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Garrison Creek Use-Based Receiving Water Study

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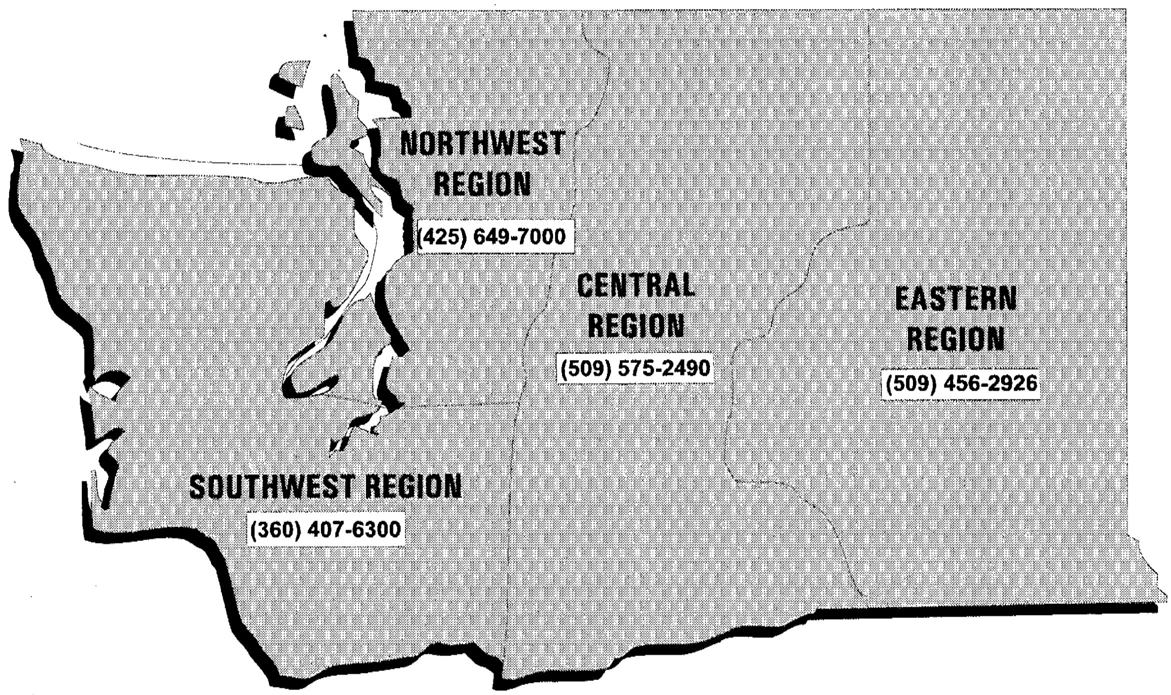

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Garrison Creek Use-Based Receiving Water Study

By
Jody White
Ed Rashin
Emmanuel Nocon
and
John Summers

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Post Office Box 47600
Olympia, Washington 98504-7600

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Table of Contents

List of Figures

List of Figures (con't)

List of Tables

Acknowledgments

Several people are responsible for assisting us in completing this project and we would like to thank them for their help. Al Radar, the College Place Wastewater Treatment Plant operator, was integral in getting this project completed. Al provided extensive information on historical data and uses in Garrison Creek and surrounding areas, and assisted us in the gathering of field data. Guy Hoyle-Doson and Dale Clark from EILS provided both technical assistance and field equipment to complete the receiving water part of the study. Other Ecology personnel that provided valuable technical assistance included Norman Olson, Art Johnson, Dale Davis, and Joe Joy of Environmental Investigations and Laboratory Services, Mark Hicks of the Water Quality Program, and William Neve in the Eastern Regional Office. We would also like to thank all those who participated in our questionnaire about beneficial uses in Garrison Creek.

Abstract

Stream conditions and potential or existing uses were surveyed both above and below the College Place Wastewater Treatment Plant on Garrison Creek in south-eastern Washington. Observations of existing beneficial uses of Garrison Creek, including human, aquatic life, and wildlife uses, were made using water column, sediment, biological, and aquatic habitat surveys during the period of September 16-19, 1996. Anecdotal information on existing and potential uses for other seasons and in other reaches of Garrison Creek, as well as historic uses, was collected by using a survey questionnaire which was sent to individuals knowledgeable about the creek and water uses.

An intensive field survey sampled water column characteristics and sediment characteristics for insecticides, herbicides, metals, nutrients, temperature, coliform bacteria and other chemical parameters with both grab samples and continuous in-situ instrumentation. The biological community, both fish and benthic invertebrates, were quantitatively assessed to estimate densities and species compositions within Garrison Creek. Tissue samples from fish were also obtained to analyze the deposition of pesticides and herbicides.

Results indicated that most beneficial uses within Garrison Creek, a Class A waterbody, were either non-supported or partially supported, based on the Washington State Water Quality Standards. Biological communities were extremely depressed below the WWTP and several water quality parameters including nutrients and ammonia were highly elevated. However, throughout the creek, temperature and fecal coliform bacteria were found at very high levels and did not meet state standards.

1.0 Introduction

Ecology's Watershed Assessments Section in the Environmental Investigations and Laboratory Services Program conducted a use-based receiving water study on lower Garrison Creek in Walla Walla County. The purpose of the study is to provide information for making decisions regarding the renewal of the NPDES permit for the planned upgrade of the College Place Wastewater Treatment Plant (WWTP), which discharges to Garrison Creek. This includes decisions regarding the development of use-based permit limits.

The use-based concept refers to a new, more site-specific approach to assigning water quality standards. Rather than treating all surface waters having the same Water Quality Standards Classification (e.g. Class A waters) as if they have the same suite of characteristic water uses, the use-based approach is premised on determining which actual or potential uses exist in a particular waterbody type or specific waterbody based on its inherent and naturally-occurring environmental characteristics. This approach is intended to facilitate water pollution control or restoration programs targeted to protecting or restoring the waterbody-specific uses. Ecology is presently considering whether to apply the use-based approach in its Water Quality Standards program, as a part of the triennial water quality standards revision process.

1.1 Study Area

Garrison Creek is a tributary to the Walla Walla River in the Lower Snake Water Quality Management Area (WRIA 32), and is classified as Class A according to the Surface Water Quality Standards (WAC 173-201A-120). The segment of the Walla Walla River of which Garrison Creek is a tributary is Class A, with special conditions for temperature criteria of 20 °C, but this criteria does not explicitly apply to Garrison Creek. Water quality of this Class shall meet or exceed the requirements for all or substantially all of the following characteristic uses:

- Domestic, industrial, and agricultural water supply;
- Stock watering;
- Salmonid and other fish migration, rearing, spawning, and harvesting;
- Clam, oyster, and mussel rearing, spawning, and harvesting;
- Wildlife habitat; and
- Primary contact recreation, sport fishing, boating, and aesthetic enjoyment.

Garrison Creek is a small, 10 mile long, distributary of Mill Creek (RM 36.4) that flows through the cities of Walla Walla and College Place until entering the Walla Walla River (Figure 1). Surrounding land uses consist of urban development and irrigated agriculture. The reach of Garrison Creek affected by the College Place wastewater treatment plant, which is the focus of this study, includes the lowermost

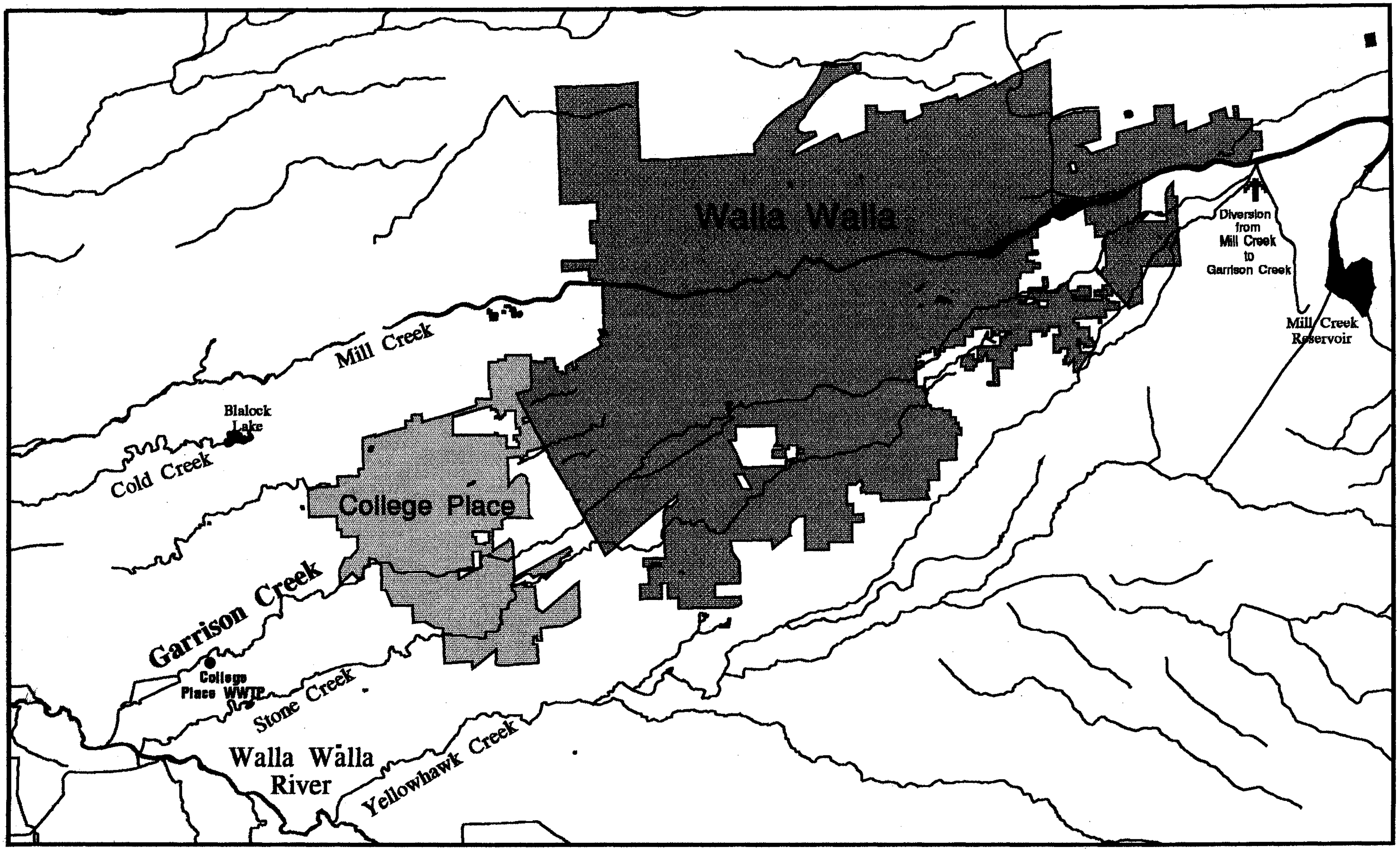


Figure 1. Site Reference Location Map

College Place Wastewater Treatment Plant (WWTP) Receiving Water Study

1 0 1 2 3 4 Miles

N

one mile of the creek. However, aquatic life uses upstream of this reach also need to be taken into account in the use-based receiving water study, as certain fish and other aquatic life need to migrate through the affected reach.

1.2 Background and Historical Information

It is likely that Garrison Creek was a spring fed stream under natural conditions existing prior to the development of the Walla Walla area. The first water right was established in late 1860s on lower Garrison Creek and by the late 1800s, gravel diversion dams on nearby Mill Creek were being constructed to augment flows in Garrison Creek for agricultural uses. The Army Corps of Engineers replaced the gravel dams with a concrete facility, the Division Works, for flood regulation on Mill Creek and to maintain flows for existing downstream water rights on Garrison Creek and nearby Yellowhawk Creek. Several irrigation diversions occur, with substantial diversions occurring immediately downstream of College Place, and just upstream of and about 500 feet below the WWTP outfall. During low flow conditions, water rights are supplemented with ground water from wells.

No historical flow data are available, but existing information suggests a perennial flow in Garrison Creek (personal communication, William Neve, Department of Ecology, Eastern Regional Office). Stream flow is variable throughout the year with perennial flows occurring downstream to College Place where the creek may become intermittent during summer due to irrigation diversions. Perennial flow resumes at the WWTP outfall.

The only known water quality monitoring has occurred at the WWTP. Ecology completed a Class II inspection of the WWTP in 1988 (Heffner, 1988), and the WWTP has conducted monthly monitoring of its effluent as required by the NPDES permit. The WWTP has been conducting weekly monitoring of selected water quality parameters upstream of the effluent discharge for comparison to effluent since about 1994.

1.3 Treatment Facility Overview

The College Place WWTP is a high rate, single stage trickling filter facility with polishing ponds. The plant consists of a headworks with hydrosieves, two primary Clarifiers, two trickling filters, two secondary Clarifiers, two aerated lagoons, a settling lagoon, a rock filter, a chlorine contact basin, two anaerobic digesters, a gas collection and storage system, and sludge drying beds (Heffner, 1988). The plant serves approximately 5,900 people, with capacity to 8,200 people, and has a permitted flow of 0.91 MGD. Two identified industrial wastewater contributors to the WWTP include a dairy and a laundry. Seasonal waste fluctuation occurs from the Walla Walla College with lower discharges occurring during the summer term. Effluent quality monitoring protocols are found in the National Pollutant Discharge Elimination System Waste Discharge Permit (NPDES, 1990).

1.4 Project Objectives

The purpose of this project is to provide certain elements to facilitate implementation of the use-based approach to managing the discharge of treated effluent from the College Place WWTP. The objectives of this use-based receiving water study are:

1. Based on field surveys, determine and describe the water uses existing in the lower mile of Garrison Creek in the summer, low flow season, including aquatic life and human uses of the waterbody.

2. Evaluate and describe other apparent potential uses of Garrison Creek, including biological and other uses which may occur in other seasons and other reaches of the creek and historic uses.

3. Evaluate the current water quality conditions within the lower mile of Garrison Creek, including conditions affecting the chemical, biological, and physical integrity of the waterbody.

4. Determine the effect of the existing discharge from the College Place WWTP on the current water quality conditions of Garrison Creek.

5. To provide a framework for determining use-based water quality criteria which are appropriate for lower Garrison Creek.

2.0 Receiving Water Study Methods

2.1 Sampling Design and Field

A water column, biological, and physical habitat survey was conducted on Garrison Creek in late summer of 1996. The intensive survey work was conducted between September 16 and September 19, 1996, with stream temperature monitoring spanning a longer period of the summer. Site descriptions for the six mainstem Garrison Creek sites and the effluent of College Place WWTP are listed in Table 1 and shown in Figure 2. Elements of the survey included:

- Continuous water temperature monitoring from July 24 through September 19, 1996.
- Water column and effluent sampling on September 17 and 19, 1996.
- Biological surveys and fish tissue sampling conducted on September 18 and 19, 1996.
- The physical habitat survey conducted on September 18, 1996.
- Sediment samples were obtained on September 19, 1996 after the conclusion of biological and water sampling.

Table 1. Description of Sampling Locations for Garrison Creek Receiving Water Study

Station ID	**Description**	Latitude	Longitude	Township	Range	Section
GU2	Garrison Creek - upper most site, approximately 150 feet above effluent outfall	46° 01' 55.7"	118° 25' 3.3"	6N	35E	3
GU1	Garrison Creek - upstream site, approximately 10 feet above effluent outfall, directly below diversion dam	46° 01' 55.3"	118° 25' 3.9"	6N	35E	3
GE1	College Place WWTP Effluent - outfall in effluent discharge channel before entry into Garrison Creek	46° 01' 55.1"	118° 25' 4.4"	6N	35E	3
GD1	Garrison Creek - downstream site, immediately below the point of mixing between Garrison Creek and the effluent outfall	46° 01' 54.9"	118° 25' 5.0"	6N	35E	3
GD2	Garrison Creek - downstream site, approximately 300 below effluent outfall	46° 01' 54.3"	118° 25' 11.1"	6N	35E	3
GD3	Garrison Creek - downstream site, approximately below GD2, located below irrigation diversion	46° 01' 50.5"	118° 25' 13.3"	6N	35E	3
GD4	Garrison Creek - lower most site, near mouth, approximately 50 feet upstream from the Walla Walla River	46° 01' 25.5"	118° 25' 9.2"	6N	35E	4

Sampling conducted on September 19 coincided with a rainfall and runoff event, with a noticeable increase in stream discharge.

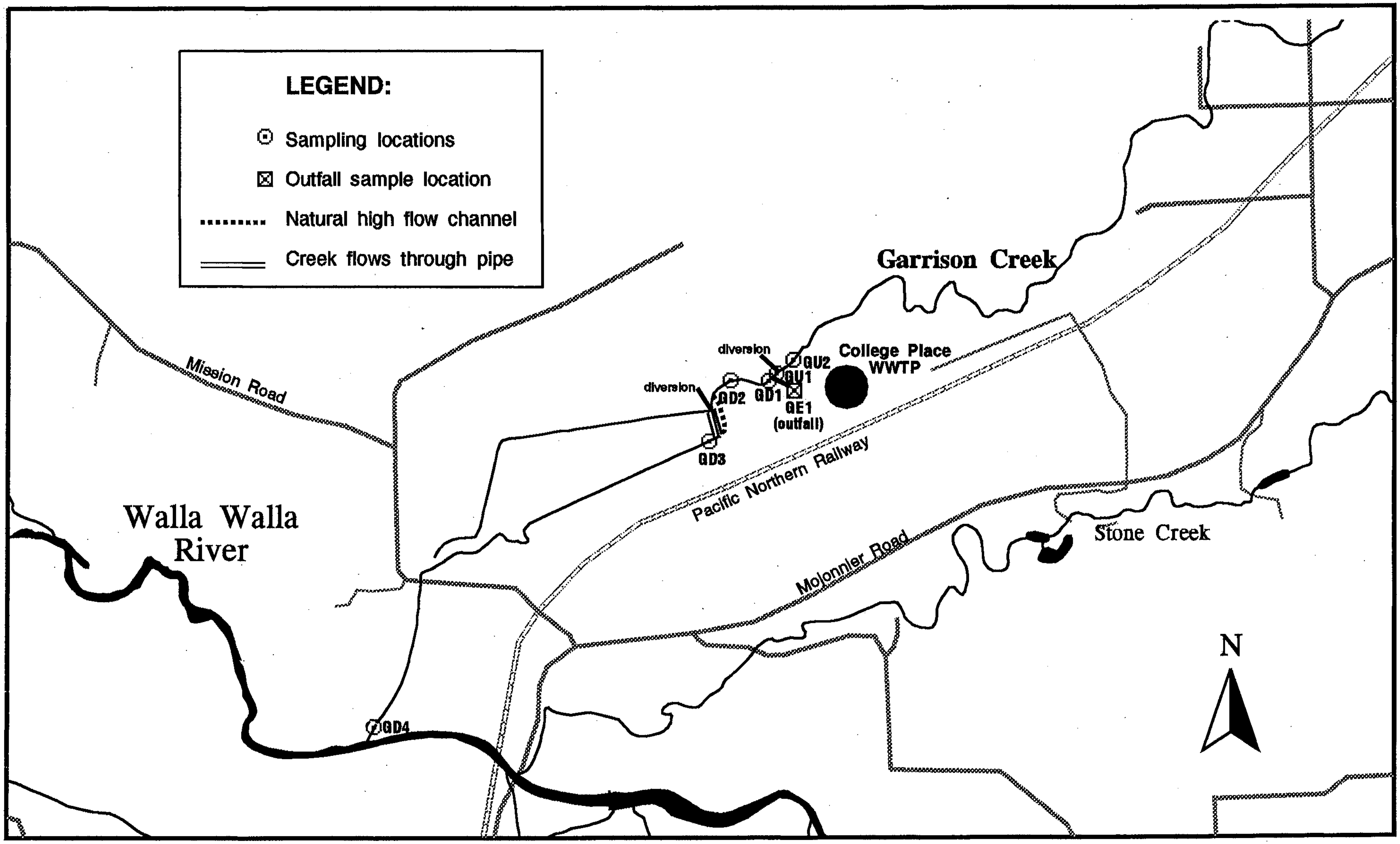
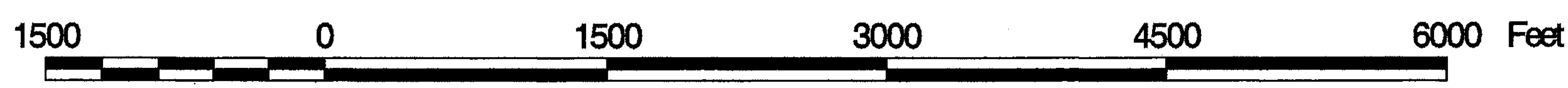


Figure 2. Sample Location Map

College Place Wastewater Treatment Plant (WWTP) Receiving Water Study



2.1.1 Water Column and Effluent Characterization

A summary of the water column sampling schedule, and field and laboratory measurements, target detection limits and methods are shown in Appendix B.1 and B.2, respectively.

Continuous monitoring for temperature, pH, specific conductivity, and dissolved oxygen were conducted using Hobotemp thermographs and Hydrolab Datasonde 3 probes. Continuous recording thermographs were launched at stations GU1, GD2, and GD4 during site reconnaissance on July 24, 1996 and were retrieved during the field survey on September 19. Datasonde 3s were deployed at GU2, GD1, and GD2 during the initial field survey on September 16 and recovered on September 19. Hobotemps and Hydrolabs were programmed to record readings at one hour and 30 minute intervals, respectively.

Discrete field measurements and collection of grab samples at all the above sites were performed on September 17 and September 19. Water temperature, pH, specific conductivity, dissolved oxygen (DO), and chlorine (CL) measurements were taken at each site corresponding to each grab sample, twice daily. Two grab samples were taken each day at stations GU2, GE1, GD2 and GD4, corresponding to the field measurement schedule. Water quality parameters measured in these grab samples included fecal coliform (FC), total coliform (TC), alkalinity, total suspended solids (TSS), turbidity, ammonia (NH_3), nitrite (NO_2), nitrite-nitrate (NO_2+NO_3), ortho-phosphate (OP), and total phosphorus (TP). Grab samples for TC were taken at station GD1 only. Alkalinity was measured at GD1 and GD4, and grab samples for NO_2, NO_2+NO_3, OP, and TP were taken only at GD4. In addition, stream discharge was measured at each of the grab sampling sites on September 19.

Two 24-hour composite samples were obtained at stations GU2, GE1, and GD2 on September 17 and September 19, using pumping samplers programmed to collect time-proportional samples. For each sample, 250 mL of water was collected every hour (total of 6 liters) and was kept cool using ice. Except for settleable solids (SS) and CL on September 19, and CL at GE1 on September 17, fourteen water quality parameters were measured at each of these composite stations, including FC, TC, alkalinity, hardness, SS, TSS, turbidity, biological oxygen demand (BOD), CL, NH_3, NO_2, NO_2+NO_3, OP, TP.

2.1.2 Sediment and Fish Tissue Sampling

Composite sediment samples were collected in the vicinity of station GD2 and in the reach below GU2. Several sub-samples of the upper 2-3 cm of the stream substrate were obtained using a petite ponar dredge, and these were thoroughly mixed using priority pollutant-cleaned containers and utensils. The sediment samples were analyzed for a variety of metals and pesticides.

2.1.3 Biological Sampling Methods

The fish community was estimated by electroshocking using a two-pass depletion method. Each reach was 50 meters long with block nets placed at the upstream and downstream boundaries. All fish were enumerated and identified to species, and returned alive to the reach where they were collected.

A composite sample of whole fish tissue was collected from the GD2 reach. Three squawfish which were collected at the time of the electroshocking surveys were used for this sample. The tissue was analyzed for selected organochlorine pesticides.

Benthic macroinvertebrate sampling sites were located in riffle habitats no greater than 10 m in length with water depths less than 3 ft and water velocities between 20 cm/sec and 150 cm/sec. Sites met the following habitat comparability criteria (Bode, 1995):

a. Substrate particle size: mean composition of the substrate should not differ by more than 3 phi units.

b. Current speed: the current speed should not differ by more than 50% unless the actual values are within 20 cm/sec.

c. Canopy cover: the canopy cover should not differ by more than 50% unless the actual values are less than 20%.

A d-frame kick net (500 micron mesh) was used to sample the benthic macroinvertebrate community. Four, $0.1m^2$ samples were randomly placed within each of the four sites. Sampleable area was defined as being within the middle 75% of the run or riffle width and middle 90% of its length. The first sample was placed at the downstream edge of the designated sampling site and each additional sample was taken upstream to prevent disturbance. Each sample had an effort of 1-2 minutes kicking upstream of the net to dislodge invertebrates. All hard substrates within the sample area were then removed by hand and scrubbed to remove attached organisms. Samples were preserved in 95% ethanol for laboratory analysis.

Micro-habitat variables measured at each sample location included depth and visual substrate characterization. Percent substrate was classified into seven categories: bedrock, boulder (>256 mm), cobble (64-256 mm), large gravel (32-64 mm), small gravel (16-32 mm), coarse sand (2-16 mm), and fine sand (<2 mm). Organic substrate was categorized as coarse particulate organic matter (>1 mm) or fine particulate organic matter (<1 mm).

Once in the laboratory, invertebrates were sorted from benthic debris with a 6x stereo-microscope and placed in 70% ethanol for later identification. Invertebrate identifications followed Plotnikoff and White (1996) with the exception of Chironomidae which were identified to the lowest taxonomic level possible by EcoAnalysts, Inc. of Moscow, Idaho.

2.1.4 Physical Habitat Characterization

Reach habitat variables were sampled at sites GU2, GD2 and GD4 to characterize the instream conditions. All sites were 50 meters long. Four cross-sectional transects, placed equi-distance throughout the reach, were used to calculate average width and depths. One hundred thalweg depths were measured every 0.5 meters. Gradient was measured with a hand-held clinometer. Overall instream and riparian habitat was visually estimated using EPA Region 10's protocol (Hayslip 1993).

2.2 Biological Assessment

2.2.1 Fish Community

Fish data was summarized by metrics and species analysis. Metrics used included relative density (no./m^2) and percent age groups for each species (age 0s, juveniles, adults). To calculate the relative density of a site, all fish collected during each of the two shocking passes were counted and adjusted for the amount of surface area measured from the habitat methods at each site. Depending on the type of pollution, density can be an indicator of pollution. Age groups were identified from length at age data summarized in Wydoski and Whitney (1979) and Scott and Crossman (1973) for fish in Washington State. Use of different age groups is important because of the differential affects that pollution has on each development stage. Species analysis was used to identify the percent abundance of each species, which can also be used to show pollution tolerance.

2.2.2 Benthic Macroinvertebrate Community

Benthic community data were summarized by metrics and indices (taxa richness, Ephemeroptera Plecoptera Trichoptera [EPT] richness, Hilsenhoff's Biotic Index [HBI]), species composition data, and trophic status. Taxa richness was defined as the total number of distinct identifiable taxa. Communities stressed from pollution or other perturbations generally decrease in overall taxa richness. EPT richness is defined as the total number of distinct identifiable taxa found in the orders Ephemeroptera, Plecoptera, and Trichoptera, which are considered the "Clean water taxa." As with total taxa richness, pollution impacts will decrease this index.

The HBI was derived by Hilsenhoff (1987) to show the relative number of organic pollution tolerant taxa within the community. This index has a range of 0 to 10 and will tend to increase with increasing levels of organic enrichment.

$$HBI = \sum (\%RA_i * t_i)$$

where, $\%RA_i$ = percent relative abundance of each taxon
t_i = pollution tolerance value of taxon

t_i values were adopted from research by Hilsenhoff (1987) in laboratory studies and field studies, and modified by Wisseman (1995) and Clark and Maret (1992). Their applicability to Garrison Creek is provisional until further information is gathered on south-western Washington benthic invertebrates.

Indicator taxa analysis and functional feeding group analysis was used to further identify macroinvertebrate response to pollution and support the metric analyses. Total and EPT taxa richness are general indicators of pollution impacts, however, community metrics average all species and are less sensitive than analysis of specific taxa. Indicator groups are defined as those groups which respond in a predictable fashion to a specific type of pollution.

Functional feeding groups are categories used to identify the mechanism and food type that an macroinvertebrate will use to gather nutrients. Invertebrates can be categorized by functional feeding groups based on food type. Six categories were used in this analysis:

- Scrapers eat algae;
- Shredders eat large pieces of leaves;
- Collector-gatherers eat large pieces of organic matter;
- Collector-filterers eat fine organic particles;
- Predators eat other invertebrates; and
- Prasites feed on other living invertebrates.

2.3 Quality Assurance/Quality Control Procedures

Quality assurance protocols (QAPP) for field sampling, instrument decontamination and calibration followed those listed in WAS guidance manuals, and the project QAPP (Ecology, 1993; Cusimano, 1994, White et al., 1996).

2.3.1 Laboratory Analytical Parameters

Duplicate samples for general chemistry parameters were collected on September 17 and September 19 for composites and grabs, respectively. Composite duplicates were obtained at station GU2 for all parameters requested except TC and SS due to insufficient volume. Duplicate grab samples were taken at GD1 for FC, TC, alkalinity, TSS, and turbidity, while duplicates for NH_3, NO_2, NO_2+NO_3, OP, TP were collected at station GD4. Data reduction, review, and reporting procedures followed those outlined in the Manchester Laboratory Users Manual (Ecology, 1994).

2.3.2 Biological Survey Data

Fish that were not positively identified in the field were verified in Ecology's lab and archived for later validation by interested parties. All macroinvertebrate taxa identified were verified with Ecology's regional invertebrate reference collection. The invertebrate samples from Garrison Creek will be stored at the Ecology headquarters building for six years and made available for validation by interested parties.

3.0 Results and Discussion

3.1 Quality Assurance/Quality Control Assessment

The quality assurance evaluation showed that the data collected were of good quality. Calibration of field instruments were performed as detailed in the Quality Assurance Project Plan (White et al. 1996) and the results were considered acceptable. To assess the overall variability of field and analytical data collected, the coefficient of variation (CV) was calculated for all duplicate samples (Appendix C).

3.2 Water Quality Results and Discussion

The complete results of the water quality survey are presented in Appendix D.

3.2.1 Physical and Chemical Water Column Parameters

3.2.1.1 Precipitation and Streamflow

No rain fell on the first day of sampling and during the previous 24 hours. About 0.15 inches of rain fell in the Walla Walla area during the 24 hours preceding 8:00 a.m. on September 19, the day of our second water sampling event. Runoff and increased stream flows were associated with this rainfall event.

Stream flows recorded during the survey are summarized in Table 2. Extensive instream vegetation probably prevented reliable streamflow measurements at some stations, particularly at GD1 and GD2, so comparisons between stations should be made with caution. As indicated in this table, the lowest flow rate was observed at station GD4, the lowermost site in the survey. Several diversions are found throughout Garrison Creek with the most notable being directly upstream of the WWTP discharge and one located 400 meters downstream of the discharge. The upstream diversion is a concrete/wood structure that is regulated by the number of vertical boards placed to divert the creek flow. The downstream diversion is a concrete dam with a long culvert used to return the stream to its channel. Flow is regulated by a head gate into the Travaille ditch directly upstream of the diversion structure.

Table 2. Garrison Creek Stream Flow and College Place WWTP Effluent Discharge Measured on September 18, 1996

Effluent Discharge (cfs)	Stream Flow (cfs)					
GE1	**GU2**	**GU1**	**GD1**	**GD2**	**GD3**	**GD4**
0.98	2.79	1.55	1.39	1.46	1.65	1.24

3.2.1.2 Temperature

Thermograph data obtained in Garrison Creek during late summer (7/24 - 9/18/96) showed average daily temperatures of 18.3°C, 20.5°C, and 19.7°C at GU1, GD2, and GD4, respectively (Table 3). Maximum temperature recorded during this study was 27.1 degrees Celsius (°C) at GD2 occurring on July 28, 1996 between 4:00 and 6:00 PM. Average temperatures during the summer months ranged between 17.3°C (GU1) to 19.7°C (GD2) during AM hours, and 19.3°C (GU1) to 21.3°C (GD2) during PM hours.

Temperature data obtained at each thermograph station location in relation to the WQ standard of 18°C are illustrated in Figure 3. Thermograph values at the upstream site (GU1) above the WWTP outfall were consistently lower than temperatures found at the closest downstream site (GD2) below the outfall. Further downstream at GD4, temperatures decreased and ranged between temperatures recorded at the other two sites.

Table 3. Mean Temperature (°C) Observed in Lower Garrison Creek

Hobotemp Temperature Data (7/24 - 9/18/96):				
Station Location	**Mean**	**Diurnal AM**	**Average PM**	**Daily Average**
GU1	18.2	17.3	19.3	18.3
GD2	20.5	19.7	21.3	20.5
GD4	19.6	19.1	20.3	19.7
All Stations	19.4			

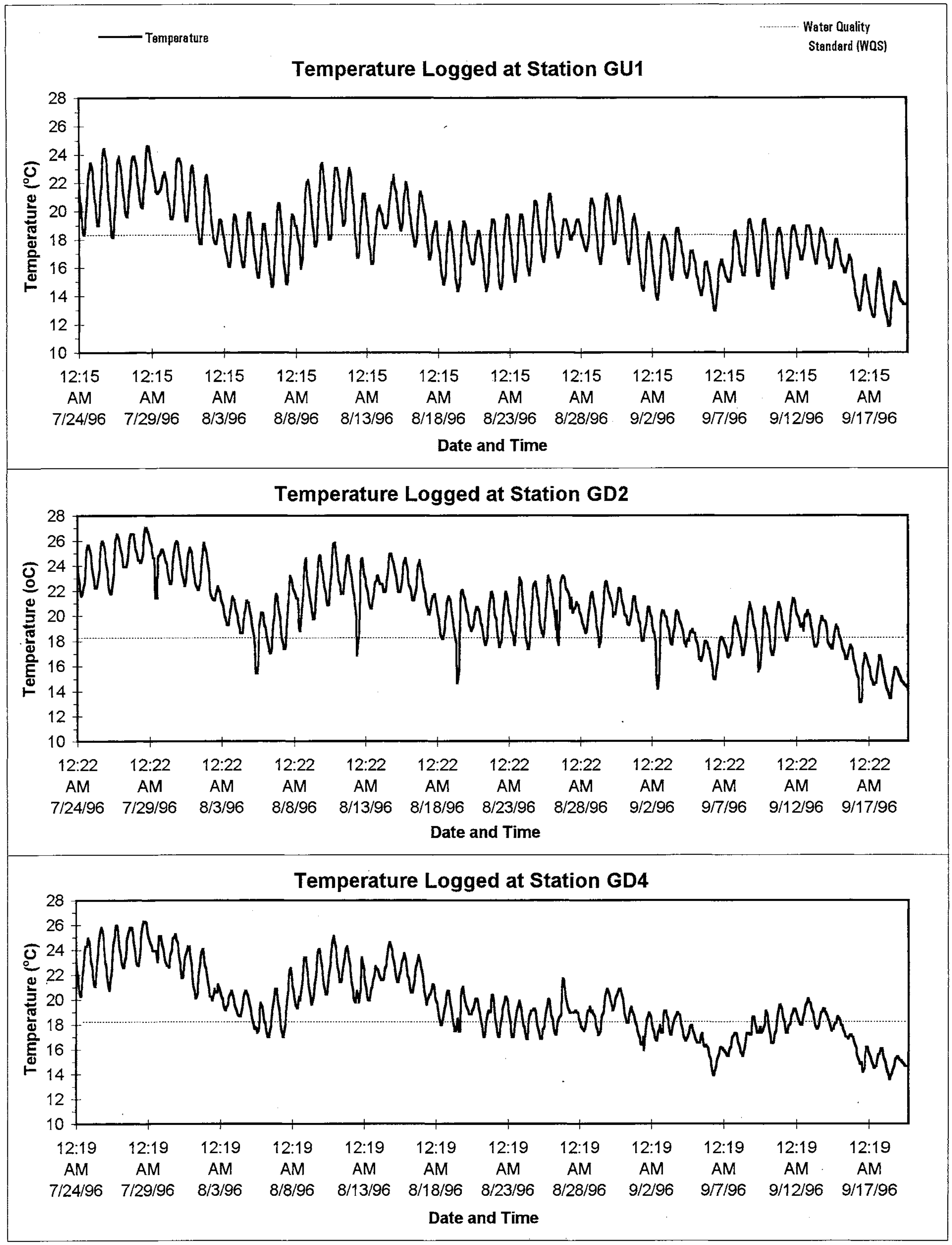


FIGURE 3. Thermograph Data for Stations GU1, GD2, and GD4

Box plots of the medium daily high and medium daily low temperature for each monitoring station are shown in Figure 4. These plots show the distribution of the daily high and daily low temperatures in a way that allows comparison of the median value and the interquartile range of the data for each monitoring station. The horizontal line in the central area of each plot is the median value, the lower boundary of the lower trapezoid is the 25th percentile of the data, and the upper boundary of the upper trapezoid is the 75th percentile. The height and shape of the upper and lower trapezoids are indicative of the skew in the data. The upper and lower whiskers identify the maximum and minimum data points within 1.5 times the interquartile range. The upper and lower notches (on the sides of the trapezoids) of each plot designate the 95% confidence interval (CI) about the median, which is based on the standard deviation of the median (determined by the sample size and the interquartile range of the data), as described in McGill et al. (1978). Where the notches do not overlap among plots, the difference between the medians is statistically significant at approximately the 95% CI.

Figure 4 shows that the median daily high and low temperatures at the upstream station location were significantly lower than the two downstream stations at the 95% confidence level. An increase of 2.1°C is seen from GU1 to GD2 in average daily high temperatures, with the increase between stations ranging from 0.9°C to 3.5°C (Table 3). This indicates that there is a substantial heat input into Garrison Creek from College Place WWTP effluent during the summer months. The source of this heat input from the WWTP is suspected to be the practice of retaining wastewater in surface impoundments. Treated wastewater entering these lagoons is retained for approximately 30 days (Al Rader, City of College Place, personal communication), during which time the effluent is heated by solar radiation prior to discharge into Garrison Creek.

The Washington State water quality standards (Chapter 173-201A WAC) for temperature state that, for Class A freshwaters, *"temperature shall not exceed 18.0°C due to human activities."* In addition, temperature standards specify criteria for incremental temperature increases resulting from point and non-point source activities. Thermograph data, obtained during the summer survey period (7/24 - 9/18/96), indicate that the temperature standards are often exceeded in lower Garrison Creek (Table 4).

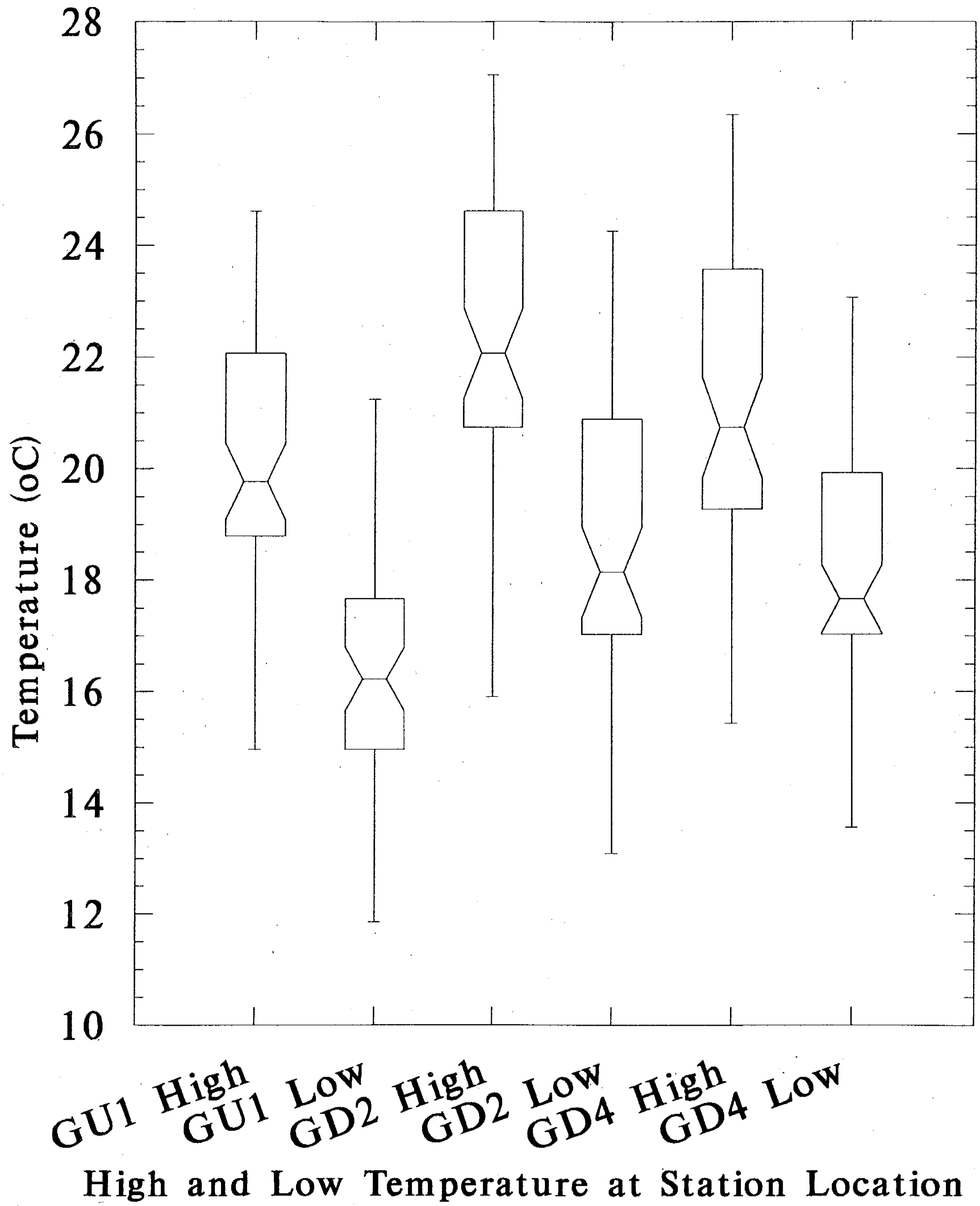


Figure 4: **Distribution of daily high and low temperatures in Garrison Creek between July 24 and September 18, 1996.**

Table 4. Percent Total Temperature Violations Identified in Lower Garrison Creek at Thermograph Stations GU1, GD2, and GD4 During Summer Months (7/24 - 9/18/96)

Temperature Data And Violation Types	% Total Violation Calculation	STATION LOCATION			
		GU1	**GD2**	**GD4**	**All Stations**
All Data	data points (n) =	1,381	1,381	1,381	4,143
	# violations =	713	1,095	953	2,761
(> 18oC)	**% Total Violation =**	**51.6%**	**79.3%**	**69.0%**	**66.6%**
Daily High	# of days (n) =	57	57	57	171
	# violations =	49	54	51	154
	% Total Violation =	**86.0%**	**94.7%**	**89.5%**	**90.1%**
Daily Average	# of days (n) =	57	57	57	171
	# violations =	28	51	44	123
	% Total Violation =	**49.1%**	**89.5%**	**77.2%**	**71.9%**
Point Incremental*	data points (n) =		1,381	1,381	
Increase < (t =28/(T+7))*	# violations =		1,276	987	
	% Total Violation =		**92.4%**	**71.5%**	

* Pursuant to WAC 173-201A-030(2)(c)(iv), incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T+7), where

T = Background temperature (GU1)
t = criteria for allowable increase

As shown above in Table 4, temperatures recorded at stations below the College Place WWTP outfall exceeded the standard for maximum water temperature (>18°C) approximately 80% and 70% of the time at GD2 and GD4, respectively, based on continuous temperature monitoring. Daily average temperatures at these respective downstream stations exceeded the 18°C standard about 90% and 77% of days during the summer monitoring period, while daily high temperatures exceeded the standard on 95% of days at GD2 and 90% of days at GD4.

The first part of the temperature standard was also exceeded at the upstream station (GU1). Approximately 52% of thermograph data collected during the summer monitoring period exceeded the standard at GU1, while daily average temperatures exceeded 18°C on about 50% of days. Daily high temperatures at the upstream station (GU1) also exceeded 18.0°C, approximately 86% of the time. The high temperatures found at GU1 are influenced by anthropogenic sources and riparian modifications further upstream, and are not representative of *"natural conditions."* However, as illustrated in Figure 4, the median daily high and low temperatures at the upstream station are significantly lower (at the 95% confidence level) than at the two downstream stations which are not significantly different from each other. This monitoring shows that the adverse stream temperature conditions are more severe and of greater duration in the reach affected by the WWTP discharge.

The second part of the standard, involving incremental increases attributable to point source activities such as the WWTP discharge, was also violated in the reach affected by the discharge. Table 4 summarizes incremental increases in temperature at stations GD2 and GD4. The criterion fluctuates between 0.3 and about 1.5 °C, depending on the background temperatures recorded at station GU1, located just upstream of the effluent discharge. Whenever the background temperature exceeds 18°C, then the allowable change is limited to 0.3°C; when the background temperature is lower than the 18°C standard, then the criteria for incremental change is determined by the formula contained in the water quality standards (see Appendix A). The criteria for incremental change was exceeded about 92% of the time at station GD2, 300 meters below the WWTP effluent discharge, and the criteria was exceeded about 72% of the time further downstream at station GD4.

Additionally, a similar trend existed in relative temperature between station locations during the much shorter 4-day intensive survey period, although stream temperatures at all stations had decreased in the range of a 6 to 8 degrees.

3.2.1.3 pH

The pH of water is an important variable as it may influence the species composition of an aquatic environment and affect the availability of nutrients and the relative toxicity of many trace elements, such as ammonia (McNeely et al., 1979). In general, continuos (Hydrolab) and insitu (Orion pH meter) pH data indicate that Lower Garrison Creek is slightly alkaline, as is the tendency for most surface water (Figure 5 and 6).

Continuous pH data collected by Hydrolab Datasonde 3 at stations GU2 and GD2 ranged from 7.13 SU (GU2) to 7.84 SU (GD2) (Figure 5). Mean pH values for GU2 and GD2 were 7.43 and 7.41, respectively. Values at both stations were fairly uniform throughout the study, with the exception of pH data recorded during the late AM hours on September 19 during which time a rainfall event occurred and significant drop in pH was observed. A Hydrolab was also deployed at GD1, however, pH data at this station was not usable because the pH probe was broken in the field. More variability was found in the insitu measurements, however the data was not found to be different from the hydrolabs (Figure 6).

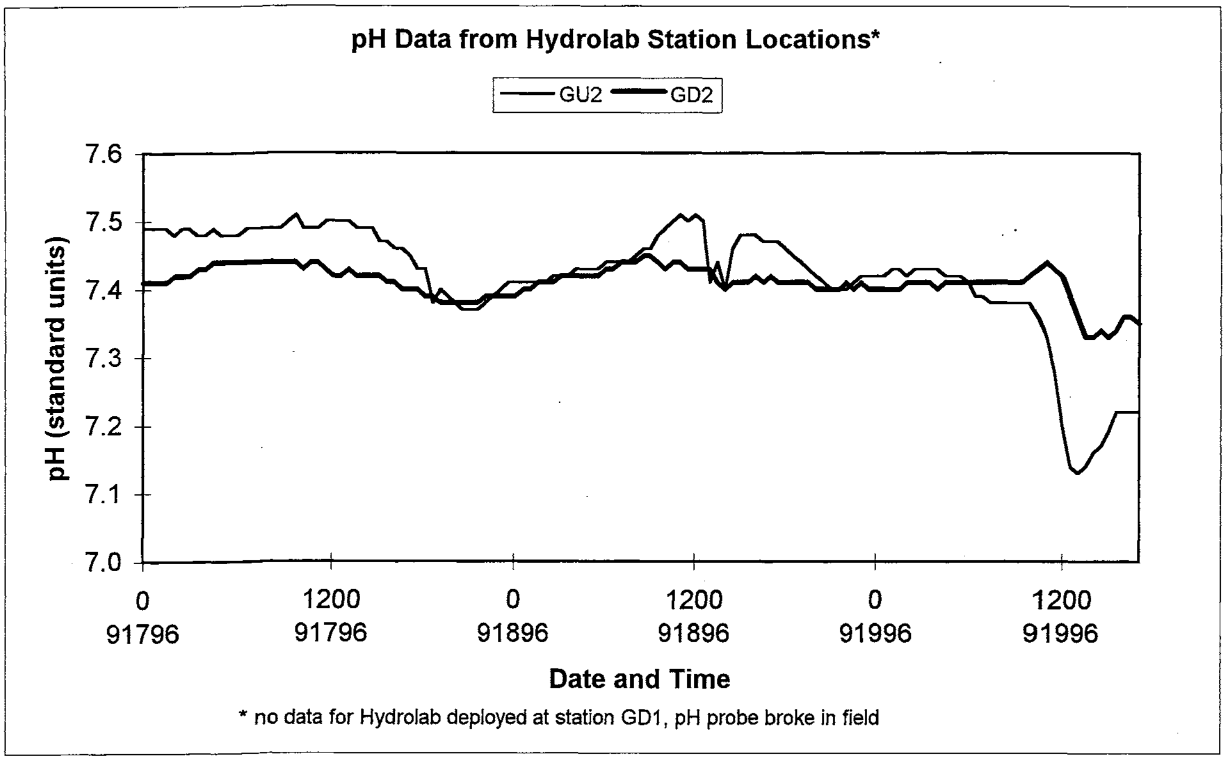


Figure 5. Hydrolab pH Data for Stations GU2 and GD2

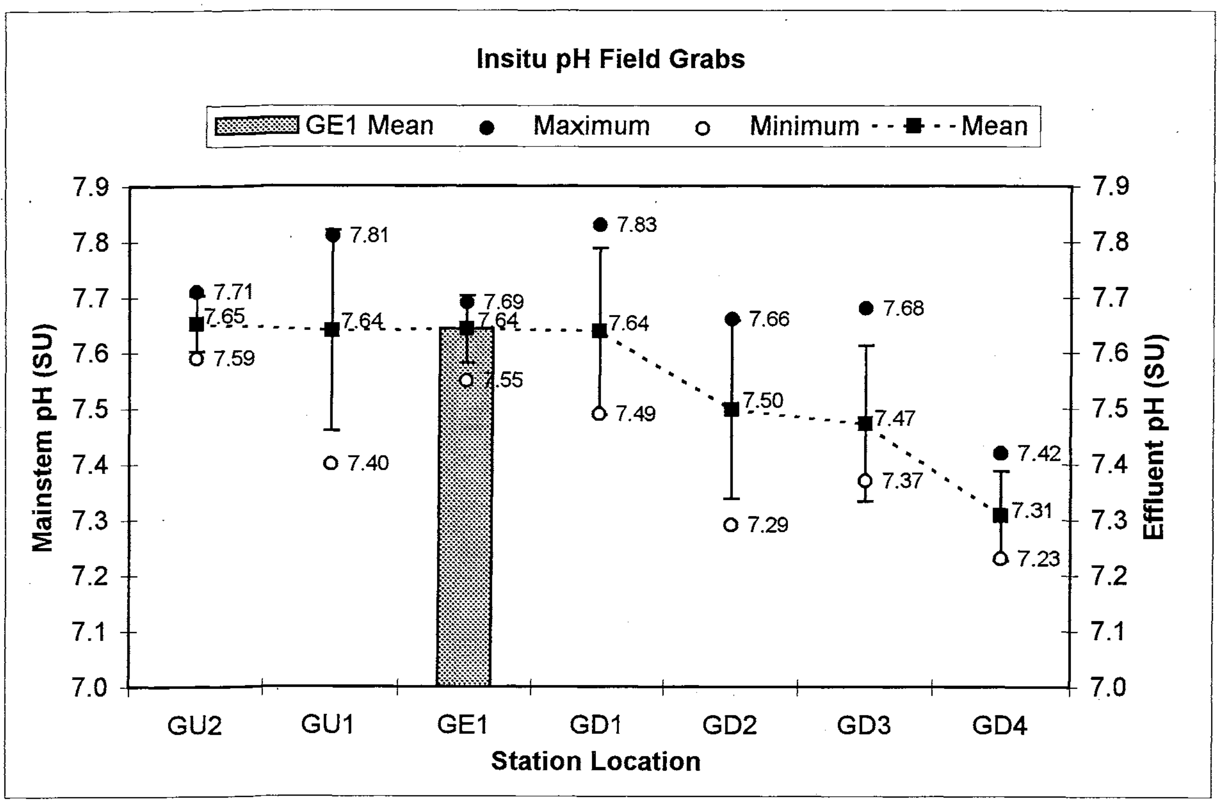


Figure 6. Insitu pH Data Measured in Garrison Creek (9/17/96 and 9/19/96)

For the protection of the aquatic environment, the pH should be within the range of 6.5 to 8.5 standard units (SU). In addition, discharges should not alter the ambient pH by more than 0.5 SU in the mixing zones. Water quality standards for pH state that, for Class A freshwaters, *"pH shall be within the range of 6.5 to 8.5,"* therefore, lower Garrison Creek was found in compliance with the water quality standard for pH during the study period.

3.2.1.4 Turbidity, Total Suspended Solids and Settleable Solids

Composite and grab samples were collected and analyzed for turbidity and total suspended solids (TSS). Composite samples analyzed for setteable solids (SS) were collected only on September 17. Turbidity values found during the study ranged from 9.2 NTU at station GD2 (composite) to 15 NTU at GU2 (grab). TSS concentrations were detected between 13 mg/L at GE1 (composite) and 32 mg/L at GD2 (grab). In all samples analyzed for SS, concentrations were found to be below the detection limit of 0.1 ml/L. With the exception of turbidity found in the effluent grab sample GE1, daily mean values for turbidity and TSS were greater in the September 19, for all mainstem samples (Figure 7). The higher levels of turbidity and TSS found in mainstem samples collected on September 19 were probably due to a rising hydrograph, the effects of the rain event. Water quality standards for turbidity were not exceeded during this study.

3.2.1.5 Specific Conductivity

During this study, lowest conductivity levels were observed at both upstream stations, GU1 and GU2, while maximum conductivity was measured at the effluent station, GE1 at 570 umhos/cm (Figure 8). Conductivity values measured within the upstream stations and effluent station were relatively consistent throughout the study, however, greater variability was observed within stations downstream of the effluent outfall where conductivity appeared to vary diurnally. In addition, daily mean conductivity values for the downstream stations showed greater values on the first day of sampling as compared to the second day when runoff occurred.

The data indicate that dissolved solids in the College Place WWTP effluent are increasing specific conductivity in the downstream stations. In addition, the downward shift in daily mean conductivity seen on September 19 may be due to precipitation and runoff having a dilution effect.

3.2.1.6 Alkalinity

Alkalinity is a measure of water's capacity to neutralize an acid. The species composition of alkalinity is affected by pH, mineral composition, temperature, and ionic strength, however, alkalinity is normally interpreted as a function of carbonates, bicarbonates, and hydroxides as was the case in this study.

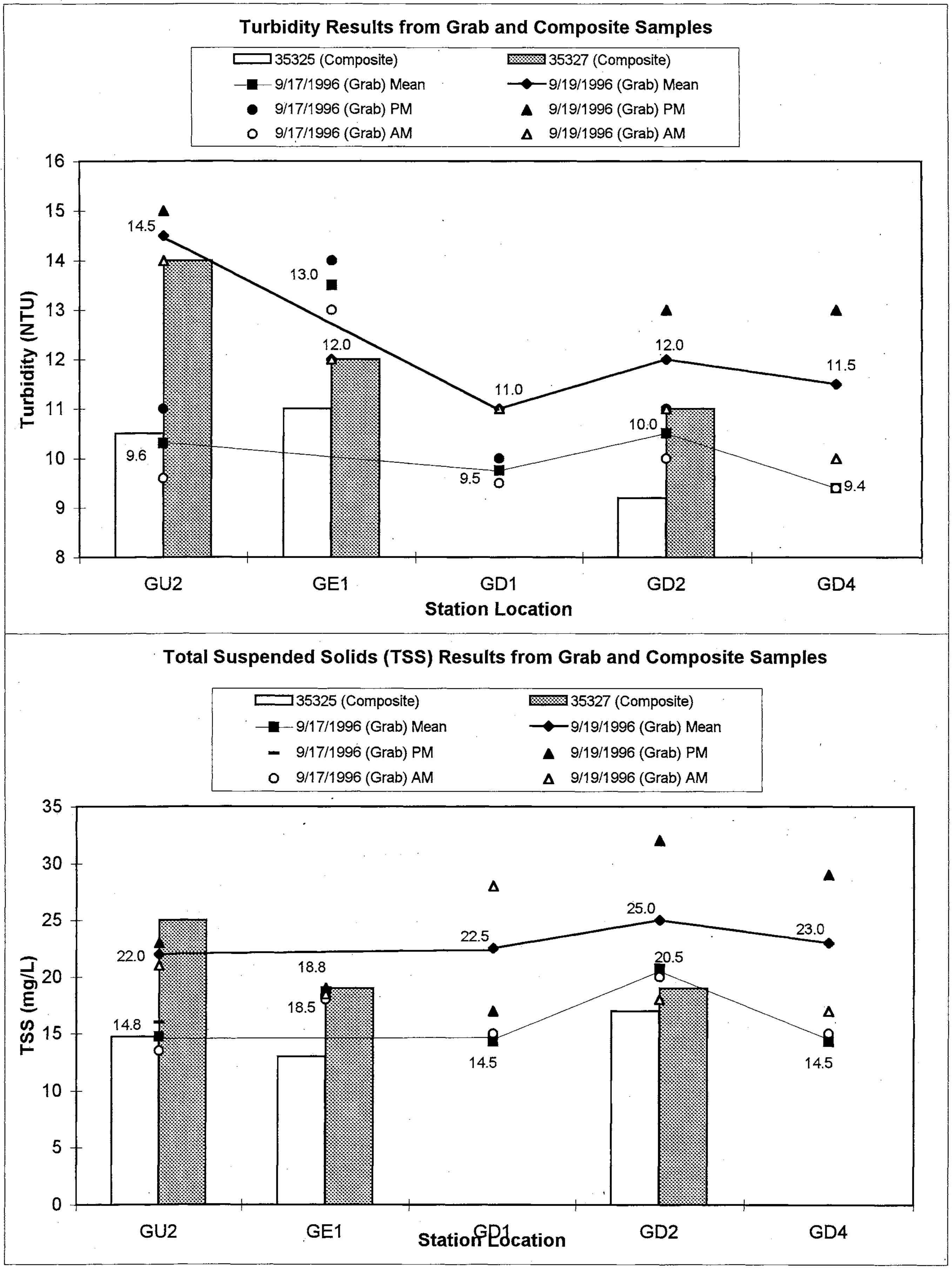


Figure 7. Comparison of Turbidity and Total Suspended Solids Found in Garrison Creek (9/17/96 and 9/19/96)

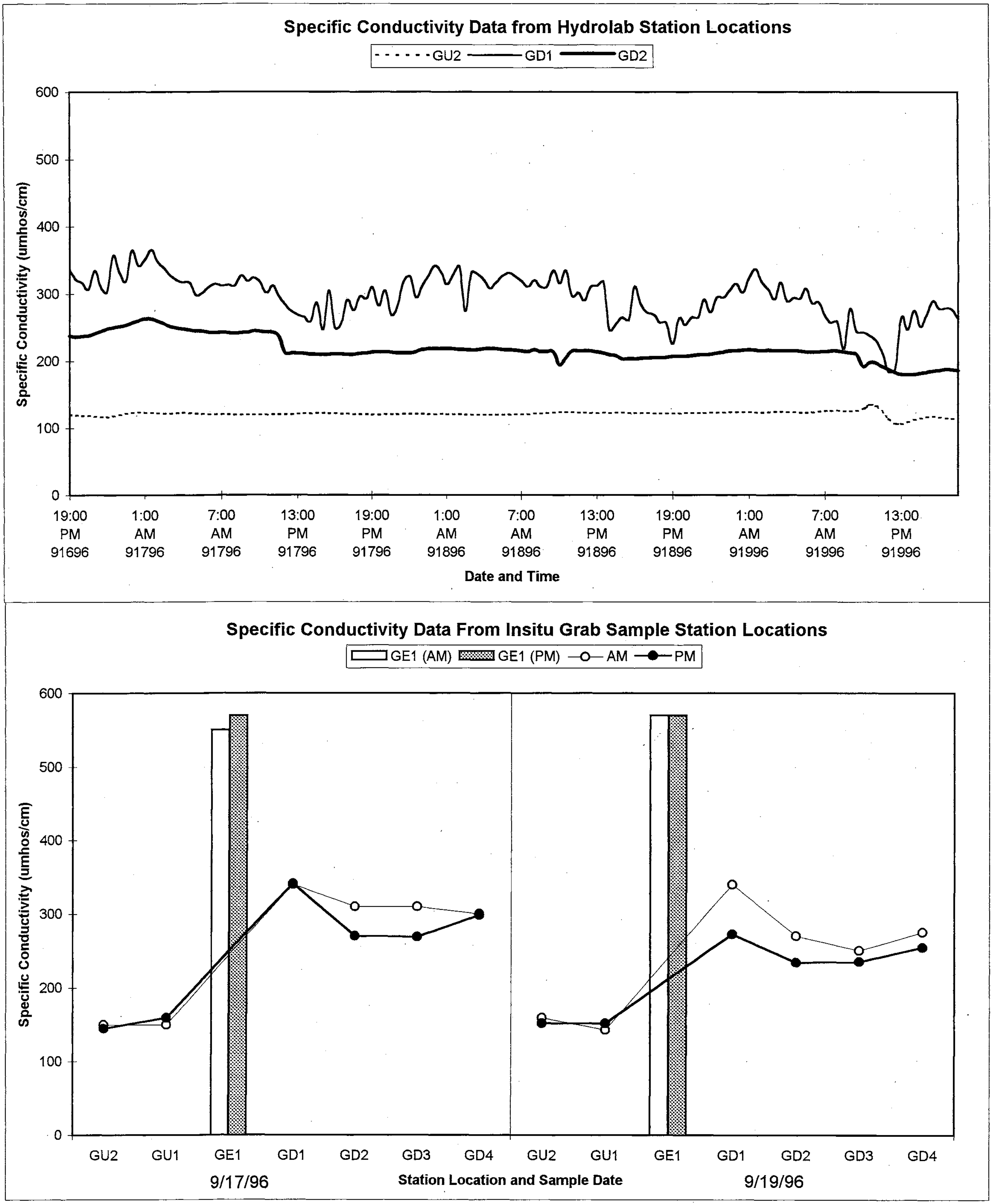


Figure 8. **Comparison of Continuous and Insitu Field Measurements of Specific Conductivity at Hydrolab and Grab Sample Station Locations**

Alkalinity results from grab samples collected at GD1 and GD4, and composite samples collected at GU2, GE1, and GD2 are found in Figure 9. Highest alkalinity values were detected in the WWTP effluent (GE1), while lowest concentrations were found at the upstream station (GU2). Alkalinity results from grab samples ranged from 82.1 mg/L at GD4 (9/19-PM) to 109 mg/L at GD1 (9/19-AM). Composite samples found greater alkalinity variation between stations, ranging in value from 61.8 mg/L at GU2 (9/17) to 163 mg/L at GE1 (9/19).

Apparently, the effluent discharge is increasing alkalinity in lower Garrison Creek. At present, no WQ standards exist for alkalinity (WAC 173-303-201A). Alkalinity values in natural surface waters rarely exceed 500 mg/L. Freshwater alkalinity in the range of 30 to 500 mg/L is generally acceptable for industrial purposes, water treatment processes, and human consumption, however, to protect the aquatic environment, alkalinity should be maintained at natural background levels with no sudden variations (McNeely et al., 1979).

3.2.1.7 Hardness

Hardness is principally determined by the sum of calcium and magnesium. The presence of other constituents such as iron, manganese, and aluminum, may contribute to total hardness although these are not usually present in appreciable concentrations. Hardness is normally expressed as an equivalent of calcium carbonate ($CaCO_3$). Water with hardness less than 120 mg/L can be deemed desirable for most uses.

In this study, composite samples collected at stations GU2, GE1, and GD2 were analyzed for hardness. Results for hardness are summarized in Figure 10. Hardness concentration ranged from 58.6 mg/L at GU2 (9/17) to 89 mg/L at GE1 (9/17). Hardness values detected in samples from each station location appeared uniform throughout the study period, however, station GD2 showed the greatest variability between sample days of the three stations sampled. Although there are no current WQ standards for hardness, it appears that the effluent from GE1 increases hardness values in Garrison Creek. Mean hardness values for GU2, GE1, and GD2 were 58.9 mg/L, 88.8 mg/L, and 67.7 mg/L, respectively.

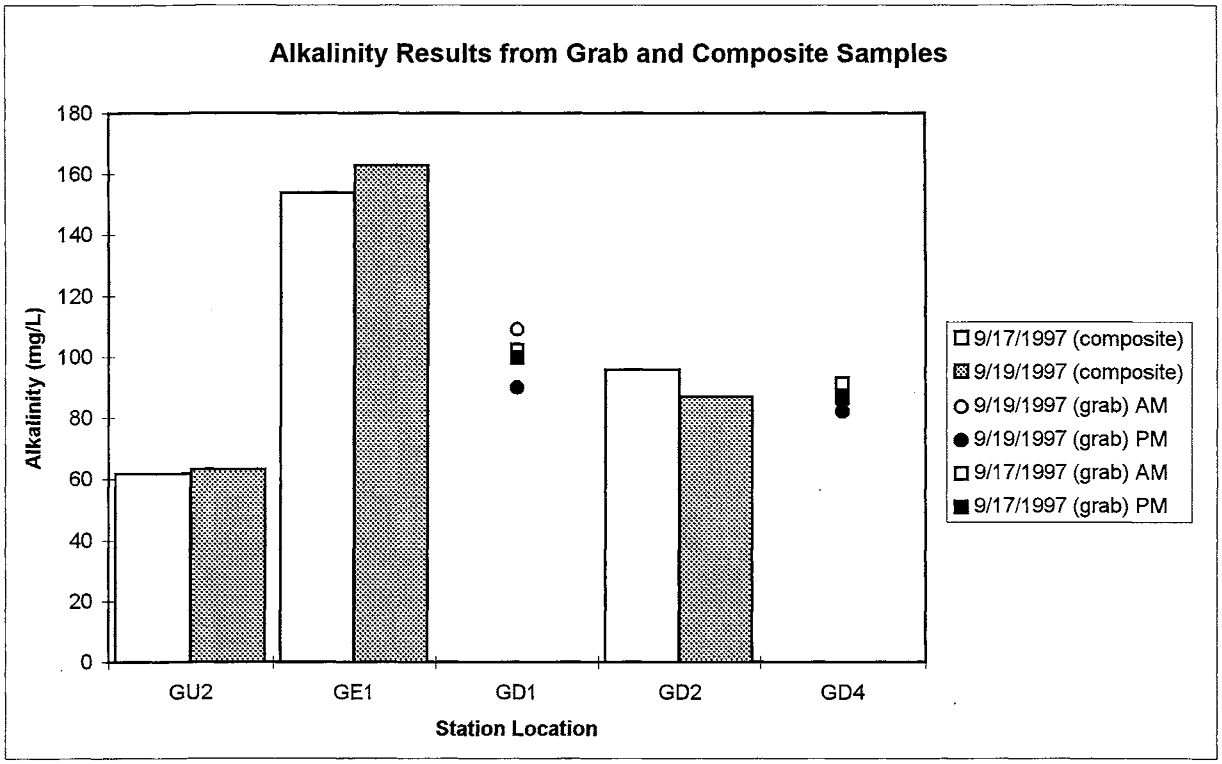


Figure 9. Alkalinity Values Measured in Garrison Creek (9/17/96 and 9/19/96)

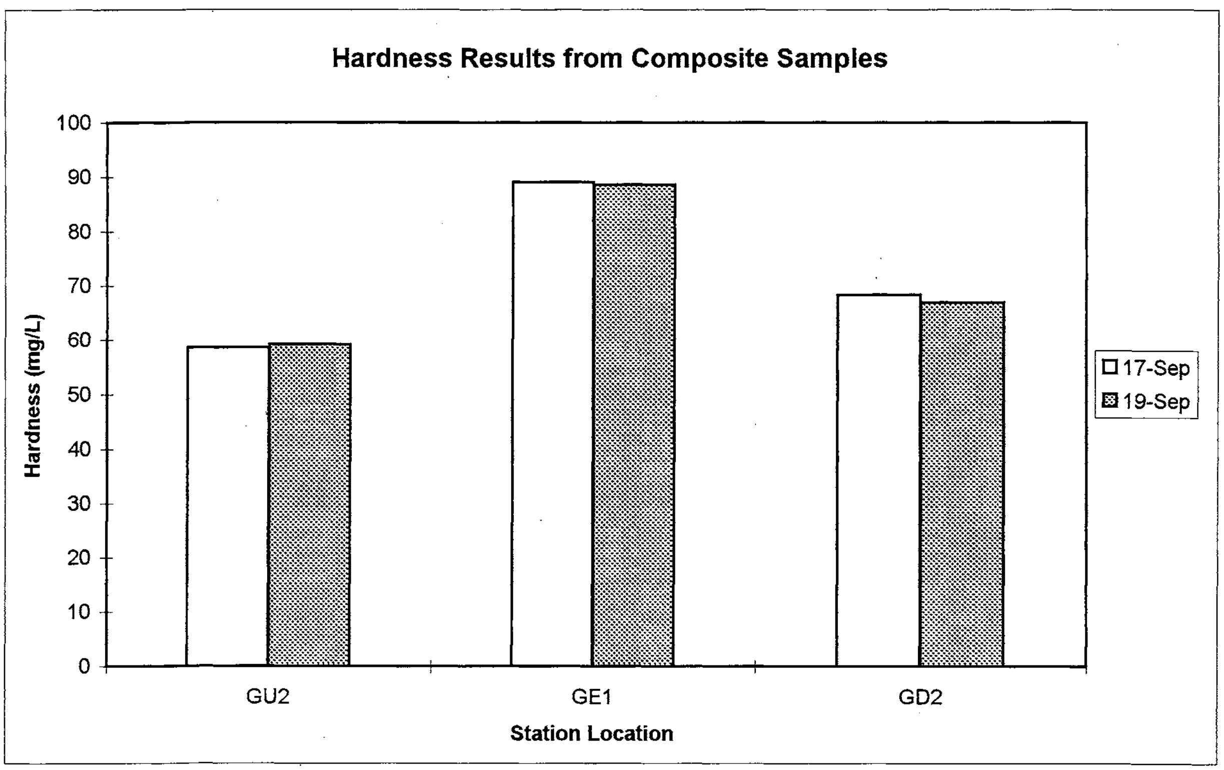


Figure 10. Hardness Values Measured in Garrison Creek (9/17/96 and 9/19/96)

3.2.1.8 Dissolved Oxygen (DO)

The amount of DO in natural waters varies, subject to diurnal and seasonal fluctuations that are due in part to variations in temperature, photosynthetic activity, and stream discharge, and input of oxygen-demanding materials. Hydrolab data obtained during the field survey found DO concentrations ranging from 10.16 mg/L at GU2 to 6.95 mg/L at GD2 (Figure 11). Results consistently indicate that DO is decreasing between upstream (GU2) and downstream (GD2) stations. Mean DO values decreased a total of 17% from GU2 to GD2, declining from 9.23 mg/L to 7.63 mg/L in mean values. Mean daily lows for DO were 8.59 mg/L, 8.23 mg/L, and 7.15 mg/L at stations GU2, GD1, and GD2, respectively, while mean daily highs for DO were 9.64 mg/L, 8.94 mg/L, and 8.04 mg/L for the same respective stations (Figure 12). The highest DO levels were found during the AM hours at all Hydrolab stations.

Insitu DO field measurements corresponded to Hydrolab results in showing the greatest amount of DO at upstream stations (GU1, GU2), while DO concentrations decreased moving downstream for similar (Hydrolab) stations (GD1, GD2) (Figure 13). Effluent DO concentrations measured at GE1 were relatively stable, ranging in value from 7.3 mg/L to 7.9 mg/. Insitu DO concentrations measured during the study showed a low of 5.4 mg/L at GD4 to a high of 9.4 mg/L at GU2. In addition, daily mean DO values at each station showed decreased concentrations during the second day of sampling (9/19/96).

The lower mean DO values found downstream of GU2 are attributed to the College Place WWTP effluent discharge located immediately upstream from GD1. Overall DO values found at Hydrolab stations (GU2, GD1, GD2) were lower during afternoon and early evening hours. The minimal diurnal fluctuation seen at GD1 and the relatively small decrease in mean DO values observed between GU1 and GD1 may be explained, in part, by re-aeration processes occurring due to spilling from the diversion dam immediately upstream of GU1, and turbulence within the effluent discharge channel.

Pursuant to Chapter 173-201A WAC, DO in Class A freshwaters of the State *"shall exceed 8.0 mg/L."* DO values from Hydrolab data obtained during the field study show two of the three stations monitored (GU2, GD2) to be in violation of this water quality standard. However, during the 4-day monitoring period, daily low DO concentrations were less than 8.0 mg/L on only one day at station GU2, while minimum daily DO concentrations observed at GD2 were in violation of the standard on each of the four days monitored.

Dissolved Oxygen (DO) Data from Hydrolab Station Locations

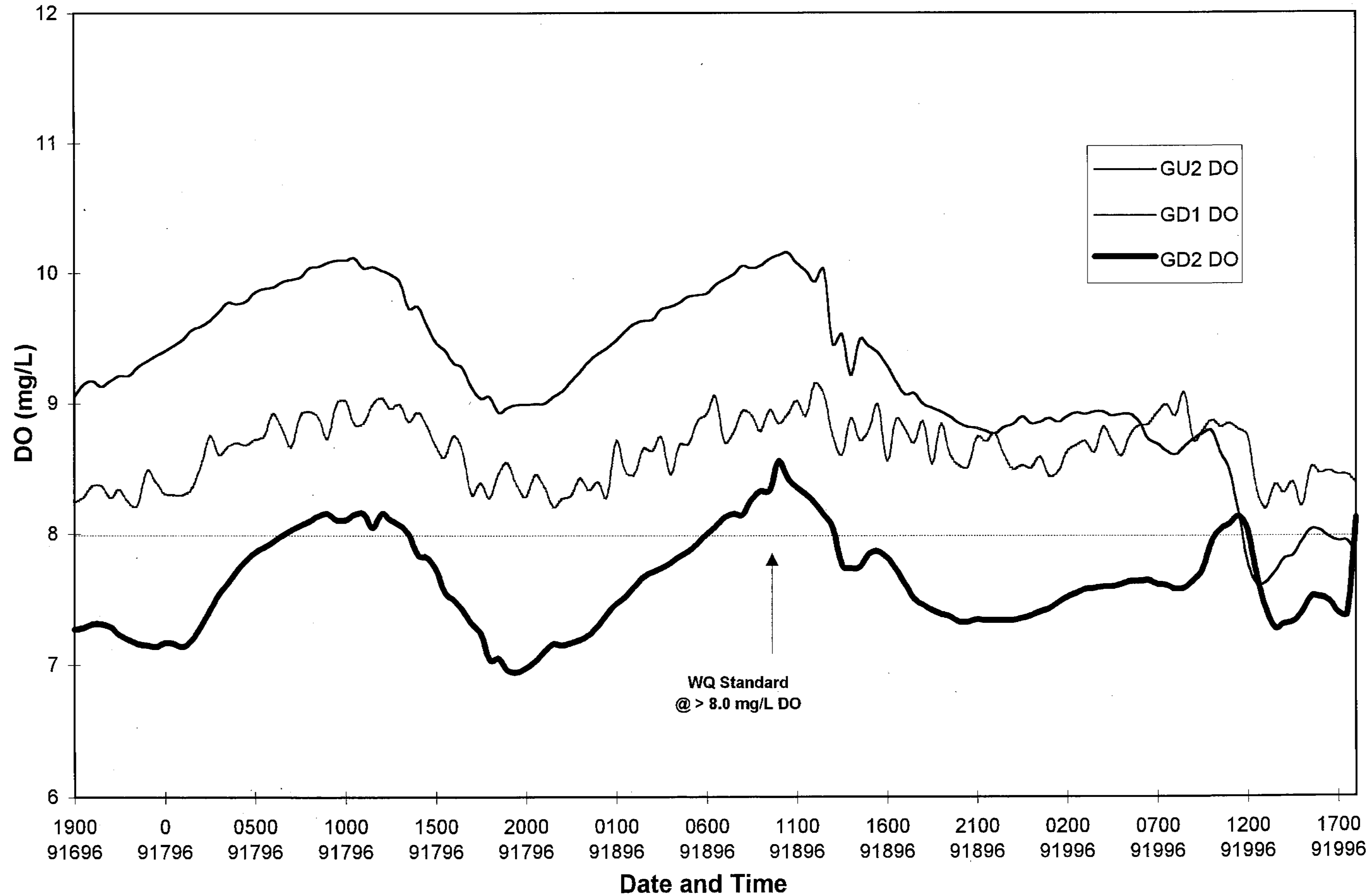


Figure 11. Dissolved Oxygen Recorded by Hydrolab DataSonde 3 at Stations GU1, GD2, and GD4 (9/16/96 - 9/19/96)

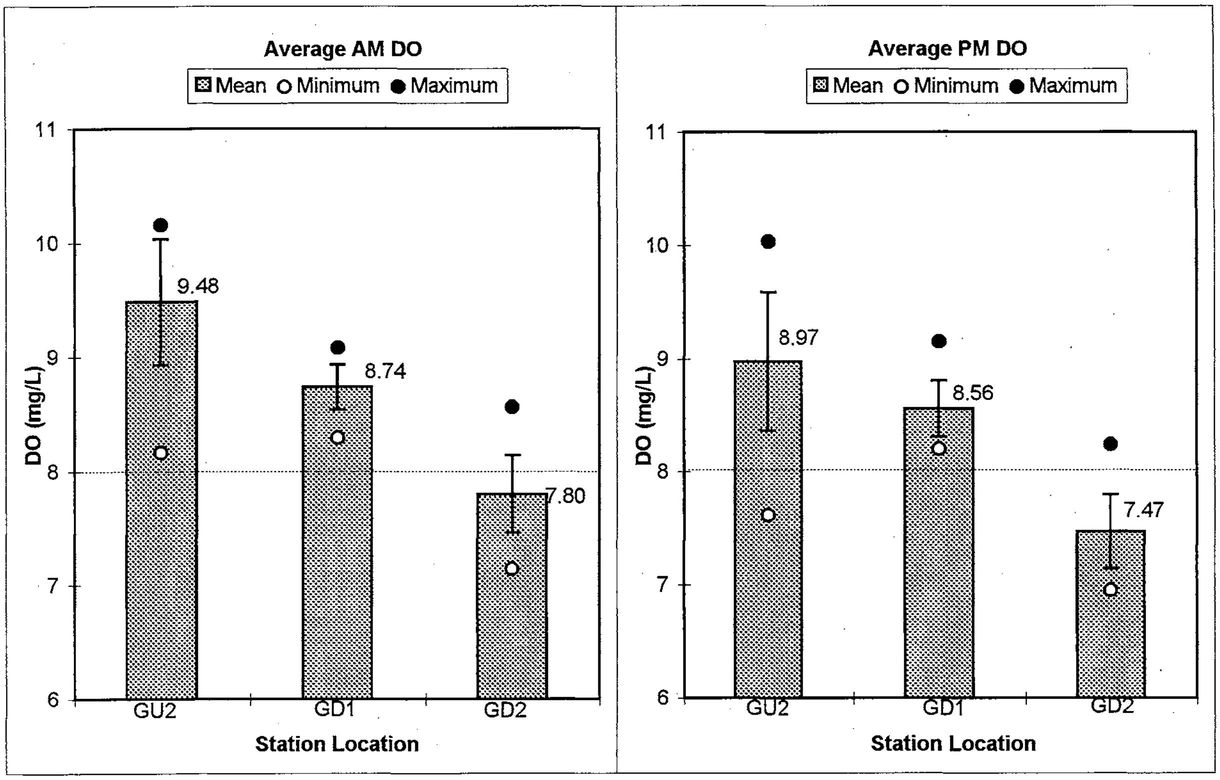


Figure 12. **Daily Mean Dissolved Oxygen (DO) Values Observed at Hydrolab Station Locations**

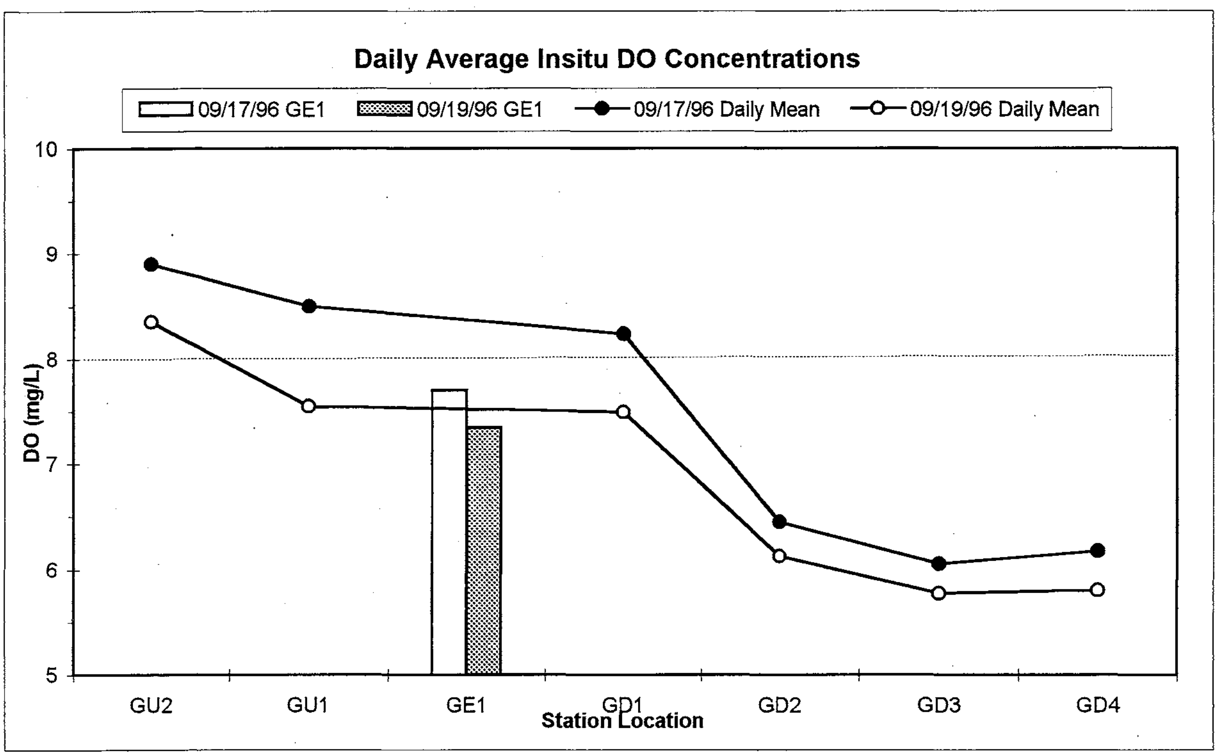


Figure 13. **Insitu Dissolved Oxygen (DO) Concentrations Observed in Lower Garrison Creek and College Place WWTP Effluent**

3.2.1.9 Biochemical Oxygen Demand (BOD)

In this study, composite samples analyzed for BOD were reported as BOD_5 (a 5-day time period at an incubation temperature of 20°C). The BOD of water is the amount of oxygen required to oxidize the organic matter by aerobic microbial decomposition to a stable inorganic form, thus measuring the amount of oxygen consumed which includes the oxygen demand of nitrogenous as well as carbonaceous compounds. Composite samples obtained from mainstem Garrison Creek found BOD_5 ranging from undetected (<4 mg/l) to 9 mg/l at station GU2 above the WWTP, while levels were substantially higher (41mg/l) at station GD2, downstream of the WWTP discharge (Appendix D). Effluent samples composited at GE1 found BOD_5 at 58 mg/L (9/17/96) and 41 mg/L (9/19/96). Due to analytical problems (e.g. inadequate dilution of samples with high BOD), the reported BOD results for the effluent and downstream sites are only minimum values, and the actual BOD levels could be much higher.

No water quality standards for BOD currently exist. In this study, BOD was measured as an indication of potential organic pollution. Waters with BOD levels greater than 10 mg/L are considered polluted since they contain large amounts of degradable organic material. A high BOD load, as indicated by the data from effluent and downstream composites, can pose a threat to the aquatic environment by depressing DO concentrations to levels that affect organisms. In addition, waters with high BOD values may be unsuitable for irrigation purposes, since they may restrict plant growth. Organic matter in streams can be derived from natural sources such as the breakdown of aquatic plants, however, BOD_5 concentrations found in the effluent samples show the influence of the WWTP effluent on conditions observed at creek station GD2, and the decreased DO concentrations identified downstream of College Place WWTP effluent outfall.

3.2.1.10 Chlorine

The results of in-situ testing for free and total chlorine in creek and effluent samples are presented in Table 5, below. Although total chlorine was not measured during the September 17 sampling, the values determined for free chlorine on that date represent minimum levels for total chlorine. The water quality standards provide aquatic life protection criteria for total chlorine. These standards prohibit acute exposure to 0.019 mg/L of total residual chlorine (as a one-hour average concentration not to be exceeded more than once every three years), and prohibit chronic exposure to 0.011 mg/L of total residual chlorine (as a four-day average concentration not to be exceeded more than once every three years). As shown in Table 5, both the acute and chronic criteria were exceeded at every station on September 17. On September 19, the day of the runoff event, ambient chlorine levels were considerable lower, but the criteria were exceeded at station GU2, GE1 and GD4. The source of chlorine detected at GU2 is unknown at this time.

Table 5. Total and Free Chlorine Observed in Lower Garrison Creek in Insitu Grab Samples Collected on September 17 and 19, 1996

Station Location	September 17, 1996				September 19, 1996			
	Free Chlorine (mg/L)		Total Chlorine (mg/L)		Free Chlorine (mg/L)		Total Chorine (mg/L)	
	AM	PM	AM	PM	AM	PM	AM	PM
GU2	0.2	0.06	ND	ND	0.06	< 0.1	0.09	< 0.1
GU1	> 0.2	ND	ND	ND	ND	< 0.1	ND	< 0.1
GE1	> 0.2	NSC	ND	NSC	< 0.1	< 0.1	< 0.1	0.1
GD1	> 0.2	> 0.2	ND	ND	< 0.1	< 0.1	ND	< 0.1
GD2	> 0.2	0.16	ND	ND	< 0.1	< 0.1	< 0.1	< 0.1
GD3	> 0.2	0.1	ND	ND	< 0.1	< 0.1	< 0.1	< 0.1
GD4	0.16	0.16	ND	ND	0.04	< 0.1	0.06	< 0.1

ND = Concentration Not Determined or no sample taken

NSC = No Sample Collected

3.2.2 Nutrient Parameters

3.2.2.1 Ammonia (NH_3)

Highest NH_3 concentrations were found in effluent samples (GE1) while lowest concentrations were observed in samples collected upstream of the effluent discharge (GU2), and at station GD4, which is farthest downstream from the effluent discharge (Figure 14). NH_3 detected in samples collected at station GE1 ranged from 3.02 mg/L to 4.69 mg/L and were observed highest in samples collected on September 19. Garrison Creek grab samples found the highest concentration of NH_3 at 1.79 mg/L from sample collected at GD1 on September 19.

A 144-fold increase in average daily mean NH_3 was observed between GU2 (background condition) and GD1 (first downstream station after the effluent discharge). After this initial increase at GD1, mean values consistently decreased in a downstream direction (Figure 14). The greatest longitudinal decrease in mean NH_3 was 84% between stations GD2 and GD4, which corresponded to the greatest distance between stations sampled on the creek. Figure 14 also shows the ammonia levels found in grab and composite samples of the final wastewater effluent (station GE1).

Consistent with the results obtained in upstream background samples (GU2), natural waters typically contain NH_3 concentrations of less than 0.1 mg/L. Levels greater than 0.1 mg/L may be indicative of anthropogenic inputs, such as the observed input from the College Place WWTP effluent. Decreasing concentrations between September 17 and September 19 at downstream stations is likely due to a dilution effect associated

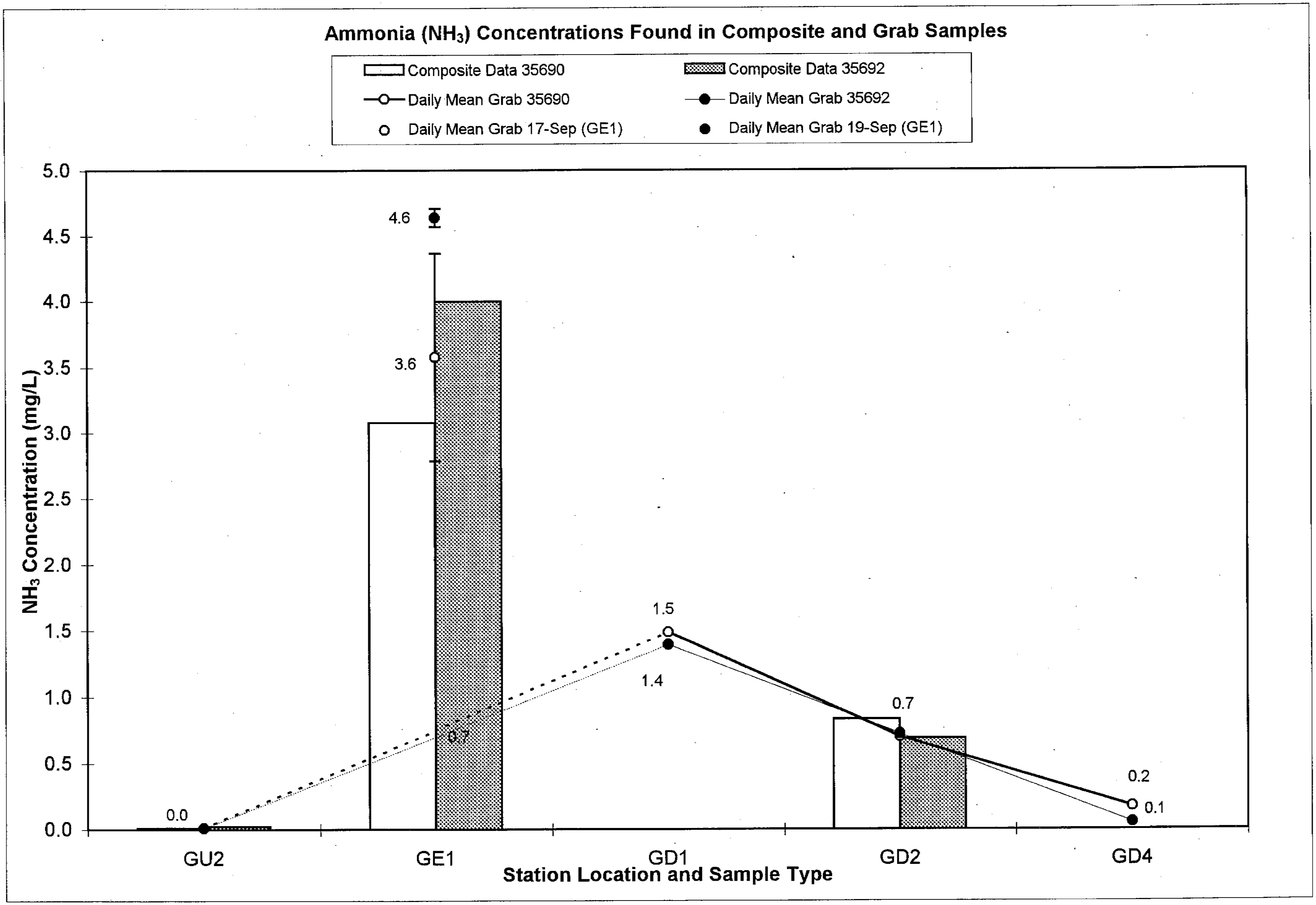


Figure 14. Daily Ammonia Concentrations Found in Grab and Composite Samples Collected from Lower Garrison Creek and College Place WWTP Effluent (9/17/96 and 9/19/96)

with the runoff event that increased stream flows in Garrison Creek. The increased ammonia values in the effluent between the first and second day are probably due to the decreased holding time in the WWTP lagoons associated with the runoff event on September 19. Both decreased water temperatures and increased flow through the lagoons would tend to decrease the bacterial metabolism of nitrogenous compounds. This decrease in metabolism will likely increase the effluent's total ammonia concentration.

NH_3 is a potentially toxic substance with specific water quality criteria for maximum concentrations for protection of aquatic life. A summary table showing total and unionized NH_3 concentrations found in grab and composite samples and the corresponding acute and chronic criteria is found in Appendix D. Acute and chronic criteria for Garrison Creek station locations compared with the NH_3 concentrations detected in grab samples are illustrated in Figure 15. NH_3 detected in the samples collected on September 19 at creek station GD1 exceeded the chronic criteria for both total and unionized forms of ammonia. None of the samples collected in this study contained NH_3 concentrations which exceeded acute criteria.

Other, unpublished data, show that the summer conditions evaluated in our intensive survey are not the critical conditions for ammonia levels. Monitoring of effluent ammonia levels show that winter levels may be up to an order of magnitude higher than those observed in our study, with effluent ammonia concentrations commonly ranging from 20 to 30 mg/L from October through May (City of College Place WWTP, 1996). This indicates a toxic impairment that may coincide with seasons of fish migration, spawning and rearing.

3.2.2.2 Nitrite + Nitrate (NO_2+ NO_3)

Highest nitrite plus nitrate (NO_2+NO_3) concentrations were detected in effluent (GE1) composite sample collected on September 17 at 2.4 mg/L. Composite samples collected at the uppermost station (GU2) found lowest concentrations of NO_2+NO_3 at 0.88 mg/L and 0.893 mg/L on September 17 and 19, respectively. The samples collected above the effluent discharge at GU2 found less variability in NO_2+NO_3 concentration, appearing steady between sample days which may reflect mainstem background conditions during summer base flow (Appendix D).

Nitrite was specifically sampled for to estimate the contribution of both nitrite and nitrate to the stream. Nitrite (NO_2) is the chemical form of nitrogen that is normally absent or present in minute quantities in surface waters, usually in the order 0.001 mg/L. Highest NO_2 concentrations were found in effluent composite samples (GE1) at 0.18 mg/L and 0.279 mg/L collected on September 17 and September 19, respectively. In addition, NO_2 variability at GE1 was largest in the study, where an approximate 56% increase in concentration was observed in effluent samples between sample days (Figure 16). An estimated 5% and 30% decrease between sample days was also observed in composite values at GD2 and daily mean grab values at GD4, respectively.

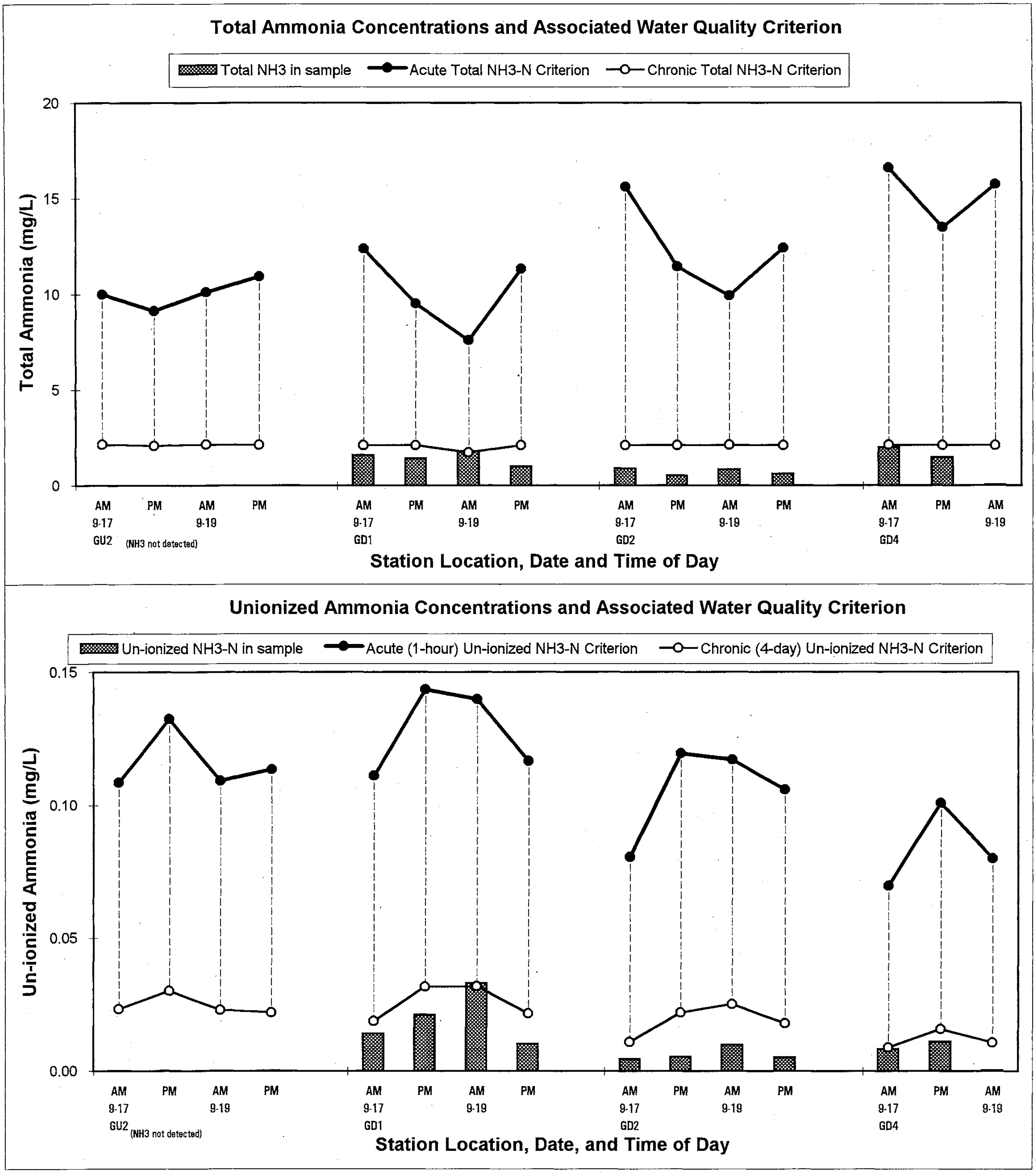


Figure 15. Ammonia Concentrations Found in Grab Samples and Associated Water Quality Criterion for Lower Garrison Creek

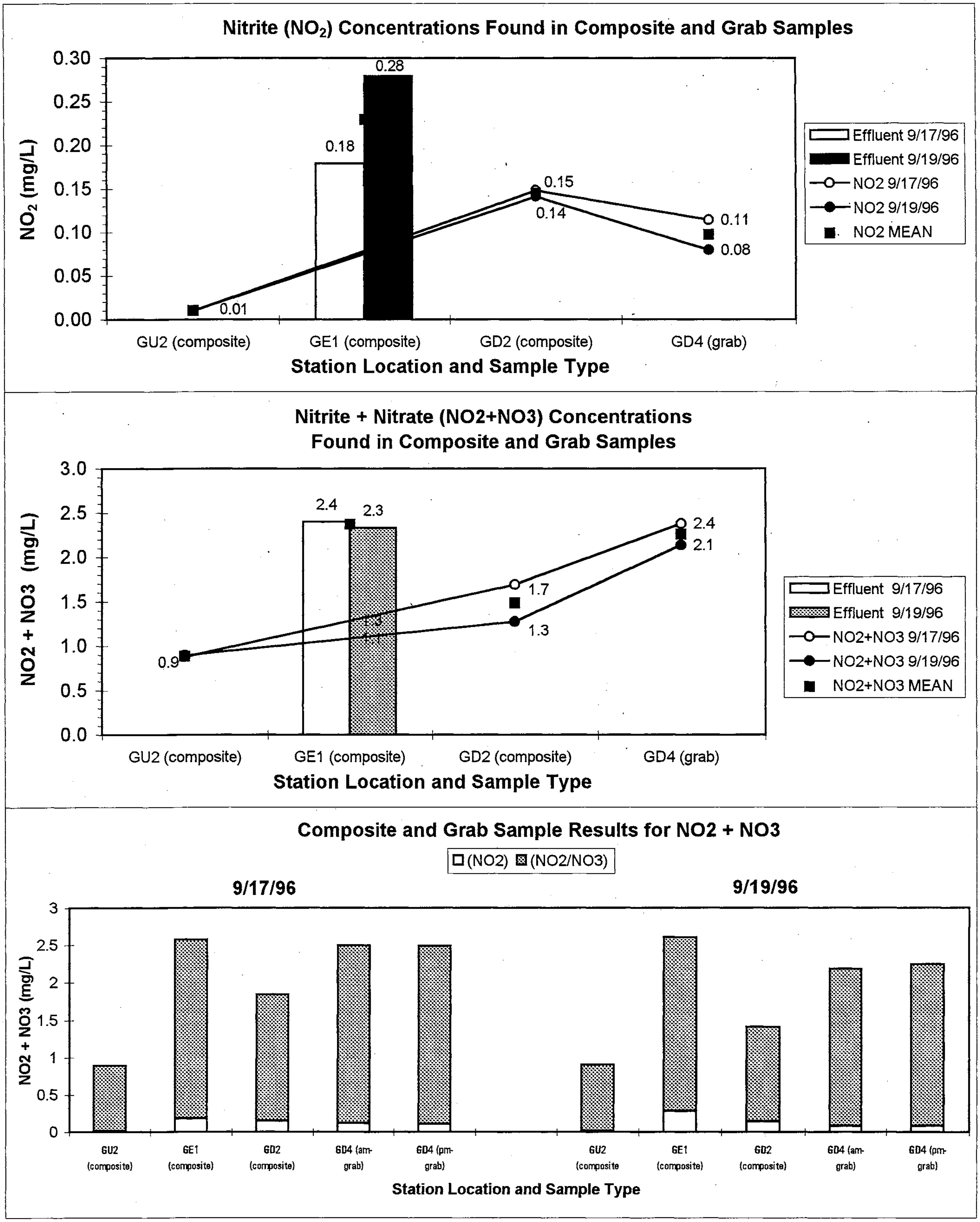


Figure 16. **Daily Nitrite + Nitrate Concentrations Found in Grab and Composite Samples Collected From Lower Garrison Creek and College Place WWTP Effluent (9/17/96 and 9/19/96)**

NO_2 was not detected in upstream composite samples (GU2) above the laboratory detection limit of 0.01 mg/L.

As one may expect, results indicate that there is an input of NO_2+NO_3 from College Place WWTP effluent discharge. Mean values effluent (GE1) concentrations which are substantially higher than those observed at GU2, and increased NO_2+NO_3 in composite and grab stations further downstream (Figure 16). The study found the largest change in mean NO_2+NO_3 concentration between GD2 and GD4. A 67% increase in mean NO_2+NO_3 values between GD2 and GD4 may indicate that there are additional anthropogenic inputs between these mainstem stations. No water quality standard for NO_2+NO_3 currently exist in WAC 173-201A, however, consumption of waters with high nitrate concentrations is known to decrease the oxygen-carrying capacity of the blood which may have adverse effects for both human and livestock. Most surface waters contain some nitrates (NO_3), however, concentrations greater than 5 mg/L may reflect unsanitary conditions, since one major source of NO_2+NO_3 is human and animal waste. Although summer concentrations of NO_2+NO_3 found during this study were somewhat low, nitrate concentrations in surface waters may fluctuate, being somewhat higher in winter months when groundwater input is proportionally greater and in the spring when contributions from overland runoff are substantial.

3.2.2.3 Orthophosphate and Total Phosphorus

The highest phosphorus concentrations for both orthophosphate and total phosphorus were found at GE1, the WWTP outfall (Figure 17). Instream grab samples and composites at all the downstream sites GD2 and GD4 consistently estimated both parameters above 2.0 mg/L on September 17 and above 1.3 mg/L on September 19. Dilution of phosphorus concentrations from the WWTP outfall seemed to occur during the high flows seen on September 19. Station GU2, above the WWTP, had both orthophosphate and total phosphorus conditions at or below the lab detection limits.

It should be noted that the total phosphorus concentrations were found at levels less than the orthophosphate levels, a component of the total phosphorus measurement. This difference is an artifact of the laboratory techniques utilized to estimate the concentrations. For each parameter, the laboratory will have separate calibration curves, each with its own variability. This variability due to different curves and dilutions, can give slightly different estimates for each parameter. Since orthophosphate was measured as most of the available total phosphorus in Garrison Creek, the variability in the analysis was greater than the difference between total phosphorus and orthophosphate.

Phosphorus is normally found in low concentrations in freshwater; it is essential for plant growth and may be a limiting factor in most freshwater ecosystems (Cusimano, 1994). However, with the introduction of large quantities of nutrients in the form of nitrogen and phosphorus from WWTP and other human caused inputs, the levels can

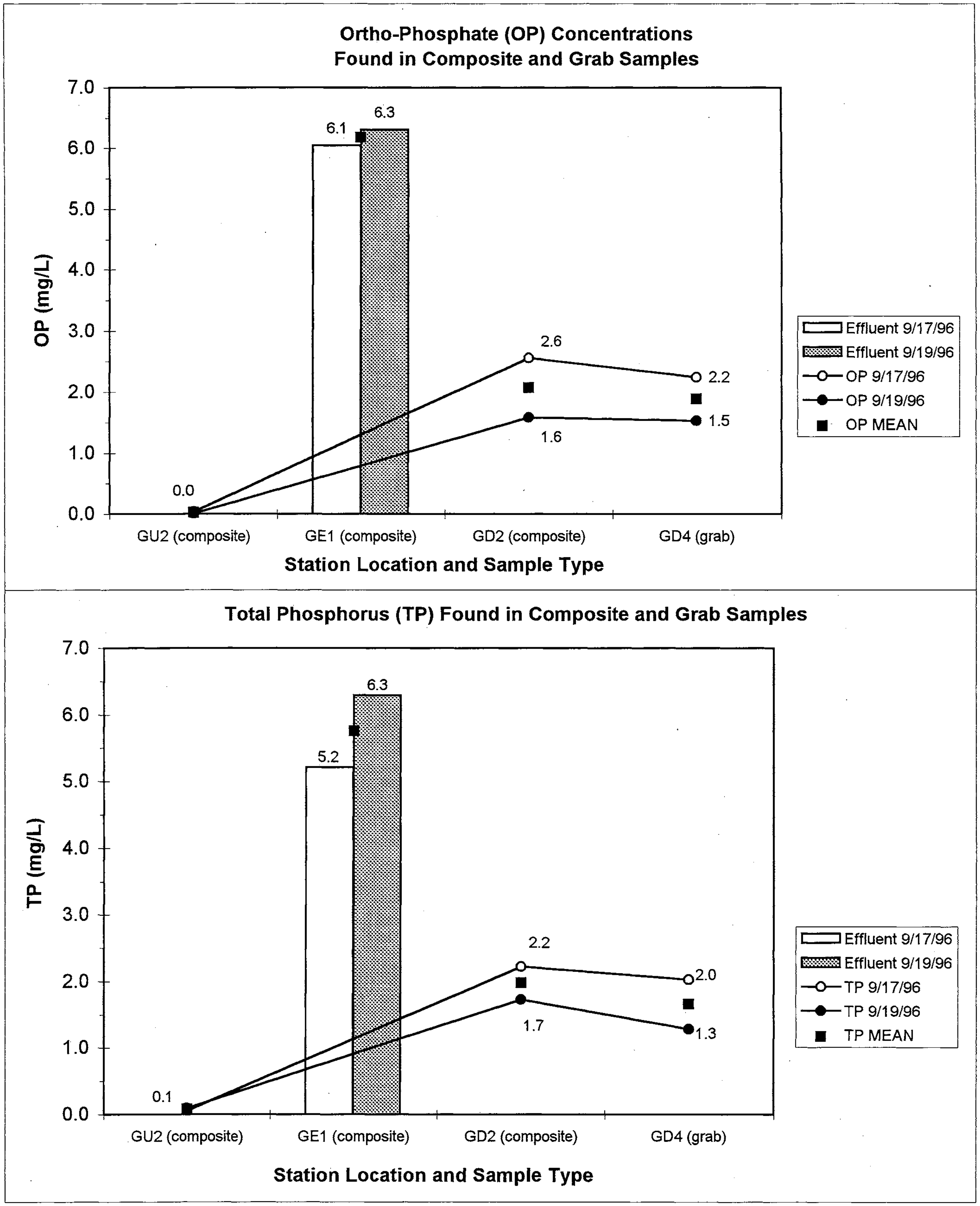


Figure 17. **Daily TP and OP Concentrations Found in Grab and Composite Samples Collected From Lower Garrison Creek and College Place WWTP Effluent (9/17/96 and 9/19/96)**

increase plant and algae growth to nuisance levels. Currently there are no water quality standards for phosphorus concentrations in freshwater systems.

3.2.3 Microbiology Parameters

3.2.3.1 Fecal Coliform Bacteria (FC)

Highest FC concentrations were found in the afternoon during final day of sampling (9/19/96), which coincided with a rain/runoff event. Station GU2, the study's uppermost site in Garrison Creek, consistently had the greatest FC concentrations in relation to other station locations (Table 6). The lower FC concentrations found in downstream samples compared to the upstream sample (GU2) suggest non-point FC sources further upstream. Samples from WWTP effluent (GE1) found negligible amounts of FC in all samples analyzed. Therefore, the WWTP effluent discharge has the effect of lowering ambient FC levels in lower Garrison Creek both due to dilution and the toxic affects of chlorine.

Table 6. Fecal Coliform Concentrations (#colonies/100 mL) Found in Garrison Creek.

STATION LOCATION	9/17/96 - AM	9/17/96 - PM	9/19/96 - AM	9/19/96 - PM	ENTIRE SURVEY
GU2	840	580	690	2,500	957
GU2 - composite	670		1,597		1,034
GD1	280	260	420	2,245	512
GD2	300	330	240	1,700	448
GD2 - composite	200		670		366
GD4	150	160	140	200	161
ALL STATIONS	321	299	314	1,175	164
ALL COMPOSITES	366		1,034		615

Previous studies indicate that "worst-case" conditions for fecal coliform have often been found to correspond to high flow events (Coots, 1994; Dickes and Patterson, 1994). It is suspected that both "continuous" and "periodic" FC inputs exist within Garrison Creek watershed and may be originating from such sources as failing septic tanks and agricultural practices, respectively. The FC concentrations in samples collected during dry conditions (September 17) imply continuos and steady FC sources, independent of rainfall, while the FC concentrations in samples collected during a rainfall event (September 17) suggest the periodic wash off of FC sources. Results from the upstream and downstream composite samples support the assumption that non-point FC sources exist further upstream, which are washed off during the rising limb of a hydrograph, as indicated by elevated FC counts detected at GU2 on September 19.

The Washington State water quality standards (Chapter 173-201A WAC) for FC state that, for Class A freshwaters, *"organism levels shall both not exceed a geometric mean value of 100 colonies/100 ml, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 ml."* In comparing our sampling results to the applicable criteria we found that:

- Stations GU2, GD1, and GD2 exceeded both parts of the criterion; and
- All lower Garrison Creek mainstem sites sampled exceeded the second part of the criterion during the study period (Figure 18).

In addition, the FC geometric mean in lower Garrison Creek for all stations sampled exceeded both parts of the criterion for the study.

3.2.3.2 Total Coliform Bacteria (TC)

The results for total coliform (TC) showed similar trends to FC previously discussed (Figure 18). As indicated in Table 7, highest TC concentrations were detected in samples collected on September 19 for both composite and grab samples. Composite

Table 7. Total Coliform Geometric Means (#colonies/100 mL) Found in Garrison Creek and Percent Increase at Stations Between Sampling Days

STATION LOCATION	Sample Type	9/17/96	9/19/96	ENTIRE SURVEY	Percent Increase
GU2	composite	2,191	4,589	3,171	109%
GE1	composite	17	140	49	724%
GD1	grab	870	6,045	2,293	595%
GD2	composite	1,600	4,300	2,626	169%
ALL	STATIONS	391	1,403	740	259%

samples ranged from 17 colonies/100 ml at GE1 (9/17) to 4589 colonies/100 ml at GU2 (September 19). TC concentrations found in grab samples collected at GD1 increased approximately 600% between the dry and wet sampling day. The largest percent increase between sampling days was observed at GE1 at approximately 725%.

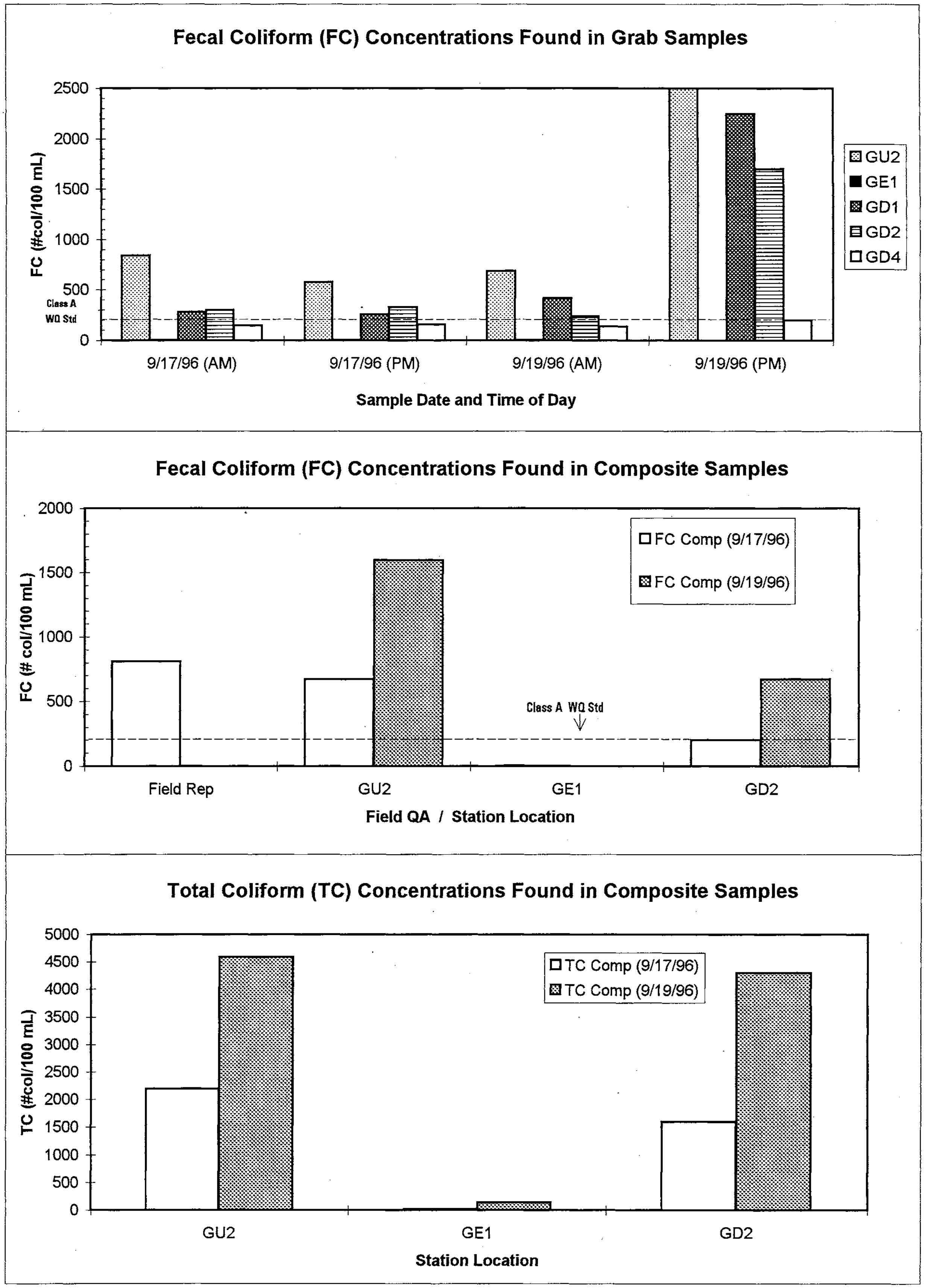


Figure 18. Fecal Coliform and Total Coliform Concentrations Measured in Garrison Creek (9/17/96 and 9/19/96)

Unlike FC, there are no WQ standards that currently exist for TC. However, the geometric means calculated for FC and TC in composite samples during this study indicate that a greater proportion of coliform bacteria other than FC exist, especially when comparing potential inputs between stations GD1, GD2 and those upstream of station GU2.

3.2.4 Metals in Water and Sediment

Of the three 24-hour composite water sample stations where samples were analyzed for the six metals (Cu, Zn, Ni, Cd, Pb, and Cr), only the sample of effluent (GE1) had detectable levels of dissolved metals. Dissolved copper and zinc were found at levels below the water quality criteria which apply to ambient surface waters (Table 8). These effluent levels should be viewed as maximum sample concentrations, however, as the samples were contaminated by spillage into the compositor basin, and may have picked up metal residues from this equipment. The two creek samples did not have dissolved metal concentrations above the level of quantification. Metals toxicity does not appear to be a water quality problem in lower Garrison Creek, based on this period of sampling.

Table 8. Concentrations Found and Corresponding Toxic Criteria for Metals Detected in Water Column Composite Samples Collected from Garrison Creek (9/19/96)

	Station Location			Freshwater Toxic Criteria (ug/L)[1]					
Substance	GU2	GE1	GD2	GU2		GE1		GD2	
Dissolved Metals	(ug/L)	(ug/L)	(ug/L)	acute	chronic	acute	chronic	acute	chronic
Copper (Cu)	5 U	6.9[2]	5 U	< 9.3	< 6.5	< 13.6	< 9.2	< 10.5	< 7.2
Zinc (Zn)	4 U	15	4 U	< 66.9	< 60.9	< 94.1	< 85.2	< 74.3	< 67.3
Total Recoverable Metals	(ug/L)	(ug/L)	(ug/L)						
Copper (Cu)	12	14	11						
Zinc (Zn)	9.1	13	8.2						

U = not detected at laboratory detection limit

[shaded] = no criteria available

1 = These ambient criteria are based on the dissolved fraction of the metal. WAC 173-201A-040(3)(dd.) specifies that the department shall apply the criteria as total recoverable values to calculate effluent limits unless data is made available to the department clearly demonstrating the seasonal partitioning of the dissolved metal in the ambient water in relation to an effluent discharge.

2 = concentration value suspect due to sample contamination

While dissolved metals concentrations are most relevant to evaluating exposure of fish and other organisms to aquatic toxicity associated with the creek water itself, total recoverable metals analyses were also conducted on composite water samples from stations GU2, GE1, and GD2. These analyses, which determine the combined level of metals in the water and particulates suspended in the water, are useful for evaluating metals loading which can effect the quality of the sediments in the creek and are also relevant to establishing permit limits for the WWTP. Total recoverable metals results are shown in Table 8. These analyses reveal that while the effluent has higher levels of total metals, the levels downstream of the WWTP discharge are similar to those observed upstream.

Analysis of sediment samples for metals is useful for ascertaining the cumulative effects of natural and anthropogenic sources of metals loading to Garrison Creek. Extremely high concentrations of metals in freshwater sediments can have toxic and other adverse effects on sediment-dwelling organisms. We use sediment quality guidelines developed by the province of Ontario for protection of aquatic life as criteria for comparing the levels found in Garrison Creek sediments. None of the levels found in Garrison Creek sediments exceed these sediment toxicity guidelines. The sediments sampled upstream of the WWTP discharge had higher levels of metals (about twice as high) than the downstream sediment sample, indicating that metal discharges from the WWTP are not a problem relative to other metals sources in the watershed (see Table 9). One factor which may explain the higher concentrations at the upstream station is that the upstream sample was obtained from a location where sediments were trapped upstream of an irrigation diversion weir. This area accumulates sediments from upstream sources as they settle out of the water column above the weir, whereas the primary source of surficial sediments from the GD2 sampling area is the WWTP discharge and any particulates which pass over or around the irrigation diversion.

Table 9. Concentrations and Toxicity Criteria for Metals Detected in Sediment Samples Collected from Garrison Creek (9/19/96)

Substance Detected	Composite Station Location		Toxic Criteria (ug/Kg dry)	
Metals (ug/Kg)	**GU2**	**GD2**	SQL-LEL[1]	SQL-SEL[2]
Chromium (Cr)	13.2	8.63	26,000	110,000
Copper (Cu)	40.9	20.3	1,600	110,000
Lead (Pb)	110	32	3,100	250,000
Nickel (Ni)	8.9	5	1,600	7,500
Zinc (Zn)	230	114	120,000	820,000

[1] = Sediment Quality Guideline - **Lowest Effect Level**
(*from Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* - Persaud *et al.*, 1993)

[2] = Sediment Quality Guideline - **Severe Effect Level**
(*from Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* - Persaud *et al.*, 1993)

3.2.5 Pesticides in Water, Sediment and Fish Tissue

Table 10 shows the pesticides detected in 24-hour composite water samples collected at two stations in Garrison Creek, and from the effluent discharge.

Table 10. Concentrations and Toxicity Criteria for Pesticides Detected in Water Column Composite Samples Collected from Garrison Creek (9/19/96)

Substance Detected	Composite Station Location			Freshwater Toxic Criteria (ug/L)		
Herbicides (ug/L)	**GU2**	**GE1**	**GD2**	**Acute**	**chronic**	**human health**
2,4-D	0.35	0.18	0.26	≤ 4.0[1]	≤ 1.0[2]	100 [3]
4-Nitrophenol	0.037	U	U	NC	NC	NC
Dicamba I	0.027	0.067	0.053	NC	NC	NC
Dichloroprop	0.015	U	U	NC	NC	10 [4]
MCPP (Mecoprop)	0.045	0.077	0.045	NC	NC	NC
Insecticides (ug/L)	**GU2**	**GE1**	**GD2**	**acute**	**chronic**	**human health**
4,4'-DDD	0.0019	U	0.002	≤ 1.1[6]	≤ 0.001[6]	8.3×10^{-7} [3,5]
4,4'-DDE	0.0036	0.0024	0.0025	≤ 1.1	≤ 0.001[6]	5.9×10^{-7} [3,5]
4,4"-DDT	0.0025	U	U	≤ 1.1[6]	≤ 0.001[6]	5.9×10^{-7} [3,5]
Bromocil	0.02	U	U	NC	NC	NC
Gamma-BHC (Lindane)	0.0031	0.0031	0.0024	≤ 2.0[4]	≤ 0.08[4]	5.9×10^{-7} [3,5]
Hexachlorobenzene	0.0008	0.0007	0.0007	6.0[3]	3.7[3]	7.2×10^{-10} [3,5]

U = not detected at laboratory detection limit
NC = no criteria available

1 = NAS 1973
2 = Norris and Dost 1993
3 = USEPA 1991
4 = USEPA 1993a
5 = USEPA 1993b
6 = Washington State Water Quality Standards

Complete results for the pesticide analyses, including those compounds not found at levels above the laboratory detection limits are given in Appendix D. For many of the pesticides detected, the water sampled upstream of the WWTP discharge at station GU2 had higher concentrations than either the effluent sample or water sampled at GD2. This was true for 2,4-D, 4-Nitrophenol, dichloroprop, 4,4'-DDE, 4,4'-DDT, and hexachlorobenzene. The highest levels of the herbicides dicamba and MCPP were found in the effluent sample. Levels of lindane were the same in the upstream sample as in the effluent sample, and 4,4'-DDD were similar in the upstream and downstream samples, and this compound was not detected in the effluent samples. Overall, the effluent from the College Place WWTP does not stand out as a cause of any ambient pesticide toxicity.

Certain chlorinated insecticides were found in Garrison Creek at levels which exceed water quality criteria established to protect aquatic life and human health (see Table 10). The human health protection criteria shown in Table 10, which consider cancer risk and other health effects, are for ambient water concentrations, and these criteria are based on lifetime exposure from ingestion of toxic substances via both water and aquatic organisms. Levels of the DDT derivative 4,4'-DDD in the upstream and downstream samples exceeded the criteria established in the state water quality standards to protect aquatic life from chronic toxicity problems, as well as human health protection criteria, but the WWTP discharge was not a source of detectable levels of this insecticide. Likewise, levels of 4,4'-DDE, another DDT breakdown product, also exceeded the chronic aquatic life and human health criteria in the ambient creek water samples, and this insecticide was also present in the effluent at levels exceeding criteria. The insecticide 4,4'-DDT exceeded the chronic aquatic life and human health criteria in the sample from the upstream station, but was not found in either the effluent or downstream sample at levels above the laboratory detection limit.

Two other chlorinated pesticides, lindane and hexachlorobenzene, exceeded the human health protection criteria, but no aquatic life criteria were exceeded during the 24-hour compositing period. All of the insecticides which were found at levels which may adversely affect aquatic life or human health have been banned from agricultural use for decades, and their presence in Garrison Creek water is likely attributable to wash-off of contaminated soils from farmland in the watershed, where they were used historically. Control of soil erosion at its source is one way to allow the aquatic system to recover over time.

As summarized in Table 11, levels of pesticides in the bottom sediments of Garrison Creek were similar or higher at the upstream sampling station (GU2) for four of the five pesticides detected. For the compound 4,4'-DDT, the highest sediment concentration was observed downstream of the WWTP. However, none of the pesticide levels found in Garrison Creek sediments approached the toxicity criteria we used for comparison.

Levels of pesticides detected in the composite whole-fish tissue sample collected from the GD2 biological sampling reach are given in Table 12, where they are compared to criteria established to protect humans and fish-eating wildlife. Levels of the banned pesticide dieldrin exceeded the criteria established to protect human health, but not the wildlife protection criteria. It should be kept in mind, however, that the human health criteria are based on levels in the edible portions of fish, which we are not able to ascertain with our whole-fish sample. The other pesticides detected in this tissue sample were found at levels below the applicable criteria.

Table 11. Concentrations and Toxicity Criteria for Pesticides Detected in Sediment Samples Collected from Garrison Creek (9/19/96)

Pesticides (ug/Kg)	**GU2**	**GD2**	SQL-LEL[1]	SQL-SEL[2]
4,4'-DDD	12	12	8,000	
4,4'-DDE	30	22	5,000	19,000
4,4"-DDT	1.2	5.2	8,000	71,000
Hexachlorobenzene	2.7	3.1	20,000	24,000
Chlordane (Tech)	46	U	NC	NC

U = not detected at laboratory detection limit
NC = no criteria available

[1] = Sediment Quality Guideline - **Lowest Effect Level**
(*from Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* - Persaud *et al.*, 1993)

[2] = Sediment Quality Guideline - **Severe Effect Level**
(*from Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* - Persaud *et al.*, 1993)

Table 12. Concentrations and Toxicity Criteria for Pesticides Detected in Tissue Samples Collected from Garrison Creek (9/19/96)

Substance Detected	**Composite Station Location**	**Toxic Criteria (ug/Kg dry)**	
Pesticides (ug/Kg)	**GD2**	**human health[1]**	**wildlife[2]**
4,4'-DDD	0.8	44.9	1,000
4,4'-DDE	10	31.6	1,000
Cis-Chlordane (Alpha-Chlordane)	0.8	8.3	100
Cis-Nonachlor	0.6	NC	NC
Dacthal (DCPA)	7.8	NC	NC
Dieldrin	2.9	0.67	100
Hexachlorobenzene	0.7	6.73	NC
PCB – 1254	31	NC	NC
PCB – 1260	16	NC	NC
Tetrachloro-m-xylene	5	NC	NC
Trans-Chlordane (Gamma)	0.7	100	8.3
Trans Nonachlor	1	NC	NC

NC = no criteria available
[1] = USEPA 1993b
[2] = NAS 1973

3.3 Biological Survey Results and Discussion

3.3.1 Fish Community

The fish community was represented by four species: redside shiners (*Richardsonius balteatus*), speckled dace (*Rhinichthys osculus*), northern squawfish (*Ptychocheilus oregonensis*), and bridgelip suckers (*Catostomus columbianus*). All four species are native to Washington and are known to be tolerant of warmer waters and moderate to high levels of pollution (Wydoski and Whitney 1979; Zoroben, Idaho Division of Environmental Quality unpublished manuscript). Only one bridgelip sucker was collected at GD2. Northern Squawfish were not collected at GU2 and were most numerous in GD4. Even though there has been documented use by salmonids in Garrison Creek, none were collected during our sampling period.

Fish densities were consistent between all sites (Figure 19), however the presence of different age groups changed dramatically below the WWTP (Figure 20). The percent of age 0 (or fish < one year old) dace and shiners decreased from 56 and 29 percent, respectively, at GU2 to three and zero percent, respectively, at GD2. There was a slight increase of age 0s for both species at GD4 when compared to GD2. Squawfish ages 0 were only present at GD4. The close proximity of the Walla Walla River to GD4 was probably affecting the distributions of squawfish, a fish usually found in larger systems.

Instream habitat structure is not considered to be a factor affecting differences in the fish community between sites. From the habitat survey, both GU2 and GD2 were similar in the amount of fish habitat and stream type; but, GD4 had a more disturbed riparian zone and less available fish habitat than the two upstream sites.

Early developmental stages, e.g. juvenile fish and age 0s, are more sensitive to pollution than are adult fish. Several pollutants of concern in Garrison Creek, including chlorine, ammonia and herbicides, were all at levels that are known to effect fish, both behaviorally and physiologically. Ammonia levels of 0.2 mg/l, well below that measured in the GD1 and GD2 during the September sampling period, can effect fish. Chlorine levels were at or above the chronic effect levels at several sites. Temperatures at all sites were also well above the preferred temperatures for salmonid species, and temperatures above the upper lethal limit have been measured by the WWTP's ambient monitoring.

Ammonia levels reported from the WWTP effluent were greater than 16 mg/l from December 1996-April 1997 with several measurements greater than 25 mg/l (City of College Place WWTP, 1997). Ecology's September 1996 study found the WWTP raised instream ammonia levels below the outfall to almost 1 mg/l when the effluent concentration was measured at 4 mg/l. With effluent levels of 25 mg/l, the creek

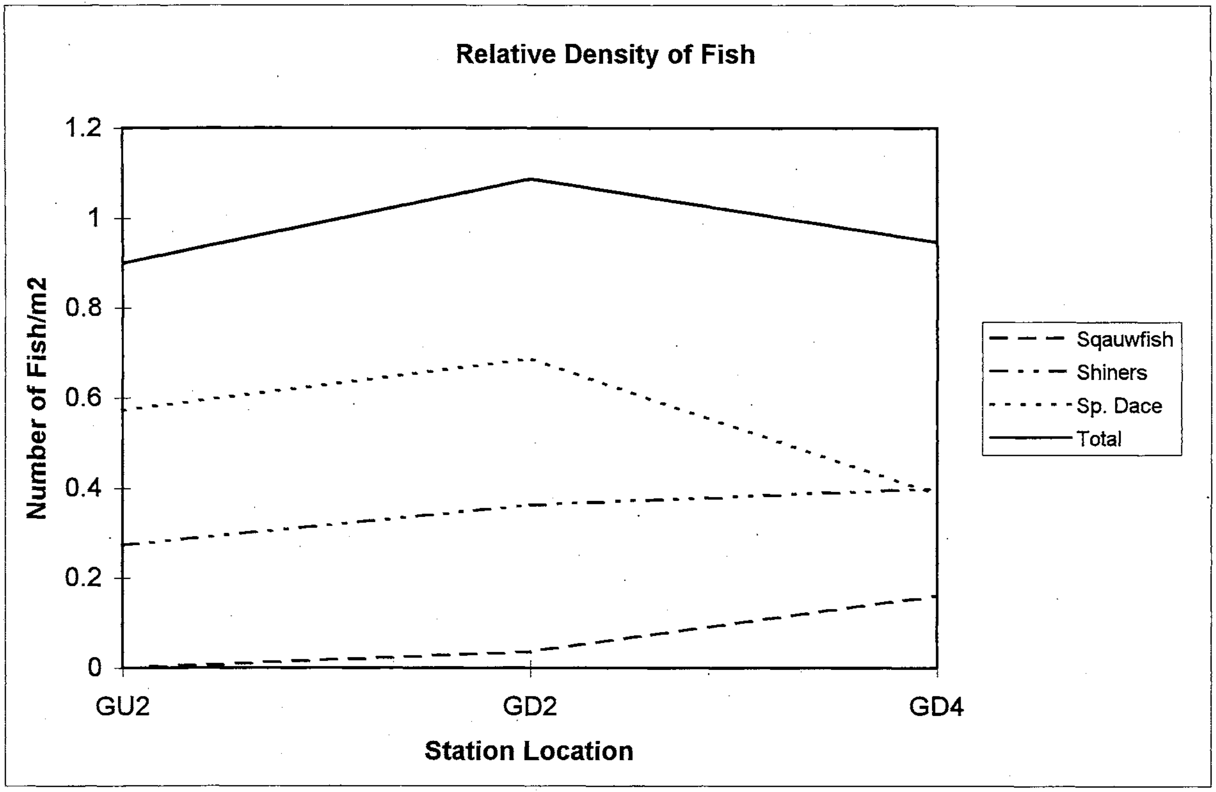


Figure 19. **Relative Density of Fish Species and Total Number for Garrison Creek Sites (9/17/96)**

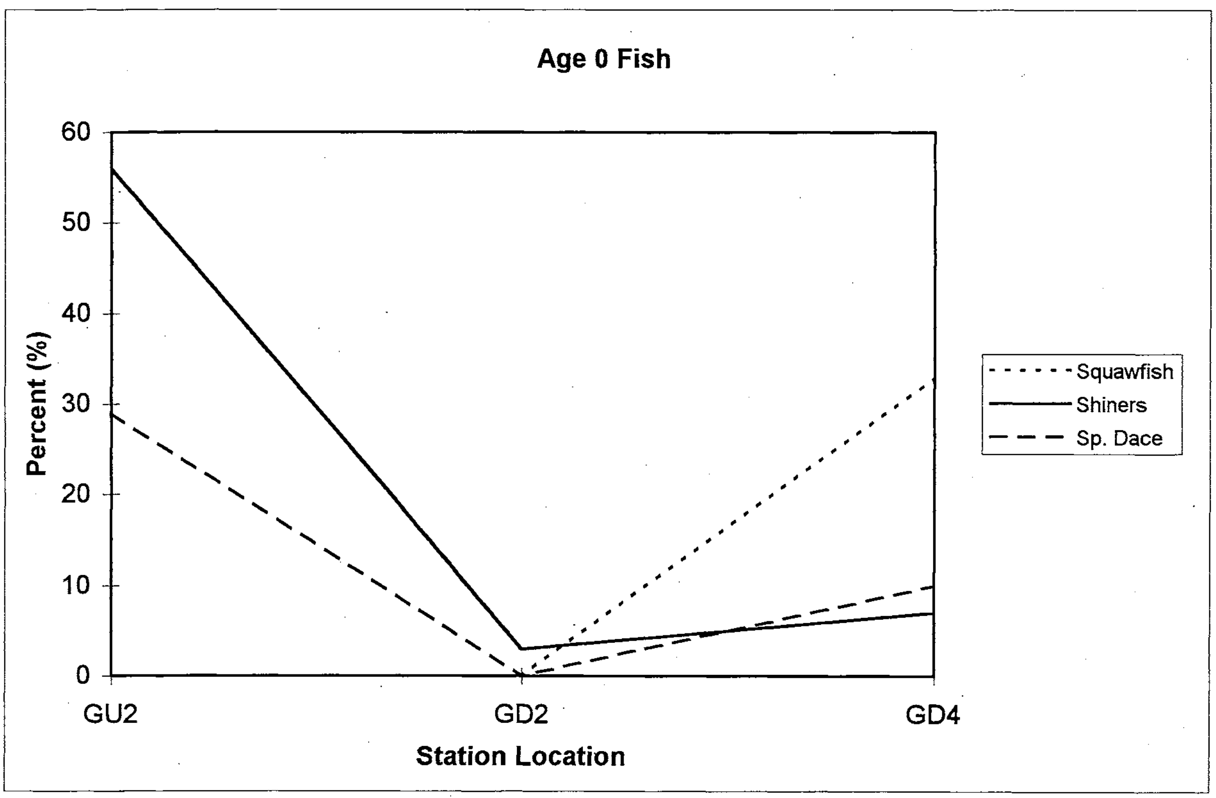


Figure 20. **Percent Age 0 Fish Found in Garrison Creek Sites (9/17/96)**

ammonia concentrations could become extremely toxic to some fish, or specific life stages (e.g. juveniles). Accordingly, high ammonia levels in the Creek could be causing significant mortality to the age 0 fish within Garrison Creek, as well as dissuading any salmonid use within the stream section (by either mortality or behaviorally changes).

With the number of diversions on Garrison Creek, fish distributions are probably limited to downstream movement and during high flows. In relation to the sampling sites, potential low water barriers exist directly below GD2 (pipe, see Figure 2) and directly above the WWTP outfall (irrigation diversion). These barriers probably limit the re-distribution of salmonids and sensitive life stages of other fish into the section directly impacted by the WWTP effluent once the conditions improve during the year. The singular effect of each pollutant can cause mortality in the fish community, especially salmonids, but the combined effect of all pollutants at or above chronic effects levels probably limits the livability above the WWTP outfall, and severely impacts the salmonid and other species below the outfall.

3.3.2 Macroinvertebrate Community

All measured attributes of the Garrison Creek macroinvertebrate community indicate an extremely depressed instream community at all three sites (GU2, GD2, GD4). Thirty-five taxa were collected and all were moderately to extremely tolerant to polluted waters (Table 13). Macroinvertebrate densities varied wildly between the sites with the site GD2, about 100 meters below the WWTP, dramatically increasing the community density to more than 30 times the upstream levels (Figure 21).

The three measured attributes, total taxa, EPT Taxa and the HBI, were all influenced by the outfall (Figure 22). Total taxa decreased by 50% between the upstream site (GU2) and downstream site (GD2) from 18 to nine. GD4 also had nine taxa present. The EPT index, which measures the number of potentially intolerant taxa, was two at the upstream site and none were present at either sites below the outfall. Both EPT taxa, *Baetis tricaudatus* and *Cheumatopsyche* sp., are two of the more tolerant taxa EPT taxa present in Washington State. The HBI index is a measure of the relative pollution tolerance of the macroinvertebrate community. HBI values for the upstream site and GD4 indicate a moderate organic pollution impact while the site below the WWTP outfall shows severe organic pollution.

Three taxa groups, Oligochaeta, Chironomidae, and Ostracoda, dominated the community at all three sites (Figure 23). Oligochaeta was the dominant group at the upstream site and GD4. High amounts of organics and soft bottom sediments are the optimal habitat for oligochaetes. However, even with the high amounts of organics and soft bottoms in the downstream site GD2, oligochaetes were in lower numbers than expected. Oligochaetes do not normally tolerate toxic conditions which are found below the WWTP outfall, e.g. high residual chlorine.

Table 13. Taxa List and Associated Tolerance Values for Garrison Creek Macroinvertebrate Samples from September 17, 1997

TAXON	Tolerance Value	GU2	GD2	GD4
Baetis tricaudatus	6	3.86	0	0
Brillia	5	2.55	0	0
Ceratopogoninae	6	2.05	0	3.75
Cheumatopsyche	8	41.32	0	0
Chironomini	6	8.	0	0
Corynoneura	7	2.55	0	0
Cryptochironomus	8	8.18	0	0
Dytiscidae	7	7.5	0	0
Ferrissia	6	4.68	0	0
Gammarus	6	246.68	581.25	52.5
Hemerodromia	6	1.	0	0
Hydrobaenus	8	2.05	0	0
Limnophyes	8	9.36	0	0
Micropsectra	7	0	11088.75	0
Nematoda	5	75.77	292.5	71.25
Oligochaeta	5	1231.59	1860.	2103.75
Optioservus	5	0.5	0	0
Ostracoda	8	0	17220.	60.
Pacifastacus	6	1.86	0	3.75
Parakiefferiella	6	31.	0	0
Paratanytarsus	6	15.5	0	0
Phaenopsectra	7	0.5	15.	0
Physidae	8	0	0	30.
Pisidium	8	27.45	243.75	420.
Planorbidae	6	0	7.5	232.5
Polypedilum	6	0.68	0	0
Pseudosmittia	6	7.5	0	0
Rheotanytarsus	6	1.	0	0
Simulium	7	14.73	105.	0
Tanytarsini	6	0.68	0	0
Thienemanniella	6	0.68	0	0
Thienemannimyia	6	17.	0	3.75
Thienemannimyia gr.	6	2.05	1897.5	0
Tricladida	5	18.5	247.5	56.25
Tvetenia		8.	0	0

* **Scale ranges from 0-10 with 10 being most pollution tolerant**

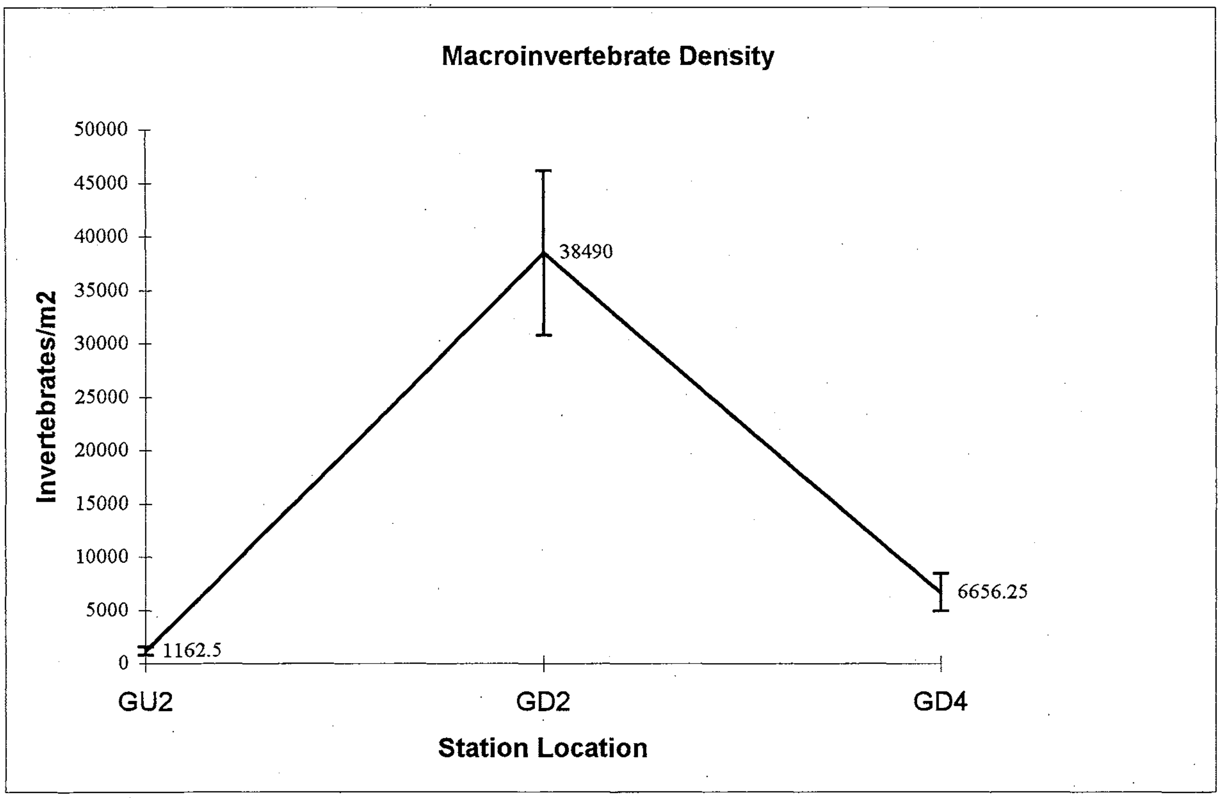


Figure 21. **Macroinvertebrate Density for Garrison Creek Sites (n = 4; error bars = 1 standard deviation)**

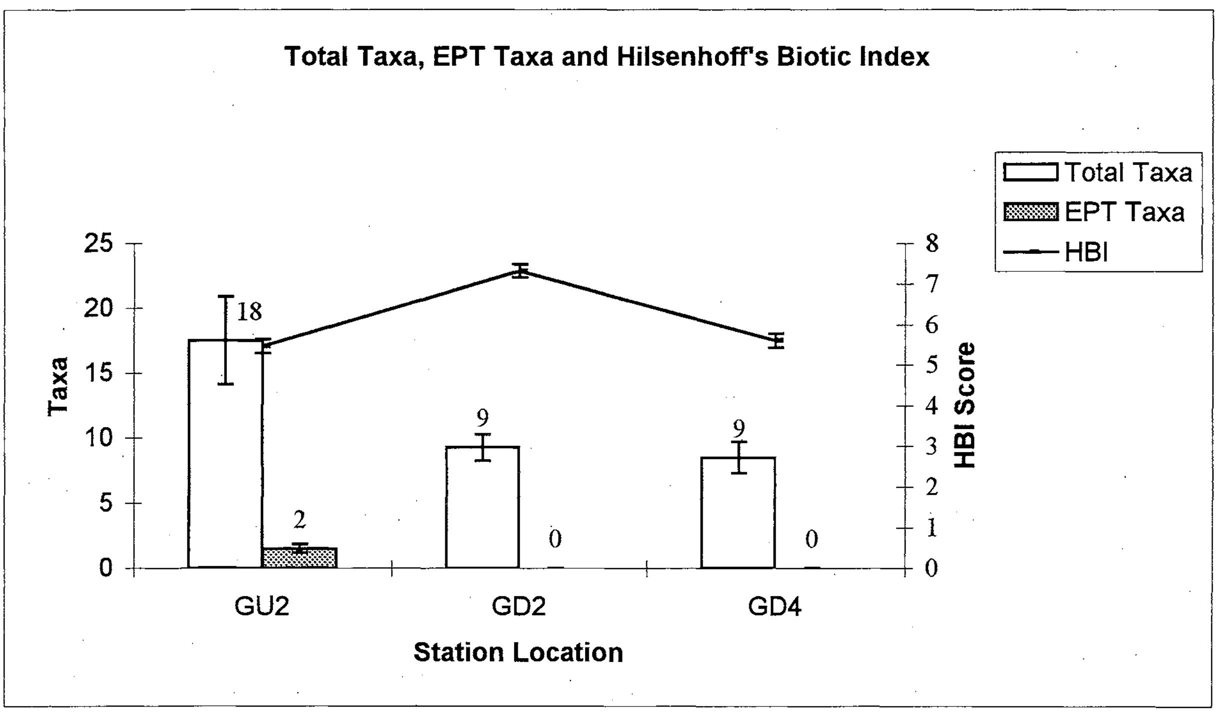


Figure 22. **Total Taxa and Hilsenhoff's Biotic Index for Macroinvertebrates at Garrison Creek Sites (n=4, error bars are 1 Standard Deviation).**

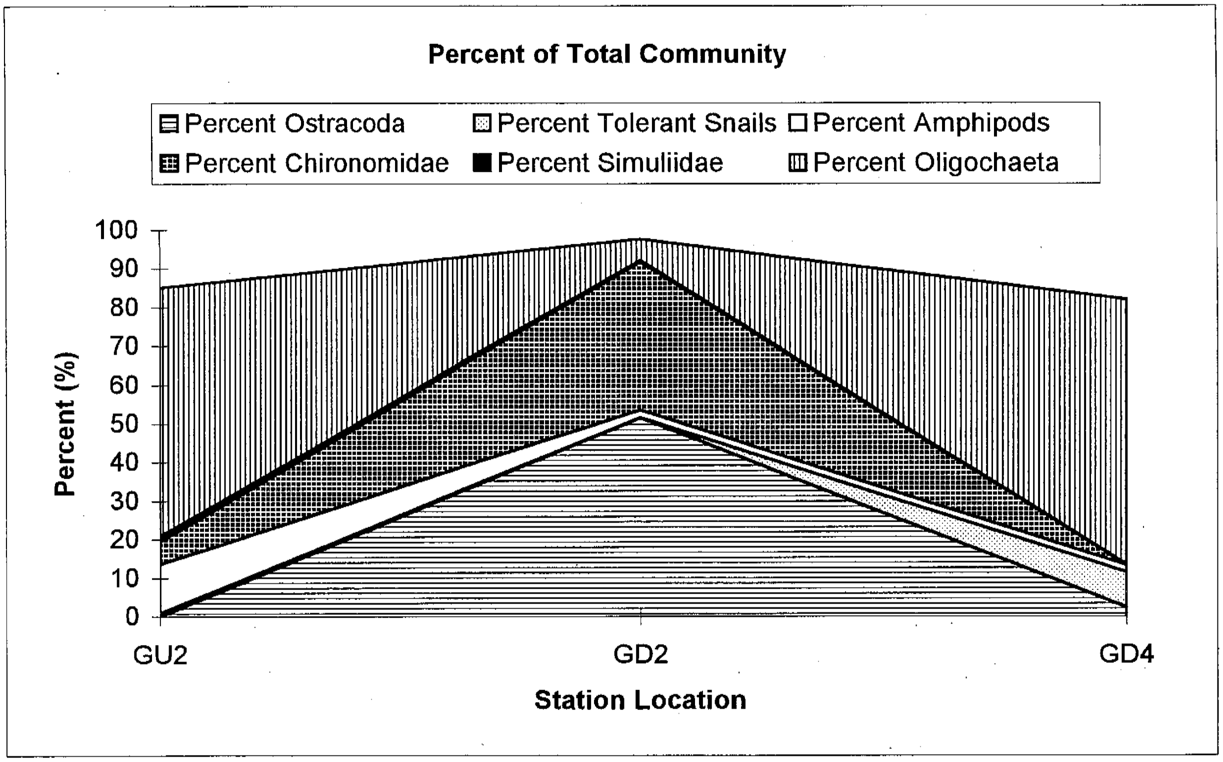


Figure 23. **Percent of Total Community for Selected Indicator Groups Found in Garrison Creek (9/16/96)**

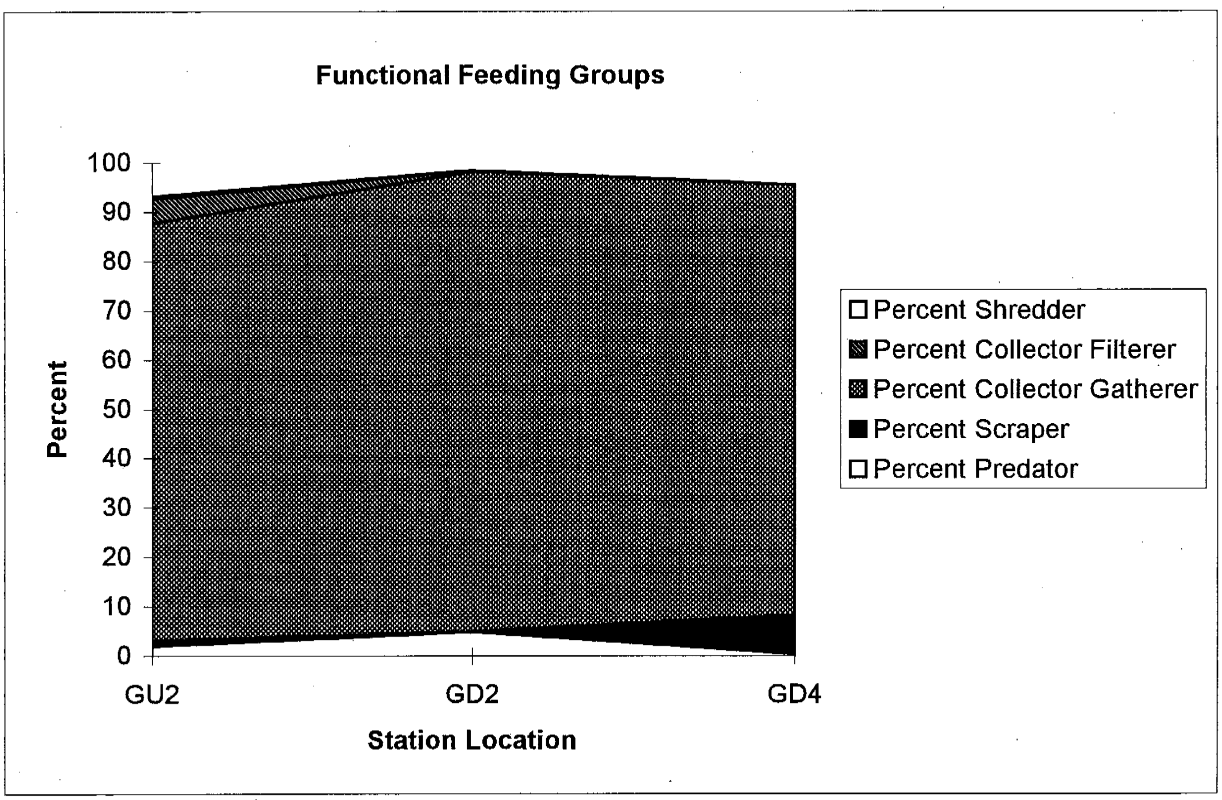


Figure 24. **Functional Feeding Groups for Garrison Creek Sites (9/16/97)**

Some chironomid taxa are normally found in toxic conditions and organically enriched waters (Hynes 1963). The two chironomid taxa, *Micropsectra* sp. and *Thienemannimyia* sp., have both been associated with high levels of toxics and organic enrichment (Dr. Bob Bode, NY DEC, personal communication). In the site immediately below the WWTP (GD2), densities of these two genera were extremely elevated above densities at the upstream site.

Ostracoda are not normally found in great numbers in benthic samples. Ostracoda were kept in the analysis because of their great numbers at the site below the WWTP (GD2) and their ecological niche. Many species of ostracods are active swimmers and can be found in almost any habitat. They are also omnivores/gatherers that probably are using the excessive amounts of organics within the discharge and can tolerate moderate to severe pollution.

Analysis of the different functional feeding groups showed all sites being dominated by collector gatherers and filterers (Figure 24). This is expected due to the high levels of organics at all sites. There was also a slight increase in scrapers at the lower sites due to the increase in snails on the submerged aquatic macrophytes.

3.4 Stream Habitat Results and Discussion

3.4.1 General Habitat

The overall condition of stream habitat within Garrison Creek was observed as poor. Sample locations were typically channelized with all riparian zones removed or severely limited by historic and current land management. The lowest site, GD4, did not have any riparian area present on the right bank, which was a dirt road. All other sites had only reed canary grass, willow, and some cattails present, in what could be classified as riparian areas. The site, GD2, directly below the sewage treatment plant had the most extensive riparian vegetation of any of the sites. Several reports from local persons indicated that heavy equipment had been periodically used to dredge the channels of macrophytes and other debris.

3.4.2 Instream Habitat

Biological communities are affected by both instream habitat characteristics and pollution. Habitat conditions were measured in Garrison Creek to help differentiate their effects on the fish and benthic communities from effects due to non-point source pollution and the WWTP discharge.

Estimates of habitat parameters at each of the three sampling sites were fairly consistent (Table 14). For the upstream/downstream comparison, both GU2 and GD2 had very similar habitat types and measurements. GD4 was the most dissimilar from all the other sites having a slightly higher gradient, greater velocity, and slightly shallower.

Table 14. Habitat Variables for Garrison Creek Sites

Habitat Parameters	Station Location GU2	GD2	GD4
Length of Sampling Reach – Fish (m)	50	50	50
Length of Sampling Reach – Invertebrates (m)	8	6	6
Channel Type	plane bed	Plane bed	plane bed
Visual Habitat Score (out of 120)	72	66	45
Gradient (%)	0.5	0.75	1
Sample Depth (m)	1.475	1.4775	1.12
Sample Velocity (m/s)	0.285	0.34	0.6325
Average Depth (m)	0.36	0.3	0.21
Average Width (m)	2.2	1.6	1.5
Average Thalweg Depth (cm)	53.5	49.2	40.3
Standard Deviation of Thalweg Depth (cm)	10.6	10.8	7.2
Volume (m^3)	39.6	24	15.8
Area (m^2)	110	80	75
Phi Value (substrate median size)	1.74	2.04	0.19
cobble (%)	2.5	2.5	0
Coarse gravel (%)	17.5	27.5	26
Fine gravel (%)	22.5	10	28
sand (%)	7.5	5	26
silt (%)	50	45	20
CPOM (%)	0	0	0
FPOM (%)	0	0	0
wood (%)	0	10	0

Several measurements were used to identify the comparability of the three sites for fish sampling:

- Standard deviation of thalweg profiles;
- Visual habitat ratings;
- Thalweg depth (or average depth); and
- Substrate.

The standard deviation of the thalweg profiles can be used to illustrate habitat complexity or habitat diversity. Larger substrate types and greater depths can also be used as measures of greater living area. Again, both the upstream site (GU2) and immediate downstream site (GD2) were similar, and GD4 was the most dissimilar.

At macroinvertebrate sampling points, all measurements for substrate, velocity, and canopy cover were within Bode's (1995) acceptable range of habitat similarity, as previously described. Substrates were dominated by sand and silt. Average depth at each sample point was also fairly uniform. All reaches were measured between 0.5 and 1 percent gradient.

4.0 Beneficial Uses of Garrison Creek

Garrison Creek is a Class A waterbody. A primary human use of the creek is irrigation water supply, with the total flow being appropriated for irrigation uses. Below the point where the College Place WWTP discharges into Garrison Creek, a portion of the discharge has historically been used for irrigation. The NPDES permit allows a discharge of up to 0.91 MGD, which can potentially be the total flow of Garrison Creek downstream of the outfall. Numerous storm drains discharge from College Place and Walla Walla into Garrison Creek, including the main municipal storm drain for College Place.

Observations of existing beneficial uses of Garrison Creek, including human, aquatic life, and wildlife uses, were made using water column, biological, and aquatic habitat surveys during the period of September 16-19, 1996. Anecdotal information on existing and potential uses for other seasons and in other reaches of Garrison Creek, as well as historic uses, was collected by using a survey questionnaire which was sent to individuals knowledgeable about the creek and water uses (Appendix E). This included farmers and other local residents, the Umatilla Indian Tribe, the Walla Walla Conservation District, the Washington Department of Fish and Wildlife, the City of College Place, and Ecology representatives from the Eastern Regional Office, who shared their observations and knowledge of creek uses. Of the 21 questionnaires sent, nine were returned by mail and two persons responded by phone. The survey results are summarized in Appendix E.

4.1 Human Water Uses

Primary contact recreation: We did not observe primary contact recreation uses in our study areas during any of our surveys. Most of the use survey respondents indicated that primary contact recreation is neither a current or historic use of lower Garrison Creek, while one respondent indicated that it is a seasonal use. Someone commented that although the area around the WWTP is seldom used now, there is some use for washing off, and wetting down. However, upstream around the City of College Place wading and swimming by children was noted by several respondents. Swimming and immersion in lower Garrison Creek is probably limited to land owners and associated residents and workers, due to access. Most respondents from local farmers indicate no or seldom use of the lower creek.

Conclusion: Occasional and potential seasonal use, which is not supported due to bacterial pollution.

Secondary contact recreation: During the September survey we observed a child wandering around the stream banks of lower Garrison Creek and he commented that he occasionally fished there. Of the survey responses, two persons have observed fishing in lower Garrison Creek and noted that children were observed along the stream corridor. Again, several responses stated that fishing was prevalent in the upper reaches of Garrison Creek. The responses were limited to current use, but probably historic uses were the same.

Uses in lower Garrison Creek, again, are limited because of access and alteration of the creek channel and riparian zone. The riparian zone has been removed and most of the creek and the creek channel have been severely channelized. Channelization decreases available habitat for instream animals (fishes, invertebrates, and amphibians), thus reducing the secondary contact activities (e.g. fishing).

Conclusion: Current seasonal use; and possibly a historic use. Lower Garrison Creek does not fully support secondary contact recreation based on observed fecal coliform bacteria levels, either upstream or downstream of the WWTP, however minimal uses occur. This use may be supported in the lowermost reach of Garrison Creek (i.e. at station GD4, at the mouth of the creek).

Aesthetic enjoyment: Wildlife uses noted during the survey included observation of several bird species and sign of use by beaver, deer and bear. Most respondents stated that Garrison Creek, including the lower one mile, is used by many people for its aesthetic beauty and the observation of wildlife (e.g. Audubon Society), both currently and historically. Garrison Creek is utilized by many wildlife species (explained in Wildlife uses) which are observed, hunted and fished. Removal of the riparian zone also removes all habitat for wildlife uses, decreasing the associated human uses.

Conclusion: Current and historic use. Again, the uses occur, but are limited by the current riparian and channel management.

Domestic water supply: We did not observe anyone drinking water directly from the creek. No surveys or conversations verified people using the water from lower Garrison Creek for household or personal consumption. One person responded that a potential use might have occurred before the advent of deeper wells, decades ago.

Conclusion: No current use known or supported; potential historical use.

Agricultural water supply: During our surveys, water was observed being removed from lower Garrison Creek at several diversions for use in crop watering. Discussion with several farmers revealed a concern for the use of the creek water below the WWTP outfall for watering of crops harvested for human consumption because of possible contamination from water borne pathogens, and recent decisions by crop buyers to not accept food crops irrigated with effluent. All respondents stated that this use was both a current and historical use since the 19th century. However, most uses occur seasonally from March – October.

Several respondents commented on the water quantity problems in the last ten years. Due to the need for domestic and agricultural uses, the creek may be de-watered above the WWTP in certain low precipitation years. Below the WWTP the creek has perennial flow. Because of the use of the WWTP effluent to irrigate food crops is of concern to growers and food buyers, the irrigation uses are not fully attained downstream of the WWTP discharge.

Conclusion: Current and historical use, mostly seasonal use for crop irrigation; not supported below the WWTP for food crop irrigation; inadequate flow may limit the use above the WWTP.

Stock watering: There was no observed stock watering from or in lower Garrison Creek. Some respondents stated a current and historical use by farmers to water stock both in upper and lower Garrison Creek. It is unknown how much or how it is affected by the WWTP effluent. Dewatering of the creek would cause stock uses to be unsupported.

Conclusion: Current and historical use; probably fully supported depending on stream flow.

4.2 Aquatic Life Uses

Salmonid migration, rearing, spawning, and harvesting: Our field survey did not collect any salmonids. The time of year and the measured water quality conditions would explain the lack of salmonid use during our survey. Several of the respondents stated they had observed steelhead and rainbow trout throughout the length of Garrison Creek, especially in the spring when conditions are more suitable for salmonids. Discussion with several biologists in the area as well as the WWTP operator, identified seasonal migratory uses for steelhead and probably rearing, as well as seasonal fishing for salmonids. Three local residents stated that steelhead and rainbows were observed "decades ago" in the creek spawning, migrating and rearing. Salmonid spawning has been observed upstream around College Place, but none in the lower reaches. This could be due to both instream conditions and lack of access for people to observe fish.

Observations by both local residents and biologists indicate a potential problem due to urban runoff from College Place into the creek. One person noted that several fish kills have occurred due to this pollution. The current uses are probably only partially supported depending on instream conditions in both upper and lower Garrison Creek.

Creek channelization, water diversions and riparian zone alteration throughout the Garrison Creek, especially in the lower sections has severely limited instream habitat and water quality conditions. Uses in the lower creek are probably seasonal due to lower spring temperatures and higher water flows to migrate around the many diversions. Two known diversions, immediately above the WWTP and the Travaille diversion downstream, either limit migration or block it depending on flows. At best, salmonid uses in lower Garrison Creek are partially supported for only salmonid migration. The population of salmonids that are reported in the area of Garrison Creek through College Place indicate that the creek could potentially support most salmonid uses throughout its length.

Conclusion: Current and historical seasonal uses, partially supported at the right stream flows, for migration, but not supporting for rearing and harvesting. Salmonid spawning was probably a historical use and its current use is unknown.

Other fish migration, rearing, spawning, and harvesting: The field surveys documented speckled dace, redside shiners, bridgelip suckers, and northern squawfish in lower Garrison Creek. Immediately above the WWTP, all non-salmonid uses were supported, however, immediately downstream of the WWTP, young-of-year fish were not observed probably due to water quality conditions associated with the WWTP discharge. This indicates that the rearing use is not supported, but would be if in-stream conditions were improved. Survey responses supported these observations for both current and historical uses. Since these fishes are not normally fished for, minimal harvest probably occurs as indicated by one survey response.

As with salmonid uses, the instream alterations and many diversions probably limit fish movements and population uses at specific times of the year in lower Garrison Creek.

Conclusion: Current uses partially supported; definite historical use. Rearing and potentially spawning not supported below WWTP discharge.

Shellfish uses: Our observations within lower Garrison Creek identified crayfish within all sections. No clams or mussels were collected within the creek. The lack of mollusks could be attributed to toxic instream conditions from WWTP effluent and cumulative affects from high sediments loads from upstream sources. Comments from surveys suggested that freshwater clams are present and crayfish are abundant in the upper reaches. Consumption was not documented, but the potential use exists. However, there were no documented or reported molluscs in the lower creek.

Conclusion: Current and historical use for some species, but not supported for clams and mussels in the lower creek.

Amphibian uses: The current field survey did not document instream amphibians, but one frog (possibly the spotted frog, *Ranus pretiosa*) was observed on the stream bank and use survey respondents identified amphibians and reptiles throughout the stream length both currently and historically. Presence of a species does not mean that all aspects of its life are supported. With the habitat alterations, the population levels are probably partially supported at best.

Conclusion: Current and historical use at least partially supported but probably limited by current management and habitat and water quality conditions. More information needed.

Aquatic invertebrates: The benthic invertebrate surveys in lower Garrison Creek identified an invertebrate community present above and below the WWTP. However, the WWTP effluent causes a definite community shift between a moderately pollution tolerant to a highly pollution tolerant community. The WWTP effluent and habitat alteration has rendered lower Garrison Creek as non-supportive for many species and those species are replaced by highly tolerant species. The respondents to our survey identified both current and historical uses throughout Garrison Creek.

Immediately above the WWTP, surveys measured the aquatic invertebrate community as also being highly altered by pollution and not supporting a clean water community.

Conclusion: Current use for many species not supported below WWTP, and only partially supported upstream of the WWTP; historical use.

Aquatic Plants: A large number of aquatic plants were observed in the creek. The amount of instream plants changed depending on the area of the creek where we were located. Most plants were seen in GD4, just upstream of the Walla Walla River. Respondents reported both native and non-native plants being present in the creek. However, the extreme channelization and constant eradication of plants within the channel by farmers were identified as factors not-supporting native plant uses in the lower creek.

Conclusion: Current and historical use; partially supporting native plants; more information needed.

Wildlife Uses: Wildlife uses were documented by both the field survey and questionnaire. Deer and bear feces were found in the riparian zone of lower Garrison Creek, as was beaver sign, and many bird species were observed. Respondents to the survey identified deer, mink, skunk, badgers, coyotes, weasels, bear, waterfowl, upland game birds and song birds utilizing the riparian zone of lower Garrison Creek.

The WWTP effluent undoubtedly helps supplement the riparian zone moisture in times of no-flow due to irrigation diversions. In the areas without riparian zones, the wildlife habitat is non-existent and the use was very limited. Several people commented that many more animals would be observed if the habitat corridor was left intact and the riparian zone was not being destroyed by current land use practices.

Conclusion: Current use where the riparian zone is still intact, however not a supported use where the zone has been removed; a historical use.

5.0 Conclusions

Our survey of the chemical, biological and physical characteristics of Garrison Creek identified several pollutant sources and land and creek management practices that are having negative effects on both the human and aquatic life uses. Pollutant sources that were identified from field surveys and a questionnaire survey of local residents and biologists included:

- College Place WWTP effluent;
- Urban runoff;
- Agricultural chemicals;
- Habitat alteration; and
- Flow diversions.

Toxic effects from both chorine and ammonia from the WWTP effluent were effecting both fish and invertebrate survival below the plant. The conditions from the upstream agricultural and urban uses were also negatively impacting instream conditions. Fecal coliform levels were elevated well above water quality standards, and chlorine levels were measured above water quality standards. The upstream source of chlorine is unknown.

In lower Garrison Creek, extreme habitat alterations due to channel dredging, channelization, flow diversion, and riparian zone clearing were documented. The instream habitat was severely degraded and habitat quality was rated as very low for use by salmonids and certain invertebrates.

The many irrigation diversion probably alter the migratory habitats of most fish or prohibit migration entirely depending on water levels and the amount of diverted water. The most notable and permanent diversion was the Travaille diversion below the WWTP. The 60 m, 0.5m diameter pipe, would probably stop all fish movement above certain water velocities.

A summary of the beneficial use survey is found in Appendix E. Several of the uses that we considered historical uses, were not found to be fully supported under current stream conditions. Of the human water uses, agricultural uses, at times can only be partially supported for certain target crops because of the WWTP's discharge. Some buyers will not purchase crops that have been irrigated with water containing effluent because of the possible pathogen contamination.

Both primary and secondary contact recreation were probably historical uses, at least seasonally, as evident in the amount of use upper Garrison Creek receives. Primary contact recreation presumably does not occur in lower Garrison Creek because of the amount and type of effluent within the creek (access problems due to private lands can also hinder use). However, it is possible that there is occasional use by farm workers or others to wash or cool off. Secondary contact is also sporadic in lower Garrison

Creek. Several respondents commented on not using that portion of the creek because of the effluent quality. As noted earlier, bacterial pollution from sources upstream of the WWTP leads to higher concentrations of pathogen indicators above the effluent discharge.

Aquatic life uses were documented as most seriously affected by the effluent and other pollutant sources within Garrison Creek. The effect due to the WWTP discharge negatively impacts both the fish and benthic invertebrate communities. Salmonid uses were not documented in the lower creek, even though both local residents and regional biologists have verified salmonid migration, rearing and attempted spawning in the upper reaches of Garrison Creek, as well as harvest. Instream conditions measured both above and below the WWTP showed conditions that were sub-optimal to salmonid life-history requirements. Conditions below the plant probably exceed temperature and toxicity levels needed for salmonid survival at certain times of the year. Urban run-off and habitat alterations were both identified by local residents and our surveys as not supporting high quality instream habitat for salmonid survival. Diversions within the creek potentially hinder fish movement or halt it completely at some times of the year.

Other fish species were present in good numbers throughout the creek at the time of our survey. However, rearing conditions within the lower section of Garrison Creek below the WWTP are not being supported. Migration is probably not supported when diversions are in place. Also, the Travaille diversion probably severely hinders all movement most times of the year.

Benthic invertebrate communities were only partially supported above the WWTP effluent and most species were not supported below the WWTP. Some species had recovered within the next mile to the Walla Walla, but most had not. Toxic effects due to chlorine and ammonia, habitat alteration, high temperatures and other pollutants all contribute to being non-supportive of the current uses.

6.0 Recommendations

The challenge of use-based analysis is the evaluation of all uses and the effective identification of which uses are supported and which are not. As with our study, the time of year is very important in documenting specific uses (e.g. steelhead migration). Most uses have a specified time of year when they occur and it is important to identify critical time periods that would be indicative of whether the targeted uses are being attained. Our time-frame of September was targeting temperature and low-flow conditions. However, 1996 was a year that had higher than normal flows and was in a wet cycle. The higher flows did not allow us to evaluate zero flow conditions that several respondents stated had occurred in almost all but the last two years. An example of a target parameter that is seasonally limiting, is ammonia. From unpublished monitoring results, ammonia levels are most severe during the winter months, yet we sampled in the early fall. All these pieces of information must be synthesized to adequately describe the designated uses.

Some uses seem to be contradictive to other uses. At certain times of the year, Garrison Creek's flow is fully allocated to irrigation, even though aquatic life is a designated use that must be fully supported. In order to support aquatic life and human uses, managers will need to be very creative, unless the current water laws are changed or adapted to the needs of the ecosystem. Through water conservation and best management practices it is possible to attain water quantity to partially support all uses within Garrison Creek.

Several recommendations have been drafted to allow all uses within lower Garrison Creek to be at least partially attained.

6.1 College Place Wastewater Treatment Plant

Several changes are needed to improve the effluent quality of the College Place WWTP so it does not degrade the instream biological communities and provide water to support instream communities during times of upstream dewatering due to irrigation.

1. Target the reduction of ammonia levels, especially during the critical months when the effluent is most or all of the creek flow. Currently, when the ammonia levels are extremely elevated, the winter and spring months, it can be very detrimental to the biological communities and levels should be kept as low as possible. Salmonids have been shown to be sensitive to total ammonia levels < 0.2 mg/l. Based on our samples and calculations for chronic criteria downstream of the mixing zone, levels should be < 2.0-2.5 mg/l for total ammonia and < 0.025 for unionized ammonia. However, these levels are maximum levels allowed by the water quality laws and target conditions should be much lower. Depending on the time of year, spikes of ammonia could be devastating to certain developmental stages of fish and invertebrates.

2. Target effluent temperatures to less than the incremental increase as defined in the water quality standards for point source discharges. Upstream ambient temperatures are already close to the upper lethal level of salmonids and any elevation in temperature could be lethal to fish during the summer and early fall.

3. Require de-chlorination of all effluent. Exposure to chlorine is extremely toxic to organisms and levels within the effluent must be kept under the water quality standards, and acute episodes should be avoided. The downstream invertebrate community and some sensitive fish life stages were missing below the WWTP, both are indicative of toxic pollution (e.g. ammonia and chlorine),

4. The point of discharge should be redesigned as discussed in a recent memo from Ed Rashin to the College Place WWTP (see Appendix F). As stated in the memo, the Travaille diversion could remain at its present plan view location, although the elevation of the intake may need to be adjusted. The steel pipe which returns creek flows to the open channel would be closed off permanently. The creek flow not diverted to the Travaille irrigation system but would be routed via a spillway back into the (presently abandoned) natural stream channel. The WWTP effluent would be discharged just downstream of the spillway, and would flow into the natural channel after mixing with the creek flows coming over the spillway. An elevation drop between the Travaille diversion and the natural channel would be maintained by the spillway structure and would keep the effluent from flowing back into the Travaille intake. This will probably require construction of a baffle separating the effluent/creek mixing area from the upstream creek flows. In addition, the old weir that presently exists at the location where the (presently abandoned) natural channel reconnects with the creek channel (near the current pipe discharge) would need to be altered to create a transition suitable for fish passage.

6.2 Agricultural Land-Use

1. Best management practices should be implemented to reestablish all riparian zones and to stabilize banks. Native vegetation should be allowed to reestablish to help decrease water temperatures, decrease streambank erosion, increase filtration of toxic substances, and increase water storage. Channel dredging and channelization should not be allowed, which would allow instream habitat to diversify and help support more diverse fish communities.

2. Stream diversions should be maintained to allow safe and efficient fish passage and all diversions should be screened so fish are not diverted. The location of the Travaille diversion was should be restored as described above to effectively move fish upstream.

3. Instream flow requirements for Garrison Creek should be set to not allow detrimental effects on the instream biological communities due to de-watering. Best management practices for efficient water use should also be set to allow all instream uses to be fully attained.

References

Bode, B., 1995. Biological impairment criteria for flowing waters in New York State. Water Quality Division, New York State Department. Environmental. Conservation. Albany, NY. 43 pp.

City of College Place Wastewater Treatment Plant (WWTP), 1996. Unpublished rainfall data and effluent monitoring data. College Place, WA.

Clark, W. H. and T. Maret, 1992. Protocols for Assessment of Biotic Integrity (macroinvertebrates) in Idaho Streams. Water Quality Monitoring Protocols No. 5, Idaho Department of Health and Welfare, Division of Environmental Quality. Boise, ID.

Coots, R., 1994. Black River Wet Season Non-point Source Total Maximum Daily Load Study. Neve, William. 1997. Personal communication. Washington State Department of Ecology. Olympia, WA.

Cusimano, B., 1994. Technical Guidance for Assessing the Quality of Aquatic Environments. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program. Olympia, WA.

Hayslip, G., 1993. Region 10 In-stream Biological Monitoring Handbook. EPA 910/9-92-013. US Environmental Protecction Agency. Seattle, WA.

Heffner, M., 1988. College Place STP Class II Inspection. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program. Olympia, WA.

Hilsenhoff, W. L., 1987. An Improved Biotic Index of Stream Organic Pollution. Great Lakes Entomologist. 20:31-39.

Hynes, H.B.N., 1963. The Biology of Polluted Waters. Liverpool University Press. Liverpool, England.

McGill, R., J.W. Tukey, and W. A. Larsen. 1978. Variations of box plots. The American Statistician, 32 (1): 12-16.

McNeely, R.N., Neimanis, V.P., and Dwyer, L., 1979. Water Quality Sourcebook. Inland Waters Directorate, Water Quality Branch. Ottawa, Canada.

NAS, 1973. National Academy of Sciences and National Academy of Engineering. Water Quality Criteria, 1972. US EPA Report R3-73-033, US EPA, Washington D.C.

Neve, William., 1997. Personal communication. Washington State Department of Ecology, Eastern Regional Office. Spokane WA.

Norris, L.A. and F. Dost. 1992. Proposed surface water Quality Criteria for Select Pesticides Used for Forest Management and Management of Forest Tree Seedling Nurseries and Christmas Tree Plantations in Oregon and Washington. Oregon State University. Corvallis, OR.

NPDES, 1990. College Place, WA: National Pollutant Discharge Elimination System Waste Discharge Permit. WA-002065-6. Washington State Department of Ecology. Olympia, WA.

Radar, Al, 1996. Personal communication. City of College Place. College Place, WA.

Plotnikoff, R. W. and J. S. White, 1996. Taxonomic Laboratory Protocol for Stream Macroinvertebrates Collected by the Washington State Department of Ecology. Washington Department of Ecology. Olympia, WA.

Scott, W. B., and E. J. Crossman, 1973. Freshwater Fishes of Canada. Bulletin 184. Fisheries Research Board of Canada. Ottawa, CA.

US EPA, 1991. Water Quality Criteria Summary. Health and Ecological Effects Division, Office of Science and Technology, Office of Water, US EPA. Washington D.C.

US EPA, 1993a. Integrated Risk Information System (IRIS) Database. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment. Cincinnati, OH.

US EPA, 1993b. Toxic Substance Spreadsheet (12/92). Water Management Division. US EPA Region IV. Atlanta, GA.

Wisseman, R.W. 1995, Benthic Invertebrate Biomonitoring and Bioassessment in Western Montana Streams. Aquatic Biology Associates, Inc. Corvallis, OR.

Wydoski, R. S., and R. R. Whitney, 1979. Inland Fishes of Washington. University of Washington Press. Seattle, WA.

APPENDICES

Appendix A.

Chapter 173-201A WAC

Class A (Excellent) Freshwater Quality Standards and Characteristic Uses

Chapter 173-201A WAC
WATER QUALITY STANDARDS FOR SURFACE WATERS OF THE STATE OF WASHINGTON

WAC 173-201A-010 Introduction. (1) The purpose of this chapter is to establish water quality standards for surface waters of the state of Washington consistent with public health and public enjoyment thereof, and the propagation and protection of fish, shellfish, and wildlife, pursuant to the provisions of chapter 90.48 RCW and the policies and purposes thereof.

(2) This chapter shall be reviewed periodically by the department and appropriate revisions shall be undertaken.

(3) The water use and quality criteria set forth in WAC 173-201A-030 through 173-201A-140 are established in conformance with present and potential water uses of the surface waters of the state of Washington and in consideration of the natural water quality potential and limitations of the same. Compliance with the surface water quality standards of the state of Washington require compliance with chapter 173-201A WAC, Water quality standards for surface waters of the state of Washington, and chapter 173-204 WAC, Sediment management standards.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-010, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-020 Definitions. The following definitions are intended to facilitate the use of chapter 173-201A WAC:

"Acute conditions" are changes in the physical, chemical, or biologic environment which are expected or demonstrated to result in injury or death to an organism as a result of short-term exposure to the substance or detrimental environmental condition.

"AKART" is an acronym for "all known, available, and reasonable methods of prevention, control, and treatment." AKART shall represent the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants associated with a discharge. The concept of AKART applies to both point and nonpoint sources of pollution. The term "best management practices," typically applied to nonpoint source pollution controls is considered a subset of the AKART requirement. "The Stormwater Management Manual for the Puget Sound Basin" (1992), may be used as a guideline, to the extent appropriate, for developing best management practices to apply AKART for storm water discharges.

"Background conditions" means the biological, chemical, and physical conditions of a water body, outside the area of influence of the discharge under consideration. Background sampling locations in an enforcement action would be up-gradient or outside the area of influence of the discharge. If several discharges to any water body exist, and enforcement action is being taken for possible violations to the standards, background sampling would be undertaken immediately up-gradient from each discharge. When assessing background conditions in the headwaters of a disturbed watershed it may be necessary to use the background conditions of a neighboring or similar watershed as the reference conditions.

"Best management practices (BMP)" means physical, structural, and/or managerial practices approved by the department that, when used singularly or in combination, prevent or reduce pollutant discharges.

"Biological assessment" is an evaluation of the biological condition of a water body using surveys of aquatic community structure and function and other direct measurements of resident biota in surface waters.

"Carcinogen" means any substance or agent that produces or tends to produce cancer in humans. For implementation of this chapter, the term carcinogen will apply to substances on the United States Environmental Protection Agency lists of A (known human) and B (probable human) carcinogens, and any substance which causes a significant increased incidence of benign or malignant tumors in a single, well conducted animal bioassay, consistent with the weight of evidence approach specified in the United States Environmental Protection Agency's Guidelines for Carcinogenic Risk Assessment as set forth in 51 FR 33992 et seq. as presently published or as subsequently amended or republished.

"Chronic conditions" are changes in the physical, chemical, or biologic environment which are expected or demonstrated to result in injury or death to an organism as a result of repeated or constant exposure over an extended period of time to a substance or detrimental environmental condition.

"Critical condition" is when the physical, chemical, and biological characteristics of the receiving water environment interact with the effluent to produce the greatest potential adverse impact on aquatic biota and existing or characteristic water uses. For steady-state discharges to riverine systems the critical condition may be assumed to be equal to the 7Q10 flow event unless determined otherwise by the department.

"Damage to the ecosystem" means any demonstrated or predicted stress to aquatic or terrestrial organisms or communities of organisms which the department reasonably concludes may interfere in the health or survival success or natural structure of such populations. This stress may be due to, but is not limited to, alteration in habitat or changes in water temperature, chemistry, or turbidity, and shall consider the potential build up of discharge constituents or temporal increases in habitat alteration which may create such stress in the long term.

"Department" means the state of Washington department of ecology.

"Director" means the director of the state of Washington department of ecology.

"Fecal coliform" means that portion of the coliform group which is present in the intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within twenty-four hours at 44.5 plus or minus 0.2 degrees Celsius.

"Geometric mean" means either the nth root of a product of n factors, or the antilogarithm of the arithmetic mean of the logarithms of the individual sample values.

"Hardness" means a measure of the calcium and magnesium salts present in water. For purposes of this chapter, hardness is measured in milligrams per liter and expressed as calcium carbonate ($CaCO_3$).

"Mean detention time" means the time obtained by dividing a reservoir's mean annual minimum total storage by the thirty-day ten-year low-flow from the reservoir.

"Migration or translocation" means any natural movement of an organism or community of organisms from one locality to another locality.

"Mixing zone" means that portion of a water body adjacent to an effluent outfall where mixing results in the dilution of the effluent with the receiving water. Water quality criteria may be exceeded in a mixing zone as conditioned and provided for in WAC 173-201A-100.

"Natural conditions" or "natural background levels" means surface water quality that was present before any human-caused pollution.

"Nonpoint source" means pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System program.

"Permit" means a document issued pursuant to RCW 90.48.160 et seq. or RCW 90.48.260 or both, specifying the waste treatment and control requirements and waste discharge conditions.

"pH" means the negative logarithm of the hydrogen ion concentration.

"Pollution" means such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

"Primary contact recreation" means activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

"Secondary contact recreation" means activities where a person's water contact would be limited (wading or fishing) to the extent that bacterial infections of eyes, ears, respiratory or digestive systems, or urogenital areas would normally be avoided.

"Storm water" means that portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

"Surface waters of the state" includes lakes, rivers, ponds, streams, inland waters, saltwaters, and all other surface waters and water courses within the jurisdiction of the state of Washington.

"Temperature" means water temperature expressed in degrees Celsius (°C).

"Turbidity" means the clarity of water expressed as nephelometric turbidity units (NTU) and measured with a calibrated turbidimeter.

"Upwelling" means the natural process along Washington's Pacific Coast where the summer prevailing northerly winds produce a seaward transport of surface water. Cold, deeper more saline waters rich in nutrients and low in dissolved oxygen, rise to replace the surface water. The cold oxygen deficient water enters Puget Sound and other coastal estuaries at depth where it displaces the existing deep water and eventually rises to replace the surface water. Such surface water replacement results in an overall increase in salinity and nutrients accompanied by a depression in dissolved oxygen. Localized upwelling of the deeper water of Puget Sound can occur year-round under influence of tidal currents, winds, and geomorphic features.

"USEPA" means the United States Environmental Protection Agency.

"Wildlife habitat" means waters of the state used by, or that directly or indirectly provide food support to, fish, other aquatic life, and wildlife for any life history stage or activity.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-020, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-030 General water use and criteria classes. The following criteria shall apply to the various classes of surface waters in the state of Washington:

(1) **Class AA (extraordinary).**

(a) General characteristic. Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam, oyster, and mussel rearing, spawning, and harvesting.

Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organisms:

(A) Freshwater - fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

(B) Marine water - fecal coliform organism levels shall both not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

(ii) Dissolved oxygen:

(A) Freshwater - dissolved oxygen shall exceed 9.5 mg/L.

(B) Marine water - dissolved oxygen shall exceed 7.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 7.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 16.0°C (freshwater) or 13.0°C (marine water) due to human activities. When natural conditions exceed 16.0°C (freshwater) and 13.0°C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed $t=23/(T+5)$ (freshwater) or $t=8/(T-4)$ (marine water). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8°C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a human-caused variation within a range of less than 0.2 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(2) **Class A (excellent).**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam, oyster, and mussel rearing, spawning, and harvesting.

Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organisms:

(A) Freshwater - fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

(B) Marine water - fecal coliform organism levels shall both not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

(ii) Dissolved oxygen:

(A) Freshwater - dissolved oxygen shall exceed 8.0 mg/L.

(B) Marine water - dissolved oxygen shall exceed 6.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 6.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 18.0°C (freshwater) or 16.0°C (marine water) due to human activities. When natural conditions exceed 18.0°C (freshwater) and 16.0°C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed $t=28/(T+7)$ (freshwater) or $t=12/(T-2)$ (marine water). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8°C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a human-caused variation within a range of less than 0.5 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(3) **Class B (good).**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for most uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (industrial and agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam, oyster, and mussel rearing and spawning.

Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (secondary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organisms:

(A) Freshwater - fecal coliform organism levels shall both not exceed a geometric mean value of 200 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.

(B) Marine water - fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 Ml.

(ii) Dissolved oxygen:

(A) Freshwater - dissolved oxygen shall exceed 6.5 mg/L.

(B) Marine water - dissolved oxygen shall exceed 5.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 5.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 21.0°C (freshwater) or 19.0°C (marine water) due to human activities. When natural conditions exceed 21.0°C (freshwater) and 19.0°C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=34/(T+9) (freshwater) or t=16/(T) (marine water). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8°C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) and 7.0 to 8.5 (marine water) with a human-caused variation within a range of less than 0.5 units.

(vi) Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.

(4) **Class C (fair).**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements of selected and essential uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (industrial).

(ii) Fish (salmonid and other fish migration).

(iii) Recreation (secondary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(iv) Commerce and navigation.

(c) Water quality criteria - marine water:

(i) Fecal coliform organism levels shall both not exceed a geometric mean value of 200 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.

(ii) Dissolved oxygen shall exceed 4.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 4.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Temperature shall not exceed 22.0°C due to human activities. When natural conditions exceed 22.0°C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C.

Incremental temperature increases shall not, at any time, exceed t=20/(T+2).

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(iv) pH shall be within the range of 6.5 to 9.0 with a human-caused variation within a range of less than 0.5 units.

(v) Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vi) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(vii) Aesthetic values shall not be interfered with by the presence of obnoxious wastes, slimes, aquatic growths, or materials which will taint the flesh of edible species.

(5) **Lake class.**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam and mussel rearing, spawning, and harvesting.

Crayfish rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

(ii) Dissolved oxygen - no measurable decrease from natural conditions.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - no measurable change from natural conditions.

(v) pH - no measurable change from natural conditions.

(vi) Turbidity shall not exceed 5 NTU over background conditions.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-030, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-040 Toxic substances. (1) Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department.

(2) The department shall employ or require chemical testing, acute and chronic toxicity testing, and biological assessments, as appropriate, to evaluate compliance with subsection (1) of this section and to ensure that aquatic communities and the existing and characteristic beneficial uses of waters are being fully protected.

(3) The following criteria shall be applied to all surface waters of the state of Washington for the protection of aquatic life. The department may revise the following criteria on a state-wide or waterbody-specific basis as needed to protect aquatic life occurring in waters of the state and to increase the technical accuracy of the criteria being applied. The department shall formally adopt any appropriate revised criteria as part of this chapter in accordance with the provisions established in chapter 34.05 RCW, the Administrative Procedure Act. The department shall ensure there are early opportunities for public review and comment on proposals to develop revised criteria. Values are µg/L for all substances except Ammonia and Chloride which are mg/L:

	Freshwater		Marine Water	
Substance	Acute	Chronic	Acute	Chronic
Aldrin/Dieldrin	2.5a	0.0019b	0.71a	0.0019b
Ammonia (un-ionized NH3) hh	f,c	g,d	0.233h,c	0.035h,d
Arsenic ff	360.0c	190.0d	69.0c	36.0d,cc
Cadmium dd	i,c	j,d	37.2c	8.0d
Chlordane	2.4a	0.0043b	0.09a	0.004b
Chloride (Dissolved) k	860.0h,c	230.0h,d	-	-
Chlorine (Total Residual)	19.0c	11.0d	13.0c	7.5d
Chloropyrifos	0.083c	0.041d	0.011c	0.0056d
Chromium (Hex)	16.0c1	11.0d	1,100.0c,1	50.0d
Chromium (Tri) gg	m,c	n,d	-	-
Copper dd	o,c	p,d	2.5c	-
Cyanide ee	22.0c	5.2d	1.0c	-
DDT (and metabolites)	1.1a	0.001b	0.13a	0.001b
Dieldrin/Aldrin e	2.5a	0.0019b	0.71a	0.0019b
Endosulfan	0.22a	0.056b	0.034a	0.0087b
Endrin	0.18a	0.0023b	0.037a	0.0023b
Heptachlor	0.52a	0.0038b	0.053a	0.0036b
Hexachlorocyclohexane (Lindane)	2.0a	0.08b	0.16a	-
Lead dd	q,c	r,d	151.1c	5.8d
Mercury s, ff	2.4c	0.012d	2.1c	0.025d
Nickel dd	t,c	u,d	71.3c	7.9d
Parathion	0.065c	0.013d	-	-
Pentachlorophenol (PCP)	w,c	v,d	13.0c	7.9d
Polychlorinated Biphenyls (PCBs)	2.0b	0.014b	10.0b	0.030b
Selenium ff	20.0c	5.0d	300.0c	71.0d,x
Silver dd	y,a	-	1.2a	-
Toxaphene	0.73c,z	0.0002d	0.21c,z	0.0002d
Zinc dd	aa,c	bb,d	84.6c	76.6d

Notes to Table:

a. An instantaneous concentration not to be exceeded at any time.

b. A 24-hour average not to be exceeded.

c. A 1-hour average concentration not to be exceeded more than once every three years on the average.

d. A 4-day average concentration not to be exceeded more than once every three years on the average.

e. Aldrin is metabolically converted to Dieldrin. Therefore, the sum of the Aldrin and Dieldrin concentrations are compared with the Dieldrin criteria.

f. Shall not exceed the numerical value given by: $\frac{0.52}{(FT)(FPH)(2)}$

where:

$FT = 10^{[0.03(20-TCAP)]}$; $TCAP \leq T \leq 30$

$FT = 10^{[0.03(20-T)]}$; $0 \leq T \leq TCAP$

$FPH = 1$; $8 \leq pH \leq 9$

$FPH = \frac{1+10^{(7.4-pH)}}{1.25}$; $6.5 \leq pH \leq 8.0$

TCAP = 20°C; Salmonids present.

TCAP = 25°C; Salmonids absent.

g. Shall not exceed the numerical value given by: $\frac{0.80}{(FT)(FPH)(RATIO)}$

where:

$RATIO = 16$; $7.7 \leq pH \leq 9$

$RATIO = \frac{24 \times 10^{(7.7-pH)}}{1+10^{(7.4-pH)}}$; $6.5 \leq pH \leq 7.7$

where: FT and FPH are as shown in (f) above except:

TCAP = 15°C; Salmonids present.

TCAP = 20°C; Salmonids absent.

h. Measured in milligrams per liter rather than micrograms per liter.

i. $\leq (0.865)(e^{(1.128[\ln(hardness)]-3.828)})$

j. $\leq (0.865)(e^{(0.7852[\ln(hardness)]-3.490)})$

k. Criterion based on dissolved chloride in association with sodium. This criterion probably will not be adequately protective when the chloride is associated with potassium, calcium, or magnesium, rather than sodium.

l. Salinity dependent effects. At low salinity the 1-hour average may not be sufficiently protective.

m. $\leq e^{(0.8190[\ln(hardness)] +3.688)}$

n. $\leq e^{(0.8190[\ln(hardness)] +1.561)}$

o. $\leq (0.862)(e^{(0.9422[\ln(hardness)] -1.464)})$

p. $\leq (0.862)(e^{(0.8545[\ln(hardness)] -1.465)})$

q. $\leq (0.687)(e^{(1.273[\ln(hardness)] -1.460)})$

r. $\leq (0.687)(e^{(1.273[\ln(hardness)] -4.705)})$

s. If the four-day average chronic concentration is exceeded more than once in a three-year period, the edible portion of the consumed species should be analyzed. Said edible tissue concentrations shall not be allowed to exceed 1.0 mg/kg of methylmercury.

t. $\leq (0.95)(e^{(0.8460[\ln(hardness)] +3.3612)})$

u. $\leq (0.95)(e^{(0.8460[\ln(hardness)] +1.1645)})$

v. $\leq e^{[1.005(pH) -5.290]}$

w. $\leq e^{[1.005(pH) -4.830]}$

x. The status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 ug/l in salt water.

y. $\leq (0.531)(e^{(1.72[\ln(hardness)] -6.52)})$

z. Channel Catfish may be more acutely sensitive.

aa. $\leq (0.891)(e^{(0.8473[\ln(hardness)] +0.8604)})$

bb. $\leq (0.891)(e^{(0.8473[\ln(hardness)] +0.7614)})$

cc. Nonlethal effects (growth, C-14 uptake, and chlorophyll production) to diatoms *(Thalassiosira aestivalis* and *Skeletonema costatum)* which are common to Washington's waters have been noted at levels below the established criteria. The importance of these effects to the diatom populations and the aquatic system is sufficiently in question to persuade the state to adopt the USEPA National Criteria value (36 µg/L) as the state threshold criteria, however, wherever practical the ambient concentrations should not be allowed to exceed a chronic marine concentration of 21 µg/L.

dd. These ambient criteria are based on the dissolved fraction (for cyanide criteria using the weak and dissociable method) of the metal. The department shall apply the criteria as total recoverable values to calculate effluent limits unless data is made available to the department clearly demonstrating the seasonal partitioning of the dissolved metal in the ambient water in relation to an effluent discharge. Metals criteria may be adjusted on a site-specific basis when data is made available to the department clearly demonstrating the effective use of the water effects ratio approach established by USEPA, as generally guided by the procedures in USEPA *Water Quality Standards Handbook*, December 1983, as supplemented or replaced. Information which is used to develop effluent limits based on applying metals partitioning studies or the water effects ratio approach shall be identified in the permit fact sheet developed pursuant to WAC 173-220-060 or 173-226-110, as appropriate, and shall be made available for the public comment period required pursuant to WAC 173-220-050 or 173-226-130(3), as appropriate.

ee. The criteria for cyanide is based on the weak and dissociable method in the 17th Ed. *Standard Methods for the Examination of Water and Wastewater*, 4500-CN I, and as revised (see footnote dd, above).

ff. These criteria are based on the total-recoverable fraction of the metal.

gg. Where methods to measure trivalent chromium are unavailable, these criteria are to be represented by total-recoverable chromium.

hh. Tables for the conversion of total ammonia to un-ionized ammonia for freshwater can be found in the USEPA's *Quality Criteria for Water*, 1986. Criteria concentrations based on total ammonia for marine water can be found in USEPA *Ambient Water Quality Criteria for Ammonia (Saltwater)-1989*, EPA440/5-88-004, April 1989.

(4) *USEPA Quality Criteria for Water, 1986* shall be used in the use and interpretation of the values listed in subsection (1) of this section.

(5) Concentrations of toxic, and other substances with toxic propensities not listed in subsection (1) of this section shall be determined in consideration of *USEPA Quality Criteria for Water, 1986,* and as revised, and other relevant information as appropriate.

(6) Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in one million.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-040, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-050 Radioactive substances. (1) Deleterious concentrations of radioactive materials for all classes shall be as determined by the lowest practicable concentration attainable and in no case shall exceed:

(a) 1/100 of the values listed in WAC 246-221-290 (Column 2, Table II, Appendix A, rules and regulations for radiation protection); or

(b) USEPA Drinking Water Regulations for radionuclides, as published in the Federal Register of July 9, 1976, or subsequent revisions thereto.

(2) Nothing in this chapter shall be interpreted to be applicable to those aspects of governmental regulation of radioactive waters which have been preempted from state regulation by the Atomic Energy Act of 1954, as amended, as interpreted by the United States Supreme Court in the cases of *Northern States Power Co. v. Minnesota 405 U.S. 1035 (1972) and Train v. Colorado Public Interest Research Group, 426 U.S. 1 (1976).*

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-050, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-060 General considerations. The following general guidelines shall apply to the water quality criteria and classifications set forth in WAC 173-201A-030 through 173-201A-140 hereof:

(1) At the boundary between waters of different classifications, the water quality criteria for the higher classification shall prevail.

(2) In brackish waters of estuaries, where the fresh and marine water quality criteria differ within the same classification, the criteria shall be interpolated on the basis of salinity; except that the marine water quality criteria shall apply for dissolved oxygen when the salinity is one part per thousand or greater and for fecal coliform organisms when the salinity is ten parts per thousand or greater.

(3) In determining compliance with the fecal coliform criteria in WAC 173-201A-030, averaging of data collected beyond a thirty-day period, or beyond a specific discharge event under investigation, shall not be permitted when such averaging would skew the data set so as to mask noncompliance periods.

(4) The water quality criteria herein established for total dissolved gas shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood.

(5) Waste discharge permits, whether issued pursuant to the National Pollutant Discharge Elimination System or otherwise, shall be conditioned so the discharges authorized will meet the water quality standards.

(a) However, persons discharging wastes in compliance with the terms and conditions of permits shall not be subject to civil and criminal penalties on the basis that the discharge violates water quality standards.

(b) Permits shall be subject to modification by the department whenever it appears to the department the discharge violates water quality standards. Modification of permits, as provided herein, shall be subject to review in the same manner as originally issued permits.

(6) No waste discharge permit shall be issued which results in a violation of established water quality criteria, except as provided for under WAC 173-201A-100 or 173-201A-110.

(7) Due consideration will be given to the precision and accuracy of the sampling and analytical methods used as well as existing conditions at the time, in the application of the criteria.

(8) The analytical testing methods for these criteria shall be in accordance with the *"Guidelines Establishing Test Procedures for the Analysis of Pollutants" (40 C.F.R. Part 136)* and other or superseding methods published and/or approved by the department following consultation with adjacent states and concurrence of the USEPA.

(9) Nothing in this chapter shall be interpreted to prohibit the establishment of effluent limitations for the control of the thermal component of any discharge in accordance with Section 316 of the federal Clean Water Act (33 U.S.C. 1251 et seq.).

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-060, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-070 Antidegradation. The antidegradation policy of the state of Washington, as generally guided by chapter 90.48 RCW, Water Pollution Control Act, and chapter 90.54 RCW, Water Resources Act of 1971, is stated as follows:

(1) Existing beneficial uses shall be maintained and protected and no further degradation which would interfere with or become injurious to existing beneficial uses shall be allowed.

(2) Whenever the natural conditions of said waters are of a lower quality than the criteria assigned, the natural conditions shall constitute the water quality criteria.

(3) Water quality shall be maintained and protected in waters designated as outstanding resource waters in WAC 173-201A-080.

(4) Whenever waters are of a higher quality than the criteria assigned for said waters, the existing water quality shall be protected and pollution of said waters which will reduce the existing quality shall not be allowed, except in those instances where:

(a) It is clear, after satisfactory public participation and intergovernmental coordination, that overriding considerations of the public interest will be served;

(b) All wastes and other materials and substances discharged into said waters shall be provided with all known, available, and reasonable methods of prevention, control, and treatment by new and existing point sources before discharge. All activities which result in the pollution of waters from nonpoint sources shall be provided with all known, available, and reasonable best management practices; and

(c) When the lowering of water quality in high quality waters is authorized, the lower water quality shall still be of high enough quality to fully support all existing beneficial uses.

(5) Short-term modification of water quality may be permitted as conditioned by WAC 173-201A-110.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-070, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-080 Outstanding resource waters. Waters meeting one or more of the following criteria shall be considered for outstanding resource water designation. Designations shall be adopted in accordance with the provisions of chapter 34.05 RCW, Administrative Procedure Act.

(1) Waters in national parks, national monuments, national preserves, national wildlife refuges, national wilderness areas, federal wild and scenic rivers, national seashores, national marine sanctuaries, national recreation

areas, national scenic areas, and national estuarine research reserves;

(2) Waters in state parks, state natural areas, state wildlife management areas, and state scenic rivers;

(3) Documented aquatic habitat of priority species as determined by the department of wildlife;

(4) Documented critical habitat for populations of threatened or endangered species of native anadromous fish;

(5) Waters of exceptional recreational or ecological significance.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-080, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-100 Mixing zones. (1) The allowable size and location of a mixing zone and the associated effluent limits shall be established in discharge permits, general permits, or orders, as appropriate.

(2) A discharger shall be required to fully apply AKART prior to being authorized a mixing zone.

(3) Mixing zone determinations shall consider critical discharge conditions.

(4) No mixing zone shall be granted unless the supporting information clearly indicates the mixing zone would not have a reasonable potential to cause a loss of sensitive or important habitat, substantially interfere with the existing or characteristic uses of the water body, result in damage to the ecosystem, or adversely affect public health as determined by the department.

(5) Water quality criteria shall not be violated outside of the boundary of a mixing zone as a result of the discharge for which the mixing zone was authorized.

(6) The size of a mixing zone and the concentrations of pollutants present shall be minimized.

(7) The maximum size of a mixing zone shall comply with the following:

(a) In rivers and streams, mixing zones, singularly or in combination with other mixing zones, shall comply with the most restrictive combination of the following (this size limitation may be applied to estuaries having flow characteristics that resemble rivers):

(i) Not extend in a downstream direction for a distance from the discharge port(s) greater than three hundred feet plus the depth of water over the discharge port(s), or extend upstream for a distance of over one hundred feet;

(ii) Not utilize greater than twenty-five percent of the flow; and

(iii) Not occupy greater than twenty-five percent of the width of the water body.

(b) In estuaries, mixing zones, singularly or in combination with other mixing zones, shall:

(i) Not extend in any horizontal direction from the discharge port(s) for a distance greater than two hundred feet plus the depth of water over the discharge port(s) as measured during mean lower low water; and

(ii) Not occupy greater than twenty-five percent of the width of the water body as measured during mean lower low water. For the purpose of this section, areas to the east of a line from Green Point (Fidalgo Island) to Lawrence Point (Orcas Island) are considered estuarine, as are all of the Strait of Georgia and the San Juan Islands north of Orcas Island. To the east of Deception Pass, and to the south and east of Admiralty Head, and south of Point Wilson on the Quimper Peninsula, is Puget Sound proper, which is considered to be entirely estuarine. All waters existing within bays from Point Wilson westward to Cape Flattery and south to the North Jetty of the Columbia River shall also be categorized as estuarine.

(c) In oceanic waters, mixing zones, singularly or in combination with other mixing zones, shall not extend in any horizontal direction from the discharge port(s) for a distance greater than three hundred feet plus the depth of water over the discharge port(s) as measured during mean lower low water. For the purpose of this section, all marine waters not classified as estuarine in (b)(ii) of this subsection shall be categorized as oceanic.

(d) In lakes, and in reservoirs having a mean detention time greater than fifteen days, mixing zones shall not be allowed unless it can be demonstrated to the satisfaction of the department that:

(i) Other siting, technological, and managerial options that would avoid the need for a lake mixing zone are not reasonably achievable;

(ii) Overriding considerations of the public interest will be served; and

(iii) All technological and managerial methods available for pollution reduction and removal that are economically achievable would be implemented prior to discharge. Such methods may include, but not be limited to, advanced waste treatment techniques.

(e) In lakes, and in reservoirs having a mean detention time greater than fifteen days, mixing zones, singularly or in combination with other mixing zones, shall comply with the most restrictive combination of the following:

(i) Not exceed ten percent of the water body volume;

(ii) Not exceed ten percent of the water body surface area (maximum radial extent of the plume regardless of whether it reaches the surface); and

(iii) Not extend beyond fifteen percent of the width of the water body.

(8) Acute criteria are based on numeric criteria and toxicity tests approved by the department, as generally guided under WAC 173-201A-040 (1) through (5), and shall be met as near to the point of discharge as practicably attainable. Compliance shall be determined by monitoring data or calibrated models approved by the department utilizing representative dilution ratios. A zone where acute criteria may be exceeded is allowed only if it can be demonstrated to the department's satisfaction the concentration of, and duration and frequency of exposure to the discharge, will not create a barrier to the migration or translocation of indigenous organisms to a degree that has the potential to cause damage to the ecosystem. A zone of acute criteria exceedance shall singularly or in combination with other such zones comply with the following maximum size requirements:

(a) In rivers and streams, a zone where acute criteria may be exceeded shall comply with the most restrictive combination of the following (this size limitation may also be applied to estuaries having flow characteristics resembling rivers):

(i) Not extend beyond ten percent of the distance towards the upstream and downstream boundaries of an authorized mixing zone, as measured independently from the discharge port(s);

(ii) Not utilize greater than two and one-half percent of the flow; and

(iii) Not occupy greater than twenty-five percent of the width of the water body.

(b) In oceanic and estuarine waters a zone where acute criteria may be exceeded shall not extend beyond ten percent of the distance established in subsection (7)(b) of this section as measured independently from the discharge port(s).

(9) Overlap of mixing zones.

(a) Where allowing the overlap of mixing zones would result in a combined area of water quality criteria nonattainment which does not exceed the numeric size limits established under subsection (7) of this section, the overlap may be permitted if:

(i) The separate and combined effects of the discharges can be reasonably determined; and

(ii) The combined effects would not create a barrier to the migration or translocation of indigenous organisms to a degree that has the potential to cause damage to the ecosystem.

(b) Where allowing the overlap of mixing zones would result in exceedance of the numeric size limits established under subsection (7) of this section, the overlap may be allowed only where:

(i) The overlap qualifies for exemption under subsections (12) and (13) of this section; and

(ii) The overlap meets the requirements established in (a) of this subsection.

(10) Storm water:

(a) Storm water discharge from any "point source" containing "process wastewater" as defined in 40 C.F.R. Part 122.2 shall fully conform to the numeric size criteria in subsections (7) and (8) of this section and the overlap criteria in subsection (9) of this section.

(b) Storm water discharges not described by (a) of this subsection may be granted an exemption to the numeric size criteria in subsections (7) and (8) of this section and the overlap criteria in subsection (9) of this section, provided the discharger clearly demonstrates to the department's satisfaction that:

(i) All appropriate best management practices established for storm water pollutant control have been applied to the discharge.

(ii) The proposed mixing zone shall not have a reasonable potential to result in a loss of sensitive or important habitat, substantially interfere with the existing or characteristic uses of the water body, result in damage to the ecosystem, or adversely affect public health as determined by the department; and

(iii) The proposed mixing zone shall not create a barrier to the migration or translocation of indigenous organisms to a degree that has the potential to cause damage to the ecosystem.

(c) All mixing zones for storm water discharges shall be based on a volume of runoff corresponding to a design storm approved by the department. Exceedances from the numeric size criteria in subsections (7) and (8) of this section and the overlap criteria in subsection (9) of this section due to precipitation events greater than the approved design storm may be allowed by the department, if it would not result in adverse impact to existing or characteristic uses of the water body or result in damage to the ecosystem, or adversely affect public health as determined by the department.

(11) Combined sewer overflows complying with the requirements of chapter 173-245 WAC, may be allowed an average once per year exemption to the numeric size criteria in subsections (7) and (8) of this section and the overlap criteria in subsection (9) of this section, provided the discharge complies with subsection (4) of this section.

(12) Exceedances from the numeric size criteria in subsections (7) and (8) of this section and the overlap criteria in subsection (9) of this section may be considered by the department in the following cases:

(a) For discharges existing prior to November 24, 1992, (or for proposed discharges with engineering plans formally approved by the department prior to November 24, 1992);

(b) Where altering the size configuration is expected to result in greater protection to existing and characteristic uses;

(c) Where the volume of water in the effluent is providing a greater benefit to the existing or characteristic uses of the water body due to flow augmentation than the benefit of removing the discharge, if such removal is the remaining feasible option; or

(d) Where the exceedance is clearly necessary to accommodate important economic or social development in the area in which the waters are located.

(13) Before an exceedance from the numeric size criteria in subsections (7) and (8) of this section and the overlap criteria in subsection (9) of this section may be allowed under subsection (12) of this section, it must clearly be demonstrated to the department's satisfaction that:

(a) AKART appropriate to the discharge is being fully applied;

(b) All siting, technological, and managerial options which would result in full or significantly closer compliance that are economically achievable are being utilized; and

(c) The proposed mixing zone complies with subsection (4) of this section.

(14) Any exemptions granted to the size criteria under subsection (12) of this section shall be reexamined during each permit renewal period for changes in compliance capability. Any significant increase in capability to comply shall be reflected in the renewed discharge permit.

(15) The department may establish permit limits and measures of compliance for human health based criteria (based on lifetime exposure levels), independent of this section.

(16) Sediment impact zones authorized by the department pursuant to chapter 173-204 WAC, Sediment management standards, do not satisfy the requirements of this section.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-100, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-110 Short-term modifications. (1) The criteria and special conditions established in WAC 173-201A-030 through 173-201A-140 may be modified for a specific water body on a short-term basis when necessary to accommodate essential activities, respond to emergencies, or to otherwise protect the public interest, even though such activities may result in a temporary reduction of water quality conditions below those criteria and classifications established by this regulation. Such modification shall be issued in writing by the director or his/her designee subject to such terms and conditions as he/she may prescribe, and such modification shall not exceed a twelve-month period.

(2) In no case will any degradation of water quality be allowed if this degradation significantly interferes with or becomes injurious to existing water uses or causes long-term harm to the environment.

(3) Notwithstanding the above, the aquatic application of herbicides which result in water use restrictions shall be considered an activity for which a short-term modification generally may be issued subject to the following conditions:

(a) A request for a short-term modification shall be made to the department on forms supplied by the department. Such request generally shall be made at least thirty days prior to herbicide application;

(b) Such herbicide application shall be in accordance with state of Washington department of agriculture regulations;

(c) Such herbicide application shall be in accordance with label provisions promulgated by USEPA under the federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 U.S.C. 136, et seq.);

(d) Notice, including identification of the herbicide, applicator, location where the herbicide will be applied, proposed timing and method of application, and water use restrictions shall be given according to the following requirements:

(i) Appropriate public notice as determined and prescribed by the director or his/her designee shall be given of any water use restrictions specified in USEPA label provisions;

(ii) The appropriate regional offices of the departments of fisheries and wildlife shall be notified twenty-four hours prior to herbicide application; and

(iii) In the event of any fish kills, the departments of ecology, fisheries, and wildlife shall be notified immediately;

(e) The herbicide application shall be made at times so as to:

(i) Minimize public water use restrictions during weekends; and

(ii) Completely avoid public water use restrictions during the opening week of fishing season, Memorial Day weekend, Independence Day weekend, and Labor Day weekend;

(f) Any additional conditions as may be prescribed by the director or his/her designee.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-110, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-120 General classifications. General classifications applying to various surface water bodies not specifically classified under WAC 173-201A-130 or 173-201A-140 are as follows:

(1) All surface waters lying within national parks, national forests, and/or wilderness areas are classified Class AA or Lake Class.

(2) All lakes and their feeder streams within the state are classified Lake Class and Class AA respectively, except for those feeder streams specifically classified otherwise.

(3) All reservoirs with a mean detention time of greater than 15 days are classified Lake Class.

(4) All reservoirs with a mean detention time of 15 days or less are classified the same as the river section in which they are located.

(5) All reservoirs established on preexisting lakes are classified as Lake Class.

(6) All unclassified surface waters that are tributaries to Class AA waters are classified Class AA. All other unclassified surface waters within the state are hereby classified Class A.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037. (Order 92-29), § 173-201A-120, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-130 Specific classifications—Freshwater. Specific fresh surface waters of the state of Washington are classified as follows:

(1)	American River.	Class AA
(2)	Big Quilcene River and tributaries.	Class AA
(3)	Bumping River.	Class AA
(4)	Burnt Bridge Creek.	Class A
(5)	Cedar River from Lake Washington to the Maplewood Bridge (river mile 4.1).	Class A
(6)	Cedar River and tributaries from the Maplewood Bridge (river mile 4.1) to Landsburg Dam (river mile 21.6).	Class AA
(7)	Cedar River and tributaries from Landsburg Dam (river mile 21.6) to headwaters. Special condition - no waste discharge will be permitted.	Class AA
(8)	Chehalis River from upper boundary of Grays Harbor at Cosmopolis (river mile 3.1, longitude 123°45'45" W) to Scammon Creek (river mile 65.8).	Class A
(9)	Chehalis River from Scammon Creek (river mile 65.8) to Newaukum River (river mile 75.2). Special condition - dissolved oxygen shall exceed 5.0 mg/L from June 1 to September 15. For the remainder of the year, the dissolved oxygen shall meet Class A criteria.	Class A
(10)	Chehalis River from Newaukum River (river mile 75.2) to Rock Creek (river mile 106.7).	Class A
(11)	Chehalis River, from Rock Creek (river mile 106.7) to headwaters.	Class AA
(12)	Chehalis River, south fork.	Class A
(13)	Chewuch River.	Class AA
(14)	Chiwawa River.	Class AA
(15)	Cispus River.	Class AA
(16)	Clearwater River.	Class A
(17)	Cle Elum River.	Class AA
(18)	Cloquallum Creek.	Class A
(19)	Clover Creek from outlet of Lake Spanaway to inlet of Lake Steilacoom.	Class A
(20)	Columbia River from mouth to the Washington-Oregon border (river mile 309.3). Special conditions - temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed 0.3°C due to any single source or 1.1°C due to all such activities combined. Dissolved oxygen shall exceed 90 percent of saturation.	Class A

(128)	Walla Walla River from mouth to Lowden (Dry Creek at river mile 27.2).	Class B
(129)	Walla Walla River from Lowden (Dry Creek at river mile 27.2) to Oregon border (river mile 40). Special condition - temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9).	Class A
(130)	Wenatchee River from Wenatchee National Forest boundary (river mile 27.1) to headwaters.	Class AA
(131)	White River (Pierce-King counties) from Mud Mountain Dam (river mile 27.1) to headwaters.	Class AA
(132)	White River (Chelan County).	Class AA
(133)	Wildcat Creek.	Class A
(134)	Willapa River upstream of a line bearing 70° true through Mailboat Slough light (river mile 1.8).	Class A
(135)	Wishkah River from mouth to river mile 6 (SW 1/4 SW 1/4 NE 1/4 Sec. 21-T18N-R9W).	Class B
(136)	Wishkah River from river mile 6 (SW 1/4 SW 1/4 NE 1/4 Sec. 21-T18N-R9W) to west fork (river mile 17.7).	Class A
(137)	Wishkah River from west fork of Wishkah River (river mile 17.7) to south boundary of Sec. 33-T21N-R8W (river mile 32.0).	Class AA
(138)	Wishkah River and tributaries from south boundary of Sec. 33-T21N-R8W (river mile 32.0) to headwaters. Special condition - no waste discharge will be permitted.	Class AA
(139)	Wynoochee River from mouth to Olympic National Forest boundary (river mile 45.9).	Class A
(140)	Wynoochee River from Olympic National Forest boundary (river mile 45.9) to headwaters.	Class AA
(141)	Yakima River from mouth to Cle Elum River (river mile 185.6). Special condition - temperature shall not exceed 21.0°C due to human activities. When natural conditions exceed 21.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9).	Class A
(142)	Yakima River from Cle Elum River (river mile 185.6) to headwaters.	Class AA

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-130, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-140 Specific classifications—Marine water. Specific marine surface waters of the state of Washington are classified as follows:

(1)	Budd Inlet south of latitude 47°04'N (south of Priest Point Park).	Class B
(2)	Coastal waters: Pacific Ocean from Ilwaco to Cape Flattery.	Class AA
(3)	Commencement Bay south and east of a line bearing 258° true from "Brown's Point" and north and west of line bearing 225° true through the Hylebos waterway light.	Class A
(4)	Commencement Bay, inner, south and east of a line bearing 225° true through Hylebos waterway light except the city waterway south and east of south 11th Street.	Class B
(5)	Commencement Bay, city waterway south and east of south 11th Street.	Class C
(6)	Drayton Harbor, south of entrance.	Class A
(7)	Dyes and Sinclair Inlets west of longitude 122°37'W.	Class A
(8)	Elliott Bay east of a line between Pier 91 and Duwamish head.	Class A
(9)	Everett Harbor, inner, northeast of a line bearing 121° true from approximately 47°59'5"N and 122°13'44"W (southwest corner of the pier).	Class B
(10)	Grays Harbor west of longitude 123°59'W.	Class A
(11)	Grays Harbor east of longitude 123°59'W to longitude 123°45'45"W (Cosmopolis Chehalis River, river mile 3.1). Special condition - dissolved oxygen shall exceed 5.0 mg/L.	Class B
(12)	Guemes Channel, Padilla, Samish and Bellingham Bays east of longitude 122°39'W and north of latitude 48°27'20"N.	Class A
(13)	Hood Canal.	Class AA
(14)	Mukilteo and all North Puget Sound west of longitude 122°39' W (Whidbey, Fidalgo, Guemes and Lummi islands and State Highway 20 Bridge at Deception Pass), except as otherwise noted.	Class AA
(15)	Oakland Bay west of longitude 123°05'W (inner Shelton harbor).	Class B
(16)	Port Angeles south and west of a line bearing 152° true from buoy "2" at the tip of Ediz Hook.	Class A
(17)	Port Gamble south of latitude 47°15'20"N.	Class A
(18)	Port Townsend west of a line between Point Hudson and Kala Point.	Class A
(19)	Possession Sound, south of latitude 47°57'N.	Class AA
(20)	Possession Sound, Port Susan, Saratoga Passage, and Skagit Bay east of Whidbey Island and State Highway 20 Bridge at Deception Pass between latitude 47°57'N (Mukilteo) and latitude 48°27'20"N (Similk Bay), except as otherwise noted.	Class A
(21)	Puget Sound through Admiralty Inlet and South Puget Sound, south and west to longitude 122°52'30"W (Brisco Point) and longitude 122°51'W (northern tip of Hartstene Island).	Class AA
(22)	Sequim Bay southward of entrance.	Class AA
(23)	South Puget Sound west of longitude 122°52'30"W (Brisco Point) and longitude 122°51'W (northern tip of Hartstene Island, except as otherwise noted).	Class A
(24)	Strait of Juan de Fuca.	Class AA
(25)	Totten Inlet and Little Skookum Inlet, west of longitude 122°5'32" (west side of Steamboat Island).	Class AA
(26)	Willapa Bay seaward of a line bearing 70° true through Mailboat Slough light (Willapa River, river mile 1.8).	Class A

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-140, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-150 Achievement considerations. To fully achieve and maintain the foregoing water quality in the state of Washington, it is the intent of the department to apply the various implementation and enforcement authorities at its disposal, including participation in the programs of the federal Clean Water Act (33 U.S.C. 1251 et seq.) as appropriate. It is also the intent that cognizance will be taken of the need for participation in cooperative programs with other state agencies and private groups with respect to the management of related problems. The department's planned program for water pollution control will be defined and revised annually in accordance with section 106 of said federal act. Further, it shall be required that all activities which discharge wastes into waters within the state, or otherwise adversely affect the quality of said waters, be in compliance with the waste treatment and discharge provisions of state or federal law.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-150, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-160 Implementation. (1) **Discharges from municipal, commercial, and industrial operations.** The primary means to be used for controlling municipal, commercial, and industrial waste discharges shall be through the issuance of waste disposal permits, as provided for in RCW 90.48.160, 90.48.162, and 90.48.260.

(2) **Miscellaneous waste discharge or water quality effect sources.** The director shall, through the issuance of regulatory permits, directives, and orders, as are appropriate, control miscellaneous waste discharges and water quality effect sources not covered by subsection (1) of this section.

(3) **Nonpoint source and storm water pollution.**

(a) Activities which generate nonpoint source pollution shall be conducted so as to comply with the water quality standards. The primary means to be used for requiring compliance with the standards shall be through best management practices required in waste discharge permits, rules, orders, and directives issued by the department for activities which generate nonpoint source pollution.

(b) Best management practices shall be applied so that when all appropriate combinations of individual best management practices are utilized, violation of water quality criteria shall be prevented. If a discharger is applying all best management practices appropriate or required by the department and a violation of water quality criteria occurs, the discharger shall modify existing practices or apply further water pollution control measures, selected or approved by the department, to achieve compliance with water quality criteria. Best management practices established in permits, orders, rules, or directives of the department shall be reviewed and modified, as appropriate, so as to achieve compliance with water quality criteria.

(c) Activities which contribute to nonpoint source pollution shall be conducted utilizing best management practices to prevent violation of water quality criteria. When applicable best management practices are not being implemented, the department may conclude individual activities are causing pollution in violation of RCW 90.48.080. In these situations, the department may pursue orders, directives, permits, or civil or criminal sanctions to gain compliance with the standards.

(d) Activities which cause pollution of storm water shall be conducted so as to comply with the water quality standards. The primary means to be used for requiring compliance with the standards shall be through best management practices required in waste discharge permits, rules, orders, and directives issued by the department for activities which generate storm water pollution. The consideration and control procedures in (b) and (c) of this subsection apply to the control of pollutants in storm water.

(4) **Allowance for compliance schedules.**

(a) Permits, orders, and directives of the department for existing discharges may include a schedule for achieving compliance with water quality criteria contained in this chapter. Such schedules of compliance shall be developed to ensure final compliance with all water quality-based effluent limits in the shortest practicable time. Decisions regarding whether to issue schedules of compliance will be made on a case-by-case basis by the department. Schedules of compliance may not be issued for new discharges. Schedules of compliance may be issued to allow for: (i) construction of necessary treatment capability; (ii) implementation of necessary best management practices; (iii) implementation of additional storm water best management practices for discharges determined not to meet water quality criteria following implementation of an initial set of best management practices; (iv) completion of necessary water quality studies; or (v) resolution of a pending water quality standards' issue through rule-making action.

(b) For the period of time during which compliance with water quality criteria is deferred, interim effluent limitations shall be formally established, based on the best professional judgment of the department.

(c) Prior to establishing a schedule of compliance, the department shall require the discharger to evaluate the possibility of achieving water quality criteria via nonconstruction changes (e.g., facility operation, pollution prevention). Schedules of compliance may in no case exceed ten years, and shall generally not exceed the term of any permit.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-160, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-170 Surveillance. A continuing surveillance program, to ascertain whether the regulations, waste disposal permits, orders, and directives promulgated and/or issued by the department are being complied with, will be conducted by the department staff as follows:

(1) Inspecting treatment and control facilities.

(2) Monitoring and reporting waste discharge characteristics.

(3) Monitoring receiving water quality.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-170, filed 11/25/92, effective 12/26/92.]

WAC 173-201A-180 Enforcement. To insure that the provisions of chapter 90.48 RCW, the standards for water quality promulgated herein, the terms of waste disposal permits, and other orders and directives of the department are fully complied with, the following enforcement tools will be relied upon by the department, in cooperation with the attorney general as it deems appropriate:

(1) Issuance of notices of violation and regulatory orders as provided for in RCW 90.48.120.

(2) Initiation of actions requesting injunctive or other appropriate relief in the various courts of the state as provided for in RCW 90.48.037.

(3) Levying of civil penalties as provided for in RCW 90.48.144.

(4) Initiation of a criminal proceeding by the appropriate county prosecutor as provided for in RCW 90.48.140.

(5) Issuance of regulatory orders or directives as provided for in RCW 90.48.240.

[Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-180, filed 11/25/92, effective 12/26/92.]

(21) Columbia River from Washington-Oregon border (river mile 309.3) to Grand Coulee Dam (river mile 596.6). Special condition from Washington-Oregon border (river mile 309.3) to Priest Rapids Dam (river mile 397.1). Temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9). Class A
(22) Columbia River from Grand Coulee Dam (river mile 596.6) to Canadian border (river mile 745.0). Class AA
(23) Colville River. Class A
(24) Coweeman River from mouth to Mulholland Creek (river mile 18.4). Class A
(25) Coweeman River from Mulholland Creek (river mile 18.4) to headwaters. Class AA
(26) Cowlitz River from mouth to base of Riffe Lake Dam (river mile 52.0). Class A
(27) Cowlitz River from base of Riffe Lake Dam (river mile 52.0) to headwaters. Class AA
(28) Crab Creek and tributaries. Class B
(29) Decker Creek. Class AA
(30) Deschutes River from mouth to boundary of Snoqualmie National Forest (river mile 48.2). Class A
(31) Deschutes River from boundary of Snoqualmie National Forest (river mile 48.2) to headwaters. Class AA
(32) Dickey River. Class A
(33) Dosewallips River and tributaries. Class AA
(34) Duckabush River and tributaries. Class AA
(35) Dungeness River from mouth to Canyon Creek (river mile 10.8). Class A
(36) Dungeness River and tributaries from Canyon Creek (river mile 10.8) to headwaters. Class AA
(37) Duwamish River from mouth south of a line bearing 254° true from the NW corner of berth 3, terminal No. 37 to the Black River (river mile 11.0) (Duwamish River continues as the Green River above the Black River). Class B
(38) Elochoman River. Class A
(39) Elwha River and tributaries. Class AA
(40) Entiat River from Wenatchee National Forest boundary (river mile 20.5) to headwaters. Class AA
(41) Grande Ronde River from mouth to Oregon border (river mile 37). Special condition - temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9). Class A
(42) Grays River from Grays River Falls (river mile 15.8) to headwaters. Class AA
(43) Green River (Cowlitz County). Class AA
(44) Green River (King County) from Black River (river mile 11.0 and point where Duwamish River continues as the Green River) to west boundary of Sec. 27-T21N-R6E (west boundary of Flaming Geyser State Park at river mile 42.3). Class A
(45) Green River (King County) from west boundary of Sec. 27-T21N-R6E (west boundary of Flaming Geyser State Park, river mile 42.3) to west boundary of Sec. 13-T21N-R7E (river mile 59.1). Class AA
(46) Green River and tributaries (King County) from west boundary of Sec. 13-T21N-R7E (river mile 59.1) to headwaters. Special condition - no waste discharge will be permitted. Class AA
(47) Hamma Hamma River and tributaries. Class AA
(48) Hanaford Creek from mouth to east boundary of Sec. 25-T15N-R2W (river mile 4.1). Special condition - dissolved oxygen shall exceed 6.5 mg/L. Class A
(49) Hanaford Creek from east boundary of Sec. 25-T15N-R2W (river mile 4.1) to headwaters. Class A
(50) Hoh River and tributaries. Class AA
(51) Hoquiam River (continues as west fork above east fork) from mouth to river mile 9.3 (Dekay Road Bridge) (upper limit of tidal influence). Class B
(52) Humptulips River and tributaries from mouth to Olympic National Forest boundary on east fork (river mile 12.8) and west fork (river mile 40.4) (main stem continues as west fork). Class A
(53) Humptulips River, east fork from Olympic National Forest boundary (river mile 12.8) to headwaters. Class AA
(54) Humptulips River, west fork from Olympic National Forest boundary (river mile 40.4) to headwaters. Class AA
(55) Issaquah Creek. Class A
(56) Kalama River from lower Kalama River Falls (river mile 10.4) to headwaters. Class AA
(57) Klickitat River from Little Klickitat River (river mile 19.8) to boundary of Yakima Indian Reservation. Class AA
(58) Lake Washington Ship Canal from Government Locks (river mile 1.0) to Lake Washington (river mile 8.6). Special condition - salinity shall not exceed one part per thousand (1.0 ppt) at any point or depth along a line that transects the ship canal at the University Bridge (river mile 6.1). Lake Class
(59) Lewis River, east fork, from Multon Falls (river mile 24.6) to headwaters. Class AA
(60) Little Wenatchee River. Class AA
(61) Methow River from mouth to Chewuch River (river mile 50.1). Class A
(62) Methow River from Chewuch River (river mile 50.1) to headwaters. Class AA
(63) Mill Creek from mouth to 13th Street Bridge in Walla Walla (river mile 6.4). Special condition - dissolved oxygen concentration shall exceed 5.0 mg/L. Class B
(64) Mill Creek from 13th Street Bridge in Walla Walla (river mile 6.4) to Walla Walla Waterworks Dam (river mile 25.2). Class A
(65) Mill Creek and tributaries from city of Walla Walla Waterworks Dam (river mile 25.2) to headwaters. Special condition - no waste discharge will be permitted. Class AA
(66) Naches River from Snoqualmie National Forest boundary (river mile 35.7) to headwaters. Class AA
(67) Naselle River from Naselle "Falls" (cascade at river mile 18.6) to headwaters. Class AA
(68) Newaukum River. Class A
(69) Nisqually River from mouth to Alder Dam (river mile 44.2). Class A
(70) Nisqually River from Alder Dam (river mile 44.2) to headwaters. Class AA
(71) Nooksack River from mouth to Maple Creek (river mile 49.7). Class A
(72) Nooksack River from Maple Creek (river mile 49.7) to headwaters. Class AA
(73) Nooksack River, south fork, from mouth to Skookum Creek (river mile 14.3). Class A
(74) Nooksack River, south fork, from Skookum Creek (river mile 14.3) to headwaters. Class AA
(75) Nooksack River, middle fork. Class AA
(76) Okanogan River. Class A
(77) Palouse River from mouth to south fork (Colfax, river mile 89.6). Class B
(78) Palouse River from south fork (Colfax, river mile 89.6) to Idaho border (river mile 123.4). Special condition - temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9). Class A

(79) Pend Oreille River from Canadian border (river mile 16.0) to Idaho border (river mile 87.7). Special condition - temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9). Class A
(80) Pilchuck River from city of Snohomish Waterworks Dam (river mile 26.8) to headwaters. Class AA
(81) Puyallup River from mouth to river mile 1.0. Class B
(82) Puyallup River from river mile 1.0 to Kings Creek (river mile 31.6). Class A
(83) Puyallup River from Kings Creek (river mile 31.6) to headwaters. Class AA
(84) Queets River and tributaries. Class AA
(85) Quillayute River. Class AA
(86) Quinault River and tributaries. Class AA
(87) Salmon Creek (Clark County). Class A
(88) Satsop River from mouth to west fork (river mile 6.4). Class A
(89) Satsop River, east fork. Class AA
(90) Satsop River, middle fork. Class AA
(91) Satsop River, west fork. Class AA
(92) Skagit River from mouth to Skiyou Slough-lower end (river mile 25.6). Class A
(93) Skagit River and tributaries (includes Baker, Suak, Suiattle, and Cascade rivers) from Skiyou Slough-lower end, (river mile 25.6) to Canadian border (river mile 127.0). Special condition - Skagit River (Gorge by-pass reach) from Gorge Dam (river mile 96.6) to Gorge Powerhouse (river mile 94.2). Temperature shall not exceed 21°C due to human activities. When natural conditions exceed 21°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C, nor shall such temperature increases, at any time, exceed t=34/(T+9). Class AA
(94) Skokomish River and tributaries. Class AA
(95) Skookumchuck River from Bloody Run Creek (river mile 21.4) to headwaters. Class AA
(96) Skykomish River from mouth to May Creek (above Gold Bar at river mile 41.2). Class A
(97) Skykomish River from May Creek (above Gold Bar at river mile 41.2) to headwaters. Class AA
(98) Snake River from mouth to Washington-Idaho-Oregon border (river mile 176.1). Special condition:
(a) Below Clearwater River (river mile 139.3). Temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9).
(b) Above Clearwater River (river mile 139.3). Temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed 0.3°C due to any single source or 1.1°C due to all such activities combined. Class A
(99) Snohomish River from mouth and east of longitude 122°13'40"W upstream to latitude 47°56'30"N (southern tip of Ebey Island at river mile 8.1). Special condition - fecal coliform organism levels shall both not exceed a geometric mean value of 200 colonies/100 mL and not have more than 10 percent of the samples obtained for calculating the mean value exceeding 400 colonies/100 mL. Class A
(100) Snohomish River upstream from latitude 47°56'30"N (southern tip of Ebey Island river mile 8.1) to confluence with Skykomish and Snoqualmie River (river mile 20.5). Class A
(101) Snoqualmie River and tributaries from mouth to west boundary of Twin Falls State Park on south fork (river mile 9.1). Class A
(102) Snoqualmie River, middle fork. Class AA
(103) Snoqualmie River, north fork. Class AA
(104) Snoqualmie River, south fork, from west boundary of Twin Falls State Park (river mile 9.1) to headwaters. Class AA
(105) Soleduck River and tributaries. Class AA
(106) Spokane River from mouth to Long Lake Dam (river mile 33.9). Special condition - temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t=34/(T+9). Class A
(107) Spokane River from Long Lake Dam (river mile 33.9) to Nine Mile Bridge (river mile 58.0). Special conditions:
(a) The average euphotic zone concentration of total phosphorus (as P) shall not exceed 25µg/L during the period of June 1 to October 31.
(b) Temperature shall not exceed 20.0°C, due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time exceed t=34/(T+9). Lake Class
(108) Spokane River from Nine Mile Bridge (river mile 58.0) to the Idaho border (river mile 96.5). Temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time exceed t=34/(T+9). Class A
(109) Stehekin River. Class AA
(110) Stillaguamish River from mouth to north and south forks (river mile 17.8). Class A
(111) Stillaguamish River, north fork, from mouth to Squire Creek (river mile 31.2). Class A
(112) Stillaguamish River, north fork, from Squire Creek (river mile 31.2) to headwaters. Class AA
(113) Stillaguamish River, south fork, from mouth to Canyon Creek (river mile 33.7). Class A
(114) Stillaguamish River, south fork, from Canyon Creek (river mile 33.7) to headwaters. Class AA
(115) Sulphur Creek. Class B
(116) Sultan River from mouth to Chaplain Creek (river mile 5.9). Class A
(117) Sultan River and tributaries from Chaplain Creek (river mile 5.9) to headwaters. Special condition - no waste discharge will be permitted above city of Everett Diversion Dam (river mile 9.4). Class AA
(118) Sumas River from Canadian border (river mile 12) to headwaters (river mile 23). Class A
(119) Tieton River. Class AA
(120) Tolt River, south fork and tributaries from mouth to west boundary of Sec. 31-T26N-R9E (river mile 6.9). Class AA
(121) Tolt River, south fork from west boundary of Sec. 31-T26N-R9E (river mile 6.9) to headwaters. Special condition - no waste discharge will be permitted. Class AA
(122) Touchet River, north fork from Dayton water intake structure (river mile 3.0) to headwaters. Class AA
(123) Toutle River, north fork, from Green River to headwaters. Class AA
(124) Toutle River, south fork. Class AA
(125) Tucannon River from Umatilla National Forest boundary (river mile 38.1) to headwaters. Class AA
(126) Twisp River. Class AA
(127) Union River and tributaries from Bremerton Waterworks Dam (river mile 6.9) to headwaters. Special condition - no waste discharge will be permitted. Class AA

Appendix B.

Water Column Sampling Plan, Lab Budget, and Lab Target Detection Limits and Methods for Garrison Creek Use-based Receiving Water Study

Appendix B.1

Sampling Plan and Lab Budget

Parameter	GU2	GU1	GE1	GD1	GD2	GD3	GD4	Total Samples	Per Sample Cost	Total Cost
Field Measurements (discrete)[1]										
Flow	X	X	X[5]	X	X	X	X			
pH	4	5	4	5	4	4	4	30		
Temperature	4	5	4	5	4	4	4	30		
Dissolved Oxygen	4	5	4	5	4	4	4	30		
Specific Conductance	4	5	4	5	4	4	4	30		
Chlorine		5	4	5	4	4	4	26		
(continuous)										
Temperature (HOBO temps)		X			X		X			
pH, temp, DO, Cond (hydrolabs)	X			X	X					
General Chemistry[1,2]										
Fecal coliform	7		6	5	6		4	28	28	784
Total coliform	3		2	2	2			9	34	306
Total suspended solids	7		6	5	6		4	28	14	392
Settleable solids	2		2		2			6	14	84
Turbidity	7		6	5	6		4	28	10	280
Ammonia-nitrogen	7		6	4	6		5	28	16[6]	256
Nitrate + nitrite	3		2		2		5	12	74[6]	888
Nitrite	3		2		2		5	12	na[6]	
Ortho-phosphate	3		2		2		5	12	na[6]	
Total phosphorus	3		2		2		5	12	na[6]	
Alkalinity	3		2	5	2		4	16	20	320
Hardness	3		2		2			7	16	112
BOD - 5 day	3		2		2			7	61	427
Chloride	2				1			3	28	84
Metals, Pesticides (water)[3]										
Metals 6 - Dissolved Metals	1		1		1			3	125	375
Metals 6 - Total Recoverable Metals	1		1		1			3	125	375
Neutral Pesticides/Herbicides	1		1		1			3	550[7]	1,650
Acid Herbicides - AED	1		1		1			3	250[7]	750
Metals, Pesticides (sediment)										
Metals 6 - Total					1			1	135	135
Neutral Pesticides/Herbicides					1			1	550[7]	550
Acid Herbicides - AED					1			1	250[7]	250
Pesticides (tissue)										
Organochlorine Pesticides/PCBs					1				405	405
Biological										
Macroinvertebrates[4]	4			4	4		4	16		
Fish	1			1	1		1	4		
Habitat	1			1	1		1	4		
TOTAL SAMPLE COSTS										**8,423**

1 grab samples/measurements: 2 per day, 2 sampling days; sample numbers include field duplicate grabs/measurements in some cases (odd #s)
2 GU2, GD2, GE1 will have compositors in addition to grab samples; sample numbers include field duplicates in some cases
3 from priority pollutant-cleaned compositors
4 contract lab for Chironomidae identifications; in-house sample analysis for remainder
5 measured by automated WWTP outfall flow recorder
6 nutrient group price (NUTS 5) for 12 samples plus 16 additional ammonia samples
7 custom pesticide/herbicide group pricing per Manchester Lab

Appendix B.2

Summary of Field and Lab Measurements, Target Detection Limits, and Methods

Parameter	Detection/Precision Limit	Method[1]
Field Measurements:		
Velocity	± 0.05 fps	Current Meter
pH	± 0.1 SU	Field Meter/electrode
Temperature	± 0.2 °C	Thermometer
Dissolved Oxygen	± 0.06 mg/L	Winkler Titration
Specific Conductance	± 20 *u*mhos	Field Meter/cond. bridge
Laboratory Measurements:		
Fecal Coliform Bacteria (FC)	1 col./100mL	SM 18 MF 9222D
Total Coliform Bacteria (TC)	1 col./100mL	SM 18 MF 9222B
Hardness	± 1 mg/L	EPA 130.2
Alkalinity	± 1 mg/L	EPA 310.1
Settleable Solids (SS)	± 1 mg/L	EPA 160.5
Total Suspended Solids (TSS)	± 1 mg/L	EPA 160.2
Turbidity	± 1 NTU	EPA 180.1
Ammonia Nitrogen (NH_3)	0.01 mg/L	EPA 350.1
Nitrite (NO_2)	0.01 mg/L	EPA 353.2
Nitrite and Nitrate Nitrogen (NO_2+NO_3)	0.01 mg/L	EPA 353.2
Orthophosphate (OP)	0.01 mg/L	EPA 365.3
Total Phosphorus (TP)	0.01 mg/L	EPA 365.3
Biological Oxygen Demand (BOD)	2.0 mg/L	EPA 405.1
Chloride (CL)	0.01 mg/L	EPA 300.0

[1]**References: (APHA, 1989; USEPA, 1983)**

Appendix C.

Quality Assurance and Quality Control for Garrison Creek Use-based Receiving Water Study

Appendix C.1a Pre- and Post-calibration Summary for Field Instrumentation

HoboTemp:

Meter #	Site	Launch Date and Time	Interval (min)	Pre-calibration	Placement	Water DepthP	Probe DepthP	Water TempP
2	GU1	7/18/96 10:15:00 AM	30	TRUE	7/23/96 11:15:00 AM	0.22	0.15	18.6
11	GD4	7/18/96 10:19:00 AM	30	TRUE	7/23/96 1:54:00 PM	0.38	0.25	23.6
12	GD2	7/18/96 10:22:00 AM	30	TRUE	7/23/96 12:40:00 PM	0.44	0.3	23.8

Meter #	Site	Removal Date and Time	Interval (min)	Post-calibration		Water DepthR	Probe DepthR	Water TempR
2	GU1	7/19/96 3:30:00 PM	30	TRUE		0.46	0.37	14.9
11	GD4	7/19/96 3:45:00 PM	30	TRUE		0.43	0.3	-999
12	GD2	9/19/96 3:45:00 PM	30	TRUE		0.5	0.33	-999

Hydrolab:

Meter	Site	Launch Date and Time	Interval (min)	Pre-calibration	Pre-calibration Date and Time	Placement
6	GD2	9/16/96 6:00:00 PM	30	TRUE	9/16/96 8:00:00 AM	9/16/96 6:15:00 PM
7	GD1	9/16/96 6:00:00 PM	30	TRUE	9/16/96 8:00:00 AM	9/16/96 6:30:00 PM
9	GD2	9/16/96 6:00:00 PM	30	TRUE	9/16/96 8:00:00 AM	9/16/96 6:45:00 PM

Meter	Site	Removal Date and Time	Interval (min)	Post-calibration	PostcalDateTime	pH7 measured	pH10 measured	Cond measured	Cond Standard	DO measured	DO winkler
6	GD2	9/19/96 4:30:00 PM	30	TRUE	9/20/96 3:00:00 PM	7.14	10.09	85.4	101.1	9.12	9.2
7	GD1	9/19/96 4:30:00 PM	30	TRUE	9/20/96 3:00:00 PM	-999	-999	85.9	101.1	9.15	9.2
9	GD2	9/19/96 4:30:00 PM	30	TRUE	9/20/96 3:00:00 PM	6.96	9.87	96.6	101.1	8.66	9.2

Appendix C.1b

Comparison Mean Coefficient of Variation for HoboTemp and Hydrolab Temperature Data Collected at Station GD2

Survey Date	AM Mean COV	PM Mean COV	Daily Average Mean COV
9/16/96	-	1.74%	-
9/17/96	3.65%	4.12%	5.14%
9/18/96	4.42%	3.40%	5.62%
9/19/96	1.94%	-	-

- No Data Obtained

Appendix C.1b **Comparison of Mean Coefficient of Variation for Hobtemp and Average Hydrolab Temperature Data Collected at Station GD2**

Date and Time of Day		Hobotemp Data Time	Hobotemp Data Temp (°C)	Hobotemp - Hydrolab (comparison) QA/QC Residuals	STD	mean	COV	Hydrolab Data Hourly Avg Temp (°C)	Approx. Time
9/16/96	PM	19:22	16.86	0.145	0.10	16.93	0.6%	17.01	19:15
9/16/96	PM	20:22	16.7	0.12	0.08	16.76	0.5%	16.82	20:15
9/16/96	PM	21:22	16.54	0.135	0.10	16.61	0.6%	16.68	21:15
9/16/96	PM	22:22	16.38	0.135	0.10	16.45	0.6%	16.52	22:15
9/16/96	PM	23:22	16.22	0.175	0.12	16.31	0.8%	16.40	23:15
9/17/96	AM	0:22	16.07	0.17	0.12	16.16	0.7%	16.24	0:15
9/17/96	AM	1:22	15.91	0.17	0.12	16.00	0.8%	16.08	1:15
9/17/96	AM	2:22	15.75	0.06	0.04	15.78	0.3%	15.81	2:15
9/17/96	AM	3:22	15.43	0.095	0.07	15.48	0.4%	15.53	3:15
9/17/96	AM	4:22	15.12	0.155	0.11	15.20	0.7%	15.28	4:15
9/17/96	AM	5:22	14.96	0.1	0.07	15.01	0.5%	15.06	5:15
9/17/96	AM	6:22	14.8	0.105	0.07	14.85	0.5%	14.91	6:15
9/17/96	AM	7:22	14.64	0.135	0.10	14.71	0.6%	14.78	7:15
9/17/96	AM	8:22	14.49	0.185	0.13	14.58	0.9%	14.68	8:15
9/17/96	AM	9:22	14.49	0.23	0.16	14.61	1.1%	14.72	9:15
9/17/96	AM	10:22	14.64	0.195	0.14	14.74	0.9%	14.84	10:15
9/17/96	AM	11:22	14.64	0.36	0.25	14.82	1.7%	15.00	11:15
9/17/96	PM	12:22	14.64	0.385	0.27	14.83	1.8%	15.03	12:15
9/17/96	PM	1:22	15.12	0.37	0.26	15.31	1.7%	15.49	13:15
9/17/96	PM	2:22	15.59	0.355	0.25	15.77	1.6%	15.95	14:15
9/17/96	PM	3:22	16.07	0.37	0.26	16.26	1.6%	16.44	15:15
9/17/96	PM	4:22	16.54	0.295	0.21	16.69	1.3%	16.84	16:15
9/17/96	PM	5:22	16.86	0.215	0.15	16.97	0.9%	17.08	17:15
9/17/96	PM	6:22	16.86	0.235	0.17	16.98	1.0%	17.10	18:15
9/17/96	PM	7:22	16.86	0.06	0.04	16.89	0.3%	16.92	19:15
9/17/96	PM	8:22	16.54	0.095	0.07	16.59	0.4%	16.64	20:15
9/17/96	PM	9:22	16.22	0.135	0.10	16.29	0.6%	16.36	21:15
9/17/96	PM	10:22	16.07	0.06	0.04	16.10	0.3%	16.13	22:15
9/17/96	PM	11:22	15.75	0.135	0.10	15.82	0.6%	15.89	23:15
9/18/96	AM	12:22	15.43	0.095	0.07	15.48	0.4%	15.53	0:15
9/18/96	AM	1:22	15.12	0.095	0.07	15.17	0.4%	15.22	1:15
9/18/96.	AM	2:22	14.8	0.18	0.13	14.89	0.9%	14.98	2:15
9/18/96	AM	3:22	14.64	0.16	0.11	14.72	0.8%	14.80	3:15
9/18/96	AM	4:22	14.49	0.12	0.08	14.55	0.6%	14.61	4:15
9/18/96	AM	5:22	14.18	0.2	0.14	14.28	1.0%	14.38	5:15
9/18/96	AM	6:22	14.02	0.135	0.10	14.09	0.7%	14.16	6:15
9/18/96	AM	7:22	13.87	0.085	0.06	13.91	0.4%	13.96	7:15
9/18/96	AM	8:22	13.71	0.11	0.08	13.77	0.6%	13.82	8:15
9/18/96	AM	9:22	13.56	0.17	0.12	13.65	0.9%	13.73	9:15
9/18/96	AM	10:22	13.4	0.17	0.12	13.49	0.9%	13.57	10:15
9/18/96	AM	11:22	13.71	0.34	0.24	13.88	1.7%	14.05	11:15
9/18/96	PM	12:22	14.02	0.485	0.34	14.26	2.4%	14.51	12:15
9/18/96	PM	1:22	14.49	0.48	0.34	14.73	2.3%	14.97	13:15
9/18/96	PM	2:22	14.96	0.405	0.29	15.16	1.9%	15.37	14:15
9/18/96	PM	3:22	15.27	0.375	0.27	15.46	1.7%	15.65	15:15
9/18/96	PM	4:22	15.59	0.345	0.24	15.76	1.5%	15.94	16:15
9/18/96	PM	5:22	15.91	0.185	0.13	16.00	0.8%	16.10	17:15
9/18/96	PM	6:22	15.91	0.23	0.16	16.03	1.0%	16.14	18:15
9/18/96	PM	7:22	15.91	0.155	0.11	15.99	0.7%	16.07	19:15
9/18/96	PM	8:22	15.75	0.195	0.14	15.85	0.9%	15.95	20:15
9/18/96	PM	9:22	15.75	0.06	0.04	15.78	0.3%	15.81	21:15
9/18/96	PM	10:22	15.59	0.095	0.07	15.64	0.4%	15.69	22:15
9/18/96	PM	11:22	15.43	0.105	0.07	15.48	0.5%	15.54	23:15
9/19/96	AM	12:22	15.27	0.095	0.07	15.32	0.4%	15.37	0:15
9/19/96	AM	1:22	15.12	0.11	0.08	15.18	0.5%	15.23	1:15
9/19/96	AM	2:22	14.96	0.135	0.10	15.03	0.6%	15.10	2:15
9/19/96	AM	3:22	14.8	0.205	0.14	14.90	1.0%	15.01	3:15
9/19/96	AM	4:22	14.8	0.155	0.11	14.88	0.7%	14.96	4:15
9/19/96	AM	5:22	14.64	0.245	0.17	14.76	1.2%	14.89	5:15
9/19/96	AM	6:22	14.64	0.15	0.11	14.72	0.7%	14.79	6:15
9/19/96	AM	7:22	14.49	0.26	0.18	14.62	1.3%	14.75	7:15
9/19/96	AM	8:22	14.49	0.205	0.14	14.59	1.0%	14.70	8:15
9/19/96	AM	9:22	14.49	0.15	0.11	14.57	0.7%	14.64	9:15
9/19/96	AM	10:22	14.33	0.16	0.11	14.41	0.8%	14.49	10:15
9/19/96	AM	11:22	14.33	0.12	0.08	14.39	0.6%	14.45	11:15
9/19/96	PM	12:22	14.18	0.335	0.24	14.35	1.7%	14.52	12:15

Mean COV= **0.9%**

Appendix C.2a Coefficient of Variation for Replicate Insitu Field Measurements Collected at Station GD1

		Field Instrumentation Parameters							
		pH	**Temperature (meter)**			**Conductivity**	**Dissolved Oxygen**	**Chlorine**	
Date	**Time**	(std. units)	(pH - °C)	(Cond - °C)	(DO - °C)	(umhos/cm)	(mg/L)	Free (mg/L)	Total (mg/L)
09/17/96	16:30	7.69	16.4	17.2	17.2	312	8	>0.2	-999
09/17/96	16:40	7.66	16.8	17.6	17.6	370	7.95	.12	-999
mean		7.675	16.6	17.4	17.4	341	7.975		
STD		0.021	0.283	0.283	0.283	41.012	0.035		
COV		**0.28%**	**1.70%**	**1.63%**	**1.63%**	**12.03%**	**0.44%**		

(shaded) = Could Not Be Determined

Appendix C.2b Coefficient of Variation for Averaged Temperature Grab Measurements for All Field Instrumentation

AM/PM	Date	SITE	DATE	Daily Average Mean	Daily Average STD	Daily Average COV
AM	09/17/96	GD1				
PM	09/17/96		9/17/96	16.7	0.719	4.30%
PM	09/17/96		9/17 (PM)	17.1	0.468	2.73%
AM	09/19/96		9/19/96	15.4	0.363	2.35%
PM	09/19/96					
AM	09/17/96	GD2				
PM	09/17/96		9/17/96	15.4	0.912	5.94%
AM	09/19/96		9/19/96	14.8	0.469	3.18%
PM	09/19/96					
AM	09/17/96	GD3				
PM	09/17/96		9/17/96	15.4	1.201	7.82%
AM	09/19/96		9/19/96	14.7	0.352	2.39%
PM	09/19/96					
AM	09/17/96	GD4				
PM	09/17/96		9/17/96	14.7	1.221	8.32%
AM	09/19/96		9/19/96	14.7	0.207	1.41%
PM	09/19/96					
AM	09/17/96	GE1				
PM	09/17/96		9/17/96	18.8	1.074	5.71%
AM	09/19/96		9/19/96	17.7	0.212	1.20%
PM	09/19/96					
AM	09/17/96	GU1				
PM	09/17/96		9/17/96	14.4	1.337	9.29%
AM	09/19/96		9/19/96	14.3	0.592	4.15%
PM	09/19/96					
AM	09/17/96	GU2				
PM	09/17/96		9/17/96	14.5	1.314	9.09%
AM	09/19/96		9/19/96	14.1	0.763	5.43%
PM	09/19/96					

Appendix C.2a

Coefficient of Variation for Replicate Insitu Field Measurements Collected Collected at Station GD1

Survey Date	Instrumentation	Temperature	pH	Conductivity	Dissolved Oxygen
9/17/96	Orion 250A pH Meter	1.70%	0.28%	-	-
	Beckman Conductivity Meter	1.63%	-	12.03%	-
	YSI 57 Dissolved Oxygen meter	1.63%	-	-	0.44%
	Mean $COV_{fieldmeas}$	**1.65%**	-	-	-

- Not Applicable

Appendix C.3

Coefficient of Variation for Replicate Analytical Samples Collected at Stations GU2, GD1, and GD4

Survey Date	Sample Type	FC	TC	ALK	HARD	SS	TSS	TURB	BOD	CL	NH3	NO2	NO2/NO3	OP	TP
9/17/96	composite	13.4%	-	0.3%	0.0%	-	12.0%	6.7%	8.3%	0.8%	0.0%	0.0%	0.1%	3.4%	1.3%
9/19/96	grab	31.5%	5.8%	0.2%	-	-	0%	0%	-	-	3.6%	0.0%	3.3%	0.5%	2.3%
Mean	**$COV_{fieldsamp}$**	**22.4%**	**5.8%**	**0.3%**	**0.0%**	-	**6.0%**	**3.4%**	**8.3%**	**0.8%**	**1.8%**	**0.0%**	**1.7%**	**2.0%**	**1.8%**

- No Data Obtained

Appendix C.3 Coefficient of Variation for Replicate Analytical Samples Collected at Stations GU2, GD1, and GD4

	General Chemistry Parameters													
Lab COV	**FC** (#col/100 ml)	**TC** (#col/100 ml)	**ALK** (mg/L)	**HARD** (mg/L)	**SS** (mg/L)	**TSS** (mg/L)	**Turbidity** (NTU)	**BOD** (mg/L)	**CL** (mg/L)	**NH3** (mg/L)	**NO2** (mg/L)	**NO2/NO3** (mg/L)	**OP** (mg/L)	**TP** (mg/L)
	8.8%	22.8%	0.9%	0.0%	-	5.2%	0.0%	-	0.8%	1.6%	1.8%	1.5%	1.6%	2.6%
	0.0%	12.9%	0.4%	0.8%	-	0.0%	0.0%	-	-	1.1%	0.0%	-	2.1%	2.5%
	-	-	-	-	-	3.8%	0.0%	-	-	0.0%	-	-	-	-
	-	-	-	-	-	5.2%	-	-	-	3.7%	-	-	-	-
Mean Lab COV	**4.4%**	**17.8%**	**0.6%**	**0.4%**	-	**3.6%**	**0.0%**	-	**0.8%**	**1.6%**	**0.9%**	**1.5%**	**1.9%**	**2.5%**
n =	2	2	2	2	-	4	3	-	1	4	2	1	2	2
Field COV														
Survey Date (PM)	**FC** (#col/100 ml)	**TC** (#col/100 ml)	**ALK** (mg/L)	**HARD** (mg/L)	**SS** (mg/L)	**TSS** (mg/L)	**Turbidity** (NTU)	**BOD** (mg/L)	**CL** (mg/L)	**NH3** (mg/L)	**NO2** (mg/L)	**NO2/NO3** (mg/L)	**OP** (mg/L)	**TP** (mg/L)
9/17/96 composite	13.4%		0.3%	0.0%	-	12.0%	6.7%	8.3%	0.8%	0.0%	0.0%	0.1%	3.4%	1.3%
9/19/96 grab	31.5%	5.8%	0.2%	-	-	0.0%	0.0%	-	-	3.6%	0.0%	3.3%	0.5%	2.3%
Mean Field COV	**22.4%**	**5.8%**	**0.3%**	**0.0%**	-	**6.0%**	**3.4%**	**8.3%**	**0.8%**	**1.8%**	**0.0%**	**1.7%**	**2.0%**	**1.8%**
n =	2	1	2	1	-	2	2	1	1	2	2	2	2	2
Mean $COV_{(total)}$														
Lab and Field Combined	**FC** (#col/100 ml)	**TC** (#col/100 ml)	**ALK** (mg/L)	**HARD** (mg/L)	**SS** (mg/L)	**TSS** (mg/L)	**Turbidity** (NTU)	**BOD** (mg/L)	**CL** (mg/L)	**NH3** (mg/L)	**NO2** (mg/L)	**NO2/NO3** (mg/L)	**OP** (mg/L)	**TP** (mg/L)
$COV_{(mean\ total)}$	**13.4%**	**11.8%**	**0.4%**	**0.2%**	-	**4.8%**	**1.7%**	**8.3%**	**0.8%**	**1.7%**	**0.4%**	**1.6%**	**1.9%**	**2.2%**

- = Not Applicable

Appendix D.

Water Column Sampling Results for Garrison Creek Use-based Receiving Water Study

Appendix D.2b Daily Average and Daily Average Diurnal Hydrolab Results (logged at 30 minute intervals)

Date	Station Location	Temp			pH			SpCond			DO		
		AM	PM	DailyAVG	AM	PM	DailyAVG	AM	PM	DailyAVG	AM	PM	DailyAVG
9/16/96	GU2												
	GD1												
	GD2												
9/17/96	GU2	12.82	14.86	13.84	7.49	7.43	7.46	121	121	121	9.84	9.31	9.58
	GD1	16.28	17.22	16.75	3.53	3.44	3.48	323	286	305	8.72	8.55	8.64
	GD2	15.24	16.32	15.78	7.43	7.40	7.42	248	212	230	7.79	7.41	7.60
9/18/96	GU2	12.38	14.27	13.32	7.44	7.44	7.44	121	123	122	9.83	9.15	9.49
	GD1	16.04	16.44	16.24	3.44	3.45	3.45	320	277	298	8.74	8.74	8.74
	GD2	14.40	15.64	15.02	7.43	7.41	7.42	215	208	212	7.95	7.60	7.78
9/19/96	GU2	13.33			7.40			125			8.78		
	GD1	15.68			3.44			280			8.75		
	GD2	14.86			7.41			211			7.65		

[shaded] = Insufficient Data to Calculate for 24 hour period

Appendix D.3a Insitu Water Column Field Results

Time of Day Date	Station Location	Temp (oC)	pH (SU)	Cond (umhos/cm)	DO (mg/L)	Free Cl (mg/L)	Total Cl (mg/L)
AM 09/17/96	GU2	13.3	7.66	150	9.4	0.2	ND
	GU1	13.2	7.61	150	9.4	> 0.2	ND
	GD1	15.9	7.49	340	8.5	> 0.2	ND
	GD2	14.6	7.29	310	6.7	> 0.2	ND
	GD3	14.5	7.4	310	6.1	> 0.2	ND
	GD4	13.7	7.23	300	6	0.16	ND
	GE1	18.0	7.55	550	7.9	> 0.2	ND
	WW	12.9	7.5	159	10.2		
PM 09/17/96	GU2	15.6	7.71	145	8.4	0.06	ND
	GU1	15.6	7.74	159	7.6	NSC	NSC
	GD1	17.1	7.68	341	7.98	> 0.2	ND
	GD2	16.1	7.55	270	6.2	0.16	ND
	GD3	16.3	7.37	269	6	0.1	ND
	GD4	15.6	7.42	298	6.35	0.16	ND
	GE1	19.6	7.66	570	7.5	NSC	NSC
	WW	15.0	8.54	175	10.8		
AM 09/19/96	GU2	13.5	7.65	159	8.5	0.06	< 0.1
	GU1	13.8	7.81	143	7.1	NSC	NSC
	GD1	15.2	7.83	340	7.49	< 0.1	NSC
	GD2	14.4	7.66	270	5.95	< 0.1	0
	GD3	14.4	7.68	250	5.7	< 0.1	0
	GD4	14.7	7.28	275	5.4	0.04	0.06
	GE1	17.6	7.67	570	7.3	< 0.1	0
	WW	13.1	7.6	235	9		
PM 09/19/96	GU2	14.8	7.59	152	8.2	< 0.1	0
	GU1	14.8	7.4	152	8	< 0.1	0
	GD1	15.6	7.56	272	7.5	< 0.1	0
	GD2	15.2	7.49	234	6.3	< 0.1	0
	GD3	14.8	7.44	235	5.85	< 0.1	0
	GD4	14.8	7.3	254	6.2	< 0.1	0
	GE1	17.8	7.69	570	7.4	< 0.1	0.1
	WW	14.2	8.17	169	5.2		

ND = Concentration Not Determined (Total Cl only)
NSC = No Sample Collected

Appendix D.3b Raw Insitu Water Column Grab Measurements

			Field Parameter											Winkler DOs			
Site	Date	Time	Watertemp	pH	temppH	Cond	tempCond	DO	tempDO	FreeCILL	TotalCILL	FreeCIHL	TotalCIHL	Site	Date	Time	DO
GD1	09/17/96	11:40		7.49	15.9	340	15.9	8.5	15.9	>0.2	-999						
GD1	09/17/96	16:30		7.69	16.4	312	17.2	8	17.2	>0.2	-999						
GD1 (dup)	09/17/96	16:40		7.66	16.8	370	17.6	7.95	17.6	.12	-999						
GD1	09/19/96	8:45	15.6	7.83	14.8	340	15.6	7.49	14.9			<0.1		GD1	09/19/96	8:30	8.15
GD1	09/19/96	15:15	15.7	7.56	15.3	272	15.7	7.5	15.6			<0.1	0	GD1	09/19/96	15:00	7.8
GD2	09/17/96	11:20		7.29	14.4	310	14.4	6.7	15	>0.2	-999						
GD2	09/17/96	16:15		7.55	15.8	270	15.8	6.2	16.7	.16	-999						
GD2	09/19/96	8:30	14.3	7.66	14.2	270	14.3	5.95	14.7			<0.1	0	GD2	09/19/96	8:00	6.6
GD2	09/19/96	15:02	15.1	7.49	14.9	234	15.1	6.3	15.5			<0.1	0	GD2	09/19/96	14:55	6.4
GD3	09/17/96	11:00		7.4	14.2	310	14.2	6.1	15	>0.2	-999						
GD3	09/17/96	16:00		7.37	15.7	269	15.7	6	17.4	.1	-999						
GD3	09/19/96	8:14	14.3	7.68	14.4	250	14.3	5.7	14.6			<0.1	0				
GD3	09/19/96	14:50	15.1	7.44	14.9	235	15.1	5.85	15			<0.1	0				
GD4	09/17/96	9:45		7.23	13.1	300	14	6	14	.16	-999						
GD4	09/17/96	15:15		7.42	14.7	298	16.1	6.35	16.1	.16	-999						
GD4	09/19/96	7:30	14.7	7.28	14.4	275	14.7	5.4	14.8	.04	.06	<0.1	0				
GD4	09/19/96	14:10	14.8	7.3	14.4	254	14.8	6.2	15			<0.1	0				
GE1	09/17/96	12:00		7.55	17.6	550	17.6	7.9	18.8	>0.2	-999						
GE1	09/17/96	17:45		7.66	18.9	570	20	7.5	20								
GE1	09/19/96	8:55	17.6	7.67	17.4	570	17.6	7.3	17.8			<0.1	0				
GE1	09/19/96	15:25	17.8	7.69	17.4	570	17.8	7.4	18			<0.1	<0.1				
GU1	09/17/96	12:05		7.61	13.1	150	13.1	9.4	13.5	>0.2	-999						
GU1	09/17/96	17:50		7.74	14.9	159	15.9	7.6	15.9								
GU1	09/19/96	9:00	13.8	7.81	13.6	143	13.8	7.1	13.8								
GU1	09/19/96	15:30	14.9	7.4	14.4	152	14.9	8	15			<0.1	0				
GU2	09/17/96	12:20		7.66	13.1	150	13	9.4	13.9	>0.2	-999						
GU2	09/17/96	18:00		7.71	14.9	145	15.9	8.4	15.9	.06	-999						
GU2	09/19/96	9:10	13.3	7.65	13.5	159	13.3	8.5	13.8	.06	.09	<0.1	0	GU2	09/19/96	8:35	8.65
GU2	09/19/96	15:45		7.59	14.5	152	15	8.2	15			<0.1	0	GU2	09/19/96	15:05	8.2
														GU2 (dup)	09/19/96	15:10	8.2
WW	09/17/96	9:55		7.5	12.6	159	13	10.2	13								
WW	09/17/96	15:20		8.54	15	175	15	10.8	15								
WW	09/19/96	7:35		7.6	13.4	235	13	9	13								
WW	09/19/96	13:40		8.17	13.7	169	14.5	5.2	14.5			<0.1					

Appendix D.4a Lab Analytical Results for Water Column Grab (-#G) and Composite (-#C) Samples

Station ID	Sample Date	Time Collected	Sample ID#	General Chemistry Parameters - Raw Data																				
				FC	qual	TC	qual	ALK (mg/L)	HARD	SS	qual	TSS	Turbidity	BOD	qual	CL	NH3	qual	NO2	qual	NO2/NO3	OP	qual	TP
GD1-1G	9/17/96	1140	96388282	280		870		102				15	9.5				1.58							
GD1-2G	9/17/96	1640	96388287	260				99.7				14	10				1.4							
GD1-3G	9/19/96	830	96388296	420				109				28	11				1.81							
(lab dup)	9/19/96	830	96388296														1.77							
GD1-4G	9/19/96	1500	96388302	2800		5800		89.9				17	11				1							
GD1-5G (re	9/19/96	1505	96388303	1800	J	6300		89.6				17	11											
GD2-1C	9/17/96	1300	96388290	200		1600		95.8	68.4	0.1	U	17	9.2	41	G	18.4	0.833		0.148		1.69	2.56		2.22
(lab dup)	9/17/96	1300	96388290													18.6								
GD2-2C	9/19/96	1605	96388306	670		4300		86.9	67			19	11	41	G		0.691		0.141		1.27	1.58		1.7
(lab dup)	9/19/96	1605	96388306						67															1.76
GD2-1G	9/17/96	1120	96388281	300								20	10				0.878							
GD2-2G	9/17/96	1615	96388286	330								21	11				0.522							
GD2-3G	9/19/96	800	96388295	240								18	11				0.832							
GD2-4G	9/19/96	1450	96388301	1700								32	13				0.612							
GD4-1G	9/17/96	935	96388280	150				91.2				15	9.4				0.197		0.122		2.35	2.24		2.19
(lab dup)	9/17/96	935	96388280														0.2		0.119		2.4	2.19		2.11
GD4-2G	9/17/96	1515	96388285	160				86.7				14	9.4				0.148		0.109		2.38	2.28		1.91
GD4-3G	9/19/96	715	96388294	140				84.9				17	10				0.05		0.082		2.1	1.68		1.35
(lab dup)	9/19/96	715	96388294					86											0.082			1.63		
GD4-4G	9/19/96	1350	96388299	200				82.1				29	13				0.057		0.078		2.22	1.4		1.24
(lab dup)	9/19/96	1350	96388299										13											
GD4-5G (re	9/19/96	1355	96388300														0.06		0.078		2.12	1.41		1.2
GE1-1C	9/17/96	1320	96388291	3	U	17		154	89.5	0.1	U	13	11	58	G		3.08		0.179		2.4	6.05		5.21
(lab dup)	9/17/96	1320	96388291						88.5															
GE1-2C	9/19/96	1615	96388307	1	U	140	X	163	88.6			19	12	41	G		4		0.279		2.33	6.31		6.29
GE1-1G	9/17/96	1200	96388283	3	U							18	13				4.14							
GE1-2G	9/17/96	1700	96388288	3	U							19	14				3.1							
(lab dup)	9/17/96	1700	96388288									19					2.94							
GE1-3G	9/19/96	815	96388297	7								18	12				4.69							
(lab dup)	9/19/96	815	96388297									19												
GE1-4G	9/19/96	1510	96388304	2								19	12				4.59							
GU2-1C	9/17/96	1645	96388292	670		2000		61.7	58.6	0.1	U	13	10	9		2.65	0.01	U	0.01	U	0.88	0.042		0.055
(lab dup)	9/17/96	1645	96388292	670		2400		62.1				14												
GU2-2C	9/19/96	1605	96388308	1700		5400		63.3	59.2			25	14	4	U		0.02		0.01	U	0.893	0.01	U	0.093
(lab dup)	9/19/96	1605	96388308	1500		3900							14											
GU2-3C	9/17/96	1655	96388293	810				61.6	58.6			16	11	8		2.62	0.01	U	0.01	U	0.881	0.04		0.056
(lab dup)	9/17/96	1655	96388293					61.7					11											
GU2-1G	9/17/96	1220	96388284	840	J							13	9.6				0.01	U						
(lab dup)	9/17/96	1220	96388284									14												
GU2-2G	9/17/96	1715	96388289	580	J							16	11				0.01	U						
GU2-3G	9/19/96	835	96388298	690								21	14				0.01	U						
GU2-4G	9/19/96	1520	96388305	2500								23	15				0.01	U						
(lab dup)	9/19/96	1520	96388305														0.01	U						

U = The analyte was not detected at or above the reported result
J = The analyte was positively identified. The associated numerical result is an estimate
G =
X = High background count

Appendix E.

Summary Results of Beneficial Use Survey for the Lower One Mile of Garrison Creek

Appendix E

Beneficial Use Survey for the lower 1 mile of Garrison Creek

Part 1 - Human Water Uses

1) Primary contact recreation:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	Historic	Use	Know	Responses
	-	-	5	2	1	1	**9**
% Total:	-	-	**56%**	**22%**	**11%**	**11%**	

Additional comments:

[1] *"In the summer for washing off, general wetting down, harvesting by crustaceans and in stream fishing. Note: the creek is seldom used for these activities now."* (Seasonal)

[2] *"Although I have observed many children swimming in Garrison Creek in the College Place area, I do not know if anyone uses this stream for swimming, ect... in its lower section."* (Don't know)

2) Secondary contact recreation:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	1	-	3	2	1	2	**9**
% Total:	**11%**	-	**33%**	**22%**	**11%**	**22%**	

Additional comments:

[1] *"Very limited in these activities now, mostly kids in the summer from time to time."* (Seasonal)

3) Aesthetic enjoyment:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	3	2	1	-	-	3	**9**
% Total:	**33%**	**22%**	**11%**	-	-	**33%**	

Additional comments:

[1] *"Used by Audubon Society and others."* (Yes, current and historic use)

[2] *"The lower stretch of Garrison Creek is utilized by ducks, beaver, muskrat, ect..., which all add to its aesthetic beauty in this section."* (Yes, current use)

[3] *"This section of the creek has been used for seasonal hunting for many years."* (Yes, current and historic use)

Part 1 - Human Water Uses (con't)

4) Domestic water supply:

	YES current	YES historic	NO current	NO historic	Seasonal Use	Don't Know	Total Responses
	-	-	5	2	-	2	**9**
% Total:	-	-	**56%**	**22%**	-	**22%**	

Additional comments:

[1] *"Probably used until the advent of deeper wells - decades ago."* (Don't know)

5) Agricultural water supply:

	YES current	YES historic	NO current	NO historic	Seasonal Use	Don't Know	Total Responses
	6	5	-	-	4	-	**15**
% Total:	**40%**	**33%**	-	-	**27%**	-	

Additional comments:

[1] *"April to October. Creek hasn't gone dry since Bill Neve has been with DOE. Did go dry 2 yrs. before for a short period."* (Seasonal)

[2] *"March - October."* (Yes, current and historic; Seasonal)

[3] *"Since the mid 19th Century."* (Yes, current and historic use)

[4] *"This creek has been used for irrigation for over 40 years. Within the last 10 years the creek has started to dry up or run real low in late July and early August."* (Yes, current and historic; Seasonal)

[5] *"Summer"* (Yes, current and historic; Seasonal)

6) Stock watering:

	YES current	YES historic	NO current	NO historic	Seasonal Use	Don't Know	Total Responses
	5	5	-	-	-	1	**11**
% Total:	**45%**	**45%**	-	-	-	**9%**	

Additional comments:

[1] *"Had to pump water from well 2 yrs. previous to Bill Neve."* (Yes, historic use)

[2] *"Again, since the mid 19th Century."* (Yes, current and historic use)

[3] *"I'm not sure if any cattle drank from water below present treatment plant outflow, I know they do upstream."* (Yes, current use)

Part 1 - Human Water Uses (con't)

7) Industrial water supply:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	-	-	6	2	-	1	**9**
% Total:	-	-	**67%**	**22%**	-	**11%**	

Part 2 - Aquatic Life Uses

1) Salmonid migration:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	3	3	1	1	1	3	**12**
% Total:	**25%**	**25%**	**8%**	**8%**	**8%**	**25%**	

Additional comments:

[1] *"There are rainbow trout and cutthroat trout in the creek at this time - Decades ago there was a steelhead run on this creek."* (Yes, current and historic use)

[2] *"I have on occasion observed steelhead in Garrison Creek in the College place area, though they are not common. When talking with neighbors who have lived in the area for longer than I have it was indicated to me that in times past there was a more substantial number than now."* (Yes, current and historic; Seasonal)

[3] *"Have seen trout in the creek for many years."* (Yes, current and historic use)

2) Salmonid rearing:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	1	-	1	-	-	4	**6**
% Total:	**17%**	-	**17%**	-	-	**67%**	

Additional comments:

[1] *"There are private parties who stock the creek with rainbow - not authorized by Fish and Wildlife."* (Yes, current use)

[2] *"Although there is very limited natural reproduction further up by rainbow trout and steelhead, I doubt there is any below the C.P. sewer discharge due to high silt loads and warm water. There may be some resident trout, however."* (Don't know)

Part 2 - Aquatic Life Uses (con't)

3) Salmonid spawning:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	-	1	1	1	-	5	**8**
% Total:	-	**13%**	**13%**	**13%**	-	**63%**	

Additional comments:

[1] *"Throughout the length of the creek."* (Yes, historic use)

[2] *"I have observed rainbow trout and steelhead on occasion digging redds in Garrison Creek in the College Place area, however I do not know if any spawn in the lower 1 mile of the stream. There are limited numbers of juvenile rainbow trout in the College Place area of the stream."* (Don't know)

4) Salmonid harvesting:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	1	1	2	1	-	4	**9**
% Total:	**11%**	**11%**	**22%**	**11%**	-	**44%**	

Additional comments:

[1] *"There are now and in the past people who fish the creek."* (Yes, current and historic use)

[2] *"Very few if any are ever fished downstream of the CP STP."* (No current use)

[3] *Although I do not know if anyone fishes in the lower 1 mile of this stream, I do know that many children fish in its upper stretches and it is conceivable that some of the fish they may be catching could have migrated from the lower parts of the stream and if they were to be contaminated in this stretch they could then carry this contamination upstream where they could be caught and consumed."* (Don't know)

5) Other fish - migration:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	4	2	-	-	-	3	**9**
% Total:	**44%**	**22%**	-	-	-	**33%**	

Additional comments:

[1] *"Some squawfish and small native shiner like fishes in the creek today."* (Yes, current use)

[2] *"Although there is some indication that suckers and squawfish may migrate upstream from the Walla Walla river into Garrison Creek, I can't positively say they do."* (Don't know)

[3] *Has always had a good number of chubs."* (Yes, current and historical use)

Part 2 - Aquatic Life Uses (con't)

6) Other fish - rearing:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	-	-	2	1	-	5	**8**
% Total:	-	-	**25%**	**13%**	-	**63%**	

Additional comments:

[1] *"Non salmonid fish found in the upper sections of Garrison Creek include squawfish, suckers, dace, shiners, muddlers and free living lamprey eels (not a true fish) and I would assume that some if not all of these occur in the lower section as well."* (Don't know)

7) Other fish - spawning:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	-	-	-	-	-	7	**7**
% Total:	-	-	-	-	-	**100%**	

Additional comments:

[1] *"All of the fish mentioned above spawn in the upper sections of the stream and it is possible they may spawn in its lower section as well."* (Don't know)

8) Other fish - harvesting:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	1	-	1	1	-	5	**8**
% Total:	**13%**	-	**13%**	**13%**	-	**63%**	

Additional comments:

[1] *"People fish the full length of the creek from time to time."* (Yes, current use)

Part 2 - Aquatic Life Uses (con't)

9) Freshwater shellfish uses:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	1	1	2	1	-	4	**9**
% Total:	**11%**	**11%**	**22%**	**11%**	-	**44%**	

Additional comments:

[1] *"There have always been crayfish in the creek."* (Yes, current and historical use)

[2] *"The portion of Garrison Creek in the College Place area contains large numbers of clams, also abundant crayfish. I see no reason why they should not be present in the lower stretches as well, although I do not know for sure if they are."* (Don't know)

10) Amphibian uses:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	2	1	1	1	-	4	**9**
% Total:	**22%**	**11%**	**11%**	**11%**	-	**44%**	

Additional comments:

[1] *"Frogs, salamanders, snakes active during the spring through fall - seems to have a healthy population of all three."* (Yes, current and historical use)

[2] *"I have from time to time seen bullfrogs in Garrison Creek in the College Place area and I would surmise that there is a good possibility that they are probably found in the lower one mile as well."* (Don't know)

11) Aquatic insects or other invertebrates:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	2	1	-	-	-	5	**8**
% Total:	**25%**	**13%**	-	-	-	**63%**	

Additional comments:

[1] *"An unknown population of insects and other crawly things - not many in the defoliated areas along the creek."* (Yes, current and historical use)

[2] *"The upper reaches contain numerous species of caddis flies, mayflies, damselflies, craneflies, chironomids, stoneflies, water beetles, water striders, alder flies, scuds, aquatic worms, snails, ect.. and I would assume that many of these would occur in the lower reaches also."*
(Don't know)

Part 2 - Aquatic Life Uses (con't)

12) Aquatic plants:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	5	3	-	-	-	2	**10**
% Total:	**50%**	**30%**	-	-	-	**20%**	

Additional comments:

[1] *"There are non-native plants present along the system and agriculture and development have impacted native plant communities, however there is still a strong native plant community."* (Yes, current use)

[2] *"A lot of the plant life downstream of the plant has been dredged and defoliated by farmers - upstream of the plant a great many non-native plant species have replaced native plants."* (Yes, historic use)

[3] *"I have seen duckweed floating on the surface of the stream in the lower stretches of Garrison Creek, there may be subsurface aquatic plants as well, as there are at least two types that I know of in the upper reaches."* (Don't know)

13) Wildlife uses:

	YES		NO		Seasonal	Don't	Total
	current	historic	current	historic	Use	Know	Responses
	6	3	1	1	-	-	**11**
% Total:	**55%**	**27%**	**9%**	**9%**	-	-	

Additional comments:

[1] *"deer, ducks, geese, small mammals."* (No current use)

[2] *"A large number of bird species adjacent to the creek, especially near the plant lagoons. A number of deer, mink, skunk, badger, coyote, weasel, and others use the available shelter and wet lands near the plant."* (Yes, current use; No historic use)

Part 3 - Other comments and concerns about Garrison Creek or wastewater discharges into it:

RESPONSES:

Response 1: *"I have farmed this area for 40 years. The effluent water has never injured any crops. We use it now only on wheat and alfalfa."*

Response 2: *"Discharge is important to maintain enough water for irrigation water right."*

Response 3: *"There is probably a lot more fish and wildlife in the general area of the lower Garrison Creek that would use the creek habitat if the creek and wetlands were refoliated with native plants and grasses, and if the obstructions and piped areas were removed from the creek."*

Note: These questionnaires often provide more questions than answers. If I can be of any further help please call me."

Response 4: *"The point at which wastewater is put in is close enough to Mill Creek and far enough from residential that very little is affected by its effluent. No ponds are downstream so fish and amphibians are much less in number. No doubt some live along the banks, but banks are not shaded much downstream, making it less desirable for most of their species."*

Response 5: *"One of my biggest concerns in regards to Garrison Creek is the large amount of storm water runoff that is discharged into it by the cities of College Place and Walla Walla. This water is discharged completely untreated and includes oil, sediment, litter and just about anything else that happens to be on the streets that will fit through a storm drain grate. In addition to this we have had numerous instances where chlorinated water or other contaminants have been flushed into storm drains that resulted in partial to total fish kills in the stream below the discharge. I feel that it is time to compel these municipalities to treat their storm drainage in such a manner as to prevent these incidents from happening. While it is well to be concerned about sewage outflows into the stream, I feel that far more damage is being done by storm drainage which little or nothing is being done to remedy."*

Appendix F.

Concept for Restoration of Traville Ditch Flow Diversion from Garrison Greek in Conjunction with redesigning the WWTP outfall

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. Box 47600 • Olympia, Washington 98504-7600 • (206) 407-6000 • TDD Only (Hearing Impaired) (206) 407-6006

December 5, 1996

Mr. Allan Rader
Utilities Supervisor
City of College Place
625 South College Avenue
College Place, Washington 99324-1516

Subject: Restoration of Garrison Creek Stream Channel

Dear Mr. Rader:

The purpose of this letter is to outline the concept I spoke with you about how the natural stream channel of Garrison Creek might be restored when the College Place Wastewater Treatment Plant (WTP) discharge is re-designed. As I understand it, you requested a write-up of the idea we discussed because you are preparing for some of the initial design work. Please bear in mind that the concept described in this letter is based on limited observations made during our field surveys this past summer, and the restoration approach suggested needs to be scrutinized from the standpoint of providing an engineered design that is feasible, in consideration of fisheries, irrigation and other uses of this section of Garrison Creek.

First of all, let me outline some key observations about the current situation along the stretch of Garrison Creek extending from your current WTP outfall location to about 300 meters downstream. Roughly 200 meters downstream from the WTP outfall, Garrison Creek's flow is diverted out of its natural channel to one of two locations: the "Travaille" irrigation ditch, and a steel pipe (roughly 60 meters long, 0.5 meters diameter) which returns that part of the flow not diverted for irrigation to the open channel of Garrison Creek, bypassing a section of the natural channel (see attached diagram). This diversion of the creek flow through the steel pipe represents a potential migration barrier for fish and other aquatic life. The steel pipe does not discharge at the level of the streambed--there is a vertical drop at the pipe outfall ranging from about 0.3 meters to around 1 meter, depending on water level in the Creek (the drop measured 0.8 meters on 7/23/96, and was about 0.5 meters during higher flows on 9/17/96). Abandonment of this pipe diversion and return of creek flows downstream of the Travaille diversion, along with any WTP effluent the creek receives, to the natural stream channel would be the goal of the restoration project I am suggesting here. As I understand it, the City of College Place is also interested in redesigning their WTP outfall so that effluent is discharged downstream of the Travaille irrigation diversion. I hope that both objectives can be accomplished when the WTP discharge is redesigned.

Here is the concept I have in mind. I have sketched this out on the attached diagram. The Travaille diversion could remain at its present plan view location, although the elevation of the intake may need to be adjusted. The steel pipe which returns creek flows to the open channel would be closed off permanently. The creek flow not diverted to the Travaille irrigation system would be routed via a spillway back into the (presently abandoned) natural stream channel. The WTP effluent would be discharged just downstream of the spillway, and would flow into the natural channel after mixing with the creek flows coming over the spillway. An elevation drop between the Travaille diversion and the natural channel would be maintained by the spillway structure and would keep the effluent from flowing back into the Travaille intake. (Note: this elevation drop should not be so great that it restricts upstream migration.) This will probably require construction of a baffle separating the effluent/creek mixing area from the upstream creek flows. In addition, the old weir that presently exists at the location where the (presently abandoned) natural channel reconnects with the creek channel (near the current pipe discharge) would need to be altered to create a transition suitable for fish passage.

I hope that this description helps explain the concept I have in mind. If it can be accomplished it will be a win-win outcome for all concerned: the City of College Place, the irrigators, and fish and other aquatic life. Please let me know if I can provide more information on this idea.

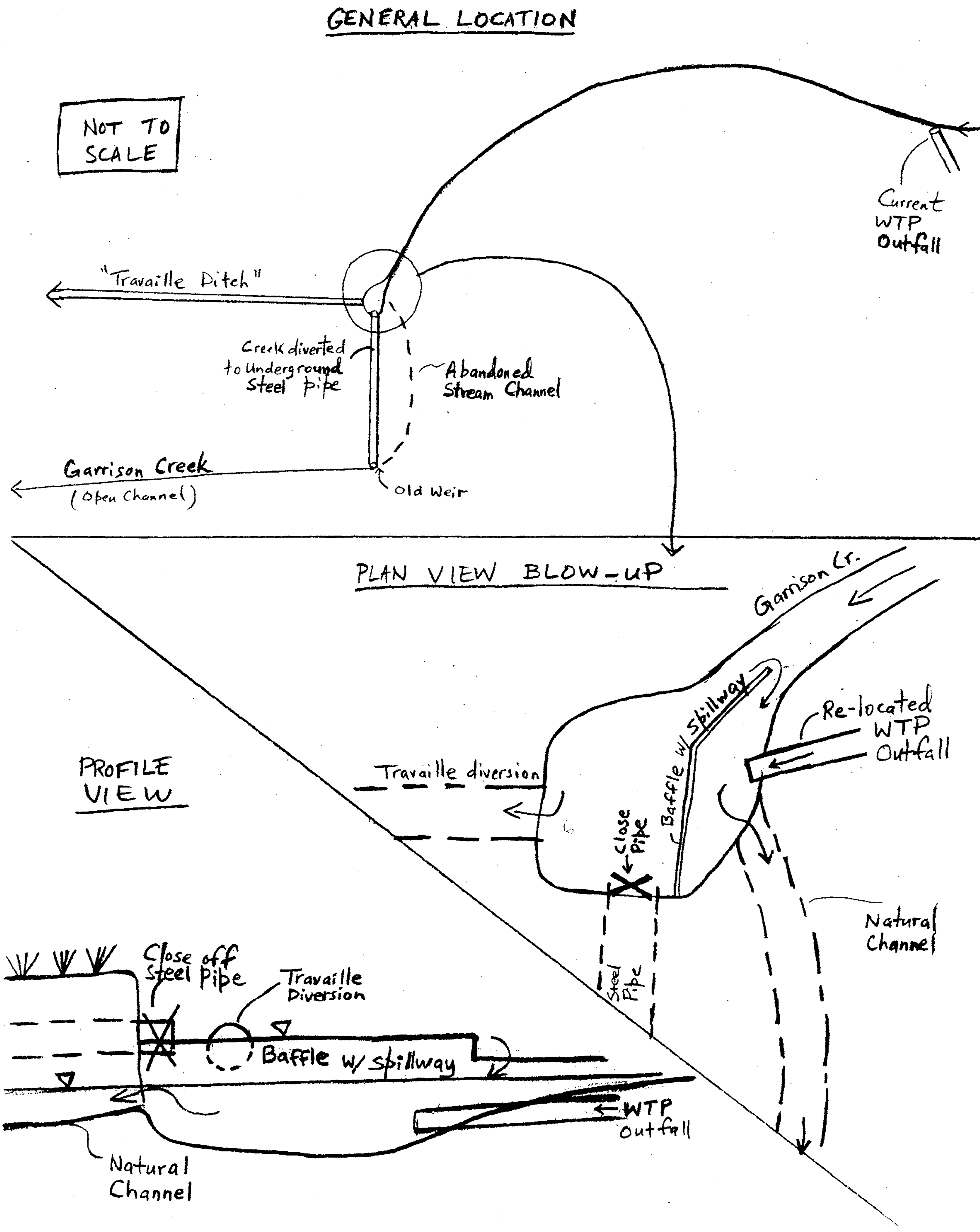
Sincerely,

Ed Rashin

Ed Rashin
Watershed Assessments Section

ER:blt

cc: Mimi Wainwright
Dennis Beich


GENERAL LOCATION
NOT TO SCALE
Current WTP Outfall
"Travaille Ditch"
Creek diverted to Underground Steel Pipe
Abandoned Stream Channel
Garrison Creek
(Open Channel)
Old Weir
PLAN VIEW BLOW-UP
Garrison Cr.
Baffle w/ Spillway
Re-located WTP Outfall
Travaille diversion
Close Pipe
Steel Pipe
Natural Channel
PROFILE VIEW
Close off Steel Pipe
Travaille Diversion
Baffle w/ Spillway
WTP outfall
Natural Channel