2006 ANNUAL REPORT FOR THE CITY OF MERCER ISLAND

Water Quality Monitoring in Five Drainage Basins

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King County

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EXECUTIVE SUMMARY

Beginning in 1999, the City of Mercer Island contracted with King County Water and Land Resources Division (WLRD) to provide stormwater monitoring in select Mercer Island drainages to assess the effectiveness of drainage basin improvements, as well as support Mercer Island's forthcoming municipal stormwater National Pollutant Discharge Elimination System (NPDES) permit application. Stormwater, sediment, and macroinvertebrate samples were collected from five Mercer Island drainage basins (Nos. 6, 10, 26, 32b, 42) in 2006. This report summarizes results from 2006, examines the efficacy of basin improvements, makes regional stream comparisons to assess relative stormwater quality, and looks for trends and/or localized water quality concerns. The Mercer Island drainage basins can be roughly separated into two groups based on land use: (1) Basins 10 is dominated by commercial land use; and (2) Basins 6, 26, 32b, and 42 are dominated by residential land use and erosive ravines.

Measurements included conventional parameters, nutrients, biological parameters (bacteria and macroinvertebrates), dissolved metals, herbicides, pesticides, and sediment (metals and hydrocarbons). Samples were analyzed according to methods used in previous years of this study (King County 2006). Water and sediment quality measurements were compared to the most relevant water quality standards and sediment guidelines, or placed in regional context when criteria were not available. Data were also analyzed to detect changes in water and sediment quality parameters after basin improvements were implemented.

Overall, water quality issues in the residential subbasins (especially Basin 26) were dominated by erosion-related problems. Erosion can cause elevated turbidity, total suspended solids (TSS), and conductivity. Total phosphorus (which binds readily to sediment) was also elevated in the residential basins and is likely associated with the elevated TSS. Water quality in the commercial subbasins (10 and 32b) was characterized by contaminants generally associated with transportation and impervious surfaces (i.e., metals and detectable levels of high molecular weight hydrocarbons). Copper and zinc levels were above water quality guidelines in these two basins, and they were also the only two subs with detectable levels of hydrocarbons. Further, Basin 10 was the only basin that continually had lead and/or zinc levels that were above the available Freshwater Sediment Guidelines. Bacteria levels were generally above the criteria for recreational use. Based on the Benthic Index of Biotic Integrity, benthic macroinvertebrate communities were ranked as either poor or very poor at all sites.

Analyses of pre- and post-improvement conditions were limited due to low sample sizes (in some cases, sampling locations were located upstream of improvements). Very few statistically significant differences were seen in mean parameter concentrations by site following basin improvements. However, as the collective benefits of these small-scale improvements coalesce and further restoration projects are completed, we may expect to see improvements in water and sediment quality over time. When compared with regional streams with similar land use patterns, the Mercer Island streams had relatively elevated dissolved phosphorus in the residential basins and elevated dissolved copper and zinc in the commercial basins. Bacteria levels in the Mercer Island streams, however, were comparable to regional streams with similar land use.

Though improved biological function is commonly a goal of stream restoration, the structure and function of the Mercer Island streams should be considered. These streams function primarily

as drainage basins, with steep slopes and erosive banks. They are also considerably smaller than other regional streams, and do not support anadromous fish populations. In other words, the drainage basins on Mercer Island may not have the capacity to function in the same ways as larger, more complex systems in other areas.

Future basin improvements should be tailored to address erosion in the residential basins, and stormwater management in the commercial centers. In erosive ravines, riparian vegetation, large woody debris, and channel diversification can slow the transport of sediment. In commercial areas, stormwater detention and other low impact development techniques (e.g., vegetated swales, porous pavement) may help filter contaminants and slow the transfer of degraded stormwater to receiving waterbodies. Source identification will be essential in determining which areas to target, and source control measures should be taken to lessen the impact of degraded stormwater runoff on Mercer Island streams and ultimately Lake Washington.

1.0 INTRODUCTION

The process of urbanization typically leads to increased impervious area, decreased vegetation, and channelized waterways, which cumulatively result in flashy stream systems with elevated inputs of surface runoff (Goonetilleke et al. 2005). Stormwater reduction and management is paramount in urban and urbanizing areas where contaminants, such as metals, hydrocarbons, and pesticides, build up on impervious surfaces before washing into receiving waters (Hall and Anderson 1985). Degraded stormwater runoff falls under the classification of non-point source pollution, or contamination that does not originate from a discrete source. Since non-point source pollution remains the largest water quality problem in the United States (Pew Oceans Commission 2003, USCOP 2004), the federal Clean Water Act (CWA) has tightened regulations on stormwater runoff. The CWA now requires municipalities to obtain National Pollutant Discharge Elimination System (NPDES) stormwater permits. These permits require the implementation of a Stormwater Management Program, which must include plans to reduce pollutant discharge, minimize impacts to receiving waters, eliminate illegal releases, and make progress towards compliance with water and sediment quality standards.

Mercer Island is part of the Cedar River–Lake Washington Watershed. As part of the City of Mercer Island's (City) comprehensive stormwater planning and management effort, as well as their Tier 2 NPDES stormwater permitting process, the City has implemented subbasin scale drainage improvements to facilitate silt removal and erosion control, and to minimize the input of degraded runoff to Lake Washington, the receiving waterbody. Since 1999, the City has contracted with the King County Water and Land Resources Division (WLRD) to evaluate the effectiveness of these stormwater facility improvements by assessing water and sediment quality, as well as examining biological indicators of ecosystem health, in five representative basins draining to Lake Washington.

Stormwater, sediment, and macroinvertebrate sampling was conducted seasonally in selected Mercer Island streams, and samples were analyzed for a variety of water and sediment quality parameters (Table 1). Although the grab samples collected only represent a snapshot in time, the data can be reviewed qualitatively for key parameters that are repeatedly above water quality standards (WQS) and freshwater sediment guidelines (Smith et al. 1996, Avocet Consulting 2003, WDOE 2006). This information can be useful for improving and focusing stormwater management techniques, and for guiding salmon conservation and recovery efforts in Lake Washington. Mercer Island's graveled stream mouths and near-shore areas serve as important salmonid spawning and rearing habitat. Therefore, with the listing of Puget Sound Chinook salmon as threatened under the Endangered Species Act (ESA; for current status see: http://www.nwr.noaa.gov/Species-Lists.cfm), Mercer Island's impacts on water and sediment quality in essential fish habitat become increasingly important.

The overarching goal of this monitoring effort is to answer the central question: What is the water and sediment quality within the main watercourses of five select basins, just prior to their draining to Lake Washington? This report presents results from field and laboratory investigations conducted in 2006, and highlights significant patterns or trends detected after eight continuous years of monitoring. Where applicable, water quality parameters measured before basin improvement implementation were compared with those measured after project completion. Mercer Island stream parameters were also compared to conditions in regional streams routinely monitored by King County. Although the regional streams included in this evaluation likely have different functionality than the Mercer Island drainage basins in terms of size or biological community, these comparisons can help qualitatively evaluate whether any

water quality problems detected are unique to Mercer Island or a common problem across urban and suburban areas in the region.

Table 1. Water and sediment quality parameters measured in 2006.

Conventional/Other	Nutrients	Biological	Dissolved Metals	Chlorinated Herbicides	Organo-phosphate Pesticides	Sediment
Discharge	Total phosphorus (TP)	Fecal coliform bacteria	Hardness	2,4,5-T	Chlorpyrifos	Cu
Rainfall	Ortho-phosphorus (OP)	*Escherichia coli* bacteria	Copper (Cu)	2,4,5-TP (Silvex)	Diazinon	Pb
Temperature	Total nitrogen (TN)	Benthic macroinvertebrates	Lead (Pb)	2,4-D	Disulfoton	Zn
Dissolved oxygen (DO)			Zinc (Zn)	2,4-DB	Malathion	Cr
Conductivity			Chromium (Cr)	Dalapon	Parathion-Ethyl	NPO
pH				Dicamba	Parathion-Methyl	
Turbidity				Dichloroprop	Phorate	
Total suspended solids (TSS)				Dinoseb		
Nonpolar oil (NPO)				MCPP		
Hydrocarbon identification				MCPA		

2.0 STUDY AREA

Water and sediment quality were evaluated in five drainage basins in 2006 (Figure 1). These basins were selected by the City as representative of typical land uses across the island. The residential basins range from 22.4 to 37.5% total impervious surface, and the commercial basin has 47.8% impervious surface (Table 2). Basins 10 represents land use dominated by commercial centers, and Basin 32b is mainly residential with a small commercial area (Figure 2). The other three basins (6, 26, and 42) drain erosive ravines adjacent to residential neighborhoods (Figure 2). These are non-salmonid bearing streams, with watercourses that are alternately free flowing and tight-lined (channelized in concrete ditches or pipes). Sampling locations were chosen to best characterize stormwater runoff draining to Lake Washington, and with the exception of Basin 32b, samples were collected from each creek at the most downstream point before the water enters the final tight-line to the lake. The following sections provide a description of the study basins.

Table 2. Surface area, percent total impervious surface, and primary land use category for the six study basins.

Basin Number	Years Sampled	Area (ft^2)	% Impervious*	Primary Land Use
10	1999 - 2006	11623830.1	47.8	Commercial
6	1999 - 2006	7895001.9	37.5	Residential/Ravine
26	2001 - 2006	4381099.0	36.7	Residential/Ravine
29	1999 - 2002	5108666.2	36.0	Residential/Ravine
32b	2001 - 2006	8013777.9	36.6	Residential
42	2003 - 2006	6692179.8	22.4	Residential/Ravine

*Imperviousness calculations conducted by City of Mercer Island Information and Geographic Services

Figure 1. Study basins and sample sites.

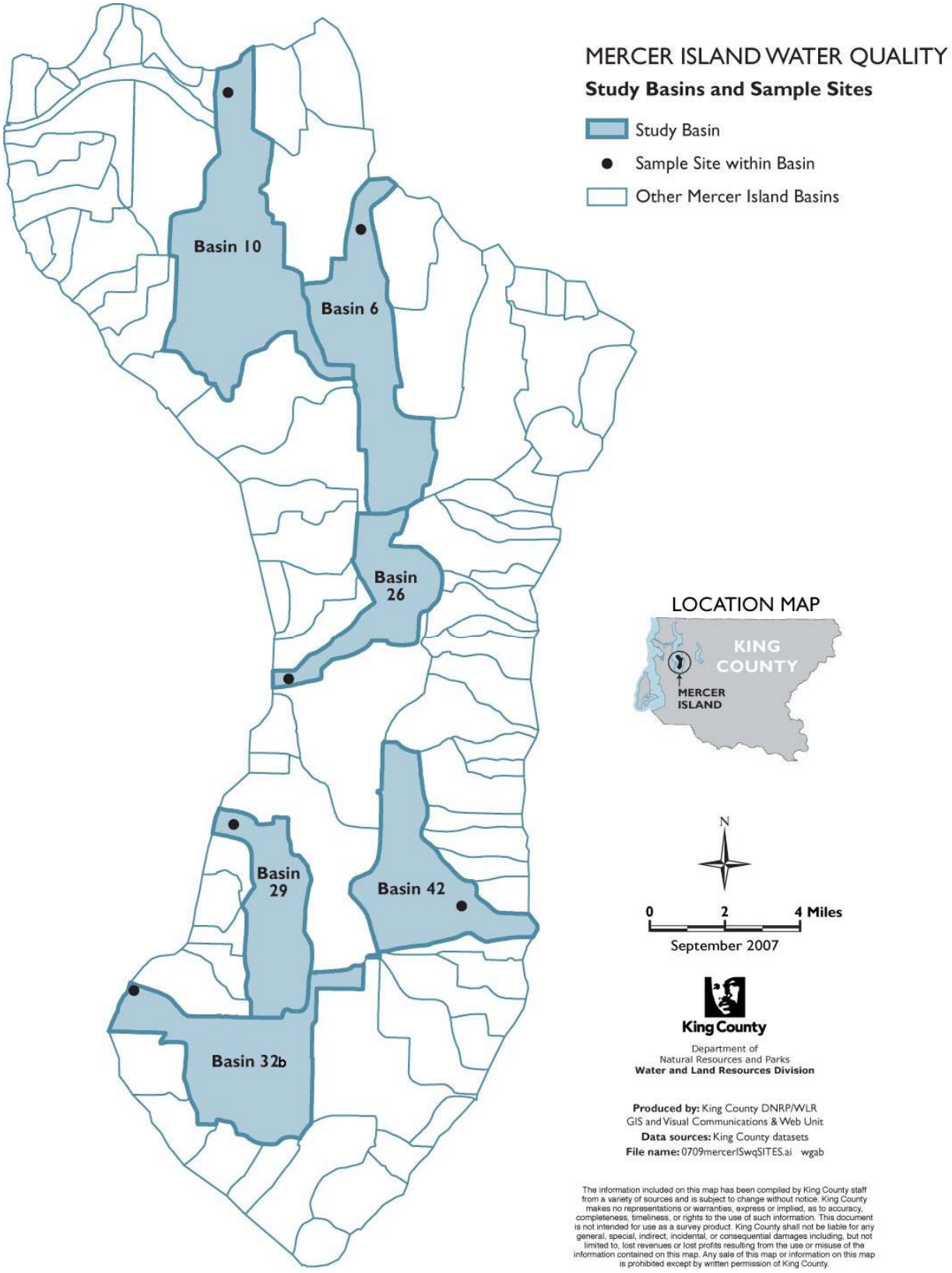
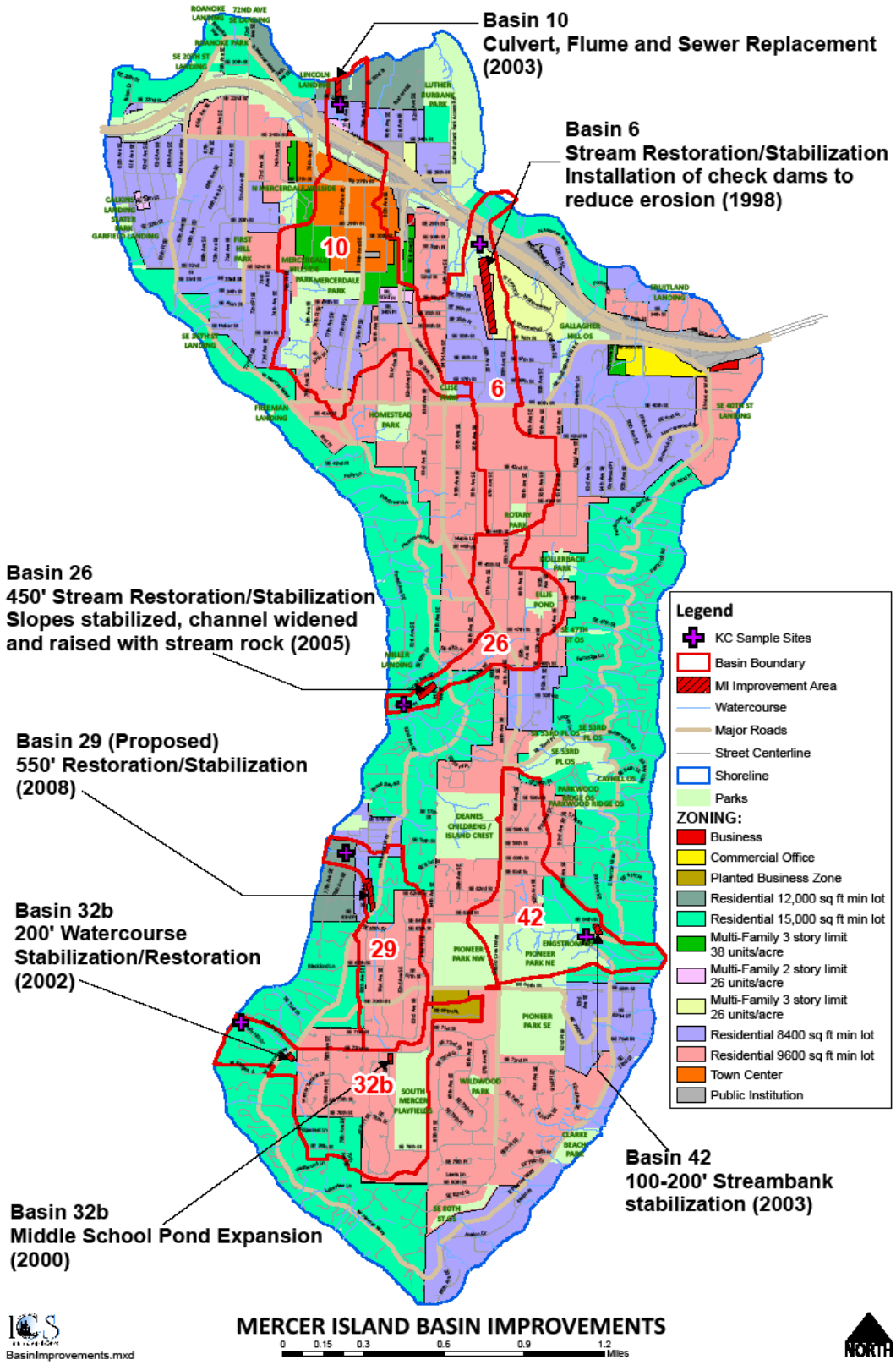


Figure 2. Mercer Island landuse, drainage basins, and basin improvement projects.



2.1 Drainage Basin 6

The main watercourse of Basin 6 captures flow from neighborhoods consisting primarily of single-family residences and limited multi-family housing (Figure 2). The creek flows above ground on the south side of Interstate 90 (I-90) through a portion of Luther Burbank Park, which drains an adjacent ravine. The creek flows into a stormwater sediment pond with a debris trap, then drops at least 30 feet before traveling under I-90 and draining into Lake Washington. During high flow conditions, the pond backs up into the stream, so samples are collected 50 to 60 feet upstream of the pond where there is visible flow. The Washington State Department of Transportation (WDOT) originally maintained the stormwater pond at this site, which also captures sediment and is periodically dredged. Maintenance responsibilities for this facility were transferred from WDOT to the City in 2002. Sampling occurred in Basin 6 from 1999 to 2006.

Improvements in the forested portion of Basin 6 were completed in 1998 and include placement of large woody debris in the channel to form a series of check-dams designed to reduce erosion, capture sediment, and minimize the transport of degraded runoff to Lake Washington. These improvements are upstream of the sampling location.

2.2 Drainage Basin 10

The watercourse within Basin 10 drains the majority of the City's business district/town center as well as single-family and multi-family residential neighborhoods (Figure 2). The headwaters are located in Mercerdale Park. Samples were collected from the south side of the SE 22nd Street crossing from 1999 to 2006. Downstream from this point, the creek passed through one of two culverts and then flowed north in a concrete-lined ditch to Lake Washington. In 2003, an improvement project replaced two smaller culverts under SE 22nd Street with one larger and longer box culvert designed to better route large stormflows under this street and across private properties to the north. These flood management improvements were located downstream from the sampling location.

2.3 Drainage Basin 26

The main watercourse within Basin 26 captures flow from neighborhoods consisting primarily of single-family residences (Figure 2). The headwaters include Ellis Pond and its surrounding greenscape. This drainage eventually passes through a steep and confined ravine on its way to Lake Washington. Samples were collected from 2001 through 2006 at a public access site at the base of the hill along SE 50th Place just upstream of a wooden footbridge. The creek is heavily armored from this access point to Lake Washington.

Basin improvements were implemented upstream of the sampling location in September and October of 2005. Slopes were stabilized and the channel was widened and raised with stream rock west of 84th Ave SE. Native vegetation was planted along the streambank. Additional restoration work is planned between West Mercer Way and Island Crest Way, and is scheduled to take place in two to three years.

2.4 Drainage Basin 29

The main watercourse in Basin 29 collects and carries stormwater from predominantly residential neighborhoods (Figure 2). The creek passes through a steep ravine, in which high urban creek flows have led to increased sediment transport. Stream restoration and stabilization (650-foot section upstream of sampling location) is scheduled to take place in 2008.

Sample collection (1999-2002) occurred downstream of the proposed project site but above the point where the creek disappears into yet another tightline and is routed to the west, directly into Lake Washington. The City decided to cease sampling in this drainage after 2002, opting instead to investigate Basin 42.

2.5 Drainage Basin 32b

Though the majority of the watershed is residential, Basin 32b drains the few commercial businesses located on the south end of Mercer Island (Figure 2). This basin is somewhat unique in that it flows into Lake Washington via a streambed possessing a true "mouth." Residential neighborhoods, schools and playfields, and a series of detention ponds also characterize this drainage, and most of the development occurred in the 1970s and 1980s. Basin improvements included expansion of the stormwater detention pond at Islander Middle School in 2000, and watercourse stabilization (200 feet) on the east side of West Mercer Way in 2002. Samples were collected from 2001-2006 at the bottom of Holly Hill Drive on private property adjacent to Lake Washington. To prevent collection of backwater from Lake Washington, the sampling location was established approximately 75 feet upstream from the mouth. Below the sampling point, the creek flows through a natural stream channel before draining into the lake.

2.6 Drainage Basin 42

Basin 42 drains the southeastern end of Mercer Island (Figure 2). The basin headwaters originate in Pioneer Park and adjacent residential neighborhoods. Erosive ravines are present in this area. Overall, this basin has more open space than the other study basins. The City maintains a stormwater detention pond and sediment basin in this watershed. After water passes through the detention facility, the flow is tight-lined to Lake Washington. Samples were collected (2003-06) downstream of Pioneer Park and approximately 10 feet upstream of the stormwater detention facility, and sediment samples were collected in the detention pond. Basin improvements included streambank stabilization (100–200 feet) on the west side of East Mercer Way, upstream of the sampling location.

2.7 Regional Streams

Regional comparisons were conducted to (1) understand the relative scale of water quality issues for parameters which were continually above WQS (i.e., bacteria, dissolved metals, and sedimentary metals); and (2) provide scope for parameters that do not have appropriate WQS or guidelines (i.e., NPO, nutrients). Five regional streams that have been monitored over the past several years as part of King County's Streams Program were chosen for comparison (Jean Power and Stephanie Hess, KCEL, personal communication). These streams have similar land use to those monitored on Mercer Island. However, these regional streams are generally larger (greater bank width and higher flow regime) systems with free-flowing watercourses that often support anadromous fishes and other species. In contrast, the Mercer Island streams are smaller, periodically tight-lined, and do not support migratory salmonids. The purpose of this comparison is to evaluate how dominant land use affects water quality, and to better understand the scale of water quality issues on Mercer Island.

Idyllwood Creek which flows into Lake Sammamish and Thornton Creek which flows into Lake Washington were categorized as "commercial" for comparison with Basin 10. Fairweather, Lewis, and Yarrow creeks were categorized as "residential with erosive ravines" for comparison with Basins 6, 26, 29, 32b, and 42. For more information about these streams, refer to the King

County Streams site (http://dnr.metrokc.gov/wlr/waterres/streamsdata/SampleSites.htm). For storm sampling criteria for these streams, refer to Section 3.1.

3.0 METHODS

King County WLRD collected water samples during storm events, and sediment and macroinvertebrates during summer low flow conditions. The following sections detail specific methodology, data analysis techniques, and WQS and freshwater sediment quality guidelines (FSQG) which were used to screen for potential problems.

3.1 Water Quality Sampling Criteria

Water samples were collected during storm events that were most likely to result in transport of urban stormwater and sediment. Various factors affect pollutant load and transport, such as length of the antecedent dry period, rates of atmospheric deposition, storm intensity, land use and ground cover (Bertrand-Krajewski et al. 1998, Goonetilleke et al. 2005). Storm sampling criteria were derived from the former King County Storm Watcher Program (King County 1995). These criteria are based on three conditions: cumulative precipitation over a given time period, antecedent dry conditions, and stream stage. Ideally, samples were collected after a particular storm reached a cumulative precipitation threshold (Table 3). Field staff monitored real-time rainfall data when deciding whether to sample during a particular storm.

Table 3. Precipitation intensity criteria for stormwater sampling.

Time Period (hours)	Precipitation (inches)
6	0.25 - 0.5
12	0.5 - 0.75
24	≥ 1.0

Since contaminants build up on surfaces during periods of little to no rainfall, antecedent dry period is another important factor in stormwater sampling. Field staff aimed to collect water samples during storm events that had a three-day pre-storm period with an overall rainfall of 0.25 inches or less. Because antecedent dry conditions are often difficult to meet in this region, it was deemed satisfactory to collect water samples under ideal conditions at a minimum of one event each spring and fall.

Finally, pollutant loads are typically greatest when storm flows are rising. Therefore, field staff aimed to collect water samples during the rising limb of the hydrograph, and as near as possible to the stream's crest stage for a given storm. Given both the flashy characteristics of the drainage systems and access issues at some of the residential sampling sites, it was not always feasible to collect samples on the rising limb of an event because this can occur rapidly or in the middle of the night.

Precipitation data were collected using a continuous recording tipping bucket rain gauge with an attached data logger recording in 0.01-inch increments at 5-minute intervals. During the sampling season, field staff monitored the King 5 SchoolNet Weather website (http://www.instaweather.com/king/) to determine when to collect samples. Subsequent

analyses were conducted by downloading precipitation data from King County's Hydrologic Information Center (http://dnrp.metrokc.gov/WLR/Waterres/hydrology/), using either the Mercer Island rain gauge (MERC; 2001-06) located at the Mercer Island school district administration offices, or the May Creek rain gauge (37U; 1999-2000) located approximately 3.8 miles from the study area. Detailed records allow King County staff to report rainfall conditions before and during the storm event, as well as to determine whether sampling criteria are met.

The precipitation criteria used for the King County streams wet weather sampling program was slightly less stringent. These samples were collected as long as there was at least ¼ inch rainfall over 24 hrs with a minimum of 24-hour antecedent dry period (King County 2002).

3.2 Field Sampling Methods

Physical, chemical, and biological parameters were analyzed in 2006 to evaluate water and sediment quality in each basin (Table 4). Water quality grab samples were taken during storm (S) conditions, and sediment and invertebrates were sampled during non-storm (NS) conditions (Table 4). In-depth descriptions of each individual parameter and its biological and/or chemical significance are available in the Years 2004-05 Annual Report for the City of Mercer Island (2006).

Table 4. 2006 Sample dates and type, and location of field replicates.

Sampling Date	Weather	Field Parameters	Water Quality	Sediment	Macro-invertebrates	Replicate Location
03/08/06	S	X	X			32b
08/03/06	NS	X			X	N/A
08/07/06	NS	X			X	N/A
08/10/06	NS			X		26
11/02/06	S	X	X			26
12/11/06	S	X	X			10

S - Storm sample
NS - Non-storm sample
N/A - Not applicable; replicate macroinvertebrate samples are not collected

3.2.1 Water Quality Parameters

Field parameters, including stream velocity, water temperature, dissolved oxygen (DO), pH, conductivity, and turbidity, were collected during storm events in March, November, and December 2006. Water quality field parameters were monitored from the thalwegs of the main watercourses in each basin (King County 2005). A Swoffer 2100 velocity meter was used to collect velocity data for calculating stream flow. A Hydrolab Series 4 sonde and datalogger was used to analyze temperature, pH, conductivity, and DO; and a Hach 2100P turbidimeter was used to measure turbidity in the field.

This assessment identifies a limited number of contaminants present in urban stormwater that may ultimately impact water quality in Lake Washington. This water quality evaluation included analysis of the following parameters: total suspended solids (TSS), non-polar oil (NPO), nutrients (total phosphorus [TP], ortho-phosphorus [OP], and total nitrogen [TN]), bacteria (fecal

coliform and *E. coli*), benthic macroinvertebrates, hardness, dissolved metals (copper, lead, zinc, and chromium), ten chlorinated herbicides, and seven organophosphate pesticides (Table 1).

All samples were processed by the King County Environmental Laboratory (KCEL) or a certified lab contracted by KCEL. Water samples were collected according to Quality Assurance/Quality Control (QA/QC) protocols provided by KCEL (King County 2005). Specific sample collection techniques varied by parameter. Field replicates were collected on each sampling date for QA/QC analysis (Table 4; replicate macroinvertebrate samples are not collected).

Laboratory results from the KCEL may be "qualified" as less than the method detection limit (MDL) or the reporting detection limit (RDL). Values less than the MDL indicate a parameter is not present in the sample above this level. Values greater than the MDL, but less than the RDL indicate confidence that the parameter is present, but at low enough levels to decrease reliability of the numerical result (King County 2004). Values greater than the RDL are considered reliable after undergoing laboratory QA/QC. Where metal levels were below the MDLs, the metal concentration was conservatively reported as the MDL. A complete listing of MDLs accompanies each laboratory report in Appendix A.

3.2.2 Macroinvertebrates

Benthic macroinvertebrate samples were collected from Basins 6, 10, and 42 under summer low flow conditions in August 2006 (Table 4). Stream flows were too low in Basins 26 and 32b to use the invertebrate sampling equipment; no samples were collected. Sampling techniques followed standardized King County protocols, which require a minimum of one inch of water to pass through the surber sampler (King County 1999). Samples were collected from three riffles and combined into one composite sample per site. Taxonomic analyses were conducted by ABR, Inc. in Forest Grove, OR (Appendix B).

3.2.3. Sediment Sampling

Annual collection of sediment samples for analysis of metals (copper, lead, zinc, and chromium) and NPO enhanced overall basin assessment by evaluating pollutants that may be potentially resuspended and transported to Lake Washington. Because sediments move less quickly through a system than water, they can provide more long-term information on contaminants that may be present in the watershed. Sediment was collected from depositional zones within each stream using 7.5cm core tubes. Samples were collected according to QA/QC protocols provided by KCEL (King County 2005), and were analyzed by KCEL for metals and NPO compounds (Appendix C).

3.3 Data Analysis

Water quality data (storm samples only) were obtained from the LIMS database (administered by King County) for both Mercer Island drainage basins and regional streams with similar characteristics and/or land use to Mercer Island. Thornton, Idyllwood, Fairweather, Lewis, and Yarrow creeks were selected for regional comparison of stormwater quality. All six Mercer Island study basins (6, 10, 26, 29, 32b, 42) sampled between 1999 and 2006 were included in interannual and regional comparisons. Statistical analyses (t-test, ANOVA, Tukey's HSD) were used to detect significant differences in mean parameter values (Zar 1999).

3.3.1 Water Quality Criteria

Washington State water quality standards (WQS) are currently only established for certain parameters. When WQS were not available, data were compared to available thresholds or guidelines. If no appropriate guidelines or literature-based thresholds were available, the results were compared to available water and sediment quality data for regional streams. The sample collection techniques (grab samples) used in this study limited the WQS that could be used for comparison because they only reflected a snapshot in time. For example, temperature measured instantaneously during a sampling event does not provide context for how the temperature fluctuates diurnally or between sampling events. Temperature WQS are based on a seven day average, so the comparisons made in this report are merely qualitative, and designed to help screen for potential water quality problems. Further, grab samples that are analyzed for contaminants (metals and pesticides) cannot be compared with chronic WQS, because these standards require an analysis of what the organism would be exposed to over a longer time period. Therefore, the water quality data were compared to acute WQS, and then screened against chronic WQS for informational purposes and to aid in the discussion and recommendations sections.

Washington State WQS were modified in November 2006 to include species and life stage-specific criteria for aquatic life (WDOE 2006). Though the WQS are still pending final approval by the EPA, they went into effect on December 31, 2006. The WQS indicate that criteria for any tributary stream to Lake Washington be based on the “Core Summer Salmonid Habitat” designated use category (Table 5). Salmonids do not enter and spawn in Mercer Island streams; however, the graveled stream mouths and nearshore areas in Lake Washington serve as important spawning and rearing habitat. As such, discharge from these streams could potentially alter water quality in Lake Washington and impact available salmonid habitat.

Dissolved metal concentrations were compared to hardness corrected acute water quality criteria for aquatic life. Standards for all metals evaluated here are hardness-dependent; the softer the water, the greater the toxicity. Chronic toxicity cannot be fully assessed because grab samples only provide information for a snapshot in time, and evaluation of chronic metal toxicity would require additional sampling. Since very few herbicides and pesticides were detected above the minimum detection limit, WQS or literature-based thresholds were only presented for detected parameters (Table 5).

Table 5. Water quality standards (WQS) and appropriate guidelines used to evaluate data.

Category	Parameter	Criteria/Guideline	Type	Reference
Conventional/ Other	Temperature	<16°C	WA WQS	WDOE 2006
	Dissolved oxygen	>9.5 mg/L	WA WQS	WDOE 2006
	pH	6.5-8.5	WA WQS	WDOE 2006
	Conductivity	n/a		
	Turbidity	<5 NTU when baseline ≤ 50 NTU, or <10% increase when baseline >50 NTU	WA WQS	WDOE 2006
	TSS	n/a		
	NPO	n/a		
Nutrients	TP[1]	n/a		
	OP[1]	n/a		
	TN[1]	n/a		
Biological	Fecal coliform	<100 colonies/100 mL	WA WQS	WDOE 2006
	E. coli	n/a		
	Benthic macroinvertebrates	B-IBI	Regional stream health index	Karr et al. 1986
Dissolved metals	Hardness	n/a; range: 16.8 - 280 µg/L		
	Chromium[2]	range: 127.32 - 1275.23[2]	WA WQS	WDOE 2006
	Copper[2]	range: 3.17 - 44.89[3]	WA WQS	WDOE 2006
	Lead[2]	range: 6.67 - 239.52[4]	WA WQS	WDOE 2006
	Zinc[2]	range: 25.25 - 273.83[5]	WA WQS	WDOE 2006
Chlorinated herbicides	2,4,5-T	n/a		
	2,4-D	30 µg/L	Literature-based threshold	Westerdahl and Hall 1983
	Dicamba	14000 µg/L	EPA criteria	USEPA 2005a
	MCPP	2573.5 µg/L	Literature-based threshold	Kirby and Sheahan 1994
	MCPA	380 µg/L	EPA criteria	USEPA 2004
Organophosphate pesticides	Chlorpyrifos	0.083 µg/L	WA WQS	WDOE 2006
	Diazinon	0.3397 µg/L	EPA criteria	USEPA 2005b
	Malathion	2 µg/L	EPA criteria	USEPA 2000

[1]compared to regional streams

[2] criteria calculated using hardness (WDOE 2006)

3.3.2 Macroinvertebrates

Macroinvertebrate community composition data were used to calculate a Benthic Index of Biotic Integrity (B-IBI) score which is calculated from metrics representing taxa richness, pollution tolerance, feeding ecology, and population structure (Kleindl 1995, Fore et al. 1996, Karr and Chu 1999; Appendix B). The B-IBI is a tool designed to evaluate the health of 2nd or 3rd order streams; scores range from 10 to 50 (Table 6). The Mercer Island drainage basins evaluated here are generally very small with flashy hydrologic regimes, and are not considered 2nd or 3rd order. Therefore, we would not expect these streams to function in the same way as systems for which this scoring system was devised. However, we have used this tool to compare sites, and evaluate temporal trends.

Table 6. Five classes of biological condition as determined by B-IBI. Modified from Karr et al. (1986) by Morley (2000).

Biological Condition	B-IBI Range	Description
Excellent	46 - 50	Comparable to least disturbed reference condition; overall high taxa diversity, particularly of mayflies, stoneflies, caddisflies, long-lived, clinger, and intolerant taxa. Relative abundance of predators high.
Good	38 - 44	Slightly divergent from least disturbed condition; absence of some long-lived and intolerant taxa; slight decline in richness of mayflies, stoneflies, and caddisflies; proportion of tolerant taxa increases.
Fair	28 - 36	Total taxa richness reduced - particularly intolerant, long-lived, stonefly, and clinger taxa. Relative abundance of predators declines; proportion of tolerant taxa continues to increase.
Poor	18 - 26	Overall taxa diversity depressed; proportion of predators greatly reduced as is long-lived taxa richness; few stoneflies or intolerant taxa present; dominance by three most abundant taxa often very high.
Very Poor	10 - 16	Overall taxa diversity very low and dominated by a few highly tolerant taxa; mayfly, stonefly, caddisfly, clinger, long-lived and intolerant taxa largely absent. Relative abundance of predators very low.

3.3.3 Freshwater Sediment Quality Guidelines

Currently, there are no formally promulgated freshwater sediment standards for Washington State; however, a number of guidelines have been developed. Two different types of guidelines were used to evaluate metal concentrations in stream sediment: Washington State Department of Ecology's Draft Freshwater Sediment Quality Values (SQV; Avocet Consulting and SAIC 2002) and the guidelines developed by Ingersoll et al. (1996) and Smith et al. (1996). There are currently no standards or guidelines for NPO in sediment.

The guidelines developed by Ingersoll et al. (1996) and Smith et al. (1996) are based on two levels of protection. The threshold effects level (TEL) is an estimate of the concentration below which adverse biological effects are not expected to occur, and the probable effects level (PEL) is the concentration above which adverse biological effect would be frequently expected to occur. The specific values used here are based on those developed by Smith et al. (1996).

The draft SQVs developed for Ecology by Avocet Consulting and SAIC (2002, 2003) are based on a "Floating Percentile" approach and include three levels of protection. The two biologically based values include the sediment quality standard (SQS), which is an estimate of the concentration below which biological effects are not expected to be observed, and the cleanup screening level (CSL), which is an estimate of the concentration above which adverse effects would be expected. The third level of protection, which is not based on biological significance, is referred to as the "STAT" which represents concentration that was statistically significant when compared to the control (Avocet Consulting 2003). Since this value does not provide biological information, only the SQS and CSL levels were used for comparison. More detailed information on the derivation of these guidelines can be found in the references listed above.

We compared sediment metal concentrations (site averages (1999-2006) and 2006 values) to all four of these guidelines to provide a framework within which sediment metals data could be interpreted.

Table 7. Suggested freshwater sediment quality guidelines (mg/kg).

Metal	Threshold Effects Level[1]	Probable Effects Level[1]	Sediment Quality Standard[2]	Cleanup Screening Level[2]
Chromium	37.3	90	95	100
Copper	35.7	196.6	80	830
Lead	35	91.3	335	430
Zinc	123.1	314.8	140	160

[1]Smith et al. 1996
[2]Avocet 2003

3.3.4 Regional Comparisons

Seven sites were initially chosen for regional comparison of water quality parameters that were either frequently above WQS or that lacked appropriate criteria or guidelines. Idyllwood,

Thornton, and Longfellow creeks were recommended for comparison with the commercial basin (10) on Mercer Island. Fairweather, Lewis, Yarrow, and Venema Creeks were recommended for comparison with the residential/erosive basins on Mercer Island (Jean Power and Stephanie Hess, KCEL, personal communication). Data collected during storm conditions were used for comparison, even though the storm criteria for this sampling program were slightly different (see Section 3.1). Data were downloaded from the King County LIMS database. Insufficient storm sample data were available for Longfellow (N = 2) and Venema (N = 0) creeks, so these two streams were eliminated from the analysis.

Parameters from regional streams that were compared to Mercer Island stream data included bacteria (fecal coliform only), dissolved metals, and nutrients. Though sediment metal concentrations were frequently above sediment quality guidelines, a statistical comparison was not conducted due to limited data. Also, NPO in water was not analyzed in the regional samples, so this comparison could not be made.

4.0 RESULTS AND DISCUSSION

This section (Section 4.1) begins by summarizing the 2006 data and highlighting any significant interannual patterns, and has been organized by parameter (Table 1). Following this (Section 4.2) is a basin- by-basin analysis of water quality indicators, as well as comparison of pre- and post-basin improvement conditions. Section 4.2 focuses on parameters that were either above WQS or changed significantly after implementation of basin improvements. This format will aid City staff in making future decisions related to specific basin improvements and source control. Because no appropriate standards or guidelines are available for some water quality parameters, regional comparisons were used to provide context (Section 4.3). For a detailed view of the raw data collected in 2006, refer to the Appendices.

As previously discussed, sampling efforts occurred in two types of drainages – commercial (Basin 10) and residential (Basins 6, 26, 29, 32b, and 42). Water quality problems identified in these subbasins could potentially be attributed to commercial and/or residential landuse practices, or to landscape erosion. Figure 2 delineates the land use characteristics in the study basins. Drainages in commercial areas (comm) are depicted in blue, and drainages in residential areas (res) are depicted in green, yellow, orange, and red.

4.1 2006 Results and Discussion

Storm samples were collected three times in 2006: March 8, November 2, and December 11. On these dates, staff collected field parameter measurements and water quality samples. Sediment samples were collected on August 10, and macroinvertebrate samples were collected on August 3 and 7.

4.1.1 Conventional/Other Parameters

In 2006, antecedent rainfall (24-hour) was highest during the December 11 storm and lowest during the November 2 storm (Figure 3). Stream discharge was consistently lowest during storm events in Basin 26, and the highest stream discharge was observed in Basin 6 during the December 11 storm (Figure 3). Overall, stream discharge and rainfall were the lowest (<1.1 cfs and 0.08 inches, respectively) at all locations during the November 2 sampling event.

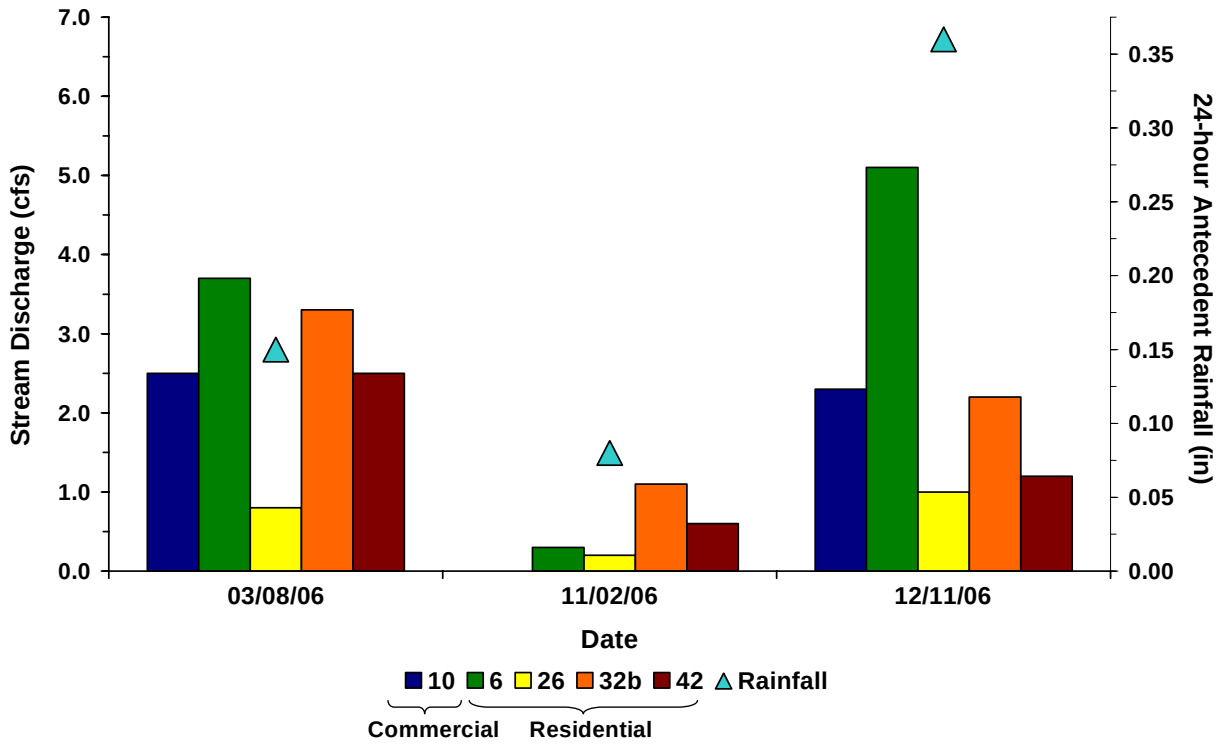


Figure 3. 2006 stream discharge (cubic feet per second) and 24-hour antecedent rainfall (inches) at time of sampling.

Conventional and other water quality parameters measured in 2006 are summarized in Table 8. Temperature was always less than 16 °C and below the WQS at all sites on all sampling dates. DO met WQS (>9.5 mg/L) with two exceptions: on December 11, 2006, DO was 9.1 mg/L in Basin 32b and 9.4 mg/L in Basin 42. The pH levels measured during all storms at all sites in 2006 were within the range specified by the WQS (range: 6.7–7.7). Specific conductivity was variable and appeared most elevated during the November 2 storm at sites 6, 26, and 42. Baseline turbidity levels measured during invertebrate sampling in August 2006 ranged from 1.2–6.4 NTU. Storm event turbidity was much higher than baseline and varied widely among sites and sampling dates (range: 19.9–220.0 NTU). WQS specify that turbidity levels should be less than 5 NTU above baseline (i.e. non-storm) levels. The lowest measured turbidity level was still greater than 5 NTU above the highest non-storm measurement in Mercer Island streams. Although the sample techniques used do not follow the WQS protocol, storm event turbidity levels were elevated compared to baseline values in 2006. TSS ranged widely among sampling dates and sites (11 to 237 mg/L) and followed the same pattern as turbidity.

NPO compounds include gasoline and petroleum products, and are common components in stormwater runoff from both residential and commercial land uses. Concentrations of NPO compounds above the RDL were only detected in Basin 26 on 3/8/06 (5.16 mg/L). NPO concentrations were below the MDL in Basins 6 and 32b on 11/2/06; otherwise all other levels were below the RDL in 2006 (Appendix A).

Hydrocarbon identification analyses (gasoline, diesel, and lube oil range hydrocarbons) were conducted only once (2 November) in 2006 (Appendix A). Most concentrations were below the MDL (0.19 mg/L for diesel and lube oil range hydrocarbons, 250 µg/L for gasoline range hydrocarbons). The commercial drainages (Basins 10 and 32b) were the only two subbasins with detectable levels of hydrocarbons. Lube oil range hydrocarbons (> C_{24}) were detected in Basins 10 (0.62 mg/L) and 32b (0.26 mg/L), and in past years the only detection occurred in 2004 in Basin 10 (King County 2006). These high molecular weight hydrocarbons have long carbon chains (24+ carbons), and may originate from sources such as asphalt and motorized vehicles. When present at elevated levels hydrocarbons can have adverse effects on aquatic life, including mortality, carcinogenesis, and developmental deformities (e.g., Phillips 1983, Barron et al. 2004, Incardona et al. 2004). Hydrocarbon identification tests provide qualitative information about the presence and type of petroleum products in Mercer Island's stormwater, and can help guide source control and monitoring programs in the future. Overall detected concentrations of hydrocarbons in Mercer Island subbasins were very low; however, samples were only collected on one day per year and this limited sampling frequency may miss hydrocarbon-contaminated stormwater inputs during other times of the year.

Table 8. Conventional/other water quality parameters measured in 2006. Highlighted values were above WQS.

BASIN	Category	Date	Temperature <16°C*	DO >9.5 mg/L*	pH 6.5-8.5*	Conductivity (µS/cm)	Turbidity <5 NTU over baseline*	TSS (mg/L)	NPO (mg/L)
10	commercial	3/8/2006	7.6	11	7.3	82.2	39.9	24.80	2.80*
		11/2/2006	10.4	10.3	6.7	36.5	43.8	64.00	2.80*
		12/11/2006	9.4	10.5	7.4	94.5	19.9	11.00	3.16*
6	residential	3/8/2006	6.9	11.3	7.4	59.5	92.2	172.00	2.70*
		11/2/2006	8.8	10.6	7.3	114	21.5	22.60	<MDL
		12/11/2006	8.5	10.8	7.7	74.6	76.3	237.00	2.75*
26	residential	3/8/2006	7.1	11.6	7.5	94.2	220	233.00	5.16
		11/2/2006	8.5	10.6	7.6	231	32.1	42.30	2.80*
		12/11/2006	8	9.9	7.6	81.1	113	205.00	3.98*
32b	residential	3/8/2006	7.2	11.7	7.3	50.6	39.2	38.80	4.00*
		11/2/2006	9.1	10.6	6.8	46.3	40.6	43.00	<MDL
		12/11/2006	8.1	9.1	7.7	83.9	18.8	16.00	3.22*
42	residential	3/8/2006	6.7	11.5	7.4	82.7	148	193.00	3.50*
		11/2/2006	8	10.8	7.3	167	80.4	119.00	2.70*
		12/11/2006	7.9	9.4	7.6	114	89	145.00	4.44*

*WA WQS
** <RDL (5.0 mg/L)

4.1.2 Nutrients

In 2006, TP and OP concentrations ranged from 0.07-0.25 mg/L, and 0.02 – 0.12 mg/L, respectively. TN ranged from 0.71 to 1.89 mg/L. Overall, nutrients tended to be highest in Basins 26, 32b, and 42 in 2006 (Figure 4). There are currently no WQS or guidelines for nutrients, so these parameters will be investigated further in the pre-and post-improvement analyses and in the regional comparisons in Sections 4.2 and 4.3.1.

Analyses of TP and OP patterns can reveal differences among drainages in terms of potential phosphorus sources. For example, Basin 26 showed TP spikes without corresponding increases in OP, suggesting that this system primarily delivers particulate phosphorus (Figure 4). In Basins 10, 32b (in November), and 42, OP was slightly higher than in the other basins, suggesting a dominant presence of dissolved phosphorus, possibly associated with fertilizers or animal waste. OP is the soluble or bioavailable component of TP, and it supports biological production such as algal growth. Phosphorus bound to sediments may also become bioavailable once it settles to the lake bottom. Therefore, due to concerns about algal blooms in Lake Washington, preventing or reducing the phosphorus load to the lake in either form should be a goal.

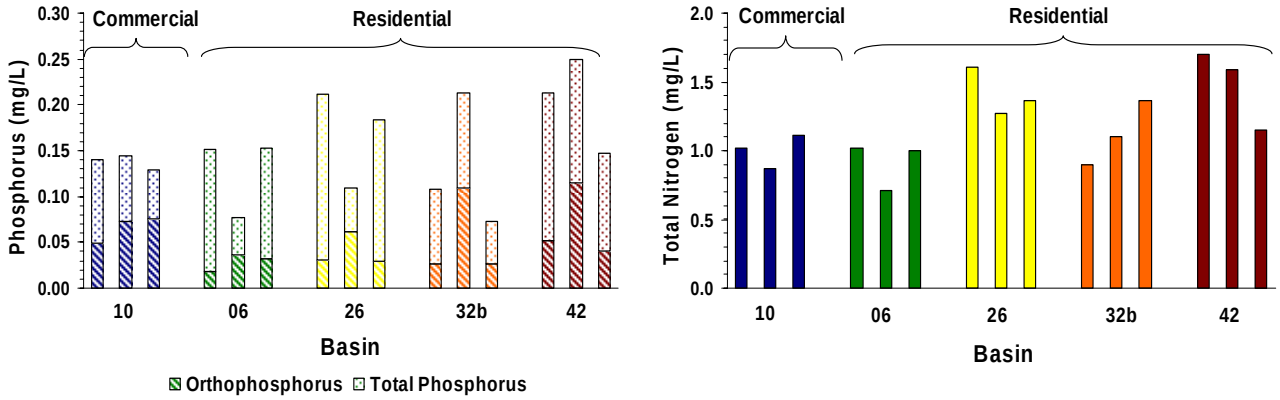


Figure 4. Orthophosphorus (as a fraction of total phosphorus) and total nitrogen. The three bars for each site represent the three 2006 sampling dates.

4.1.3 Biological Parameters

Fecal coliform levels were above the Extraordinary Primary Contact Recreation criteria (<100 colonies/100 mL) at all sites and dates in 2006, with the exception of Site 26 in November. Since bacteria were only analyzed in 2005 and 2006, all available data are presented here (Figure 5). With only two years of data, however, it is not possible to analyze for trends or differences, but general examination of the data reveal that bacteria levels were highly variable across sampling dates. On three of the six sampling dates, the commercial sites (10 and 32b) had the highest values. Elevated bacteria levels can indicate the presence of human or animal waste (see also http://dnr.metrokc.gov/wlr/waterres/swimbeach/aboutswimbch.htm). However, the specific bacteria sources in the study basins cannot be determined without additional specialized testing.

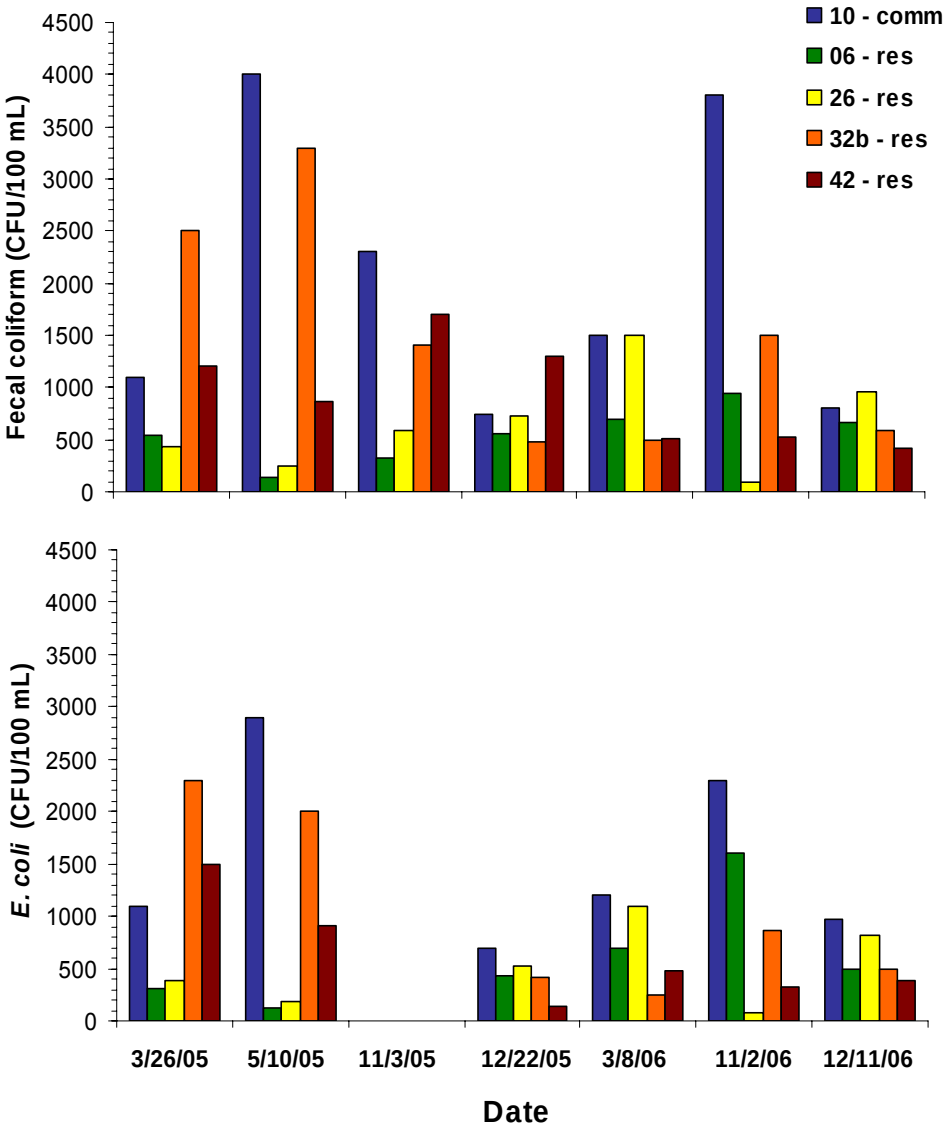


Figure 5. Fecal coliform and *E. coli* levels in 2005 and 2006. The red dotted line indicates WA State Extraordinary Primary Contact Recreation criteria.

Macroinvertebrate samples were collected from three sites in 2006: Basins 6, 10, and 42 (Figure 6). B-IBI values for these streams were 18, 14, and 18, respectively; categorizing Basin 10 as “very poor” (10–16), and Basins 6 and 42 as “poor” (18–26). For purposes of comparison, B-IBI scores from all years of this study have been presented in Figure 6.

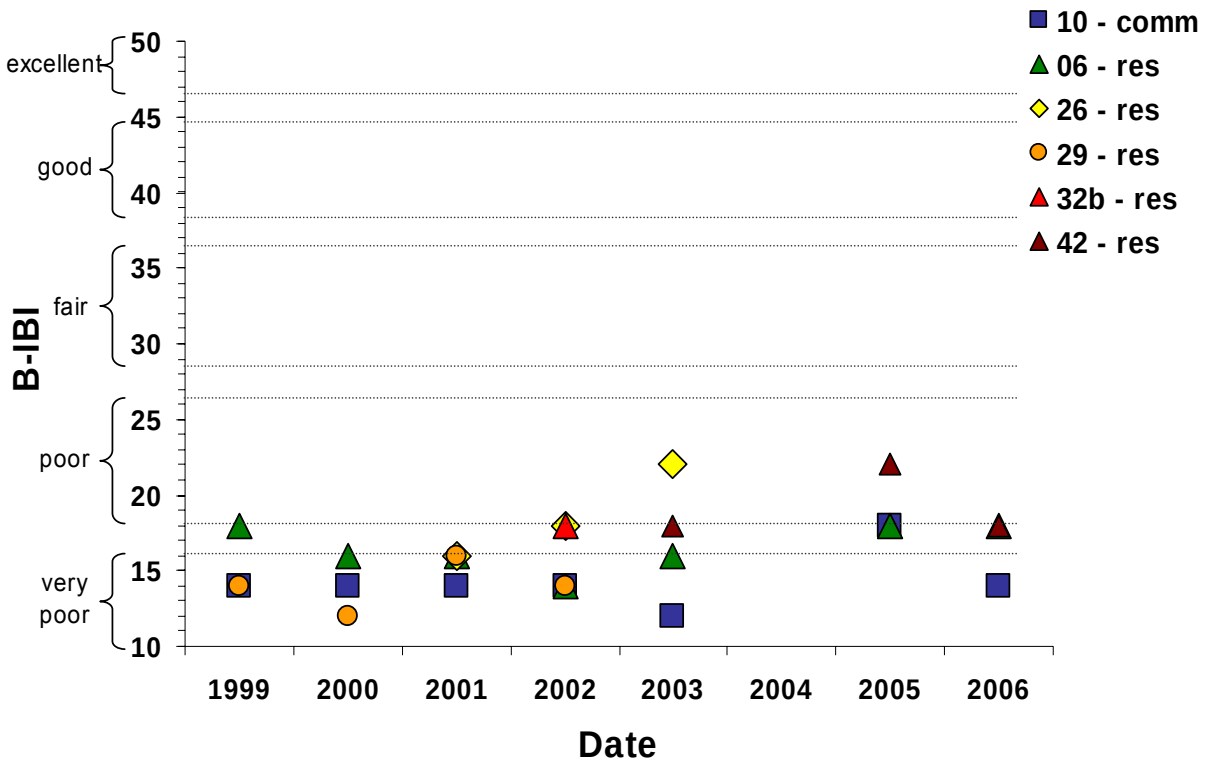


Figure 6. Benthic Index of Biotic Integrity (B-IBI) (1999-2006; samples not collected in 2004). Missing data points represent low flow conditions where samples could not be collected.

The Mercer Island drainage basins had low B-IBI scores compared to other regional streams (EVS Golder 2005). Very low B-IBI scores of 12 to 22 (1999-2006) demonstrate potential cumulative biological implications of poor water quality, habitat degradation, and urbanization. Woodcock and Huryn (2007) found that streams with the highest levels of metal pollution had the most extreme decreases in macroinvertebrate production. Other research has documented strong negative correlation between extent of urbanization and health of stream macroinvertebrate communities (Sponseller et al. 2001, Urban et al. 2006, Walsh et al. 2007).

Although the B-IBI is a useful measure of water quality and overall biological function within a stream system, it may not be the most appropriate method to evaluate Mercer Island streams. The B-IBI was developed primarily for evaluation of 2nd and 3rd order streams. The drainage basins evaluated here are generally very small with flashy hydrologic regimes and are not considered 2nd or 3rd order streams. Localized basin improvements and source control measures may help raise the B-IBI scores slightly; however, due to the natural physical

limitations of these water bodies, the benthic macroinvertebrate communities in these streams are not likely to reach the abundance and diversity of other larger systems in the region.

4.1.4 Dissolved metals

In 2006, dissolved copper concentrations were above WQS three times and dissolved zinc was above WQS once (Table 9). Lead and chromium values were below WQS on all dates at all sites.

Table 9. Water hardness (mg/L $CaCO_3$), dissolved metal (µg/L) concentrations, and WQS. Highlighted bold values were greater than acute WQS. Values in italics indicate < RDL.

Site	Category	Date	Hardness	Cu	Cu Acute WQS[1]	Pb	Pb Acute WQS[1]	Zn	Zn Acute WQS[1]	Cr	Cr Acute WQS[1]
10	commercial	3/8/06	34.5	3.59	6.2	<MDL	16.7	15.40	46.5	*0.64*	229.5
		11/2/06	19.4	**5.04**	3.6	*0.28*	8.0	**33.10**	28.5	7.23	143.2
		12/11/06	40.7	3.98	7.3	<MDL	20.6	18.40	53.4	*0.69*	262.8
6	residential	3/8/06	35.5	*2.00*	6.4	<MDL	17.3	5.37	47.6		235.0
		11/2/06	52.5	2.66	9.3	*0.37*	28.4	5.02	66.3	*0.47*	323.7
		12/11/06	40.8	2.13	7.3	<MDL	20.6	4.73	53.5	*0.75*	263.3
26	residential	3/8/06	53.4	2.26	9.4	<MDL	29.1	*2.00*	67.3	*1.30*	328.3
		11/2/06	111	*1.80*	18.8	<MDL	73.8	*2.30*	125.0	*1.10*	597.7
		12/11/06	45.9	2.03	8.2	<MDL	24.0	5.64	59.2	*1.30*	290.0
32b	residential	3/8/06	22	**4.33**	4.1	<MDL	9.4	10.70	31.7	2.88	158.8
		11/2/06	21.4	**11.90**	4.0	*0.27*	9.1	20.90	31.0	8.69	155.2
		12/11/06	36.5	4.68	6.6	<MDL	17.9	11.00	48.7	*1.90*	240.4
42	residential	3/8/06	47	2.39	8.4	<MDL	24.7	5.30	60.4	*1.20*	295.7
		11/2/06	84.3	2.91	14.5	<MDL	52.0	2.75	99.0	*1.30*	477.1
		12/11/06	57.6	2.55	10.1	<MDL	32.0	5.34	71.7	*1.00*	349.3

[1]criteria corrected based on site-specific hardness concentration

Dissolved metal concentrations were above WQS most frequently in the commercial drainages (copper and zinc in Basin 10; copper in Basin 32b); concentrations were never above WQS in the residential basins. A few common sources of dissolved metals include runoff from roads and parking lots, automobiles, pressure-treated wood, galvanized metals such as rain gutters and roofs, and construction/demolition activities (Hall and Anderson 1985, Pitt et al. 1995, USEPA 2002). Elevated water column metal concentrations can reduce primary production in streams (McKnight 1981, Kettle and DeNoyelles 1986), as well as have both lethal and sub-lethal impacts on invertebrates and fishes (e.g., Santore et al. 2001, Hansen et al. 2002, Baldwin et al. 2003, Kiffney and Clements 2003, McPherson et al. 2003, Niyogi and Wood 2004, Linbo et al. 2006).

4.1.5 Herbicides and Pesticides

In 2006, chlorinated herbicides and organophosphate pesticides were below the detection limit at all sites and sampling dates, with two exceptions (Appendix A). In Basin 6, the herbicides 2,4-D and MCPP were detected on December 11, 2006 (0.46 and 0.28 µg/L; respectively). Over the course of this project, only one herbicide or pesticide has been above available guidelines (Table 10). Diazinon was detected in Basin 32b in 2001 at a concentration of

1.69 µg/L, which is higher than USEPA's aquatic life ambient water quality criteria (USEPA 2005).

Although organophosphate pesticides (diazinon and chlorpyrifos) were detected in the study streams in previous years, neither compound was detected in 2006 (Table 10). Pesticides are typically transported during storm events, especially soon after application. The highest stormwater concentrations are usually detected in late spring, summer, and early fall, when pesticide use is highest. The timing of storm sampling in 2006 could potentially explain why pesticides were not detected. Storms were sampled in early spring and late fall and winter, missing the typical period of high pesticide usage. Also, the Environmental Protection Agency has phased out use of some pesticides (such as diazinon), so as residents run out of existing product, detections in stormwater would be expected to decrease as well.

Pesticides and herbicides are still ubiquitous in residential areas, and can have adverse (and often additive or synergistic) effects on stream flora and fauna (e.g., Pape-Lindstrom and Lydy 1997, Scholz et al. 2006). Herbicides may kill off algae and aquatic plants that invertebrates rely on for food. Pesticides may extirpate invertebrate communities which, among other things, serve as important food resources for fish and amphibians. Therefore, although these compounds were not detected during the fall and winter in 2006, they are still important parameters to analyze in future years of the study. As products are phased out and other products (such as pyrethroids) become more widely used, the City may consider revisiting the list of herbicides and pesticides tested.

Table 10. Chlorinated herbicide and organophosphate pesticide detections by basin, frequency of detection (FOD), concentration range, and appropriate criteria/guidelines/thresholds (1999-2006).

Parameter	1999	2000	2001	2002	2003	2004	2005	2006	FOD (N=118)	Range (µg/L)	Criteria/Guideline[1] (µg/L)
2,4,5-T			6						0.01	0.53	--
2,4-D	6, 10, 29	10, 29	6, 10, 26, 29, 32b	6, 10, 29, 32b		6, 10, 26, 32b	10, 26, 32b, 42	6	0.25	0.04 - 4.97	30.0
Dicamba	29	29							0.02	0.10 - 0.23	14000
MCPP	6, 10, 29	10, 29	10, 26, 29,32b	10, 29, 32b		32b	10, 26, 32b	6	0.18	0.10 - 1.50	2573.5
MCPA		10, 29	6, 10, 32b						0.04	0.14 - 0.63	380.0
Chlorpyrifos	29	10, 29							0.03	0.05 - 0.06	0.083
Diazinon	6, 10, 29	6, 10, 29	10, 29, 32b	29	6				0.12	0.04 - 1.69	0.3397
Malathion			10						0.01	0.05	2.0

[1]see Table 5 for water quality criteria/guideline references

4.1.6 Sediment

Figure 7 provides a summary of the sediment chemistry data and a comparison to sediment guidelines described in Section 3.3.3. In 2006, metal levels in Basin 10 were above at least one of the sediment guidelines for all four metals. Chromium levels in Basin 42 were just above the TEL in 2006. Metal levels in the other basins have not been above any of the guidelines over the course of the study. Zinc levels in Basin 10 were routinely above both the TEL and SQS and periodically above the CSL. These data suggest that Zn may be having an adverse impact in this basin and may be reflected by the very low BIBI scores at this site. Elevated sediment metal levels in Basin 10 are also reflected in the elevated metal levels in water at this location.

Sediment chemistry can provide insight into water quality issues that periodic stormwater sampling may miss, simply because sediment tends to move more slowly through a system than water. The field notes for this project documented that the sediment samples were comprised mainly of sand. In general, contaminants are associated with fines, so these results may underestimate the concentrations of sediment-associated metals in Mercer Island streams.

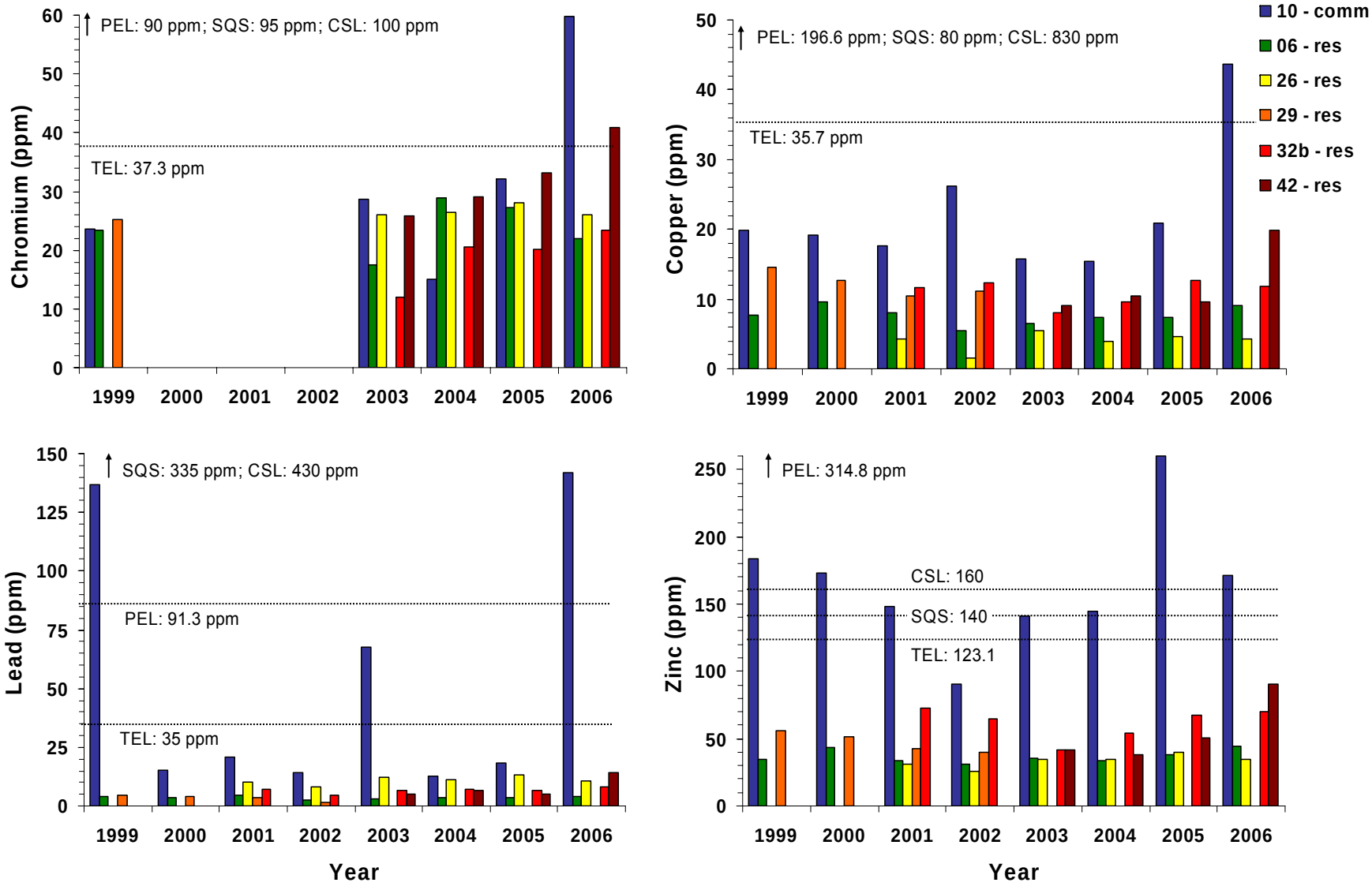


Figure 7. Sediment metal concentrations (chromium, copper, lead, and zinc) and Freshwater Sediment Quality Guidelines.

4.2 Individual Basin Results and Discussion

Over the past eight years (1999-2006), water quality has been measured 28 times in stormwater samples and twice in baseflow samples. Sediment chemistry and benthic macroinvertebrates have been evaluated annually, with the exception of macroinvertebrates in 2004. Basin improvements have been implemented in different basins at different times over the course of this monitoring period. Though most basin improvements have been initiated upstream of the sampling locations, a few were downstream. In general, any shifts in water or sediment quality in basins with downstream improvements would be attributed to other basin activities.

Some water and sediment quality parameters measured in the study basins varied predictably according to dominant land use classification. In general, residential areas with erosive ravines tended to have more problems associated with sedimentation (i.e., conductivity, turbidity, TSS, and nutrients), and commercial centers tended to have more water quality problems associated with transportation and other contaminants associated with impervious surfaces (i.e., metals and NPO). Although this study was not designed to provide data for analyses of pre- and post-improvement water quality conditions, in some cases, there were sufficient data to conduct statistical analyses. This provides the opportunity to examine basin conditions over time and to use observed trends to make informed recommendations for future basin improvements. Understanding differences among drainages can help to better focus residential source control measures and/or the City's drainage improvement projects to more effectively improve water quality within each basin. The following basin-by-basin discussion focuses on parameters in each individual basin which were elevated compared to the other basins or regional streams, and/or those that were above WQS or appropriate guidelines.

4.2.1 Basin 6 - Residential

In general, over the course of the monitoring period few parameters in Basin 6 were above WQS or guidelines (Table 11). Improvements in Basin 6 were located upstream of the sampling location and were completed in 1998. This project was designed to reduce erosion, and was completed before sampling commenced. Therefore, we were not able to conduct statistical analyses on pre- and post-improvement conditions.

Basin 6 continues to have elevated TP and TSS, indicating that erosion and sediment transport continue to occur during storm events. Increased erosion control in this basin may help lower the nutrient and sediment loading to this stream. If possible, future sampling should occur downstream of the detention pond to determine whether the sediment and nutrients detected upstream of the pond are being transported to Lake Washington.

4.2.2 Basin 10 - Commercial

Improvements in Basin 10 were implemented downstream of the sampling location, and included culvert, flume, and sewer replacement in 2003. Therefore, changes in water quality due to these improvements cannot be evaluated. Instead, analyses focused on detecting interannual trends in contaminants associated with commercial land uses (i.e., dissolved metals, NPO, bacteria) over the course of the sampling history in Basin 10. Bacteria were not analyzed in Basin 10 until 2005, as such they were not included in the statistical analysis.

There were no significant differences in mean annual dissolved metal concentrations (ANOVA, $p>0.834$) or NPO ($p = 0.632$). Over the course of this study, concentrations of copper and zinc

in Basin 10 were frequently above acute WQS (Table 11). Metals were also frequently detected in the sediment samples in this basin; zinc and lead concentrations were frequently above sediment guidelines (Figure 7).

As discussed in Section 4.1.4, elevated metal concentrations in sediment and water are frequently associated with stormwater. Since Basin 10 is dominated by commercial land use and has the highest percent impervious surface of any other basin sampled, the detection of metals in water and sediment samples is not unexpected. However, elevated metal concentrations can pose serious risks for invertebrate and fish health (see Section 4.1.4), so source control in areas that may discharge substantial amounts of contaminated stormwater runoff from impervious areas should be a consideration. The basin improvements conducted in Basin 10 were not designed to reduce the input of degraded stormwater runoff to the stream. improvements in Basin 10 should focus on stormwater management (treatment, street sweeping, etc.) and education.

Table 11. Sample size (N), mean hardness (mg/L $CaCO_3$) and metal concentrations (µg/L), standard error (SE), and number of times metal concentrations were above acute WQS between 1999-2006. Metal concentrations greater than the chronic criteria are shown in parentheses. All criteria were corrected for hardness.

			Hardness		Copper			Lead			Zinc			Chromium			
BASIN	**Category**	**N**	**mg/L $CaCO_3$**	**Range**	**µg/L**	**SE**	**>WQS[1]**	**µg/L**	**SE**	**>WQS[1]**	**µg/L**	**SE**	**>WQS[1]**	**µg/L[2]**	**N[2]**	**SE**	**>WQS[1]**
10	commercial	29	56.64	16.8 - 98.1	4.40	0.27	3 (8)	0.27	0.03	0 (2)	20.28	1.47	3 (3)	1.29	15	0.31	0 (0)
6		28	67.30	35.5 - 118.0	2.70	0.17	0 (0)	0.22	0.01	0 (0)	5.43	0.61	0 (0)	0.69	13	0.04	0 (0)
26		22	99.62	45.9 - 280.0	3.01	0.49	0 (1)	0.24	0.04	0 (0)	1.94	0.27	0 (0)	1.23	14	0.08	0 (0)
29	residential	15	73.04	36.3 - 129.0	3.74	0.44	0 (1)	0.21	0.01	0 (0)	3.89	0.44	0 (0)	0.74	1		0 (0)
32b		22	48.30	18.4 - 119.0	5.98	0.61	6 (10)	0.21	0.00	0 (0)	11.75	1.70	0 (0)	3.94	14	0.66	0 (0)
42		14	68.29	47.0 - 121.0	3.28	0.37	0 (0)	0.22	0.01	0 (0)	3.47	0.36	0 (0)	1.49	14	0.14	0 (0)

[1]Chronic WQS (in parentheses) used only for qualitative purposes; sampling methods not appropriate for chronic toxicity

[2]Chromium was not analyzed between 10/8/99-12/16/02

4.2.3 Basin 26 - Residential

Basin 26 consistently experienced higher conductivity, turbidity, TSS, and TP concentrations than the other study basins. This basin is subject to erosion problems, which is reflected in the elevated turbidity and TSS. Conductivity measures the amount of total dissolved inorganic substances in the water. Although the biological implications of alterations in conductivity remain unclear, studies suggest this parameter is linked to urbanization (May et al. 1997, Avolio 2003). The linkage between high TSS and high TP exists because phosphorus binds readily to sediments. Elevated phosphorus levels may lead to nutrient enrichment and increased biological activity (e.g., algal blooms), potentially contributing to oxygen depletion and eutrophication. Phosphorus is the limiting nutrient in Lake Washington and therefore the nutrient of primary concern.

Improvements in Basin 26 consisted of slope stabilization and channel widening in 2005. There were no significant changes in water quality parameters following basin improvements were implemented, though sample size was low for post-improvement conditions. These trends should be reexamined after additional data are collected. Statistical tests were not conducted on sediment data due to low sample sizes. B-IBI scores in Basin 26 increased slightly between 2001 and 2003 (Figure 6). However, due to insufficient flow macroinvertebrate samples have only been collected in three of the eight years of monitoring. As such, it is not possible to infer trends from these data. Analysis of bacteria was not initiated in Basin 26 until 2005; therefore, post-improvement changes in bacteria levels could not be evaluated.

As mentioned above, the lack of discernable changes in water quality following basin improvements could be due to low sample sizes following project completion (less than two years). Additional restoration work is planned between West Mercer Way and Island Crest Way, and is scheduled to take place in two to three years. Future monitoring in Basin 26 should focus on parameters typically associated with erosive processes, such as conductivity, turbidity, TSS, and nutrients. Herbicides have also been detected in Basin 26. As such, monitoring for herbicides and pesticides should continue, focusing on compounds that are most commonly used in western Washington. This may involve revisiting the list of currently sampled pesticides and herbicides to remove banned pesticides (i.e., diazinon) and to add more commonly used compounds (i.e., pyrethroids).

4.2.4 Basin 29 - Residential

Improvements in Basin 29 are planned for 2008. Samples have not been collected from this basin since 2002. Therefore, discussion of potential water and sediment quality improvements in this basin will be reserved for future analyses if sampling is resumed. Refer to the Year 2002 Annual Report for the City of Mercer Island for detailed information about this basin (King County 2003).

4.2.5 Basin 32b - Residential

Sampling began in Basin 32b in 2001, after the first improvement (stormwater detention pond expansion) was implemented in 2000. In addition, a 200’ stretch of the watercourse was stabilized in 2002. Data were evaluated to test for significant differences in water and sediment quality parameters after the 2002 improvements were completed. There were no significant differences found. However, pre-improvement data were limited to one year of monitoring

(N = 4). Bacteria were not analyzed in Basin 32b until 2005, as such it was not possible to test for post-improvement changes in bacteria levels.

Basin 32b was one of the two basins where copper concentrations were above acute WQS (Table 11). However, unlike Basin 10, elevated metal concentrations in water did not correspond with sediment metal levels. Though Basin 32b is mainly residential, it does have a small commercial area, which, along with the roads running through the area, may be contributing to the elevated copper levels. Source control (e.g., stormwater management, street cleaning, etc.) and resident education about the sources and implications of copper may help reduce dissolved metal concentrations in this basin. The City may also consider sampling water quality above and below the detention pond to determine whether pond maintenance needs to be improved.

4.2.6 Basin 42 - Residential

Sampling in Basin 42 was initiated in 2003, and improvements were implemented in the same year, downstream of the sampling location. Therefore, statistical analyses could not be conducted to evaluate pre- and post-improvement conditions. Basin 42 did have significantly higher mean OP than the other residential basins (6 and 32b) (averaged across years; ANOVA, $p<0.001$; Tukey HSD, $p \leq 0.018$). Elevated OP input could be an indicator of fertilizer use or animal waste in the basin. The fertilizer input could be attributed to residential use or landscape care, and the animal waste could be coming from domesticated pets or wild animals/birds. Further investigations as to the potential sources of OP are warranted. Elevated nutrient levels can cause algal blooms in Lake Washington, the receiving water body, so preventing the phosphorus load to Mercer Island streams and ultimately the lake should be a goal of future restoration and/or education plans.

4.3 Regional Comparisons

Regional comparisons were conducted to (1) provide context for parameters that do not have appropriate WQS or guidelines (i.e., nutrients); and (2) understand the scale of the water quality problem for parameters which are frequently above WQS (i.e., bacteria and dissolved metals). Idyllwood and Thornton creeks were categorized as commercial for comparison with Mercer Island Basins 10 and 32b, and Fairweather, Lewis, and Yarrow creeks were categorized as residential with erosive ravines for comparison with Mercer Island Basins 6, 26, 29, and 42.

There are two main caveats that are important to discuss before comparing the Mercer Island data with data collected in these streams. First, stream ecological function is likely to vary considerably among the selected regional streams and Mercer Island streams due to stream size, habitat diversity, and biological communities. Though the size of the regional streams and their associated basins are generally larger than the Mercer Island streams, the relevant land uses in these basins are similar. Second, storm sampling criteria are slightly less stringent for the regional stream sampling program (see Section 3.1) than for this study. This may result in slightly lower levels of measured contaminants in the associated storm samples from the regional streams.

4.3.1 Nutrients

Since there are no WQS for nutrients, TP, OP, and TN levels in Mercer Island streams were compared with five regional streams. Statistical analyses (ANOVA and Tukey's HSD) were

conducted to detect differences in nutrients among Mercer Island and regional streams (Figure 8). In most years in the commercial basins, Mercer Island Basin 10 had significantly higher OP levels than the regional streams (Idyllwood and Thornton). However, fewer significant differences were seen for TP and TN. In the residential streams, OP levels were significantly higher in Fairweather and Mercer Island Basin 42 than many of the other streams across years. As in the commercial streams, fewer significant differences were seen for TP and TN. These results indicate that OP levels in Basins 10 and 42 were consistently elevated among study years. Fertilizer and animal use patterns should be investigated in these two basins, working with landscapers and private property owners to determine whether OP input can be reduced by changing land use practices. If there are septic systems or leaky/broken sewer lines in these basins, they should also be investigated.

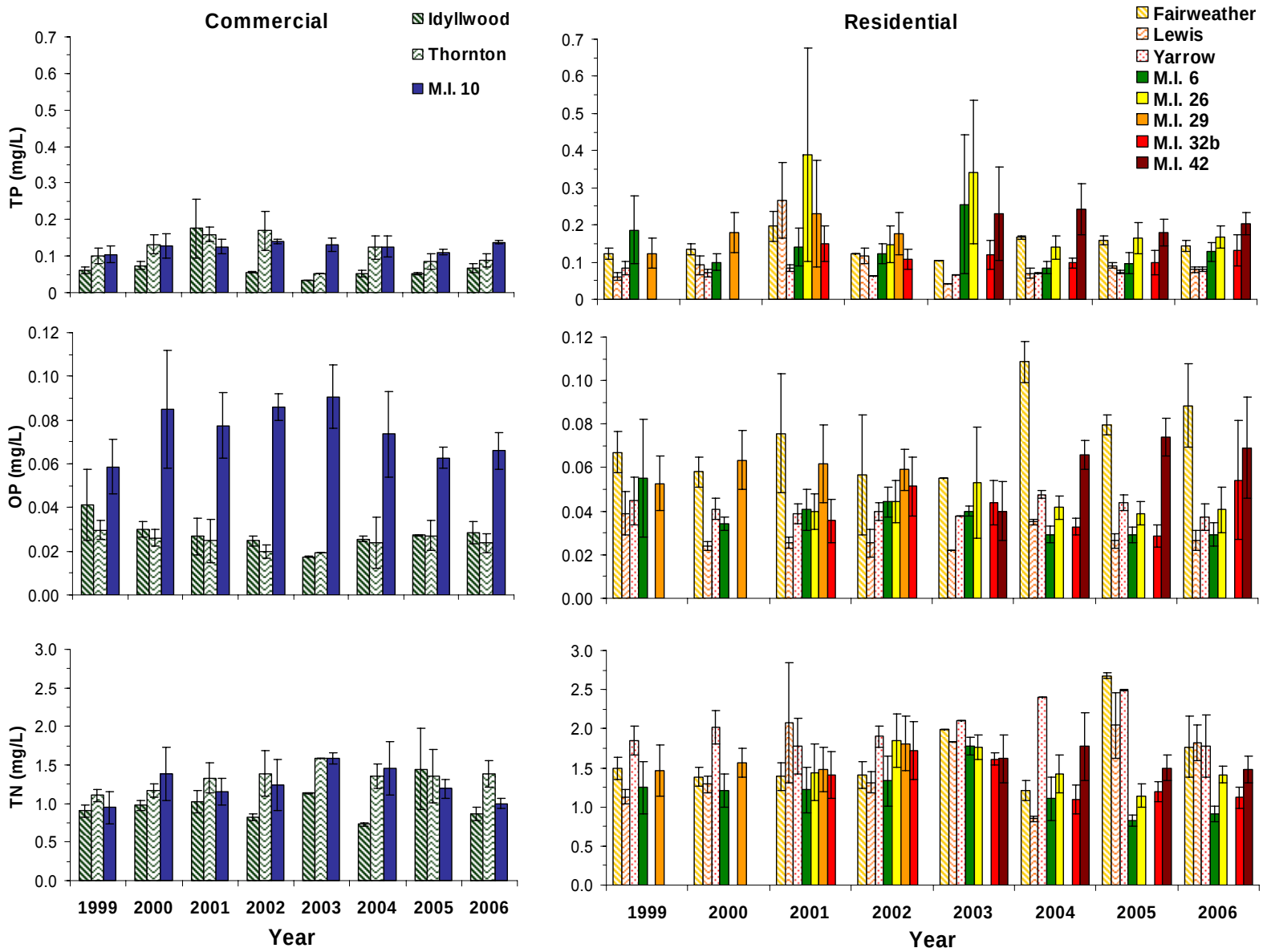


Figure 8. Nutrients (TP, OP, and TN) in regional and Mercer Island streams. Error bars represent one standard error.

4.3.2 Bacteria

Bacteria were only analyzed in Mercer Island streams in 2005 and 2006. Fecal coliform levels were above the Extraordinary Primary Contact Recreation WQS in nearly every case. However, statistical analyses did not reveal any significant differences among regional and Mercer Island streams. Although bacteria levels in the study streams did not exceed levels observed in other streams with similar land use in the region, elevated bacteria levels are of interest due to health risks and the ultimate impact on Lake Washington. Source identification and control should be considered in future basin planning on Mercer Island.

4.3.3 Dissolved metals

Dissolved Cu and Zn were compared among the commercial Mercer Island and regional streams because concentrations in these basins were frequently above WQS (Figure 9). We included Basin 32b in this analysis. Though Basin 32b is considered residential, it does have a small commercial area and Basin 32b also had copper concentrations above WQS on six occasions. In some years, Cu was significantly higher in Basins 10 and 32b than Idyllwood and Thornton Creeks. Zn was significantly higher in Basin 10 than in the regional streams in almost all cases. Due to the ecological implications of elevated metal concentrations in the water column (see Section 4.1.4), future basin improvements in the commercial basins should be directed at this issue. Although dissolved metals are commonly associated with road runoff, source identification should be a priority to identify the origin of the dissolved metals. Stormwater management strategies can then be directed toward the areas that are contributing most significantly to dissolved metal input.

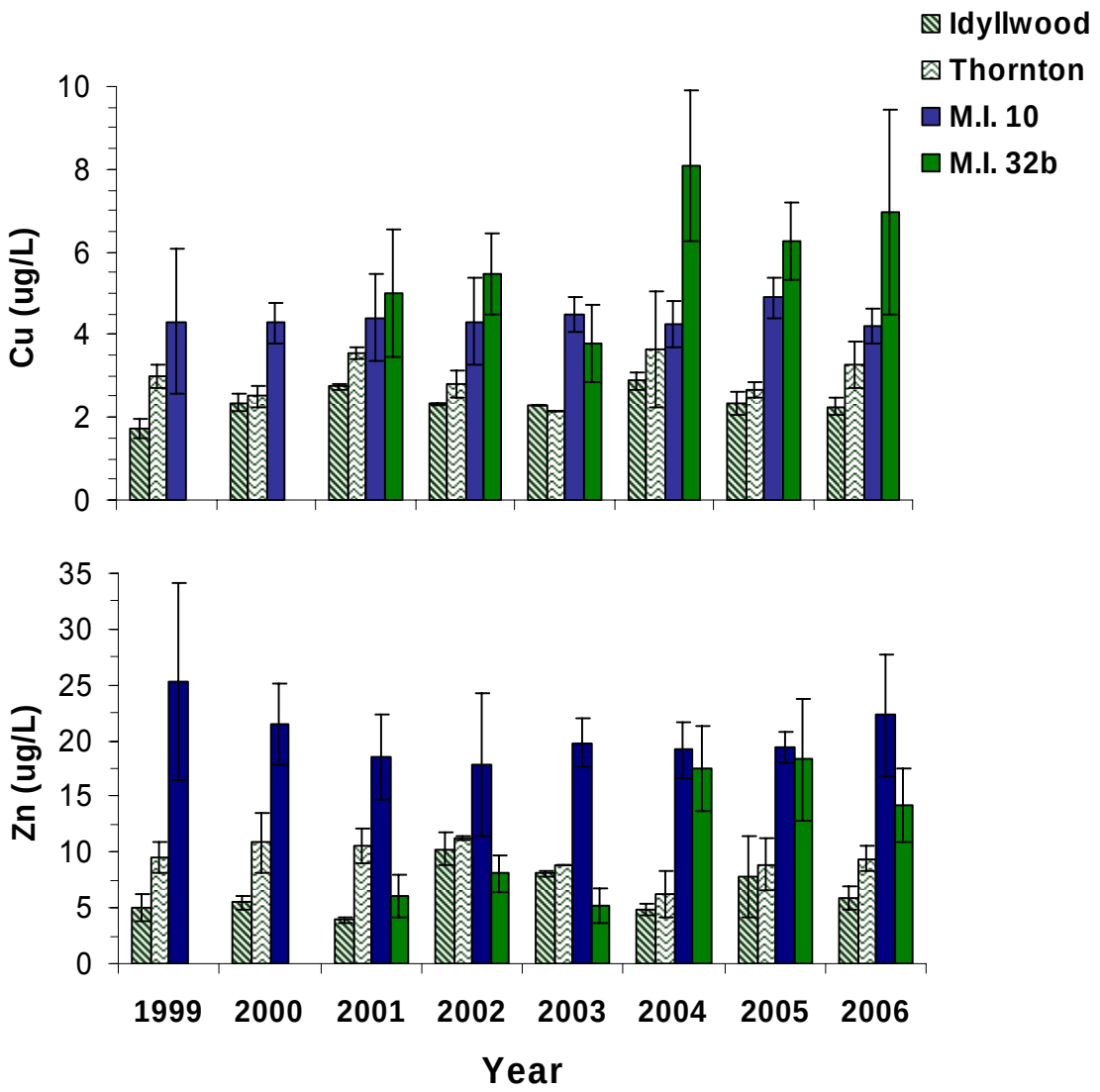


Figure 9. Regional comparison of dissolved Cu and Zn in the commercial basins. Error bars represent one standard error.

5.0 CONCLUSIONS/RECOMMENDATIONS

Overall, water quality issues in the Mercer Island drainage basins were generally correlated with dominant land use. In the residential subbasins (especially Basin 26), water quality problems were dominated by issues related to erosion (turbidity, phosphorus, etc.). In the commercial subbasins, water quality problems were characterized by contaminants associated with transportation and impervious surfaces (i.e. metals and detectable levels of high molecular weight hydrocarbons). Also, in 2006, sediment metal concentrations in Basin 10 (commercial) was considerably higher than past years.

The data collection methods for this monitoring program were not designed to statistically analyze for changes over time (i.e., samples were not collected downstream of basin improvements, sample sizes before or after project completion were low). As we collect more data, make modifications to the sampling design, and continue to implement improvements, we may expect to see measureable changes in water and sediment quality over time.

Regional comparison of nutrients, bacteria, and dissolved metals revealed that some Mercer Island stream parameter concentrations were higher than streams in the area with similar land use. For example, orthophosphorus levels in Basins 10 and 42 were high when compared with regional streams. Dissolved metals (copper and zinc) were elevated in the commercial basins compared to regional streams with similar land use.

Basin improvements should be tailored to address the water quality issues described in this report. In the erosive ravines, further improvements focusing on reducing erosion and sediment/nutrient input may help lower elevated nutrients and total suspended solids during storm events. Sewers and septic systems (if any remaining on the island) should be inspected for leaks and functionality. In the commercial centers, investigation into contaminant sources and reduction in contaminant input should be the focus of future subbasin improvements. Stormwater detention and other low impact development techniques (e.g., vegetated swales, porous pavement) may help filter contaminants and slow the transfer of degraded stormwater runoff to receiving waterbodies. The following list specifies priority action items for each basin, followed by recommendations for future study design and implementation.

Commercial Basin

Basin 10:

- Dissolved copper and zinc concentrations were repeatedly higher than acute WQS – tailor future basin improvements to control non-point source runoff and treat stormwater before it drains to Lake Washington
- Sediment metal concentrations were considerably higher than past years – investigate the cause and source of this increase
- Elevated OP when compared to regional streams – identify nutrient source and increase erosion control
- Implement additional sampling downstream of improvement project

Residential Basins

Basin 6:

- TSS and TP remain high – increase erosion control
- Implement additional sampling downstream of sediment pond (or sample from the detention pond outlet) to determine stormwater treatment effectiveness

Basin 26:

- High turbidity, TSS, and TP – increase erosion control

Basin 32b:

- Dissolved copper concentrations were repeatedly higher than acute WQS – tailor future basin improvements to control non-point source runoff and treat stormwater before it drains to Lake Washington

- Implement additional sampling above and below detention pond to determine stormwater treatment effectiveness

Basin 42:

- Implement additional sampling downstream of detention pond (or sample from the detention pond outlet) to determine stormwater treatment effectiveness
- High OP – identify nutrient source and increase erosion control

Recommendations for study design and implementation:

- Diazinon use in residential areas has been banned, and pyrethroid use is increasing. The City should consider revising the list of herbicides and pesticides analyzed to align with current use patterns.
- Bacteria levels were higher than Extraordinary Primary Contact Recreation WQS in all study streams. The City should identify source(s) of elevated bacteria and implement source control in all basins.
- Macroinvertebrate sampling and calculation of B-IBI scores placed the Mercer Island drainage basins in either "poor" or "very poor" categories. Due to the natural physical limitations of these water bodies, the benthic macroinvertebrate communities in these streams are not likely to reach the abundance and diversity of other larger systems in the region. The City should consider whether continued macroinvertebrate sampling is necessary to meet the objectives of this study.

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Appendix A

Raw Water Quality Data for Five Mercer Island Basins

Provided by:

King County Water and Land Resources Division
Environmental Laboratory

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King County

Water and Land Resources Division
Environmental Laboratory
Department of Natural Resources and Parks
322 West Ewing Street
Seattle, WA 98119-1507
206-684-2300 Fax 206-684-2395
TTY Relay: 711

May 16, 2006

TO: Fran Solomon, Senior Ecologist
WLRD, Scientific and Technical Support

FROM: Fritz Grothkopp, Laboratory Project Manager
WLRD, Environmental Laboratory

SUBJECT: Attached Report for Project 421195CY
Mercer Island Stormwater Monitoring,
Samples L37799-1 to 7

Attached is the comprehensive report for the water samples collected and delivered to the laboratory on March 8, 2006. The samples were analyzed in the Organics, Metals, Microbiology and Conventionals sections of the laboratory. QA/QC data summaries are included for your information.

Conventionals:
There were no anomalies associated with the preparation and analysis of these samples.

Metals:
There were no anomalies associated with the preparation and the analysis of these samples.

Microbiology:
There were no anomalies associated with the preparation and the analysis of these samples.

Organics:

Oil, Non-Polar Analysis:
There were no anomalies associated with the analysis of these samples.

Herbicide Analyses:
There were no anomalies associated with the analysis of these samples.

Organophosphorus Pesticides (short list) Analyses:
Organophosphorus pesticide analysis for these samples and QC were performed by method EPA 3520C/8270C using gas chromatography-mass spectrometer/Selective Ion Monitoring (SIM) techniques. The matrix spike has percent recoveries for Phorate and Diazinon slightly above the lab limits. No target compounds were detected in any of the sample.

The data have passed all internal QA/QC checks for accuracy and completeness and may be used without qualification, except where noted above.

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King County Environmental Lab Analytical Report

PROJECT: 421195

Locator:	MERCERISL06	MERCERISL10	MERCERISL26	MERCERISL32	MERCERISL42	MERCERISL32	KCO
Descrip:	R/D FACILITY SOUTH	SE 22ND ST, NEAR M	FOREST AVE. AND 84	CREEK NEAR HOLLYHI	E. MERCER WAY	CREEK NEAR HOLLYHI	King County Locato
Sampled:	Mar 08, 2006	Mar 08, 2006	Mar 08, 2006	Mar 08, 2006	Mar 08, 2006	Mar 08, 2006	Mar 08, 2006
Lab ID:	L37799-1	L37799-2	L37799-3	L37799-4	L37799-5	L37799-6	L37799-7
Matrix:	STORM WTR	STORM WTR	STORM WTR	STORM WTR	STORM WTR	STORM WTR	BLANK WTR
% Solids:							

Parameters	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units
			- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis		
COMBINED LABS																																			
M=CV SM2130-B (03-01-011-003)																																			
Turbidity																										29		0.5	2	NTU					
M=CV SM2510-B (03-01-002-003)																																			
Conductivity																										55.6		0.5	10	umhos/cm					
M=CV SM2540-D (03-01-009-002)																																			
Total Suspended Solids	172		1	2	mg/L	24.8		2	4	mg/L	233		2	4	mg/L	38.8		2	4	mg/L	193		3.3	6.7	mg/L	38		2	4	mg/L					
M=CV SM4500-0-C (03-03-007-003)																																			
Dissolved Oxygen																										11.5		0.5	1	mg/L					
M=CV SM4500-H-B (03-01-003-004)																																			
pH																										7.51				pH					
M=CV SM4500-N-C (03-03-013-002)																																			
Total Nitrogen	1.02		0.05	0.1	mg/L	1.02		0.05	0.1	mg/L	1.61		0.05	0.1	mg/L	0.894		0.05	0.1	mg/L	1.7		0.05	0.1	mg/L	0.919		0.05	0.1	mg/L					
M=CV SM4500-P-B,FMOD(03-03-013-002)																																			
Total Phosphorus	0.152		0.005	0.01	mg/L	0.14		0.005	0.01	mg/L	0.212		0.005	0.01	mg/L	0.108		0.005	0.01	mg/L	0.213		0.005	0.01	mg/L	0.108		0.005	0.01	mg/L					
M=CV SM4500-P-F (03-03-012-003)																																			
Orthophosphate Phosphorus	0.0187		0.002	0.005	mg/L	0.0491		0.002	0.005	mg/L	0.0303		0.002	0.005	mg/L	0.0273		0.002	0.005	mg/L	0.0518		0.002	0.005	mg/L	0.0268		0.002	0.005	mg/L					
M=ES Hydrolab (02-01-005-002)																																			
Conductivity, Field	59.5		0.5	10	umhos/cm	82.2		0.5	10	umhos/cm	94.2		0.5	10	umhos/cm	50.6		0.5	10	umhos/cm	82.7		0.5	10	umhos/cm	52.2		0.5	10	umhos/cm					
Dissolved Oxygen Saturation, Field	94				%	93				%	98				%	99				%	96				%	99				%					
Dissolved Oxygen, Field	11.3		0.5	1	mg/L	11		0.5	1	mg/L	11.6		0.5	1	mg/L	11.7		0.5	1	mg/L	11.5		0.5	1	mg/L	11.8		0.5	1	mg/L					
pH, Field	7.4				pH	7.3				pH	7.5				pH	7.3				pH	7.4				pH	7.3				pH					
Sample Temperature, Field	6.9				deg C	7.6				deg C	7.1				deg C	7.2				deg C	6.7				deg C	7.2				deg C					
Turbidity, Field	92.2		0.5	2	NTU	39.9		0.5	2	NTU	220		0.5	2	NTU	39.2		0.5	2	NTU	148		0.5	2	NTU	34.9		0.5	2	NTU					
M=ES NONE																																			
Discharge Rate of Stream	3.7		0.05	0.1	cfs	2.5		0.05	0.1	cfs	0.8		0.05	0.1	cfs	3.3		0.05	0.1	cfs	2.5		0.05	0.1	cfs	3		0.05	0.1	cfs					
Field Personnel	SH,JP				none	SH,JP				none	SH,JP				none	SH,JP				none	SH,JP				none	SH,JP				none					
Sample Function																										FREP@L37799-4				none					
Sample Start Time	1647				hr	1707				hr	1520				hr	1543				hr	1615				hr	1548				hr	1550				hr
M=MC METRO MC SOP 6.5.1																																			
Escherichia coli	700				CFU/100ml	1200				CFU/100ml	1100				CFU/100ml	250				CFU/100ml	480				CFU/100ml	440				CFU/100ml					
M=MC SM-9222 D ed.17																																			
Fecal Coliform	700				CFU/100ml	1500				CFU/100ml	1500				CFU/100ml	500				CFU/100ml	510				CFU/100ml	630				CFU/100ml					
M=MT EPA 200.8 (06-03-004&004A-001)																																			
Chromium, Dissolved, ICP-MS		<MDL	0.4	2	ug/L	0.64	<RDL	0.4	2	ug/L	1.3	<RDL	0.4	2	ug/L	2.88		0.4	2	ug/L	1.2	<RDL	0.4	2	ug/L	2.93		0.4	2	ug/L					
Chromium, Total, ICP-MS																																<MDL	0.4	2	ug/L
Copper, Dissolved, ICP-MS	2	<RDL	0.4	2	ug/L	3.59		0.4	2	ug/L	2.26		0.4	2	ug/L	4.33		0.4	2	ug/L	2.39		0.4	2	ug/L	4.4		0.4	2	ug/L					
Copper, Total, ICP-MS																																<MDL	0.4	2	ug/L
Lead, Dissolved, ICP-MS		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L					
Lead, Total, ICP-MS																																<MDL	0.2	1	ug/L
Zinc, Dissolved, ICP-MS	5.37		0.5	2.5	ug/L	15.4		0.5	2.5	ug/L	2	<RDL	0.5	2.5	ug/L	10.7		0.5	2.5	ug/L	5.3		0.5	2.5	ug/L	10.8		0.5	2.5	ug/L					
Zinc, Total, ICP-MS																															0.73	<RDL	0.5	2.5	ug/L
M=MT SM2340B.ED19 (06-02-004-002)																																			
Hardness, Calc	35.5		0.2	1.25	mg CaCO3/L	34.5		0.2	1.25	mg CaCO3/L	53.4		0.2	1.25	mg CaCO3/L	22		0.2	1.25	mg CaCO3/L	47		0.2	1.25	mg CaCO3/L	21.8		0.2	1.25	mg CaCO3/L					
M=OR EPA 3520C/8270C (7-3-04-001)																																			
Chlorpyrifos		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L					
Diazinon		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L					
Disulfoton		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L					
Malathion		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L					
Parathion-Ethyl		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L					
Parathion-Methyl		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L					
Phorate		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L					
M=OR SM5520-B,F (07-03-016-000)																																			
Oil, Petro (Non-Polar)	2.7	<RDL	2	5	mg/L	2.8	<RDL	2	5	mg/L	5.16		2	5	mg/L	4	<RDL	2	5	mg/L	3.5	<RDL	2	5	mg/L	4.7	<RDL	2	5	mg/L					
M=OR SW-846 8151A GCMS MODIFIED																																			
2,4,5-T		<MDL	0.032	0.2	ug/L		<MDL	0.032	0.2	ug/L		<MDL	0.032	0.2	ug/L		<MDL	0.032	0.2	ug/L		<MDL	0.032	0.2	ug/L	0.22		0.032	0.2	ug/L					
2,4,5-TP (Silvex)		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L					
2,4-D		<MDL	0.014	0.2	ug/L		<MDL	0.014	0.2	ug/L		<MDL	0.014	0.2	ug/L		<MDL	0.014	0.2	ug/L		<MDL	0.014	0.2	ug/L		<MDL	0.014	0.2	ug/L					
2,4-DB		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L	0.34		0.024	0.2	ug/L					
Dalapon		<MDL	0.033	0.4	ug/L		<MDL	0.033	0.4	ug/L		<MDL	0.033	0.4	ug/L		<MDL	0.033	0.4	ug/L		<MDL	0.033	0.4	ug/L		<MDL	0.033	0.4	ug/L					
Dicamba		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L		<MDL	0.024	0.2	ug/L					
Dichloroprop		<MDL	0.041	0.2	ug/L		<MDL	0.041	0.2	ug/L		<MDL	0.041	0.2	ug/L		<MDL	0.041	0.2	ug/L		<MDL	0.041	0.2	ug/L		<MDL	0.041	0.2	ug/L					
Dinoseb		<MDL	0.021	0.2	ug/L		<MDL	0.021	0.2	ug/L		<MDL	0.021	0.2	ug/L		<MDL	0.021	0.2	ug/L		<MDL	0.021	0.2	ug/L		<MDL	0.021	0.2	ug/L					
MCPA		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L					
MCPP		<MDL	0.016	0.2	ug/L		<MDL	0.016	0.2	ug/L		<MDL	0.016	0.2	ug/L		<MDL	0.016	0.2	ug/L		<MDL	0.016	0.2	ug/L		<MDL	0.016	0.2	ug/L					

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King County

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December 12, 2006

TO: Fran Solomon, Senior Ecologist
WLRD, Scientific and Technical Support

FROM: Fritz Grothkopp, Laboratory Project Manager
WLRD, Environmental Laboratory

SUBJECT: Attached Report for Project 421195CY
Mercer Island Stormwater Monitoring,
Samples L38476-1 to 7

Attached is the comprehensive report for the water samples collected and delivered to the laboratory on November 2, 2006. The samples were analyzed in the Organics, Metals, Microbiology and Conventionals sections of the laboratory. QA/QC data summaries are included for your information.

Conventionals:
The conductivity container for sample L38476-6 was accidentally left out of the refridgerator overnight. As a result, the sample result for conductivity has been flagged with the "H" qualifier indicating that it was not stored properly prior to analysis. There were no other anomalies associated with the preparation and analysis of these samples.

Metals:
There were no anomalies associated with the preparation and the analysis of these samples.

Microbiology:
There were no anomalies associated with the preparation and the analysis of these samples.

Organics:

Oil, Non-Polar Analysis:
There were no anomalies associated with the analysis of these samples.

Herbicide Analyses:
There were no anomalies associated with the analysis of these samples.

Organophosphorus Pesticides (short list) Analyses:
There were no anomalies associated with the analysis of these samples.

Diesel Range Hydrocarbon Analysis
There were no anomalies associated with the analysis of these samples.

The data have passed all internal QA/QC checks for accuracy and completeness and may be used without qualification, except where noted above.

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King County Environmental Lab Analytical Report

PROJECT: 421195CY

Locator:	MERCERISL06	MERCERISL10	MERCERISL26	MERCERISL32	MERCERISL42	MERCERISL26	KCO
Descrip:	R/D FACILITY SOUTH	SE 22ND ST, NEAR M	FOREST AVE. AND 84	CREEK NEAR HOLLYHI	E. MERCER WAY	FOREST AVE. AND 84	King County Locato
Sampled:	Nov 02, 2006	Nov 02, 2006	Nov 02, 2006	Nov 02, 2006	Nov 02, 2006	Nov 02, 2006	Nov 02, 2006
Lab ID:	L38476-1	L38476-2	L38476-3	L38476-4	L38476-5	L38476-6	L38476-7
Matrix:	STORM WTR	STORM WTR	STORM WTR	STORM WTR	STORM WTR	STORM WTR	BLANK WTR
% Solids:							

Parameters	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units
			- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis		
COMBINED LABS																																			
M=CV SM2130-B (03-01-011-003)																																			
Turbidity																										34.4		0.5	2	NTU					
M=CV SM2510-B (03-01-002-003)																																			
Conductivity																										258	H	0.5	10	umhos/cm					
M=CV SM2540-D (03-01-009-002)																																			
Total Suspended Solids	22.6		1	2	mg/L	64		2.5	5	mg/L	42.3		1.7	3.3	mg/L	43		2.5	5	mg/L	119		5	10	mg/L	53.3		1.7	3.3	mg/L					
M=CV SM4500-0-C (03-03-007-003)																																			
Dissolved Oxygen																										11.3		0.5	1	mg/L					
M=CV SM4500-H-B (03-01-003-004)																																			
pH																										7.94				pH					
M=CV SM4500-N-C (03-03-013-002)																																			
Total Nitrogen	0.71		0.05	0.1	mg/L	0.872		0.05	0.1	mg/L	1.27		0.05	0.1	mg/L	1.1		0.05	0.1	mg/L	1.59		0.05	0.1	mg/L	1.37		0.05	0.1	mg/L					
M=CV SM4500-P-B,FMOD(03-03-013-002)																																			
Total Phosphorus	0.077		0.005	0.01	mg/L	0.145		0.005	0.01	mg/L	0.109		0.005	0.01	mg/L	0.213		0.005	0.01	mg/L	0.25		0.01	0.02	mg/L	0.125		0.005	0.01	mg/L					
M=CV SM4500-P-F (03-03-012-003)																																			
Orthophosphate Phosphorus	0.0368		0.002	0.005	mg/L	0.073		0.002	0.005	mg/L	0.0618		0.002	0.005	mg/L	0.109		0.002	0.005	mg/L	0.115		0.002	0.005	mg/L	0.0646		0.002	0.005	mg/L					
M=ES NONE																																			
Conductivity, Field	114		0.5	10	umhos/cm	36.5		0.5	10	umhos/cm	231		0.5	10	umhos/cm	46.3		0.5	10	umhos/cm	167		0.5	10	umhos/cm	223		0.5	10	umhos/cm					
Discharge Rate of Stream	0.3		0.05	0.1	cfs	Not done	TA	0.05	0.1	cfs	0.2		0.05	0.1	cfs	1.1		0.05	0.1	cfs	0.6		0.05	0.1	cfs	Not done	TA	0.05	0.1	cfs					
Dissolved Oxygen Saturation, Field	92				%	93				%	92				%	93				%	92				%	91				%					
Dissolved Oxygen, Field	10.6		0.5	1	mg/L	10.3		0.5	1	mg/L	10.6		0.5	1	mg/L	10.6		0.5	1	mg/L	10.8		0.5	1	mg/L	10.6		0.5	1	mg/L					
Field Personnel	JP				none	JP				none	JP				none	JP				none	JP				none	JP				none					
pH, Field	7.3				pH	6.7				pH	7.6				pH	6.8				pH	7.3				pH	7.6				pH					
Sample Function																										FREP@L38476-3				none					
Sample Start Time	1615				hr	1640				hr	1430				hr	1505				hr	1530				hr	1440				hr	1455				hr
Sample Temperature, Field	8.8				deg C	10.4				deg C	8.5				deg C	9.1				deg C	8				deg C	8.5				deg C					
Turbidity, Field	21.5		0.5	2	NTU	43.8		0.5	2	NTU	32.1		0.5	2	NTU	40.6		0.5	2	NTU	80.4		0.5	2	NTU	31.5		0.5	2	NTU					
M=MC METRO MC SOP 6.5.1																																			
Escherichia coli	1600				CFU/100ml	2300				CFU/100ml	76				CFU/100ml	870				CFU/100ml	320				CFU/100ml	220				CFU/100ml					
M=MC SM-9222 D ed.17																																			
Fecal Coliform	940				CFU/100ml	3800				CFU/100ml	90				CFU/100ml	1500				CFU/100ml	530				CFU/100ml	280				CFU/100ml					
M=MT EPA 200.7 (06-02-004-002)																																			
Calcium, Total, ICP	10000		50	250	ug/L	4840		50	250	ug/L	20200		50	250	ug/L	5480		50	250	ug/L	13800		50	250	ug/L	19700		50	250	ug/L					
Magnesium, Total, ICP	6660		30	150	ug/L	1760		30	150	ug/L	14800		30	150	ug/L	1870		30	150	ug/L	12100		30	150	ug/L	14600		30	150	ug/L					
M=MT EPA 200.8 (06-03-004&004A-001)																																			
Chromium, Dissolved, ICP-MS	0.47	<RDL	0.4	2	ug/L	7.23		0.4	2	ug/L	1.1	<RDL	0.4	2	ug/L	8.69		0.4	2	ug/L	1.3	<RDL	0.4	2	ug/L	1.1	<RDL	0.4	2	ug/L					
Chromium, Total, ICP-MS																																<MDL	0.4	2	ug/L
Copper, Dissolved, ICP-MS	2.66		0.4	2	ug/L	5.04		0.4	2	ug/L	1.8	<RDL	0.4	2	ug/L	11.9		0.4	2	ug/L	2.91		0.4	2	ug/L	1.8	<RDL	0.4	2	ug/L					
Copper, Total, ICP-MS																																<MDL	0.4	2	ug/L
Lead, Dissolved, ICP-MS	0.37	<RDL	0.2	1	ug/L	0.28	<RDL	0.2	1	ug/L		<MDL	0.2	1	ug/L	0.27	<RDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L					
Lead, Total, ICP-MS																																<MDL	0.2	1	ug/L
Zinc, Dissolved, ICP-MS	5.02		0.5	2.5	ug/L	33.1		0.5	2.5	ug/L	2.3	<RDL	0.5	2.5	ug/L	20.9		0.5	2.5	ug/L	2.75		0.5	2.5	ug/L	1.3	<RDL	0.5	2.5	ug/L					
Zinc, Total, ICP-MS																																<MDL	0.5	2.5	ug/L
M=MT SM2340B.ED19 (06-02-004-002)																																			
Hardness, Calc	52.5		0.2	1.25	mg CaCO3/L	19.4		0.2	1.25	mg CaCO3/L	111		0.2	1.25	mg CaCO3/L	21.4		0.2	1.25	mg CaCO3/L	84.3		0.2	1.25	mg CaCO3/L	109		0.2	1.25	mg CaCO3/L					
M=OR EPA 3520C/8270C (7-3-04-001)																																			
Chlorpyrifos		<MDL	0.032	0.0472	ug/L		<MDL	0.032	0.0472	ug/L		<MDL	0.032	0.0472	ug/L		<MDL	0.032	0.0472	ug/L		<MDL	0.032	0.0472	ug/L		<MDL	0.032	0.0472	ug/L					
Diazinon		<MDL	0.041	0.0472	ug/L		<MDL	0.041	0.0472	ug/L		<MDL	0.041	0.0472	ug/L		<MDL	0.041	0.0472	ug/L		<MDL	0.041	0.0472	ug/L		<MDL	0.041	0.0472	ug/L					
Disulfoton		<MDL	0.025	0.0472	ug/L		<MDL	0.025	0.0472	ug/L		<MDL	0.025	0.0472	ug/L		<MDL	0.025	0.0472	ug/L		<MDL	0.025	0.0472	ug/L		<MDL	0.025	0.0472	ug/L					
Malathion		<MDL	0.045	0.0472	ug/L		<MDL	0.045	0.0472	ug/L		<MDL	0.045	0.0472	ug/L		<MDL	0.045	0.0472	ug/L		<MDL	0.045	0.0472	ug/L		<MDL	0.045	0.0472	ug/L					
Parathion-Ethyl		<MDL	0.042	0.0472	ug/L		<MDL	0.042	0.0472	ug/L		<MDL	0.042	0.0472	ug/L		<MDL	0.042	0.0472	ug/L		<MDL	0.042	0.0472	ug/L		<MDL	0.042	0.0472	ug/L					
Parathion-Methyl		<MDL	0.034	0.0472	ug/L		<MDL	0.034	0.0472	ug/L		<MDL	0.034	0.0472	ug/L		<MDL	0.034	0.0472	ug/L		<MDL	0.034	0.0472	ug/L		<MDL	0.034	0.0472	ug/L					
Phorate		<MDL	0.031	0.0472	ug/L		<MDL	0.031	0.0472	ug/L		<MDL	0.031	0.0472	ug/L		<MDL	0.031	0.0472	ug/L		<MDL	0.031	0.0472	ug/L		<MDL	0.031	0.0472	ug/L					
M=OR SM5520-B,F (07-03-016-000)																																			
Oil, Petro (Non-Polar)		<MDL	2	5	mg/L	2.8	<RDL	2	5	mg/L	2.8	<RDL	2	5	mg/L		<MDL	2	5	mg/L	2.7	<RDL	2	5	mg/L		<MDL	2	5	mg/L					
M=OR SW-846 8151A GCMS MODIFIED																																			
2,4,5-T		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L					
2,4,5-TP (Silvex)		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L					
2,4-D		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L					
2,4-DB		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L					
Dalapon		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L					
Dicamba		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L					
Dichloroprop		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L					
Dinoseb		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L					
MCPA		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L					
MCPP		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L					
M=OR WDOE NWTPH-DX (7-3-06-001)																																			
Diesel Range (>C12-C24)		<MDL	0.19	0.19	mg/L							<MDL	0.19	0.19	mg/L							<MDL	0.19	0.19	mg/L		<MDL	0.19	0.19	mg/L					
Lube Oil Range (>C24)		<MDL	0.19	0.19	mg/L	0.62		0.19	0.19	mg/L		<MDL	0.19	0.19	mg/L	0.26		0.19	0.19	mg/L		<MDL	0.19	0.19	mg/L		<MDL	0.19	0.19	mg/L					
M=OR WDOE NWTPH-GX (7-3-07-003)																																			
Gasoline Range (C7-C12)		<MDL	250	250	ug/L		<MDL	250	250	ug/L		<MDL	250	250	ug/L		<MDL	250	250	ug/L		<MDL	250	250	ug/L		<MDL	250	250	ug/L					

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King County

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January 17, 2007

TO: Fran Solomon, Senior Ecologist
WLRD, Scientific and Technical Support

FROM: Fritz Grothkopp, Laboratory Project Manager
WLRD, Environmental Laboratory

SUBJECT: Attached Report for Project 421195CY
Mercer Island Stormwater Monitoring,
Samples L41069-1 to 7

Attached is the comprehensive report for the water samples collected and delivered to the laboratory on December 11, 2006. The samples were analyzed in the Organics, Metals, Microbiology and Conventionals sections of the laboratory. QA/QC data summaries are included for your information.

Conventionals:
There were no anomalies associated with the preparation and the analysis of these samples.

Metals:
There were no anomalies associated with the preparation and the analysis of these samples.

Microbiology:
There were no anomalies associated with the preparation and the analysis of these samples.

Organics:

Oil, Non-Polar Analysis:
There were no anomalies associated with the analysis of these samples.

Herbicide Analyses:
Herbicide analysis was subcontracted to STL Seattle (Severn Trent Laboratory). There were no anomalies associated with the analysis of these samples.

Organophosphorus Pesticides (short list) Analyses:
There were no anomalies associated with the analysis of these samples.

The data have passed all internal QA/QC checks for accuracy and completeness and may be used without qualification, except where noted above.

1202M

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King County Environmental Lab Analytical Report

PROJECT: 421195CY

Locator:	MERCERISL06	MERCERISL10	MERCERISL26	MERCERISL32	MERCERISL42	MERCERISL10	KCO
Descrip:	R/D FACILITY SOUTH	SE 22ND ST, NEAR M	FOREST AVE. AND 84	CREEK NEAR HOLLYHI	E. MERCER WAY	SE 22ND ST, NEAR M	King County Locato
Sampled:	Dec 11, 2006	Dec 11, 2006	Dec 11, 2006	Dec 11, 2006	Dec 11, 2006	Dec 11, 2006	Dec 11, 2006
Lab ID:	L41069-1	L41069-2	L41069-3	L41069-4	L41069-5	L41069-6	L41069-7
Matrix:	STORM WTR	STORM WTR	STORM WTR	STORM WTR	STORM WTR	STORM WTR	BLANK WTR
% Solids:							

Parameters	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units
			- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis					- Wet Weight Basis		
COMBINED LABS																																		
M=CV SM2130-B (03-01-011-003)																																		
Turbidity																					19.9		0.5	2	NTU									
M=CV SM2510-B (03-01-002-003)																																		
Conductivity																					101		0.5	10	umhos/cm									
M=CV SM2540-D (03-01-009-002)																																		
Total Suspended Solids	237		2	4	mg/L	11		1	2	mg/L	205		5	10	mg/L	16		1	2	mg/L	145		2	4	mg/L	10.4		1	2	mg/L					
M=CV SM4500-H-B (03-01-003-004)																																		
pH																					7.02				pH									
M=CV SM4500-N-C (03-03-013-002)																																		
Total Nitrogen	1		0.05	0.1	mg/L	1.11		0.05	0.1	mg/L	1.36		0.05	0.1	mg/L	1.36		0.05	0.1	mg/L	1.15		0.05	0.1	mg/L	1.13		0.05	0.1	mg/L					
M=CV SM4500-P-B,FMOD(03-03-013-002)																																		
Total Phosphorus	0.153		0.005	0.01	mg/L	0.129		0.005	0.01	mg/L	0.183		0.005	0.01	mg/L	0.0723		0.005	0.01	mg/L	0.147		0.005	0.01	mg/L	0.131		0.005	0.01	mg/L					
M=CV SM4500-P-F (03-03-012-003)																																		
Orthophosphate Phosphorus	0.032		0.002	0.005	mg/L	0.0755		0.002	0.005	mg/L	0.03		0.002	0.005	mg/L	0.0267		0.002	0.005	mg/L	0.0407		0.002	0.005	mg/L	0.0772		0.002	0.005	mg/L					
M=ES NONE																																		
Conductivity, Field	74.6		0.5	10	umhos/cm	94.5		0.5	10	umhos/cm	81.1		0.5	10	umhos/cm	83.9		0.5	10	umhos/cm	114		0.5	10	umhos/cm	101		0.5	10	umhos/cm					
Discharge Rate of Stream	5.1		0.05	0.1	cfs	2.3		0.05	0.1	cfs	1		0.05	0.1	cfs	2.2		0.05	0.1	cfs	1.2		0.05	0.1	cfs	3.2		0.05	0.1	cfs					
Dissolved Oxygen Saturation, Field	93				%	92				%	84				%	78				%	80				%	95				%					
Dissolved Oxygen, Field	10.8		0.5	1	mg/L	10.5		0.5	1	mg/L	9.9		0.5	1	mg/L	9.1		0.5	1	mg/L	9.4		0.5	1	mg/L	10.7		0.5	1	mg/L					
Field Personnel	JO,KS				none	JO,KS				none	JO,KS				none	JO,KS				none	JO,KS				none	JO, KS				none					
pH, Field	7.7				pH	7.4				pH	7.6				pH	7.7				pH	7.6				pH	7.4				pH					
Sample Function																										FREP@L41069-2				none					
Sample Start Time	1425				hr	1512				hr	1110				hr	1220				hr	1309				hr	1515				hr	1425				hr
Sample Temperature, Field	8.5				deg C	9.4				deg C	8				deg C	8.1				deg C	7.9				deg C	9.4				deg C					
Turbidity, Field	76.3		0.5	2	NTU	19.9		0.5	2	NTU	113		0.5	2	NTU	18.8		0.5	2	NTU	89		0.5	2	NTU	21.4		0.5	2	NTU					
M=MC METRO MC SOP 6.5.1																																		
Escherichia coli	500				CFU/100ml	970				CFU/100ml	820				CFU/100ml	490				CFU/100ml	390				CFU/100ml	820				CFU/100ml					
M=MC SM-9222 D ed.17																																		
Fecal Coliform	670				CFU/100ml	800				CFU/100ml	960				CFU/100ml	590				CFU/100ml	410				CFU/100ml	1500				CFU/100ml					
M=MT EPA 200.8 (06-03-004&004A-001)																																		
Calcium, Total, ICP-MS	8530		50	250	ug/L	9790		50	250	ug/L	8910		50	250	ug/L	10200		50	250	ug/L	10400		50	250	ug/L	10600		50	250	ug/L					
Chromium, Dissolved, ICP-MS	0.75	<RDL	0.4	2	ug/L	0.69	<RDL	0.4	2	ug/L	1.3	<RDL	0.4	2	ug/L	1.9	<RDL	0.4	2	ug/L	1	<RDL	0.4	2	ug/L	0.67	<RDL	0.4	2	ug/L					
Chromium, Total, ICP-MS																																<MDL	0.4	2	ug/L
Copper, Dissolved, ICP-MS	2.13		0.4	2	ug/L	3.98		0.4	2	ug/L	2.03		0.4	2	ug/L	4.68		0.4	2	ug/L	2.55		0.4	2	ug/L	3.95		0.4	2	ug/L					
Copper, Total, ICP-MS																																<MDL	0.4	2	ug/L
Lead, Dissolved, ICP-MS		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L		<MDL	0.2	1	ug/L					
Lead, Total, ICP-MS																																<MDL	0.2	1	ug/L
Magnesium, Total, ICP-MS	4740		30	150	ug/L	3960		30	150	ug/L	5740		30	150	ug/L	2690		30	150	ug/L	7670		30	150	ug/L	4260		30	150	ug/L					
Zinc, Dissolved, ICP-MS	4.73		0.5	2.5	ug/L	18.4		0.5	2.5	ug/L	5.64		0.5	2.5	ug/L	11		0.5	2.5	ug/L	5.34		0.5	2.5	ug/L	17.7		0.5	2.5	ug/L					
Zinc, Total, ICP-MS																																<MDL	0.5	2.5	ug/L
M=MT SM2340B.ED19 (06-03-009-000)																																		
Hardness, Calc	40.8		0.2	1.25	mg CaCO3/L	40.7		0.2	1.25	mg CaCO3/L	45.9		0.2	1.25	mg CaCO3/L	36.5		0.2	1.25	mg CaCO3/L	57.6		0.2	1.25	mg CaCO3/L	44		0.2	1.25	mg CaCO3/L					
M=OR EPA 3520C/8270C (7-3-04-001)																																		
Chlorpyrifos		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L		<MDL	0.032	0.0476	ug/L					
Diazinon		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L		<MDL	0.041	0.0476	ug/L					
Disulfoton		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L		<MDL	0.026	0.0476	ug/L					
Malathion		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L		<MDL	0.046	0.0476	ug/L					
Parathion-Ethyl		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L		<MDL	0.043	0.0476	ug/L					
Parathion-Methyl		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L		<MDL	0.034	0.0476	ug/L					
Phorate		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L		<MDL	0.031	0.0476	ug/L					
M=OR EPA1664A(703-19-D)																																		
SGT-Hem (oil, nonpolar)	2.75	<RDL	2	5	mg/L	3.16	<RDL	2	5	mg/L	3.98	<RDL	2	5	mg/L	3.22	<RDL	2	5	mg/L	4.44	<RDL	2	5	mg/L	4.95	<RDL	2	5	mg/L					
M=OR SW-846 8151A GCMS MODIFIED																																		
2,4,5-T		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L		<MDL	0.012	0.2	ug/L					
2,4,5-TP (Silvex)		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L					
2,4-D	0.46		0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L		<MDL	0.0092	0.2	ug/L					
2,4-DB		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L					
Dalapon		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L		<MDL	0.034	0.4	ug/L					
Dicamba		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L		<MDL	0.017	0.2	ug/L					
Dichloroprop		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L		<MDL	0.019	0.2	ug/L					
Dinoseb		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L		<MDL	0.044	0.2	ug/L					
MCPA		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L		<MDL	0.015	0.2	ug/L					
MCPP	0.28		0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L		<MDL	0.011	0.2	ug/L					

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Appendix B

Benthic Macroinvertebrate Sampling Results and Summary Report

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				Mercer 42/06		Mercer Site#6		Mercer 10/06	
		Site		Mercer 42/06		Mercer Site#6		Mercer 10/06	
		ABR Sample ID		06-6110-130		06-611-131		06-611-132	
		Sample date		8/3/2006		8/7/2006		8/3/2006	
		Number of grids used (max = 30)		30		30		7.5	
		Sorting Efficacy QC Result						PASS	
Taxon			**Voucher**	Count	Unique?	Count	Unique?	Count	Unique?
Non-insect taxa		Nematoda	*2198*	1					
		Oligochaeta		7		52		303	
	Pisidiidae	Pisidiidae	*2023*					1	
	Planorbidae	Planorbidae	*2024*	1				1	
	Crangonyctidae	*Crangonyx*	*2128*			1			
	Acari	Acari	*2139*			3			
Ephemeroptera		*Baetis tricaudatus*	*2006*			55		29	
Plecoptera	Nemouridae	*Zapada cinctipes*	*2012*	1		36			
Trichoptera	Hydropsychidae	*Hydropsyche*	*2019*			5			
		Parapsyche almota	*2078*	2		3			
	Rhyacophilidae	*Rhyacophila grandis*	*2016*	1					
Diptera	Dixidae	*Dixa*	*2145*	1		2			
	Dolichopodidae	Dolichopodidae				1			
	Empididae	*Chelifera*	*2146*			4			
		Empididae - early instar or pupa				1	NO		
		Hemerodromia	*2192*			1			
	Simuliidae	*Simulium*	*2151*	15		306			
	Tipulidae	*Antocha*	*2153*					1	
		Dicranota	*2154*	1		7		1	
		Limnophila	*2037*			1			
		Molophilus						1	
		Pedicia	*2133*	1					
		Tipula	*2196*			1			
	Chironomidae	Chironomidae		5		88		244	
		Totals		36		567		581	
		B-IBI METRIC CALCULATIONS							
		METRIC VALUES							
		Taxa richness		11		16		8	
		E richness		0		1		1	
		P richness		1		1		0	
		T richness		2		2		0	
		Intolerant taxa richness		0		0		0	
		Clinger richness		4		4		2	
		LL richness		1		1		0	
		% tolerant		2.78		0.53		0.17	
		% predator		13.89		3.17		0.17	
		% dominance (3)		75.00		79.19		99.14	
		SITE SCORE CALCULATION							
		Taxa richness		1		3		1	
		E richness		1		1		1	
		P richness		1		1		1	
		T richness		1		1		1	
		Intolerant taxa richness		1		1		1	
		Clinger richness		1		1		1	
		LL richness		1		1		1	
		% tolerant		5		5		5	
		% predator		3		1		1	
		% dominance (3)		3		3		1	
		SITE SCORE		**18**		**18**		**14**	

2006 Mercer Island Stormwater Monitoring

Benthic Macroinvertebrate Sample Processing and Data Analysis Summary Report

Prepared for

King County Department of Natural Resources, Land & Water Resources
Environmental Laboratory
322 West Ewing Street
Seattle, WA 98119-9830

Prepared by

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ABR, Inc.—Environmental Research & Services
PO Box 249
Forest Grove, OR 97116

March 27, 2007

INTRODUCTION

ABR, Inc. was contracted in 2006 by King County to perform freshwater benthic macroinvertebrate analysis services for the King County Department of Natural Resources. In October 2006, ABR received three benthic samples from the "Mercer Island Stormwater Monitoring" project. Sample processing included subsampling and identification following standard laboratory protocols and a thorough quality control plan, as described herein. Taxonomic data were then analyzed using the species/family-level Puget Sound Lowlands Benthic Index of Biotic Integrity.

METHODS

Upon arrival at our laboratory, we ensured that all samples were properly labeled and preserved. Each sample was assigned a unique internal tracking number (for this project, 06-611-XXX) that accompanied the project and sample information provided by the client. All of this information was entered into the project's sample log that was maintained in the laboratory.

ABR used two trained and tested laboratory technicians, Tia Adams and Tony Roberts, to sort macroinvertebrates from raw field samples for this project. Each sample was processed using strict laboratory sample handling and labeling protocols (**Cole, M. B. 2005. Macroinvertebrate Sample Handling and Sorting Procedures. Unpublished internal ABR training and reference document**). A Caton gridded tray was used to subsample approximately 525 organisms from each sample. Using this subsampling procedure, each sample was distributed evenly across a 30-square wire-mesh tray. Individual squares were randomly selected and the contents removed and placed into a Petri dish. Macroinvertebrates were removed from the sample material under a dissecting microscope. This process was repeated until a total count of 525-550 organisms was achieved. The remainder of the sample (the unsorted fraction) was then inspected for large or rare taxa that were not encountered during the subsampling procedure; these "large/rare" taxa were recorded on the laboratory bench sheet as such and placed in a separate vial. The following products resulted from the sample sorting procedure:

1) 525-550 macroinvertebrates sorted into a series (4-7) of small vials by order, class, and/or phylum.
2) A separate vial containing organisms found during the large-rare search
3) Sorted residue – material from which the 525-550 organisms were sorted.
4) Unsorted fraction – portion of the original sample that was not sorted.

All macroinvertebrate samples will be saved by ABR for a minimum of six years or returned to the client, at their request. More than 10% of all sample residues were inspected by the laboratory manager, Adam Harris, to determine whether macroinvertebrate sorts were attaining 95% efficacy. Sorted residues will be saved until quality control results are reviewed and approved by the client. Unsorted sample

fractions will be held by ABR for six months following project completion and acceptance of data by the client or returned to the client upon their request.

Macroinvertebrate identification also followed strict protocols (Cole, M. B. 2006. Macroinvertebrate Sample Identification Standard Operating Procedures, Unpublished ABR training and reference manual). All identification work followed taxonomic standards established by the Northwest Biological Assessment Workgroup and Jeff Adams of the Xerces Society. Specimens identified for this project but not previously encountered during processing of other King County samples were added to ABR's King County voucher specimen collection. A list of taxonomic literature sources used to aid in the identification of project specimens is provided at the end of this report.

All raw data were entered into Excel spreadsheets and crosschecked against paper copies of the data for errors and omissions before the data are analyzed. Electronic data were also checked for outliers and other errors using summary statistics and graphic analyses. Data were analyzed using the most up-to-date version of the Benthic Index of Biotic Integrity for Puget Sound Lowland Streams. Back up copies of all raw data were produced electronically and on paper. An Excel file accompanying this summary report, entitled "**06-611_KC_2006_Mercer_invert_data.xls**", contains all of the raw macroinvertebrate taxonomic data, quality control results, voucher specimen record numbers, metric scores, and B-IBI total scores.

RESULTS

Quality Control

One of the three samples (33.3%) was checked for sorting efficacy and passed with a greater than 95% sorting efficacy. No rare or unusual or rare taxa that were difficult to identify were encountered during sample identification. As such, no specimens were sent to outside specialists. Taxa identified for this project that had not been identified in 2004 or 2005 by ABR for King County were added to ABR's King County projects voucher specimen collection. This collection will be permanently archived in ABR's master reference collection.

2006 IBI Scores

2006 Mercer Island B-IBI scores ranged from 14 to 18 and averaged 16.7. IBI scores from all three sample sites were similar to 2005 scores. Merceer Isl 6 scored an 18 in each year, while Mercer Isl 10 scored a 14 in 2006 versus an 18 in 2005, and Mercer Isl 42 scored an 18 in 2006 versus a slightly higher 22 in 2005.

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Appendix C

Raw Sediment Quality Data for Five Mercer Island Basins

Provided by: King County Water and Land Resources Division Environmental Laboratory

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King County

Water and Land Resources Division
Environmental Laboratory
Department of Natural Resources and Parks
322 West Ewing Street
Seattle, WA 98119-1507
206-684-2300 Fax 206-684-2395
TTY Relay: 711

October 10, 2006

TO: Fran Solomon, Senior Ecologist
WLRD, Scientific and Technical Support

FROM: Fritz Grothkopp, Laboratory Project Manager
WLRD, Environmental Laboratory

SUBJECT: Attached Report for Project 421195CY, Mercer Island Sediments
Samples L39920-1- 7, collected August 10, 2006

Attached is the comprehensive report for the sediment samples delivered to the laboratory on August 10, 2006. The samples were analyzed in the Organics, Metals and Conventionals sections of the laboratory. QA/QC data summaries are included for your information.

Conventionals:

There were no anomalies associated with the preparation and analysis of these samples. The data have passed all internal QA/QC checks for accuracy and completeness and may be used without qualification.

Metals:

The data have passed all QA/QC checks and the data may be used without qualification

Organics:

The data have passed all internal QA/QC checks for accuracy and completeness and may be used without qualification.

If you have any questions or need additional information, please call me at 684-2327.

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King County Environmental Lab Analytical Report

PROJECT: 421195CY

Locator:	MERCERISL06	MERCERISL10	MERCERISL42	MERCERISL26	MERCERISL32	MERCERISLDUP
Descrip:	R/D FACILITY SOUTH	SE 22ND ST, NEAR M	E. MERCER WAY	FOREST AVE. AND 84	CREEK NEAR HOLLYHI	FIELD REPLICATE
Sampled:	Aug 10, 2006	Aug 10, 2006	Aug 10, 2006	Aug 10, 2006	Aug 10, 2006	Aug 10, 2006
Lab ID:	L39920-1	L39920-2	L39920-3	L39920-4	L39920-5	L39920-6
Matrix:	FRSHWTRSED	FRSHWTRSED	FRSHWTRSED	FRSHWTRSED	FRSHWTRSED	FRSHWTRSED
% Solids:	74.1	44.5	38.9	72.8	76.8	64.1

MERCERISL06 (L39920-1)

Parameters	Value	Qual	MDL (- Dry Weight Basis)	RDL	Units
COMBINED LABS					
M=CV SM2540-G (03-01-007-002)					
Total Solids *	74.1		0.005	0.01	%
M=ES NONE					
Sample Function					
Sample Start Time *	1145				hr
M=MT EPA3050A/6010B (06-02-004-002)					
Chromium, Total, ICP	22		0.34	1.67	mg/Kg
Copper, Total, ICP	9.1		0.27	1.33	mg/Kg
Lead, Total, ICP	4.3	<RDL	2	10	mg/Kg
Zinc, Total, ICP	44.4		0.34	1.67	mg/Kg
M=OR SM5520-B,D,F (07-03-017-000)					
Oil, Petro (Non-Polar)	344		130	337	mg/Kg

MERCERISL10 (L39920-2)

Parameters	Value	Qual	MDL (- Dry Weight Basis)	RDL	Units
Total Solids *	44.5		0.005	0.01	%
Sample Function					
Sample Start Time *	1205				hr
Chromium, Total, ICP	59.8		0.54	2.74	mg/Kg
Copper, Total, ICP	43.6		0.45	2.2	mg/Kg
Lead, Total, ICP	142		3.4	16.5	mg/Kg
Zinc, Total, ICP	171		0.54	2.74	mg/Kg
Oil, Petro (Non-Polar)	899		220	562	mg/Kg

MERCERISL42 (L39920-3)

Parameters	Value	Qual	MDL (- Dry Weight Basis)	RDL	Units
Total Solids *	38.9		0.005	0.01	%
Sample Function					
Sample Start Time *	1110				hr
Chromium, Total, ICP	40.9		0.67	3.34	mg/Kg
Copper, Total, ICP	19.9		0.54	2.67	mg/Kg
Lead, Total, ICP	14	<RDL	4.1	20.1	mg/Kg
Zinc, Total, ICP	90.7		0.67	3.34	mg/Kg
Oil, Petro (Non-Polar)	746		260	643	mg/Kg

MERCERISL26 (L39920-4)

Parameters	Value	Qual	MDL (- Dry Weight Basis)	RDL	Units
Total Solids *	72.8		0.005	0.01	%
Sample Function					
Sample Start Time *	1000				hr
Chromium, Total, ICP	26		0.34	1.7	mg/Kg
Copper, Total, ICP	10.9		0.27	1.37	mg/Kg
Lead, Total, ICP	4.3	<RDL	2.1	10.3	mg/Kg
Zinc, Total, ICP	34.3		0.34	1.7	mg/Kg
Oil, Petro (Non-Polar)	371		140	343	mg/Kg

MERCERISL32 (L39920-5)

Parameters	Value	Qual	MDL (- Dry Weight Basis)	RDL	Units
Total Solids *	76.8		0.005	0.01	%
Sample Function					
Sample Start Time *	1035				hr
Chromium, Total, ICP	23.4		0.33	1.63	mg/Kg
Copper, Total, ICP	11.9		0.26	1.3	mg/Kg
Lead, Total, ICP	7.9	<RDL	2	9.75	mg/Kg
Zinc, Total, ICP	70.3		0.33	1.63	mg/Kg
Oil, Petro (Non-Polar)	592		130	326	mg/Kg

MERCERISLDUP (L39920-6)

Parameters	Value	Qual	MDL (- Dry Weight Basis)	RDL	Units
Total Solids *	64.1		0.005	0.01	%
Sample Function	FREP@L39920-4				none
Sample Start Time *	1015				hr
Chromium, Total, ICP	23.9		0.37	1.89	mg/Kg
Copper, Total, ICP	10.4		0.3	1.51	mg/Kg
Lead, Total, ICP	3.6	<RDL	2.3	11.3	mg/Kg
Zinc, Total, ICP	33.4		0.37	1.89	mg/Kg
Oil, Petro (Non-Polar)	459		160	390	mg/Kg

* Not converted to dry weight basis for this parameter

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