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Date: 4/25/06

To: Rod Garrett, Director of Public Works

Cc: Margaret Fleek, Director of Planning Department

From: Jenna Scholz, Water Quality Specialist

RE: **2005 Annual Water Quality Assessment for Gages Slough**

INTRODUCTION

Water quality was assessed in Gages Slough for a second consecutive year. Data were gathered to characterize general surface water conditions and identify point and non-point sources of pollution associated with stormwater runoff that may persist within Gages Slough and discharge points to the Skagit River. Physical, chemical, and biological water quality parameters were monitored throughout 2005. Sampling was conducted along the length of Gages Slough and selected outfalls within the city limits to assess water quality conditions and highlight any potential contaminants of concern.

This memo provides a summary of the water quality monitoring effort conducted in 2005 along with a brief discussion of findings and a comparison of results between the 2004 and 2005 monitoring years. Water quality data are compared with state and Federal criteria as well as ambient data from other wetlands in the Puget Sound Lowlands. Using these criteria, parameters of specific concern are identified and a brief discussion of their potential impact to wetland water quality is given.

METHODS

Standard techniques to assess water quality were used to monitor water quality within Gages Slough. A complete discussion of the methods used for this assessment can be found in the City of Burlington Surface Water Monitoring Plan (S&A 2004). Methodologies were developed to ensure a consistent and accurate sampling approach over a five-year monitoring period (S&A 2004).

Both comparison and compliance monitoring were conducted. Comparison monitoring was conducted by collecting samples in key wetland habitats within the slough and comparing them to other highly urbanized wetland systems in Puget Sound. Compliance monitoring was conducted by collecting samples from the upper- and lower-most stations within the slough. In addition samples were taken at specific stormwater outfalls. Sampling data were then compared with water quality criteria established by the Washington State Department of Ecology (Ecology 2003) and Environmental Protection Agency (EPA).

Analytes Evaluated

Physical parameters measured included temperature, total dissolved solids, total suspended solids, dissolved oxygen, and pH. Chemical parameters included nutrients such as nitrogen and phosphorus which are essential components of plant and animal diets; metals such as copper, lead, and zinc. Total petroleum hydrocarbons

and pesticides were also collected in 2005. Biological parameters included microorganisms such as fecal coliform bacteria from human sewage or animal manure. These disease-causing microorganisms have the potential to affect human and livestock health and generally enter surface waters in runoff containing animal or human wastes. Municipal discharges of sewage can also deliver bacteria and other organisms to surface waters.

Sampling Methods

Surface water samples were collected as grab samples by directly filling pre-labeled bottles containing the EPA recommended preservative for each parameter to be tested. During the storm sampling, composite water samples were collected and combined. Each stormwater sampling location was sampled three times during a storm event and combined into a single composite sample allowing for a 10% duplicate sampling for quality control and quality assurance protocol. Edge Analytical (an EPA accredited laboratory) performed the sample testing using EPA approved methods.

All samples were tested for the complete list of analytes at the beginning of the monitoring program in January 2005. Subsequently, sampling was conducted bi-monthly. Stormwater samples were collected once in November 2005.

Sampling location

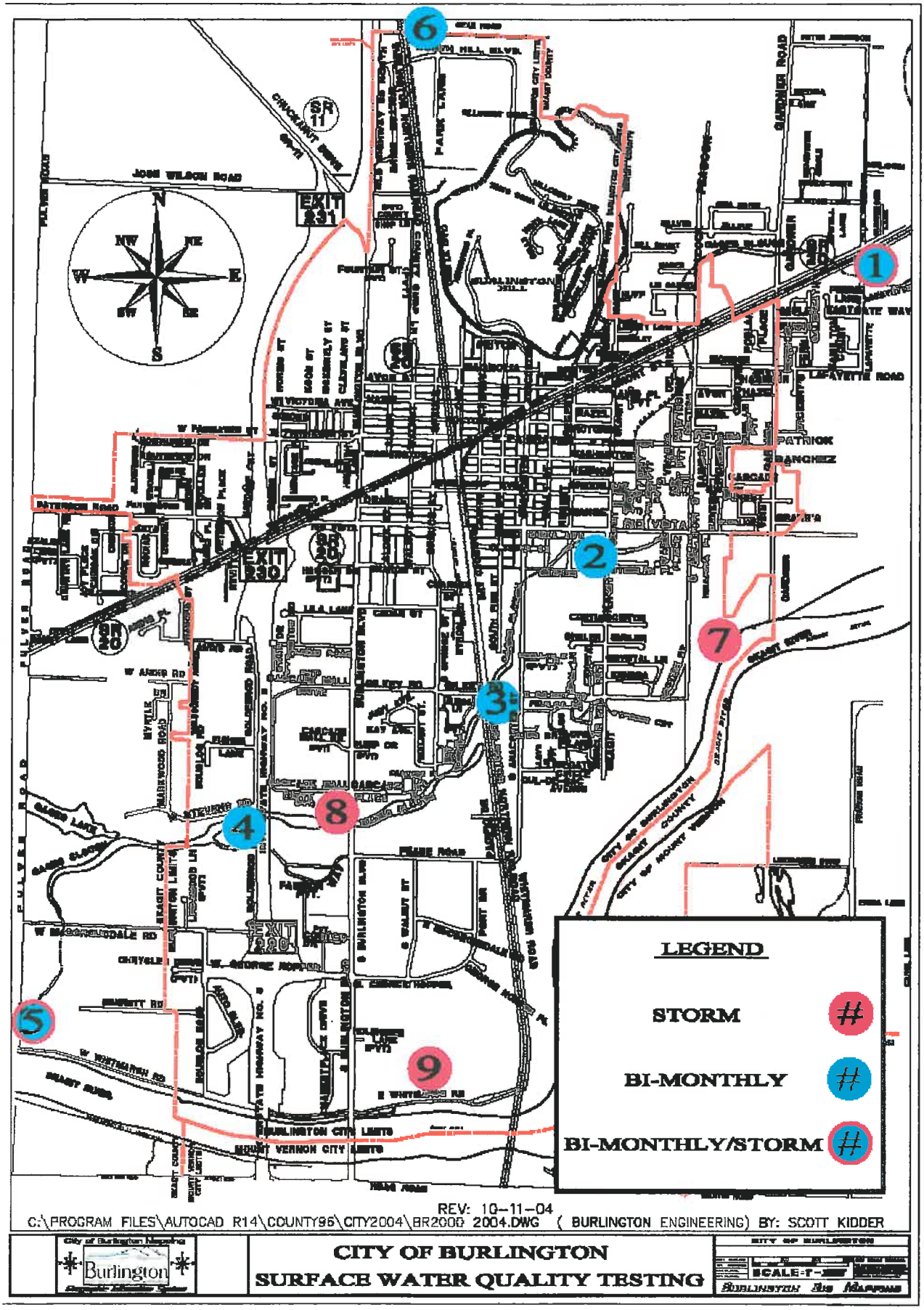
A total of six water quality stations were sampled bi-monthly. These sites were established at locations along the slough within the City of Burlington at stations 1,2,3,4,5, and 6 (Figure 1). Stations were also established (1, 5, 7, 8, and 9) for the collection and analysis of stormwater samples. Note that sites one and five are used for both surface and stormwater sampling. These station locations were selected because they meet the study objectives of characterizing existing surface and stormwater conditions as well as identifying existing point and non-point source pollution to Gages Slough and the Skagit River.

1. In Gages Slough at the upper most end at the City boundary off Gardner Road
2. In Gages Slough at the intersection of Skagit Road and Rio vista Avenue
3. In Gages Slough along Gilkey Road below the Burlington Northern Railroad Bridge
4. In Gages Slough at the intersection of Interstate 5 and Goldenrod Road
5. In Gages Slough at Pulver Road upstream of the pump station discharging to the Skagit River
6. At the outfall at the intersection with Old Highway 99 and Joe Leary (northern most site)
7. At the outfall for the City of Burlington Wastewater Treatment Facility
8. In Gages Slough along Burlington Boulevard near the Cascade Mall
9. At the outfall to the Skagit River along East Whitmarsh Road

Evaluation Criteria

The Federal Clean Water Act (CWA) requires states to set standards for pollution and to enforce violations. The goals of the CWA include maintaining surface water that does not threaten the health of fish, shellfish, or wildlife. These goals establish standards for the specific chemical criteria set by the State of Washington Department of Ecology (Ecology).

Ecology has established water quality criteria for the protection of fresh waters of the state (Ecology 2003). These surface water criteria are used to highlight discrepancies between the quality of the water body being analyzed and the quality of water needed to support a healthy aquatic ecosystem. Water bodies not meeting state criteria are placed on Ecology's 303 (d) list for non-compliance. Section 303 (d) of the federal Clean Water Act (CWA) mandates that the state establish the Total Maximum Daily Load (TMDL) of pollutants for surface waters that do not meet standards after application of technology-based pollution controls. The TMDL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CITY OF BURLINGTON
SURFACE WATER QUALITY TESTING

determines the amount of a given pollutant that can be discharged to the water body and still meet water quality standards. In the case of non-point source wetland analysis, these surface water criteria are not used to determine exceedances in a regulatory context, as there are currently no specific water quality criteria for wetlands. Rather, the standards are used in an ecological context to highlight the pollutants of concern within a given water body. Ecology has developed criteria for fecal coliform bacteria, dissolved oxygen, temperature, and pH (Table 1).

Table 1. Surface water quality criteria for the designated uses of salmon and trout spawning, core rearing and migration; and extraordinary primary contact recreation (Ecology 2003).

Fecal coliform bacteria	Dissolved oxygen	Temperature	pH
Not > 50 colonies/100 mL	9.5 mg/L	16.0 °C (60.8 °F)	6.5 to 8.5

Ecology criteria are also provided for trace metals such as copper, lead and zinc (Ecology 2003). Unlike other criteria, which are adjusted by designated use, criteria for trace metals are based on the specific hardness of the water sampled; the harder the water the less toxic the metal. In order to determine the correct criteria, it is important to use a hardness value that reflects ambient conditions because the higher the hardness value the higher the criteria will be. Criteria for this assessment was calculated based on an average hardness value of for the period being analyzed. Two sampling periods included metals analysis; one in March and one in September. 56.0 mg/L (Table 2), which is the mean value reported in 2005.

Table 2. Ecology criteria for total trace metals.

Month	Hardness (mg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)
March	66.0	11.50	35.23	10.4
November	19.0	3.5	9.15	7.56

In addition to the Ecology criteria, the EPA has recommended section 304(a) water quality criteria for nutrients (Table 3). These criteria were developed with the aim of reducing and preventing eutrophication on a national scale. Eutrophication is the input of significant loading of nutrient such that the tropic level of a water body is changed. The tropic level of a water body is the chemical and biological characteristic that defines the habitat of the system. Highly eutrophied systems support increasingly less diversity and can be associated with odor problems and the production of noxious weeds. Criteria are recommended for both causal (total nitrogen and total phosphorus) and response (chlorophyll a) variables. Results from the sampling effort are compared against these criteria to determine the potential of nutrients to increase the rate of eutrophication in Gages Slough.

Table 3. EPA recommended regional criteria for nutrients.

Water body type	Total nitrogen (mg/L)	Total phosphorus (mg/L)
Rivers and Streams	0.31	0.05

Regional Wetland Comparisons

The same regional criteria identified in 2004 were used to evaluate the relative quality of water within Gages Slough in 2005. Data collected in other wetlands (Azous and Horner 1997) located in the Puget Sounds Lowlands were used to establish ambient conditions (Table 4). These data were used to provide a relative understanding of pollutant concentrations and identify sites that require further analyses. In this study, ambient water quality was established for wetlands with different levels of urbanization. The nonurbanized category had both < 4% impervious land cover and > 40% forest and highly urbanized sites had watersheds that were both > 20% impervious and < 7% forest by area.

The data for nonurbanized wetlands characterizes the Puget Sound Basin lowland palustrine wetlands as relatively unaffected by humans (Table 4). They are slightly acidic (median pH = 6.4) systems with dissolved oxygen levels often well below saturation. Suspended solids are routinely low but quite variable, reflecting the strong influence of storm runoff events on total suspended solids. Total dissolved nitrogen concentrations are higher than dissolved phosphorus, suggesting general limitation of plant and algal growth by phosphorus. Fecal coliform concentrations are low (< 10 colonies/100 mL), and heavy metals concentrations are in the low parts per billion range.

Table 4. Ambient values of water quality variables for wetlands with varying degrees of urbanization (adopted from Azous and Horner 1997).

Variable	Non-urbanized	Highly Urbanized
pH	6.4	6.9
Dissolved oxygen (mg/L)	5.9	6.3
Total suspended solids (mg/L)	2.0	4.0
Ammonia (mg/L)	0.021	0.032
Nitrate+nitrite-nitrogen (mg/L)	0.112	0.376
Total phosphorus (mg/L)	0.029	0.069
Fecal coliform bacteria (CFU/100 mL)	9.0	61.0
Zinc (ug/L)	5.0	20.0

RESULTS AND DISSCUSSION

Results from the water quality monitoring are presented for each of the 13 parameters analyzed. Data are compared against state and federal criteria and recommended standards as well as the ambient water quality data for wetlands at different levels of urbanization. Seasonal patterns are identified and, where possible, site-specific information is analyzed. Specific parameters of concern are also identified and their potential impacts to aquatic ecosystems are discussed. Finally, water quality results are compared with those from 2004.

Physical Parameters

pH:

Data for pH were collected from January through December (Figure 2). Values were generally below both the Ecology criteria (6.5-8.5) and ambient values for wetlands in the Puget Sound Lowlands (nonurbanized = 6.4; highly urbanized = 6.9. Site 4 had the lowest pH values for four of the six months sampled.

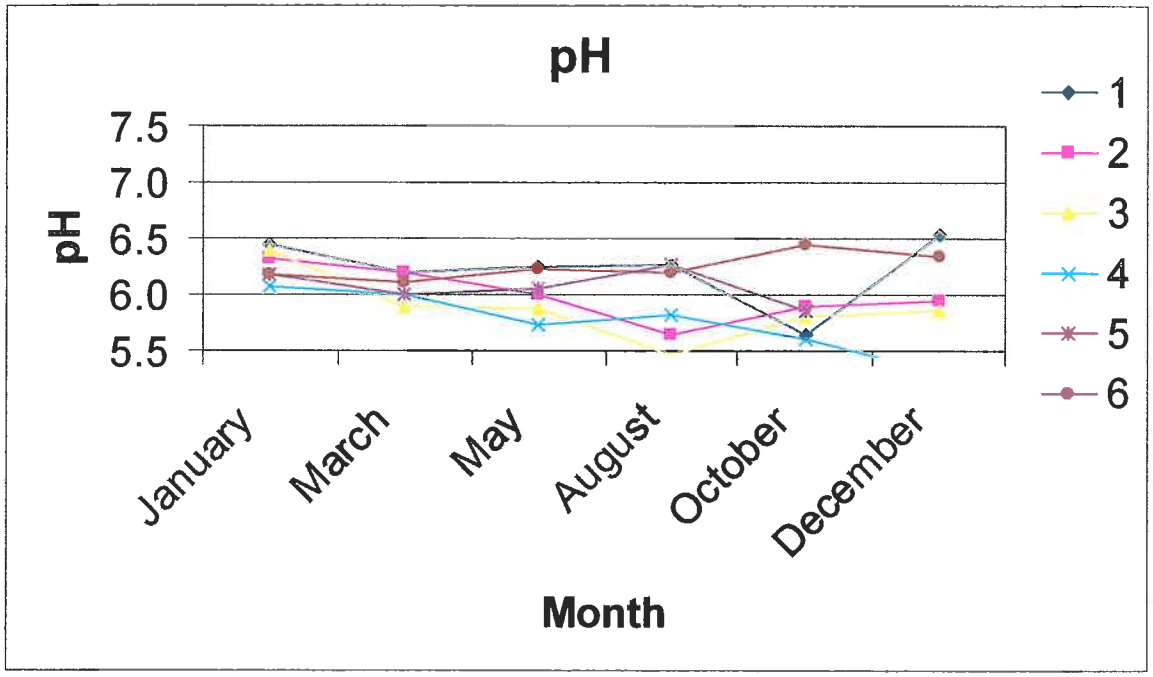

Figure 2. Levels of pH measured at study sites from January through December 2005.

Wetlands tend strongly to be more acidic than streams, and some more than others. However, the wetlands in Gages Slough are generally more acidic than most other wetlands in the Puget Sound Lowlands. This difference is very likely the result of too much production of organic acid by plants in the system. As Gages Slough is considered a wetland system, these pH values are not considered a parameter of concern. They do they warrant additional monitoring and attention to be sure they do not continue to decrease which could signify another potential source of pollution that may be linked to this parameter.

Dissolved oxygen:

Dissolved oxygen (DO) concentrations were collected from January through December (Figure 3). Values fell below the Ecology criteria (9.5 mg/L) at all sites during each month of sampling. Furthermore, DO values were below values for other wetlands in Puget Sound (nonurbanized = 5.9; highly urbanized = 6.3) during both December at January at all sites, and at sites 1, 2, 4, and 5 during each of the six months that this parameter was measured. Site three was above the 5.9 mg/L for non-urban wetlands in March and May only and Site 6 was also above this value for the majority of the sampling period.

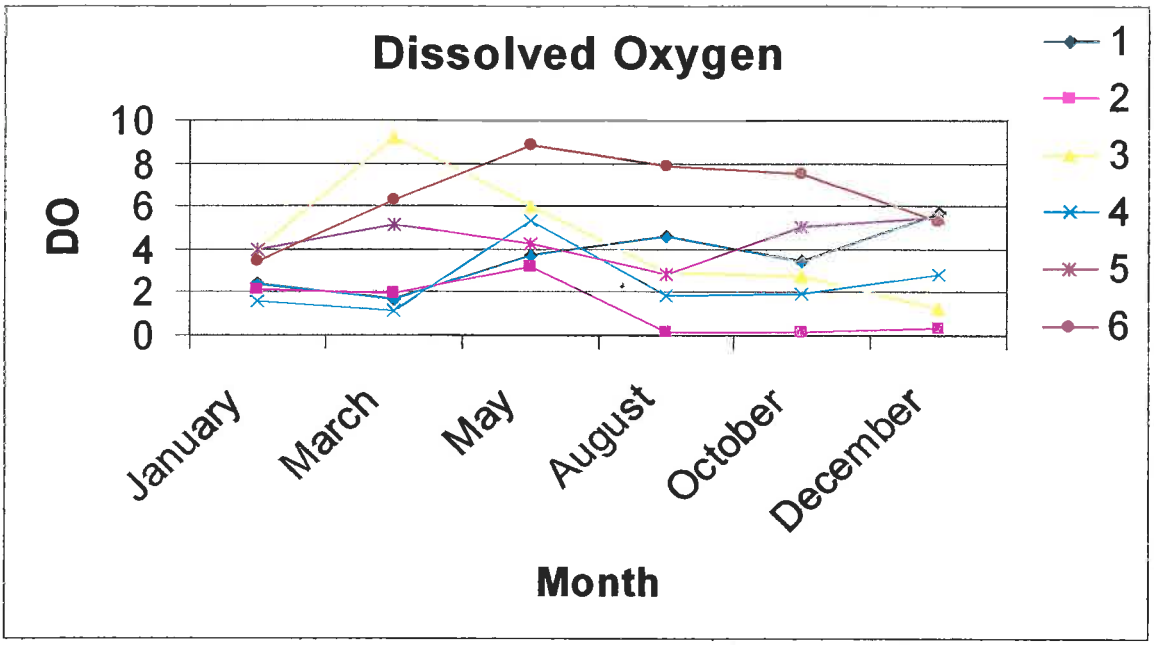

Figure 3. Dissolved oxygen concentrations at study sites from January through December 2005.

Flowing streams are typically better oxygenated than wetlands. This is due to the constant mixing that occurs when water is moving. This is in contrast to the slow moving, shallow water in a wetland. DO is also inversely correlated to temperature. DO levels in Gages Slough in 2005 appear to be consistently low at most sites sampled. And, although wetlands are typically lower in DO than streams, Gages Slough is well below that of a typical wetland with several samples in concentrations below 1.0 mg/L. Consistent low oxygen levels can lead to anoxic conditions that result in a change in plant community and odor problems. This parameter should continue to be monitored to determine if this low DO conditions is persisting.

It should also be noted that, although DO was low in Gages Slough during the bi-monthly sampling, this parameter was at or above standards during storm sampling (Appendix ??). For example, values at Site 5 at the confluence between Gages Slough and the Skagit River were 8.65 mg/L which exceeds the upper range of the Ecology Criteria of 8.5 mg/L. The difference in DO concentrations between the different sampling periods is likely due to the mixing effect discussed above as stormwater undergoes aeration through the discharge process. Therefore, although DO is a parameter that warrants observation during the bi-monthly sampling it is not a parameter of concern during storm events.

Water temperature:
Water temperature data are seasonally dependent with the highest recorded values in August (Figure 4). Values exceeding the Ecology criteria (> 16.0 ° C) were reported in August at sites 1,2,4 and 5. Increased water temperatures typically occur during the summer months when air temperatures are highest and low water volumes and slow velocities are present (Brown 1969).

Although values at some sites within Gages Slough do exceed Ecology standards during the summer months, they are not typical for lowland wetlands, and may in fact be lower than some lowland streams. Furthermore, water temperatures return to values below standards at the discharge point to the Skagit River (Site 5). Therefore, water temperatures are not considered a parameter of concern for Gages Slough and the slough does not appear to be contributing to thermal loading in the Skagit River.

Total suspended solids:
Concentrations of total suspended solids (TSS) varied seasonally and were generally above those observed in both non-urbanized (2.0 mg/L) and highly urbanized (4.0 mg/L) wetlands (Figure 5). Of the samples collected, nearly ninety percent were 4.0 mg/L or higher. Pulses of TSS are reported in March, August, and October with a reported 810.0 mg/L as the highest concentrations reported at Site 1 in October. These values were greater than 200 times that observed in highly urbanized wetlands.

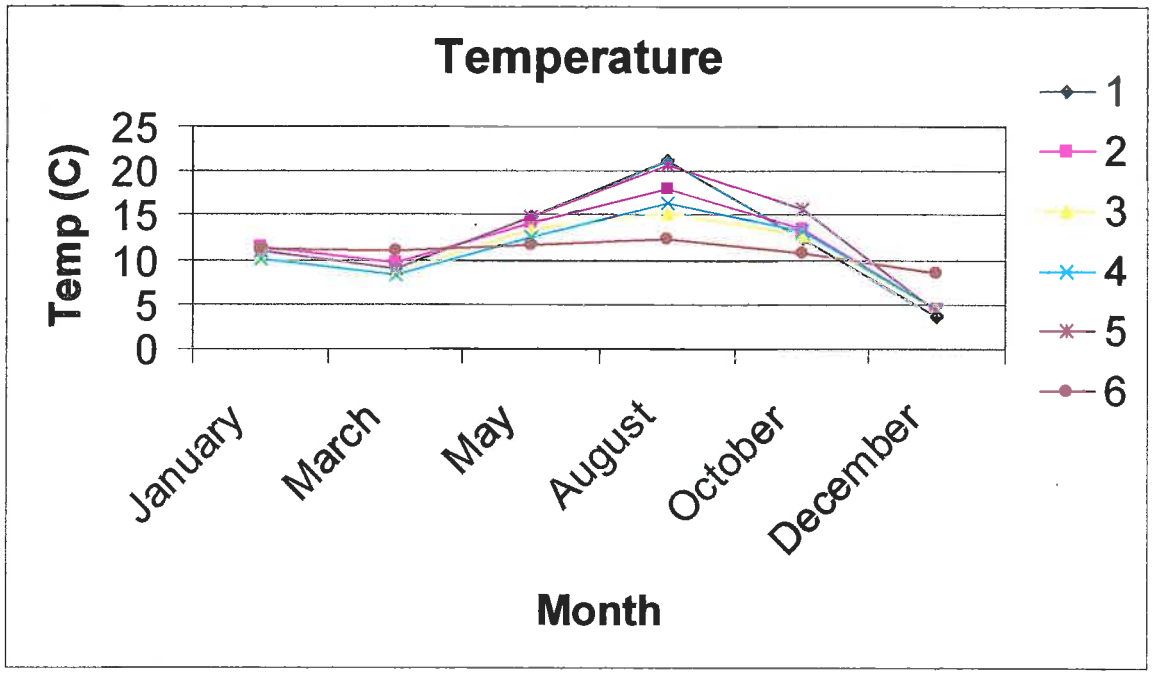

Figure 4. Water temperatures at study sites from January through December 2005.

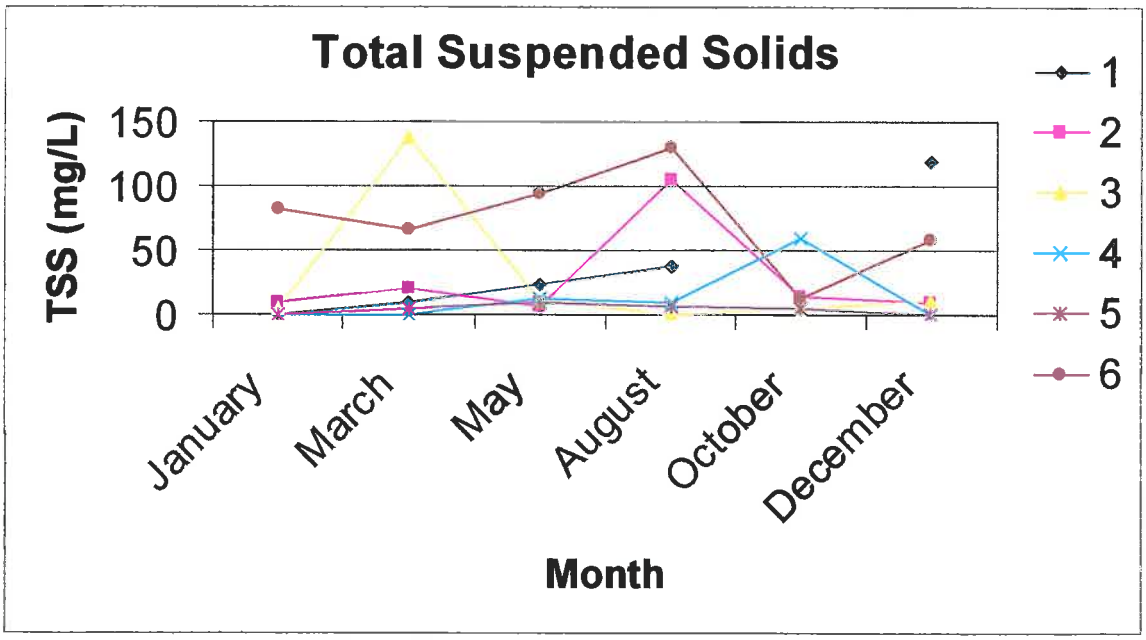

Figure 5. Total suspended solids concentrations at study sites from March through December 2004.

Suspended matter has a strong tendency to absorb and adsorb other pollutants (Stockdale 1991). Sedimentation, therefore, is a major mechanism of pollutant removal in wetlands (Chan et al. 1981; Silverman 1983). Accordingly, sites furthest downstream in Gages Slough should have the lowest concentrations of sediment. This is the case in Gages Slough as Site 5 consistently has lower TSS concentrations than the majority of the other sites monitored throughout the year. This indicates that, despite high degree of sedimentation in Gages Slough, the wetland plants are able to remove a high degree of suspended material. However, there are still values that exceed both recommended standards of this parameter and those seen in typical Puget Sound wetlands. Therefore, suspended sediment is considered a parameter of concern in this system.

Chemical Parameters

Nutrients:
Results for ammonia, nitrate+nitrite-nitrogen (N+N), and the sum of the two nutrient forms as total nitrogen (TN) are examined below. Data for these nutrients were collected from January through December (Figures 6,7, and 8).

No consistent seasonal pattern of peak concentration was observed for ammonia (Figures 6). However, 44 percent of the sampling results were above the typical ambient value reported for highly urbanized wetlands in Puget Sound. Sites 4 and 5 had concentrations below both the ambient values (nonurbanized = 0.021 mg/L; highly urbanized = 0.32 mg/L) during most months sampled. Concentrations typically exceeded these values at sites 1, 3, and 6. With the exception of two sampling efforts, Site 1 was above the values typically reported for other highly urbanized wetlands in the region, while Site 6 was above this value (0.32 mg/L) during all sampling periods in 2005.

Although wetlands do produce ammonia in decomposing the abundant organic matter internally produced (Mitsch and Gosselink 1993), it is possible that levels in Gages Slough reflect both naturally produced and external inputs of this parameter. Internal sources of ammonia may include those particular to the slough's hydrology and soil conditions. External sources may include inputs associated with land use activities within Burlington, but may also be a result of sources upstream of the City limits (Site 1) or outside it's boundary (Site 6).

N+N remained relatively constant across seasons and within each site, with the exception of Sites 3 and 4, which had a nitrogen peak in August (Figure 7). Site 3 had the highest single concentration of N+N (2.14 mg/L) in August. About 57 percent of the samples analyzed for N+N were above the ambient criteria for nonurbanized wetlands (0.112 mg/L), while nearly 27 percent were above the ambient value for highly urbanized wetlands (0.376 mg/L). Nurtient concentrations are typically greater in the summer months when flows decrease and dilution of these parameters is at a minimum.

Interestingly, during the winter months, concentrations of N+N were highest at the sites located at the boundaries of the City (Sites 1 and 6). This again suggests that nutrient inputs to Gages Slough may be contributed, at least in part, by sources outside of the City limits.

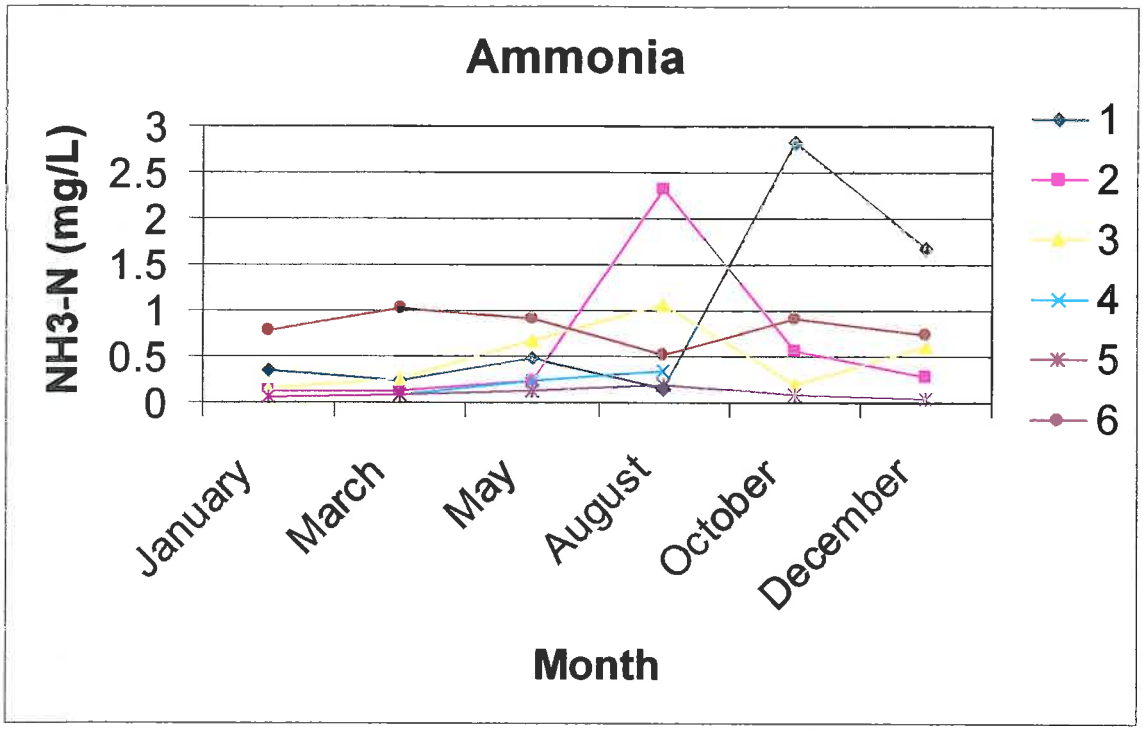

Figure 6. Ammonia concentrations at study sites from January through December 2005.

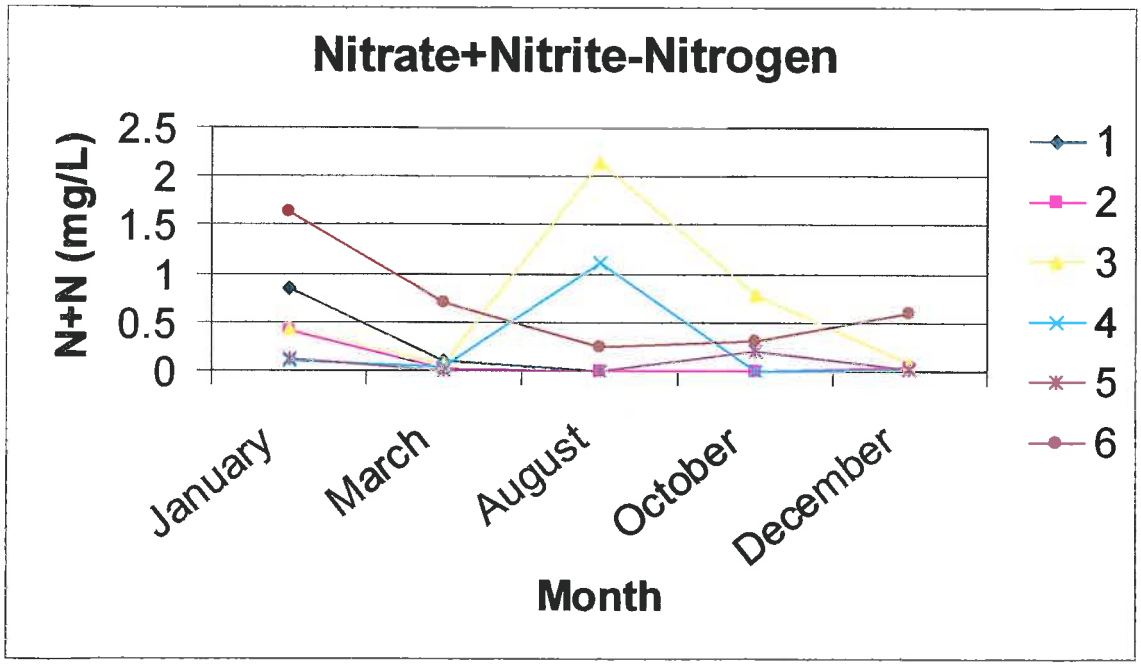

Figure 7. Nitrate+nitrite-nitrogen concentrations at study sites from January through December 2005.

Data for TN were also collected from January through December (Figures 8). TN was the highest reported at Site 1 in October, where it was roughly ten times that measured at other sites during that month (Figure 8). For TN, over 90 percent of the samples collected in 2005 were above ambient values (nonurbanized = 0.021 mg/L; highly urbanized = 0.032 mg/L) or EPA criteria (0.31 mg/L in rivers).

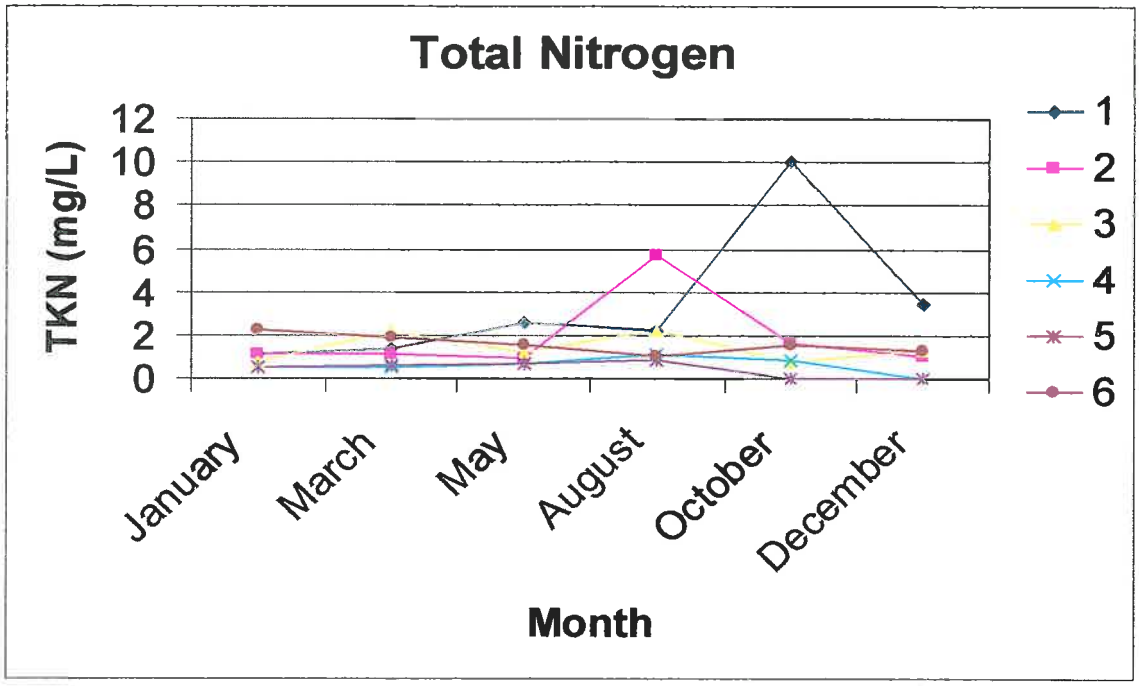

Figure 8. Total nitrogen concentrations at study sites from January through December 2005.

TN measurements comprise the sum of ammonia and N+N concentrations in the water column. Accordingly, TN concentrations naturally track those of these two nutrients. Values were above the EPA criteria for these nutrients particularly at sites 1, 3, and 6. Concentrations of TN at Site 1 were the highest observed when compared to the other sites. This further suggests that upstream sources of nitrogen are likely contributing to the overall nutrient load in Gages slough.

The concentrations of ammonia, N+N, and necessarily TN in Gages Slough are indicative of a highly eutrophic system. Nutrient conditions should continue to be monitored throughout the slough with special attention to those sites were these parameters have been reported in concentrations above Federal criteria.

Another nutrient of that can indicate the overall ecosystem health of aquatic systems is total phosphorus (TP). It is recognized that TP in concentrations greater than 0.05 mg/L is an indication of a eutrophic state (Welch 1980). This criteria was exceeded in about 70 percent of samples collected in 2005. Concentrations were highest at Sites 1, 2, and 6 and lowest at Site 5 (Figure 9.) TP was above 0.05 mg/L at Site 1 throughout the sampling year. High concentrations at this site indicate that areas upstream of the City of Burlington limits are, in part, contributing to the nutrient loading to Gages Slough. Levels were also high at Site 6 indicating further nutrient loading from sources outside of the City limits. This is the same pattern of nutrient input observed for nitrogen and the potential addition of nutrients from upstream and off-site should be considered in the analysis of Gages Slough.

It should be noted, however, that, although Gages Slough does contain nutrient concentrations at higher than recommended levels, concentrations at the discharge point (Site 5) remained relatively low compared to the other locations. This may be the result of dilution at this site, as well as an indication that the wetlands within the Gages Slough system are able to uptake much of the TP entering the system.

The ability of the Gages Slough wetland system to uptake nutrients is a positive characteristic, but continued high levels of nutrient loading could become a concern. Data from 2005 indicate that the wetlands in Gages Slough contain levels of nutrients (both TN and TP) that are above that observed in other wetland habitats in Puget Sound, even those experiencing a high degree of urbanization. When wetlands receive excessive nutrient loadings, ecosystem processes such as plant productivity and nutrient cycling are altered. Some of these alterations include changes in wetland structure and function (Carpenter et al. 1998) such as replacement of the slow growing native vegetation by faster growing invasive species (Davis 1991). Because concentrations of nutrients remain high in Gages Slough, eutrophication is a concern and monitoring of both nitrogen and phosphorous should continue.

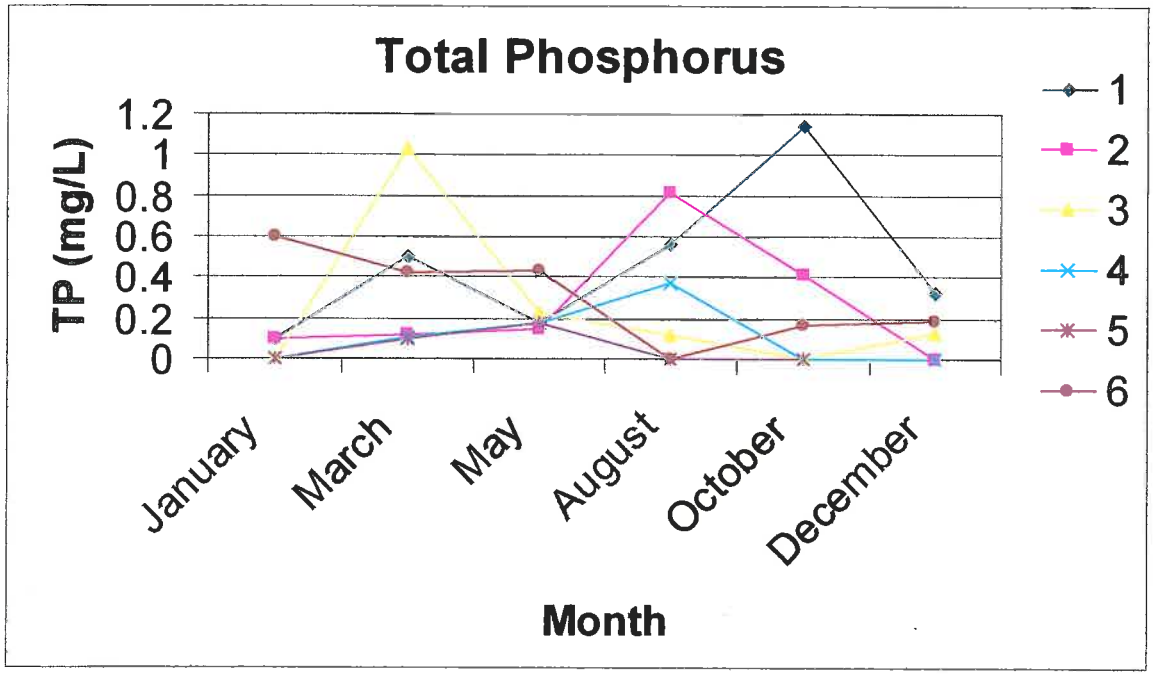

Figure 9. Total phosphorous concentrations at study sites from January through December 2005.

Pesticides and hydrocarbons:
A variety of pesticides were sampled for on March 21, 2005 and September 29, 2005. Analyses of samples from both of these dates reveals that these parameters are not currently a concern in Gages Slough or in stormwater discharging to the Skagit River. Pesticides were not detected in any of the samples collected on either date.

Similarly total petroleum hydrocarbons were sampled simultaneously with the pesticides. Samples were tested for gasoline, diesel fuel, and heavy hydrocarbons such as lube oil. None of these parameters were detected in any of the samples collected in either March or September with the exception of Site 3 which contained only a trace amount of lube oil during the March sampling. This site was not sampled in September so data confirming the continued presence of this substance is not available.

Metals:
Metals concentrations (copper, lead, and zinc) were monitored twice during the 2005 monitoring effort. The first sampling was done in March (3/21/06) and the second was a storm sampling conducted in late September (9/30/06). Different monitoring sites were monitored in March than in November, with the exception of sites

1 and 5, which were sampled on both dates. During the March sampling effort, samples were collected at the six bi-monthly locations that are located within Gages Slough (Figure 1). In September samples were collected at a total of five sites; 2 sites in Gages Slough - one at the uppermost location in Gages Slough (Site 1) and one at the point of discharge from the Slough into the Skagit River, and three sites located at stomwater outfalls (Sites 7, 8, and 9). This sampling schedule allows for the analysis of metals concentrations within the slough as well as within stormwater discharge. Concentrations of metals were higher in the stormwater samples collected in September than those collected in Gages Slough in March and they exceeded criteria more frequently.

Table 5. Hardness, metals, and total suspended solids in samples collected in March and September 2006.

Parameter	Site 1 (March/Sept.)	Site 2	Site 3	Site 4	Site 5 (March/Sept.)	Site 6	Site 7	Site 8	Site 9
Hardness	94.0 / 13.4	67.0	54.0	35.0	53.0 / 16.9	93.0	28.8	10.1	24.3
Copper (µg/L)	ND / ND	ND	ND	ND	ND / 6.0	ND	8.0	5.0	8.0
Lead (µg/L)	ND / 3.0	ND	ND	ND	ND / 1.0	ND	1.0	ND	ND
Zinc (µg/L)	6.0 / 20.0	9.0	1.0	13.0	12.0 / 77.0	5.0	62.0	43.0	42.0
TSS (mg/L)	10.0 / 216.0	20.0	137.0		4.0 / 14.0	66.0	37.0	48.0	25.0

During the March sampling effort, neither copper nor lead were detected at any of the sampling locations (Table 5). Zinc was found in concentrations above the hardness adjusted Ecology criteria (11.50 µg/L) at sites 4 and 5 while although these values were less than 2.0 µg/L above than the criteria. Concentrations at the other four stations were below these criteria. All of the stations sampled in March contained concentrations below those typically observed in other urbanized wetlands in Puget Sound (20. µg/L). Accordingly, Zinc is not considered a parameter of concern during dry conditions in Gages Slough.

During the storm sampling, concentrations of copper were above the hardness adjusted Ecology criteria (3.5 µg/L) at the discharge point of Gages Slough to Skagit River (Site 5) as well as all of the stormwater outfall locations sampled (sites 7, 8, and 9). Site 1 was the only site with stormwater concentrations below these criteria (Figure 1), indicating limited loading of copper from upstream sources.

Lead concentrations were below the hardness adjusted Ecology criteria (9.2 µg/L) at all sites sampled. Lead is not considered a parameter of concern for the gages Slough wetland system.

Zinc concentrations were consistently high in stormwater samples at all sites sampled throughout the monitoring period. Values for this parameter were above the hardness adjusted Ecology criteria (7.5 µg/L) at all sites sampled. They also exceeded the value typically observed (20.0 µg/L) in highly urbanized wetlands in the region.

Zinc is typically the most frequently detected metal in wetlands (Azous and Horner 1997). Furthermore, stormwater runoff tends to contain higher concentrations than surface water, as was observed in this study. This is because zinc is collected on impervious surfaces where it accumulates over time and is then washed into receiving waters and subsequently diluted. The most likely sources of zinc detected in stormwater runoff from the study area are associated with automobiles. While break linings and clutch pads contain copper, tires contain zinc, released as they wear along the roadway.

High concentrations of toxic materials such as copper and zinc can interfere with the biological processes of wetland plants, resulting in impaired growth, mortality, and changes in plant communities. The degree to which plants bioaccumulate these metals is highly variable. Although zinc is frequently detected in water samples, it is not often in quantities that exceed Ecology toxic criteria. For example, Azous and Horner 1997, found that criteria were only violated in one of their study wetlands, a highly urbanized one, in individual samples during the entire program. This same general situation prevailed for copper as well. The high

COMPARISON OF 2004 AND 2005 WATER QUALITY DATA

Two years of water quality data have been collected from within Gages Slough as well as from the stromwater discharge points from the City of Burlington into the Skagit River. Although it is recognized that wetlands are inherently dynamic systems, with annual, seasonal, and diurnal variability in water chemistry, there is still value in examining the quality of water within the wetland even over a short period of time. For example, this comparison can provide information primarily on the parameters that are chronically above the recommended criteria for aquatic life, or those that are consistently above values observed in other similar wetlands in the region.

Water quality results were compared between the 2004 and 2005 monitoring efforts. The first year of water quality monitoring identified several parameters that may be degrading the health of the Gages Slough wetland system and water quality in the Skagit River (Table 6). These included fecal coliform bacteria, ammonia, total nitrogen, total phosphorus, and zinc. The comparison between 2004 and 2005 water quality data indicates that in addition to the parameters recognized in last year's report, four new parameters may also be contributing to the degradation of water quality within Gages Slough including, pH, TSS, DO, and copper. Furthermore, high concentrations of these parameters above state and Federal standards or in excess of those observed more typically in other urbanized wetlands in the Puget Sound Lowlands may also be resulting in poor stormwater quality in outfall discharge to the Skagit River. Of particular concern to the Skagit River is the potential exacerbation of existing problems with parameters such as dissolved oxygen and fecal coliform bacteria. Both of these parameters are a consistent problem within outfall discharge from the City of Burlington which flows directly to the river. Finally, there appears to be a continuing trend toward eutrophication within the Gages Slough wetland complex as levels of both TN and TP were high. Nutrient loading from outside of the City limits is also indicated and could be a potential concern should this conditions persist.

Table 6. Comparison of water quality parameters of concern in 2004 and 2005.

Parameter of Concern	Parameters of Concern	
	2004	2005
Total Suspended Solids		X
Dissolved Oxygen		X
Fecal Coliform Bacteria		X
Ammonia	X	
Total nitrogen	X	X
Total Phosphorus	X	X
Copper		X
Zinc	X	X

X = indicated as a parameter of concern; *na* = data not available for this parameter

In general, the Gages Slough wetland system characteristics are more similar to those of a highly urbanized wetland than a non-urbanized system. Therefore, it is important to understand where potential sources of parameters of concern are and what measure can be taken to avoid further pollution of this wetland system. Continued focus on following the guidelines outlined in the City of Burlington Surface Water Management Plan as well as the list of recommended structural and nonstructural best management practices (BMPs) can help to achieve this. In addition, a habitat Management Plan for the wetlands within the slough is currently being prepared. New mitigation and water quality treatment strategies should be incorporated into this document to ensue the continued health of the Gages Sough system.

I have enjoyed the opportunity to continue to work with you on this project. Becky Ziel has collected outstanding data for this report ensuring the highest quality of analysis. Please contact me with any questions and provide comments on this draft report after May 24th, 2006. I look forward to getting your feedback on this report and completing the Gages Slough Habitat Management Plan.

Sincerely,

Jenna G. Scholz, Senior Aquatic Biologist
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