Zinc, Copper, and Lead Concentrations in Quilceda and Allen Creeks

Results of Cooperative Monitoring by Snohomish County and the Washington State Department of Ecology

October 2001

Publication No. 01-03-031

printed on recycled paper

This report is available on the Department of Ecology home page on the World Wide Web at http://www.ecy.wa.gov/biblio/0103031.html

For additional copies of this publication, please contact:

Department of Ecology Publications Distributions Office
Address: PO Box 47600, Olympia WA 98504-7600
E-mail: ecypub@ecy.wa.gov
Phone: (360) 407-7472

Refer to Publication Number 01-03-031

Zinc, Copper, and Lead Concentrations in Quilceda and Allen Creeks

Results of Cooperative Monitoring by Snohomish County and the Washington State Department of Ecology

by

Art Johnson
Washington State Department of Ecology, Environmental Assessment Program

Kathy Thornburgh and Ellen Stewart
Snohomish County Public Works Department, Surface Water Management

October 2001

Waterbody Numbers: WA-07-1012, WA-07-1015

Publication No. 01-03-031
printed on recycled paper

This page is purposely blank for duplex printing

Table of Contents

List of Figures and Tables

Page

Figures

Tables

Abstract

Results are reported from a routine water quality monitoring program focused on zinc, copper, and lead concentrations in Quilceda and Allen creeks, two urban streams in Snohomish County, Washington. The data are examined for spatial and temporal trends, and compared to results from other western Washington creeks.

The highest metals concentrations were found in Allen Creek. Although elevated levels of total recoverable metals were occasionally observed, the dissolved fraction remained within state water quality standards. An analysis of historical data showed a significant decrease in total recoverable zinc and lead concentrations has occurred in both creeks. Recommendations include analyzing dissolved metals as part of the county's routine monitoring of lower Allen Creek and assessing the potential for sediment toxicity in these two drainages.

Acknowledgements

This report benefited from review by Dale Norton and Ralph Svrjcek. It was formatted by Joan LeTourneau.

Introduction

Snohomish County Surface Water Management began routine water quality monitoring of Quilceda and Allen creeks in 1992 as part of the County's Ambient Water Quality Program. The County selected streams in already populated or in rapidly developing areas for long-term monitoring. The monitoring was designed to establish baseline water quality data and to test for spatial and temporal trends in water quality parameters. The first three years of monitoring were funded by a Centennial Clean Water Fund grant from the Washington State Department of Ecology (Ecology).

The data showed a pattern of elevated zinc, copper, and lead concentrations (Thornburgh, 1996). As a result, Ecology considered placing Quilceda and Allen creeks on the 1998 Clean Water Act Section 303(d) list as being water quality limited for metals. However, because total recoverable rather than dissolved metals[1] had been analyzed, the results could not be directly compared to Washington State surface water aquatic life standards (Washington Administrative Code [WAC] Chapter 173-201A). Therefore it was determined that the data did not strictly meet 303(d) listing criteria.

The Ecology Northwest Regional Office remained concerned about the potential for adverse metals impacts to the biota in Quilceda and Allen creeks. They proposed a cooperative monitoring program by Snohomish County and Ecology's Environmental Assessment Program. Snohomish County was to conduct the field sampling and obtain data on total recoverable metals, ancillary water quality parameters, and flow. Ecology was to provide equipment and training for collecting low-level dissolved metals samples, following the guidance in EPA (1995a) *Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Levels*, and to analyze the dissolved samples. The objective was to collect accurate dissolved metals data at sufficiently low detection limits to determine compliance with state aquatic life standards.

1 In a total recoverable metals analysis, whole water samples are acidified in the field, then digested at the laboratory with a mixture of nitric and hydrochloric acids prior to analysis. Dissolved metals samples are filtered and acidified in the field, then analyzed directly.

Sampling Program

The locations of the water quality stations monitored cooperatively by Snohomish County and Ecology are shown in Figure 1 and described in more detail below.

1. Quilceda Creek Long-term Upstream station (QCLU): Located at 67th Ave. NE and 172nd St. NE; 48.152°N x 122.138°W. Sampled south of 172nd, upstream of culvert by railroad tracks.

2. Quilceda Creek Long-term Downstream station (QCLD): Located at 88th St. NE bridge; 48.076°N x 122.178°W. Sampled on upstream side of bridge.

3. Allen Creek Long-term Upstream station (ACLU): Located at 67th Ave. NE and 112th St. NE; 48.096°N x 122.138°W. Sampled downstream of culvert and upstream of small tributary that comes in along 112th – 5/92-9/98. Site moved to the south side of 100th St. NE in 10/98 and for present study.

4. Allen Creek Long-term Downstream station (ACLD): Located at 4th St. in Marysville; 48.051°N x 122.162°W. Sampled from the bridge in deepest part of channel or, for metals samples, by wading into the channel.

Water samples were collected by Snohomish County on five occasions at each of the above stations between June 2000 and April 2001. Parameters analyzed included zinc, copper, lead, hardness, temperature, pH, conductivity, dissolved oxygen, turbidity, total suspended solids, fecal coliform bacteria, nitrate, and total phosphorus. Dissolved metals and hardness were analyzed by Ecology's Manchester Environmental Laboratory. Total recoverable metals and the other parameters were analyzed by North Creek Analytical, Seattle (a Snohomish County contractor) or measured in the field by the County. Flows were recorded at the upper station on each creek, the lower stations being tidally influenced or difficult to gauge due to marshy conditions. Discharge estimates for lower Quilceda Creek were obtained from the County's gauges on the west and middle forks.

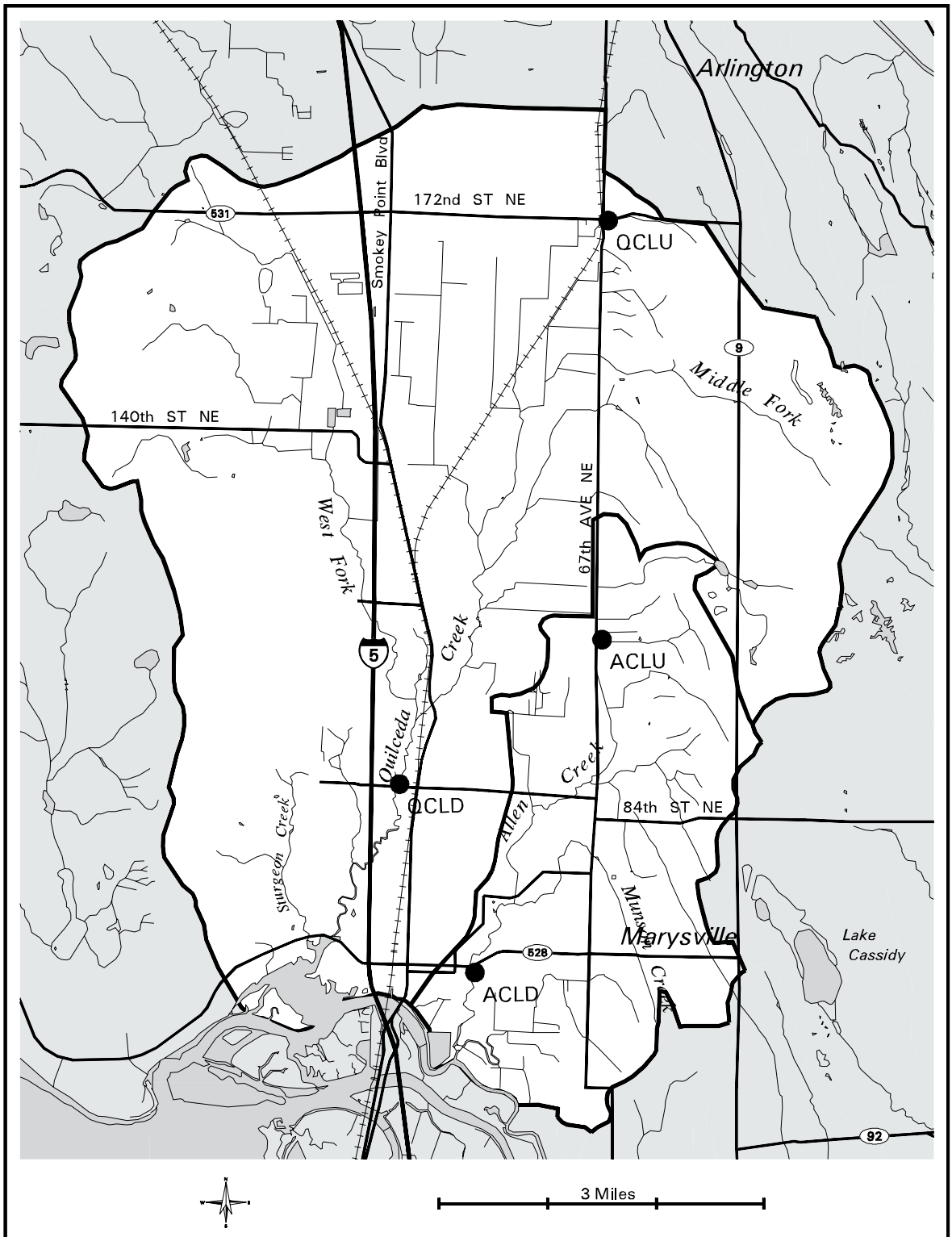

Figure 1. Snohomish County Monitoring Stations on Quilceda and Allen Creeks

This page is purposely blank for duplex printing

Field Methods

All samples were collected as simple grabs. Table 1 shows the sample containers, preservatives, and holding times for each parameter requiring laboratory analysis. The methods used to measure field parameters are shown in Table 2. Flows were gauged with a Swoffer model 2100 meter and top-setting rod.

Table 1. Sample Containers, Preservation, and Holding Time

Parameter	Container	Preservation	Holding Time
Dissolved metals	500 mL Teflon bottle	HNO_3 to pH<2, 4°C	6 months
Total recoverable metals	500 mL Teflon bottle	HNO_3 to pH<2, 4°C	6 months
Hardness	125 mL poly bottle	HNO_3 to pH<2, 4°C	6 months
Total suspended solids	500 mL Teflon bottle	cool to 4°C	7 days
Fecal coliform bacteria	200 mL sterile	HNO_3 to pH<2, 4°C	30 hours
Nitrate+nitrite-nitrogen	125 mL poly bottle	H_2SO_4 to pH<2, 4°C	28 days
Total phosphorus	125 mL poly bottle	HNO_3 to pH<2, 4°C	28 days

Table 2. Field Measurement Methods

Parameter	Method	Detection Limit
Temperature	meter - YSI model 55	0.1° C
Dissolved oxygen	EPA 360.1/2 meter - YSI model 50B	0.1 mg/l
Conductivity	EPA 120.1 meter - Hanna HI 9533	1 µmhos/cm
pH	meter - Hanna model HI 9023 microcomputer	0.05 pH unit
Turbidity	meter - LaMotte model 2008	1 NTU

Sampling methods for dissolved metals followed the guidance in EPA Method 1669. Metals samples were collected by hand into pre-cleaned 1.0 liter Teflon bottles. The samples were taken away from the bank by wading into the stream. After collection, the sample was split 50:50 for total recoverable and dissolved metals.

The dissolved metals samples were filtered in the field through a pre-cleaned 0.45 µm Nalgene filter unit (#450-0045, type S). The filtrate was transferred to a pre-cleaned 500 mL Teflon bottle and preserved to pH <2 with sub-boiled nitric acid, carried in small Teflon vials, one per sample. Teflon sample bottles, Nalgene filters, and Teflon acid vials were obtained from Manchester Laboratory, cleaned as described in Kammin et al. (1995), and sealed in plastic bags.

Non-talc nitrile gloves were worn by personnel filtering the samples. Filtering was done in a glove box constructed of a PVC frame and polyethylene cover. Each dissolved metals sample was placed in double polyethylene bags and held on ice for transport to Manchester Laboratory.

Laboratory Methods

The analytical methods used are shown in Table 3.

Table 3. Laboratory Methods

Analysis	Method	Method No.	Detection Limit
Total Recoverable Zinc	Digestion, ICP/MS	EPA 200.8	10 µg/L
Total Recoverable Copper	Digestion, ICP/MS	EPA 200.8	1 µg/L
Total Recoverable Lead	Digestion, ICP/MS	EPA 200.8	1 µg/L
Dissolved Zinc	ICP/MS	EPA 200.8	0.5 µg/L
Dissolved Copper	ICP/MS	EPA 200.8	0.05 µg/L
Dissolved Lead	ICP/MS	EPA 200.8	0.02 µg/L
Hardness	ICP	SM2340B	1 mg/L
Total suspended solids	Gravimetric	EPA 160.2	4 mg/L
Fecal coliform bacteria	Membrane filter	SM9222	1 colony/100 mL
Nitrate+nitrite-nitrogen	Automated cadmium reduction	EPA 353.2	10 µg/L
Total phosphorus	Persulfate digestion, automated ascorbic acid	EPA 365.2	2 µg/L

This page is purposely blank for duplex printing

Quality of Metals Data

Holding Time

All metals were analyzed within the 180-day holding time specified by EPA.

Method Blanks

Method blanks were analyzed with each sample set (Table 4). Zinc, copper, and lead were at or below detection limits in all cases.

Table 4. Method Blanks (µg/L)

Sample Set	Total Recoverable			Dissolved		
	Zinc	Copper	Lead	Zinc	Copper	Lead
13-Jun-00	4.3	0.6	0.3	<0.4	<0.05	<0.02
3-Aug-00	9.4	0.4	0.3	<0.4	<0.1	<0.02
7-Nov-00	<10	<1	<1	<0.4	<0.05	<0.02
8-Feb-01	<10	<1	<1	<0.1	<0.02	<0.02
10-Apr-01	<10	<1	<1	<0.1	<0.02	<0.02

Matrix Spikes

Selected water samples were spiked with known concentrations of the metals of interest to assess bias from interferences in the sample matrix (Table 5). The spiking level for total recoverable metals was 200 µg/L. Spiking levels in the dissolved metals analyses were 10 µg/L for zinc and copper, and 1 µg/L for lead.

Recoveries were 73 - 109% in the total recoverable analyses and 85 - 116% in the dissolved analyses. Method acceptance criteria are 75 - 125%. Precision estimates based on duplicate matrix spike recoveries were well within the acceptance criterion of +/-20%.

Table 5. Matrix Spike Recoveries (%)

Sample Type	Sample Set	Total Recoverable			Dissolved		
		Zinc	Copper	Lead	Zinc	Copper	Lead
Matrix Spike	13-Jun-00	109	106	102	90	85	92
Matrix Spike Duplicate	13-Jun-00	109	105	101	98	86	92
RPD		0.4%	0.9%	1.5%	8.5%	1.2%	0%
Matrix Spike	3-Aug-00	73	83	84	109	99	105
Matrix Spike Duplicate	3-Aug-00	82	92	96	116	103	107
RPD		11%	11%	13%	6.2%	1.9%	6.2%
Matrix Spike	7-Nov-00	96	103	109	102	87	96
Matrix Spike Duplicate	7-Nov-00	97	102	105	101	89	100
RPD		0.8%	1.3%	3.6%	1.0%	2.3%	4.1%
Matrix Spike	8-Feb-01	100	108	102	104	97.8	96.8
Matrix Spike Duplicate	8-Feb-01	99.5	108	106	96.5	95.6	96.3
RPD		0.5%	0.5%	3.8%	7.5%	2.3%	0.5%
Matrix Spike	10-Apr-01	86.8	98.0	113	92	97.3	96.8
Matrix Spike Duplicate	10-Apr-01	86.8	99.5	114	90	98.9	101
RPD		0%	1.5%	0.9%	2.2%	1.6%	4.2%

Laboratory Control Samples/Standard Reference Material

A laboratory control sample was analyzed with each total recoverable sample set (Environmental Express Custom Mix #HP1583-A-250 at 200 µg/L concentration). Recoveries of 95 - 108% were achieved (Table 6).

A standard reference material (SRM; River Water Reference Material for Trace Metals [SLRS-4], National Research Council Canada) was analyzed with each set of dissolved metals samples. This material has low certified values for zinc, copper, and lead, in the range normally encountered in uncontaminated rivers and streams. The results showed close agreement with certified values (Table 7). The SRM was analyzed in duplicate for the April and February sample sets. Results showed excellent precision.

Table 6. Recoveries in Laboratory Control Samples (%)

Sample Set	Total Recoverable		
	Zinc	Copper	Lead
13-Jun-00	105	107	104
3-Aug-00	97.0	98.5	95.0
7-Nov-00	102	108	106
8-Feb-01	98.0	100	104
10-Apr-01	101	106	102

Table 7. Results on Standard Reference Material* (µg/L)

Sample Set	Dissolved		
	Zinc	Copper	Lead
13-Jun-00	1.39	1.84	0.093
3-Aug-00	0.93	1.81	0.086
7-Nov-00	1.03	1.62	0.076
8-Feb-01	0.88	1.75	0.080
" dup.	0.83	1.77	0.080
10-Apr-01	0.88	1.75	0.080
" dup.	0.83	1.77	0.080
certified value =	0.93+/-0.10	1.81+/-0.08	0.086+/-0.007

*SLRS-4 (River Water Reference Material for Trace Metals, Nat. Res. Council Canada)

Field Blanks

Field blanks were analyzed to detect metals contamination arising from sample containers, preservation, or the filtration procedure. Bottle blanks for dissolved metals were prepared at Manchester Laboratory by filling the 500 mL Teflon sample bottles with deionized water. Filter blanks were prepared by filtering half the contents of a bottle blank, the remainder being analyzed as the bottle blank for that sample set.

Filter blanks were analyzed on three occasions during the project, and a bottle blank was analyzed once (Table 8). Metals concentrations in the filter blanks were comparable to the bottle blank, showing the filtration procedure was not contributing significant amounts of metals to the samples.

Table 8. Field Blanks (µg/L)

Sample Type	Sample Set	Dissolved Zinc	Dissolved Copper	Dissolved Lead
Bottle Blank	13-Jun-00	<0.4	<0.05	<0.02
	8-Feb-01	na	na	na
	10-Apr-01	na	na	na
Filter Blank	13-Jun-00	0.91	0.068	0.029
	8-Feb-01	0.20	<0.02	<0.02
	10-Apr-01	0.31	0.037	<0.02

na = not analyzed

Filter blank results for copper and lead were insignificant relative to field samples. Except for the June filter blank, the results for zinc were also well below the levels seen in field samples. The filter blank result for June suggests that some of the dissolved zinc data reported here could be biased slightly high.

A bottle blank analyzed with the total recoverable samples had 0.64 µg/L zinc, 0.18 µg/L copper, and 0.023 µg/L lead. Again, these concentrations are insignificant relative to field samples.

Field Replicates

The variability of the data (field + laboratory) can be assessed from results on replicate samples collected approximately five minutes apart on three occasions at each creek (Table 9). Agreement between replicates was generally within 20% for both total recoverable and dissolved metals. Greater variability was encountered for zinc than for copper or lead, with several zinc replicates differing by 76 - 89%.

Table 9. Variability Between Replicates (ug/L)

Station	Date	Total Recoverable			Dissolved		
		Zinc	Copper	Lead	Zinc	Copper	Lead
Quilceda Creek							
QCLU	13-Jun-00	4.6	1.1	0.43	1.7	0.27	0.051
QCLU-rep	13-Jun-00	12	1.0	0.43	2.3	0.19	0.046
	RPD* =	89%	10%	0%	30%	35%	10%
QCLU	3-Aug-00	2.8	0.83	0.21	0.63	0.27	<0.02
QCLU-rep	3-Aug-00	2.4	0.93	0.17	0.74	0.31	<0.02
	RPD =	15%	11%	21%	16%	14%	0%
QCLU	7-Nov-00	2.8	0.56	0.11	0.62	0.28	<0.02
QCLU-rep	7-Nov-00	3.9	0.60	0.13	0.57	0.28	<0.02
	RPD =	33%	7%	17%	8%	0%	0%
Allen Creek							
ACLU	8-Feb-01	7.0	3.5	0.24	na	na	na
ACUL-rep	8-Feb-01	6.7	3.8	0.70	na	na	na
	RPD =	4%	8%	98%			
ACLD	8-Feb-01	6.3	2.1	0.24	1.4	1.4	0.032
ACLD-rep	8-Feb-01	4.7	1.9	0.23	1.3	1.4	0.031
	RPD =	29%	10%	4%	7%	0%	3%
ACLD	10-Apr-01	3.2	1.9	0.16	1.5	1.4	0.037
ACLD-rep	10-Apr-01	8.3	2.3	0.17	3.2	1.4	0.032
	RPD =	89%	19%	6%	76%	0%	14%

*RPD = range as percent of replicate mean
na = not analyzed

This page is purposely blank for duplex printing

Results and Discussion

Stream Flow and General Water Quality Conditions

Flows measured during the project were representative of general flow conditions measured in the creeks by Snohomish County (1998). Table 10 compares the average flows during the project to average annual flows and the project maximum flows to one-year flood events. No flood events were sampled during the project. The project average flows were less than the annual averages reported by the County.

Table 10. Flow Comparison (cubic feet per second)
[Annual Average and One-Year Flood are from Snohomish County, 1998.]

Station	Project Average	Annual Average	Project Maximum	One-Year Flood
Quilceda Creek				
QCLU	1.6	5.6	2.7	59
QCLD	20.1	27.8	44	95
Allen Creek				
ACLU	3.3	4.5	9	16

The data for conventional water quality parameters are shown in Table 11. Table 11 also compares the mean value for the five sampling events during the project to the long-term mean from the County's ambient monthly sampling from 1992 through 2001. A two-sample Student's t-Test showed no significant difference between project and long-term means for any parameters at any site. This result indicates that the range of water quality parameters measured during the project were representative of those measured during the long-term period of sampling.

There were no significant differences in temperature, conductivity, turbidity, total suspended solids, or nitrate-nitrite between streams or between sites within a stream. Temperature and turbidity remained within state standards for Class A streams. Quilceda Creek had a higher pH than Allen Creek (Mann-Whitney test, $p<.01$), but all pH measurements met state standards.

Table 11. General Water Quality Parameters

Station	Date	Flow (CFS)	Temp. (^{o}C)	pH (S.U.)	Conduct. (umhos/cm)	D.O. (mg/L)
Quilceda Creek						
QCLU	13-Jun-00	1.7	10.7	7.8	132	10.8
"	3-Aug-00	0.69	12.9	7.9	159	10.4
"	7-Nov-00	0.66	8.3	7.8	162	12.5
"	8-Feb-01	2.3	4.9	7.4	114	11.5
"	10-Apr-01	2.7	7.4	7.2	90	12.7
	Project mean	1.6	8.8	7.6	131	11.6
	Long-term mean	5.6	9.2	7.3	117	10.9
QCLD*	13-Jun-00	14.4	12.0	7.5	161	9.3
"	3-Aug-00	7.1	15.5	7.2	191	8.9
"	7-Nov-00	6.1	7.9	7.1	201	10.8
"	8-Feb-01	29	4.4	7.3	150	10.5
"	10-Apr-01	44	8.1	7.2	137	11.2
	Project mean	20.1	9.6	7.3	168	10.2
	Long-term mean	27.8	9.9	7.2	151	9.6
Allen Creek						
ACLU	13-Jun-00	1.5	11.8	7.1	147	7.3
"	3-Aug-00	0.38	14.6	7.2	179	5.9
"	7-Nov-00	1.1	7.4	7.2	193	9.7
"	8-Feb-01	4.4	4.8	6.9	192	9.0
"	10-Apr-01	9.0	7.8	6.6	152	10.2
	Project mean	3.3	9.3	7.0	173	8.4
	Long-term mean	4.5	9.7	6.9	143	8.3
ACLD	7-Nov-00	na	8.3	7.1	186	5.7
"	13-Jun-00	na	12.5	6.8	153	4.3
"	3-Aug-00	na	14.7	6.8	183	2.3
"	8-Feb-01	na	4.0	7.2	166	8.5
"	10-Apr-01	na	8.4	7.0	147	7.0
	Project mean	na	9.6	7.0	167	5.6
	Long-term mean	na	10	6.8	159	4.5

na = not analyzed
*combined flows for middle and west fork

Table 11. (continued)

Station	Date	Turbidity (NTU)	Total Suspended Solids (mg/L)	Fecal Coliform Bacteria* (col./100mL)	Nitrate+ Nitrite-Nitrogen (mg/L)	Total Phosphorus (mg/L)
Quilceda Creek						
QCLU	13-Jun-00	1.3	na	na	na	na
"	3-Aug-00	0.8	na	na	na	na
"	7-Nov-00	0.9	na	na	na	na
"	8-Feb-01	6.5	12	na	na	na
"	10-Apr-01	5.1	11	na	na	na
	Project mean	2.9	12	na	na	na
	Long-term mean	2.5	7	na	na	na
QCLD	13-Jun-00	5.6	7	240	0.88	0.13
"	3-Aug-00	4.0	1	59	0.91	0.12
"	7-Nov-00	2.8	4	57	0.80	0.09
"	8-Feb-01	5.7	4	260	1.1	0.09
"	10-Apr-01	8.0	12	150	1.1	0.10
	Project mean	5.2	6	126	0.94	0.11
	Long-term mean	6.0	6	260	1.1	0.11
Allen Creek						
ACLU	13-Jun-00	2.3	3	450	0.39	0.14
"	3-Aug-00	6.1	4	270	0.17	0.15
"	7-Nov-00	1.2	2	54	0.45	0.14
"	8-Feb-01	3.1	2	270	3.4	0.10
"	10-Apr-01	3.9	3	63	2.4	0.12
	Project mean	3.3	3	162	1.4	0.13
	Long-term mean	3.5	3	437	0.9	0.18
ACLD	7-Nov-00	1.1	1	4	0.97	0.10
"	13-Jun-00	2.8	0	38	0.88	0.12
"	3-Aug-00	2.3	2	77	1.2	0.12
"	8-Feb-01	1.4	1	55	2.3	0.06
"	10-Apr-01	1.4	7	36	1.5	0.06
	Project mean	1.8	2	30	1.4	0.09
	Long-term mean	4.1	14	365	1.5	0.15

na = not analyzed
*geometric mean used for fecal coliform data

Dissolved oxygen was higher in Quilceda Creek than in Allen Creek (Mann Whitney test, $p<.01$), and higher upstream in Allen Creek than at the downstream site (Mann-Whitney test, $p<.05$). The extreme low oxygen levels measured in lower Allen Creek are a result of marshy conditions and the tide gate at the mouth of the creek. The state standard of 8.0 mg/L was not met at lower Allen Creek on four of the five sampling events and twice in upper Allen Creek.

Both bacteria and phosphorus were higher in upper Allen Creek than at the lower site (Mann-Whitney test, $p<.05$), probably as a result of commercial agricultural operations upstream of the upper site. Upper Allen Creek and lower Quilceda Creek exceeded the Class A standard for fecal coliform bacteria (geometric mean <100 colonies/100 mL and not more than 10% of samples can exceed 200 colonies/100 mL).

Metals Concentrations

The metals data are in Tables 12 and 13. As is typical of most rivers and streams, concentrations decreased in the order zinc > copper > lead. Median concentrations of total recoverable metals were in the range of 3.4 - 5.9 µg/L zinc, 1.1 - 2.1 µg/L copper, and 0.24 - 0.43 µg/L lead. For dissolved metals the medians were 1.0 - 2.5 µg/L zinc, 0.29 - 1.5 µg/L copper, and 0.041 - 0.075 µg/L lead. The highest concentrations tended to occur in the winter and spring.

Although the peak metal concentration was often recorded at the downstream station, overall there were no significant differences between the levels of total recoverable or dissolved metals in upstream vs. downstream samples for either creek (Mann-Whitney test, $p>.05$; detection limit used for two non-detected values for lead).

There were, however, significant differences between creeks (Mann-Whitney, $p<.05$). Total recoverable and dissolved copper were, on average, twice as high in Allen Creek compared to Quilceda Creek. Dissolved zinc was also higher in Allen Creek, again by about a factor of 2. No significant between-creek differences were seen for lead or for total recoverable zinc. These findings can be better visualized in Figure 2[2] (note that the scales are different for total recoverable and dissolved).

The reasons for the higher metals concentrations in Allen Creek are unclear. Allen Creek has had more recent residential development that is more concentrated in a smaller watershed than Quilceda. On the other hand, Quilceda has commercial and industrial development upstream of the sampling sites while Allen does not. Land use in the Allen Creek watershed is residential or agricultural upstream of the sampling sites.

[2] In these box plots, the median is the center horizontal line. The ends of the box mark the first and third quartiles (25% and 75% of values; i.e., 50% of the values lie within the box). The whiskers show the range of values that fall within 1.5 times the interquartile or midrange. Outside values and far outside values are represented by an * and o, respectively.

Table 12. Metals and Hardness Results (metals in µg/L, hardness in mg/L)

Station	Date	Zinc		Copper		Lead		Hardness
		Tot. Rec.	Dissolved	Tot. Rec.	Dissolved	Tot. Rec.	Dissolved	
Quilceda Creek								
QCLU	13-Jun-00	8.0	2.0	1.1	0.23	0.43	0.049	61
"	3-Aug-00	2.6	0.69	0.88	0.29	0.19	<0.020	31
"	7-Nov-00	3.4	0.60	0.58	0.28	0.12	<0.020	84
"	8-Feb-01	6.1	0.82	1.6	0.58	1.1	0.096	46
"	10-Apr-01	3.2	0.99	1.1	0.59	0.61	0.074	40
QCLD	13-Jun-00	7.7	3.7	1.1	0.31	0.34	0.15	59
"	3-Aug-00	3.2	1.1	1.0	0.61	0.22	0.067	79
"	7-Nov-00	3.6	0.70	0.67	0.46	0.16	0.029	83
"	8-Feb-01	7.9	1.8	3.7	0.69	0.55	0.057	62
"	10-Apr-01	5.9	1.5	1.6	0.83	0.35	0.063	60
Allen Creek								
ACLU	13-Jun-00	5.4	3.0	1.7	1.0	0.65	0.11	72
"	3-Aug-00	4.0	1.1	1.7	0.68	0.24	0.027	51
"	7-Nov-00	3.6	1.7	2.0	1.5	0.09	0.023	95
"	8-Feb-01	6.8	2.9	3.6	2.6	0.47	0.041	82
"	10-Apr-01	6.1	3.7	3.1	2.5	0.16	0.051	72
ACLD	13-Jun-00	6.4	2.4	2.7	0.92	0.63	0.075	69
"	3-Aug-00	5.1	3.1	1.3	0.76	1.1	0.24	27
"	7-Nov-00	29	2.1	5.5	0.86	8.3	0.46	87
"	8-Feb-01	5.5	1.3	2.0	1.4	0.23	0.032	75
"	10-Apr-01	5.8	2.3	2.1	1.4	0.16	0.034	67

Table 13. Summary Statistics for Metals (µg/L)

Station	Metal	Total Recoverable			Dissolved		
		mean	median	maximum	mean	median	maximum
QCLU	Zinc	4.7	3.4	8.0	1.0	0.82	2.0
	Copper	1.0	1.1	1.6	0.39	0.29	0.59
	Lead	0.49	0.43	1.1	0.052	0.049	0.10
QCLD	Zinc	5.6	5.9	7.9	1.8	1.5	3.7
	Copper	1.6	1.1	3.7	0.58	0.61	0.83
	Lead	0.32	0.34	0.55	0.073	0.063	0.15
ACLU	Zinc	5.2	5.4	6.8	2.5	2.9	3.7
	Copper	2.4	2.0	3.6	1.7	1.5	2.6
	Lead	0.32	0.24	0.65	0.050	0.041	0.11
ACLD	Zinc	10	5.8	29	2.3	2.3	3.1
	Copper	2.7	2.1	5.5	1.1	0.92	1.4
	Lead	2.1	0.63	8.3	0.17	0.075	0.46

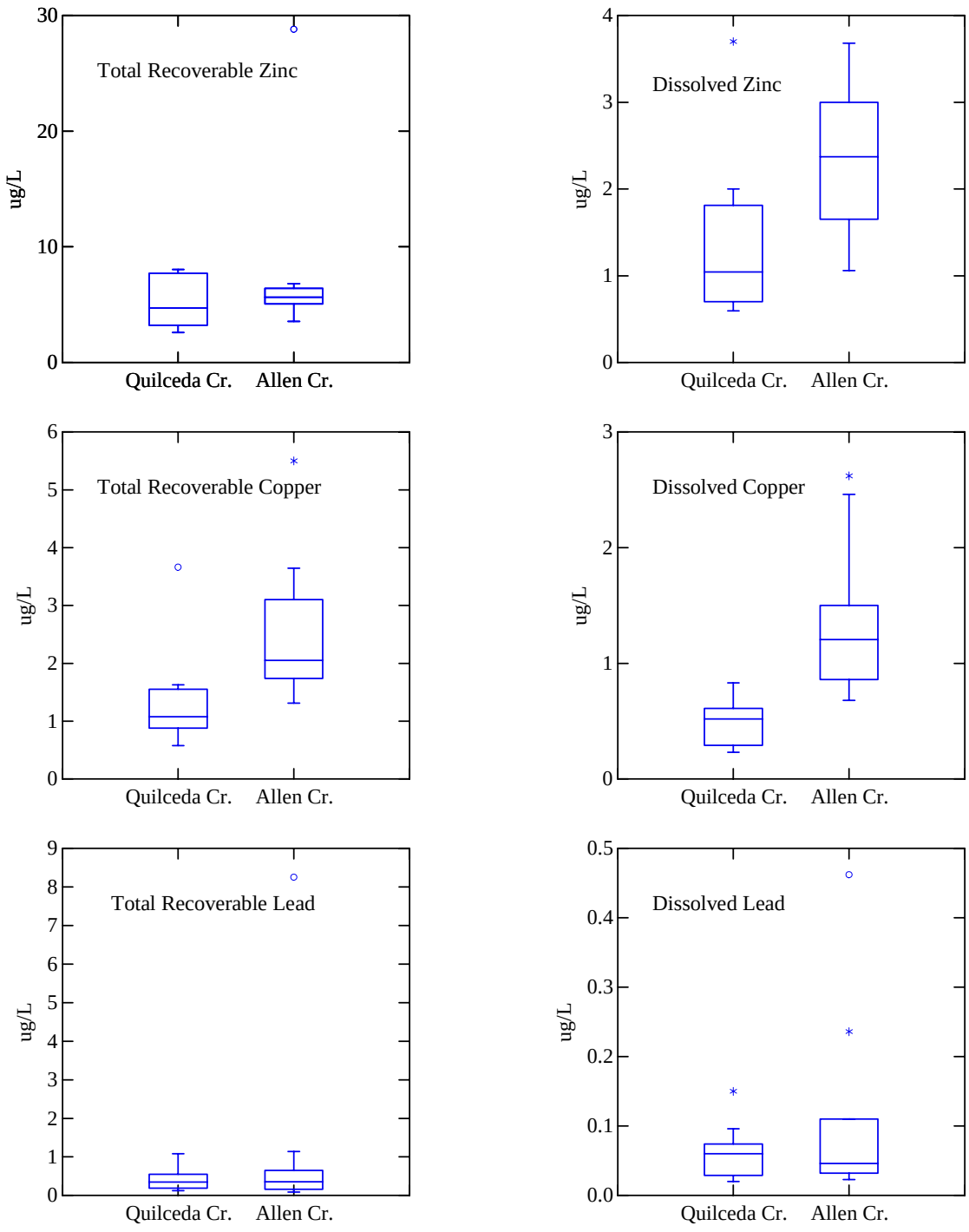

Figure 2. Comparison of Metals Concentrations in Quilceda and Allen Creeks.

Comparison to Aquatic Life Standards

Washington State surface water aquatic life standards (WAC Chapter 173-201A) for zinc, copper, and lead are for the dissolved form of the metal. For these metals the standards vary with hardness, metals toxicity generally decreasing with increasing hardness. Equations for calculating the hardness-dependent standards are in Appendix A.

Table 14 shows how dissolved metals concentrations in Quilceda and Allen creeks compared to the standards. No exceedances of water quality standards were encountered in the present study. In most cases, dissolved zinc, copper, and lead concentrations were lower than the chronic standard by a factor of 10 or more. The acute standards were never approached.

Table 14. Metals Concentration Ranges and Associated State Water Quality Standards (µg/L)

Metal	Quilceda Creek	Allen Creek
Dissolved Zinc	0.60 - 3.7	1.1 - 3.7
Chronic standards*	39 - 90	34 - 100
Acute standards**	42 - 99	38 - 110
Dissolved Copper	0.23 - 0.83	0.68 - 2.6
Chronic standards*	4.2 - 9.8	3.7 - 11
Acute standards**	5.6 - 14	5.0 - 16
Dissolved Lead	<0.020 - 0.15	0.23 - 0.46
Chronic standards*	0.69 - 2.1	0.59 - 2.4
Acute standards**	18 - 53	15 - 61

Note: Standards ranges shown are for minimum and maximum hardness values.

*Four-day average not to be exceeded more than once every three years on average

**One-hour average not to be exceeded more than once every three years on average

Figure 3 shows a more detailed comparison of dissolved metals concentrations with the chronic standards. The hardness measured in each sample was used to calculate the appropriate criterion. The criterion was then divided by the sample concentration and the results plotted. Metals concentration / standard ratios greater than 1 would exceed the standard.

As shown in the figure, dissolved copper and lead concentrations in Allen Creek occasionally reached levels that were about 1/3 the chronic standard. The dissolved copper and lead concentrations in Quilceda Creek were always less than 1/5 the chronic standard. Dissolved zinc levels remained at or below 1/10 the chronic standard in both creeks.

Total Recoverable vs. Dissolved Metals

A strong relationship between the concentrations of total recoverable and dissolved metals was not consistently observed. Regression lines, 90% confidence intervals, and correlation coefficients[3] are shown for each creek in Figure 4. In Allen Creek, correlations ranged from highly positive for lead ($r^2 = 0.94$) to weak or no correlation for zinc and copper ($r^2 = -0.02$ and -0.26, respectively). [The correlations for zinc and copper improve to 0.59 and 0.85, respectively, if the two outliers are excluded.] Somewhat better correlations were found for Quilceda Creek ($r^2 = 0.46$ to 0.75). Contrary to what might be expected, total recoverable metals were poorly correlated with suspended solids ($r^2 = 0.04$ to -0.016, data not shown in figure).

Although necessary for a determination of compliance with standards, an analysis of the dissolved metals fraction alone would have failed to detect the several spikes in metals concentrations that occurred in the drainage. For example, total recoverable zinc and lead concentrations in lower Allen Creek reached 29 µg/L and 8.3 µg/L, respectively, in November.

Comparison to Other Local Streams

Table 15 summarizes Ecology data on dissolved zinc, copper, and lead in other western Washington streams and compares them to data on Quilceda and Allen creeks. The studies from which these data were obtained used the same field methods as in the present monitoring program. Laboratory analysis was also similar, except that there was an improvement in the instrument blank within the last year.

As can be seen in the table, the metals concentrations in most of these creeks are similar. The dissolved zinc, copper, and lead concentrations typical of Quilceda and Allen creeks fall in the middle to upper range of values from other local streams.

[3] A correlation coefficient (r^2) of +1 indicates one variable can be predicted perfectly for a positive linear function of another, and vice versa. A value of –1 indicates the same, except the relationship is inverse.

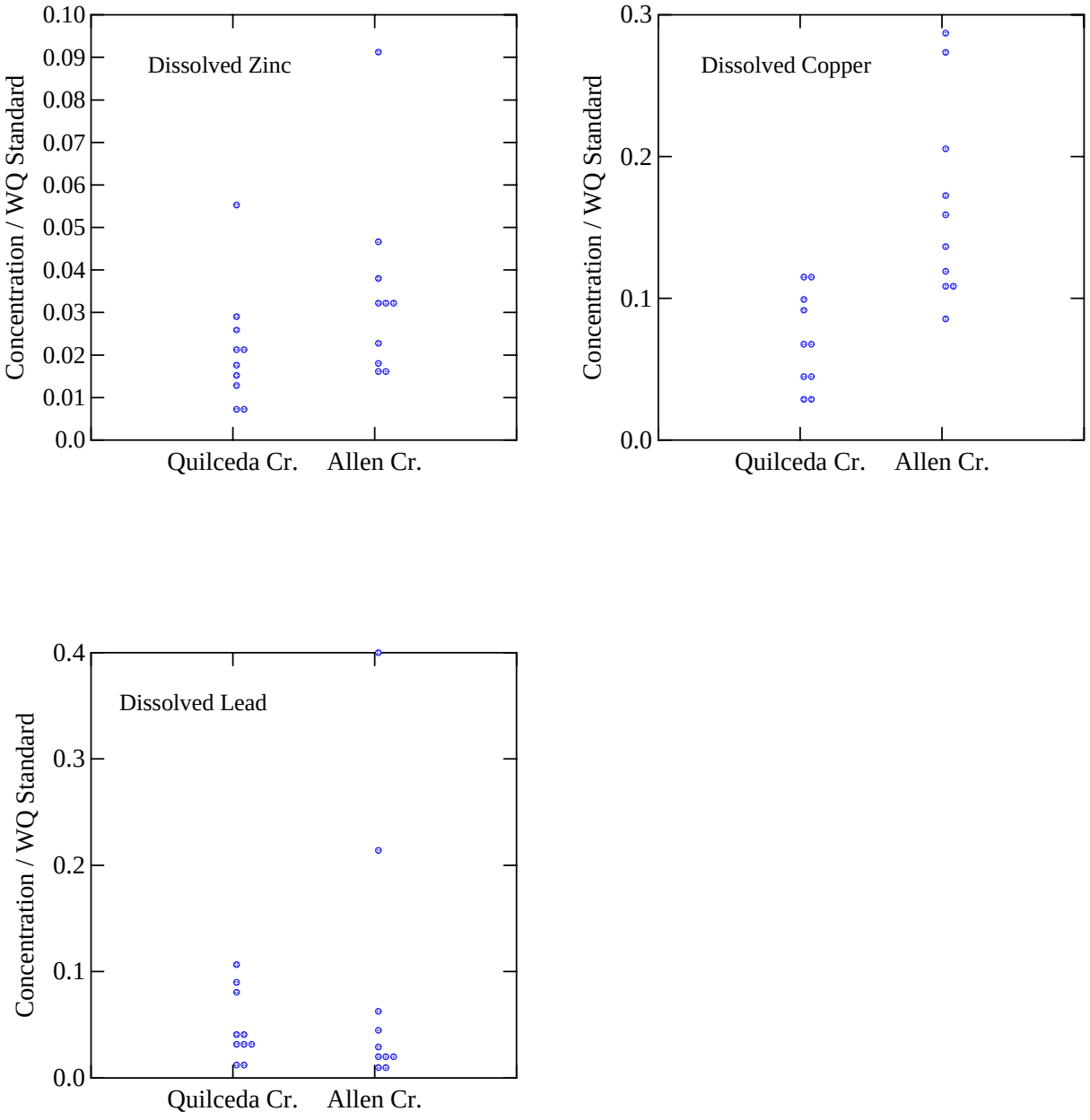

Figure 3. Dissolved Metals Concentrations / Chronic Water Quality Standard Ratios for Quilceda and Allen Creeks (ratios >1 would exceed standards).

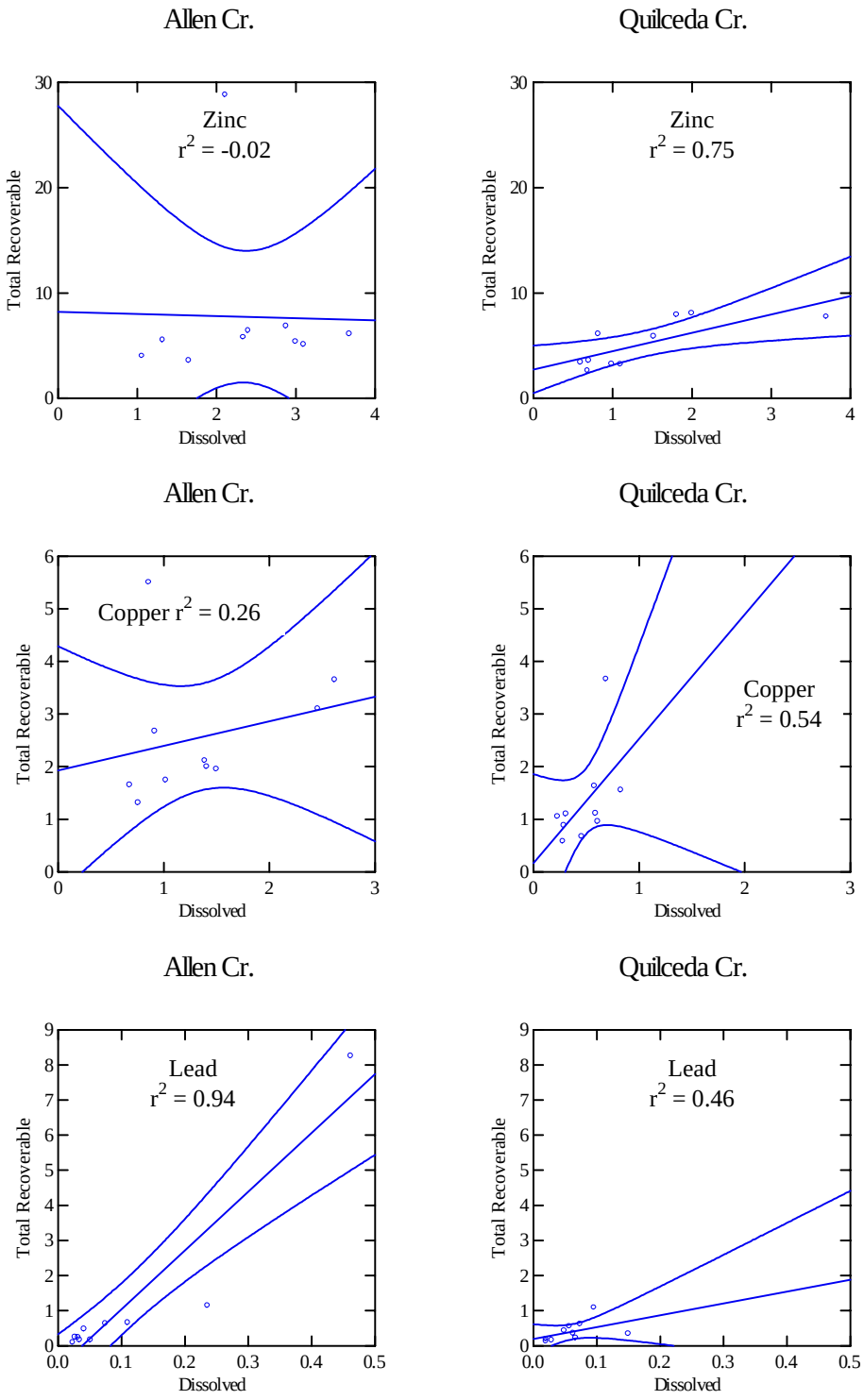

Figure 4. Relationships between Total Recoverable and Dissolved Metals in Quilceda and Allen Creeks (regression line with 90% confidence interval; µg/L)

Table 15. Summary of Recent Ecology Data on Dissolved Zinc, Copper, and Lead Concentrations in Western Washington Streams (medians in µg/L)

Waterbody	County	Year	N =	Zinc	Copper	Lead	Reference
Clover Creek	Pierce	1995	4	3.1	0.84	0.53	Johnson (1996)
Chambers Creek	Pierce	1995	4	1.0	0.56	0.05	"
Whatcom Creek	Whatcom	1998	12	5.5	2.9	0.13	Serdar & Davis (1999)
Church Creek	Snohomish	2000-01	5	na	1.5	0.11	Joy (unpub)
Manser Creek	Skagit	2000-01	6	0.60	0.24	0.015	Summers (unpub)
Cedar Creek	King	2000-01	9	0.50	0.24	0.02	
Issaquah Creek	King	2000-01	6	0.70	0.39	0.018	"
Big Beef Creek	Kitsap	2000-01	9	0.40	0.34	0.014	"
Bingham Creek	Mason	2000-01	9	0.40	0.15	0.008	"
Quilceda Creek	**Snohomish**	**2000-01**	**5**	**1.0**	**0.52**	**0.060**	**present study**
Allen Creek	**Snohomish**	**2000-01**	**5**	**2.4**	**1.2**	**0.046**	**present study**

na = not analyzed

Trends in Total Recoverable Metals

Snohomish County sampled for total recoverable copper and lead at all four sites on Quilceda and Allen creeks beginning in 1992 as part of the ambient long-term monitoring program. Sampling for total recoverable zinc began in 1994. Sampling on both Allen sites and the lower Quilceda site is ongoing. Sampling at the upper Quilceda site ended in 1998.

To test for differences in metals concentrations, a three-way analysis of variance was conducted with site, season, and year as independent variables using the statistical software STATISTICA. Based on average annual rainfall patterns, the dry season was defined as the period from April through September, and the wet season from October through March.

No seasonal trends were detected in any metals at any of the sites. Copper concentrations showed no trends over time. Copper concentrations in Allen Creek were higher than those in Quilceda Creek, but the difference was not significant.

Zinc concentrations decreased significantly since the beginning of sampling in 1994 ($p<.001$). Zinc was higher at all sites in 1994 and decreased in subsequent years. Zinc was significantly higher in lower Allen Creek than at the other sites ($p<.04$). Nothing is known to have occurred to reduce the zinc loading to Allen Creek. Automobile tires are a major source of zinc, and the population and road traffic has not been decreasing in the watershed.

Lead concentrations decreased significantly at all sites ($p<.001$). Most of the decrease occurred after 1993. Lead was significantly higher in lower Allen Creek than at the other sites ($p<.003$). Decreasing lead can probably be explained by the use of unleaded gasoline. Snohomish County has observed a similar trend at all their urban sampling sites.

The historical data for lower Allen Creek are plotted in Figure 5 (note that the units are mg/L). The complete data set is in Appendix B.

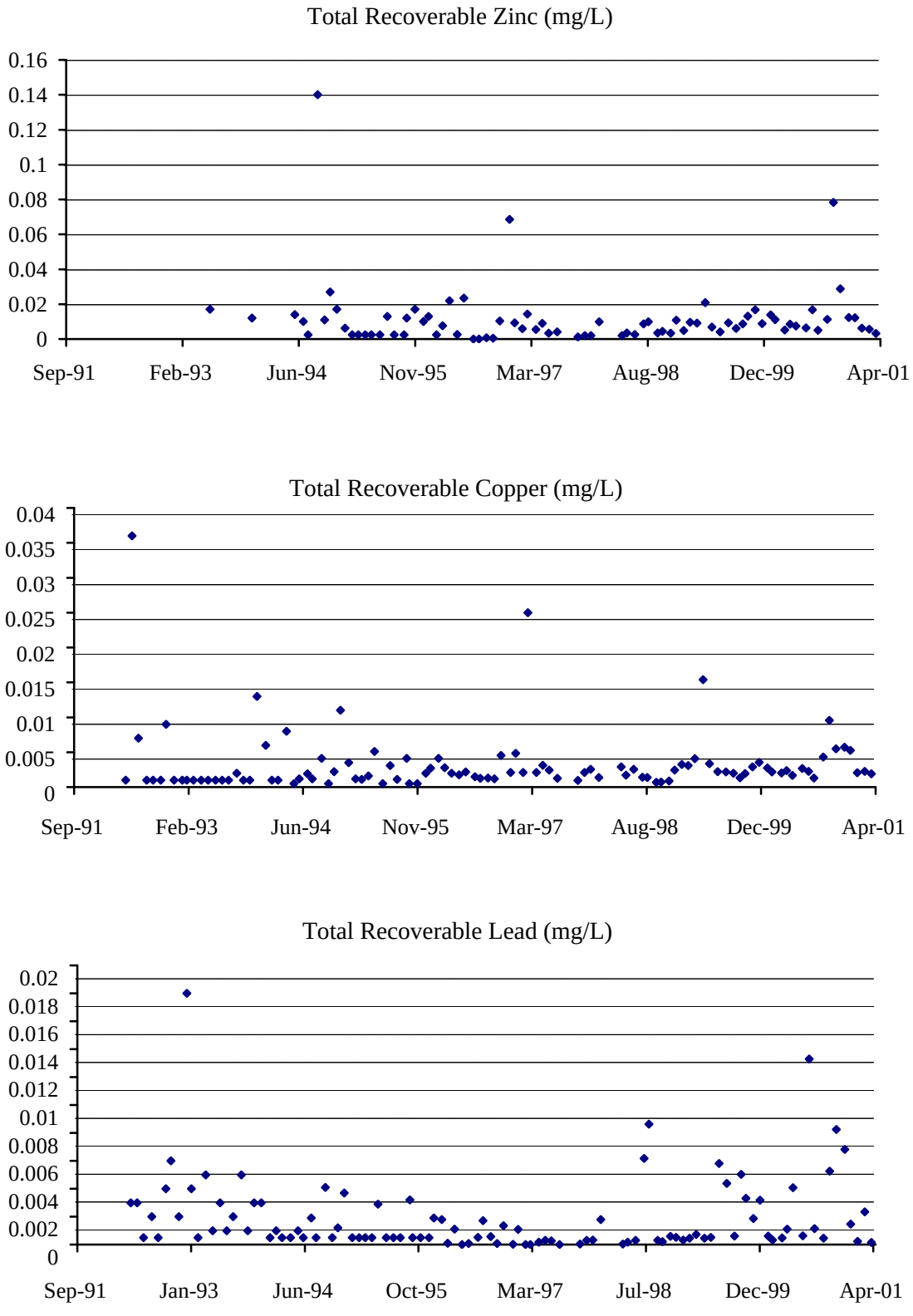

Figure 5. Historical Data on Metals Concentrations in Lower Allen Creek (ACLD)

Conclusions and Recommendations

No exceedances of state water quality standards for zinc, copper, or lead were encountered in the present study. In most cases, dissolved zinc, copper, and lead concentrations were lower than the chronic standard by a factor of 10 or more. The acute standards were never approached. The highest concentrations tended to occur in Allen Creek. The dissolved metals concentrations typical of Quilceda and Allen creeks fall in the middle to upper range of values from other local streams.

A strong relationship between total recoverable and dissolved metals was not consistently observed. In Allen Creek, correlations ranged from highly positive for lead to weak or no correlation for zinc and copper. Somewhat better correlations were found for Quilceda Creek. Further work with a larger sample size may be necessary to test the relationship between total recoverable and dissolved metals. An analysis of the historical data showed that a significant decrease in total recoverable zinc and lead has occurred in both creeks.

In 1995 EPA revised their metals criteria from total recoverable to dissolved (EPA, 1995b). The dissolved criteria have been adopted by Washington State as water quality standards. While total recoverable criteria are more conservative and provide a greater level of protection, EPA considers dissolved metals to more closely approximate the biologically available fraction. For a routine monitoring program such as Snohomish County conducts in the Quilceda/Allen creek drainage, a total recoverable analysis can be a better means of identifying spatial and temporal trends and has the additional advantage of being more economical.

Some of the highest metals concentrations in the recent historical data are substantially higher than levels measured during this study. Including dissolved metals as part of the routine monitoring at the lower Allen Creek site, where the highest concentrations have been measured, would be useful in determining the extent of problem. The elevated total recoverable metals concentrations that have been observed in these drainages, both recently and historically, point to the need for an assessment of sediment toxicity.

This page is purposely blank for duplex printing

References

EPA. 1995a. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Levels. U.S. Environmental Protection Agency. EPA 821-R-95-034.

EPA. 1995b. Stay of Federal Water Quality Criteria for Metals; Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance – Revision of Metals Criteria Water Quality Standards; Final Rules. U.S. Environmental Protection Agency. 40 CFR Part 31.

Johnson, A. 1996. Results of Monitoring Metals in Chambers/Clover Creek Drainage. Memorandum to B. Duffy. Washington State Dept. Ecology, Olympia, WA.

Joy, J. (unpublished). Data collected during Stillaguamish TMDL project. Washington State Dept. Ecology, P.O. Box 47710, Olympia, WA. 98504-7710.

Kammin, W.R., S. Cull, R. Knox, J. Ross, M. McIntosh, and D. Thomson. 1995. Labware Cleaning Protocols for the Determination of Low-level Metals by ICP-MS. American Environmental Laboratory 7(9).

Serdar, D. and D. Davis. 1999. Lake Whatcom Watershed Cooperative Drinking Water Protection Project: Results of 1998 Water, Sediment, and Fish Tissue Sampling. Washington State Dept. Ecology, Olympia, WA. Pub. No. 99-337.

Snohomish County. 1998. Quilceda/Allen Watershed Management Plan Technical Supplement. Public Works Department, Surface Water Management Division, Everett, WA.

Summers, J. (unpublished). Data collected during Salmon Recovery Index project. Washington State Dept. Ecology, P.O. Box 47710, Olympia, WA. 98504-7710.

Thornburgh, K. 1996. Snohomish County Ambient Water Quality Monitoring – Summary Report for 1992-1995. Snohomish County Public Works Department, Everett, WA.

This page is purposely blank for duplex printing

Appendices

This page is purposely blank for duplex printing

Appendix A

Equations for Calculating Washington State Surface Water Aquatic Life Standards for Zinc, Copper, and Lead (WAC Chapter 173-201A, 11/18/97 update)

This page is purposely blank for duplex printing

Appendix A. Equations for Calculating Washington State Surface Water Aquatic Life Standards for Zinc, Copper, and Lead (WAC Chapter 173-201A, 11/18/97 update)

Zinc (dissolved)

Chronic: $(0.987)(e^{(0.8473[\ln(\text{hardness})+0.7614)})$
Acute: $(0.978)(e^{(0.8473[\ln(\text{hardness})+0.8604)})$

Copper (dissolved)

Chronic: $(0.960)(e^{(0.8545[\ln(\text{hardness})-1.465)})$
Acute: $(0.960)(e^{(0.9422[\ln(\text{hardness})-1.464)})$

Lead (dissolved)

Chronic: $(0.791)(e^{(1.273[\ln(\text{hardness})-4.705)})$ at hardness = 100 mg/L
Acute: $(0.791)(e^{(1.273[\ln(\text{hardness})-1.460)})$ at hardness = 100 mg/L

The lead conversion factor of 0.791 is hardness dependent and can be calculated for other hardness values as follows: CF = 1.46023 – [(ln hardness)(0.145712)].

This page is purposely blank for duplex printing

Appendix B

Snohomish County Monitoring Data for Quilceda and Allen Creeks

This page is purposely blank for duplex printing

Appendix B. Snohomish County Monitoring Data for Quilceda and Allen Creeks

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
acld	5/11/92	10.3	3.82	7.0	170.1		172	0.77
acld	6/8/92	14.1	1.63	6.7	209.0		340	0.66
acld	7/6/92	15.4	1.09	6.6	131.9		38	0.12
acld	8/11/92	16.2	0.55	6.6	148.4		220	0.26
acld	9/8/92	12.6	1.22	6.5	150.4		764	0.49
acld	10/12/92	11.8	1.61	6.3	152.0		12	0.82
acld	11/4/92	8.7	2.41	7.3	152.6		46	1.10
acld	12/8/92	4.3	3.93	7.0	162.6		120	2.70
acld	1/13/93	0.2	5.85	7.3	89.8		18	3.20
acld	2/2/93	4.5	5.28	7.2	96.2		2	3.60
acld	3/3/93	7.2	4.78	7.2	99.7		33	2.80
acld	4/6/93	8.1	3.53	7.3	98.2		8	2.10
acld	5/6/93	12.2	2.02	7.1	117.6		340	1.60
acld	6/8/93	13.6	3.36	7.2	180.3		15	0.81
acld	7/7/93	13.7	3.31	7.4	158.8		17	1.40
acld	8/4/93	16.8	1.01	7.1	166.3		43	1.00
acld	9/9/93	15.6	1.89	7.2	154.8		27	0.83
acld	10/7/93	12.6	1.53	6.9	153.8		470	2.50
acld	11/4/93	9.0	4.22	7.1	159.7		32	2.00
acld	12/6/93	3.5	6.56	7.1	129.1		4	4.60
acld	1/13/94	9.0	3.31	7.1	172.6		9	4.00
acld	2/9/94	3.2	5.11	7.1	167.9		22	3.00
acld	3/7/94	6.6	7.64	7.2	168.7		7	3.60
acld	4/13/94	10.1	3.54	7.0	192.1		21	2.10
acld	5/16/94	12.3	2.04	6.7	223.0		190	0.93
acld	6/8/94	14.1	1.05	6.2	99.4		360	0.59
acld	7/14/94	15.4	0.59	6.8	98.8		150	0.29
acld	8/4/94	16.8	0.37	7.1	99.0		140	0.13
acld	9/14/94	13.0	1.04	6.5	98.5		12	0.04
acld	10/14/94	10.6	1.65	6.8	93.6		2000	0.54
acld	11/7/94	7.8	6.28	6.8	89.7		630	0.42
acld	12/5/94	1.4	8.39	6.8	102.1		20	2.90
acld	1/10/95	5.6	6.76	6.5	120.3		240	2.50
acld	2/9/95	5.7	4.75	6.8	60.0		51	2.50
acld	3/8/95	6.3	4.61	6.8	71.9		90	2.00
acld	4/6/95	9.4	4.26	7.2	86.0		18	1.40
acld	5/3/95	10.9	3.15	6.4			3800	0.84
acld	6/8/95	12.9	2.09	6.5			70	0.87
acld	7/10/95	14.9	0.56	6.5			1000	0.40

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
acld	8/9/95	14.2	0.48	6.2	176.3		182	0.11
acld	9/20/95	13.6	0.12	6.2	177.6			0.01
acld	10/2/95	12.6	0.3	6.5	186.4		100	0.34
acld	11/6/95	5.7	3.98	6.9			40	1.30
acld	12/13/95	8.5	5.5	6.7	128.6		190	2.70
acld	1/3/96	8.8	3.31	6.8	178.6		43	3.30
acld	2/7/96	6.6	8.52	6.6	133.8			2.90
acld	3/4/96	5.8	4.44	6.8	184.7		15	3.40
acld	4/3/96	7.3	5.52	6.8	177.8		50	1.70
acld	5/6/96	10.7	1.1	6.3	236.0		33	1.76
acld	6/4/96	14.6	0.84	6.5	180.5		75	0.70
acld	7/15/96	16.2	1.27	6.4	208.0		65	1.09
acld	8/7/96	13.8		6.5	189.7		58	0.76
acld	9/9/96	9.2	0.98	6.7	190.8		81	0.65
acld	10/7/96	11.0	1.07	6.4	172.0		130	0.35
acld	11/5/96	8.2	2.95	6.4	183.0		829	1.88
acld	12/17/96	4.2	5.6	6.3	169.7		18	2.31
acld	1/8/97	6.9	6.89	6.5	113.4		290	1.90
acld	2/10/97	4.8	5	6.2	170.4		18	2.87
acld	3/3/97	6.5	5.81		146.5		190	1.87
acld	4/9/97	8.9	4.06	6.8			52	1.40
acld	5/7/97	11.5	2.91	6.8	152.9		32	0.96
acld	6/3/97	14.7	2.5	6.9	183.9		144	1.01
acld	7/9/97	15.5	1.16	6.4	144.8		504	0.36
acld	10/7/97	11.4	2.23	6.6	185.6		59	0.59
acld	11/5/97	10.6	3.48	6.7	200.0		11	1.28
acld	12/2/97	5.9	6.17	6.5	184.5		30	1.56
acld	1/6/98	6.5	9.15	6.8	153.3		22	2.08
acld	4/14/98	9.0	6.45	7.0	151.4	1.4	13	1.10
acld	5/5/98	12.7	4.97	7.0	177.3	1.68	230	1.46
acld	6/8/98	16.1	2.58	6.9	178.2	2.8	730	0.73
acld	7/16/98	15.7	4.58	7.0	193.0	2.6	2400	1.37
acld	8/6/98	15.9	4.68	7.1	198.0	2.7	83	1.72
acld	9/14/98	13.3	4.5	6.8	192.0	1.2	48	1.56
acld	10/5/98	13.0	8.61	7.5	180.0	1.8	200	1.96
acld	11/9/98	8.9	10.14	7.3	194.0	2	220	1.74
acld	12/3/98	7.7	10.5	6.3	183.0	5.6	2100	
acld	1/4/99	4.9	12	6.9	177.3	5.68	78	3.02
acld	2/1/99	6.6	11.32	7.0	147.9	5.83	580	3.03

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
acld	3/2/99	5.6	11.05	6.4	117.4	19.01	2600	1.14
acld	4/7/99	8.6	10.11	7.2	217.0	15.21	5700	2.08
acld	5/5/99	10.6	10.1	7.4	159.9	8.63	6400	1.14
acld	6/10/99	12.4	6.08	7.1	170.3	2.15	95	1.04
acld	7/15/99	14.3	5.44	7.3	158.7	4.26	55	1.45
acld	8/17/99	14.8	5.13	7.0	187.7	2.54	48	0.30
acld	9/15/99	12.2	4.39	7.0	194.6	4.26	90	1.59
acld	10/7/99	11.6	3.72	6.7	191.5	3.19	24	1.37
acld	11/8/99	9.5	4.14	6.8	185.0	3.55	11	0.86
acld	12/7/99	7.3	6.66	6.9	155.0	2.71	0	1.67
acld	1/13/00	5.2	8.15	6.5		3.07	15	1.96
acld	2/1/00	6.8	8.04	6.8	167.2	4.48	16	1.64
acld	3/14/00	8.7	7.62	7.1	152.1	1.9	33	1.30
acld	4/5/00	7.7	9	6.7	147.2	3.45	87	1.09
acld	5/1/00	11.7	6.56	6.9	166.9	1.78	40	1.35
acld	6/13/00	12.5	4.25	6.8	153.3	2.83	38	0.88
acld	7/11/00	13.8	3.69	6.9	180.0	8.56	71	1.24
acld	8/3/00	14.7	2.34	6.8	182.5	2.25	77	1.16
acld	9/12/00	12.2	2.37	6.9	171.5	8.8	250	1.05
acld	10/9/00	10.7	3.03	6.9	165.9	7.45	270	1.39
acld	11/7/00	8.3	5.72	7.1	185.9	1.05	4	0.97
acld	12/14/00	1.6	7.65	7.3	187.5	2.66	59	1.43
acld	1/9/01	5.5	6.74	7.1	190.9	2.56	36	2.43
acld	2/8/01	4.0	8.48	7.2	165.6	1.37	55	2.29
acld	3/12/01	7.8	7.79	7.1	184.6	1.51	5	1.45
acld	4/10/01	8.4	6.96	7.0	146.5	1.41	36	1.52
acld	4/30/01	10.1	6.53	7.0	175.2	1.07	18	0.91
aclu	5/11/92	9.7	9.68	7.4	149.2		1520	0.32
aclu	6/8/92	15.1	2.22	6.9	129.9		200	0.00
aclu	7/6/92	15.3	5.34	6.9	129.4		573	0.35
aclu	8/11/92	15.6	4.05	6.8	103.5		194	0.27
aclu	9/8/92	12.7	6.39	6.8	111.9		1050	0.74
aclu	10/12/92	11.6	5.18	6.8	170.5		50	0.87
aclu	11/4/92	8.7	5.82	7.5	170.7		2	0.49
aclu	12/8/92	4.7	5.69	7.0	172.7		900	0.58
aclu	1/13/93	0.4	7.87	7.3	62.0		40	0.88
aclu	2/2/93	4.4	7.25	7.1	81.1		24	1.30
aclu	3/3/93	7.8	7.12	7.4	90.6		1500	0.72
aclu	4/6/93	8.1	6.21	7.6	89.9		1200	0.53

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
aclu	5/6/93	11.0	4.5	7.1	121.9		5400	0.70
aclu	6/8/93	12.7	5.81	7.5	132.8		1800	0.52
aclu	7/7/93	11.7	7.84	7.5	115.8		840	0.60
aclu	8/4/93	15.0	5.1	7.3	113.3		450	0.41
aclu	9/9/93	12.7	10.86	7.7	104.6		173	0.49
aclu	10/7/93	11.1	9.57	7.3	101.6		410	0.56
aclu	11/4/93	8.6	8.73	7.5	182.9		420	0.60
aclu	12/6/93	3.5	7.85	7.0	175.6		8600	1.60
aclu	1/13/94	8.8	5.35	7.1	133.8		320	1.70
aclu	2/9/94	2.7	9.63	6.8	115.8		68	0.92
aclu	3/7/94	6.3	10.72	7.1	113.8		14000	2.00
aclu	4/13/94	8.8	9.11	7.4	178.2		340	1.00
aclu	5/16/94	10.2	9.03	7.3	149.0		200	0.42
aclu	6/8/94	12.4	6.27	7.2	66.2		7800	0.45
aclu	7/14/94	13.6	12.08	7.4	67.0		2600	0.29
aclu	8/4/94	15.6	7.41	7.5	68.0		710	0.20
aclu	9/14/94	11.3	10.53	7.2	74.1		570	0.28
aclu	10/14/94	9.3	9.22	7.3	73.5		400	0.39
aclu	11/7/94	6.1	8.68	6.6	104.0		550	0.47
aclu	12/5/94	2.0	9.6	6.2	95.9		420	0.62
aclu	1/10/95	4.9	9.12	6.6	88.5		964	0.91
aclu	2/9/95	5.7	9.18	6.8	75.7		1154	0.77
aclu	3/8/95	6.7	10.53	6.9	50.2		29	0.66
aclu	4/6/95	8.3	10.36	7.2	75.9		1600	0.44
aclu	5/2/95	10.5	9.25	6.6			3600	0.29
aclu	6/8/95	15.1	8.25	7.0			70	0.35
aclu	7/10/95	16.2	7.58	7.1			117	0.38
aclu	8/9/95	12.4	7.11	6.8	141.7		836	0.47
aclu	9/20/95	13.6		6.2	177.6			0.39
aclu	10/2/95	11.7	7.43	6.7	128.6		8000	0.42
aclu	11/6/95	5.9	9.68	7.0	147.7		750	0.24
aclu	12/13/95	8.2	6.95	6.8	130.9		200	2.50
aclu	1/3/96	8.4	7.86	6.7	142.3		300	1.90
aclu	2/7/96	6.4	6.39	6.7	147.0			2.00
aclu	3/4/96	6.1	10.92	6.9	142.3		118	0.94
aclu	4/3/96	6.9	10.33	7.0	167.2		6000	0.52
aclu	5/6/96	9.9	9.12	6.6	147.0		3900	0.57
aclu	6/4/96	13.6	6.3	6.6	135.3		80	0.32
aclu	7/15/96	14.5	7.88	6.8	133.8		430	0.39

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
aclu	8/7/96	12.2		6.9	138.1		550	0.31
aclu	9/9/96	13.2	8.41	7.0	139.0		2400	0.35
aclu	10/7/96	11.7	7.85	6.9	150.0		430	0.31
aclu	11/5/96	7.9	7.67	6.3	176.6		4000	0.83
aclu	12/17/96	3.9	8.93	6.5	146.5		550	1.30
aclu	1/8/97	6.7	9.37	6.8	96.4		171	1.64
aclu	2/10/97	5.4	12.9	6.3	126.5		400	0.85
aclu	3/3/97	6.0	10.27		122.8		90	1.00
aclu	4/9/97	8.2	14.9	7.3			1120	0.49
aclu	5/7/97	11.1	10.8	7.0	131.7		865	0.40
aclu	6/3/97	13.7	7.3	7.0	160.5		910	0.26
aclu	7/9/97	14.5	6.67	6.7	147.1		2220	0.18
aclu	10/7/97	10.6	7.35	7.0	175.6		1640	0.32
aclu	11/5/97	10.5	6.45	6.9	180.8		440	0.63
aclu	12/2/97	4.6	9.2	6.4	162.4		120	0.90
aclu	1/6/98	6.6	12.4	6.3	138.8		920	2.22
aclu	4/14/98	9.8	10.79	6.8	129.8	3.1	50	0.71
aclu	5/5/98	13.1	10.48	7.5	121.5	1.96	2800	0.57
aclu	6/8/98	14.6	5.95	6.7	140.8	1.8	4800	0.28
aclu	7/16/98	15.8	7.57	7.5	131.1	1.7	440	0.36
aclu	8/6/98	18.0	10.6	8.0	128.0	1.4	350	0.17
aclu	9/14/98	13.9	10.41	7.6	126.0	1.3	450	0.29
aclu	10/5/98	11.9	7.61	7.3	164.0	1.4	48	0.24
aclu	11/9/98	8.3	8.51	6.6	197.0	1.7	740	1.17
aclu	12/3/98	7.6	7.72	6.6	220.0	2.8	6300	
aclu	1/4/99	5.0	10.05	6.7	199.7	2.76	890	4.18
aclu	2/1/99	6.4	9.41	6.5	158.6	2.71	89	3.54
aclu	3/2/99	5.4	10.18	5.8	114.7	15.86	5500	2.23
aclu	4/7/99	7.9	9.8	7.0	211.0	11.92	3500	1.47
aclu	5/5/99	10.9	9.94	6.7	185.5	4.53	20000	0.97
aclu	6/10/99	12.2	8.64	6.9	171.3	3.62	1600	0.64
aclu	7/15/99	14.5	6.92	7.2	175.9	2.27	87	0.49
aclu	8/17/99	15.1	6.2	7.1	174.8	3.73	82	0.93
aclu	9/15/99	11.5	5.83	7.0	173.3	1.64	32	0.26
aclu	10/7/99	11.0	5.43	6.9	186.9	4.27	960	0.39
aclu	11/8/99	9.6	6.82	7.0	195.9	1.39	88	0.45
aclu	12/7/99	7.5	6.53	6.6	181.1	3.01	100	2.66
aclu	1/13/00	5.5	9.02	6.4		3.09	0	2.39
aclu	2/1/00	7.1	9.53	6.6	165.8	6.17	77	1.62

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
aclu	3/14/00	8.8	9.23	6.9	175.6	4.52	23	1.37
aclu	4/5/00	10.1	8.6	6.4	175.6	4.34	140	1.37
aclu	5/1/00	10.9	7.93	6.8	155.7	1.75	230	0.67
aclu	6/13/00	11.8	7.3	7.1	146.9	2.32	450	0.39
aclu	7/11/00	14.4	6.47	7.2	160.8	2	3400	0.25
aclu	8/3/00	14.6	5.9	7.2	179.3	6.08	270	0.17
aclu	9/12/00	11.1	7.25	7.3	170.6	2.4	230	0.22
aclu	10/9/00	10.6	7.35	7.1	167.6	1.84	440	0.44
aclu	11/7/00	7.4	9.66	7.2	192.9	1.22	54	0.45
aclu	12/14/00	0.5	8.96	7.1	186.9	3.57	2400	0.86
aclu	1/9/01	5.4	8.57	6.8	228.0	1.81	72	3.72
aclu	2/8/01	4.8	9.04	6.9	192.0	3.07	270	3.46
aclu	3/12/01	7.7	9.85	7.0	188.5	2.68	200	1.71
aclu	4/10/01	7.8	10.15	6.6	152.3	3.87	63	2.35
aclu	4/30/01	9.7	10.1	7.0	167.6	1.83	310	0.82
qcld	5/11/92	9.7	10.45	8.1	177.8		274	0.93
qcld	6/8/92	14.4	9.42	7.4	182.3		330	1.10
qcld	7/6/92	14.0	8.35	7.1	168.1		200	0.83
qcld	8/11/92	14.5	8.35	7.1	164.4		240	0.86
qcld	9/8/92	13.1	8.01	7.0	148.6		963	0.93
qcld	10/12/92	11.6	6.17	7.3	161.0		81	1.10
qcld	11/4/92	9.1	5.77	7.4	140.1		340	0.81
qcld	12/7/92	5.7	7.38	7.4	147.0		220	1.10
qcld	1/13/93	1.6	8.88	7.1	83.1		240	1.50
qcld	2/2/93	4.9	8.26	6.7	83.8		25	1.50
qcld	3/3/93	8.2	7.18	7.4	97.6		380	1.50
qcld	4/6/93	8.2	6.06	7.6	108.2		80	1.60
qcld	5/6/93	11.4	4.98	7.2	118.9		640	1.20
qcld	6/8/93	11.4	9.74	7.2	134.5		840	0.99
qcld	7/7/93	13.6	11.18	7.7	169.9		240	0.97
qcld	8/4/93	15.9	8.84	7.5	158.2		420	0.94
qcld	9/9/93	13.6	9.55	7.5	156.8		182	1.00
qcld	10/7/93	11.8	9.36	7.5	156.1		127	1.90
qcld	11/4/93	9.2	10.38	7.5	160.5		120	0.00
qcld	12/6/93	3.9	13.02	7.2	144.0		42	1.80
qcld	1/13/94	9.1	8.05	7.5	129.2		72	1.80
qcld	2/9/94	4.4	9.6	7.3	144.3		63	1.50
qcld	3/7/94	6.5	12.07	7.3	130.2		54	1.70
qcld	4/13/94	9.3	9.85	7.5	169.4		105	1.10

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
qcld	5/16/94	11.3	8.96	6.9	212.0		200	1.00
qcld	6/8/94	13.7	7.15	6.7	100.6		400	1.00
qcld	7/14/94	13.6	11.57	7.5	100.9		45	0.80
qcld	8/4/94	15.1	10.74	7.9	103.5		180	0.65
qcld	9/14/94	12.8	7	7.2	84.5		360	0.84
qcld	10/14/94	10.2	8.6	7.2	97.2		300	0.92
qcld	11/7/94	6.5	10.61	7.2	96.1		300	0.70
qcld	12/5/94	2.0	13.23	6.9	79.9		94	0.92
qcld	1/10/95	5.1	12.57	6.9	80.8		3370	1.30
qcld	2/9/95	4.9	11.12	7.3	63.6		230	1.30
qcld	3/8/95	6.6	10.66	7.0	64.6		230	1.20
qcld	4/6/95	9.0	10.75	7.3	83.8		200	0.96
qcld	5/2/95	11.2	9.35	6.7			2000	0.87
qcld	6/8/95	12.5	9.53	7.0			300	1.20
qcld	7/10/95	14.0	8.9	6.9			420	1.00
qcld	8/9/95	12.8	7.67	6.9	182.5		460	1.10
qcld	9/20/95	12.6	8.02	7.0	181.0			1.10
qcld	10/2/95	12.0	6.97	6.7	181.5		673	0.89
qcld	11/6/95	6.6	10.02	6.7	180.7		127	0.92
qcld	12/13/95	8.4	9.15	6.8	112.5		1400	1.40
qcld	1/3/96	8.7	10.5	7.1	154.7		2200	1.40
qcld	2/7/96	6.1	10.45	6.9	118.8			1.40
qcld	3/4/96	6.4	11.35	7.4	167.3		140	1.40
qcld	4/3/96	7.8	11.06	7.1	159.0		3700	0.99
qcld	5/6/96	10.4	10.07	7.0	155.0		310	0.79
qcld	6/4/96	13.4	8.98	6.9	177.6		360	0.90
qcld	7/15/96	14.4	9.16	6.9	201.0		290	1.26
qcld	8/7/96	12.2		6.8	203.0		290	1.13
qcld	9/9/96	12.1	8.85	6.9	203.0		510	1.13
qcld	10/7/96	11.6	8.86	6.9	194.0		259	1.03
qcld	12/17/96	4.1	11.26	7.0	150.0		83	1.25
qcld	1/8/97	6.6	10.39	6.5	93.4		919	1.04
qcld	2/10/97	5.6	10.75	6.7	159.2		103	1.29
qcld	3/3/97	6.6	10.72		134.7		380	1.16
qcld	4/9/97	8.8	10.01	7.5			230	1.14
qcld	5/7/97	11.6	9.77	7.6	151.6		93	0.66
qcld	6/3/97	13.8	8.7	7.2	179.8		2200	0.88
qcld	7/9/97	14.5	7.8	7.1	141.0		545	0.52
qcld	10/7/97	11.0	8.9	7.3	192.3		290	0.87

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
qcld	11/5/97	11.0	8.68	7.3	178.3		220	0.99
qcld	12/2/97	5.7	11.2	7.2	171.1		90	1.10
qcld	1/6/98	6.6	9.4	7.3	135.6		220	1.46
qcld	4/14/98	9.6	10.97	7.3	138.6	6.3	270	0.90
qcld	5/5/98	12.1	9.82	7.3	171.8	5.1	260	1.26
qcld	6/8/98	14.1	9.92	6.8	166.5	8.4	840	0.86
qcld	7/16/98	17.0	9.14	7.5	185.1	3.6	290	0.96
qcld	8/6/98	14.7	8.98	7.5	200.0	5	340	1.03
qcld	9/14/98	12.8	9.3	7.3	191.0	3.8	4900	0.95
qcld	10/5/98	12.5	9.02	7.4	186.0	3.8	50	0.95
qcld	11/9/98	8.8	9.31	7.4	188.0	3.3	210	0.89
qcld	12/3/98	7.1	10.58	6.6	139.0	8.9	3000	1.31
qcld	1/4/99	5.3	11.56	7.3	151.8	5.17	150	1.49
qcld	2/1/99	6.0	11.03	7.0	122.3	4.43	220	1.45
qcld	3/2/99	5.6	11.24	6.3	100.5	11.48	2200	1.11
qcld	4/7/99	8.8	10.25	7.5	163.4	5.22	22	1.25
qcld	5/5/99	10.5	10.3	7.4	142.8	10.36	6000	0.65
qcld	6/10/99	12.6	10.28	7.4	165.2	4.29	460	0.66
qcld	7/15/99	14.5	9.46	7.5	192.7	4.35	94	0.96
qcld	8/17/99	15.1	8.69	7.4	197.0	4.28	120	0.03
qcld	9/15/99	12.5	9.05	7.3	209.0	4.65	240	1.02
qcld	10/7/99	11.3	8.76	7.1	211.0	4.71	250	0.95
qcld	11/8/99	9.8	9.11	7.2	187.4	6.25	190	0.82
qcld	12/7/99	7.1	9.78	6.9	133.7	5.23	46	1.11
qcld	2/1/00	7.5	14.7	6.9	160.7	11.2	81	1.20
qcld	3/14/00	8.9	10.46	7.5	144.1	11.72	220	1.04
qcld	4/5/00	10.7	8.6	6.9	149.7	13.2	300	0.88
qcld	5/1/00	11.4	9.95	7.1	162.5	3.6	290	0.84
qcld	6/13/00	12.0	9.32	7.5	160.6	5.55	240	0.88
qcld	7/11/00	13.5	8.45	7.4	187.9	5.74	210	0.94
qcld	8/3/00	15.5	8.94	7.2	190.8	4.02	59	0.91
qcld	9/12/00	11.8	9.09	7.4	187.6	3.8	86	0.83
qcld	10/9/00	11.4	8.5	7.2	175.8	9.11	27000	0.86
qcld	11/7/00	7.9	10.81	7.1	201.0	2.81	57	0.80
qcld	12/14/00	1.8	9.7	7.3	181.0	4.96	45	0.96
qcld	1/9/01	5.6	11.55	7.3	158.7	4.35	68	1.21
qcld	2/8/01	4.4	10.53	7.3	14.9	5.7	260	1.09
qcld	3/12/01	8.0	10.98	7.5	164.0	4.32	72	0.91
qcld	4/10/01	8.1	11.24	7.2	136.8	7.97	150	1.05

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
qcld	4/30/01	10.2	9.76	7.4	160.7	4.54	640	0.68
qclu	5/11/92	9.5	11.26	7.9	144.1		35	0.99
qclu	6/8/92	11.5	9.88	7.6	147.8		270	0.83
qclu	7/6/92	11.7	9.62	7.3	145.9		106	0.77
qclu	8/11/92	12.1	9.02	7.2	127.1		270	0.60
qclu	9/8/92	11.1	9.59	7.4	127.3		575	1.00
qclu	10/12/92	10.3	6.57	6.9	134.8		50	0.64
qclu	11/4/92	9.1	6.68	6.9	120.9		42	0.72
qclu	12/7/92	5.9	7.56	7.0	106.5		25	1.30
qclu	1/13/93	2.3	9.4	6.8	68.8		100	1.30
qclu	2/2/93	4.9	9.65	7.1	62.6		13	2.20
qclu	3/3/93	7.0	7.8	7.6	86.4		100	1.20
qclu	4/6/93	7.8	6.58	7.5	108.1		12	0.96
qclu	5/6/93	10.1	5.7	7.0	67.5		240	0.76
qclu	6/8/93	11.1	10.92	7.0	121.8		36	0.71
qclu	7/7/93	11.5	11.16	7.9	130.9		52	0.59
qclu	8/4/93	12.8	10.38	7.6	132.4		71	0.55
qclu	9/9/93	11.9	11.99	7.7	126.3		680	0.64
qclu	10/7/93	10.8	12.56	7.4	130.6		210	1.30
qclu	11/4/93	9.0	13.73	7.5	124.5		94	0.00
qclu	12/6/93	5.0	13.76	7.8	119.8		44	3.20
qclu	1/13/94	8.3	9.77	7.5	101.9		23	2.60
qclu	2/9/94	4.6	10.58	7.1	108.7		45	1.20
qclu	3/7/94	6.2	12.76	7.2	110.6		16	2.50
qclu	4/13/94	8.3	11.39	7.0	118.6		35	1.70
qclu	5/16/94	9.8	11.26	7.2	179.8		78	0.63
qclu	6/8/94	11.2	7.66	7.4	81.3		500	0.52
qclu	7/14/94	12.0	12.08	7.5	81.4		420	0.40
qclu	8/4/94	12.2	11.42	7.6	82.1		850	0.34
qclu	9/14/94	11.6	14.13	7.3	64.6		0	0.46
qclu	10/14/94	9.4	11.36	7.3	205.0		2300	0.55
qclu	11/7/94	7.5	12.36	7.2	79.0		149	0.69
qclu	12/5/94	3.4	13.81	7.3	63.0		43	1.20
qclu	1/10/95	5.6	14.08	7.3	52.2		370	1.90
qclu	2/9/95	6.0	11.83	7.4	60.5		42	1.10
qclu	3/8/95	7.3	11.57	7.4	58.4		2900	1.00
qclu	4/6/95	8.4	11.88	7.5	63.0		61	0.94
qclu	5/2/95	10.0	10.66	7.2			1082	0.71
qclu	6/8/95	12.6	10.4	7.6			400	0.61

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Temp. ^{0}C	DO mg/l	pH	Conductivity umhos/cm	Turbidity NTU	Fecal Col. col/100 ml	Nitrate mg/l
qclu	7/10/95	13.0	9.86	7.5			117	0.70
qclu	8/9/95	11.4	9.34	7.2	164.1		680	0.84
qclu	9/20/95	11.0	10.64	7.0	161.0			0.57
qclu	10/2/95	11.3	9.85	6.9	137.3		550	0.65
qclu	11/6/95	6.9	12.23	7.5	138.4		20	0.64
qclu	12/13/95	8.1	11.08	6.9	86.1		0	1.80
qclu	1/3/96	7.9	12.27	6.8	83.9		54	1.50
qclu	2/7/96	5.4	12.98	6.9	76.3			1.70
qclu	3/4/96	6.1	13.27	7.4			20	1.20
qclu	4/3/96	6.8	12.22	7.1	93.3		190	1.20
qclu	5/6/96	9.1	11.5	6.9	104.0		47	0.84
qclu	6/4/96	11.3	10.63	7.1	137.2		130	0.84
qclu	7/15/96	12.3	10.9	7.2	163.4		67	0.71
qclu	8/7/96	10.9	12.1	7.1	168.2		130	0.71
qclu	9/9/96	11.4	11.07	7.5	166.3		380	0.68
qclu	10/7/96	10.4	10.62	7.2	163.0		185	0.77
qclu	11/5/96	7.7	11.42	6.4	101.8		182	1.03
qclu	12/17/96	4.6	12.03	7.0	101.8		41	1.29
qclu	1/8/97	6.4	11.8	7.1	62.8		36	1.30
qclu	2/10/97	4.9	11.52	6.6	110.7		14	1.17
qclu	3/3/97	6.2	11.98		84.0		22	1.04
qclu	4/9/97	8.4	16.24	7.7			5	0.93
qclu	5/7/97	10.6	11.08	7.7	103.6		12	0.60
qclu	6/3/97	11.4	10.4	7.2	149.6		320	0.86
qclu	7/9/97	13.5	9.7	7.2	84.2		1050	0.48
qclu	10/7/97	10.4	10.6	7.7	174.8		104	0.87
qclu	11/5/97	10.5	10.1	7.4	118.2		162	1.09
qclu	12/2/97	6.0	11.3	7.2	119.0		10	0.84
qclu	1/6/98	6.5	13.6	6.7	93.2		14	1.89
qclu	4/14/98	8.9	11.15	7.2	96.2	3	22	0.92
qclu	5/5/98	11.0	11.23	7.8	154.1	2.9	23	0.88
qclu	6/8/98	12.0	10.55	7.7	134.9	1.9	51	0.71
qclu	7/16/98	13.4	10.27	8.0	160.4	2.6	300	0.70
qclu	8/6/98	13.2	10.41	8.2	164.0	1.5	250	0.71
qclu	9/14/98	13.5	13.31	8.9	163.0	0.8	37	0.51
qclu	6/13/00	10.7	10.84	7.8	131.7	1.25		
qclu	8/3/00	12.9	10.44	7.9	159.1	0.84		
qclu	11/7/00	8.3	12.54	7.8	161.5	0.9		
qclu	2/8/01	4.9	11.5	7.4	113.7	6.45		
qclu	4/10/01	7.4	12.65	7.2	90.1	5.08		

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
acld	5/11/92	0.072	1	1.00	3.00		
acld	6/8/92	0.110	6	36.00	3.00		
acld	7/6/92	0.170	3	7.00	0.50		
acld	8/11/92	0.150	6	1.00	2.00		
acld	9/8/92	0.100	2	1.00	0.50		
acld	10/12/92	0.065	0	1.00	4.00		
acld	11/4/92	0.081	2	9.00	6.00		
acld	12/8/92	0.087	1	1.00	2.00		
acld	1/13/93	0.057	0	1.00	18.00		
acld	2/2/93	0.071	0	1.00	4.00		
acld	3/3/93	0.070	0	1.00	0.50		
acld	4/6/93	0.059	7	1.00	5.00		
acld	5/6/93	0.066	4	1.00	1.00		
acld	6/8/93	0.120	3	1.00	3.00	17.00	
acld	7/7/93	0.130	5	1.00	1.00		
acld	8/4/93	0.270	10	1.00	2.00		
acld	9/9/93	0.650	40	2.00	5.00		
acld	10/7/93	0.110	1	1.00	1.00		
acld	11/4/93	0.094	4	1.00	3.00		
acld	12/6/93	0.150	2	13.00	3.00	12.00	
acld	1/13/94	0.110	0	6.00	0.50		
acld	2/9/94	0.088	0	1.00	1.00		
acld	3/7/94	0.090	2	1.00	0.50		
acld	4/13/94	0.110	0	8.00	0.50		
acld	5/16/94	0.050	0	0.50	1.00		
acld	6/8/94	0.170	0	1.20	0.50	14.00	
acld	7/14/94	0.330	150	1.90	1.90	10.00	
acld	8/4/94	0.250	21	1.20	0.50	2.50	
acld	9/14/94	0.320	50	4.10	4.10	140.00	
acld	10/14/94	0.065	21	0.50	0.50	11.00	
acld	11/7/94	0.140	1	2.20	1.20	27.00	
acld	12/5/94	0.087	66	11.00	3.70	17.00	
acld	1/10/95	0.093	2	3.50	0.50	6.30	
acld	2/9/95	0.059	2	1.20	0.50	2.50	
acld	3/8/95	0.061	4	1.10	0.50	2.50	
acld	4/6/95	0.055	0	1.60	0.50	2.50	
acld	5/3/95	0.086	3	5.10	2.90	2.50	
acld	6/8/95	0.083	4	0.50	0.50	2.50	
acld	7/10/95	0.180	5	3.10	0.50	13.00	

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
acld	8/9/95	0.110	4	1.10	0.50	2.50	
acld	9/20/95	0.075	0	4.10	3.20	2.50	
acld	10/2/95	0.081	24	0.50	0.50	12.00	
acld	11/6/95	0.048	7	0.50	0.50	17.00	
acld	12/13/95	0.170	0	2.00	0.50	10.00	
acld	1/3/96	0.098	0	2.70	1.90	13.00	
acld	2/7/96	0.150	10	4.10	1.80	2.50	
acld	3/4/96	0.120	1	2.80	0.10	7.60	
acld	4/3/96	0.099	3	2.00	1.10	22.00	
acld	5/6/96	0.158	2	1.75	0.00	2.61	
acld	6/4/96	0.152	2	2.16	0.07	23.40	
acld	7/15/96	0.132	2	1.48	0.52		
acld	8/7/96	0.111	1	1.24	1.72		
acld	9/9/96	0.098	2	1.31	0.57	0.71	
acld	10/7/96	0.099	1	1.17	0.08	0.45	
acld	11/5/96	0.233	3	4.55	1.36	10.30	
acld	12/17/96	0.159	0	2.10	0.02	68.50	
acld	1/8/97	0.246	3	4.82	1.09	9.24	
acld	2/10/97	0.145	4	2.08	0.00	5.89	
acld	3/3/97	0.151	2	25.00	0.00	14.30	
acld	4/9/97	0.111	1	2.10	0.17	5.43	
acld	5/7/97	0.116	2	3.11	0.30	9.03	
acld	6/3/97	0.147	3	2.45	0.26	3.29	
acld	7/9/97	0.190	7	1.25	0.00	4.05	
acld	10/7/97	0.033	0	0.95	0.04	1.18	
acld	11/5/97	0.072	4	2.10	0.30	2.03	
acld	12/2/97	0.038	0	2.54	0.32	2.02	
acld	1/6/98	0.045	0	1.37	1.80	9.85	
acld	4/14/98	0.059	2	2.91	0.03	1.94	
acld	5/5/98	0.071	4	1.72	0.18	3.50	
acld	6/8/98	0.141	0	2.56	0.31	2.56	
acld	7/16/98	0.113	8	1.41	6.18	8.70	
acld	8/6/98	0.117	7	1.39	8.63	9.84	
acld	9/14/98	0.080	0	0.69	0.30	3.49	
acld	10/5/98	0.097	4	0.72	0.20	4.45	
acld	11/9/98	0.070	3	0.87	0.60	3.28	
acld	12/3/98	0.108	5	2.43	0.51	10.80	
acld	1/4/99	0.070	8	3.24	0.32	4.94	
acld	2/1/99	0.106	4	3.07	0.46	9.66	

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
acld	3/2/99	0.254	10	4.06	0.72	9.14	
acld	4/7/99	0.421	9	15.40	0.47	20.90	
acld	5/5/99	0.095	11	3.34	0.52	6.86	
acld	6/10/99	0.091	0	2.20	5.81	4.18	
acld	7/15/99	0.164	10	2.16	4.38	9.37	
acld	8/17/99	0.140	6	2.00	0.61	6.11	
acld	9/15/99	0.259	7	1.32	5.02	8.64	
acld	10/7/99	0.135	11	1.95	3.32	13.10	
acld	11/8/99	0.148	9	2.90	1.86	16.70	
acld	12/7/99	0.140	3	3.56	3.19	8.87	
acld	1/13/00	0.100	2	2.73	0.60	13.80	
acld	2/1/00	0.071	0	2.16	0.33	11.10	
acld	3/14/00	0.078	3	2.02	0.47	5.25	
acld	4/5/00	0.089	5	2.36	1.10	8.52	
acld	5/1/00	0.076	3	1.68	4.07	7.52	
acld	6/13/00	0.117	0	2.67	0.63	6.41	
acld	7/11/00	0.262	18	2.23	13.30	16.70	
acld	8/3/00	0.123	2	1.31	1.14	5.07	
acld	9/12/00	0.941	77	4.32	0.45	11.30	
acld	10/9/00	2.340	670	9.58	5.25	78.40	
acld	11/7/00	0.097	1	5.50	8.25	28.80	
acld	12/14/00	0.181	11	5.71	6.81	12.40	
acld	1/9/01	0.114	8	5.25	1.47	12.20	
acld	2/8/01	0.062	1	2.06	0.24	6.28	
acld	3/12/01	0.066	3	2.25	2.34	5.57	
acld	4/10/01	0.059	7	1.89	0.16	3.22	
acld	4/30/01	0.065	4	1.46	0.69	5.58	
aclu	5/11/92	0.180	11	1.00	10.00		
aclu	6/8/92	0.240	13	40.00	2.00		
aclu	7/6/92	0.250	3	6.00	0.50		
aclu	8/11/92	0.220	8	1.00	1.00		
aclu	9/8/92	0.290	6	1.00	8.00		
aclu	10/12/92	0.210	0	1.00	4.00		
aclu	11/4/92	0.190	0	13.00	1.00		
aclu	12/8/92	0.190	3	1.00	2.00		
aclu	1/13/93	0.095	0	1.00	2.00		
aclu	2/2/93	0.100	0	1.00	0.50		
aclu	3/3/93	0.280	2	1.00	0.50		
aclu	4/6/93	0.120	2	1.00	5.00		

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
aclu	5/6/93	0.860	16	1.00	2.00		
aclu	6/8/93	0.220	0	1.00	14.00	17.00	
aclu	7/7/93	0.240	3	1.00	2.00		
aclu	8/4/93	0.290	5	1.00	6.00		
aclu	9/9/93	0.250	3	1.00	3.00		
aclu	10/7/93	0.210	0	1.00	1.00		
aclu	11/4/93	0.160	1	1.00	6.00		
aclu	12/6/93	0.400	6	10.00	3.00	30.00	
aclu	1/13/94	0.240	0	4.00	1.00		
aclu	2/9/94	0.110	0	1.00	2.00		
aclu	3/7/94	0.240	0	1.00	0.50		
aclu	4/13/94	0.160	0	6.00	0.50		
aclu	5/16/94	0.110	0	0.50	3.10		
aclu	6/8/94	0.300	3	1.30	0.50	18.00	
aclu	7/14/94	0.280	13	2.10	1.30	36.00	
aclu	8/4/94	0.260	3	1.20	0.50	2.50	
aclu	9/14/94	0.270	0	0.50	0.50	21.00	
aclu	10/14/94	0.220	7	1.40	0.50	8.70	
aclu	11/7/94	0.180	5	3.00	0.50	14.00	
aclu	12/5/94	0.150	0	3.30	0.50	2.50	
aclu	1/10/95	0.230	2	4.80	0.50	13.00	
aclu	2/9/95	0.100	0	2.30	0.50	2.50	
aclu	3/8/95	0.110	5	0.50	0.50	2.50	
aclu	4/6/95	0.110	5	0.50	0.50	2.50	
aclu	5/2/95	0.120	10	2.60	1.20	2.50	
aclu	6/8/95	0.230	0	0.50	0.50	14.00	
aclu	7/10/95	0.210	0	2.00	0.50	2.50	
aclu	8/9/95	0.200	3	0.50	0.50	2.50	
aclu	9/20/95	0.220	4	1.60	0.50	2.50	
aclu	10/2/95	0.270	8	0.50	0.50	6.60	
aclu	11/6/95	0.110	0	0.50	0.50	6.00	
aclu	12/13/95	0.210	7	2.00	0.50	2.50	
aclu	1/3/96	0.130	0	1.80	0.50	9.40	
aclu	2/7/96	0.250	8	4.50	0.50	12.00	
aclu	3/4/96	0.100	7	1.70	0.50	4.90	
aclu	4/3/96	0.084	4	1.40	3.30	7.40	
aclu	5/6/96	0.110	7	0.00	0.42	0.31	
aclu	6/4/96	0.161	2	2.07	0.61	2.48	
aclu	7/15/96	0.192	2	1.37	0.80		

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
aclu	8/7/96	0.155	1	0.70	1.70		
aclu	9/9/96	0.232	1	0.48	0.70	0.91	
aclu	10/7/96	0.175	4	0.82	0.00	1.69	
aclu	11/5/96	0.147	6	3.28	1.08	8.72	
aclu	12/17/96	0.099	6	1.65	0.32	7.99	
aclu	1/8/97	0.151	11	115.00	0.66	12.90	
aclu	2/10/97	0.076	5	1.19	0.00	3.92	
aclu	3/3/97	0.105	8	1.40	0.03	4.51	
aclu	4/9/97	0.075	3	1.33	0.19	2.92	
aclu	5/7/97	0.094	6	2.22	0.46	8.46	
aclu	6/3/97	0.161	3	1.39	0.00	5.53	
aclu	7/9/97	0.211	9	2.08	0.03	5.54	
aclu	10/7/97	0.075	0	4.73	0.00	3.53	
aclu	11/5/97	0.102	1	1.56	0.31	1.51	
aclu	12/2/97	0.045	2	1.82	0.10	4.54	
aclu	1/6/98	0.051	4	1.78	2.38	5.15	
aclu	4/14/98	0.078	3	2.45	0.10	2.41	
aclu	5/5/98	0.139	8	0.82	0.17	2.24	
aclu	6/8/98	0.162	2	2.19	0.57	9.31	
aclu	7/16/98	0.194	8	0.99	0.29	2.75	
aclu	8/6/98	0.205	3	0.65	0.24	3.89	
aclu	9/14/98	0.218	0	0.55	0.29	2.41	
aclu	10/5/98	0.148	0	1.41	0.26	4.06	
aclu	11/9/98	0.091	0	2.16	0.44	7.69	
aclu	12/3/98	0.187	0	3.63	0.39	11.00	
aclu	1/4/99	0.102	0	4.73	0.22	8.84	
aclu	2/1/99	0.165	1	3.96	0.28	20.60	
aclu	3/2/99	0.353	7	4.76	0.59	11.90	
aclu	4/7/99	0.369	8	13.60	0.22	16.70	
aclu	5/5/99	0.127	5	5.63	0.36	11.80	
aclu	6/10/99	0.112	3	2.75	0.28	2.55	
aclu	7/15/99	0.129	4	2.16	0.26	2.74	
aclu	8/17/99	0.149	3	1.10	0.24	1.30	
aclu	9/15/99	0.138	0	1.32	0.99	1.65	
aclu	10/7/99	0.288	6	3.90	0.80	7.01	
aclu	11/8/99	0.106	0	3.19	0.23	3.74	
aclu	12/7/99	0.324	6	3.81	0.00	12.20	
aclu	1/13/00	0.191	3	3.53	0.17	8.55	
aclu	2/1/00	0.097	0	3.05	0.25	7.44	

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
aclu	3/14/00	0.123	5	3.11	0.39	5.47	
aclu	4/5/00	0.146	3	5.09	0.27	21.10	
aclu	5/1/00	0.088	1	1.83	0.10	3.34	
aclu	6/13/00	0.136	3	1.74	0.65	5.36	1.52
aclu	7/11/00	0.157	0	1.12	0.29	8.10	
aclu	8/3/00	0.149	4	1.65	0.24	3.99	0.378
aclu	9/12/00	0.162	1	0.98	0.35	5.27	
aclu	10/9/00	0.183	0	1.18	0.22	6.41	
aclu	11/7/00	0.139	2	1.95	0.09	3.55	1.116
aclu	12/14/00	0.080	2	3.47	0.27	3.45	
aclu	1/9/01	0.143	2	4.22	0.23	8.33	
aclu	2/8/01	0.097	3	3.46	0.24	6.99	4.352
aclu	3/12/01	0.092	0	3.06	0.11	4.95	
aclu	4/10/01	0.121	3	3.10	0.16	6.08	9.027
aclu	4/30/01	0.095	5	3.60	0.27	5.00	
qcld	5/11/92	0.120	7	1.00	3.00		
qcld	6/8/92	0.150	12	36.00	2.00		
qcld	7/6/92	0.160	3	3.00	0.50		
qcld	8/11/92	0.087	4	1.00	2.00		
qcld	9/8/92	0.120	1	9.00	0.50		
qcld	10/12/92	0.058	0	6.00	1.00		
qcld	11/4/92	0.087	0	9.00	4.00		
qcld	12/7/92	0.100	3	3.00	4.00		
qcld	1/13/93	0.130	10	1.00	3.00		
qcld	2/2/93	0.069	3	1.00	0.50		
qcld	3/3/93	0.110	0	1.00	4.00		
qcld	4/6/93	0.087	5	1.00	2.00		
qcld	5/6/93	0.083	8	5.00	2.00		
qcld	6/8/93	0.200	26	1.00	5.00	19.00	
qcld	7/7/93	0.120	7	1.00	1.00		
qcld	8/4/93	0.130	10	1.00	2.00		
qcld	9/9/93	0.150	13	1.00	3.00		
qcld	10/7/93	0.150	1	1.00	0.50		
qcld	11/4/93	0.086	1	1.00	3.00		
qcld	12/6/93	0.080	2	12.00	0.50	22.00	
qcld	1/13/94	0.088	2	8.00	1.00		
qcld	2/9/94	0.088	3	1.00	0.50		
qcld	3/7/94	0.084	0	1.00	0.50		
qcld	4/13/94	0.072	0	11.00	0.50		

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
qcld	5/16/94	0.050	6	0.50	1.00		
qcld	6/8/94	0.140	0	0.50	0.50	13.00	
qcld	7/14/94	0.100	8	0.50	1.20	6.20	
qcld	8/4/94	0.130	5	0.50	0.50	2.50	
qcld	9/14/94	0.100	0	0.50	0.50	250.00	
qcld	10/14/94	0.110	5	0.50	0.50	42.00	
qcld	11/7/94	0.082	2	0.50	0.50	2.50	
qcld	12/5/94	0.066	3	0.50	0.50	2.50	
qcld	1/10/95	0.110	7	4.20	1.80	27.00	
qcld	2/9/95	0.060	8	0.50	0.50	2.50	
qcld	3/8/95	0.086	8	0.50	0.50	2.50	
qcld	4/6/95	0.078	7	0.50	0.50	6.70	
qcld	5/2/95	0.042	30	4.50	4.10	2.50	
qcld	6/8/95	0.063	5	0.50	1.60	18.00	
qcld	7/10/95	0.098	2	0.50	1.30	2.50	
qcld	8/9/95	0.090	4	0.50	0.50	2.50	
qcld	9/20/95	0.075	4	1.50	4.80	2.50	
qcld	10/2/95	0.083	4	0.50	0.50	2.50	
qcld	11/6/95	0.058	2	0.50	0.50	2.50	
qcld	12/13/95	0.150	4	3.30	0.50	6.50	
qcld	1/3/96	0.130	7	3.60	0.50	7.00	
qcld	2/7/96	0.110	3	2.40	0.50	2.50	
qcld	3/4/96	0.097	10	1.20	1.20	3.70	
qcld	4/3/96	0.081	12	1.30	1.10	3.60	
qcld	5/6/96	0.085	5	0.00	0.52	0.65	
qcld	6/4/96	0.112	7	0.86	0.59	2.96	
qcld	7/15/96	0.112	2	1.18	0.96		
qcld	8/7/96	0.129	15	0.99	1.74		
qcld	9/9/96	0.092	3	0.17	0.86	0.61	
qcld	10/7/96	0.087	4	0.67	0.11	0.23	
qcld	12/17/96	0.087	5	1.47	0.61	3.54	
qcld	1/8/97	0.163	9	2.44	0.61	10.10	
qcld	2/10/97	0.076	6	1.79	0.00	5.74	
qcld	3/3/97	0.081	5	1.83	0.26	5.48	
qcld	4/9/97	0.120	10	2.03	0.50	5.67	
qcld	5/7/97	0.840	9	2.24	0.75	16.20	
qcld	6/3/97	0.140	7	1.44	0.00	2.92	
qcld	7/9/97	0.174	8	3.67	0.09	5.35	
qcld	10/7/97	0.031	0	1.35	0.00	1.73	

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
qcld	11/5/97	0.058	4	1.87	0.47	1.13	
qcld	12/2/97	0.036	9	1.60	0.63	4.51	
qcld	1/6/98	0.054	3	1.34	0.70	4.33	
qcld	4/14/98	0.100	2	2.63	0.34	3.14	
qcld	5/5/98	0.059	1	1.03	0.28	2.70	
qcld	6/8/98	0.133	9	2.01	0.84	8.81	
qcld	7/16/98	0.120	7	1.00	0.27	2.33	
qcld	8/6/98	0.266	3	0.78	0.72	2.62	
qcld	9/14/98	0.099	0	0.68	0.33	3.27	
qcld	10/5/98	0.097	1	0.99	0.31	3.89	
qcld	11/9/98	0.090	3	0.37	0.52	16.50	
qcld	12/3/98	0.176	8	1.82	0.65	6.35	
qcld	1/4/99	0.087	5	1.80	0.39	4.68	
qcld	2/1/99	0.097	3	1.85	0.40	6.48	
qcld	3/2/99	0.129	7	1.87	0.64	5.05	
qcld	4/7/99	0.092	7	1.83	0.50	8.06	
qcld	5/5/99	0.127	12	3.07	0.73	16.20	
qcld	6/10/99	0.102	9	1.47	0.37	2.73	
qcld	7/15/99	0.118	3	0.95	0.37	3.18	
qcld	8/17/99	0.208	5	0.93	0.31	4.50	
qcld	9/15/99	0.113	2	0.97	0.70	2.07	
qcld	10/7/99	0.111	7	2.76	0.25	3.97	
qcld	11/8/99	0.105	3	1.34	0.60	5.33	
qcld	12/7/99	0.101	2	1.87	0.33	6.47	
qcld	2/1/00	0.095	6	1.40	0.40	5.58	
qcld	3/14/00	0.121	13	1.48	0.60	6.38	
qcld	4/5/00	0.125	14	1.44	0.62	10.40	
qcld	5/1/00	0.099	6	0.89	0.26	3.02	
qcld	6/13/00	0.126	7	1.10	0.34	7.72	
qcld	7/11/00	0.115	2	1.45	1.07	77.60	
qcld	8/3/00	0.124	1	0.95	0.22	3.19	
qcld	9/12/00	0.116	1	1.01	0.45	11.30	
qcld	10/9/00	0.162	12	2.42	2.03	17.30	
qcld	11/7/00	0.093	4	0.67	0.16	3.56	
qcld	12/14/00	0.129	7	1.63	0.38	3.95	
qcld	1/9/01	0.123	6	1.44	0.36	4.92	
qcld	2/8/01	0.089	4	3.66	0.55	7.90	
qcld	3/12/01	0.094	4	1.09	0.16	4.39	
qcld	4/10/01	0.102	12	1.55	0.35	5.85	

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
qcld	4/30/01	0.103	10	1.72	0.25	5.30	
qclu	5/11/92	0.200	8	1.00	6.00		
qclu	6/8/92	0.250	6	1.00	1.00		
qclu	7/6/92	0.300	20	9.00	0.50		
qclu	8/11/92	0.270	8	1.00	1.00		
qclu	9/8/92	0.320	10	1.00	1.00		
qclu	10/12/92	0.240	2	7.00	8.00		
qclu	11/4/92	0.230	10	16.00	4.00		
qclu	12/7/92	0.200	9	6.00	0.50		
qclu	1/13/93	0.190	1	1.00	1.00		
qclu	2/2/93	0.120	5	1.00	0.50		
qclu	3/3/93	0.200	5	1.00	0.50		
qclu	4/6/93	0.130	4	1.00	4.00		
qclu	5/6/93	0.130	68	1.00	4.00		
qclu	6/8/93	0.250	6	1.00	4.00	20.00	
qclu	7/7/93	0.260	6	4.00	1.00		
qclu	8/4/93	0.280	4	1.00	3.00		
qclu	9/9/93	0.270	5	4.00	5.00		
qclu	10/7/93	0.280	1	1.00	2.00		
qclu	11/4/93	0.260	1	1.00	2.00		
qclu	12/6/93	0.140	11	9.00	4.00	27.00	
qclu	1/13/94	0.120	2	4.00	1.00		
qclu	2/9/94	0.190	1	1.00	2.00		
qclu	3/7/94	0.093	2	1.00	0.50		
qclu	4/13/94	0.066	1	4.00	0.50		
qclu	5/16/94	0.140	0	0.50	2.30		
qclu	6/8/94	0.290	0	0.50	0.50	11.00	
qclu	7/14/94	0.180	4	0.50	3.90	7.40	
qclu	8/4/94	0.280	0	0.50	0.50	2.50	
qclu	9/14/94	0.240	2	0.50	0.50	32.00	
qclu	10/14/94	0.037	33	2.80	1.10	12.00	
qclu	11/7/94	0.220	6	1.10	0.50	7.80	
qclu	12/5/94	0.150	9	0.50	0.50	2.50	
qclu	1/10/95	0.110	17	5.10	1.10	2.50	
qclu	2/9/95	0.140	3	0.50	0.50	2.50	
qclu	3/8/95	0.140	5	0.50	0.50	2.50	
qclu	4/6/95	0.140	6	0.50	0.50	2.50	
qclu	5/2/95	0.180	14	2.70	1.60	2.50	
qclu	6/8/95	0.270	5	0.50	0.50	17.00	

Appendix B. Quilceda/Allen Data (continued)

Site	Date	Total Phos. mg/l	TSS mg/l	T.R. Copper ug/L	T.R. Lead ug/L	T.R. Zinc ug/L	Discharge cfs
qclu	7/10/95	0.260	5	1.90	0.50	2.50	
qclu	8/9/95	0.250	4	0.50	0.50	2.50	
qclu	9/20/95	0.260	5	1.20	0.50	2.50	
qclu	10/2/95	0.210	11	1.70	0.50	2.50	
qclu	11/6/95	0.190	2	0.50	0.50	2.50	
qclu	12/13/95	0.043	12	2.80	0.50	11.00	
qclu	1/3/96	0.076	8	0.50	0.50	0.50	
qclu	2/7/96	0.056	12	1.70	0.50	2.50	
qclu	3/4/96	0.120	3	0.70	0.10	2.20	
qclu	4/3/96	0.099	10	0.69	5.20	3.40	
qclu	5/6/96	0.112	5	0.04	0.00	0.26	
qclu	6/4/96	0.182	1	0.11	0.39	2.46	
qclu	7/15/96	0.258	4	1.33	1.11		
qclu	8/7/96	0.272	1	2.01	1.82		
qclu	9/9/96	0.280	3	0.25	0.61	0.65	
qclu	10/7/96	0.259	5	2.06	0.39	0.99	
qclu	11/5/96	0.105	2	1.02	1.00	2.88	
qclu	12/17/96	0.105	4	2.26	0.47	2.60	
qclu	1/8/97	0.034	36	2.67	2.96	20.60	
qclu	2/10/97	0.109	5	0.77	0.00	2.53	
qclu	3/3/97	0.075	2	1.31	0.54	2.40	
qclu	4/9/97	0.143	1	0.78	0.34	1.89	
qclu	5/7/97	0.108	7	3.55	0.76	9.92	
qclu	6/3/97	0.218	4	0.85	0.00	3.43	
qclu	7/9/97	0.110	10	1.09	0.30	3.77	
qclu	10/7/97	0.151	0	0.92	0.00	1.57	
qclu	11/5/97	0.114	3	0.98	0.37	1.06	
qclu	12/2/97	0.082	2	1.12	0.32	2.21	
qclu	1/6/98	0.051	2	0.97	0.42	3.02	
qclu	4/14/98	0.109	11	2.25	0.27	3.07	
qclu	5/5/98	0.210	13	0.69	0.53	7.48	
qclu	6/8/98	0.185	2	0.85	0.35	2.97	
qclu	7/16/98	0.250	7	0.91	0.23	3.10	
qclu	8/6/98	0.265	5	1.25	0.20	7.87	
qclu	9/14/98	0.258	1	0.50	0.27	2.51	
qclu	6/13/00			1.09	0.43	4.58	1.72
qclu	8/3/00			0.83	0.21	2.84	0.685
qclu	11/7/00			0.56	0.11	2.82	0.656
qclu	2/8/01		12	1.63	1.08	6.09	2.299
qclu	4/10/01		11	1.11	0.61	3.23	2.749