



Chehalis River BMP Evaluation Project

Interim Report on the Chehalis River Project Area

Abstract

This interim report describes the first year's water quality monitoring results for a site where nonpoint source best management practices (BMPs) will be installed. The site is a dairy located on the east bank of the mainstem Chehalis River at river mile 70.6. The overall study design includes pre- and post-BMP water quality monitoring during the wet season. The Chehalis River upstream and downstream of the BMP site and two tributaries in the vicinity of the BMP site were monitored. This serves as follow-up to the Chehalis Total Maximum Daily Load (TMDL) Study. Monitoring results for the tributary adjacent to the BMP site exceeded water quality standards for fecal coliform, turbidity, and ammonia. One more year of pre-BMP monitoring is recommended, and two years of post-BMP monitoring.

Introduction

The purpose of this study is to document improvements in surface water quality associated with best management practices (BMPs) installed at a specific site, and to follow-up the Upper Chehalis River Dry Season Total Maximum Daily Load (TMDL) Study. A Quality Assurance Project Plan (QAPP) was developed for this project (Sargeant, 1994). The QAPP describes monitoring activities for the period July 1994 through June 1995.

In the Chehalis River basin, poor water quality has been identified as a threat to the fisheries resource. To protect this beneficial use, the TMDL process is being implemented by Ecology for the upper Chehalis River basin (Pickett, 1994a, 1994b; Coats, 1994). The TMDL study found that nonpoint pollution is a source of poor water quality. Successful implementation of the Chehalis Basin TMDL includes establishing BMPs to control nonpoint pollution. In an effort to enhance the fisheries resource the U.S. Fish and Wildlife Service (USFWS) is funding installation of BMPs in the Chehalis River basin.

In the Chehalis mainstem low dissolved oxygen is a critical problem for the fish resource during the dry season low flow period. The Chehalis TMDL study found that a pool north of the Chehalis-Centralia airport had anoxic hypolimnetic conditions, low pH (possibly associated with decomposition and leaching of organic sediments), and higher conductivity at depth. The study found the most likely pollutant source to be a dairy farm located on the east side of the river. Two small channels were observed cut into the river bank in the vicinity of the dairy farm and the sampling site. The study surmised these channels could be a wet weather direct discharge to the river (Pickett, 1994b).

This is the first year of pre-BMP baseline monitoring being done on the mainstem Chehalis and tributaries that may have caused the problems noted in the Chehalis TMDL Study. Objectives of this study are to determine which of the two tributaries is the source of problems noted in the TMDL, to gather pre-BMP data on the dairy site, and to follow-up on the Chehalis TMDL Study.

Study Area

The study area (Figure 1) includes two sites on the mainstem of the Chehalis: river mile (RM) 69.7, at the overhanging tree; and RM 70.7, a site just north of the Chehalis-Centralia airport. Both sites were also monitored for the Chehalis TMDL study. Two tributary sites on the east side of the Chehalis River were monitored: a tributary at RM 70.3T, an unnamed intermittent creek bordering fields that are National Frozen Foods waste application sites; and a tributary at RM 70.6T, an eroded ditch that runs through or adjacent to the northern boundary of a dairy operation on the east side of the Chehalis River.

Methods

Five winter sampling events were conducted on the following dates:

November 16, 1994;
November 29, 1994;
January 23, 1995;
January 31, 1995; and
March 5, 1995.

For four out of the five sampling events, 0.25 inches or more of rainfall had fallen in the previous 24 hours. One sampling event was during a dry period. For the sampling event on January 31, the Chehalis River was near flood stage and both the tributary sites were backed up due to high river flows.

Field measurements for temperature, pH, and conductivity were made during all surveys as described in the QAPP. Flows were taken at RM 70.6T during four sampling events using either a five gallon bucket and timing device, or a velocity meter and top-set wading rod.

Laboratory samples were collected at all sites for fecal coliform, nitrate/nitrite, ammonia, total persulfate nitrogen, and turbidity. Samples were collected from flowing water by subsurface grab from the center channel (3 to 12 inches depth). Immediately following collection, samples were placed in the dark, on ice. Analysis commenced within 24 hours of collection at Ecology's Manchester Environmental Laboratory (MEL). Samples were analyzed in accordance with the QAPP.

Quality Assurance

Data quality assurance results can be found in Appendix A.

Results

A summary of the monitoring data from the project area can be found in Appendix B.

Conductivity

Conductivity is a measure of how easily electricity can pass through water. It is an indirect measure of the amount of dissolved ions. Conductivity can often be used to predict total dissolved solids (TDS). Conductivity was used in this study to evaluate dissolved materials at each site in order to identify suspected pollutant sources that exhibit higher concentrations of TDS. There are no water quality standards for conductivity.

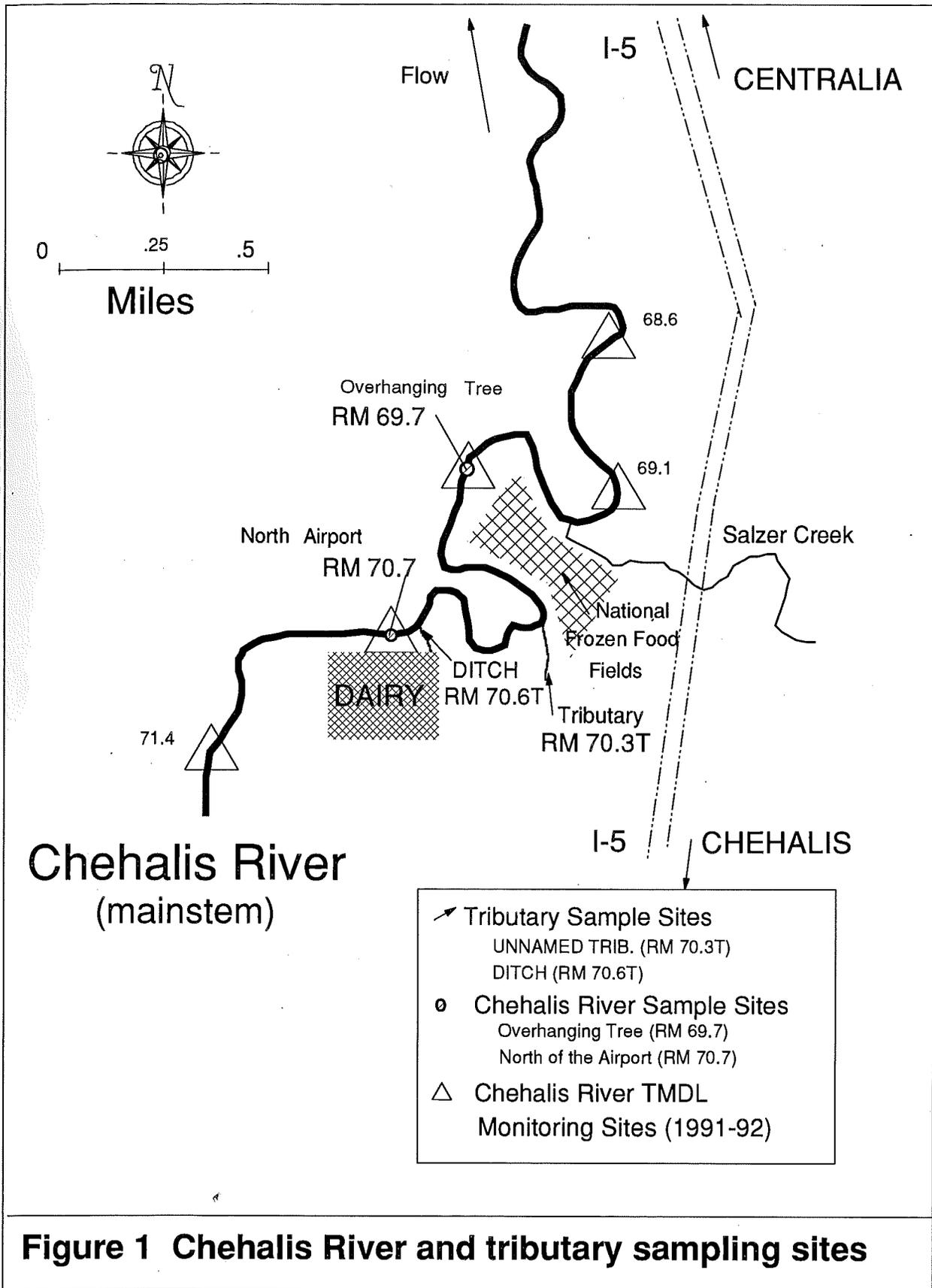


Figure 1 Chehalis River and tributary sampling sites

Figure 2 presents conductivity readings at each site. Conductivity at the mainstem sites ranged from 45 to 87 $\mu\text{mho/cm}$. Any influence from the tributaries could not be determined. Conductivity at the tributary RM 70.3T, ranged from 71 to 133 $\mu\text{mho/cm}$. Conductivity values at the tributary RM 70.6T were notably the highest, ranging from 186 to 380 $\mu\text{mho/cm}$.

Temperature

Temperatures at all sites met the Water Quality Standard of 18° C for this area of the Chehalis River.

pH

The pH for all sites fell within the range of 6.5 to 8.5, which is the Water Quality Standard for this area.

Turbidity

The Water Quality Standard for turbidity in the mainstem Chehalis requires that turbidity levels not exceed 5 NTU above background turbidity when background is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

Figure 3 presents turbidity levels at each site. During all five sampling events the two mainstem stations were within 5 NTU of each other. Mainstem station turbidity levels ranged from 4.5 NTU to 50 NTU. Any influence from the tributaries could not be determined. On one occasion both mainstem sites had high turbidity levels due to heavy rainfall (1.41 inches) in the preceding 24 hours. The Chehalis River was near flood stage and was backing up into both tributary sites at this time. Tributary sampling may have been biased by mainstem flooding during this sampling event.

In comparing the two tributary sites, turbidity levels at the unnamed creek, RM 70.3T, ranged from 4.1 NTU to 22 NTU; while in the ditch tributary, RM 70.6T, levels ranged from 19 NTU to 70 NTU. The unnamed creek was used as a background station for comparing turbidity levels in the two tributaries because the soil types, gradient, basin orientation, and weather conditions are similar for both tributaries. Turbidity levels at the ditch station were 8 NTU to 66 NTU higher than the creek station. The ditch at RM 70.6T exceeded turbidity criteria for all five sample events, using turbidity levels at the creek at RM 70.3T as background.

Fecal Coliform

The Water Quality Standard for fecal coliform in the mainstem Chehalis system is both not exceeding a geometric mean value of 100 cfu/100mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceed 200 cfu/100mL.

Exceedences of the fecal coliform standard are described in Table 1, and a comparison of fecal coliform results can be found in Figure 4. It is important to note that a single value above 200 cfu/100mL would constitute a violation of the second part of the fecal coliform standard. Only one station, RM 70.3T, met Water Quality Standards for fecal coliform. Both mainstem stations exceeded criteria for fecal coliform. The ditch at RM 70.6T exceeded both parts of the standard during all sampling events, with fecal coliform values that ranged from 1,300 cfu/100mL to 17,000 cfu/100mL. Any influence on the mainstem from the tributaries could not be determined.

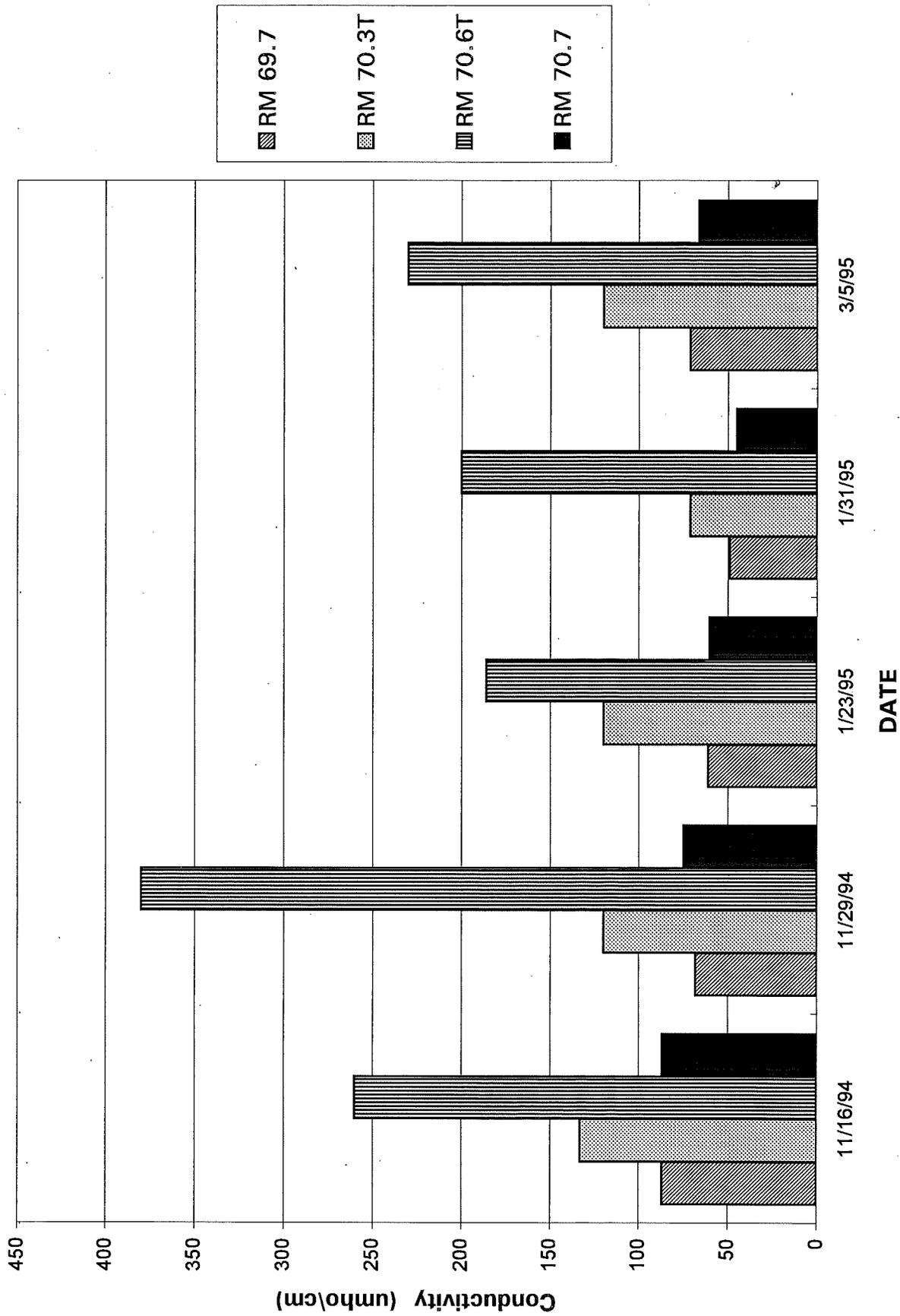


Figure 2.
Conductivity at four sampling sites in the mainstem Chehalis project area during winter 1994-95.

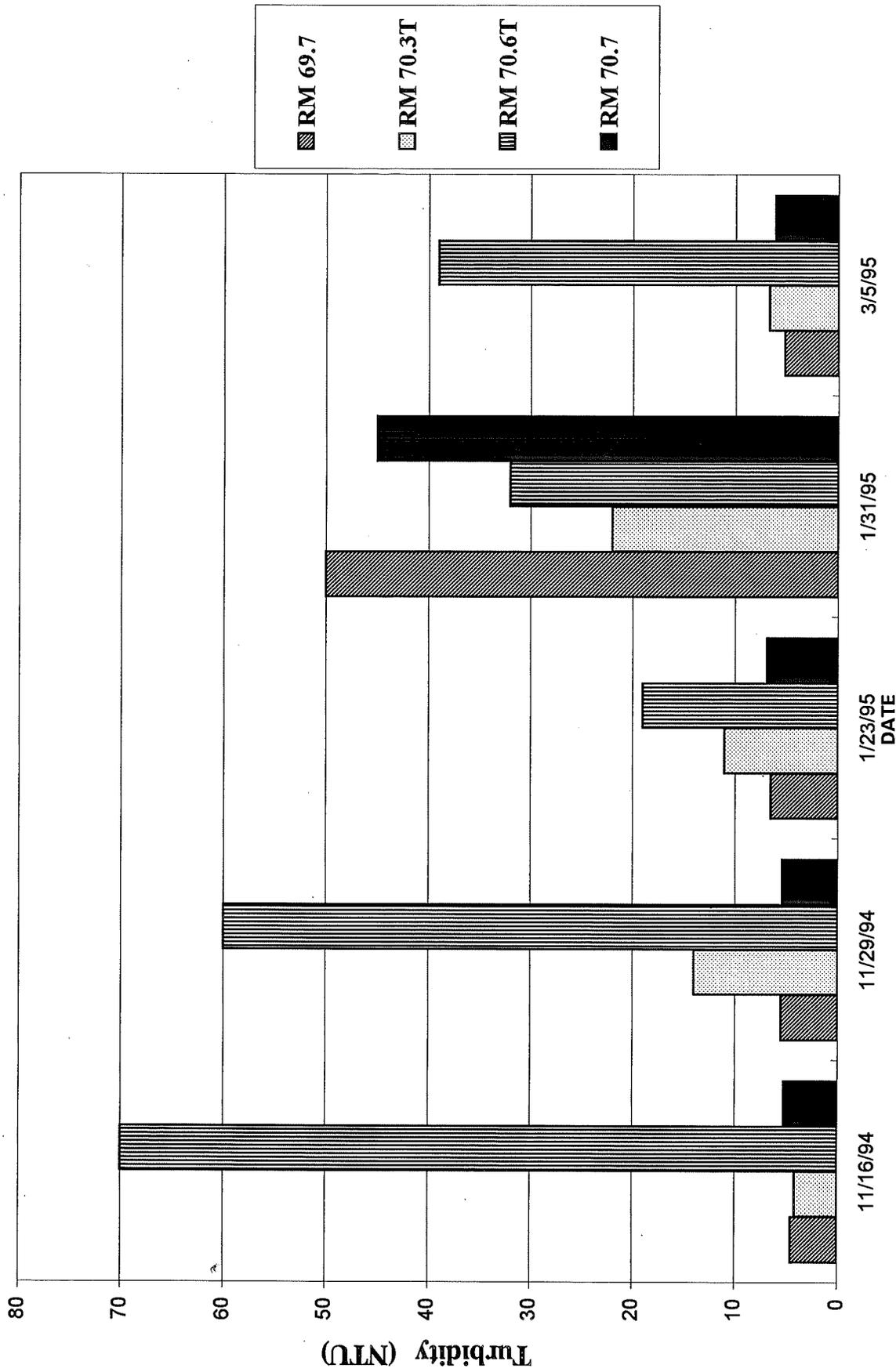


Figure 3.
Turbidity at four sampling sites in the mainstem Chehalis project area during winter 1994-95.

Nutrients

Total persulfate nitrogen, nitrate/nitrite, and ammonia were collected for all stations. Figure 5 shows nitrogen levels for each station. For the mainstem stations and the tributary at RM 70.3T, ammonia levels were minimal, ranging from below the detection limit of 0.010 mg/L to 0.083 mg/L. At the ditch, RM 70.6T, ammonia levels were much higher, ranging from 1.78 to 3.07 mg/L. The ammonia criteria for chronic toxicity were exceeded during four out of five sampling events in the ditch (Table 2). The ammonia criteria uses a calculation that factors in the fisheries resource, temperature, and pH to determine chronic and acute criteria for ammonia.

Nitrate/nitrite levels in the mainstem ranged from 0.635 to 0.868 mg/L. Nitrate/nitrite levels at tributary RM 70.3T tended to be higher ranging from 0.723 to 2.16 mg/L. Higher levels of nitrate/nitrite may be due to application of wastewater or fertilizer to fields adjacent to the creek (Brown and Caldwell, 1994). Since total persulfate nitrogen measures total organic and inorganic nitrogen, subtracting the inorganic portions (ammonium, nitrate, and nitrite) will give an idea of the organic nitrogen available. Organic nitrogen is found in soil organic matter, animal manure, crops, sewage sludge, and compost. Organic nitrogen at tributary RM 70.6T ranged from 1.172 to 7.372 mg/L, while the range at the other sites was from 0.007 to 0.420 mg/L.

The ditch at RM 70.6T had high levels of organic nitrogen and ammonia and lower levels of nitrate/nitrite relative to the other sites. This indicates loading of an organic nitrogen source and likely a lack of nitrification that would convert ammonia to nitrate. The lack of nitrification could be due to low dissolved oxygen, cold water, absence of nitrifying bacteria, or close proximity to the source.

Table 1. Fecal coliform results for mainstem Chehalis Project

Station	Exceeds geometric mean of 100 colonies /100 mL?	More than 10 % of all samples for calculating GM exceed 200 colonies/100mL?
Mainstem, RM 69.7	YES (GM=110)	YES (2 of 7 samples exceed 200)
Unnamed Creek RM 70.3T	NO (GM=36)	NO (none of 7 exceed)
Ditch RM 70.6T	YES (GM=3300)	YES (8 of 8 samples exceed 200)
Mainstem RM 70.7	YES (GM=120)	YES (1 of 6 samples exceed 200)

◆ Sampling Data ■ Geometric Mean

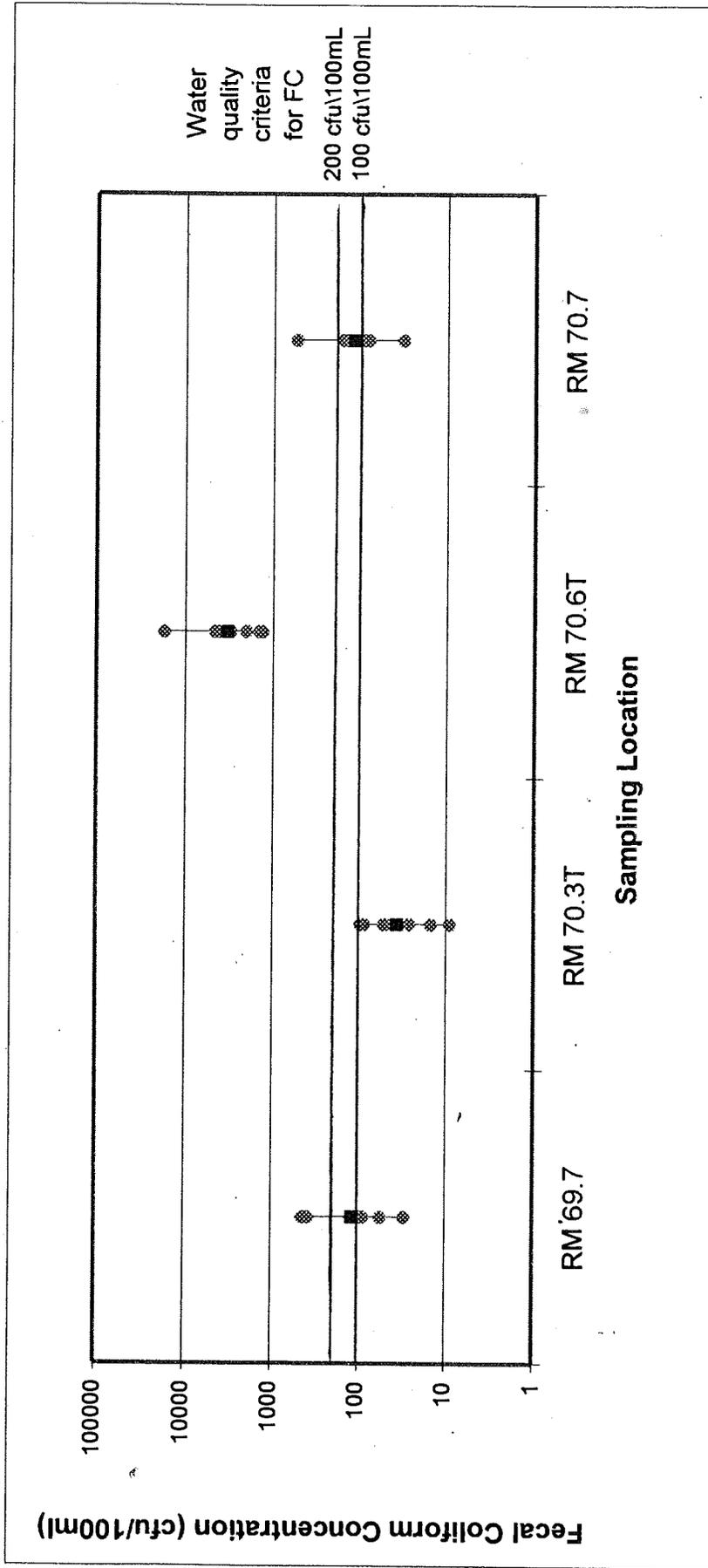


Figure 4.
Fecal coliform sample results at four sampling sites in the mainstem Chehalis project area during winter 1994-95.

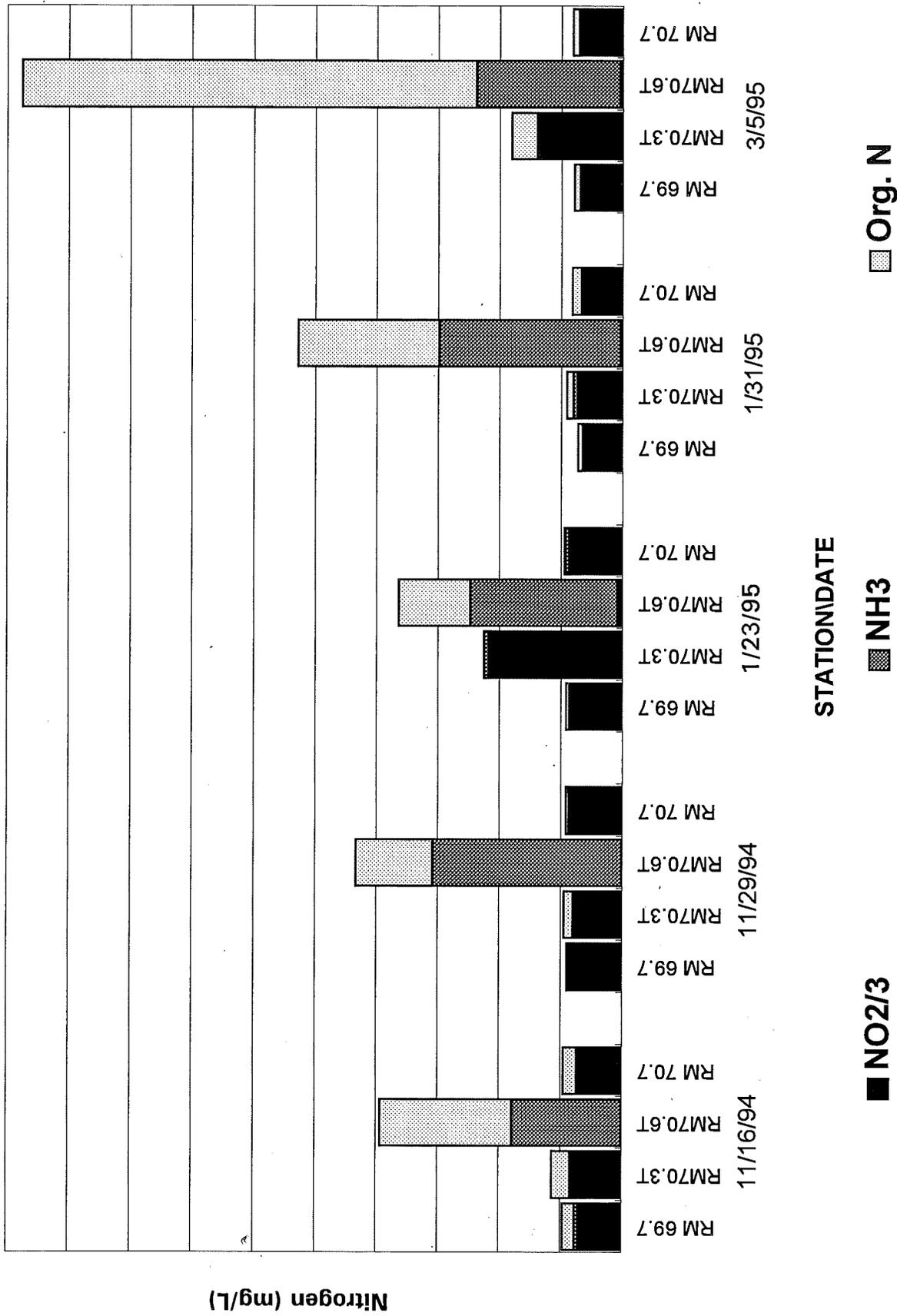


Figure 5.
Inorganic\organic nitrogen at four sampling sites in the mainstem Chehalis project area during winter 1994-95.

Conclusions

The ditch tributary at RM 70.6T exceeded fecal coliform and turbidity standards five out of five times, and chronic criteria for ammonia four out of five times. During all sampling events this tributary had higher fecal coliform, turbidity, conductivity, ammonia, and organic nitrogen levels than the unnamed tributary at RM 70.3T. The ditch tributary at RM 70.6T appears to be the suspected source of pollutant loading suggested by the results of the Chehalis TMDL study.

Water quality for the unnamed creek at RM 70.3T met Water Quality Standards in all cases. Nitrate/nitrite levels at times tended to be higher than the mainstem stations.

Both of the mainstem stations exceeded standards for fecal coliform. Turbidity and fecal coliform were highest on January 31, 1995 after heavy rainfall when the Chehalis River was near flood stage.

Table 2. Ammonia criteria and levels for site at RM 70.6T, mainstem Chehalis River project [Based on EPA (1986;1992)].

Date	Temp (°C)	pH	Sample total NH3 (mg/L)	Acute total NH3 criteria (mg/L)	Chronic total NH3 criteria (mg/L)
11/16/94	6.4	7.0	1.78	21.94	2.26
11/29/94	5.8	7.0	3.07	21.41	2.28
1/23/95	5.6	7.3	2.39	16.06	2.29
1/31/95	10.3	7.2	2.95	17.85	2.18
3/5/95	8.8	7.3	2.34	15.53	2.21

Recommendations

Ecology's Southwest Regional Office should investigate the source of ditch runoff at RM 70.6T, and initiate corrective action to eliminate pollutant loading problems.

Continue pre-BMP monitoring at tributary site RM 70.6T and the mainstem to better define baseline conditions. One more year of pre-BMP monitoring is recommended. After BMPs are in place two years of follow-up monitoring are recommended.

References

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Appendix A: Quality Assurance

Quality Assurance Procedures

Standard laboratory quality assurance (QA) procedures were followed for all samples, including calibration standards, spikes, and laboratory duplicates. All meters used in the survey were calibrated and used in accordance with user manuals. Field QA procedures are described in the QAPP (Sargeant, 1994).

Quality Assurance Results

To estimate the precision of field sampling the percent standard deviation or coefficient of variation (CV) was calculated for each replicate pair for the entire 1994-95 Chehalis BMP Evaluation Study. Replicates are two samples collected one after the other in the field.

The CV is calculated by dividing the standard deviation by the mean. This value is then multiplied by 100 so the CV can be expressed as a percentage. To evaluate the central tendency of CV values, both the mean and median were calculated. The mean and median were chosen rather than the root mean squared value (RMS), because values near the detection limit tend to skew the RMS value. Also, in Coots (1994), a mean CV was used to determine precision for fecal coliform data, and for the sake of comparability it was used here as well.

The mean and median CV for all fecal coliform replicates is shown in Table A-1. When bacteria densities are low (nearer the detection limit), a higher CV is expected (e.g., the CV for replicate samples with values of 1 and 2 is 47%, whereas the CV for 100 and 101 is 0.7%). Overall mean CV values for fecal coliform replicates in the Black River TMDL study were 20%, for fecal coliform densities > 100/100mL the mean CV was 14% while for fecal coliform densities < 100/100 mL the mean CV was 21%. Based on mean CV values from the Black River TMDL study, the fecal coliform replicate variability is considered acceptable.

The CV was also calculated for NH₃, NO₂/3, TPN, and turbidity. The mean and median are shown in Table A-1.

Table A-1. Precision as mean and Median CV

Parameter	Mean CV	Median CV	number of replicates
Fecal Coliform (FC)	15.5%	10.7%	n=54
FC ≤ 100cfu/100mL	20.7%	18.7%	n=34
FC > 100cfu/100mL	8.0%	6.4%	n=20
Ammonia	23.4%	6.6%	n=12
Nitrate/nitrite	2.4%	0.7%	n=15
Total persulfate nitrogen	7.2%	4.0%	n=16
Turbidity	1.5%	0.0%	n=13

The mean for all parameters except ammonia fell within reasonable limits, ten percent or less. For ammonia, three values at or near the detection limit tended to skew the mean. Since the variability near the reporting limit is high, results at this level need to be used with caution. For values above the reporting limit (beginning at 0.06 mg/L) the mean and median CV values for ammonia were calculated as 5.7% and 3.6% (n=7) respectively, indicating a reasonable level of precision.

Data qualifiers were reported with some data from the Chehalis mainstem project area, as indicated in Appendix B. All data are considered usable, subject to the qualification provided.

APPENDIX B

CHEHALIS MAINSTEM FIELD AND LABORATORY DATA

RM CODE	DATE	TIME	FIELD DATA				LABORATORY DATA							
			TEMP °C	pH	COND µmho/cm	TURB NTU	NH3 mg/L	NO2/3 mg/L	TPN mg/L	Organic N mg/L*	FC cfu/100mL			
69.7	11/16/94	9:10	7.4	7.3	87	4.5	< 0.010	0.054	0.701	0.697	0.959	0.204	120	
69.7	11/29/94	12:20	5.9	7.3	68	5.5	0.015	0.015	0.868		0.892	0.009	88	
69.7	1/23/95	13:35	5.2	7.6	61	6.5	< 0.010	< 0.010	0.857		0.917	0.05	29	
69.7	1/31/95	9:45	8.8	7.7	49	50	< 0.010	< 0.010	0.635		0.731	0.086	440 S	
69.7	3/5/95	13:05	6.1	7.6	71	5.2	< 0.010	< 0.010	0.684		0.792	0.098	55	
70.3T	11/16/94	11:44	7.3	6.9	133	4.1	< 0.010	< 0.010	0.829		1.14	0.301	26	
70.3T	11/29/94	13:15	7.1	6.9	120	14	< 0.010	< 0.010	0.792		0.951	0.149	88	
70.3T	1/23/95	14:30	5.1	7.5	120	11	0.083	0.083	2.16		2.25	0.007	49	
70.3T	1/31/95	10:30	9.8	7.4	71	22	0.063	0.063	0.723	0.743	0.903	0.117	96	
70.3T	3/5/95	13:45	7.0	7.3	120	6.7	< 0.010	< 0.010	1.38		1.81	0.420	9	
70.6T	11/16/94	12:08	6.4	7.0	260	70	1.78	1.78	< 0.010		3.94	2.15	2000	
70.6T	11/29/94	12:50	5.8	7.0	380	60	3.07	3.07	< 0.010		4.33	1.249	3900 S	
70.6T	1/23/95	14:03	5.6	7.3	186	19	2.39	2.39	0.078		3.64	1.172	1300 S	
70.6T	1/31/95	10:05	10.3	7.2	200	32	2.95	2.95	0.022		5.27	2.298	4300 S	
70.6T	3/5/95	13:25	8.8	7.3	230	39	2.34	2.34	0.038		9.75	7.372	17000	
70.7	11/16/94	11:55	7.4	7.5	87	5.2	0.038	0.038	0.688		0.945	0.219	160 S	
70.7	11/29/94	12:35	6.0	7.4	75	5.4	0.011	0.011	0.849		0.913	0.053	88	
70.7	1/23/95	13:50	5.2	7.7	60	6.9	0.052	0.052	0.864		0.940	0.024	79	
70.7	1/31/95	9:55	8.9	7.8	45	45	0.017	0.017	0.645		0.817	0.155	540	
70.7	3/5/95	13:15	6.0	7.6	66	6.1	< 0.010	< 0.010	0.699		0.813	0.104	32	

S Spreader colony present; number reported is likely underestimated.

< Less than the reported result

* Organic nitrogen was calculated by subtracting NH3 and NO2/3 from TPN

Appendix B.

Chehalis mainstem project area field and laboratory data for winter 1994-95.

Contacts: Debby Sargeant
Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600
(360) 407-6684

Paul Pickett
Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600
(360) 407-6685

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Barbara Tovrea, EILS Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
(360) 407-6696

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