

Lead and Copper Concentrations In North Creek, Gig Harbor



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Cover photo: North Creek sampling site #1. The creek is about 3 feet wide at that point, typical of its width throughout the project area. The black area that appears behind the Ecology employee is a culvert where the creek enters the Gig Harbor Sportsman Club property.

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Lead and Copper Concentrations in North Creek, Gig Harbor

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Water Quality Assessment Listing ID: 12525

Water Resource Inventory Area (WRIA): 15

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Abstract

On April 10 and 21, 2008, the Washington State Department of Ecology (Ecology) monitored lead and copper concentrations at three locations on North Creek and two locations on Donkey Creek.

The Gig Harbor Sportsman Club had been implicated as a source of lead to North Creek based on preliminary sampling efforts by the Tacoma-Pierce County Health Department in 2002. North Creek flows across the eastern quarter of the Club property.

Samples from North Creek taken just downstream of the Club on April 10 and 21 showed dissolved lead concentrations as high as 200 µg/L. This level was higher than the chronic water quality criteria by a factor of approximately 900, and the acute criteria by a factor of 36. This is the highest lead concentration found in Washington State surface waters. Samples taken just upstream of the Club showed dissolved lead concentrations of 0.82 µg/L. Lead concentrations downstream of the Club exceeded the upstream concentrations by more than 200 times, indicating that the Club was the source of lead in North Creek.

Copper concentrations upstream and downstream of the Club exceeded acute or chronic water quality criteria by a small margin three times.

Based on the findings of this study, the lead listings for North Creek should be retained as Category 5 (impaired waterbody) of the federal Clean Water Act Section 303(d) list. Copper listings for North Creek should be added as Category 5 during the next 303(d) listing cycle.

The Gig Harbor Sportsman Club site should undergo a Site Hazard Assessment through the Department of Ecology's Toxics Cleanup Program, and receive a hazard ranking based on the results. The site would then be placed on the state Hazardous Sites List with priority for cleanup which depends on the ranking.

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- Randy Coots for his initial work on the Quality Assurance Project Plan, aid in locating sampling sites, and reviewing the final report.
- Dale Norton for reviewing the Quality Assurance Project Plan and final report.
- Joan LeTourneau for formatting and editing the final report.

Introduction

Responding to a citizen's concern about the water quality of North Creek, the Tacoma-Pierce County Health Department collected water and soil samples from North Creek in 2002 (Bell, 2002). Dissolved lead concentrations in North Creek were as high as 200 µg/L compared with the Washington State acute water quality criteria of 6.62 µg/L.

North Creek is located within the city of Gig Harbor which is west of Point Defiance on the Kitsap peninsula. The creek drains a small watershed of approximately 0.2 square miles (130 acres) made up of mixed forest, family residences, a shooting range, athletic fields, and a business park. North Creek is within Water Resource Inventory Area (WRIA) 15.

North Creek flows across the Gig Harbor Sportsman Club property. The headwaters of the creek are within one mile of the Club. The Club is an active shooting range located off Burnham Drive in Gig Harbor. It has operated since the 1940s. Club property consists of a shotgun range with seven regulation trap fields and a rifle and pistol range. Nearby property has been developed for residential and business uses.

North Creek discharges into Donkey Creek, a salmon-bearing stream which flows through the city of Gig Harbor and into Puget Sound.

On April 10 and 21, 2008, the Washington State Department of Ecology (Ecology) monitored lead and copper concentrations at three locations on North Creek and two locations on Donkey Creek. A third monitoring date was planned for May 15, but North Creek was not flowing.

The purpose of this project was to verify the status of a lead listing in North Creek as Category 5 (impaired waterbodies) on the 2006 federal Clean Water Act Section 303(d) list. Copper in North Creek is also listed. The initial Category 5 listing was based on the Health Department monitoring conducted on one day in 2002. At least two days of concentrations higher than (exceeding) water quality standards are required for 303(d) listing, prompting this verification study.

Samples from North Creek taken just downstream of the Club on April 10 and 21 showed dissolved lead concentrations as high as 200 µg/L. This level was higher than the chronic water quality criteria by a factor of approximately 900, and the acute criteria by a factor of 36. This is the highest lead concentration found in Washington State surface waters. Samples taken just upstream of the Club showed dissolved lead concentrations of 0.82 µg/L. Lead concentrations downstream of the Club exceeded the upstream concentrations by more than 200 times, indicating that the club was the source of lead in North Creek.

Copper concentrations were measured in this 2008 study. It was considered possible that copper from bullet casings could impact water quality. Copper is also a metal commonly found in concentrations approaching fresh water quality criteria. This was not confirmed by the study. Downstream copper concentrations proved to be slightly higher than upstream concentrations.

The Sportsman Club site was withdrawn from the Voluntary Cleanup Program in May 2006 due to inactivity in volunteer efforts. Its current status is *Awaiting SHA* (Site Hazard Assessment), which is an evaluation of the site that results in adding the Club property to Ecology's Hazardous Sites List database. For Pierce County, the SHAs are typically conducted by the Tacoma-Pierce County Health Department (Rose, 2008).

Study Design

This study of lead and copper concentrations in North Creek was designed to take place toward the end of the 2008 wet season because the creek had been described as intermittent (Bell, 2002). North Creek is narrow, in some places only one or two feet in width.

Five locations were sampled during each of the two sampling days, April 10 and 21. The sampling was to evaluate lead and copper concentrations in (1) North Creek upstream and downstream of the Gig Harbor Sportsman Club, and (2) Donkey Creek. The Club and all five sampling sites are located within the city of Gig Harbor.

Figure 1 shows sampling stations on North Creek adjacent to the Club boundary and upstream and downstream of the site (#1; #2, Figure 1). North Creek was also sampled just upstream of North Creek's confluence with Donkey Creek (#3). Donkey Creek was sampled above and below the confluence (#4; #5) to determine background levels of lead and copper in Donkey Creek and any measurable impact of North Creek metals on Donkey Creek.

Clean sampling techniques were used following the guidance in EPA Method 1669: *Sampling Ambient Water for Trace Metals at EPA Water Quality Levels* (EPA, 1995).

To be listed under Category 5 of the 303(d) list, dissolved metals must exceed Washington State water quality criteria on two occasions within a three-year period (WQP, 2006).

Creek water was collected to determine dissolved lead and copper concentrations, hardness, and total suspended solids (TSS). The results of hardness analyses are required to determine water quality standards for dissolved lead, copper, and other metals.

Samples were collected April 10 and 21, 2008. A third monitoring date was planned for May 15 but the creek was dry. This confirmed indications that the creek is intermittent (Bell, 2002).



Figure 1. Site map showing Sportsman Club boundaries, creeks, and sampling sites .

Field Methods

All samples were collected as single grabs directly from North and Donkey creeks. In all cases for both creeks, streamflow was turbulent and well mixed so that single grabs were adequate to represent creek water.

Samples were collected directly into HDPE bottles. Dissolved metals were filtered in the field through a 0.45 μm Nalgene filter unit (#450-00045, type S). All samples were preserved to $\text{pH} < 2$ with sub-boiled 1:1 nitric acid, carried in small Teflon® vials. Teflon acid vials and Nalgene filters were cleaned at Manchester Laboratory as described by Kammin et al. (1995). Powder-free nitrile gloves were worn by field staff during filtering and when handling sample containers.

Each sample was given an ID number, tagged, put on ice, and kept cooled to 4°C. Chain-of-custody procedures were observed, and samples were delivered to the laboratory within allowable holding times for each parameter.

A summary of parameters, collection containers, sample preservation, and holding times appears in Table 1.

Table 1. Sample size, container, preservation, and holding time by parameter.

Parameter	Sample Size (mL)	Container	Preservation	Holding Time
Pb, Cu (TR)	500	1 L HDPE bottle	HNO_3 to $\text{pH} < 2$	6 months
Pb, Cu (dissolved)	500	1 L HDPE bottle	HNO_3 to $\text{pH} < 2$	6 months
Hardness	100	100 mL	H_2SO_4 to $\text{pH} < 2$	6 months
TSS	1000	1000 mL	Cool to 4°C	7 days

Pb – lead

Cu – copper

TR – total recoverable (total)

TSS – total suspended solids

Analytical Methods

Laboratory analytical methods are shown in Table 2. Method reporting limits for are for low-level metals analyses (Kammin et al., 1995).

Table 2. Analytical methods for metals analysis of water samples.

Parameter	Sample Preparation Method	Analytical Method	Method Reporting Limit
Pb, Cu (TR)	Digested with mixture of nitric and hydrochloric acids	EPA 200.8	0.10 µg/L
Pb, Cu (dissolved)	Field Filtered	EPA 200.8	0.02 µg/L Pb 0.10 µg/L Cu
Hardness	--	EPA 200.7	1 mg/L
TSS	--	SM 2540D	1 mg/L

Pb – lead

Cu – copper

TR – total recoverable (total)

TSS – total suspended solids

SM – Standard Method

Data Quality

Quality assurance (QA) requirements are included in the QA Project Plan for this project (Golding, 2008). Manchester Environmental Laboratory (MEL) prepared written QA reviews on the quality of the metals data for this project. The reviews include an assessment of sample condition on receipt at the laboratory, compliance with holding times, instrument calibration, procedural blanks, laboratory control samples, matrix spike and matrix spike duplicate recoveries, and duplicate sample analyses.

Problems that compromise the accuracy, validity, or usefulness of the data were not encountered. MEL case narratives indicated that all QA measures included in the QA Project Plan were met with the exception that there was no determination of spike recoveries for dissolved lead. This was because the standard spiking level was too low for the elevated metal levels of the sample from site 2 collected 4/21/08 with a concentration of 188 µg/L.

Samples were received with acceptable temperatures (0° – 6°C). The laboratory performed all analyses within established EPA holding times. All initial and continuing calibration checks were within control limits. No significant levels of analytes were detected in laboratory method blanks. Matrix spikes, other than the exception cited above, were within the acceptance limit of 75% - 125%.

Relative percent difference (RPD) is a measure of variability obtained by dividing the difference between two values by their mean, expressed as a percentage. All lab duplicate RPDs were within the acceptable range of 0% - 20%. All laboratory control sample recoveries were within the acceptance limits of 85% - 115%. All internal standard recoveries were within acceptance limits of 60% - 125%.

Appendix B shows precision data from laboratory duplicates and field replicates. Blank samples of deionized water were used to assess any contamination of samples from transfer or filtering into containers.

All laboratory duplicates had an RPD of 7% or lower. Field replicates for lead showed acceptable variability: an RPD of 4% for samples above 2 µg/L and a maximum of 20% for samples lower than 2 µg/L. Sample pairs tend to have higher RPDs when they approach the lower end of detection limits. Field replicates for copper had a maximum RPD of 3%. The two dissolved lead blanks showed nondetected results of 0.020 µg/L. This is equal to the MEL reporting limit for dissolved lead.

The two dissolved copper blanks showed nondetected results of 0.10 µg/L, equal to the MEL reporting limit for dissolved copper. Dissolved and not total recoverable blanks were analyzed because dissolved samples show any transfer contamination as well as filter contamination. Also, it is the dissolved form of metals that are compared with water quality criteria.

Results

Results are shown in Table 3. Samples from North Creek (site 2) just downstream of the Sportsman Club boundaries showed total recoverable and dissolved lead concentrations of roughly 200 µg/L on both sampling dates. This is two orders of magnitude greater than samples just upstream of the Club where total and dissolved lead concentrations approximated 1 µg/L. The highest total recoverable lead concentration was found to be 212 µg/L.

These downstream concentrations are the highest lead concentrations found in surface waters of Washington State. The next highest concentration, 52.1 µg/L, was found at SE Thornton Creek in Seattle in 2003. In 1992, concentrations up to 44 µg/L were found in the Longview Ditches, in a heavily industrialized area (EIM database, 2008).

No lead shot was visibly evident in North Creek or adjacent property. An investigation in 2002, that included a reconnaissance of an interior portion of the Club property, found large amounts of lead. In some cases, lead was found covering the ground (Bell, 2002).

Hardness concentrations, upon which water quality criteria are dependent, were found from about 11 to 12 mg/L both upstream and downstream from Club boundaries for samples collected on April 10. Values were 39.9 mg/L farther downstream on North Creek. Donkey Creek showed values of approximately 50 mg/L. These hardness values were similar on the April 21 collection date. Therefore, the spatial variations in hardness were systematic and real.

Table 3. Results of lead and copper sampling on North and Donkey Creeks.

Lab #	Sample site	Map site	Pb (TR) µg/L	Pb (diss) µg/L	Fraction: Pb (diss)/ Pb (TR)	Cu (TR) µg/L	Cu (diss) µg/L	Fraction: Cu (diss)/ Cu (TR)	TSS mg/L	Hardness mg/L
Collection Date: 4/10/08										
8154205	NCREEK1	1	1.15	0.82	0.71	2.71	2.19	0.81	2	12.5
8154206	NCREEK2	2	212	200	0.94	2.30	1.96	0.85	1 U	11.1
8154207	NCREEK3	3	28.0	21.8	0.78	0.96	0.81	0.84	1 U	39.9
8154208	DONKEY4	4	0.17	0.09	0.53	0.60	0.43	0.72	4	51.0
8154209	DONKEY5	5	3.22	1.25	0.39	0.56	0.35	0.62	3	53.3
Collection Date: 4/21/08										
8174205	NCREEK1	1	1.44	0.82	0.56	2.68	2.41	0.89	5	13.0
8174206	NCREEK2	2	188	178	0.95	2.6	2.08	0.80	1 U	10.0
8174207	NCREEK3	3	32.6	25.1	0.77	1.16	1.02	0.88	1	26.0
8174208	DONKEY4	4	0.14	0.08	0.58	0.55	0.39	0.71	1	55.5
8174209	DONKEY5	5	1.81	0.77	0.43	0.48	0.33	0.69	2	57.3

Pb – lead

Cu – copper

TR – total recoverable

Diss – dissolved

TSS – total suspended solids

Comparisons to Washington State Water Quality Standards

Table 4 shows dissolved lead concentrations compared to water quality criteria. Samples from North Creek taken just downstream of the Club (site 2) on April 10 and 21, 2008 showed dissolved lead concentrations as high as 200 µg/L. These levels exceeded chronic water quality criteria by a factor of slightly above 900 and the acute criteria by a factor of 36. Samples taken at a site downstream near the confluence with Donkey Creek (site 3) exceeded chronic lead criteria by a factor of 44 or lower and the acute criteria by a factor of 2. Samples taken just upstream of the Club boundary found dissolved lead concentrations approximately three times the chronic water quality criteria.

Based on the findings of water quality exceedances on the two dates, the listing of this segment of North Creek for lead has been verified as Category 5 on the 303(d) list of impaired waterbodies. Category 5 waterbodies are impaired and require TMDLs (Total Maximum Daily Load allocations) or other source control actions. The segment is from the upstream boundary with the Club to the creek's confluence with Donkey Creek.

Water quality exceedances for lead on North Creek were generally downstream of the Club with the exception of two samples taken just upstream (site 1). The upstream samples from April 10 and 21 both had dissolved lead concentrations of 0.82 µg/L, approximately three times an associated chronic water quality criteria of 0.25 µg/L and 0.26 µg/L, respectively. Sources of lead upstream may be relatively small amounts from the Club entering the creek since the sampling site (#1) was slightly below the north end of the Club boundary.

Table 5 shows dissolved copper concentrations compared to water quality criteria. There were three exceedances of chronic water quality criteria for the two sampling events (April 10 and 21) and one acute exceedance for the second event. All exceedances for copper were a factor of 1.3 or less above acute and chronic criteria. The exceedances verify a 303(d) listing for copper on North Creek. Measured copper concentrations downstream of the Club were lower than those above. The differences could not be shown to differ with statistical significance. The presumption that copper from bullet casings may have resulted in elevated copper concentrations in the creek was unsupported.

Table 4. Comparison of dissolved lead concentrations with water quality criteria.

Lab #	Site	Pb (TR) µg/L	Pb (diss) µg/L	Hardness mg/L	Acute WQ Criteria µg/L	Chronic WQ Criteria µg/L	Diss Pb as Factor of Acute Criteria	Diss Pb as Factor of Chronic Criteria
Collection Date: 4/10/08								
8154205	NCREEK1	1.15	0.82	12.5	6.33	0.25	36.1	3.3
8154206	NCREEK2	212	200	11.1	5.53	0.22		910
8154207	NCREEK3	28.0	21.8	39.9	23.45	0.91		24
8154208	DONKEY4	0.17	0.09	51.0	30.14	1.17		
8154209	DONKEY5	3.22	1.25	53.3	32.35	1.26		
Collection Date: 4/21/08								
8174205	NCREEK1	1.44	0.82	13	6.62	0.26	36.2	3.2
8174206	NCREEK2	188	178	10	4.91	0.19		937
8174207	NCREEK3	32.6	25.1	26	14.51	0.57		44
8174208	DONKEY4	0.14	0.08	55.5	33.8	1.32		
8174209	DONKEY5	1.81	0.77	57.3	35.05	1.37		

 - exceeds both chronic and acute criteria
 -exceeds chronic criteria only

Lab Blank (reporting limit) for dissolved lead = 0.02 U (µg/L)

Pb (TR) - lead, total recoverable
 Pb (diss) - lead, dissolved

Table 5. Comparison of dissolved copper concentrations with water quality criteria.

Lab #	Site	Cu (TR) µg/L	Cu (diss) µg/L	Hardness mg/L	Acute WQ Criteria µg/L	Chronic WQ Criteria µg/L	Diss Cu as Factor of Acute Criteria	Diss Cu as Factor of Chronic Criteria
Collection Date: 4/10/08								
8154205	NCREEK1	2.71	2.19	12.5	2.40	1.92		1.2
8154206	NCREEK2	2.30	1.96	11.1	2.14	1.73		1.1
8154207	NCREEK3	0.96	0.81	39.9	7.16	5.18		
8154208	DONKEY4	0.60	0.43	51.0	9.02	6.38		
8154209	DONKEY5	0.56	0.35	53.3	9.41	6.63		
Collection Date: 4/21/08								
8174205	NCREEK1	2.68	2.41	13	2.49	1.99		1.2
8174206	NCREEK2	2.6	2.08	10	1.94	1.59	1.1	1.3
8174207	NCREEK3	1.16	1.02	26	4.78	3.59		
8174208	DONKEY4	0.55	0.39	55.5	9.77	6.86		
8174209	DONKEY5	0.48	0.33	57.3	10.07	7.05		

- exceeds both chronic and acute criteria
 -exceeds chronic criteria only

Lab Blank (reporting limit) for dissolved copper = 0.01 U (µg/L)

Cu (TR) - copper, total recoverable
 Cu (diss) - copper, dissolved

Conclusions and Recommendations

Conclusions

Monitoring of North Creek and Donkey Creek for lead and copper on April 10 and 21, 2008 showed dissolved lead concentrations higher than (exceeding) both acute and chronic water quality criteria.

The site on North Creek at the downstream boundary of the Gig Harbor Sportsman Club had dissolved lead concentrations of 200 and 178 µg/L compared with acute criteria of approximately 5 µg/L. These are the highest concentrations of lead that have been found in the waters of Washington State.

Two samples taken from North Creek just upstream of the Club exceeded the chronic water quality criteria for lead, but by relatively small margins. Exceedances of acute or chronic criteria for lead were found in North Creek approximately 1,000 feet south of the Club boundary, though lead concentrations were much lower than just below the Club boundary. The southern boundary of the Club is just upstream of North Creek's confluence with Donkey Creek (site 3). No water quality exceedances were found in Donkey Creek.

Copper concentrations found in North Creek just upstream and downstream of the Club exceeded acute or chronic criteria by a factor of 1.3 and below.

Recommendations

The lead listing for North Creek should be retained as Category 5 (impaired waterbody) of Washington's 303(d) list. The copper listing for North Creek should be added as Category 5 during the next 303(d) listing cycle.

The Gig Harbor Sportsman Club site should undergo a Site Hazard Assessment through the Department of Ecology's Toxics Cleanup Program, and receive a hazard ranking based on the results. The site would then be placed on the state Hazardous Sites List with priority for cleanup which depends on the ranking.

Bioassessment of North Creek below the Club boundary would help determine if adverse ecological impacts are occurring due to high lead concentrations.

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Appendices

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Appendix A. Rainfall at Tacoma-Narrows Airport

Table A-1. Rainfall (inches) at the Tacoma-Narrows Airport during the 2008 sampling season.

February		March		April		May		June	
1	0.09	1	0.18	1	0.00	1	0.00	1	0.00
2	0.02	2	0.00	2	0.00	2	0.00	2	0.06
3	0.10	3	0.05	3	0.00	3	0.15	3	0.49
4	0.01	4	0.00	4	0.14	4	0.00	4	0.00
5	0.25	5	0.00	5	0.09	5	0.00	5	0.19
6	0.37	6	0.01	6	0.24	6	0.00	6	0.39
7	0.30	7	0.05	7	0.11	7	0.00	7	0.00
8	0.50	8	0.00	8	0.03	8	0.00	8	0.00
9	0.08	9	0.00	9	0.00	9	0.00	9	0.00
10	0.23	10	0.25	10	0.02	10	0.03	10	0.14
11	0.00	11	0.13	11	0.00	11	0.00	11	0.02
12	0.02	12	0.00	12	0.00	12	0.00	12	0.00
13	0.00	13	0.49	13	0.10	13	0.51	13	0.00
14	0.01	14	0.18	14	0.05	14	0.00	14	0.00
15	0.01	15	0.03	15	0.00	15	0.00	15	0.00
16	0.01	16	0.04	16	0.00	16	0.00	16	0.00
17	0.00	17	0.01	17	0.01	17	0.00	17	0.00
18	0.00	18	0.01	18	0.01	18	0.00	18	0.00
19	0.00	19	0.10	19	0.10	19	0.00	19	0.01
20	0.00	20	0.01	20	0.17	20	0.27	20	0.00
21	0.01	21	0.01	21	0.01	21	0.12	21	0.00
22	0.01	22	0.00	22	0.02	22	0.00	22	0.00
23	0.00	23	0.60	23	0.01	23	0.02	23	0.00
24	0.01	24	0.00	24	0.00	24	0.00	24	0.00
25	0.02	25	0.20	25	0.00	25	0.05	25	0.00
26	0.00	26	0.32	26	0.00	26	0.00	26	0.00
27	0.08	27	0.04	27	0.11	27	0.00	27	0.00
28	0.02	28	0.28	28	0.23	28	0.00	28	0.00
29	0.21	29	0.14	29	0.01	29	0.00	29	0.00
		30	0.00	30	0.00	30	0.00	30	0.00
		31	0.00			31	0.00		

 = 0.10 inches of rainfall or more in 24 hours or more.
 = 0.01 to 0.09 inches of rainfall in 24 hours.
 = scheduled monitoring events. North Creek was monitored April 10 and 21.
 North Creek was dry on May 15 so monitoring was cancelled.

Appendix B. Quality Assurance Data

Table B-1. Precision Data and Blank Results: Lab Duplicates.

Parameter	Sample	Date	Lab Duplicates		
			Sample 1	Sample 2	RPD *
Pb, diss (µg/L)	DONKEY4	4/21/08	0.081	0.079	2.5%
Cu, diss (µg/L)	DONKEY4	4/21/08	0.39	0.39	0%
Hardness (mg/L)	NCREEK1	4/21/08	13	14	7%

Table B-2. Precision Data and Blank Results (µg/L): Field Replicates.

Parameter	Sample	Date	Field Replicates		
			Sample 1	Sample 2	RPD
Pb, TR	NCREEK2	4/10/08	212	203	4%
	NCREEK1	4/21/08	1.44	1.17	20%
Pb, diss	NCREEK2	4/10/08	200	193	4%
	NCREEK1	4/21/08	0.82	0.756	12%
Cu, TR	NCREEK2	4/10/08	2.30	2.32	1%
	NCREEK1	4/21/08	2.68	2.76	3%
Cu, diss	NCREEK2	4/10/08	1.96	1.95	1%
	NCREEK1	4/21/08	2.41	2.33	3%

Table B-3. Precision Data and Blank Results (µg/L): Field Blanks.

Parameter	Field Blanks		
	Sample Type	Date	Result
Pb, diss	Filter Blanks	4/10/08	0.020 U
		4/21/08	0.020 U
Cu, diss	Filter Blanks	4/10/08	0.10 U
		4/21/08	0.10 U

RPD – relative percent difference

Diss – dissolved

U – the analyte was not detected at or above the reported estimated result

Appendix C. Glossary and Acronyms

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which designated uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation’s waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

Club	Gig Harbor Sportsman Club
Cu	Copper
Diss	Dissolved
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
Pb	Lead
QA	Quality assurance
RPD	Relative percent difference