
		6/11/2007	150
		7/16/2007	75
		8/13/2007	79
		9/18/2007	59
		10/16/2007	68

Table 4 lists the summary statistics for the daily streamflow data listed in Table 3. It shows that annual flows were greater for the 2005-2007 monitoring dates.

Statistic	Streamflow (cfs)	
	2000-2001	2005-2007
Median	99	146
Average	165	246
90th Percentile	318	567

Tables 5 and 6 list the estimated “daily” bacteria loads at the South Prairie Creek sampling locations. “Daily” loads were calculated for each day that a fecal coliform sample was collected. The “daily” loads were calculated using the fecal coliform concentration for each sample and the average daily flow measured at the USGS gage on the sampling date. The “daily” values should be regarded as very rough estimates because they are based on single grab samples collected approximately once per month; fecal coliform bacteria concentrations in a stream can vary by several orders of magnitude during a single day. Moreover, the flows used to estimate the loads were measured at the USGS gage (1209500) about 2 miles upstream of SPCB4 and SPCID. The median, average, and 90th percentile values listed in Tables 5 and 6 were calculated based on all of the “daily” loads for each site.

Statistic	Billion Colonies / Day	
	2000-2001	2005-2007
Median	192	84
Average	433	204
90th Percentile	1,191	350

Statistic	Billion Colonies / day	
	2000-2001	2005-2007
Median	257	91
Average	399	242
90th Percentile	875	752

As shown in Tables 5 and 6, the estimated daily loads for 2005-2007 appear to be considerably lower than the estimated daily loads for 2000-2001. The average of the estimated daily loads for 2005-2007 was about one-half of the average for 2000-2001, even though flows in 2005-2007 were considerably higher (Table 4). As previously discussed, “daily” loads could not be estimated for T1 due to lack of flow data.

The average daily load at SPCB4 was about 200 billion fecal coliform colonies per day lower and the 90th percentile was about 900 billion colonies/day lower during 2005-2007 than during 2000-2001, despite the higher flows during 2005-2007. The average daily load at SPCID also appeared to drop considerably but the 90th percentile did not drop as dramatically as the SPCB4 monitoring site. This difference may be due to the relatively small number of samples collected at SPCID. The WTM analysis in 2005 estimated that the Inclin

Dairy could have contributed from 300 to 4,000 billion fecal coliform colonies per day. Thus, the observed load reductions are consistent with the load reductions predicted by the WTM.

5. CONCLUSIONS

Fecal coliform bacteria concentrations in South Prairie Creek downstream of the dairy site decreased significantly after the dairy was closed. Samples collected after dairy closure show that South Prairie Creek adjacent to and downstream of the dairy site met the state water quality standards for bacteria. Therefore, these reaches of the creek appear to meet the criteria for removal from the state's 303(d) list of impaired or polluted waters.

Fecal coliform concentrations in Tributary T1 appear to have declined since the dairy was closed. More than 10 percent of the samples collected at T1 after the dairy closed exceeded 200 colonies/100 mL. Therefore, T1 did not meet the state water quality standards for bacteria during 2005-2007.

Review of available streamflow data suggests that daily bacteria loads in 2005-2007 were about half the daily loads in 2000-2001, even though flows during 2005-2007 were considerably higher than during 2000-2001. The observed fecal coliform load reductions are consistent with the load reductions predicted by the WTM in 2005.

The South Prairie Creek TMDL listed target load reductions during the growing and the non-growing seasons. Ecology used the "statistical rollback method" (Ott, 1995) to determine the necessary reduction for both the geomean and 90th percentile bacteria concentration to meet the applicable water quality standard. Compliance with the most restrictive of the dual fecal coliform criteria determines the bacteria reduction needed. Ecology analyzed the 200-2001 monitoring results and determined that meeting the standards would require a proportionately greater reduction in the 90th percentile (rather than the geomean). Therefore, the target TMDL load reduction for each site was calculated based on the difference between the observed 90th percentile concentration and the state standard (i.e., 200 colonies/100 mL).

Table 7 presents a summary of the geomean and the 90th percentile for the growing and the non-growing seasons at the three monitoring sites. This table shows that the SPCB4 and SPCID sites met the TMDL targets and state water quality standards during 2005-2007, after the dairy had closed. Tributary T1, which receives drainage from the town of South Prairie and agricultural areas upstream of the dairy site, did not meet the TMDL target or state water quality standards during 2005-2007.

			SPCB4	SPCID	T1ID
Geomean	Growing Season	2000-2001 Samples	92	78	583
		2005- 2007 Samples	51	55	134
		TMDL Target: Geomean	54	57	61
		Was TMDL Target Met in 2005-07?	Yes	Yes	No
	Non Growing Season	2000-2001 Samples	44	*	*
		2005- 2007 Samples	12	13	57
		TMDL Target: Geomean	17	36	48
		Was TMDL Target Met in 2005-07?	Yes	Yes	No
90th Percentile	Growing Season	2000-2001 Samples	339	290	1915
		2005- 2007 Samples	183	185	808
		TMDL Target: 90 th Percentile	200	200	200
		Was TMDL Target Met in 2005-07?	Yes	Yes	No
	Non Growing Season	2000-2001 Samples	494	*	*
		2005- 2007 Samples	39	37	158
		TMDL Target: 90 th Percentile	200	200	200
		Was TMDL Target Met in 2005-07?	Yes	Yes	No
Met WQ Standard during 2005-2007?			Yes	Yes	No

* Insufficient data

6. REFERENCES

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