A Sediment/Biological Assessment of Lyons Creek East

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SUMMARY

This report is a compilation of Ministry of the Environment (MOE) studies on the Polychlorinated Biphenyl (PCB) and metal contamination of Lyons Creek sediments east of the Welland Canal.

Elevated concentrations of PCBs were located in the lower sediments at three sampling locations. Elevated concentrations of metals were also located at the lower depths of these locations, suggesting historical problems. There were PCB concentrations above the detection limit at 5 locations in soils adjacent to the creek. A trend toward higher concentrations close to the creek compared to samples more distant from the creek may suggest that at these locations historical accumulations of PCBs in sediments have made their way to soils beyond the banks of the creek. Contaminants in the creek sediments are toxic to sediment dwelling organism, are biologically available to bottom dwelling organisms and are being transferred through the food chain to small fish and ultimately sport fish. However, PCB were not detected in vegetation, suggesting that the PCB are not being translocated by vegetation No conclusions regarding the source of the contamination were drawn at the time of initial contamination due to the lack of information on sedimentation rate.

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1.0 INTRODUCTION

This study is a compilation of a variety of studies conducted to determine the extent of polychlorinated biphenyl contamination (PCB) in the sediments of Lyons Creek and the effects of this contamination on the biota of Lyons Creek. The study area is located east of the City of Welland, on the eastern side of the Welland Canal, extending from the canal to Schisler Road (Figure 1).

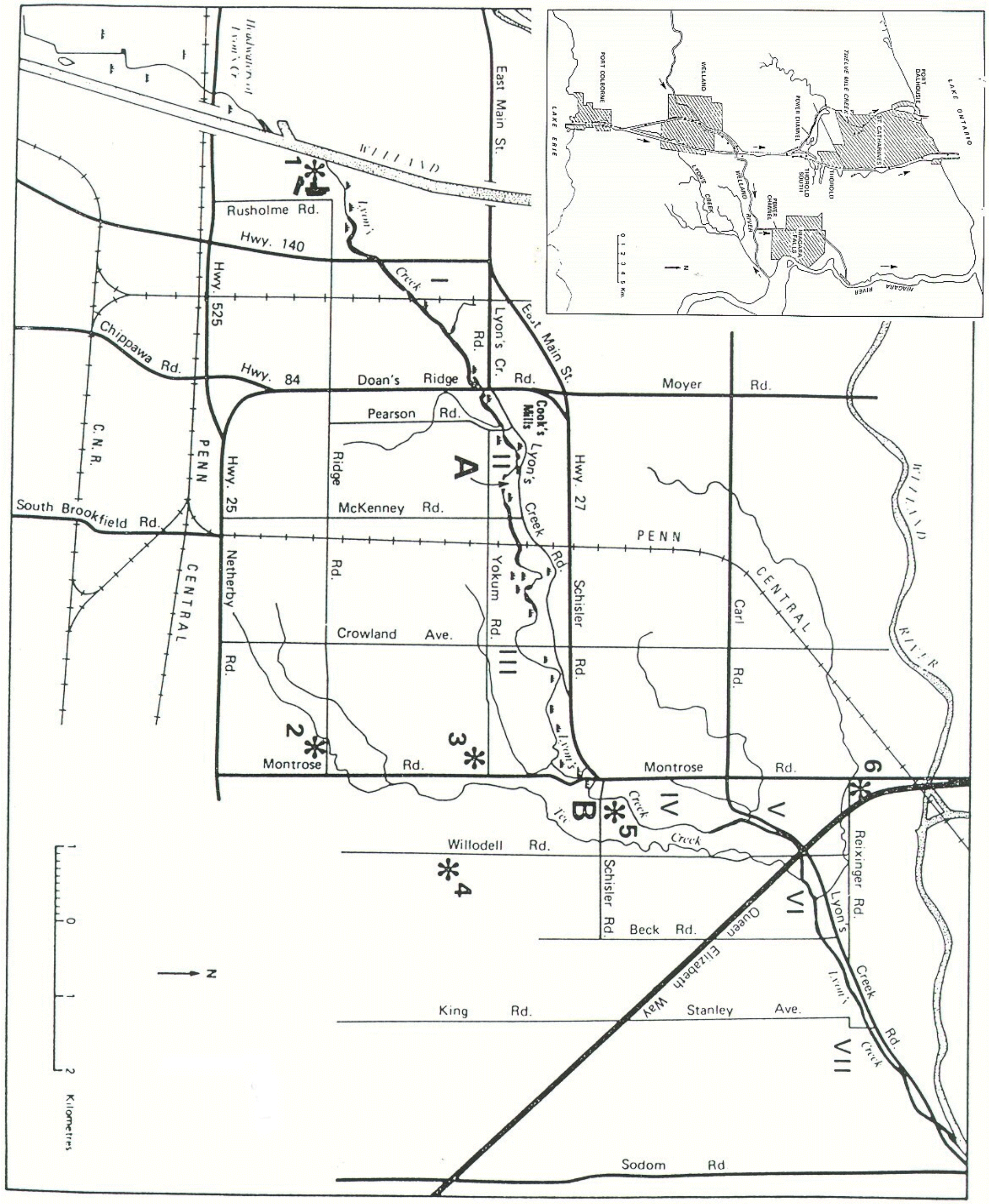
In the spring of 1990, after an oil spill from the Ontario Hydro Crowland Transformer, PCB studies were conducted in Lyons Creek on the west side of the Welland Canal. These analyses indicated that bottom sediments were contaminated with PCBs. Sampling conducted at this time indicated PCB contamination at depths up to one metre and at concentrations as high as 180 μg/l (Environmental Strategies Ltd., 1992). However, the types of PCBs identified in the sediments did not all correspond to the types of PCBs spilled by that transformer. This led to the hypothesis that a notable portion of the contamination in Lyons Creek was due to historical problems.

As a result of these early findings, preliminary investigations were undertaken on the east section of Lyons Creek to determine if these sediments were also contaminated with PCBs. After it was established that these sediments were contaminated with PCBs, additional studies were undertaken with the following major objectives:

- define the spatial extent of PCB contamination of sediments in the creek;
- determine if PCBs are currently being discharged into the creek;
- determine through laboratory studies if creek sediments are toxic to aquatic life;
- determine if sediment-bound PCBs are biologically available to bottom-dwelling organisms;
- determine if PCBs are being transferred through the food chain to small fish and ultimately to sport fish;
- determine if sport fish in Lyons Creek are suitable for human consumption.

The Phytotoxicology Section later extended the results of earlier sediment and biological studies on Lyons Creek (east of the canal) to include the sampling of soils near the creek for PCBs. Additional sampling of emergent aquatic vegetation was conducted to address concerns that composted vegetation from the creek may contribute PCBs to local gardens.

Figure 1: The Lyons Creek Watershed



2.0 BACKGROUND

2.1 Study Area

The Lyons Creek wetland runs north-easterly from the Welland Canal and discharges into the Welland River at Chippawa. The sediment study area is comprised of an approximately 11 km stretch of the creek along the eastern bank of the Welland Canal, as shown in Figure 1. The creek is the habitat of numerous species of fowl, flowers, fish, and vegetation. A Ministry of Natural Resources (MNR) survey classified the area to be 85.6 % marsh area and 14.4 % swamp. It was defined by the MNR as a Class One Wetland which, due to its high degree of community structure and diversity of wildlife, is given maximum protection considerations in order to avoid any detrimental impacts. The primary human uses for the wetland areas are hunting, fishing, canoeing, and as an area of nature appreciation.

Lyons Creek is situated on a bedrock formation named "The Salina Formation" which is approximately 90 metres of interbedded limestone, shale and sandstone. There is approximately 24 to 37 metres of clay covering roughly 3 metres of gravel on top of the bedrock. From well water records of the area, a fresh water aquifer is located between 24 to 37 metres below the land surface. The surficial geology of the tract that the creek traverses is mainly clay, silt, sand and gravel with some organic matter.

During the construction of the Welland Canal in the 1960s, the natural flow of Lyons Creek was interrupted where the canal bisected the creek. Flow from the creek on the canal's west bank is pumped into the canal while the flow on the east side of the creek is maintained by continuous pumping of water from the canal to the creek. The desired pumping rate determined for the natural ecological surroundings was increased to 0.28 m^3/s from 0.14 m^3/s in September 1989.

2.2 History

A significant number of industry was established in the Niagara River and the surrounding areas due to the availability of electricity from Niagara Falls and transportation access along the adjacent waterways. This land use led to industrial spills and contamination of the environment.

The major industry situated on the eastern side of the Welland Canal near Lyons Creek is StelPipe, which forms flat steel sheets into large diameter pipes. This facility takes water from the ship canal for pressure sizing, hydrostatic testing of the finished pipe and rinsing, in preparation for painting. Water is also used in photographic processing of x-ray films that ensure the quality of the welds on the tubes. This process passes water through an oil/water separator and one of two settling lagoons prior to discharging to Lyons Creek.

More recent events near the Lyons Creek study area include a fish kill on July 19, 1988 downstream of StelPipe. On July 20, analysis performed by StelPipe revealed that the effluent from the lagoon was lethal with respect to standardized toxicity testing.

On April 5, 1989, 5,800 gallons of emulsified oil was spilled into Lyons Creek east of the canal. As a precaution, flow was reduced in the creek in an attempt to limit the dispersion of the oil. Toxicity testing on rainbow trout was performed at five stream sample locations in the days following this spill. These tests did not result in fish mortality, and the St. Lawrence Seaway Authority resumed normal pumping rates and flow to the creek the next day.

On the west side of Lyons Creek, in May of 1990, approximately 4,500 gallons of PCB oil, containing only the congener Arochlor 1260 was spilled from the Ontario Hydro Crowland Transformer. The MOE requested Ontario Hydro sample the area to confirm the extent of the contamination.

A consultant's report (Environmental Strategies Ltd., 1992) on the situation detailed the extensive contamination of the sediments in the wetland. Elevated levels were found of two types of PCBs (Arochlor 1248 and 1254) along with trace amounts of 1260. Arochlor 1248 and 1254 are possible byproducts resulting from natural dechlorination of more highly chlorinated PCBs. However, the dechlorination process is slow, so the discovery of these other congeners so soon after the spill implied that there was a different source for the PCBs that were found in the wetland. Due to the possibility of PCB pollution occurring before the creek was bisected, it was proposed that an extensive study of the sediment of Lyons Creek on the east side of the Welland Canal be undertaken by the MOE. Sediment core samples collected from the creek could provide a historical background of the area. Sedimentation rates and the presence of concentrations at various depths supply a basic relationship between the contamination and time elapsed since its release. The results of this sampling survey are presented in this report.

3.0 METHODS

3.1 Sampling - Study Area

A survey of Lyons Creek was conducted by MOE staff in October 1991. This study encompassed the section east of Welland Canal running approximately 1.5 km to Highway 140. The tests included five sediment sample transects (labelled T1 through T5), where T5 is the furthest downstream from the canal. Four locations per transect were taken at equal distances across the creek's width. Samples consisted of sediment cores taken from above till materials. These sediment cores were sectioned into the 0-0.25 metre, 0.25-0.5 metre and the >0.5 m horizons.

In July 1992 and June 1994 additional sediment samples were taken at locations further downstream of the original study. Transects were sampled at three locations: the south bank, mid-channel and north bank. These sediment cores were also divided into the 0-0.25 m and 0.25 - 0.50 m horizons. The total depths of the sediment cores is summarized in Table 1.

Table 1: Depth of Sediment Cores

Core	Total Depth of Core		
Transect 1	50 cm at all 4 locations		
Transect 2	50 cm at all 4 locations		
Transect 3	50 cm at all 4 locations		
Transect 4	50 cm at all 4 locations		
Transect 5	50 cm at all 4 locations		
	South	**Mid**	**North**
Transect 6	56	59	57
Transect 7	45	61	62
Transect 8	57	51	48
Transect 9A	71	80	36
Transect 9	42	38	50
Transect 10A	50	59	78
Transect 10	40	50	50
Transect 11	65		
Transect 12	50		

The approximated distance downstream from the inlet into the eastern portion of Lyons Creek and the sample locations is given in Table 2.

Table 2: Sample Locations - Distance Downstream of the Canal.

Sample Number	Approximate Distance Downstream (m)
Transect 1	30
Grab 1	60
Transect 2	140
Grab 2	212
Transect 3	258
Grab 3	310
Transect 4	365
Grab 4	605
Transect 5	755
Grab 5	1485
Transect 6	1055
Transect 7	1400
Transect 8	2400
Transect 9	3200
Transect 9a	5000
Transect 10	6400
Transect 10a	8400
Transect 11	9400
Transect 12	126

3.2 SAMPLING - PROCEDURE

3.21 Transect Extractions

At each transect location, a plexy glass tube was driven into the sediment. A rubber stopper was used to plug the top of the tube, creating a vacuum to stabilize the sediment layers and preserve the water - sediment interface. The tube was then extracted from the sediment and a second stopper was placed at the bottom of the tube. After clamping the tube onto a support, a compressed water tank was connected to the sample tube by a rubber hose, and a tight seal was obtained. The valve of the tank was then opened and the compressed water pushed the sediment core up through the tube. The rubber stopper on the bottom prevented dilution of the sample.

A stainless steel flat pan was attached to the top of the sample tube and as the core moved through the circular opening of the pan, an inner core sample was cut away. A section of each depth was then sliced off into a plastic sampling cup. After each sample was completed, acetone and compressed water were used to clean the pan and tubing to prevent cross-contamination of samples.

3.22 Grab Extraction

An Eckman dredge was used to obtain surface sediment samples. A representative sample was taken from the middle of the dredge box.

3.3 SAMPLING PARAMETERS

Each of the samples were tested for:

Total PCBs	Copper	Nickel
Aluminum	Chromium	Strontium
Barium	Iron	Titanium
Beryllium	Lead	Vanadium
Cadmium	Manganese	Zinc
Cobalt	Molybdenum	Total Organic Carbon (TOC)

In May 1992, staff of the ministry's Water Resources Branch collected sediment dwelling worms for tissue analysis of PCBs. Samples were collected at three of the original five transects (T1, T3 and T5). At each of these transects, 5 grams of worms were collected. Over time, tissue analyses were also conducted on minnows, mussels, sportfish, juvenile fish and turtles.

In June 1992, surface sediments were collected for chemical analysis and sediment bioassays at five locations as indicated in Figure 2. These analyses were repeated in June of 1996 at two of the five sample locations.

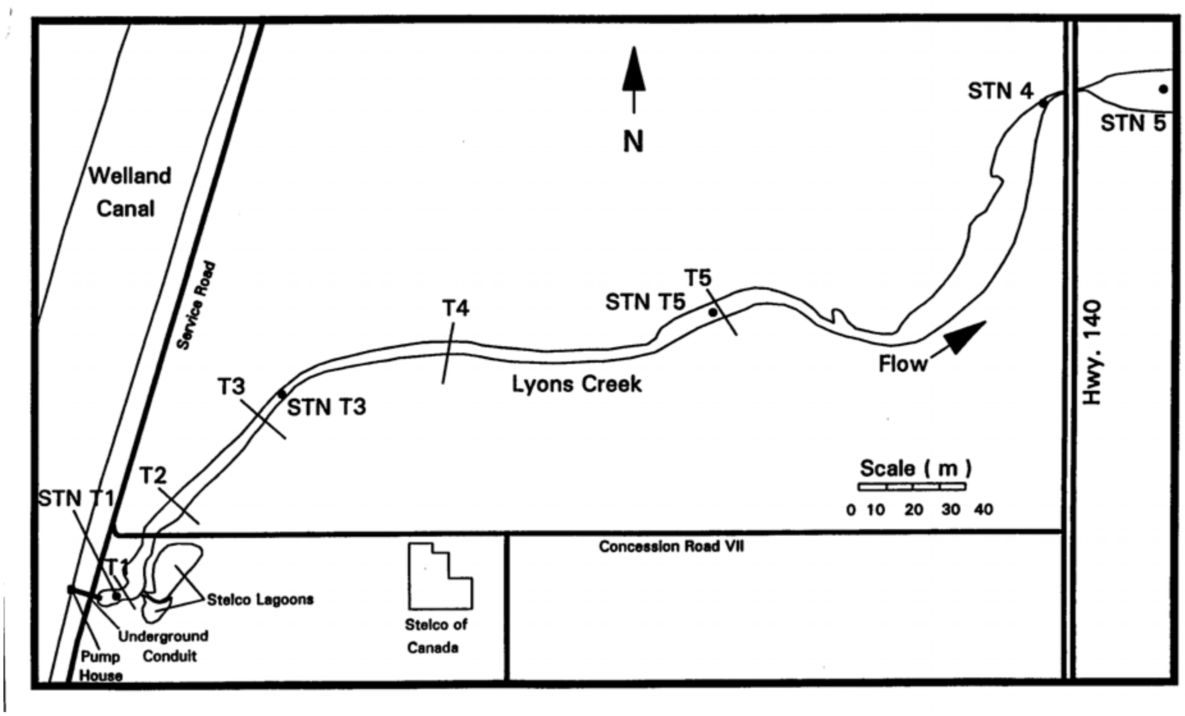
3.4 SEDIMENT BIOASSESSMENT

Surficial sediments were collected at five locations along Lyons Creek, extending from the Welland Canal to just east of Highway 140 as indicated in Figure 2. Sediment biological tests were conducted following Ministry of the Environment standardized procedures (Bedard *et al.*, 1992). The experimental unit was a 1.8 L test chamber containing 325 mL of sediment and dechlorinated municipal tap water. Moist field-collected bottom sediment was pressed through a

2 mm polyethylene sieve to remove existing large biota and debris prior to use. The chambers were kept at ambient room temperature and maintained under a 16 hour light to 8 hour dark photoperiod. The samples were continuously aerated. A clean sediment sample was also used as a negative control for each bioassay.

The chambers were monitored regularly for pH, conductivity and dissolved oxygen. Dead organisms were removed and the number recorded on a daily basis. Any signs of abnormal behaviour of the test organisms or changes in appearance of the test chambers were noted. Water loss due to evaporation was replenished as needed. Subsamples of this sediment were submitted for chemical and physical characterization.

Figure 2: Sediment Sample Locations for Sediment Bioassays



3.4.1 *Hexagenia limbata* (Mayflies) Lethality and Growth Assay

The tests used 3 month old, laboratory reared, mayfly nymphs with an average wet weight of 3.64 mg. Mayflies were reared according to OMOE procedures (Bedard *et al*., 1992) and methods described in the literature (Friesen, 1981).

During sorting, 40 individuals were randomly selected and individually weighed to the nearest ± 0.01 mg. Ten nymphs were added to four jars for each test and to the control sediments and kept in these jars for a period of 21 days. The animals were not fed during the length of the test.

At the end of the test, the contents of each jar was emptied and rinsed in a sieve bucket. Surviving animals were counted and transferred into 150 mL beakers holding 100 mL dechlorinated tap water. The nymphs were immobilized by the carbon dioxide from Alka-Seltzer® and blotted dry. Individuals were re-weighed to the nearest 0.01 mg, then submitted for chemical analysis.

3.4.2 *Chironomus tentans* (Midges) Lethality and Growth Assay

The tests used 10-12 day old midge larvae having an average wet weight of less than 1 mg. The MOE continuously cultures *C. tentans* larvae from egg to adult following standard methods (Bedard *et al*., 1992, Mosher *et al*., 1987, Townsend *et al*., 1981).

A total of 15 animals were added per jar. Identical conditions were created in three jars for each sediment sample. This replication of tests is to rule out outside influences on the test results. Animals were fed 30 mg of a Cerophyll®:Tetra Conditioning Vegetable® diet daily. Within 18 hours, the jars were checked and "floaters" were removed and replaced.

After 10 days, the contents of the test chambers were emptied and washed in a sieve bucket. Surviving animals were sorted, removed and placed into 150 mL beakers holding 100 mL dechlorinated water and 15 mL of sand. The larvae were counted, blotted dry and individuals re-weighed to the nearest 0.01 mg.

3.4.3 *Pimephales promelas* (Minnow) Lethality and Bioaccumulation Assay

The tests used juvenile fathead minnows with a wet weight average of 336 mg. The minnows were cultured at the MOE laboratory under the supervision of Dr. G. Westlake. Culture techniques for the most part follow USEPA procedures (USEPA, 1987) with minor revisions (Bedard *et al*., 1992).

Each test consisted of 10 juvenile minnows placed in four replicate containers. The minnows were exposed for 21 days. They were fed Tetra Conditioning Vegetable Diet® , in an amount equivalent to 1% of their average starting wet weight, on a daily basis. After 21 days, the surviving fathead minnows were pooled from each replicate, counted, immobilized with the carbon dioxide from Alka-Seltzer® and submitted for tissue chemical analysis.

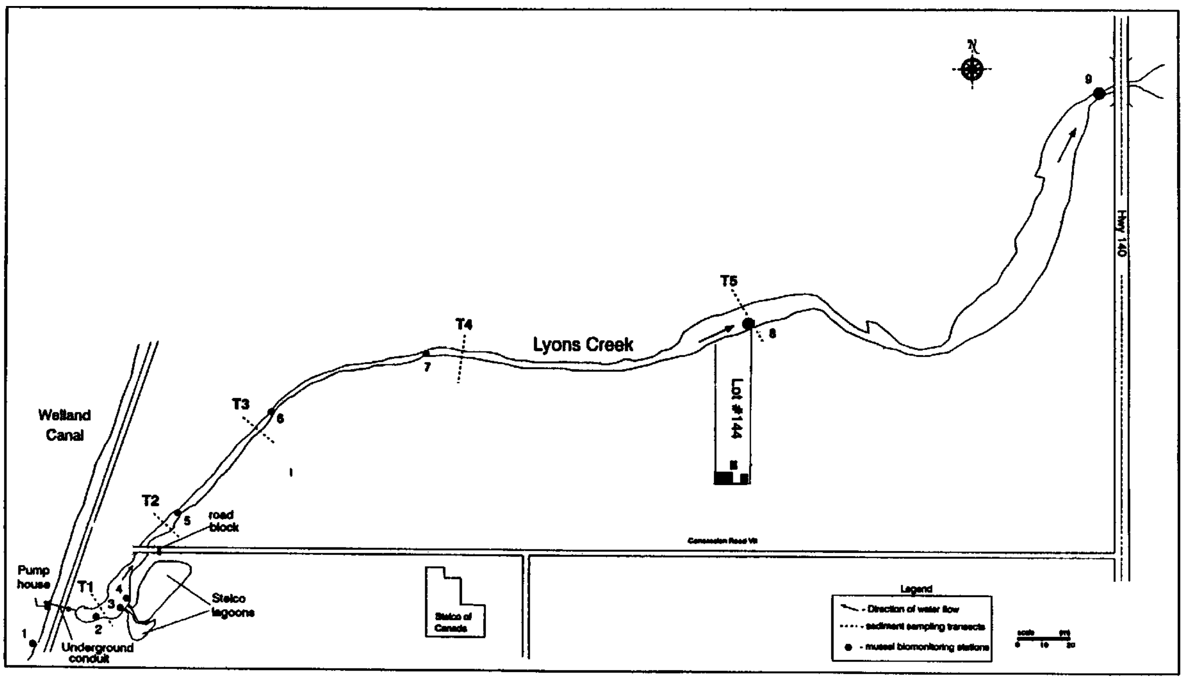
3.5 MUSSEL BIOMONITORING

Mussels (*Elliptio complanata*) with a maximum shell length of 65 to 72 mm were collected from Balsam Lake (Victoria County) on October 16, 1991 and maintained. They were kept in aerated Balsam Lake water at room temperature. Mussels from this lake are used since the concentrations of organochlorine contaminants in them are usually below analytical detection limits (Kauss and Hamdy 1985).

On October 17, 1991, the mussels were transferred into envelope-shaped cages 30 cm by 45 cm of 1.25 cm galvanized mesh poultry netting. At each of the nine stations (Stations 1 through 9; see Figure 3), four cages containing 5 mussels each were placed across the creek bed.

On November 7, 1991, after an exposure period of 21 days, all the caged mussels were collected, except for those at station 8 which could not be located. The mussels were immediately shucked, individually wrapped in foil, stored on ice and transported to the Ministry of the Environment (OMOE) Laboratory in Rexdale, Ontario. Mussel tissue was stored at -20 °C prior to analysis. Three replicate analyses were performed for each station for PCBs.

Figure 3: Mussel Biomonitoring Sample Locations



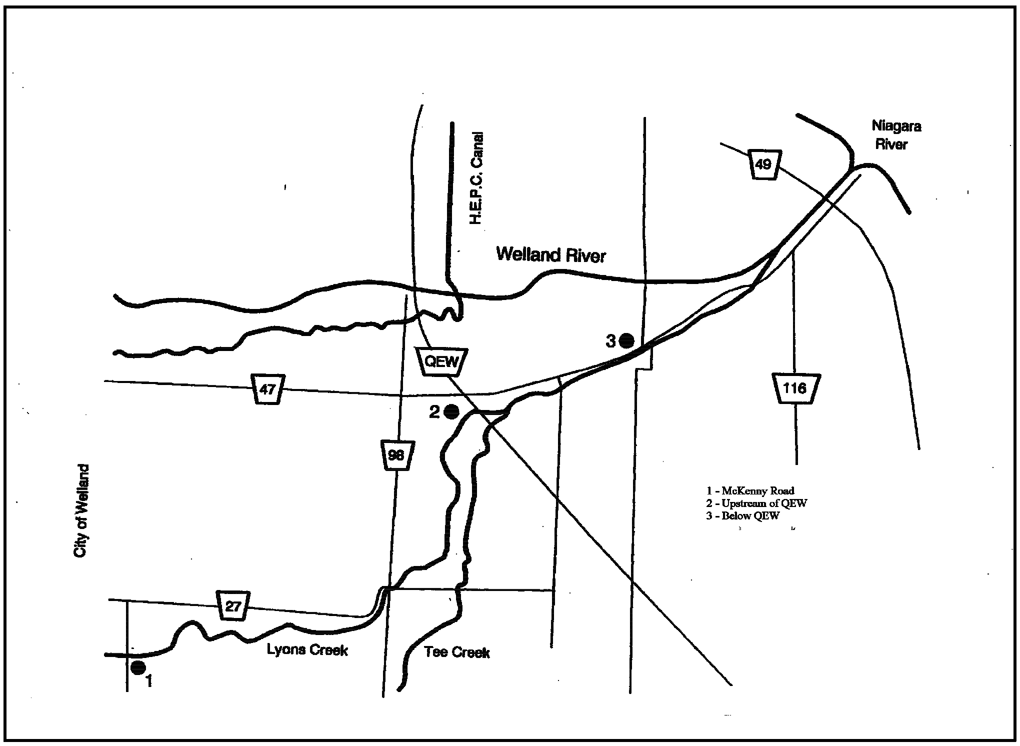
3.6 SPORT FISH

Sport fish are collected by MNR as part of the annual Sport Fish Contaminant Monitoring Program. The edible portion of fish was analysed by MOE for PCBs, pesticide and mercury levels. This program has operated Province-wide since 1976 as a cooperative program between the MOE and MNR. The results of the study are incorporated into the 1994 (and subsequent) *Guide To Eating Ontario Sport Fish*.

3.7 JUVENILE FISH

Juvenile fish were collected using a 0.6 cm-mesh bag seine net, frozen in the field using dry ice and kept at -10○C until analysed. The combined tissue from five fish were analysed. More details on the methodology can be found in Suns *et al.* (1991). Juvenile fish sample collection sites are shown in Figure 4.

Figure 4: Juvenile Fish Collection Sites



3.8 SNAPPING TURTLES

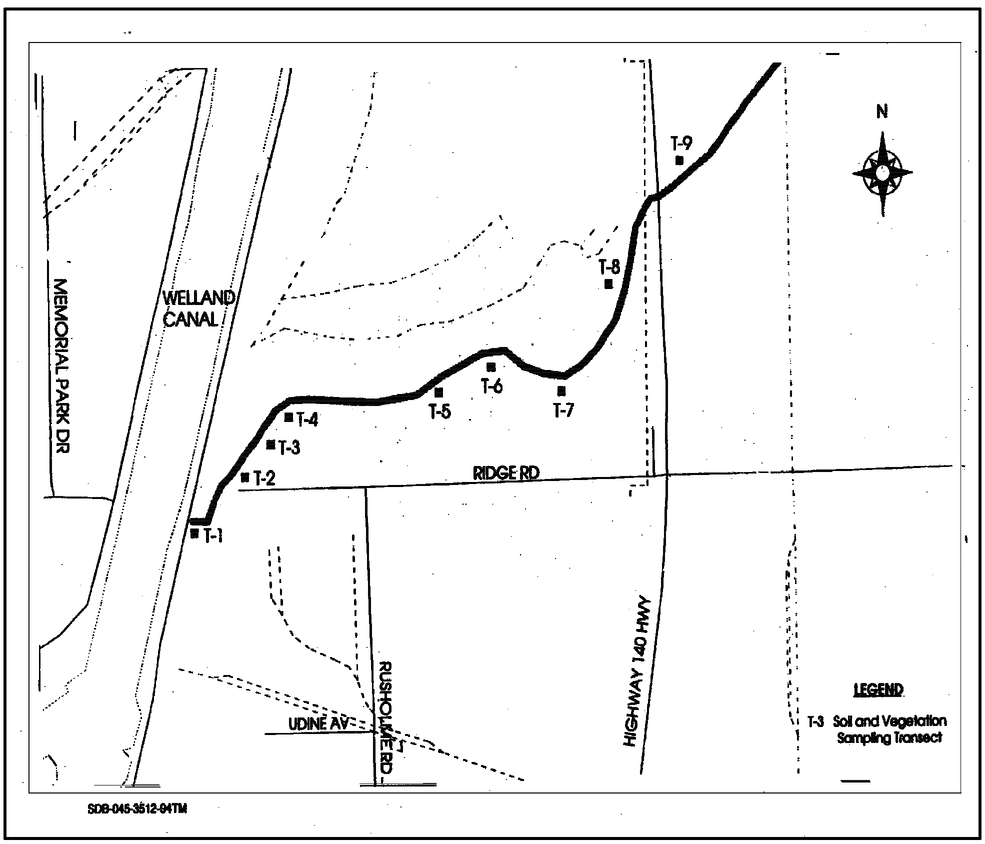
Snapping turtles (*Chelydra serpentina*) were identified as a species that is periodically exploited for consumption in Lyons Creek. Five snapping turtles (*C. serpentina*) were collected by trapping by the ministry's Welland District Office on June 3 and 4, 1996. The turtles were weighed, measured and their sex was determined along with their reproductive status (e.g. the presence and state of development of eggs). Selected tissues from each turtle were removed for analysis. This included muscle tissue from the hind leg, loose visceral fat, liver, heart and eggs. Tissues were stored at -20 ºC prior to analysis.

3.9 SOILS AND VEGETATION

Soil and vegetation collections along the east section of Lyons Creek were conducted by the Ministry's Phytotoxicology Lab, on June 22, 1993.

Nine sampling transects were selected along the creek from the pumping station on the east side of the Welland Canal to just east of Highway 140. These transects were selected to coincide with the locations of previously sampled sediment transects. The locations of these transects are illustrated in Figure 5. A control transect was sampled approximately 12 km downstream of the pumping station on Tee Creek, a tributary of Lyons Creek which flows almost due south from the intersection of Lyons Creek and Tee Creeks and the Queen Elizabeth Way.

Figure 5: Soil and Vegetation Collection Transects



Soil samples were collected from each transect at distances of 1, 5 and 25 metres from the edge of the creek at the time of the sampling. Each soil sample consisted of a minimum of 50 individual cores collected from random locations within the sample area using a stainless steel corer and combined to form a single sample.

Samples of vegetation from the creek edge were also collected at each of the transects. Single compost samples of foliage were collected above the surface of the water from arrowhead and Carex plants (sedges) where available. The roots of these plants were not sampled.

Soil and vegetation samples were stored under ice during transport to the Phytotoxicology processing lab where they were frozen to -80 ºC. Samples were submitted to the OMOE laboratory in Etobicoke for PCB analysis.

4.0 ANALYTICAL METHODS

Chemical analysis of sediment and tissue samples was carried out by the Ministry of the Environment's Laboratory Services Branch, in accordance with procedures described in "Handbook of Analytical Methods for Environmental Sampling - Volumes 1 and 2 "(OMOE, 1983).

5.0 RESULTS

5.1 LABORATORY RESULTS

A complete summary of sample results is presented in APPENDIX A.

5.2 STATISTICAL SUMMARY OF RESULTS

The following table (Table 3) provides a summary of the mean, standard deviation and range of sample results relative to sample depth and location of transects.

Grab samples were taken at the surface of the creek bed. Upper samples were taken at a depth of 0 to 0.25 metres, middle samples at a depth of 0.25 0.50 metres and lower samples at a depth of greater than 0.5 metres.

Table 3: Mean, Standard Deviation, and Range Results for Lyons Creek Sediments

Parameter	Mean			Standard Deviation			Range		
	G1- 8	T 1-5	T6- 12	G1 - 8	T1 - 5	T6 - 12	G1 - 8	T1 - 5	T6 - 12
PCBs µg/g									
Upper	0.35	1.17	3.78	0.035	1.33	3.66	0-1.5	0-5	0-14
Middle		25.00			55.3			0-180	
Lower		4.89	4.27		6.8	5.5		0-25	0-21
Aluminum µg/g									
Upper	14,467	18,300	25,353	7,760	4,450	1,869	0.04-26,000	9,000-26,000	21,000-29000
Middle		18,560			5,845				
Lower		24,100	29,900		5,160	3,347			
Barium µg/g									
Upper	81.3	90	102	40.2	25.9	36.6	0-120	21-130	38-150
Middle		71			40.1			18-130	
Lower		80	95		38.5	36.0		24-140	33-150
Beryllium µg/g									
Upper	0.33	0.57	0.98	0.3	0.21	0.06	0-0.79	0-0.9	0.85-1.1
Middle		0.66			0.29			0.37-1.2	
Lower		0.68	0.97		0.25	0.08		0-1.2	0.83-1.1
Cadmium µg/g									
Upper	0.97	1.62	1.25	0.63	0.77	0.38	0-1.9	0.46-3.3	0.64-1.9
Middle		1.88			1.16			0.45-3.8	
Lower		1.88	1.23		1.35	0.5		0.47-5.7	0.6-2.7
Chromium µg/g									
Upper	25.7	38.6	48.8	12.7	13.4	11.5	0-38	16-59	38-76
Middle		69.3			50.4			18-160	
Lower		48.3	51.3		24.0	15.6		21-120	37-94
Cobalt µg/g									
Upper	9.02	10.1	13.8	4.1					
Middle		9.8							
Lower		12.2	13.7						
Copper µg/g									
Upper	30.78	47.9	54.1	17.6	22.9	20.1	0-11	5.0-14	12-17
Middle		100.3			86.1			5.4-12	
Lower		51.7	49.8		39.6	25.9		7.9-15	11-15
Iron µg/g									
Upper	21,000	29,850	43,059	10,284	10,429	12,784	0.14-33,000	2,000-49,000	29,000-77,000
Middle		54,300			54,300			14,000-100,000	
Lower		46,450	51,250		46,450	18,549		19,000-110,000	29,000-89,000
Lead µg/g									
Upper	18.7	46.5	62.2				0-28	8.1-140	21-120
Middle		121.2						9.2-330	
Lower		56.7	52.6					8.8-270	24-130
Manganese µg/g									
Upper	422	394	449	198	104	97	0-670	190-670	340-750
Middle		489			174			180-750	
Lower		386	373		152	121		170-860	220-620
Molybdenum µg/g									
Upper	0.27	0.77	1.5	0.42	1.13	1.32	0-1.3	0-4.4	0-5.0
Middle		2.7			3.66			0-10	
Lower		1.3	2.0		1.76	1.51		0.-5.0	0-5.8
Nickel µg/g									
Upper	33.3	47.2	64.1	15.9	16.2	18.5	0-48	20-88	39-110
Middle		70.4			34.0			22-120	
Lower		61.5	78.4		34.4	22.1		27-140	43-110

Parameter	Mean			Standard Deviation			Range		
	G1- 8	T 1-5	T6- 12	G1 - 8	T1 - 5	T6 - 12	G1 - 8	T1 - 5	T6 - 12
Strontium µg/g Upper Middle Lower	106.6	116.9 70.4 61.5	96.0 78.4	64.4	37.9 31.1 19.6	29.1 18.1	0.25-170	29-190 40-140 35-110	51-150 51-110
Titanium µg/g Upper Middle Lower	199	198 148 127	207 210	110.3	42.6 49.0 58.5	28.2 37.8	0-340	84-340 62-220 31-210	160-260 81-220
TOC mg/g Upper Middle Lower	26.3	44.4 74.1 56.7	27.5 50.7						
Vanadium µg/g Upper Middle Lower	30.4	40.2 47.0 50.7	47.2 52.5						
Zinc µg/g Upper Middle Lower	221	774 2,765 1,515	1,651 1,970	165	804 2,924 1,854	1,260 1,435	0-500	83-2,900 100-8,700 140-6,500	140-4,700 290-4,900

5.3 ANALYSIS AND DISPLAY OF RESULTS

The Ministry of the Environment has produced *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (PSQGs) to relate the effects of various contaminants on the benthic organisms. The levels are based on the chronic effects of the contaminants on bottom sediment dwelling organisms. The lowest effect level (LEL) is "a level of sediment contamination that can be tolerated by the majority of benthic (bottom dwelling) organisms" (Persaud *et.al.,* 1992). The severe effect level (SEL) will cause a significant detrimental result to the majority of the sediment dwelling species.

The comparison of recorded values and the effect levels for each compound must include an examination of the background concentrations. For this report, if the background concentration was greater than the LEL, then the local background level was used for the lowest effect level. Each of the sediment guideline values obtained from the PSQGs are compared to the laboratory results in the following sections, along with a site map for each parameter. Areas where samples were not analysed are indicated by the letters NA.

A summary of sediment sample properties in relation to Provincial Sediment Quality Guidelines is presented in Table 4. A listing for all samples collected is presented in APPENDIX B.

Table 4: Sediment Chemical Property Summary

Parameter		Number of Samples Below LEL	Number of Samples Between LEL and SEL	Number of Samples Above SEL
PCBs	Surface Grabs	0	6	0
	0-25 cm	4	34	0
	25-50 cm	29	9	0
	>50 cm	2	36	0
	Total	40	85	0
Cadmium	Grabs	0	6	0
	0-25 cm	3	36	0
	25-50 cm	28	10	0
	>50 cm	2	36	0
	Total	33	88	0
Chromium	Grabs	0	4	0
	0-25 cm	5	34	0
	25-50 cm	4	31	3
	>50 cm	2	35	1
	Total	11	104	4
Cobalt	Grabs			
	0-25 cm	38	0	0
	25-50 cm	37	0	0
	>50 cm	37	0	0
	Total	112	0	0
Copper	Grabs	0	7	0
	0-25 cm	2	36	0
	25-50 cm	28	7	3
	>50 cm	2	33	3
	Total	32	82	6
Iron	Grabs	0	0	9
	0-25 cm	1	0	37
	25-50 cm	27	0	11
	>50 cm	1	0	37
	Total	29	0	94
Lead	Grabs			
	0-25 cm	11	27	0
	25-50 cm	30	6	2
	>50 cm	13	24	1
	Total	54	57	3
Manganese	Grabs	0	3	0
	0-25 cm	29	9	0
	25-50 cm	31	7	0
	>50 cm	27	1	0
	Total	87	29	0

Parameter		Number of Samples Below LEL	Number of Samples Between LEL and SEL	Number of Samples Above SEL
Nickel	Grabs	9	0	0
	0-25 cm	1	34	3
	25-50 cm	27	7	4
	>50 cm	1	20	19
	Total	38	61	26
TOC	Grabs		6	2
	0-25 cm	8	36	1
	25-50 cm	0	8	3
	>50 cm	1	34	3
	Total	9	84	9
Zinc	Grabs	0	6	0
	0-25 cm	5	15	18
	25-50 cm	28	3	7
	>50 cm	1	16	21
	Total	34	40	46

5.4 GENERAL TRENDS IN SEDIMENT CHEMISTRY

The data indicate that chromium, copper, iron, lead nickel, total organic carbon and zinc exceed severe effect levels at a variety of locations. Chromium, copper lead and TOC are each elevated above the SEL in a limited area, generally below a depth of 0.25 metres in the area between transects 3 and 6. Iron, nickel and zinc exceed the severe effect level at all sample depths and at almost all transects. This suggests a historic and continuing source of iron, nickel and zinc with the majority of the other metals being historic in origin.

Aluminum is a natural component of many clays and as such will form a significant proportion of most sediments. The relative proportion of other metals to an element such as aluminum can be used to identify areas of trace metal enrichment. In comparing metals concentrations to aluminum concentrations in Lyons Creek east, a relatively constant ratio is maintained for most metals with the exception of iron. Iron is generally enriched throughout the eastern portion of the watershed, particularly in the 0.25 to 0.5 metre depths of transect 2 and 3 and the greater than 0.5 metre depths of transects 5 and 6. While iron is also a component of some clays, the significant variability in concentrations throughout the watershed implies a long time source loading of iron to the creek.

5.5 PARAMETER SPECIFIC TRENDS IN SEDIMENT QUALITY

5.5.1 PCBs

The PSQGs for total PCBs are:

No Effect Level	0.01 µg/g
Background Level	0.02 µg/g
Lowest Effect Level	0.07 µg/g **
Severe Effect Level	maximum of 53 µg/g (see below)

The analytical results for PCBs indicated that there were several types of PCBs within the sediments. In Transects 1 through 5 the PCB samples resembled Arochlor 1248. At the downstream Transects 6 through 12, the PCBs resemble a mixture of Arochlor 1248 and 1256. Two transects, 9A and 10A, appear to have a mixture of Arochlor 1260 and 1248 in the surface sediments and Arochlor 1248 at depth. This supports the theory that PCB contamination in the area is from historical causes and not from a recent spill. These results also imply multiple sources - likely a common historical deposit and possibly some traces of the 1990 Hydro spill.

The availability of PCBs to biota is directly related to the organic matter content of the sediments. PCBs are hydrophobic (not readily mixed with water) and tend to bind to the organic matter present in sediments. Therefore, the Severe Effect Level (SEL) of PCBs on biota is determined by multiplying the Total Organic Carbon concentration (% TOC) by the SEL for PCB (530 µg/g) in order to determine the bulk sediment value SEL. A maximum of 10 % TOC can be used, since this value is the SEL for TOC which relates to a SEL maximum of 53 ppm for PCBs. A summary of the TOC results, PCB Severe Effect Levels and actual PCB results for each of the sample locations is given in Appendix B.

Two thirds of PCB samples analysed exceeded the lowest effect level of 0.07 µg/g, one third were below the no effect level and no samples exceed the severe effect level for PCBs. Transect 1, which is the furthest upstream sample location, was the least contaminated area, with half of the sample results being non detectable. Transects 10 and 12 each had a single sample result where PCB was not detected, the former at depth, the latter at the surface of the sediment cores. The 0.25 m to 0.5 m horizon of the north shore of transect 4, had a PCB concentration of 180 µg/g and while the mid-channel location recorded a PCB concentration 73.5 of µg/g. These two locations also had TOC concentrations above the SEL of 10 %.

The spatial distribution of PCBs within the sediments varies with distance away from the ship canal. In general PCB concentrations diminish with increasing distance from the ship canal. The graph in Appendix E illustrates the PCB concentration versus distance downstream for the upper, middle and lower sample depths. This indicates that the middle and lower transects are more contaminated in comparison to sediment surface samples.

There is an absence of a trend for PCB concentrations across the river (i.e. concentrations are not elevated relative to either bank or the centre of the stream). This indicates that the distribution of PCBs is related to natural sediment transport mechanisms as influenced by channel bottom characteristics. The influence of sediment transport mechanisms is evident when PCB concentrations are correlated with the TOC concentration. This correlation shows two distinct patterns based on depth and downstream distance from the Welland canal. PCBs are not significantly correlated with TOC at any location in the upper sediments. However, there is a positive correlation with TOC in the lower sediments of Transects 1 through 5. This correlation is absent in Transects 6 through 12. As noted earlier, the highest recorded concentrations of PCB occur in the areas with the highest recorded TOC concentrations. These trends imply that the distribution of PCB is related to sediment deposition patterns. The wetland area near Highway 140 appears to be acting as a sediment trap. Along with capturing the organic sediments, this area is capturing the PCBs associated with these sediments. The higher levels of PCB observed immediately downstream of this wetland are rapidly diminished further downstream. This appears to be related to the re-suspension and washdown of sediments that is related to periodic higher flows and flooding and their subsequent deposition downstream. There is not a positive correlation with TOC concentrations downstream of the wetland since sediments are filtered by the wetland.

5.5.2 Cadmium

The effect levels for sediment for Cadmium are:
Lowest Effect Level 0.6 μg/g
Background Level 1.1 μg/g **
Severe Effect Level 10 μg/g
** indicates which level was utilized as the lowest effect level for that metal.

No cadmium samples were above the SEL. However, of the 121 tests, 67 were above the background level. Cadmium concentrations ranged from 0.6 μg/g to 5.7 μg/g. The majority of cadmium enrichment was across Transect 5 and along the north shore of Transects 2 and 3. These were moderately elevated, with concentrations between 1.6 to 5.7 μg/g. The remainder of the study areas had cadmium concentrations that were not significantly higher than the background concentration of 1.1 μg/g. With the above noted exceptions of Transects 2, 3 and 5, there is no strong trend in cadmium concentration with either depth of sample or distance from the canal.

5.5.3 Chromium

The PSQGs for chromium are:
Lowest Effect Level 26 μg/g
Background Level 31 μg/g**
Severe Effect Level 110 μg/g
** indicates which level was utilized as the lowest effect level for that metal.

Chromium concentrations ranged from 34 μg/g to 160 μg/g. All results exceed background concentrations and the LEL. Four samples exceeded the SEL. These were in the middle sediment layers of Transects 3 and 4 with concentrations ranging from 120 to 160 μg/g. The majority of chromium has been deposited in the lower sediments of the centre channel. The lower mid channel section displays a decrease in chromium concentrations with greater downstream distance. Chromium concentrations do not vary significantly in the upper sediments.

5.5.4 Copper

The sediment guidelines for Copper are:

Lowest Effect Level	16 μg/g
Background Level	25 μg/g **
Severe Effect Level	110 μg/g

** indicates which level was utilized as the lowest effect level for that metal.

Sediment copper concentrations ranged from 11 to 230 μg/g. Of the 120 sediment samples, 16 were below background concentrations, 82 were between the adjusted LEL and SEL, and 6 were above the SEL of 110 μg/g. The highest values 210, 220, and 230 (μg/g) were observed across the middle depth of Transect 3.

The distribution of copper within the sediments is similar to that of chromium - the greatest concentrations are observed in the central part of the channel, at depth, with a decline in concentration with distance downstream. Copper concentrations are similar to the other metals in the upper samples with slightly higher concentrations in the centre of the channel.

5.5.5 Iron

The PSQGs for iron (in percentages) are:

Lowest Effect Level	2 %
Background Level	3.12 % **
Severe Effect Level	4%

** indicates which level was utilized as the lowest effect level for that metal.

Actual laboratory results (μg/g) were converted to percentages for comparison with established guidelines. A wide range of iron concentrations were observed. Seventy-six per cent of all samples were above the SEL of 4% iron. Both the upper and lower sediments were highly enriched with iron. This widespread nature of iron enrichment indicates both historical loadings and an ongoing source of iron to the creek.

5.5.6 Lead

The PSQGs for lead are:
Background Level 23 μg/g
Lowest Effect Level 31 μg/g **
Severe Effect Level 250 μg/g
** indicates which level was utilized as the lowest effect level for that metal.

Sediment lead levels were generally low, with 54 samples below the LEL of 31 μg/g. Levels increased downstream and along the northern side of the creek, with 57 samples between the LEL and SEL. Three concentrations were greater than the 250 μg/g SEL. At the 0.25 - 0.50 depth along either bank of Transect 3, levels of 330 and 300 μg/g were noted. Lead concentrations of 270 μg/g were measured at the 0.5 m level at the centre channel area of Transect 4.

5.5.7 Manganese

The PSQGs for manganese are:
Background Level 400 μg/g
Lowest Effect Level 460 μg/g **
Severe Effect Level 1100 μg/g
** indicates which level was utilized as the lowest effect level for that metal.

87 of 116 samples had manganese concentrations less than the LEL and the SEL, with the remaining 29 samples being at concentrations between the LEL and the SEL. No sediment samples had manganese concentrations above the SEL There are no clear patterns in manganese distribution with respect to either location on the creek or sediment depth.

5.5.8 Nickel

The PSQGs for nickel are:
Lowest Effect Level 16 μg/g
Background Level 31 μg/g **
Severe Effect Level 75 μg/g
** indicates which level was utilized as the lowest effect level for that metal.

Nickel concentrations were elevated at all depths. Thirty eight samples were below the LEL and these were located at either bank of the 0 to 0.25 level of T1 and at the > 0.5 m level near the centre of the channel at Transect 2. Sixty-one samples were between the LEL and SEL and 26 samples were above the SEL for nickel. Nickel results were elevated across the channel at Transect 3. At depths of 0.25 to 0.5 and < 0.5 m, nickel concentrations ranged from 40 to 120 μg/g, with most exceeding 90 μg/g. High levels were also detected near the centre of the channel at Transect 4. Values ranging from 80 to 140 µg/g were detected at the central channel area of Transect 5. The upper sediments were generally below the SEL, except along the north bank of the downstream Transects of 8, 9 and 9A. Nickel concentrations were amongst the highest observed here, ranging from 89 to 110 µg/g. This pattern suggests a historical deposition of nickel in the vicinity of Transects 3 - 5 and a more recent deposition around Transects 8 and 9.

5.5.9 Total Organic Carbon(TOC)

The PSQGs for TOC are:
Lowest Effect Level 1 %
Severe Effect Level 10 %
** indicates which level was utilized as the lowest effect level for that metal.

The laboratory results for TOC were converted from µg/g to percentages and both forms are given in Appendix A. A comparison of TOC values to guidelines showed that all but one sample, near the south bank at Transect 1, in the upper sediment layer, were above the lowest effect level. Eight locations had TOC above the SEL: across Transect 3 in the 0.25-50m horizon, the lower mid-channel samples at Transect 4 and the upper and lower horizons of the north bank of Transect 5. The maximum noted TOC reading was at the centre of the channel near Transect 4, just below the 0.5 m level at 24%. The second highest observed TOC concentrations was observed at Transect 3 North at the 0.25 - 0.50 m depth at 19 %.

5.5.10 Zinc

The sediment guidelines for zinc are:
Background Level 65 µg/g
Lowest Effect Level 120 µg/g **
Severe Effect Level 820 µg/g
** indicates which level was utilized as the lowest effect level for that metal.

Thirty-four of the samples tested for zinc were below the LEL of 120 µg/g. These were located across the upper depths of Transect 1 and the centre channel area of Transect 2. Forty samples were between the LEL and SEL and the remaining forty-six were above the SEL of 820 µg/g. Areas of zinc enrichment were clustered. The locations with the highest concentrations of zinc were found at the 0.25 - 0.50 cm depth across Transect 3, at 0.5 m in the centre channel portion of Transect 4 and at the central, lower depths of Transect 5. At these sites, the zinc concentrations ranged from 5300 µg/g to 8700 µg/g. In the lower sediments of the south bank, Transects 6 through 9 had concentrations of zinc at 3 times the SEL. The mid river had the highest zinc concentrations, 3900 to 4900 µg/g in Transects 6 and 7, but concentrations were only 360 and 300 µg/g in Transects 9 and 10A further downstream in the mid river section. The lower north bank also had extremely high zinc concentrations (2600 and 3700 µg/g) in transect 6 and 7, yet some of the lowest concentrations of the survey, 290 µg/g, were noted at the lower north bank sediments of Transect 9. Zinc levels exceeded the SEL in the upper sediments at all transects except T7. Zinc concentrations were particularly highly elevated across transects 6, 8, and 9, with the majority of zinc enrichment occurring along the north bank. This is likely the result of loadings from a common source.

5.5.11 Other Metals

The sediment guidelines do not include maximum ranges for eight of the metals tested. There is not enough conclusive evidence on the problems associated with these parameters and minimal results at the present time to allow the development of feasible guideline levels. Aluminum, barium, beryllium, cobalt, molybdenum, strontium, titanium and vanadium were compared to sediment sampling results obtained from eight Smithville test sites on four dates in 1990 and 1991. The majority of sediment results obtained were within the same relative range with few minor exceedences.

Aluminum - Ranges of values were from 8200 μg/g (Transect 1 south bank upper) to 32000 μg/g (Transect 3 centre channel lower). The higher levels of samples were located in the lower depths of transects, especially T2 (south and central), T3 and T5 (central and North) and grab sample 5. The Smithville results had ranges of values from 16000 to 36000 μg/g.

Barium - Barium results varied from a low reading of 18 μg/g (T4 central) to a high of 130 μg/g at three locations (T2 south 0.25 - 0.50, T2 central, lower, and T5 south, upper). These are comparable to 63 to 170 μg/g obtained from Smithville.

Beryllium - The majority of sediment results for beryllium were trace values which is similar to the compared study.

Cobalt - Cobalt results had a low of 5.0 μg/g (T1 south, upper) and a maximum of 15.0 μg/g (T5 central and north, lower). The levels increased with depth and were the highest at the downstream location of transect 5. The samples from Smithville were from 5.7 to 15 μg/g.

Molybdenum - The majority of sediment samples analysed were trace levels of molybdenum except for the sites across the channel at T3 in the 0.25 - 0.50 layer, T3 south lower, and T4 central. The maximum value was 10.0 μg/g at T3 central, which was quite above the range found at Smithville of trace (0.2) to a high of 1.8 μg/g.

Strontium - The concentration of strontium generally increased closer to the surface. The lowest value was at transect 1 (upper) with 29 μg/g and the high was 190 μg/g at the centre of T4 (upper) with another high of 170 μg/g present at T4 north (upper) and G1. The compared range values were from 33 to 140 μg/g. Strontium was the only metal to exhibit a normal distribution in sediments. A normal distribution would be expected for those metals where the principal source is the natural weathering of rock, especially in such a small area where local geological variation would be small.

Titanium - There appeared to be a spread of high and low values over various locations and depths, with some higher readings in the upper transects. The range of values was from trace (31 µg/g) at Transect 2 (lower, centre) to a high of 250 µg/g at Transect 1 (south, upper). The Smithville results ranged between 82 and 300 µg/g.

Vanadium - The highest concentrations of vanadium were typically in the lower depths of the sediment, with a high of 66 µg/g at Transect 3 central (0.25 - 0.50), and a low of 20 µg/g in a surface grab sample taken near Transect 1. Similar values were obtained from Smithville records with ranges from 21 to 53 µg/g.

5.6 SEDIMENT BIOASSAY

5.6.1 Visual Characterization of Lyons Creek Sediments and Observed Indigenous Biota

The following observations were made in 1992 on the sediments at the end of the mayfly and midge bioassays. Similar observations were not made in 1996.

Table 5: Sediment Bioassay Summary

Location	Observations
Stn T1	Moderate number of oligochaetes.
Stn T2	Oily odour. High to moderate number of oligochaetes. Low number of chironmids.
Stn T3	Strong oily odour, oil, coal tar present. Low number of oligochaetes.
Stn T4	Strong oily odour, oil, coal tar present. Moderate number of oligochaetes.
Stn T5	Oily odour.

5.6.2 *Hexagenia limbata* (Mayfly) Growth Assay

As shown in Table 6, survival effects were detected in station 4 and T5 samples in the 1992 study, with 40% and 45% observed mortality, repectively. Station T5 was sampled and tested again in 1996; however, this time no mortality was observed. Station T3 was also tested in 1992 and 1996 with 7.5% mortality observed both tests. Mortality in T3 was the highest observed in 1996.

In the 1992 study, no growth effects were detected in sediments from stations 4, 5, T3 and T5 when compared to the Balsalm Lake (clean) control sediment. However, growth was significantly lower at all stations (including the Balsalm Lake) when compared to the reference station T1. The stimulated growth at station T1 may be due to several factors such as the presence of worms and fresh organic matter. In 1996, Honey Harbour replaced Balsalm Lake as the clean control sediment. Of the four samples tested, the Honey Harbour produced the lowest growth, which was significantly lower than station T1. Compared to T1 alone, station T3 showed reduced growth.

5.6.3 *Chironomus tentans* (Midge) Lethality and Growth Assay

The increased mortality and reduced growth observed in 1992 samples may have been related to the presence of worms in moderate to heavy densities. Unlike mayflies, worms and midges directly compete for the same food source. So even though food was provided during testing, the worms may have out-competed the midges for this food. Similarly, there was limited space available. This need to share space may also have reduced growth rates.

5.6.4 *Pimephales promelas* (Minnow) Lethality and Bioaccumulation Assay

As shown in Table 6, minnow mortality was relatively low, ranging from 0 to 7%. No significant differences in minnow mortality were detected among sediment sample locations.

Table 6: Sediment Biological Test Results- Mayflies, Midges and Minnows

Species/Endpoint	Stations						
	Control/Reference Sediments						
	Balsam Lake	Honey Harbour	Reference*	T3	T5	St. 4	St. 5
1992							
Mayfly mortality (%)	2.5		0.0	7.5	45	40	5.0
Mayfly growth (mg wet wt.)	5.46		27.91	6.19	5.74	8.14	8.73
Midge mortality (%)	8.8		2.2	19.9	40.0	66.6	2.2
Midge growth (mg wet wt.)	7.37		9.17	2.06	1.21		3.88
Fathead minnow mortality (%)	2.5		5.0	2.5	7.5	0.0	0.0
1996							
Mayfly mortality (%)		0.0	0.0	7.5	0.0		
Mayfly growth (mg wet wt.)		4.13	10.16	4.89	12.68		
Midge mortality (%)		3.3	3.3	16.6	6.6		
Midge growth (mg wet wt.)				3.86	13.27		
Fathead minnow mortality (%)		0.0	0.0	10.0	0.0		

* Reference sample location varies.

5.7 BENTHIC INVERTEBRATE TISSUE RESIDUES

Analysis results for the three locations sampled yielded the following tissue PCB residue levels in benthic organisms:

- T1 - 160 ng/g
- T3 - 680 ng/g
- T5 - 900 ng/g

Tissue residue concentrations were then converted to a dry weight basis:

- T1 - 1006 ng/g dry weight
- T3 - 4277 ng/g dry weight
- T5 - 5660 ng/g dry weight

There is a consistent rise in tissue PCB levels with distance downstream from Transect 1 to Transect 5. In all cases, PCBs accumulated in worm tissues to higher levels than were found in the sediments.

The ratio of tissue residues to sediment concentrations gives an indication of the bioconcentration factor of PCBs in the sediments of Lyons Creek. These ratios ranged from 2.2 at Transect 3 to 6.3 at Transect 5, to 20.1 at Transect 1. Thus, PCB residues in tissues are 2 to 20 times higher in organisms than in sediments.

5.8 SEDIMENT BIOASSAY

In 1992, two of the Lyons Creek test sediments received a low sediment quality ranking due to the mortality observed at Station T5 and Station T4. Percent mortality was at or above 40% in both the mayfly and midge toxicity tests and total PCB sediment concentrations exceeded 3,080 ng/g. The minnow PCB concentration was also the highest reported (over 1,800 ng/g) and fell within the sportfish consumption restriction guidelines of 500 ng/g to 4,000 ng/g (MOEE/MNR, 1997). Station T5 sediment was considered moderately impacted and Station T3 slightly impacted according to the degree of sublethal benthic effect. This was particularly apparent in the midge test where growth was 70% reduced. The above information coupled with minnow PCB concentrations greater than the International Joint Commission (IJC) Aquatic Life Guideline of 100 ng/g (IJC, 1988), also contributed to the overall ranking at these sites. Only the reference control sediment (Station T1) was deemed non-impacted.

Of the 1992 test sediments that were re-examined in 1996, neither had attained the same ranking. Station T3 had a poorer ranking in 1996, dropping from the classification of slight impairment in 1992 to being moderately impacted in 1996. Conversely, Station T5 went from a low ranking to being slightly impacted. At these sites, there was about a four-fold difference in sediment PCB concentrations between the two sampling periods, either increasing or decreasing depending on the location. This was likely a result of highly localized variations in contaminant concentrations, as illustrated in the PCB sediment distribution measured along a transect, or could be a result of contaminant redistribution in certain portions of the creek over time. In terms of minnow PCB concentrations, both sites consistently resulted in tissue concentrations well above PCB tissue guidelines. As expected, the reference control sediment did not generate any adverse test response or quantifiable PCB uptake by fish.

Statistical analyses indicate that mayfly and midge survival and growth effects were highly intercorrelated. Sites that had poor survival rates often had smaller-sized animals. This also helped to distinguish between non-toxic and toxic sediments.

Fish mortality was not an indicator of sediment quality. This lack of mortality suggests the fish had a higher tolerance towards the test sediments and could actually increase exposure to any sediment-associated or water-borne contaminants. Since the fish are not avoiding areas with contaminated sediments and are actively feeding in the contaminated areas, they are not reducing their exposure to the contaminants.

The presence of other organic contaminants in the most lethal Lyons Creek sediments must be considered. A common feature observed in both Stn T5 and Stn 4 1992 sediments was the presence of an oily odour and also a visible oily sheen. A sheen was not noted in any of the other test sediments. Field studies have found the presence of visible oil in sediment to be a reliable indicator of the relative abundance of sediment dwellers, including mayflies (Hiltunen and Schloesser, 1983; Burt *et al.*, 1988; UGLCCS, 1989).

Correlation analysis also revealed a strong relationship between total PCBs and zinc, mercury and iron, and to a lesser degree with manganese, nickel and lead (Table 4). Chemical analysis on field samples collected throughout Lyons Creek also showed this relationship, as if the contaminants were derived from a common source. Among the metals, only zinc was measured above the PSQG-SEL (Max: 2,500 μg/g) at some sites. It is possible that elevated zinc, along with high PCB sediment concentrations, may be acting jointly towards organism toxicity. The question of joint chemical toxicity was examined in a laboratory sediment toxicity study which tested different groups of inorganic and organic chemicals, individually and in combination (Swartz *et al*., 1988). The study found the additive effect of zinc and PCB (Arochlor 1254) was minimal. On the other hand, the same study found a 32% increase in amphipod (scud) mortality when more than one class of organic compound was tested (Arochlor 1254 and fluoranthene). This further supports the probability that other compounds are also acting toward the mortality of sediment dwellers in some areas.

Correlation analysis also found a negative relationship between midge growth and sediment TOC in the 1992 study. The quantity of organic matter in the Lyons Creek sediments (>3% TOC) is considered suitable for midge survival, according to work by Suedel and Rodgers (1994). Midge larvae feed by grazing upon the food supplied during the test, thereby making growth less dependent on organic matter associated with the sediment (Ankley *et al*., 1994). Interestingly, midge growth was the only study that also correlated with sediment PCB concentration, which in turn co-varied with sediment TOC.

Another variable that may have influenced the outcome of the toxicity tests is the relative number of worms in most of the test sediments. Reynoldson *et al*., (1994) demonstrated the ability of aquatic worms to negatively affect organism growth by as much as 90% for midges and 50% for mayflies, depending on the number of worms in the sample. Test sediments from Lyons Creek included either none, low, moderate or high numbers of worms, based on estimates made at the end of the midge test on sieved material caught on a fine-mesh screen. The reference control sediment used in the 1992 study contained a moderate number of worms and this did not adversely impact midge growth. Conversely, Station T5 in 1992 had few worms and still resulted in a severe midge growth reduction, indicating a potential adverse effect to both midges and worms. These results make it difficult to assess what, if any, effect the presence of worms may have had on the test results. It may be possible that sediment contamination was so severe at Station T5 that even the normally extremely pollution tolerant worms avoided this area.

Substantial amounts of PCB were found to accumulate in whole fish in each of the test exposures, which raises a concern for its' potential transfer through the food chain via the sediment. Despite the differences between laboratory and field conditions, the range in minnow PCB concentrations of 660 ng/g to 2,480 ng/g (wet weight) measured in this study were quite comparable to those PCB tissue concentrations recorded for assorted species of fish collected in Lyons Creek. Hitchin (1997) observed elevated PCB levels in 1992 that ranged from 783 ng/g for rosyface shiners to 1,460 ng/g for spottail shiners. At a location near Hwy 140, in 1994, maximum PCB concentrations in fish flesh were 9,600 ng/g in carp and 3,380 ng/g in pumpkinseed, which indicate a significant degree of biomagnification.

5.9 TISSUE RESIDUES

Tissue residue analysis indicates that PCBs are being concentrated in organism tissues and suggest that PCBs are available to benthic organisms from the sediments. Tissue residues, expressed on a dry weight basis, exceeded sediment concentrations at all three locations. Furthermore, tissue residues increased as sediment concentrations increased, suggesting that sediment, and not the water column, are the principal sources of the tissue residues. There is strong evidence from the literature that PCBs can accumulate in organism tissues through ingestion (Adams 1987; Fry and Fisher 1990).

Table 7: Spearman Rank Correlations - Sediment Metals, Total Organic Carbon and PCB.
Values in bold indicate significant ($p < 0.001$) correlations

	TOC	Zinc	Iron	Cu	St	Mn	Ni	Pb	Cd	Cr	Va	Ti
Zinc	**.9027**											
Iron	**.8466**	**.9214**										
Copper	**.8003**	**.9148**	**.8374**									
Strontium	-.1450	-.0289	-.2146	.2147								
Manganese	.2355	.4226	.4800	**.6292**	.2974							
Nickel	**.8530**	**.8917**	**.8386**	**.8538**	.0403	.3833						
Lead	**.7694**	**.9015**	**.8483**	**.9546**	.1161	**.6526**	**.8098**					
Cadmium	**.7384**	**.8182**	**.7338**	**.8866**	.2478	**.4900**	**.8244**	**.8417**				
Chromium	**.8686**	**.9372**	**.9265**	**.9138**	-.0523	.5118	**.8655**	**.9113**	**.8520**			
Vanadium	**.7920**	**.8008**	**.9152**	**.6874**	-.3383	.2838	**.7367**	**.6916**	**.6638**	**.8755**		
Titanium	-.1365	-.1931	-.3241	.0054	.4028	.0722	-.0973	-.0539	.0801	-.1814	-.4011	
PCB	**.5830**	**.7279**	**.7290**	**.6968**	-.0567	.4979	**.5968**	**.6665**	.5364	**.7136**	**.6145**	-

5.9.1 Mussel Biomonitoring

The primary purpose of the mussel biomonitoring component of the study was to investigate whether or not PCBs are currently present in the water column. The mussel *E. complanata* has been used for this purpose because it is a filter feeder which ingests large quantities of water. Because of this method of feeding, mussels tend to concentrate waterborne contaminants in their tissues and are therefore considered an indicator of water quality rather than sediment quality.

The mussel tissue analyses for PCBs were all below the analytical detection limits of 20 ng/g at all stations except for one replicate at each of station 6 and 9 (Table 8). Both of these samples had levels of 21 ng/g, which is just above the analytical detection limit. This strongly suggests that the levels of PCBs within the water column are low. Results of an unpublished study undertaken in July-August of 1991 by the Great Lakes Section of the Water Resources Branch found the PCB concentration in mussel tissue to be between 23 and 37 ng/g close to station 4, suggesting that low levels of PCBs may be available in the water column. However, these are still trace concentrations which should be interpreted with caution. These results were not repeated in the second fall sampling period.

Table 8: PCB Tissue Levels in Mussels Exposed in Lyons Creek (October 1991)

Station Location	PCB*(ng/g)	Mean wet weight	Lipid (%)
Balsam Lake	10.0		0.73
Balsam Lake	10.0	10.0	0.99
Balsam Lake	10.0		0.93
Welland Canal	10.0		0.79
Welland Canal	10.0	10.0	1.13
Welland Canal	10.0		1.04
Upstream of Outfall #1	10.0		1.05
Upstream of Outfall #1	10.0	10.0	0.76
Upstream of Outfall #1	10.0		0.76
Outfall #1	10.0		0.72
Outfall #1	10.0	10.0	1.17
Outfall #1	10.0		1.16
Outfall #2	10.0		0.82
Outfall #2	10.0	10.0	0.91
Outfall #2	10.0		0.86

Station Location	PCB*(ng/g)	Mean wet weight	Lipid (%)
Transect 2	10.0		0.96
Transect 2	10.0	10.0	0.79
Transect 2	10.0		0.87
Transect 3	10.0		0.97
Transect 3	10.0	13.7	0.80
Transect 3	21.0		0.83
Transect 4	10.0		0.78
Transect 4	10.0	10.0	0.87
Transect 4	10.0		0.80
At Highway #140	10.0		0.78
At Highway #140	10.0	13.7	0.68
At Highway #140	21.0		

* The PCB detection limit is 20 ng/g, one half of this value was applied to calculate the average.

5.9.2 Juvenile Fish

Juvenile fish have been used widely in Ontario to identify areas of contamination and to monitor both spatial and temporal trends. More detail on their use can be found in Appendix F.

The highest concentrations of PCBs were found in samples collected at Highway 140, where PCBs averaged 783 ng/g in rosy-face shiners, 1060 ng/g in common shiner and 1460 ng/g in spottail shiner (Table 9). Similar concentrations were found in samples collected downstream at McKenny Road where PCBs averaged 810 ng/g in bluntnose minnows.

At the two stations furthest downstream, PCBs were much lower, ranging from 40 ng/g in spottail shiners to 90 ng/g in golden shiners.

Other parameters were measured but have not been reported here because concentrations were either below the detection limit or at trace levels.

As indicated in Appendix F, the IJC (1988) has established 100 ng/g of PCBs as an acceptable tissue residue guideline for the protection of piscivorous wildlife. Concentrations of 100 ng/g PCBs in prey items such as juvenile fish is considered to be without risk. The greater the concentration above 100 ng/g, the greater the risk to piscivorous wildlife. Juvenile fish in Lyons Creek from the Welland Canal downstream to McKenny Road exceeded the guideline by 8 to 15 fold. Further downstream PCB concentrations in juvenile fish did not exceed the IJC guideline.

5.9.3 Sport Fish

Eight species of sport fish from Lyons Creek (at Highway 140) have been collected and analysed for PCBs, pesticides and mercury (Table 10). With the exception of bowfin (which are restricted because of mercury), all species are restricted in the *Guide to Eating Ontario Sport Fish* because of elevated PCBs. The highest concentrations were found in carp (9600 ng/g), pumpkinseed (3380 ng/g) and bluegill (1580 ng/g). Pesticides were rarely detected in the fish and only at trace levels and have not been reported here. Mercury concentrations found in sport fish were considered to be typical background and also have not been reported here.

Generally PCB concentrations vary among species reflecting differences in feeding behaviour and differences in the lipid levels of the muscle tissue (edible portion). Bottom-feeding species with higher muscle lipid levels such as carp tend to have the highest PCB concentrations. Species with low muscle lipid levels such as pumpkinseed, bluegill, bass and crappie usually have low levels of PCBs in their muscle tissue. This is not the case in Lyons Creek where all species had high levels of PCBs. Concentrations of PCBs found in pumpkinseed and bluegill are the highest recorded in Ontario.

The Province of Ontario, through the Sport Fish Contaminant Monitoring Program establishes consumption advisories based Health Canada guidelines. Sport fish with up to 500 ng/g of PCBs are not restricted. Sport fish exceeding 500 ng/g should not be consumed by women of childbearing age and children under 15 but can be consumed in limited quantities by others. Sport fish exceeding 4000 ng/g are not acceptable for consumption. Further details can be found in the *Guide to Eating Ontario Sport Fish*.

Table 9: PCB Residues In Juvenile Fish From Lyons Creek in 1992 and 1996

Location	Year	species	length ±SD (mm)	# of reps	PCBs±SD (ng/g)	Lipid±SD (%)
Highway 140	1992	Common Shiner	72±1	2	1060±85	0.9±0.4
		Spottail Shiner	66	1	1460	2.3
		Rosyface Shiner	63±5	6	783±88	1.0±0.6
Stn. 1 McKenny Rd.	1996	Bluntnose Minnow	55±1	2	810±269	2.0+0.2
Stn. 2 Upstream QEW		Bluntnose Minnow	60±4	5	72±72	1.9±0.5
Stn. 3 Below QEW		Golden Shiner	76±1	2	90±42	2.7±0.4
		Emerald Shiner	65	1	80	2.1
		Spottail Shiner	62	1	40	1.6

Table 10: Contaminant Concentrations in Sportfish Tissues

Date	species	number sampled	mean length (cm)	max length (cm)	min length (cm)	PCB mean value	PCB max value	PCB Min value	Mercury mean value	Mercury max value	Mercury min value
1991	Bluegill	2	19.35	19.5	19.2	120	160	80	0.065	0.07	0.06
1994	Bluegill	10	15.67	17.2	14.4	930	1580	420	0.031	0.05	0.02
1999	Bluegill	10	16.14	17.7	15.2	348	580	180	0.01	0.01	0.01
1991	Bowfin	10	52.63	66.8	40	307	500	80	0.2	0.36	0.07
1992	Brown Bullhead	1	19.7	19.7	19.7	490	540	440	0.13	0.13	0.13
1994	Brown Bullhead	7	26.51	33.1	22.2	20	20	20	0.05571	0.08	0.04
1992	Carp	3	56.4	63.5	48.5	153	300	20	0.12667	0.2	0.05
1994	Carp	20	40.4	69	22.6	2016	9600	580	0.062	0.12	0.02
1991	Largemouth Bass	2	25.45	26.5	24.4	270	380	160	0.11	0.13	0.09
1994	Largemouth Bass	20	26.75	32.5	20.9	397	780	180	0.1675	0.51	0.05
1999	Largemouth Bass	7	18.8	20.5	17	389	660	120			
1991	Pumpkinseed	5	12.32	17.5	9.5	1104	2500	80	0.026	0.04	0.01
1992	Pumpkinseed	10	14	15.4	11.4	92	170	20	0.056	0.09	0.03
1994	Pumpkinseed	10	15.3	16.2	13.8	2160	3380	980	0.06	0.11	0.02
1999	Pumpkinseed	5	14.88	15.7	14.4	577	680	380	0.03	0.05	0.01
1991	Rock Bass	3	17.43	20.7	12.5	160	200	120	0.06667	0.09	0.04
1991	White Sucker	1	35.5	35.5	35.5	640	640	640	0.05	0.05	0.05
1992	White Sucker	2	29.35	34.9	23.8	340	440	240	0.035	0.04	0.03

Extracted from the *Guide to Eating Ontario Sportfish*.

5.9.4 Snapping Turtles

Two females and three males were collected for tissue analysis. These individuals varied in weight from 2408 g to 11000 g (Table 11). The highest concentrations of PCBs were found in visceral fat followed by eggs, liver, heart and muscle (Table 12). The concentration of fat in organs followed the same pattern (Table 12). These results are consistent with other studies which have found a similar pattern of PCB and fat distribution in tissues and organs (Olafsen *et al.* 1983; Bryan *et al.* 1987).

Table 11: Observations on Snapping turtles collected from Lyons Creek

Turtle #	Sex	Carapace Length (cm)	Vent Length (cm)	Weight (g)	Observation
1	female	23.5	17.3	2408	undeveloped eggs
2	female	25.7	19	3390	developed eggs
3	male	35.5	27.2	11000	
4	male	33.7	23.7	7500	
5	male	33.7	23.8	7500	

Table 12: **Concentration of lipids and PCBs in different tissues of Snapping Turtles from Lyons Creek**

	Tissue type														
	Muscle			Fat			Liver			Heart			Egg		
Turtle	% Lipid	PCB µg/g	PCB µg/g lipid	% Lipid	PCB µg/g	PCB µg/g lipid	%Lipid	PCB µg/g	PCB µg/g lipid	% Lipid	PCB µg/g	PCB µg/g lipid	% Lipid	PCB µg/g	PCB µg/g lipid
1	0.1	ND	ND	38	14	37	2	0.2	12	0.5	0	8	--	--	--
2	0.3	ND	ND	5.6	0.6	11	1.6	0.2	10	0.9	0	4.4	6	0.3	4.7
3	0.3	ND	ND	63	28	44	1.5	0.1	6.7	0.6	0	10	--	--	--
4	0.3	ND	ND	--	--	--	0.6	0	10	0.7	0	8.6	--	--	--
5	0.3	0	13	63	39	62	1.7	0.3	20	0	0.1	2.3	--	--	–

The concentration of PCBs in Lyons Creek turtles has been compared to concentrations found elsewhere (Table 3). Bryan *et al*. (1987) analysed snapping turtles from areas of low and high contamination. They found that turtle visceral fat from areas of low contamination had 4.2 μg/g (ppm) PCBs whereas turtle visceral fat from highly contaminated areas had up to 1600 μg/g. Lyons Creek turtles had a mean concentration of 38.6 μg/g PCBs in their visceral fat. PCB concentrations in other organs of turtles from Lyons Creek were lower than those reported by Bryan *et al.* (1987) for uncontaminated areas.

Turtles from Lyons Creek were analysed for PCBs to determine if they are acceptable for human consumption. The following assessment is based on the same set of assumptions used to determine if sport fish are acceptable for consumption (i.e. meal size is approximately 227 g (8 oz) for an average weight adult and that meal size varies directly with body weight). Based on these assumptions, if the portion of turtle consumed has less than 0.5 μg/g PCBs, it is suitable for unlimited consumption (defined as up to 8 meals per month). However, with increasing PCB concentrations in the animal tissue, the fewer the number of meals that can be consumed. For example, if turtle tissue was in the range of 0.5-1.0 μg/g, turtle flesh could be eaten at four meals per month; if the turtle tissue was at 1.0-2.0 μg/g, only two meals per month could be eaten; turtles having tissue concentrations of 2.0-4.0 μg/g could only be consumed once per month; and turtle tissues having PCB concentrations in excess of 4.0 μg/g should not be consumed at all.

Based on sport fish consumption guidelines, it appears that tissues such as leg muscle which have low lipid levels can be consumed. However, if any of the surrounding fat is not removed or is purposely added (as might be the case in the preparation of stews or soups) the meal would have elevated levels of PCBs. Since the concentration of PCBs in fat was up to 61.9 μg/g, if even 1% of the meal consisted of visceral fat, the first level of consumption restriction (0.5 μg/g) would be exceeded. Similarly, any stews or soups made with a variety of tissues and organs are likely to exceed recommended consumption limits.

5.10 SOILS AND VEGETATION

The analytical results for concentrations of PCBs in soils are presented in Table13. Sample results are compared to the Canadian Council of Ministers of the Environment's "Interim Guidelines for PCBs in Soils". These guidelines were developed by a joint federal/provincial committee and documented in a report prepared for the Canadian Council of Resource and Environment Ministers. The interim maximum acceptable concentrations (on a dry weight basis) of PCBs in soils are:

Agricultural Soil (including home gardens)	0.5 μg/g
Non-agricultural soil (e.g. residential or public access)	5.0 μg/g
Industrial/Commercial Soil	50.0 μg/g

All of the soils sampled in this survey would classify as non-agricultural soils. In no case did

PCB concentrations exceed the Interim guideline for non-agricultural soils There were PCB concentrations above the detection limit at Transects T1, T2, T3, T4 and T7. At Transects 1 and 2, there was a trend toward higher concentrations close to the creek compared to samples collected 25 m from the creek. This may suggest that at these locations, historical accumulations of PCBs in sediments have made their way to soils beyond the banks of the creek. With the exception of T7, PCBs were not detected at the locations more distant from the creek. The PCB concentration 25 m from the creek at T4 was the highest found in this study (1.48 µg/g). This sampling site is located in a low area suspected to have been backfilled during construction of the new Welland Canal by-pass. In addition, sediments in the creek at this location are known to have elevated PCB concentrations at depth. Because the area is low relative to the creek, it may have been prone to flooding and deposition of contaminated sediments. It is also possible that some of the fill moved to the area during construction contained PCBs.

Table 13: Concentration of PCBs in Soils Collected at Different Distances from Lyons Creek Along Transect East of the Welland Ship Canal

Transect	PCB Concentration (µg/g)		
1	1 m	5 m	25 m
2	0.5	0.3	DL
3	0.28	0.62	DL
4	DL	0.16 T	DL
5	DL	DL	1.48
6	DL	DL	DL
7	0.11 T	DL	DL
8	DL	DL	DL
9	DL	DL	DL
Control	DL	DL	DL
	----------------Distance from creek bank----------------------------->		

PCBs were not detected in any of the vegetation samples. This indicates that PCBs are not translocated from contaminated sediments to above water plant parts in sufficient quantities to be detected (detection limit 0.02 µg/g). This would suggest that composted tops of Carex and arrowhead should not pose a problem for use in gardens. Three concerns should be emphasized, however: 1) this study involved the collection of only two species of vegetation of 5 transects known to have some degree of PCB contamination in sediments (T1-T5) and should not be considered a definitive study of vegetation contamination in the creek; 2) prolonged use of vegetation from the creek for compost, even if concentrations of PCBs are very low, may theoretically result in accumulation of PCBs in garden soils; and 3), if plants used for composting include roots, they will undoubtedly contain sediment attached to the root mass and the soil residue may be contaminated.

The PCB concentrations in soils collected at varying distances (1, 5 and 25 m) from Lyons Creek East, from the pumping station to Hwy 140, did not exceed the CCME Interim guideline for PCBs in non-agricultural soils. However, elevated concentrations of PCBs close to the creek (i.e. within 5 m), at two transects near the pumping station suggest that historical accumulations of PCBs in sediments have made their way to soils beyond the banks of the creek. Generally, PCB concentration were not detectable at the location more distant from the creek. However, at one sampling site, PCBs were notably elevated (1.48 µg/g) at a distance of 25 m from the creek. Additional surface soil sampling may be warranted in the vicinity of sample transect T4.

6.0 DISCUSSION

The investigation has shown that PCBs have accumulated in the sediments of the east section of Lyons Creek. Since the highest sediment concentrations were found below the surface sediment layer (0.25 to 0.5 metres down), the main PCB accumulation appears to be historical in origin. Considering the depth at which the material has been deposited in the sediments, there is a strong possibility that most accumulation may have taken place prior to construction of the Welland Canal. There is no evidence that PCBs are continuing to accumulate in the sediments. Studies undertaken by the District did not find detectable levels of PCBs in the water column and the results of the mussel biomonitoring study also indicate there was no active source to the water column. PCB concentrations at the sediment surface were consistently lower than in subsurface layers. PCB accumulation in the sediments have not been uniform and appears to have been focussed in particular areas such as those of low current velocity. Since PCB concentrations and sediment TOC were not strongly correlated, PCB accumulation appears to be influenced by other factors in addition to sediment organic matter. The most likely of these is bottom dynamics which can redistribute material through re-suspension of sediments. Redeposition of this material could then result in locally higher concentrations of PCB contaminated material.

The significantly elevated sediment concentrations of zinc, copper, nickel, chromium and iron, as well as the increases in PCB concentrations indicate these have originated from a specific source within the area. Metals that occur naturally are expected to have a more even distribution in the sediments, with no high concentrations. The distributions of strontium and manganese within the creek sediments would be typical of natural metals distribution.

The distribution of zinc, copper, nickel, chromium and iron in sediments was strongly correlated with the distribution of sediment organic matter, indicating that these have absorbed to organic particles. Many of the metals were also strongly correlated with each other indicating that they have accumulated together from a specific source. The relatively high correlation of sediment PCB with these metals also indicates that the PCBs have originated from these same sources.

Zinc, and to a lesser extent, iron and copper have accumulated to very high levels in the sediments at Transects 3, 4, and 5. Sediment zinc concentrations were highest in the mid depths (0.25 m) and were similar to levels observed in sediments in some of the Great Lakes Areas of Concern (Indiana Harbour, Hamilton Harbour). The concentrations at Transect 3 (midsection) were well above the SEL for zinc and could potentially result in significant detrimental effects on aquatic organisms.

The results indicate that both PCBs and the metals zinc and copper have accumulated in sediments to levels that would be expected to result in pronounced detrimental effects on aquatic organisms. The highest concentrations were found up to 0.5 metres below the sediment surface, while surficial concentrations were generally lower. In the case of zinc, surficial concentrations at some of the transects (T3 , T5, T6 and T8-11) also exceeded the Severe Effect Level.
The physical characteristics of the stream also play a role in PCB availability. Currently, flow in the river is maintained artificially through pumping of water from the canal. As a result, there is little seasonal fluctuation in discharge volume. The only changes are those due to runoff from the now relatively small drainage area of the creek. Thus, additional sediment accumulation is expected to be low. The likelihood of the contaminated material being buried and thus removed as a potential source to biota is also low. Similarly, since flows are maintained, the exposure of sediments during periods of drought are also low.

Studies have indicated that sediment dwelling individuals are ingesting and accumulating PCBs. These contaminants are being passed up the food chain to juvenile and adult fish as well as turtles. This has resulted in some restrictions for human consumption of sport fish and snapping turtles from Lyons Creek, depending on individual preferences in the means of preparation and frequency of consumption.

7.0 AREAS OF CONCERN

As seen in the previous discussion section, a high percentage of concentrations of various parameters were above the recommended LEL and also above the SEL. Approximately 19% of all metal samples were above SEL. The predominant areas for the highly toxic levels of PCB and metal concentrations are:

Transect # 3 A, C, D: 0.25 - 0.50 level
Transect # 4 B, lower level
Transect # 5 C : lower level
Transect #5 C, D: upper and lower levels

The majority of contaminants that are above severe effect levels are in the 0.25 - 0.50 or lower regions of the sediment which is mainly clay. These contaminants are likely due to historical problems in the area.

The layers of sediment represent an approximate history of the area. The different layers of the creek bottom, caused by sedimentation, highlight the time span which contain contamination. However, since there are no exact measurements on the rate of sedimentation in the area, the exact length of time from the original contamination is unknown. Sediments naturally act as a sink and the clay in the area should be acting as a block to delay the migration of any particles to other layers. However, iron, zinc and nickel were found at above SEL ranges in all sampling levels indicating possible particle movement.

An increase in concentration levels in the upper transects levels or constant values over the entire depth as seen in strontium, manganese, titanium and vanadium could be due to recent contamination or by the fact that heavy metals are diffusing upwardly by natural motion. The latter is difficult to prove. Various metals bond to different particulates which may mask their toxic properties. Conclusions on the exact areas of sediment pollution is difficult to make from the results of this study alone.

Since contaminants are not linked to sediment organic matter content, contaminant accumulation reflects stream velocity changes and bottom dynamics. Contaminant accumulations in this section of Lyons Creek reflect areas of lower current velocity.

Sedimentation properties of the stream would be necessary to more precisely interpret variations in sediment contamination levels with respect to depth of sediment and location within the stream channel. Sediment contamination is generally greatest at depth, in the centre of the stream channel and is related to the proximity to an upstream source near the Old Welland Ship Canal. However, it is unclear as to the cause of the increased levels of sediment contamination in the upper sediments around Transect 8. These results may reflect migration/re-suspension of sediment particles, the natural upward diffusion of contaminants by natural motion, the presence of another source of contaminants or a combination of these mechanisms. The lack of correlation with TOC suggests the potential mobility of contaminants due to a lack of adsorption to suspended particles, particularly local clays. The elevated levels of iron, nickel and zinc across the stream channel and throughout all sediment depths also implies contaminant mobility, the potential for more than one historical source as well as the potential for an ongoing source of metals contamination. (The contaminants around Transect 8 are consistent with road runoff contaminants).

8.0 CONCLUSIONS

High levels of PCBs were present in the middle and lower sample depths of sampling transects downstream of the Welland Canal. Only two out of fifty nine PCB sediment results were above the Severe Effect Level of the Draft Provincial Sediment Quality Guidelines for that site. The highest PCB sediment results were at Transect 4 roughly 365 m downstream of the canal at middle and lower depths close to the left bank. PCBs were also significantly elevated at Transect 3 and Transect 5, approximately 258 m and 755 m downstream of the canal.

High concentrations of metals were found at Transect 3 at the middle level sample, at Transect 4 near the left bank of the lower level samples, Transect 5 from the near surface through the lower levels. Eighteen point eight percent of all metal sediment samples were above the SEL.

The majority of contamination appears to be due to historical problems, based on the higher values located at lower sediment depths. The time frame of the original contamination cannot be determined from existing data.

The creek sediments are toxic to sediment dwelling organisms. This may be the result of both the presence of PCBs and the simultaneous presence of high concentrations of metals. Sediment-bound PCBs are biologically available to bottom-dwelling organisms. PCBs are being transferred through the food chain to small fish and ultimately to sport fish.

Appendix A:
Sediment Chemistry Results

		PCB (ug/g)			Aluminum Unf. Tot (Al ug/g)		
PSQG	SEL	530.00			NA		
	LEL	0.07			NA		
	NEL	0.01			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0			8200.00		
1991	G1A	0.40	3.10	0.70	8000.00	23000.00	27000.00
1991	G2	0.73			12000.00		
1991	G3	0.38			17000.00		
1991	G4	1.05			17000.00		
1991	G-5	0.43			26000.00		
1992	G-6	0.16			18000.00		
1992	G-7	0.00			13000.00		
1992	G-8	0.00			11000.00		
1991	T1A	0.07	0.21	0.23	9000.00	9600.00	14000.00
1991	T1B	0.00	0.00	0.15	24000.00	11000.00	23000.00
1991	T1C	0.00	0.00	0.13	11000.00	13000.00	29000.00
1991	T1D	0.11		0.09	19000.00		23000.00
1991	T2A	2.10	1.95	6.30	24000.00	26000.00	30000.00
1991	T2B	4.50		0.68	13000.00		31000.00
1991	T2C	0.68	1.40	3.25	16000.00	24000.00	23000.00
1991	T2D	1.81	7.77	1.42	22000.00	22000.00	20000.00
1991	T3A	1.69	26.00	15.00	20000.00	18000.00	28000.00
1991	T3B	1.01	21.00	0.15	15000.00	25000.00	32000.00
1991	T3C	0.47	11.40	4.80	16000.00	19000.00	25000.00
1991	T3D	4.60	180.00	16.90	21000.00	18000.00	25000.00
1991	T4A	0.82		1.95	18000.00		24000.00
1991	T4B	0.26		10.90	16000.00		21000.00
1991	T4C	0.99		4.80	16000.00		16000.00
1991	T4D	0.69		2.04	16000.00		18000.00
1991	T5A	0.84		2.00	23000.00		20000.00
1991	T5B	0.58		1.87	21000.00		30000.00
1991	T5C	0.90		24.50	21000.00		21000.00
1991	T5D	1.28		0.68	25000.00		29000.00
1992	T6A	14.00		7.50	21000.00		25000.00
1992	T6B	3.84		20.80	23000.00		26000.00
1992	T6C	9.46		7.30	24000.00		32000.00
1992	T7A	0.78		4.44	26000.00		26000.00
1992	T7B	2.30		7.24	24000.00		26000.00
1992	T7C	1.16		9.86	25000.00		26000.00
1992	T8A	2.38		4.82	26000.00		30000.00
1992	T8B	6.98		2.12	26000.00		34000.00
1992	T8C	6.04		0.12	26000.00		34000.00
1992	T9A	3.14		2.24	26000.00		24000.00
1992	T9B	3.64		0.20	26000.00		31000.00
1992	T9C	5.32		0.10	25000.00		32000.00
1992	T10A	1.64		0.00	27000.00		33000.00
1992	T10B	1.18		0.24	28000.00		28000.00
1992	T10C	2.02		0.06	25000.00		29000.00
1992	T11A	0.44		1.32	29000.00		28000.00
1992	T12A	0.00			24000.00		

		Barium Unf. Tot (Ba ug/g)			Beryllium Unf. Tot (Be ug/g)		
PSQG	SEL	NA			NA		
	LEL	NA			NA		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	58.00			0.00		
1991	G1A	64.00	110.00	55.00	0.00	0.62	0.50
1991	G2	71.00			0.00		
1991	G3	79.00			0.21		
1991	G4	100.00			0.22		
1991	G-5	120.00			0.54		
1992	G-6	120.00			0.79		
1992	G-7	69.00			0.64		
1992	G-8	51.00			0.55		
1991	T1A	55.00	47.00	67.00	0.65	0.66	0.53
1991	T1B	100.00	70.00	110.00	0.77	0.38	0.75
1991	T1C	72.00	77.00	110.00	0.30	0.47	0.93
1991	T1D	69.00		100.00	0.65		0.92
1991	T2A	120.00	130.00	120.00	0.90	1.20	1.20
1991	T2B	72.00		130.00	0.54		0.92
1991	T2C	100.00	120.00	82.00	0.72	0.93	0.65
1991	T2D	110.00	120.00	110.00	0.73	0.98	0.86
1991	T3A	120.00	52.00	59.00	0.55	0.37	0.66
1991	T3B	100.00	47.00	140.00	0.26	0.48	0.69
1991	T3C	100.00	28.00	32.00	0.00	0.68	0.37
1991	T3D	83.00	18.00	25.00	0.48	0.40	0.00
1991	T4A	94.00		120.00	0.58		0.73
1991	T4B	99.00		45.00	0.80		0.78
1991	T4C	89.00		75.00	0.54		0.51
1991	T4D	91.00		83.00	0.57		0.77
1991	T5A	130.00		110.00	0.58		0.47
1991	T5B	110.00		42.00	0.49		0.71
1991	T5C	59.00		24.00	0.54		0.43
1991	T5D	21.00		25.00	0.77		0.69
1992	T6A	58.00		79.00	0.85		0.89
1992	T6B	120.00		33.00	0.97		0.85
1992	T6C	130.00		49.00	1.00		1.00
1992	T7A	130.00		140.00	1.00		0.99
1992	T7B	150.00		67.00	0.97		0.97
1992	T7C	120.00		110.00	1.00		1.00
1992	T8A	140.00		56.00	1.00		0.91
1992	T8B	62.00		150.00	1.00		0.93
1992	T8C	38.00		130.00	0.93		1.10
1992	T9A	96.00		47.00	1.00		0.90
1992	T9B	58.00		120.00	1.00		0.83
1992	T9C	42.00		120.00	0.91		1.00
1992	T10A	97.00		120.00	0.98		1.10
1992	T10B	130.00		99.00	1.10		1.00
1992	T10C	120.00		110.00	0.96		1.00
1992	T11A	130.00		89.00	1.10		1.00
1992	T12A	120.00			0.95		

		Cadmium Unf. Tot (Cd ug/g)	Chromium Unf. Tot (Cr ug/g)		
PSQG	SEL	10.0	110.0		
	LEL	0.6	26.0		
	NEL	NA	NA		
Year	Transect	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.72	19.00		
1991	G1A	1.40	22.00	48.00	51.00
1991	G2	1.10	31.00		
1991	G3	1.40	33.00		
1991	G4	1.60	32.00		
1991	G-5	1.90	38.00		
1992	G-6	0.51	25.00		
1992	G-7	0.46	17.00		
1992	G-8	0.40	14.00		
1991	T1A	0.94	16.00	18.00	21.00
1991	T1B	1.60	43.00	20.00	33.00
1991	T1C	0.77	18.00	21.00	32.00
1991	T1D	0.47	23.00		30.00
1991	T2A	1.20	57.00	49.00	48.00
1991	T2B	1.00	22.00		40.00
1991	T2C	0.65	52.00	47.00	28.00
1991	T2D	1.90	40.00	67.00	49.00
1991	T3A	1.90	48.00	130.00	61.00
1991	T3B	1.20	35.00	61.00	36.00
1991	T3C	1.70	38.00	160.00	50.00
1991	T3D	1.60	59.00	120.00	53.00
1991	T4A	1.80	33.00		42.00
1991	T4B	3.30	31.00		120.00
1991	T4C	1.10	31.00		35.00
1991	T4D	0.79	29.00		28.00
1991	T5A	2.10	42.00		45.00
1991	T5B	4.30	41.00		56.00
1991	T5C	5.70	57.00		99.00
1991	T5D	3.50	56.00		60.00
1992	T6A	1.40	76.00		52.00
1992	T6B	2.70	43.00		94.00
1992	T6C	1.70	59.00		66.00
1992	T7A	1.20	40.00		49.00
1992	T7B	1.20	42.00		71.00
1992	T7C	0.86	39.00		55.00
1992	T8A	1.40	47.00		61.00
1992	T8B	1.10	57.00		52.00
1992	T8C	0.84	72.00		38.00
1992	T9A	1.50	47.00		48.00
1992	T9B	0.75	53.00		38.00
1992	T9C	0.60	54.00		40.00
1992	T10A	0.93	41.00		38.00
1992	T10B	1.00	42.00		38.00
1992	T10C	0.95	40.00		37.00
1992	T11A	1.60	40.00		43.00
1992	T12A		38.00		

		Cobalt Unf. Total (Co ug/g)			Copper Unf. Tot (Cu ug/g)		
PSQG	SEL	NA			110.0		
	LEL	50.0			16.0		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	5.70			28.00		
1991	G1A	5.50	11.00	12.00	31.00	65.00	68.00
1991	G2	8.10			38.00		
1991	G3	9.30			44.00		
1991	G4	9.60			46.00		
1991	G-5	11.00			46.00		
1992	G-6	11.00			21.00		
1992	G-7	11.00			13.00		
1992	G-8	10.00			10.00		
1991	T1A	5.00	5.40	8.00	16.00	13.00	20.00
1991	T1B	11.00	6.80	12.00	33.00	33.00	28.00
1991	T1C	6.90	7.20	11.00	20.00	22.00	19.00
1991	T1D	10.00		14.00	11.00		24.00
1991	T2A	11.00	12.00	12.00	80.00	52.00	30.00
1991	T2B	7.60		13.00	26.00		27.00
1991	T2C	10.00	11.00	7.90	57.00	56.00	14.00
1991	T2D	10.00	11.00	13.00	39.00	97.00	67.00
1991	T3A	11.00	11.00	12.00	68.00	210.00	69.00
1991	T3B	9.40	12.00	13.00	41.00	70.00	21.00
1991	T3C	10.00	11.00	12.00	52.00	220.00	59.00
1991	T3D	11.00	11.00	11.00	98.00	230.00	60.00
1991	T4A	10.00		12.00	43.00		59.00
1991	T4B	8.70		11.00	44.00		180.00
1991	T4C	9.80		11.00	41.00		44.00
1991	T4D	9.70		13.00	34.00		23.00
1991	T5A	13.00		13.00	49.00		51.00
1991	T5B	12.00		15.00	54.00		66.00
1991	T5C	13.00		15.00	80.00		120.00
1991	T5D	14.00		15.00	72.00		53.00
1992	T6A	12.00		15.00	100.00		54.00
1992	T6B	13.00		14.00	58.00		120.00
1992	T6C	13.00		15.00	81.00		67.00
1992	T7A	14.00		14.00	38.00		47.00
1992	T7B	13.00		13.00	49.00		83.00
1992	T7C	13.00		13.00	43.00		63.00
1992	T8A	13.00		13.00	53.00		62.00
1992	T8B	13.00		14.00	66.00		48.00
1992	T8C	15.00		14.00	83.00		21.00
1992	T9A	14.00		14.00	53.00		49.00
1992	T9B	14.00		11.00	62.00		28.00
1992	T9C	14.00		13.00	60.00		24.00
1992	T10A	15.00		14.00	37.00		23.00
1992	T10B	15.00		14.00	41.00		34.00
1992	T10C	13.00		13.00	37.00		30.00
1992	T11A	14.00		15.00	37.00		44.00
1992	T12A	17.00			21.00		

		Iron Unf. Tot (Fe ug/g)			Lead Unf. Tot (Pb ug/g)		
PSQG	SEL	4.0			250.0		
	LEL	2.0			31.0		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	13000.00			12.00		
1991	G1A	13000.00	40000.00	53000.01	10.00	91.00	56.00
1991	G2	20000.00			25.00		
1991	G3	26000.00			24.00		
1991	G4	24000.00			25.00		
1991	G-5	33000.00			28.00		
1992	G-6	24000.00			17.00		
1992	G-7	19000.00			17.00		
1992	G-8	17000.00			10.00		
1991	T1A	12000.00	14000.00	19000.00	10.00	9.20	14.00
1991	T1B	36000.00	15000.00	29000.00	33.00	14.00	16.00
1991	T1C	15000.00	17000.00	26000.00	12.00	15.00	8.80
1991	T1D	22000.00		30000.00	8.10		16.00
1991	T2A	46000.01	44000.01	32000.00	110.00	72.00	26.00
1991	T2B	17000.00		31000.00	12.00		34.00
1991	T2C	35000.00	66000.02	26000.00	61.00	77.00	14.00
1991	T2D	31000.00	52000.01	49000.01	36.00	160.00	160.00
1991	T3A	38000.00	96000.00	57000.01	85.00	330.00	74.00
1991	T3B	27000.00	61000.01	31000.00	30.00	55.00	14.00
1991	T3C	29000.00	100000.00	70000.02	47.00	180.00	40.00
1991	T3D	49000.01	78000.02	68000.02	140.00	300.00	46.00
1991	T4A	27000.00		37000.00	24.00		66.00
1991	T4B	24000.00		82000.02	24.00		270.00
1991	T4C	24000.00		40000.00	23.00		48.00
1991	T4D	23000.00		33000.00	22.00		14.00
1991	T5A	28000.00		28000.00	45.00		53.00
1991	T5B	27000.00		58000.01	46.00		58.00
1991	T5C	40000.00		110000.00	86.00		110.00
1991	T5D	47000.01		73000.02	75.00		53.00
1992	T6A	58000.01		65000.01	120.00		46.00
1992	T6B	33000.00		89000.00	66.00		130.00
1992	T6C	45000.01		70000.02	100.00		59.00
1992	T7A	30000.00		43000.01	40.00		55.00
1992	T7B	32000.00		72000.02	50.00		93.00
1992	T7C	33000.00		62000.01	37.00		61.00
1992	T8A	38000.00		65000.01	62.00		61.00
1992	T8B	51000.01		46000.01	84.00		49.00
1992	T8C	77000.02		29000.00	100.00		25.00
1992	T9A	42000.01		58000.01	58.00		51.00
1992	T9B	54000.01		31000.00	72.00		24.00
1992	T9C	58000.01		30000.00	63.00		25.00
1992	T10A	38000.00		32000.00	43.00		29.00
1992	T10B	40000.00		38000.00	49.00		38.00
1992	T10C	36000.00		32000.00	40.00		35.00
1992	T11A	38000.00		58000.01	52.00		61.00
1992	T12A	29000.00			21.00		

		Manganese Unf. Tot (Mn ug/g)			Molybdenum Unf. Tot (Mo ug/g)		
PSQG	SEL	1100.0			NA		
	LEL	460.0			NA		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	330.00			0.00		
1991	G1A	320.00	500.00	340.00	0.60	0.00	2.40
1991	G2	400.00			1.30		
1991	G3	460.00			0.00		
1991	G4	360.00			0.00		
1991	G-5	410.00			0.00		
1992	G-6	670.00			0.00		
1992	G-7	510.00			0.54		
1992	G-8	340.00			0.00		
1991	T1A	210.00	180.00	270.00	0.00	0.62	0.43
1991	T1B	360.00	380.00	540.00	1.30	0.00	1.60
1991	T1C	330.00	360.00	260.00	0.96	0.00	0.00
1991	T1D	190.00		240.00	0.00		0.00
1991	T2A	620.00	640.00	370.00	0.00	0.24	0.00
1991	T2B	420.00		350.00	0.00		0.79
1991	T2C	480.00	470.00	170.00	1.70	0.00	0.00
1991	T2D	540.00	690.00	860.00	0.00	0.00	0.36
1991	T3A	500.00	750.00	380.00	1.60	6.20	3.80
1991	T3B	400.00	390.00	260.00	1.20	2.80	0.00
1991	T3C	430.00	570.00	380.00	1.50	10.00	2.40
1991	T3D	500.00	460.00	370.00	2.10	6.60	3.60
1991	T4A	400.00		510.00	0.00		0.00
1991	T4B	390.00		520.00	0.00		4.70
1991	T4C	400.00		330.00	0.00		0.00
1991	T4D	330.00		490.00	0.00		0.00
1991	T5A	340.00		380.00	0.00		0.00
1991	T5B	370.00		330.00	0.00		0.00
1991	T5C	390.00		460.00	0.56		5.00
1991	T5D	280.00		240.00	4.40		2.60
1992	T6A	400.00		410.00	3.90		2.20
1992	T6B	430.00		440.00	0.74		5.80
1992	T6C	400.00		350.00	2.30		3.10
1992	T7A	380.00		480.00	0.00		1.40
1992	T7B	430.00		480.00	0.94		3.60
1992	T7C	460.00		530.00	0.00		2.30
1992	T8A	380.00		320.00	0.84		3.60
1992	T8B	410.00		270.00	1.90		2.40
1992	T8C	440.00		250.00	5.00		0.00
1992	T9A	430.00		450.00	1.10		2.50
1992	T9B	430.00		220.00	2.00		0.61 ,T
1992	T9C	410.00		220.00	2.70		0.79
1992	T10A	340.00		260.00	1.10		0.51
1992	T10B	530.00		390.00	0.93		1.10
1992	T10C	420.00		280.00	0.93		0.86
1992	T11A	600.00		620.00	0.72		1.20
1992	T12A	750.00			1.10		

		Nickel Unf. Tot (Ni ug/g)			Strontium Unf. Tot (Sr ug/g)		
PSQG	SEL	75.0			NA		
	LEL	16.0			NA		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	32.00			170.00		
1991	G1A	34.00	43.00	68.00	160.00	130.00	68.00
1991	G2	36.00			110.00		
1991	G3	40.00			99.00		
1991	G4	41.00			170.00		
1991	G-5	48.00			92.00		
1992	G-6	27.00			97.00		
1992	G-7	25.00			37.00		
1992	G-8	17.00			24.00		
1991	T1A	23.00	22.00	33.00	120.00	40.00	57.00
1991	T1B	54.00	44.00	42.00	77.00	110.00	81.00
1991	T1C	37.00	41.00	32.00	150.00	140.00	58.00
1991	T1D	20.00		34.00	29.00		43.00
1991	T2A	47.00	53.00	37.00	130.00	82.00	67.00
1991	T2B	40.00		38.00	150.00		80.00
1991	T2C	49.00	61.00	27.00	89.00	70.00	35.00
1991	T2D	45.00	53.00	50.00	94.00	140.00	89.00
1991	T3A	57.00	100.00	85.00	100.00	72.00	80.00
1991	T3B	48.00	100.00	40.00	110.00	85.00	73.00
1991	T3C	48.00	120.00	110.00	110.00	88.00	85.00
1991	T3D	55.00	110.00	99.00	110.00	91.00	81.00
1991	T4A	38.00		43.00	150.00		110.00
1991	T4B	34.00		77.00	190.00		91.00
1991	T4C	36.00		51.00	150.00		85.00
1991	T4D	38.00		32.00	170.00		47.00
1991	T5A	54.00		62.00	95.00		96.00
1991	T5B	52.00		68.00	130.00		100.00
1991	T5C	80.00		130.00	120.00		83.00
1991	T5D	88.00		140.00	63.00		84.00
1992	T6A	75.00		95.00	110.00		56.00
1992	T6B	49.00		110.00	130.00		84.00
1992	T6C	60.00		100.00	150.00		60.00
1992	T7A	59.00		61.00	85.00		91.00
1992	T7B	50.00		83.00	140.00		100.00
1992	T7C	43.00		75.00	120.00		110.00
1992	T8A	55.00		93.00	100.00		72.00
1992	T8B	64.00		99.00	110.00		76.00
1992	T8C	110.00		43.00	110.00		55.00
1992	T9A	59.00		100.00	82.00		70.00
1992	T9B	75.00		51.00	85.00		57.00
1992	T9C	97.00		45.00	70.00		54.00
1992	T10A	80.00		48.00	61.00		51.00
1992	T10B	58.00		84.00	98.00		75.00
1992	T10C	61.00		79.00	60.00		54.00
1992	T11A	55.00		88.00	51.00		58.00
1992	T12A	39.00			69.00		

		Titanium Unf. Tot (Ti ug/g)			Vanadium Unf. Tot (V ug/g)		
PSQG	SEL	NA			NA		
	LEL	NA			NA		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	160.00			20.00		
1991	G1A	190.00	210.00	130.00	21.00	49.00	53.00
1991	G2	210.00			29.00		
1991	G3	210.00			36.00		
1991	G4	130.00			33.00		
1991	G-5	51.00			42.00		
1992	G-6	290.00			37.00		
1992	G-7	340.00			32.00		
1992	G-8	210.00			24.00		
1991	T1A	250.00	220.00	180.00	23.00	23.00	30.00
1991	T1B	84.00	190.00	210.00	48.00	26.00	46.00
1991	T1C	200.00	110.00	44.00	26.00	28.00	49.00
1991	T1D	270.00		69.00	41.00		46.00
1991	T2A	140.00	62.00	100.00	52.00	52.00	53.00
1991	T2B	230.00		31.00	30.00		51.00
1991	T2C	200.00	120.00	96.00	41.00	53.00	39.00
1991	T2D	200.00	190.00	190.00	45.00	52.00	49.00
1991	T3A	220.00	180.00	110.00	47.00	59.00	60.00
1991	T3B	190.00	110.00	68.00	34.00	54.00	54.00
1991	T3C	130.00	170.00	80.00	36.00	66.00	57.00
1991	T3D	210.00	130.00	110.00	51.00	57.00	55.00
1991	T4A	210.00		120.00	39.00		47.00
1991	T4B	200.00		200.00	35.00		61.00
1991	T4C	190.00		180.00	35.00		40.00
1991	T4D	210.00		79.00	36.00		40.00
1991	T5A	250.00		200.00	43.00		41.00
1991	T5B	200.00		95.00	39.00		65.00
1991	T5C	170.00		200.00	47.00		65.00
1991	T5D	200.00		170.00	55.00		65.00
1992	T6A	200.00		160.00	45.00		48.00
1992	T6B	230.00		200.00	43.00		55.00
1992	T6C	220.00		190.00	46.00		58.00
1992	T7A	210.00		210.00	49.00		49.00
1992	T7B	230.00		220.00	44.00		52.00
1992	T7C	260.00		220.00	45.00		49.00
1992	T8A	210.00		170.00	45.00		55.00
1992	T8B	220.00		220.00	48.00		59.00
1992	T8C	180.00		160.00	51.00		54.00
1992	T9A	200.00		210.00	48.00		47.00
1992	T9B	210.00		130.00	48.00		52.00
1992	T9C	170.00		81.00	48.00		54.00
1992	T10A	160.00		150.00	51.00		55.00
1992	T10B	170.00		190.00	50.00		49.00
1992	T10C	220.00		170.00	45.00		51.00
1992	T11A	180.00		180.00	51.00		53.00
1992	T12A	250.00			45.00		

		Zinc Unf. Tot (Zn ug/g)			Total Organic Carbon (TOC mg/g)		
PSQG	SEL	820.0			NA		
	LEL	120.0			NA		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	160.00			21.00		
1991	G1A	160.00	740.00	2400.00	26.00	31.00	98.00
1991	G2	270.00			30.00		
1991	G3	330.00			31.00		
1991	G4	370.00			38.00		
1991	G-5	500.00			62.00		
1992	G-6	73.00			4.10		
1992	G-7	74.00			13.00		
1992	G-8	54.00			11.00		
1991	T1A	83.00	130.00	160.00	10.00	14.00	20.00
1991	T1B	750.00	100.00	140.00	52.00	11.00	13.00
1991	T1C	97.00	120.00	170.00	14.00	14.00	28.00
1991	T1D	85.00		270.00	51.00		26.00
1991	T2A	1500.00	1300.00	400.00	42.00	57.00	28.00
1991	T2B	100.00		370.00	13.00		34.00
1991	T2C	780.00	1600.00	320.00	52.00	61.00	20.00
1991	T2D	290.00	1800.00	1400.00	22.00	47.00	40.00
1991	T3A	1000.00	5900.00	1900.00	45.00	130.00	94.00
1991	T3B	390.00	2700.00	310.00	38.00	97.00	40.00
1991	T3C	570.00	5300.00	2500.00	44.00	120.00	95.00
1991	T3D	2300.00	8700.00	2600.00	64.00	190.00	88.00
1991	T4A	420.00		710.00	35.00		26.00
1991	T4B	360.00		6500.00	31.00		140.00
1991	T4C	310.00		1500.00	35.00		52.00
1991	T4D	320.00		170.00	37.00		23.00
1991	T5A	540.00		680.00	46.00		43.00
1991	T5B	590.00		1400.00	47.00		87.00
1991	T5C	2900.00		6100.00	70.00		120.00
1991	T5D	2100.00		2700.00	140.00		120.00
1992	T6A	3600.00		2500.00	77.00		62.00
1992	T6B	970.00		4900.00	33.00		91.00
1992	T6C	2600.00		2600.00	54.00		72.00
1992	T7A	400.00		1500.00	54.00		48.00
1992	T7B	700.00		3900.00	42.00		55.00
1992	T7C	510.00		3700.00	29.00		48.00
1992	T8A	1400.00		2400.00	36.00		72.00
1992	T8B	2800.00		1500.00	42.00		65.00
1992	T8C	4700.00		300.00	65.00		42.00
1992	T9A	1500.00		2500.00	39.00		47.00
1992	T9B	2500.00		360.00	49.00		41.00
1992	T9C	2500.00		290.00	63.00		38.00
1992	T10A	1000.00		390.00	65.00		36.00
1992	T10B	960.00		1100.00	26.00		32.00
1992	T10C	870.00		680.00	36.00		35.00
1992	T11A	920.00		2900.00	39.00		27.00
1992	T12A	140.00			40.00		

		Total Organic Carbon (TOC %)		
PSQG	SEL	10.0 %		
	LEL	1.0 %		
	NEL	NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	2.10		
1991	G1A	2.60	3.10	9.80
1991	G2	3.00		
1991	G3	3.10		
1991	G4	3.80		
1991	G-5	6.20		
1992	G-6	0.41		
1992	G-7	1.30		
1992	G-8	1.10		
1991	T1A	1.00	1.40	2.00
1991	T1B	5.20	1.10	1.30
1991	T1C	1.40	1.40	2.80
1991	T1D	5.10	0.00	2.60
1991	T2A	4.20	5.70	2.80
1991	T2B	1.30	0.00	3.40
1991	T2C	5.20	6.10	2.00
1991	T2D	2.20	4.70	4.00
1991	T3A	4.50	13.00	9.40
1991	T3B	3.80	9.70	4.00
1991	T3C	4.40	12.00	9.50
1991	T3D	6.40	19.00	8.80
1991	T4A	3.50	0.00	2.60
1991	T4B	3.10	0.00	14.00
1991	T4C	3.50	0.00	5.20
1991	T4D	3.70	0.00	2.30
1991	T5A	4.60	0.00	4.30
1991	T5B	4.70	0.00	8.70
1991	T5C	7.00	0.00	12.00
1991	T5D	14.00	0.00	12.00
1992	T6A	7.70	0.00	6.20
1992	T6B	3.30	0.00	9.10
1992	T6C	5.40	0.00	7.20
1992	T7A	5.40	0.00	4.80
1992	T7B	4.20	0.00	5.50
1992	T7C	2.90	0.00	4.80
1992	T8A	3.60	0.00	7.20
1992	T8B	4.20	0.00	6.50
1992	T8C	6.50	0.00	4.20
1992	T9A	3.90	0.00	4.70
1992	T9B	4.90	0.00	4.10
1992	T9C	6.30	0.00	3.80
1992	T10A	6.50	0.00	3.60
1992	T10B	2.60	0.00	3.20
1992	T10C	3.60	0.00	3.50
1992	T11A	3.90	0.00	2.70
1992	T12A	4.00	0.00	0.00

Appendix B:
Severe Effect Level Determination for PCBs

SEVERE EFFECT LEVEL DETERMINATION FOR PCBs

Location ‘A’

		TOC Result (mg/g)	Percent TOC (%)	S.E.L (µg/g)	PCB Result (µg/g)
1	Upper	10	1	5.3	0.07 <T*
	Middle	14	1.4	7.42	0.21
	Lower	20	2	10.6	0.23
G1	Upper	26	2.6	13.78	0.4
	Middle	31	3.1	16.43	3.1
	Lower	98	9.8	51.94	0.7
2	Upper	42	4.2	22.26	2.1
	Middle	57	5.7	30.21	1.95
	Lower	28	2.8	14.84	6.3
3	Upper	45	4.5	23.85	1.69
	Middle	130	13**	53	26
	Lower	94	9.4	49.82	15
4	Upper	35	3.5	18.55	0.82
	Middle	NA	NA	NA	NA
	Lower	26	2.6	13.78	1.95
5	Upper	46	4.6	24.38	0.84
	Middle	NA	NA	NA	NA
	Lower	43	4.3	22.79	2

Note:
***** <T – a measureable trace amount: interpret with caution
** Represents TOC values that are above the S.E.L of 10% and cannot be related to the S.E.L of PCBs. The maximum allowable PCB under this restriction is 53ppm (µg/g). This value is substituted for the calculated value.

SEVERE EFFECT LEVEL DETERMINATION FOR PCBs

Location 'B'

	TOC Result (µg/g)	Percent TOC (%)	S.E.L (µg/g)	PCB Result (µg/g)
1 Upper	52	5.2	27.56	<0.02 <W*
Middle	11	1.1	5.83	<0.02 <W*
Lower	13	1.3	6.89	0.15 <T***
G1 Upper				
Middle				
Lower				
2 Upper	13	1.3	6.89	4.5
Middle	NA	NA	NA	NA
Lower	34	3.4	18.02	0.675
3 Upper	38	3.8	20.14	1.01
Middle	97	9.7	51.41	21
Lower	40	4.0	21.2	0.15 <T***
4 Upper	31	3.1	61.43	0.26
Middle	NA	NA	NA	NA
Lower	140	14**	53	10.9
	240	24**	53	73.5
5 Upper	47	4.7	24.91	0.58
Middle	NA	NA	NA	NA
Lower	87	8.7	46.11	1.87

Note:
*<W – no measureable response (zero): < reported value
** Represents TOC values that are above the S.E.L of 10% and cannot be related to the S.E.L of PCBs. The maximum allowable PCB under this restriction is 53ppm (µg/g). This value is substituted for the calculated value.
***<T - – a measureable trace amount: interpret with caution

Severe Effect Level Determination for PCBs

Location 'C'

	TOC Result (µg/g)	Percent TOC (%)	S.E.L (µg/g)	PCB Result (µg/g)
1 Upper	14	1.4	7.42	<0.02 <W*
Middle	14	1.4	7.42	<0.02 <W*
Lower	28	2.8	14.84	0.125 <T***
G1 Upper				
Middle				
Lower				
2 Upper	52	5.2	27.56	0.675
Middle	61	6.1	32.33	1.4
Lower	20	2.0	10.6	3.25
3 Upper	44	4.4	23.32	0.47
Middle	120	12**	53	11.4
Lower	95	9.5	50.35	4.8
4 Upper	35	3.5	18.55	0.99
Middle	NA	NA	NA	NA
Lower	52	5.2	27.56	4.8
5 Upper	70	7.0	37.1	0.9
Middle	NA	NA	NA	NA
Lower	120	12**	53	24.54

Note:
*****<W – no measureable response (zero): < reported value
** Represents TOC values that are above the S.E.L of 10% and cannot be related to the S.E.L of PCBs. The maximum allowable PCB under this restriction is 53ppm (µg/g). This value is substituted for the calculated value.
***<T - – a measureable trace amount: interpret with caution

SEVERE EFFECT LEVEL DETERMINATION FOR PCBS

Location ‘D’

		TOC Result (µg/g)	Percent TOC (%)	S.E.L (µg/g)	PCB Result (µg/g)
1	Upper	51	5.1	27.03	0.11 <T*
	Middle	NA	NA	NA	NA
	Lower	26	2.6	13.78	0.09 <T*
G1	Upper				
	Middle				
	Lower				
2	Upper	22	2.2	11.66	1.81
	Middle	47	4.7	24.91	7.77
	Lower	40	4.0	21.2	1.42
3	Upper	64	6.4	33.92	4.6
	Middle	190	1.9	100.7	180
	Lower	88	8.8	46.64	16.9
4	Upper	37	3.7	19.61	0.69
	Middle	NA	NA	NA	NA
	Lower	23	2.3	12.19	2.04
5	Upper	140	14**	53	1.28
	Middle	NA	NA	NA	NA
	Lower	120	12**	53	0.68

*<T - – a measureable trace amount: interpret with caution

Severe Effect Level Determination

GRAB SAMPLES

	TOC Result (µg/g)	Percent TOC (%)	S.E.L (µg/g)	PCB Result (µg/g)
G1	21	2.1	11.13	<0.02 <W*
G2	30	3.0	15.9	0.73
G3	31	3.1	16.43	0.38
G4	38	3.8	20.14	1.05
G5	62	6.2	32.86	0.43

Note:
*<W – no measureable response (zero): < reported value
** Represents TOC values that are above the S.E.L of 10% and cannot be related to the S.E.L of PCBs. The maximum allowable PCB under this restriction is 53ppm (µg/g). This value is substituted for the calculated value.

Appendix C:
Sediment Sample Results Relative to Provincial Sediment Quality Guidelines

		PCB (ng/g)			**Cadmium Unf. Tot** (Cd ug/g)		
PSQG	**SEL**	**530.00**			**10.0**		
	LEL	**0.07**			**0.6**		
	NEL	**0.01**			**NA**		
Year	**Transect**	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1				Exceeds LEL		
1991	G1A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	G2	Exceeds LEL			Exceeds LEL		
1991	G3	Exceeds LEL			Exceeds LEL		
1991	G4	Exceeds LEL			Exceeds LEL		
1991	G-5	Exceeds LEL			Exceeds LEL		
1992	G-6	Exceeds LEL					
1992	G-7						
1992	G-8						
1991	T1A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL
1991	T1B	Acceptable	Acceptable	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T1C	Acceptable	Acceptable	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T1D	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T2A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T2B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T2C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T2D	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3B	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3D	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T4A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	**T4B**	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T4C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T4D	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5D	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T6A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T6B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T6C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T7A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T7B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T7C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T9A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T9B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T9C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T10A	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL	Acceptable	Exceeds LEL
1992	T10B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T10C	Exceeds LEL	Acceptable	Exceeds NEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T11A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T12A	Acceptable	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable

		Chromium Unf. Tot (Cr ug/g)			Cobalt Unf. Total (Co ug/g)		
PSQG	SEL	110.0			NA		
	LEL	26.0			50.0		
	NEL	NA			NA		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1						
1991	G1A		Exceeds LEL	Exceeds LEL			
1991	G2	Exceeds LEL					
1991	G3	Exceeds LEL					
1991	G4	Exceeds LEL					
1991	G-5	Exceeds LEL					
1992	G-6						
1992	G-7						
1992	G-8						
1991	T1A	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1991	T1B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T1C	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T1D	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T2A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T2B	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T2C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T2D	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T3A	Exceeds LEL	Exceeds SEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T3B	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T3C	Exceeds LEL	Exceeds SEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T3D	Exceeds LEL	Exceeds SEL	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T4A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	**T4B**	Exceeds LEL	Acceptable	Exceeds SEL	Acceptable	Acceptable	Acceptable
1991	T4C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T4D	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T5A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T5B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T5C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T5D	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T6A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T6B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T6C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T7A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T7B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T7C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T8A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T8B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T8C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T9A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T9B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T9C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T10A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T10B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T10C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T11A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T12A	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

		Copper Unf. Tot (Cu ug/g)			Iron Unf. Tot (Fe ug/g)		
PSQG	SEL	110.0			4.0		
	LEL	16.0			2.0		
	NEL	NA			NA		
Year	**Transect**	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	Exceeds LEL			Exceeds SEL		
1991	G1A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	G2	Exceeds LEL			Exceeds SEL		
1991	G3	Exceeds LEL			Exceeds SEL		
1991	G4	Exceeds LEL			Exceeds SEL		
1991	G-5	Exceeds LEL			Exceeds SEL		
1992	G-6	Exceeds LEL			Exceeds SEL		
1992	G-7				Exceeds SEL		
1992	G-8				Exceeds SEL		
1991	T1A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T1B	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T1C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T1D	Acceptable	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T2A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T2B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T2C	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T2D	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T3A	Exceeds LEL	Exceeds SEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T3B	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T3C	Exceeds LEL	Exceeds SEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T3D	Exceeds LEL	Exceeds SEL	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T4A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	**T4B**	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T4C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T4D	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T5A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T5B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T5C	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds SEL	Acceptable	Exceeds SEL
1991	T5D	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6B	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T7A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T7B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T7C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T8A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T8B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T8C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T9A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T9B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T9C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T10A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T10B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T10C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T11A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T12A	Exceeds LEL	Acceptable	Acceptable	Exceeds SEL	Acceptable	Acceptable

		Lead Unf. Tot (Pb ug/g)			**Manganese Unf. Tot** (Mn ug/g)		
PSQG	**SEL**	**250.0**			**1100.0**		
	LEL	**31.0**			**460.0**		
	NEL	**NA**			**NA**		
Year	**Transect**	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1						
1991	G1A		Exceeds LEL	Exceeds LEL		Exceeds LEL	
1991	G2						
1991	G3				Exceeds LEL		
1991	G4						
1991	G-5						
1992	G-6				Exceeds LEL		
1992	G-7				Exceeds LEL		
1992	G-8						
1991	T1A	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1991	T1B	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable	Exceeds LEL
1991	T1C	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1991	T1D	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1991	T2A	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable
1991	T2B	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T2C	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable
1991	T2D	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3A	Exceeds LEL	Exceeds SEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable
1991	T3B	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable
1991	T3C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable
1991	T3D	Exceeds LEL	Exceeds SEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Acceptable
1991	T4A	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL
1991	**T4B**	Acceptable	Acceptable	Exceeds SEL	Acceptable	Acceptable	Exceeds LEL
1991	T4C	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T4D	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Exceeds LEL
1991	T5A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T5B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1991	T5C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL
1991	T5D	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T6A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T6B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T6C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T7A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL
1992	T7B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL
1992	T7C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T8B	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T8C	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1992	T9A	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T9B	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1992	T9C	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1992	T10A	Exceeds LEL	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
1992	T10B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Acceptable
1992	T10C	Exceeds LEL	Acceptable	Exceeds LEL	Acceptable	Acceptable	Acceptable
1992	T11A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T12A	Acceptable	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable

		Nickel Unf. Tot (Ni ug/g)			**Total Organic Carbon** (TOC %)		
PSQG	**SEL**	**75.0**			**10.0**		
	LEL	**16.0**			**1.0**		
	NEL	**NA**			**NA**		
Year	**Transect**	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	Exceeds LEL			Exceeds LEL		
1991	G1A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	G2	Exceeds LEL			Exceeds LEL		
1991	G3	Exceeds LEL			Exceeds LEL		
1991	G4	Exceeds LEL			Exceeds LEL		
1991	G-5	Exceeds LEL			Exceeds LEL		
1992	G-6	Exceeds LEL					
1992	G-7	Exceeds LEL			Exceeds LEL		
1992	G-8	Exceeds LEL			Exceeds LEL		
1991	T1A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T1B	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T1C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T1D	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T2A	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T2B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T2C	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T2D	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3A	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds LEL	Exceeds SEL	Exceeds LEL
1991	T3B	Exceeds LEL	Exceeds SEL	Exceeds LEL	Exceeds LEL	Exceeds LEL	Exceeds LEL
1991	T3C	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds LEL	Exceeds SEL	Exceeds LEL
1991	T3D	Exceeds LEL	Exceeds SEL	Exceeds SEL	Exceeds LEL	Exceeds SEL	Exceeds LEL
1991	T4A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	**T4B**	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds SEL
1991	T4C	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T4D	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5B	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5C	Exceeds SEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds SEL
1991	T5D	Exceeds SEL	Acceptable	Exceeds SEL	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6A	Exceeds SEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T6B	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T6C	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T7A	Exceeds LEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T7B	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T7C	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8A	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8B	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T8C	Exceeds SEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T9A	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T9B	Exceeds SEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T9C	Exceeds SEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T10A	Exceeds SEL	Acceptable	Exceeds LEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T10B	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T10C	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T11A	Exceeds LEL	Acceptable	Exceeds SEL	Exceeds LEL	Acceptable	Exceeds LEL
1992	T12A	Exceeds LEL	Acceptable	Acceptable	Exceeds LEL	Acceptable	Acceptable

		Zinc Unf. Tot (Zn ug/g)		
PSQG	**SEL**	**820.0**		
	LEL	**120.0**		
	NEL	**NA**		
Year	**Transect**	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	Exceeds LEL		
1991	G1A	Exceeds LEL	Exceeds LEL	Exceeds SEL
1991	G2	Exceeds LEL		
1991	G3	Exceeds LEL		
1991	G4	Exceeds LEL		
1991	G-5	Exceeds LEL		
1992	G-6			
1992	G-7			
1992	G-8			
1991	T1A	Acceptable	Exceeds LEL	Exceeds LEL
1991	T1B	Exceeds LEL	Acceptable	Exceeds LEL
1991	T1C	Acceptable	Exceeds LEL	Exceeds LEL
1991	T1D	Acceptable	Acceptable	Exceeds LEL
1991	T2A	Exceeds SEL	Exceeds SEL	Exceeds LEL
1991	T2B	Acceptable	Acceptable	Exceeds LEL
1991	T2C	Exceeds LEL	Exceeds SEL	Exceeds LEL
1991	T2D	Exceeds LEL	Exceeds SEL	Exceeds SEL
1991	T3A	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T3B	Exceeds LEL	Exceeds SEL	Exceeds LEL
1991	T3C	Exceeds LEL	Exceeds SEL	Exceeds SEL
1991	T3D	Exceeds SEL	Exceeds SEL	Exceeds SEL
1991	T4A	Exceeds LEL	Acceptable	Exceeds LEL
1991	**T4B**	Exceeds LEL	Acceptable	Exceeds SEL
1991	T4C	Exceeds LEL	Acceptable	Exceeds SEL
1991	T4D	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5A	Exceeds LEL	Acceptable	Exceeds LEL
1991	T5B	Exceeds LEL	Acceptable	Exceeds SEL
1991	T5C	Exceeds SEL	Acceptable	Exceeds SEL
1991	T5D	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6A	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6B	Exceeds SEL	Acceptable	Exceeds SEL
1992	T6C	Exceeds SEL	Acceptable	Exceeds SEL
1992	T7A	Exceeds LEL	Acceptable	Exceeds SEL
1992	T7B	Exceeds LEL	Acceptable	Exceeds SEL
1992	T7C	Exceeds LEL	Acceptable	Exceeds SEL
1992	T8A	Exceeds SEL	Acceptable	Exceeds SEL
1992	T8B	Exceeds SEL	Acceptable	Exceeds SEL
1992	T8C	Exceeds SEL	Acceptable	Exceeds LEL
1992	T9A	Exceeds SEL	Acceptable	Exceeds SEL
1992	T9B	Exceeds SEL	Acceptable	Exceeds LEL
1992	T9C	Exceeds SEL	Acceptable	Exceeds LEL
1992	T10A	Exceeds SEL	Acceptable	Exceeds LEL
1992	T10B	Exceeds SEL	Acceptable	Exceeds SEL
1992	T10C	Exceeds SEL	Acceptable	Exceeds LEL
1992	T11A	Exceeds SEL	Acceptable	Exceeds SEL
1992	T12A	Exceeds LEL	Acceptable	Acceptable

Appendix D:
Trace Metal Concentrations Relative to Aluminum Concentrations

		PCB : TOC			Barium : Aluminum (Ba ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0000			0.0071		
1991	G1A	0.1538	1.0000	0.0714	0.0080	0.0048	0.0020
1991	G2	0.2433			0.0059		
1991	G3	0.1226			0.0046		
1991	G4	0.2763			0.0059		
1991	G-5	0.0694			0.0046		
1992	G-6	0.3902			0.0067		
1992	G-7	0.0000			0.0053		
1992	G-8	0.0000			0.0046		
1991	T1A	0.0700	0.1500	0.1150	0.0061	0.0049	0.0048
1991	T1B	0.0000	0.0000	0.1154	0.0042	0.0064	0.0048
1991	T1C	0.0000	0.0000	0.0446	0.0065	0.0059	0.0038
1991	T1D	0.0216		0.0346	0.0036		0.0043
1991	T2A	0.5000	0.3421	2.2500	0.0050	0.0050	0.0040
1991	T2B	3.4615		0.1985	0.0055		0.0042
1991	T2C	0.1298	0.2295	1.6250	0.0063	0.0050	0.0036
1991	T2D	0.8227	1.6532	0.3550	0.0050	0.0055	0.0055
1991	T3A	0.3756	2.0000	1.5957	0.0060	0.0029	0.0021
1991	T3B	0.2658	2.1649	0.0375	0.0067	0.0019	0.0044
1991	T3C	0.1068	0.9500	0.5053	0.0063	0.0015	0.0013
1991	T3D	0.7188	9.4737	1.9205	0.0040	0.0010	0.0010
1991	T4A	0.2343		0.7500	0.0052		0.0050
1991	T4B	0.0839		0.7786	0.0062		0.0021
1991	T4C	0.2829		0.9231	0.0056		0.0047
1991	T4D	0.1865		0.8870	0.0057		0.0046
1991	T5A	0.1826		0.4651	0.0057		0.0055
1991	T5B	0.1234		0.2149	0.0052		0.0014
1991	T5C	0.1286		2.0417	0.0028		0.0011
1991	T5D	0.0914		0.0567	0.0008		0.0009
1992	T6A	1.8182		1.2097	0.0028		0.0032
1992	T6B	1.1636		2.2857	0.0052		0.0013
1992	T6C	1.7519		1.0139	0.0054		0.0015
1992	T7A	0.1444		0.9250	0.0050		0.0054
1992	T7B	0.5476		1.3164	0.0063		0.0026
1992	T7C	0.4000		2.0542	0.0048		0.0042
1992	T8A	0.6611		0.6694	0.0054		0.0019
1992	T8B	1.6619		0.3262	0.0024		0.0044
1992	T8C	0.9292		0.0286	0.0015		0.0038
1992	T9A	0.8051		0.4766	0.0037		0.0020
1992	T9B	0.7429		0.0488	0.0022		0.0039
1992	T9C	0.8444		0.0263	0.0017		0.0038
1992	T10A	0.2523		0.0000	0.0036		0.0036
1992	T10B	0.4538		0.0750	0.0046		0.0035
1992	T10C	0.5611		0.0171	0.0048		0.0038
1992	T11A	0.1128		0.4889	0.0045		0.0032
1992	T12A	0.0000			0.0050		

		Beryllium : Aluminum (Be ug/g)			Cadmium : Aluminum (Cd ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0000			0.0001		
1991	G1A	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
1991	G2	0.0000			0.0001		
1991	G3	0.0000			0.0001		
1991	G4	0.0000			0.0001		
1991	G-5	0.0000			0.0001		
1992	G-6	0.0000			0.0000		
1992	G-7	0.0000			0.0000		
1992	G-8	0.0001			0.0000		
1991	T1A	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001
1991	T1B	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
1991	T1C	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
1991	T1D	0.0000		0.0000	0.0000		0.0000
1991	T2A	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
1991	T2B	0.0000		0.0000	0.0001		0.0000
1991	T2C	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
1991	T2D	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
1991	T3A	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001
1991	T3B	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
1991	T3C	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001
1991	T3D	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001
1991	T4A	0.0000		0.0000	0.0001		0.0001
1991	T4B	0.0001		0.0000	0.0001		0.0002
1991	T4C	0.0000		0.0000	0.0001		0.0001
1991	T4D	0.0000		0.0000	0.0001		0.0000
1991	T5A	0.0000		0.0000	0.0001		0.0001
1991	T5B	0.0000		0.0000	0.0001		0.0001
1991	T5C	0.0000		0.0000	0.0002		0.0003
1991	T5D	0.0000		0.0000	0.0001		0.0001
1992	T6A	0.0000		0.0000	0.0001		0.0001
1992	T6B	0.0000		0.0000	0.0000		0.0001
1992	T6C	0.0000		0.0000	0.0001		0.0001
1992	T7A	0.0000		0.0000	0.0001		0.0000
1992	T7B	0.0000		0.0000	0.0001		0.0000
1992	T7C	0.0000		0.0000	0.0000		0.0000
1992	T8A	0.0000		0.0000	0.0000		0.0000
1992	T8B	0.0000		0.0000	0.0001		0.0000
1992	T8C	0.0000		0.0000	0.0001		0.0000
1992	T9A	0.0000		0.0000	0.0000		0.0001
1992	T9B	0.0000		0.0000	0.0001		0.0000
1992	T9C	0.0000		0.0000	0.0001		0.0000
1992	T10A	0.0000		0.0000	0.0000		0.0000
1992	T10B	0.0000		0.0000	0.0000		0.0000
1992	T10C	0.0000		0.0000	0.0000		0.0000
1992	T11A	0.0000		0.0000	0.0000		0.0001
1992	T12A	0.0000			0.0000		

		Chromium : Aluminum (Cr ug/g)			Copper : Aluminum (Cu ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0023			0.0034		
1991	G1A	0.0028	0.0021	0.0019	0.0039	0.0028	0.0025
1991	G2	0.0026			0.0032		
1991	G3	0.0019			0.0026		
1991	G4	0.0019			0.0027		
1991	G-5	0.0015			0.0018		
1992	G-6	0.0014			0.0012		
1992	G-7	0.0013			0.0010		
1992	G-8	0.0013			0.0009		
1991	T1A	0.0018	0.0019	0.0015	0.0018	0.0014	0.0014
1991	T1B	0.0018	0.0018	0.0014	0.0014	0.0030	0.0012
1991	T1C	0.0016	0.0016	0.0011	0.0018	0.0017	0.0007
1991	T1D	0.0012		0.0013	0.0006		0.0010
1991	T2A	0.0024	0.0019	0.0016	0.0033	0.0020	0.0010
1991	T2B	0.0017		0.0013	0.0020		0.0009
1991	T2C	0.0033	0.0020	0.0012	0.0036	0.0023	0.0006
1991	T2D	0.0018	0.0030	0.0025	0.0018	0.0044	0.0034
1991	T3A	0.0024	0.0072	0.0022	0.0034	0.0117	0.0025
1991	T3B	0.0023	0.0024	0.0011	0.0027	0.0028	0.0007
1991	T3C	0.0024	0.0084	0.0020	0.0033	0.0116	0.0024
1991	T3D	0.0028	0.0067	0.0021	0.0047	0.0128	0.0024
1991	T4A	0.0018		0.0018	0.0024		0.0025
1991	T4B	0.0019		0.0057	0.0028		0.0086
1991	T4C	0.0019		0.0022	0.0026		0.0028
1991	T4D	0.0018		0.0016	0.0021		0.0013
1991	T5A	0.0018		0.0023	0.0021		0.0026
1991	T5B	0.0020		0.0019	0.0026		0.0022
1991	T5C	0.0027		0.0047	0.0038		0.0057
1991	T5D	0.0022		0.0021	0.0029		0.0018
1992	T6A	0.0036		0.0021	0.0048		0.0022
1992	T6B	0.0019		0.0036	0.0025		0.0046
1992	T6C	0.0025		0.0021	0.0034		0.0021
1992	T7A	0.0015		0.0019	0.0015		0.0018
1992	T7B	0.0018		0.0027	0.0020		0.0032
1992	T7C	0.0016		0.0021	0.0017		0.0024
1992	T8A	0.0018		0.0020	0.0020		0.0021
1992	T8B	0.0022		0.0015	0.0025		0.0014
1992	T8C	0.0028		0.0011	0.0032		0.0006
1992	T9A	0.0018		0.0020	0.0020		0.0020
1992	T9B	0.0020		0.0012	0.0024		0.0009
1992	T9C	0.0022		0.0013	0.0024		0.0008
1992	T10A	0.0015		0.0012	0.0014		0.0007
1992	T10B	0.0015		0.0014	0.0015		0.0012
1992	T10C	0.0016		0.0013	0.0015		0.0010
1992	T11A	0.0014		0.0015	0.0013		0.0016
1992	T12A	0.0016			0.0009		

		Cobalt : Aluminumal (Co ug/g)			Iron : Aluminum (Fe ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0007			1.5854		
1991	G1A	0.0007	0.0005	0.0004	1.6250	1.7391	1.9630
1991	G2	0.0007			1.6667		
1991	G3	0.0005			1.5294		
1991	G4	0.0006			1.4118		
1991	G-5	0.0004			1.2692		
1992	G-6	0.0006			1.3333		
1992	G-7	0.0008			1.4615		
1992	G-8	0.0009			1.5455		
1991	T1A	0.0006	0.0006	0.0006	1.3333	1.4583	1.3571
1991	T1B	0.0005	0.0006	0.0005	1.5000	1.3636	1.2609
1991	T1C	0.0006	0.0006	0.0004	1.3636	1.3077	0.8966
1991	T1D	0.0005		0.0006	1.1579		1.3043
1991	T2A	0.0005	0.0005	0.0004	1.9167	1.6923	1.0667
1991	T2B	0.0006		0.0004	1.3077		1.0000
1991	T2C	0.0006	0.0005	0.0003	2.1875	2.7500	1.1304
1991	T2D	0.0005	0.0005	0.0007	1.4091	2.3636	2.4500
1991	T3A	0.0006	0.0006	0.0004	1.9000	5.3333	2.0357
1991	T3B	0.0006	0.0005	0.0004	1.8000	2.4400	0.9688
1991	T3C	0.0006	0.0006	0.0005	1.8125	5.2632	2.8000
1991	T3D	0.0005	0.0006	0.0004	2.3333	4.3333	2.7200
1991	T4A	0.0006		0.0005	1.5000		1.5417
1991	T4B	0.0005		0.0005	1.5000		3.9048
1991	T4C	0.0006		0.0007	1.5000		2.5000
1991	T4D	0.0006		0.0007	1.4375		1.8333
1991	T5A	0.0006		0.0007	1.2174		1.4000
1991	T5B	0.0006		0.0005	1.2857		1.9333
1991	T5C	0.0006		0.0007	1.9048		5.2381
1991	T5D	0.0006		0.0005	1.8800		2.5172
1992	T6A	0.0006		0.0006	2.7619		2.6000
1992	T6B	0.0006		0.0005	1.4348		3.4231
1992	T6C	0.0005		0.0005	1.8750		2.1875
1992	T7A	0.0005		0.0005	1.1538		1.6538
1992	T7B	0.0005		0.0005	1.3333		2.7692
1992	T7C	0.0005		0.0005	1.3200		2.3846
1992	T8A	0.0005		0.0004	1.4615		2.1667
1992	T8B	0.0005		0.0004	1.9615		1.3529
1992	T8C	0.0006		0.0004	2.9615		0.8529
1992	T9A	0.0005		0.0006	1.6154		2.4167
1992	T9B	0.0005		0.0004	2.0769		1.0000
1992	T9C	0.0006		0.0004	2.3200		0.9375
1992	T10A	0.0006		0.0004	1.4074		0.9697
1992	T10B	0.0005		0.0005	1.4286		1.3571
1992	T10C	0.0005		0.0004	1.4400		1.1034
1992	T11A	0.0005		0.0005	1.3103		2.0714
1992	T12A	0.0007			1.2083		

		Lead : Aluminum (Pb ug/g)			Manganese : Aluminum (Mn ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0015			0.0402		
1991	G1A	0.0013	0.0040	0.0021	0.0400	0.0217	0.0126
1991	G2	0.0021			0.0333		
1991	G3	0.0014			0.0271		
1991	G4	0.0015			0.0212		
1991	G-5	0.0011			0.0158		
1992	G-6	0.0009			0.0372		
1992	G-7	0.0013			0.0392		
1992	G-8	0.0009			0.0309		
1991	T1A	0.0011	0.0010	0.0010	0.0233	0.0188	0.0193
1991	T1B	0.0014	0.0013	0.0007	0.0150	0.0345	0.0235
1991	T1C	0.0011	0.0012	0.0003	0.0300	0.0277	0.0090
1991	T1D	0.0004		0.0007	0.0100		0.0104
1991	T2A	0.0046	0.0028	0.0009	0.0258	0.0246	0.0123
1991	T2B	0.0009		0.0011	0.0323		0.0113
1991	T2C	0.0038	0.0032	0.0006	0.0300	0.0196	0.0074
1991	T2D	0.0016	0.0073	0.0080	0.0245	0.0314	0.0430
1991	T3A	0.0043	0.0183	0.0026	0.0250	0.0417	0.0136
1991	T3B	0.0020	0.0022	0.0004	0.0267	0.0156	0.0081
1991	T3C	0.0029	0.0095	0.0016	0.0269	0.0300	0.0152
1991	T3D	0.0067	0.0167	0.0018	0.0238	0.0256	0.0148
1991	T4A	0.0013		0.0028	0.0222		0.0213
1991	T4B	0.0015		0.0129	0.0244		0.0248
1991	T4C	0.0014		0.0030	0.0250		0.0206
1991	T4D	0.0014		0.0008	0.0206		0.0272
1991	T5A	0.0020		0.0027	0.0148		0.0190
1991	T5B	0.0022		0.0019	0.0176		0.0110
1991	T5C	0.0041		0.0052	0.0186		0.0219
1991	T5D	0.0030		0.0018	0.0112		0.0083
1992	T6A	0.0057		0.0018	0.0190		0.0164
1992	T6B	0.0029		0.0050	0.0187		0.0169
1992	T6C	0.0042		0.0018	0.0167		0.0109
1992	T7A	0.0015		0.0021	0.0146		0.0185
1992	T7B	0.0021		0.0036	0.0179		0.0185
1992	T7C	0.0015		0.0023	0.0184		0.0204
1992	T8A	0.0024		0.0020	0.0146		0.0107
1992	T8B	0.0032		0.0014	0.0158		0.0079
1992	T8C	0.0038		0.0007	0.0169		0.0074
1992	T9A	0.0022		0.0021	0.0165		0.0188
1992	T9B	0.0028		0.0008	0.0165		0.0071
1992	T9C	0.0025		0.0008	0.0164		0.0069
1992	T10A	0.0016		0.0009	0.0126		0.0079
1992	T10B	0.0018		0.0014	0.0189		0.0139
1992	T10C	0.0016		0.0012	0.0168		0.0097
1992	T11A	0.0018		0.0022	0.0207		0.0221
1992	T12A	0.0009			0.0313		

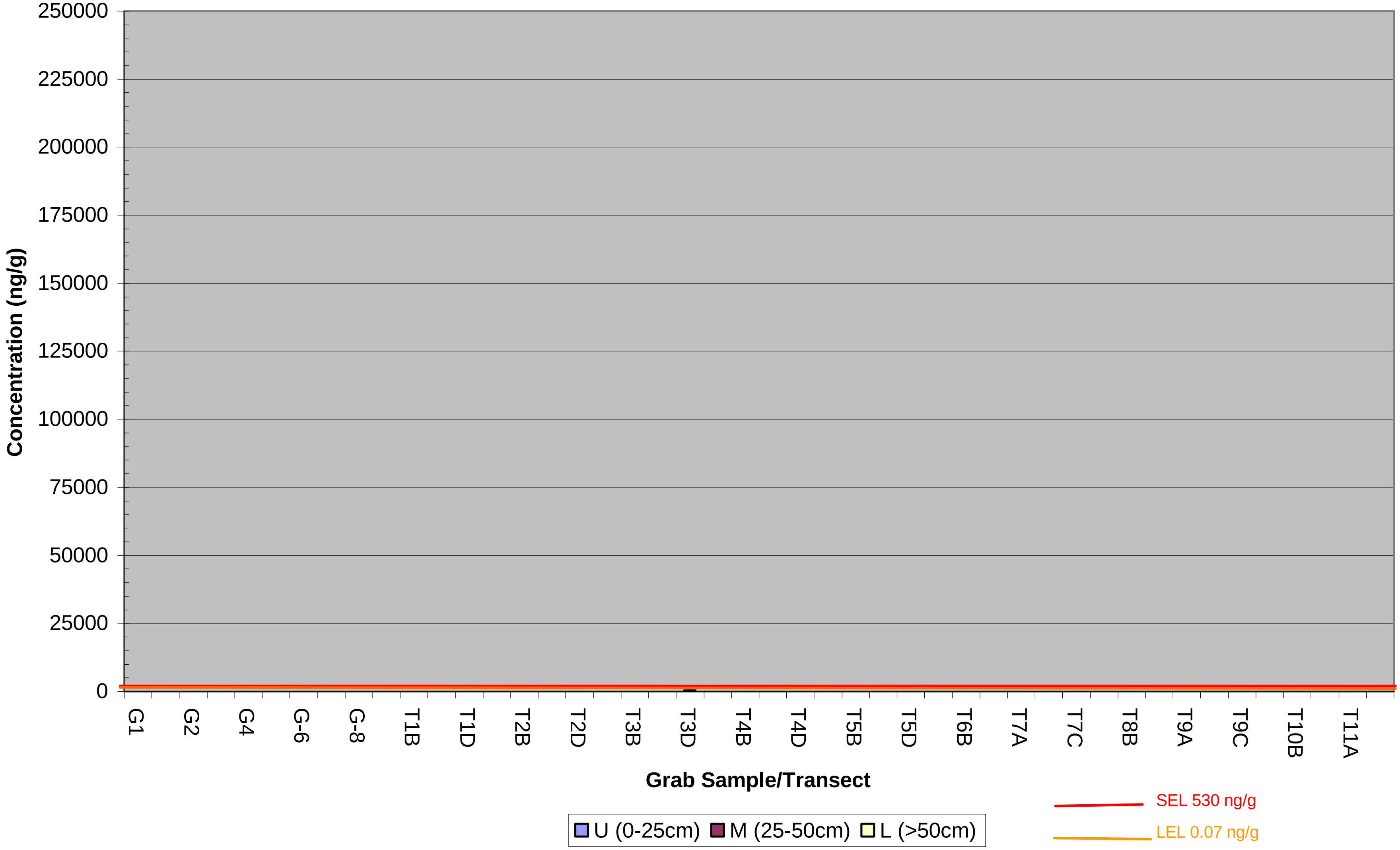
		Molybdenum : Aluminum (Mo ug/g)			Nickel : Aluminum (Ni ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0000			0.0039		
1991	G1A	0.0001	0.0000	0.0001	0.0043	0.0019	0.0025
1991	G2	0.0001			0.0030		
1991	G3	0.0000			0.0024		
1991	G4	0.0000			0.0024		
1991	G-5	0.0000			0.0018		
1992	G-6	0.0000			0.0015		
1992	G-7	0.0000			0.0019		
1992	G-8	0.0000			0.0015		
1991	T1A	0.0000	0.0001	0.0000	0.0026	0.0023	0.0024
1991	T1B	0.0001	0.0000	0.0001	0.0023	0.0040	0.0018
1991	T1C	0.0001	0.0000	0.0000	0.0034	0.0032	0.0011
1991	T1D	0.0000		0.0000	0.0011		0.0015
1991	T2A	0.0000	0.0000	0.0000	0.0020	0.0020	0.0012
1991	T2B	0.0000		0.0000	0.0031		0.0012
1991	T2C	0.0001	0.0000	0.0000	0.0031	0.0025	0.0012
1991	T2D	0.0000	0.0000	0.0000	0.0020	0.0024	0.0025
1991	T3A	0.0001	0.0003	0.0001	0.0029	0.0056	0.0030
1991	T3B	0.0001	0.0001	0.0000	0.0032	0.0040	0.0013
1991	T3C	0.0001	0.0005	0.0001	0.0030	0.0063	0.0044
1991	T3D	0.0001	0.0004	0.0001	0.0026	0.0061	0.0040
1991	T4A	0.0000		0.0000	0.0021		0.0018
1991	T4B	0.0000		0.0002	0.0021		0.0037
1991	T4C	0.0000		0.0000	0.0023		0.0032
1991	T4D	0.0000		0.0000	0.0024		0.0018
1991	T5A	0.0000		0.0000	0.0023		0.0031
1991	T5B	0.0000		0.0000	0.0025		0.0023
1991	T5C	0.0000		0.0002	0.0038		0.0062
1991	T5D	0.0002		0.0001	0.0035		0.0048
1992	T6A	0.0002		0.0001	0.0036		0.0038
1992	T6B	0.0000		0.0002	0.0021		0.0042
1992	T6C	0.0001		0.0001	0.0025		0.0031
1992	T7A	0.0000		0.0001	0.0023		0.0023
1992	T7B	0.0000		0.0001	0.0021		0.0032
1992	T7C	0.0000		0.0001	0.0017		0.0029
1992	T8A	0.0000		0.0001	0.0021		0.0031
1992	T8B	0.0001		0.0001	0.0025		0.0029
1992	T8C	0.0002		0.0000	0.0042		0.0013
1992	T9A	0.0000		0.0001	0.0023		0.0042
1992	T9B	0.0001			0.0029		0.0016
1992	T9C	0.0001		0.0000	0.0039		0.0014
1992	T10A	0.0000		0.0000	0.0030		0.0015
1992	T10B	0.0000		0.0000	0.0021		0.0030
1992	T10C	0.0000		0.0000	0.0024		0.0027
1992	T11A	0.0000		0.0000	0.0019		0.0031
1992	T12A	0.0000			0.0016		

		Strontium : Aluminum (Sr ug/g)			Titanium : Aluminum (Ti ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0207			0.0195		
1991	G1A	0.0200	0.0057	0.0025	0.0238	0.0091	0.0048
1991	G2	0.0092			0.0175		
1991	G3	0.0058			0.0124		
1991	G4	0.0100			0.0076		
1991	G-5	0.0035			0.0020		
1992	G-6	0.0054			0.0161		
1992	G-7	0.0028			0.0262		
1992	G-8	0.0022			0.0191		
1991	T1A	0.0133	0.0042	0.0041	0.0278	0.0229	0.0129
1991	T1B	0.0032	0.0100	0.0035	0.0035	0.0173	0.0091
1991	T1C	0.0136	0.0108	0.0020	0.0182	0.0085	0.0015
1991	T1D	0.0015		0.0019	0.0142		0.0030
1991	T2A	0.0054	0.0032	0.0022	0.0058	0.0024	0.0033
1991	T2B	0.0115		0.0026	0.0177		0.0010
1991	T2C	0.0056	0.0029	0.0015	0.0125	0.0050	0.0042
1991	T2D	0.0043	0.0064	0.0045	0.0091	0.0086	0.0095
1991	T3A	0.0050	0.0040	0.0029	0.0110	0.0100	0.0039
1991	T3B	0.0073	0.0034	0.0023	0.0127	0.0044	0.0021
1991	T3C	0.0069	0.0046	0.0034	0.0081	0.0089	0.0032
1991	T3D	0.0052	0.0051	0.0032	0.0100	0.0072	0.0044
1991	T4A	0.0083		0.0046	0.0117		0.0050
1991	T4B	0.0119		0.0043	0.0125		0.0095
1991	T4C	0.0094		0.0053	0.0119		0.0113
1991	T4D	0.0106		0.0026	0.0131		0.0044
1991	T5A	0.0041		0.0048	0.0109		0.0100
1991	T5B	0.0062		0.0033	0.0095		0.0032
1991	T5C	0.0057		0.0040	0.0081		0.0095
1991	T5D	0.0025		0.0029	0.0080		0.0059
1992	T6A	0.0052		0.0022	0.0095		0.0064
1992	T6B	0.0057		0.0032	0.0100		0.0077
1992	T6C	0.0063		0.0019	0.0092		0.0059
1992	T7A	0.0033		0.0035	0.0081		0.0081
1992	T7B	0.0058		0.0038	0.0096		0.0085
1992	T7C	0.0048		0.0042	0.0104		0.0085
1992	T8A	0.0038		0.0024	0.0081		0.0057
1992	T8B	0.0042		0.0022	0.0085		0.0065
1992	T8C	0.0042		0.0016	0.0069		0.0047
1992	T9A	0.0032		0.0029	0.0077		0.0088
1992	T9B	0.0033		0.0018	0.0081		0.0042
1992	T9C	0.0028		0.0017	0.0068		0.0025
1992	T10A	0.0023		0.0015	0.0059		0.0045
1992	T10B	0.0035		0.0027	0.0061		0.0068
1992	T10C	0.0024		0.0019	0.0088		0.0059
1992	T11A	0.0018		0.0021	0.0062		0.0064
1992	T12A	0.0029			0.0104		

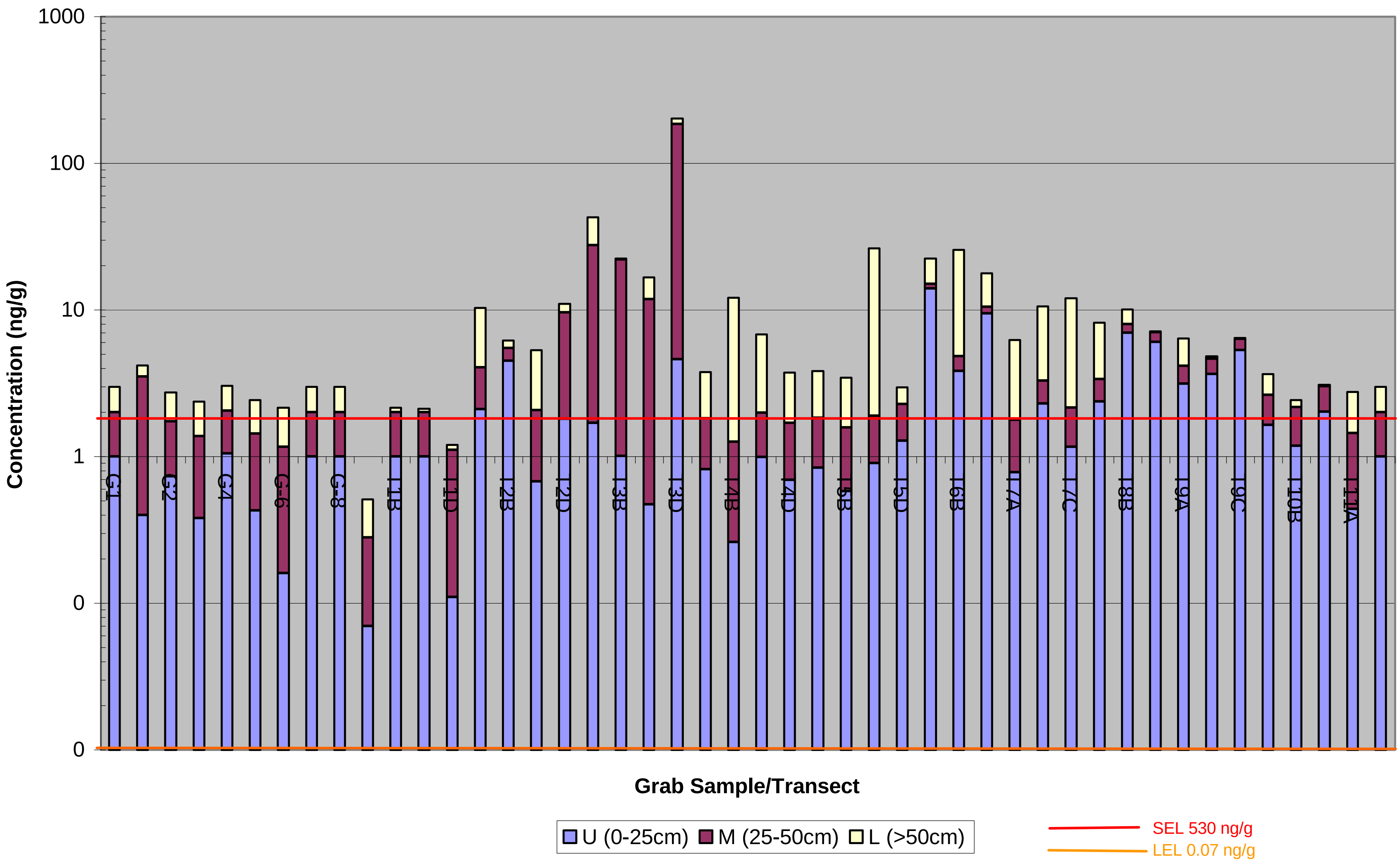
		Vanadium : Aluminum (V ug/g)			Zinc : Aluminum (Zn ug/g)		
Year	Transect	U (0-25cm)	M (25-50cm)	L (>50cm)	U (0-25cm)	M (25-50cm)	L (>50cm)
1991	G1	0.0024			0.0195		
1991	G1A	0.0026	0.0021	0.0020	0.0200	0.0322	0.0889
1991	G2	0.0024			0.0225		
1991	G3	0.0021			0.0194		
1991	G4	0.0019			0.0218		
1991	G-5	0.0016			0.0192		
1992	G-6	0.0021			0.0041		
1992	G-7	0.0025			0.0057		
1992	G-8	0.0022			0.0049		
1991	T1A	0.0026	0.0024	0.0021	0.0092	0.0135	0.0114
1991	T1B	0.0020	0.0024	0.0020	0.0313	0.0091	0.0061
1991	T1C	0.0024	0.0022	0.0017	0.0088	0.0092	0.0059
1991	T1D	0.0022		0.0020	0.0045		0.0117
1991	T2A	0.0022	0.0020	0.0018	0.0625	0.0500	0.0133
1991	T2B	0.0023		0.0016	0.0077		0.0119
1991	T2C	0.0026	0.0022	0.0017	0.0488	0.0667	0.0139
1991	T2D	0.0020	0.0024	0.0025	0.0132	0.0818	0.0700
1991	T3A	0.0024	0.0033	0.0021	0.0500	0.3278	0.0679
1991	T3B	0.0023	0.0022	0.0017	0.0260	0.1080	0.0097
1991	T3C	0.0023	0.0035	0.0023	0.0356	0.2789	0.1000
1991	T3D	0.0024	0.0032	0.0022	0.1095	0.4833	0.1040
1991	T4A	0.0022		0.0020	0.0233		0.0296
1991	T4B	0.0022		0.0029	0.0225		0.3095
1991	T4C	0.0022		0.0025	0.0194		0.0938
1991	T4D	0.0023		0.0022	0.0200		0.0094
1991	T5A	0.0019		0.0021	0.0235		0.0340
1991	T5B	0.0019		0.0022	0.0281		0.0467
1991	T5C	0.0022		0.0031	0.1381		0.2905
1991	T5D	0.0022		0.0022	0.0840		0.0931
1992	T6A	0.0021		0.0019	0.1714		0.1000
1992	T6B	0.0019		0.0021	0.0422		0.1885
1992	T6C	0.0019		0.0018	0.1083		0.0813
1992	T7A	0.0019		0.0019	0.0154		0.0577
1992	T7B	0.0018		0.0020	0.0292		0.1500
1992	T7C	0.0018		0.0019	0.0204		0.1423
1992	T8A	0.0017		0.0018	0.0538		0.0800
1992	T8B	0.0018		0.0017	0.1077		0.0441
1992	T8C	0.0020		0.0016	0.1808		0.0088
1992	T9A	0.0018		0.0020	0.0577		0.1042
1992	T9B	0.0018		0.0017	0.0962		0.0116
1992	T9C	0.0019		0.0017	0.1000		0.0091
1992	T10A	0.0019		0.0017	0.0370		0.0118
1992	T10B	0.0018		0.0018	0.0343		0.0393
1992	T10C	0.0018		0.0018	0.0348		0.0234
1992	T11A	0.0018		0.0019	0.0317		0.1036
1992	T12A	0.0019			0.0058		

Appendix E:
Sediment Chemistry Trends

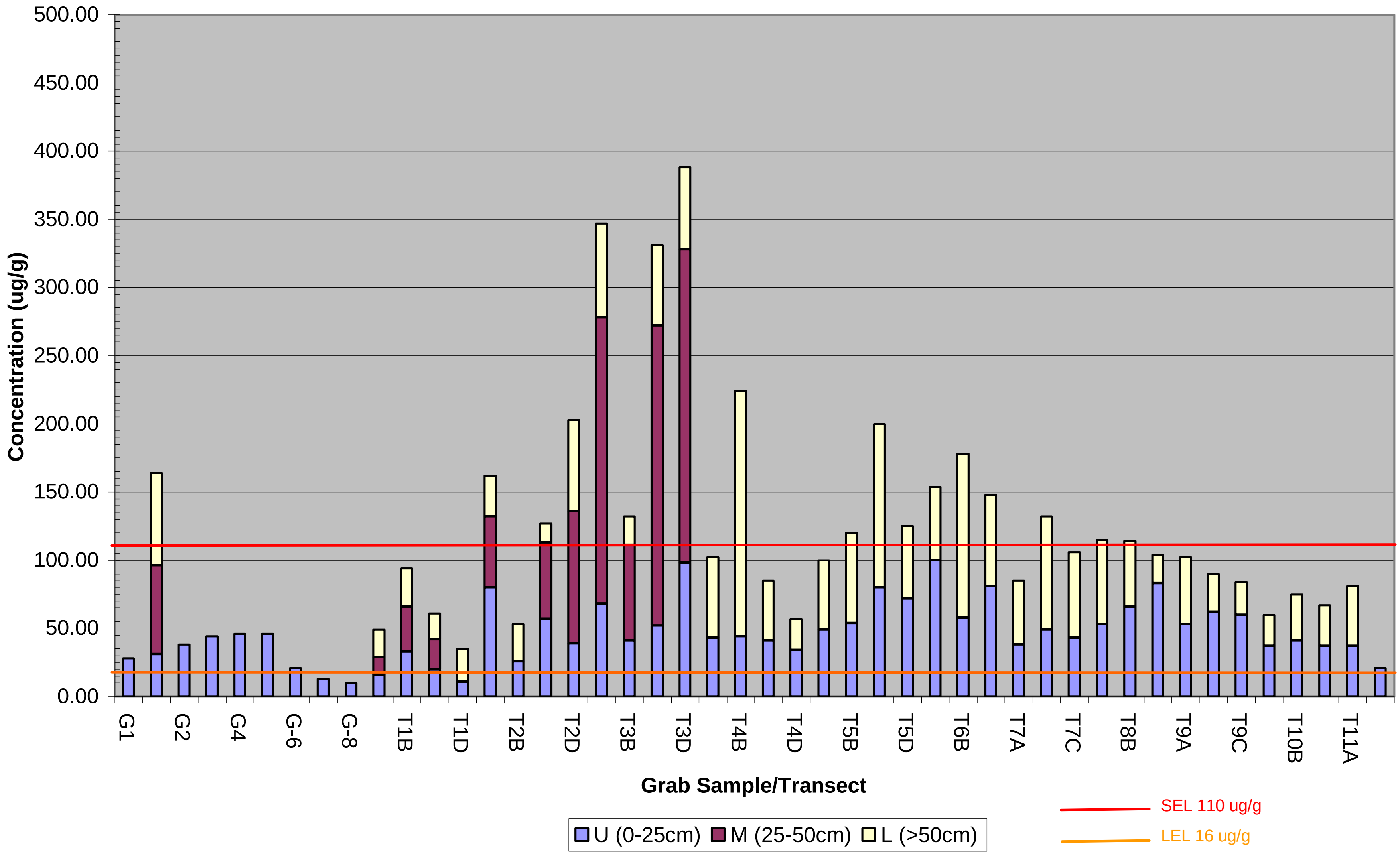
Lyons Creek Sediment Survey Total PCB Concentrations (ng/g)

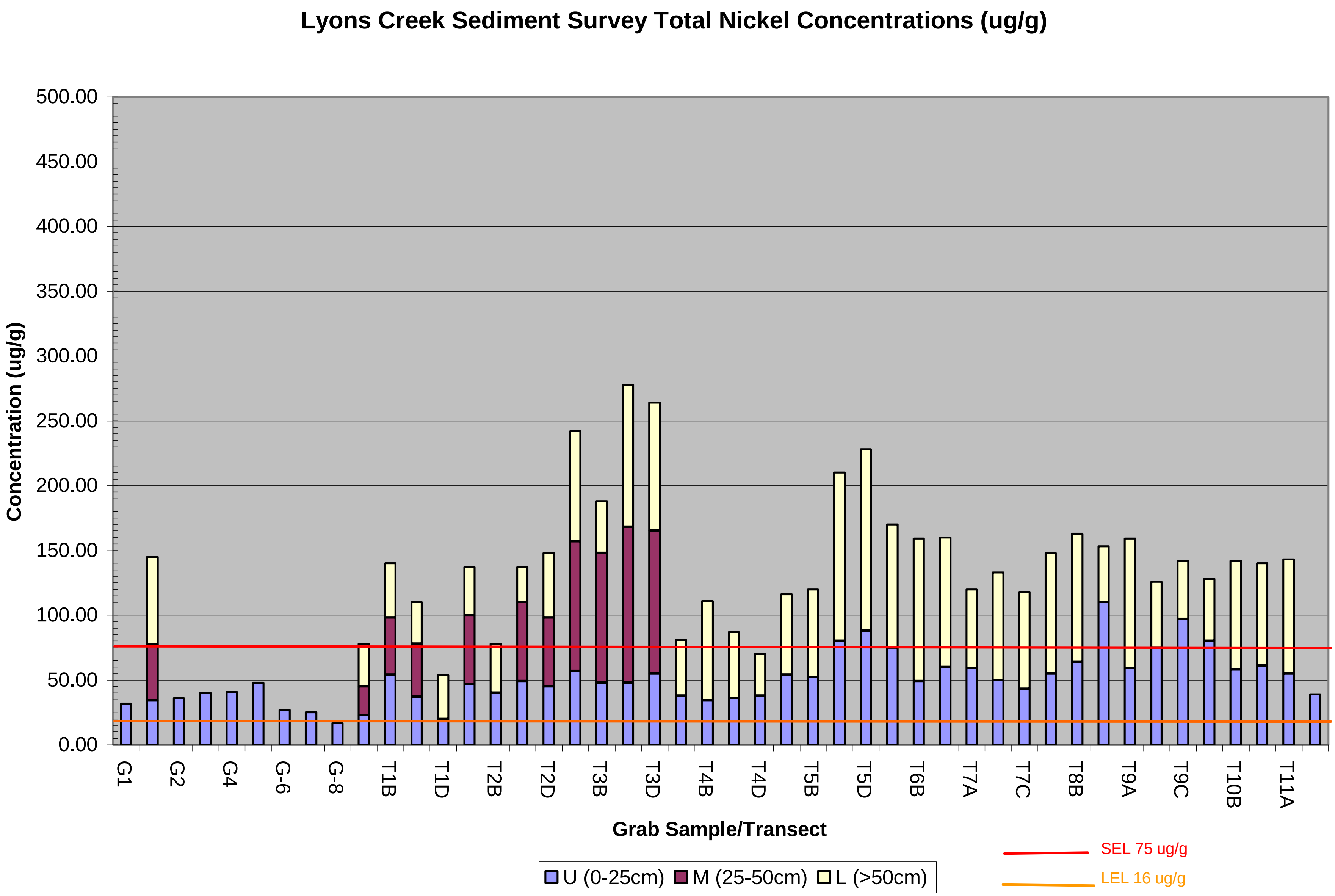


Lyons Creek Sediment Survey Total PCB Concentrations (ng/g)



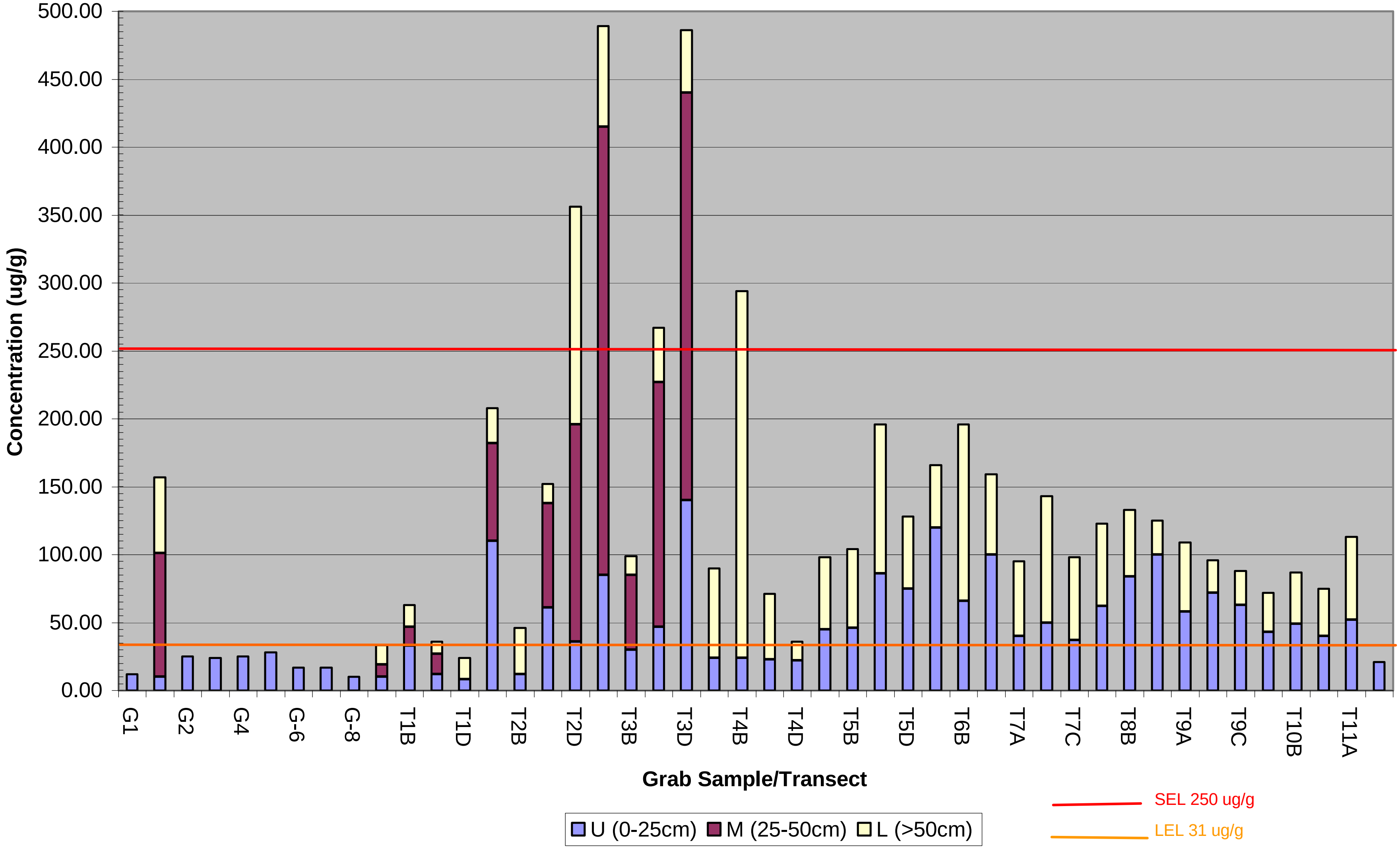
Lyons Creek Sediment Survey Total Copper Concentrations (ug/g)

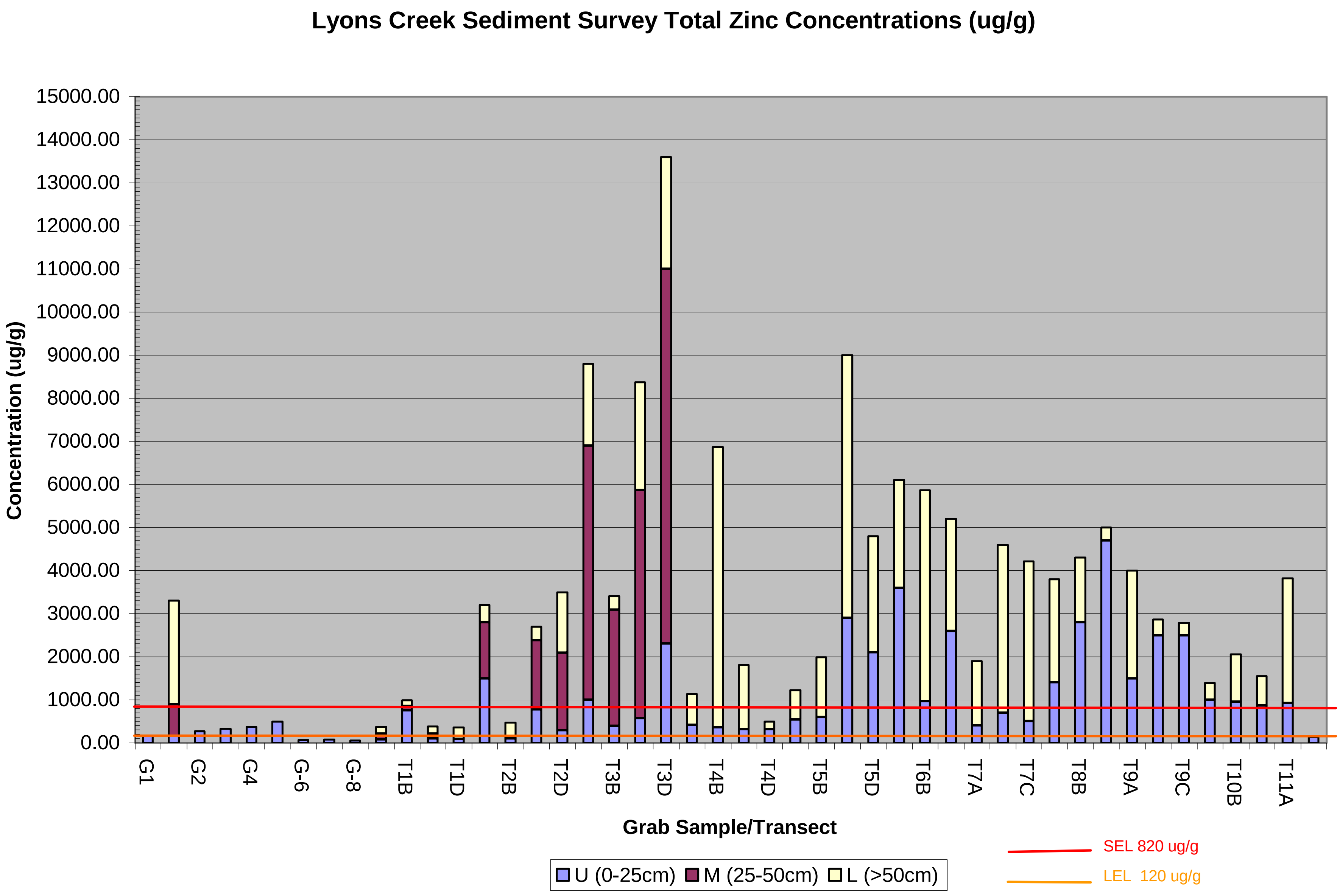




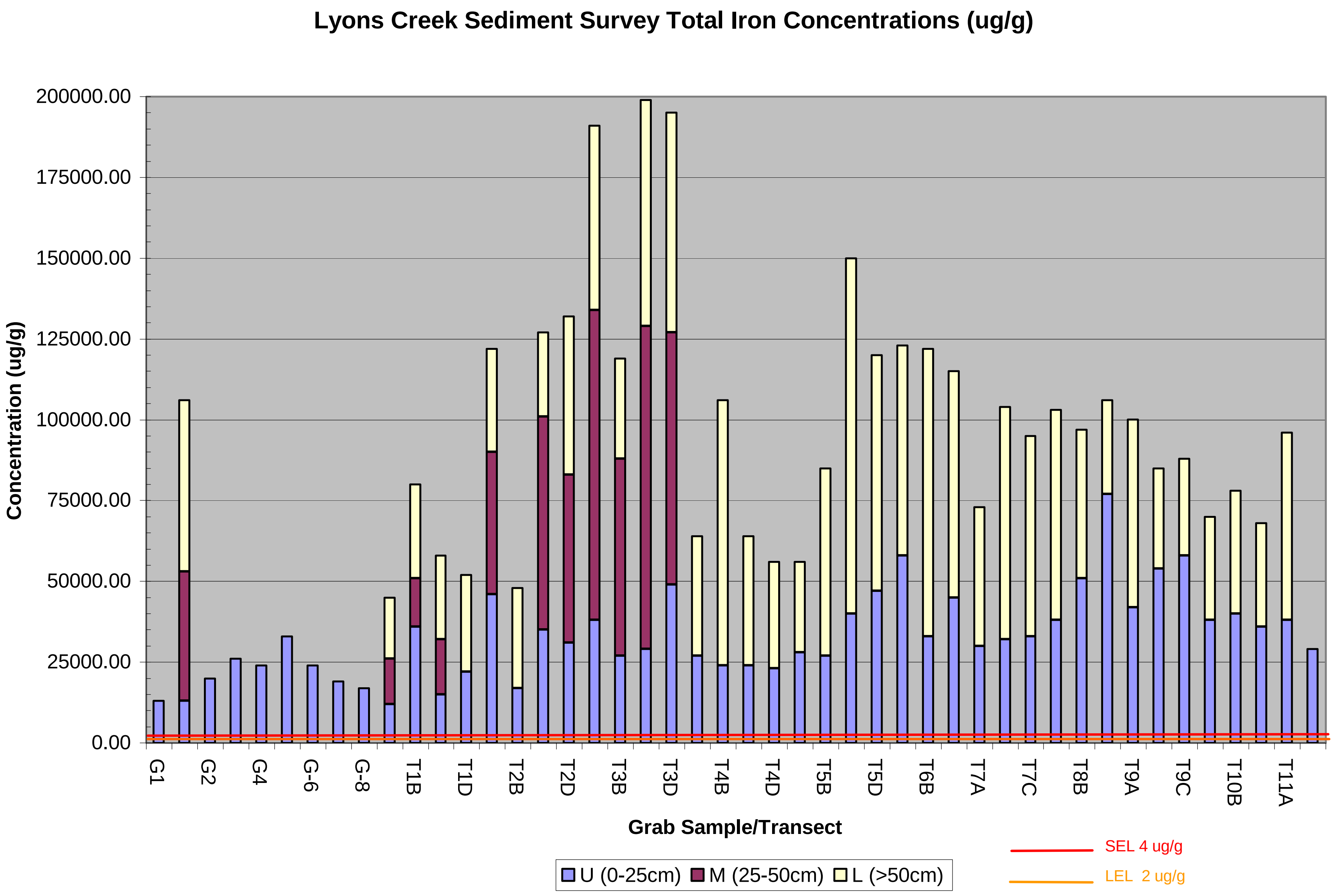
Lyons Creek Sediment Survey Total Nickel Concentrations (ug/g)
Concentration (ug/g)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 75 ug/g
LEL 16 ug/g

Lyons Creek Sediment Survey Total Lead Concentrations (ug/g)

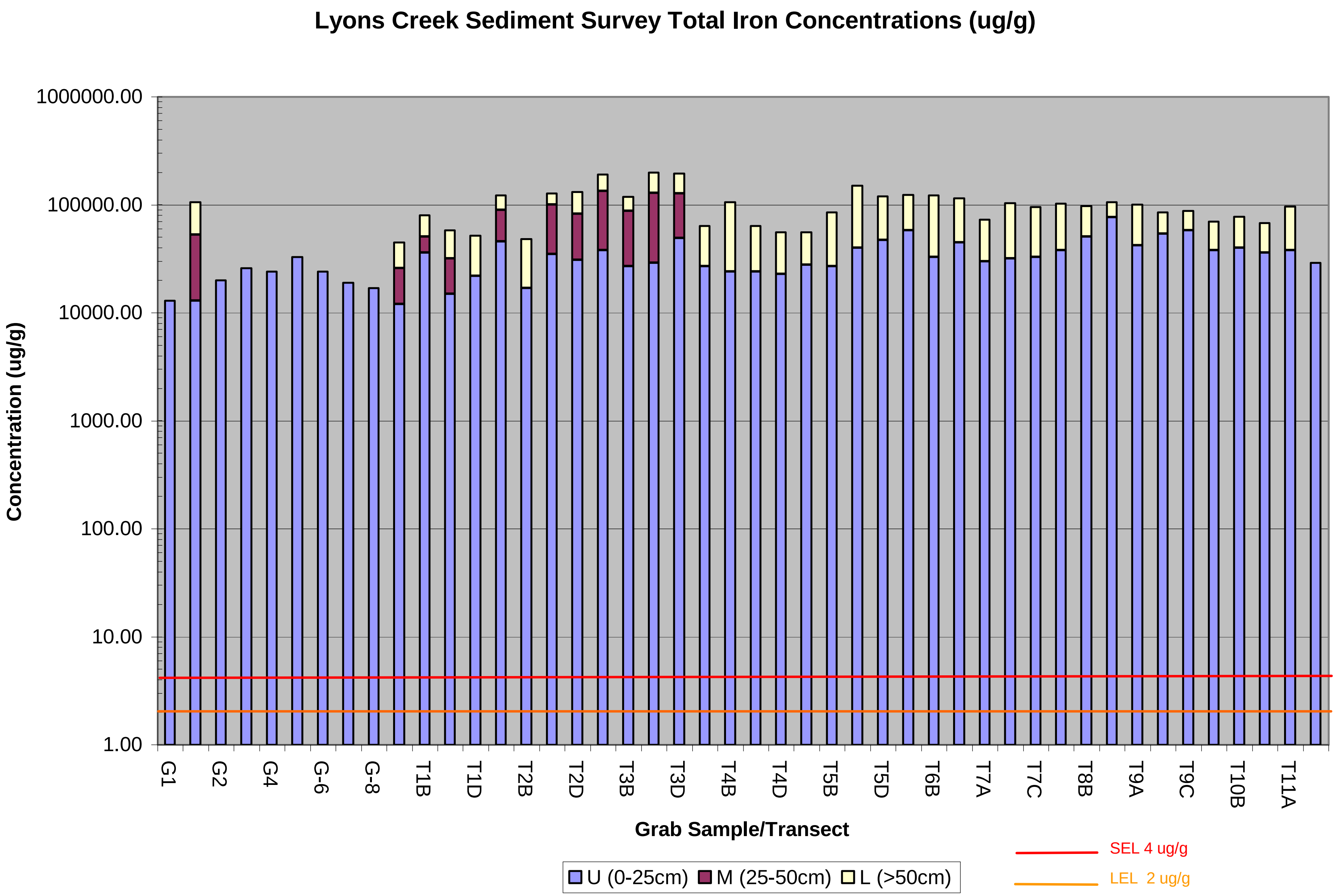




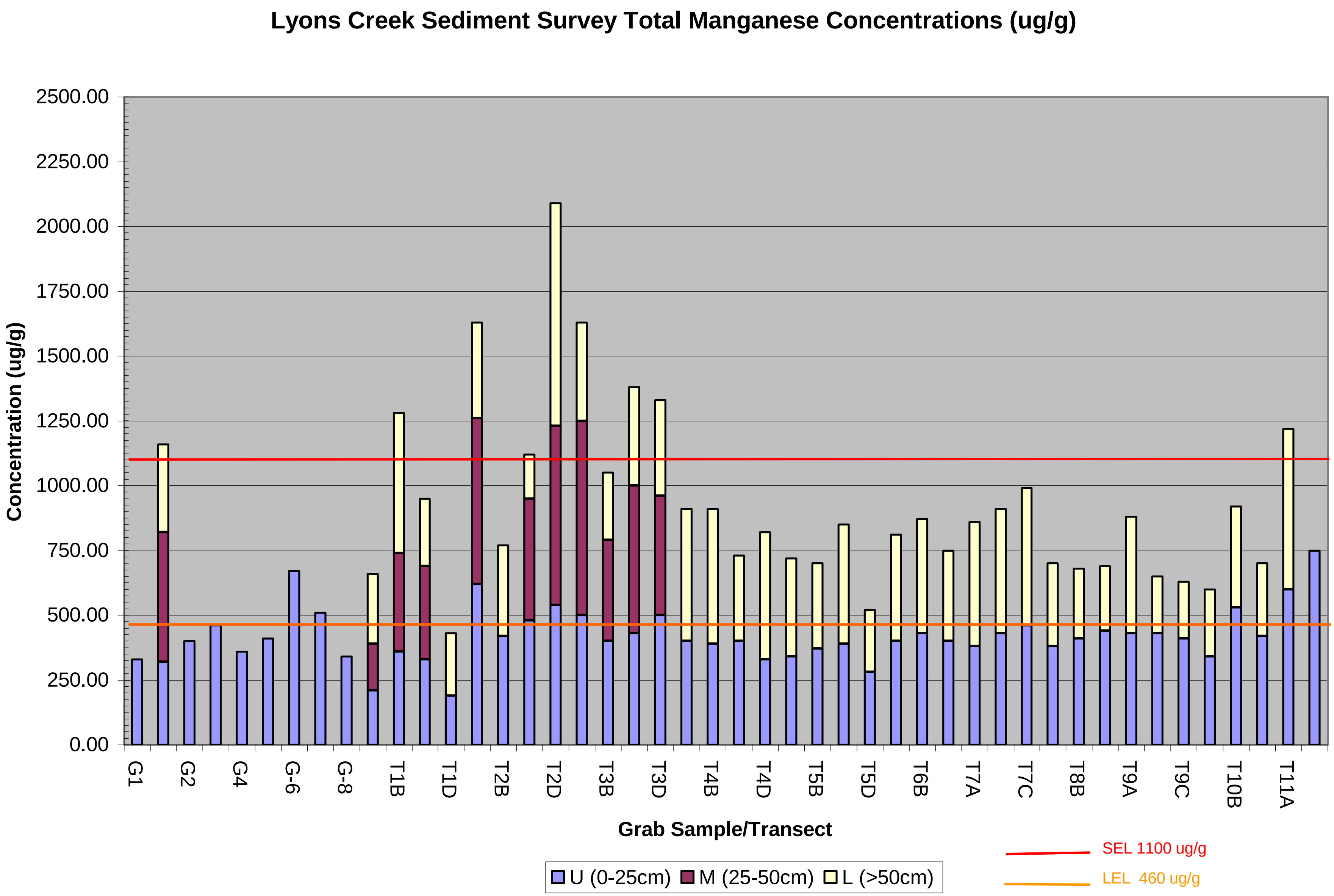
Lyons Creek Sediment Survey Total Zinc Concentrations (ug/g)
Concentration (ug/g)
15000.00
14000.00
13000.00
12000.00
11000.00
10000.00
9000.00
8000.00
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 820 ug/g
LEL 120 ug/g



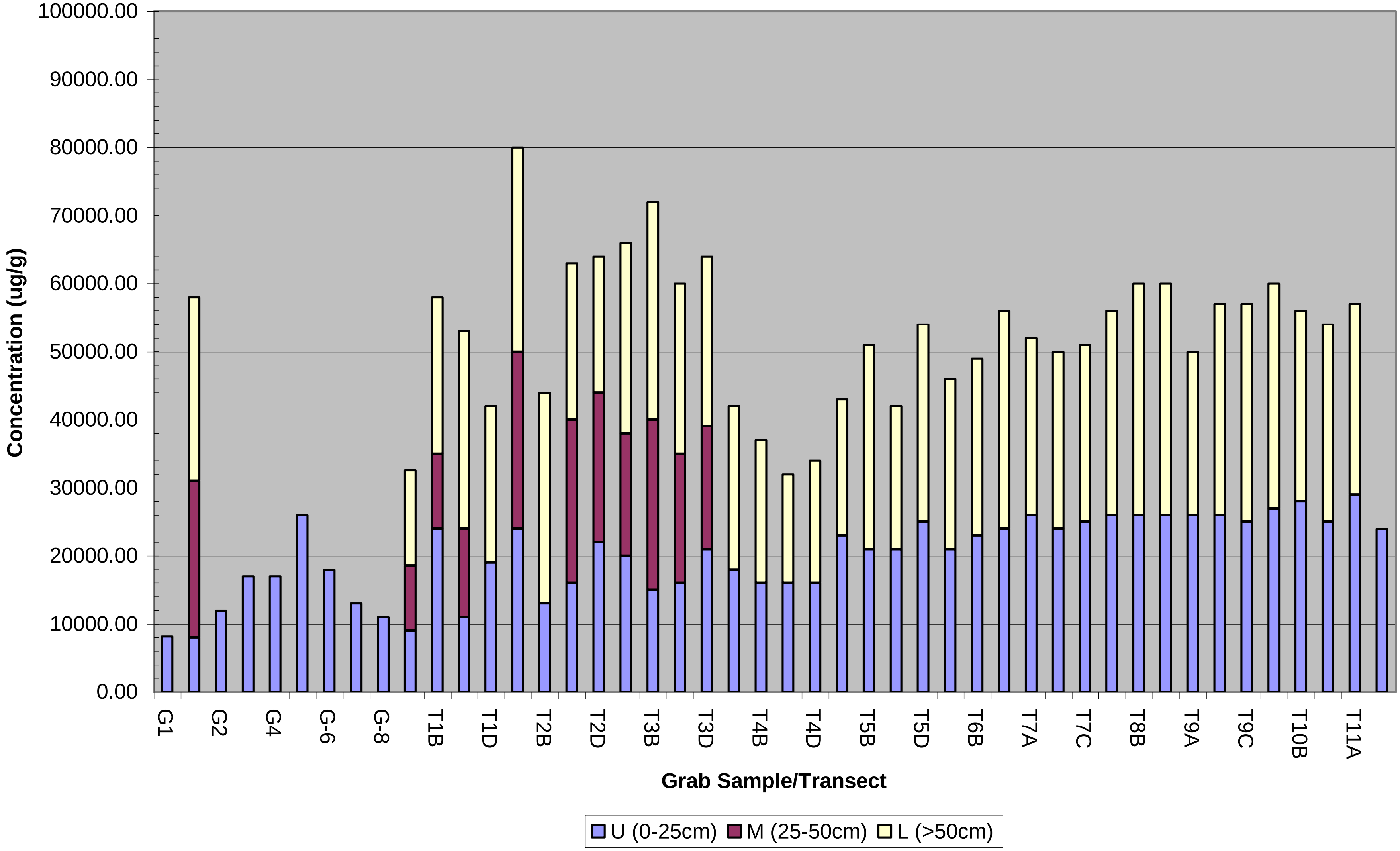
Lyons Creek Sediment Survey Total Iron Concentrations (ug/g)
Concentration (ug/g)
200000.00
175000.00
150000.00
125000.00
100000.00
75000.00
50000.00
25000.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 4 ug/g
LEL 2 ug/g

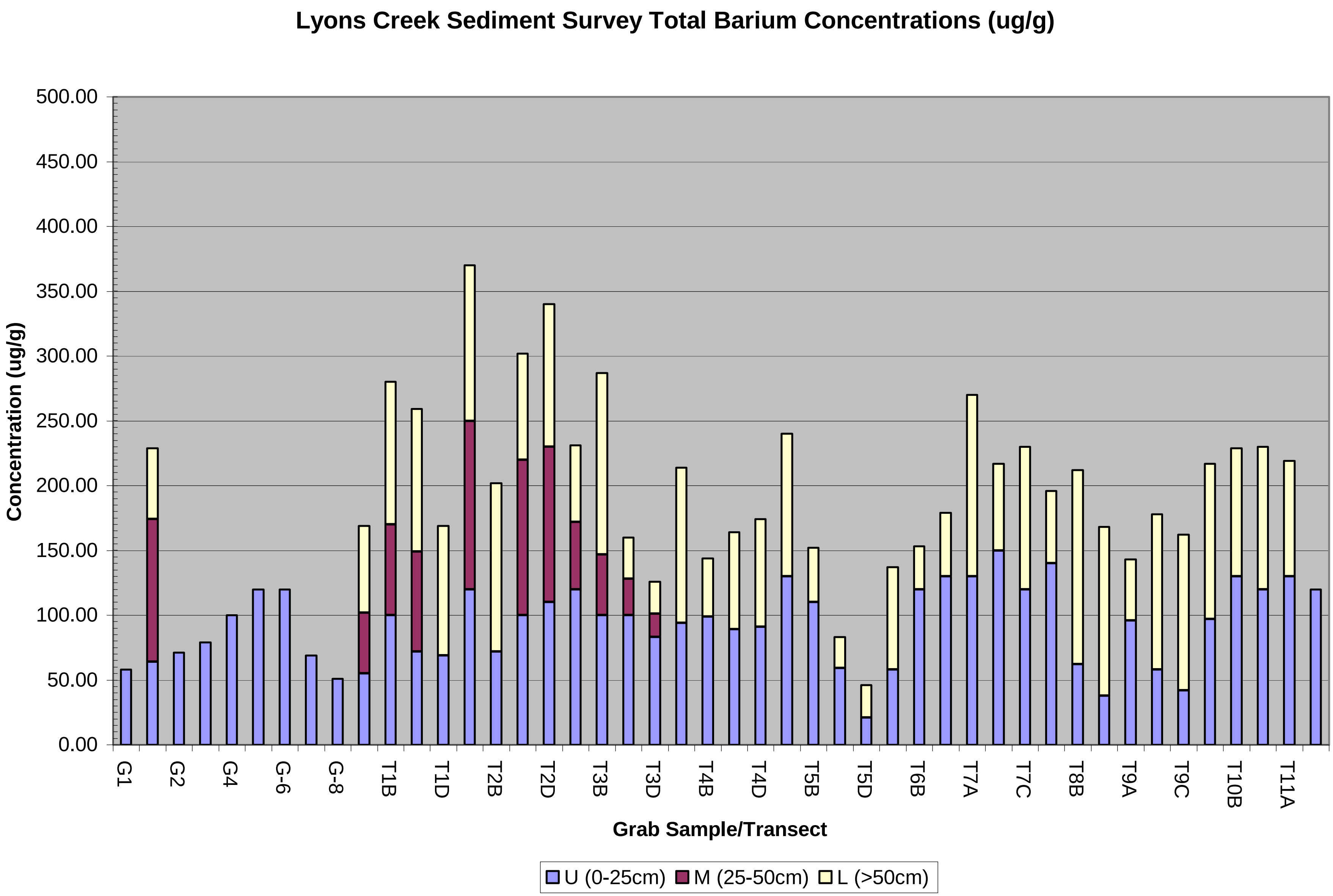


Lyons Creek Sediment Survey Total Iron Concentrations (ug/g)
Concentration (ug/g)
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 4 ug/g
LEL 2 ug/g

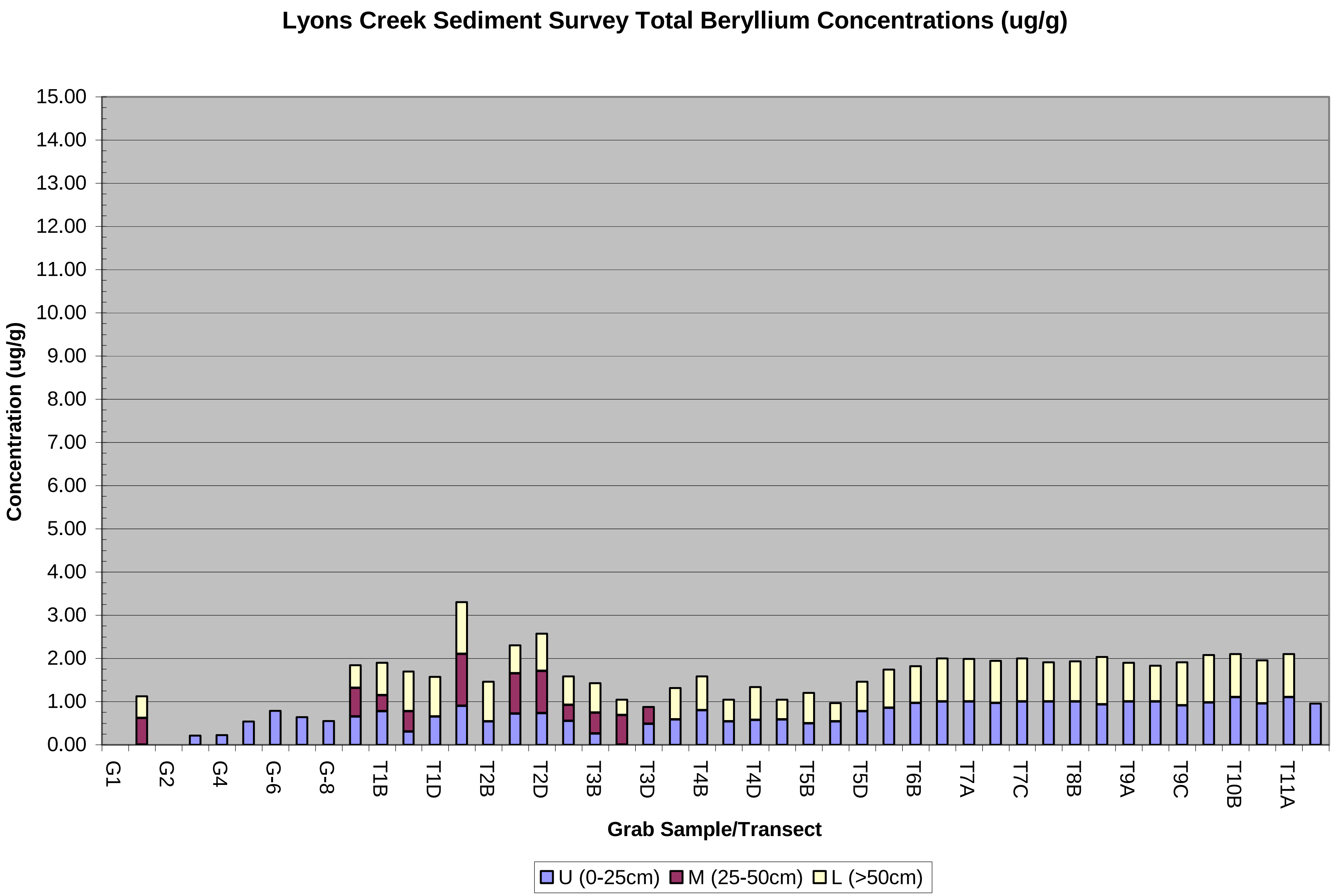

Lyons Creek Sediment Survey Total Manganese Concentrations (ug/g)
Concentration (ug/g)
2500.00
2250.00
2000.00
1750.00
1500.00
1250.00
1000.00
750.00
500.00
250.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 1100 ug/g
LEL 460 ug/g

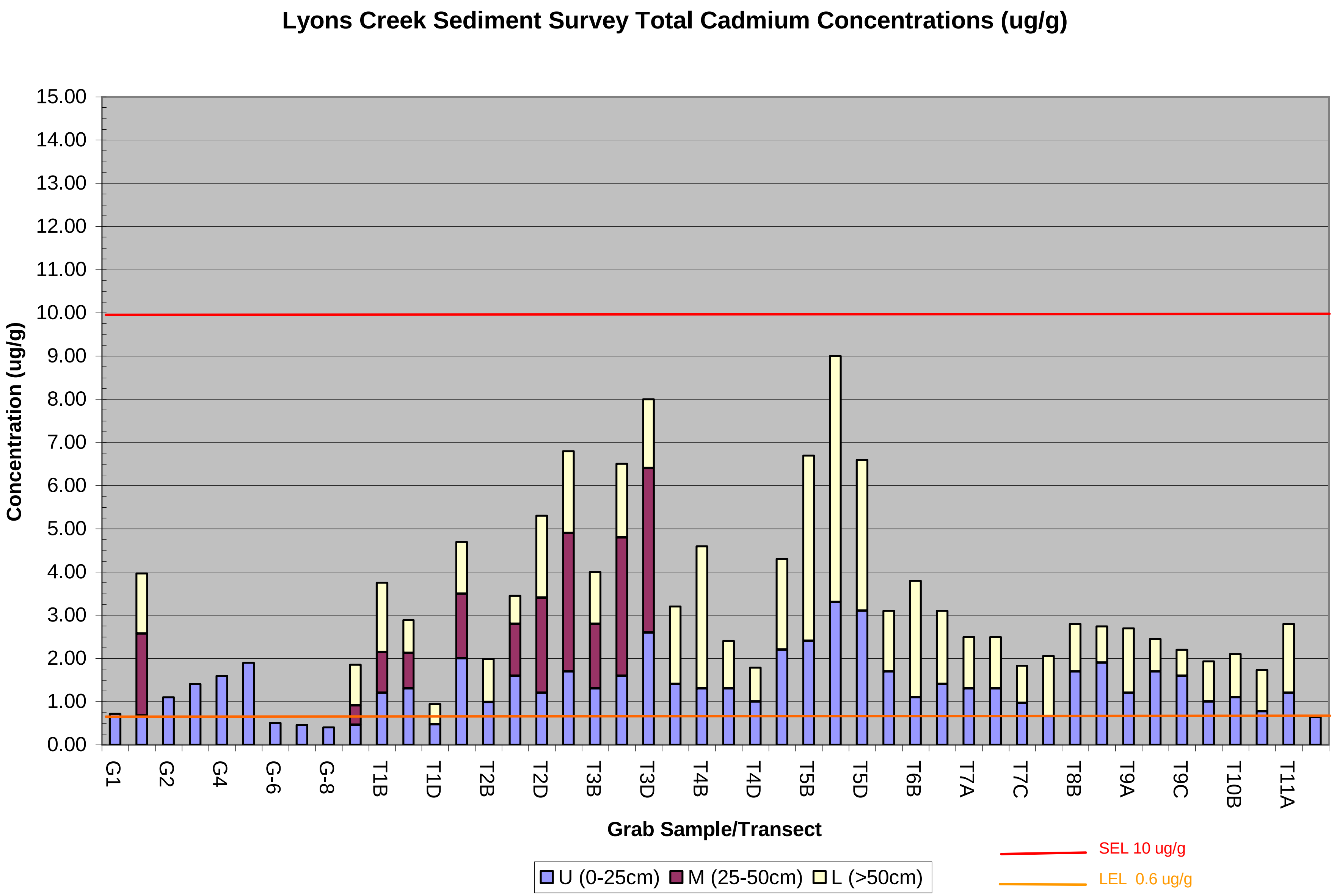
Lyons Creek Sediment Survey Total Aluminum Concentrations (ug/g)





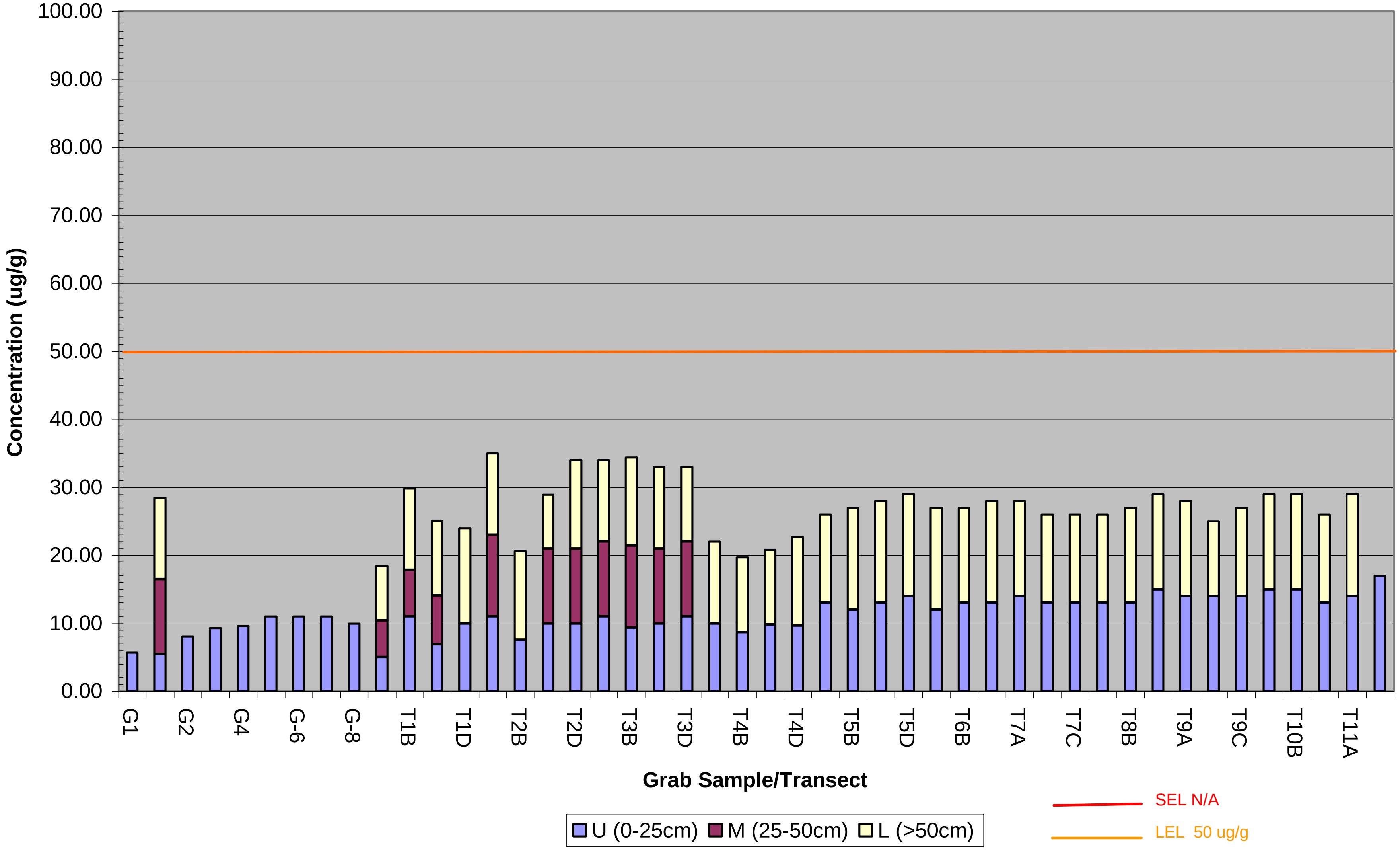
Lyons Creek Sediment Survey Total Barium Concentrations (ug/g)
Concentration (ug/g)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)

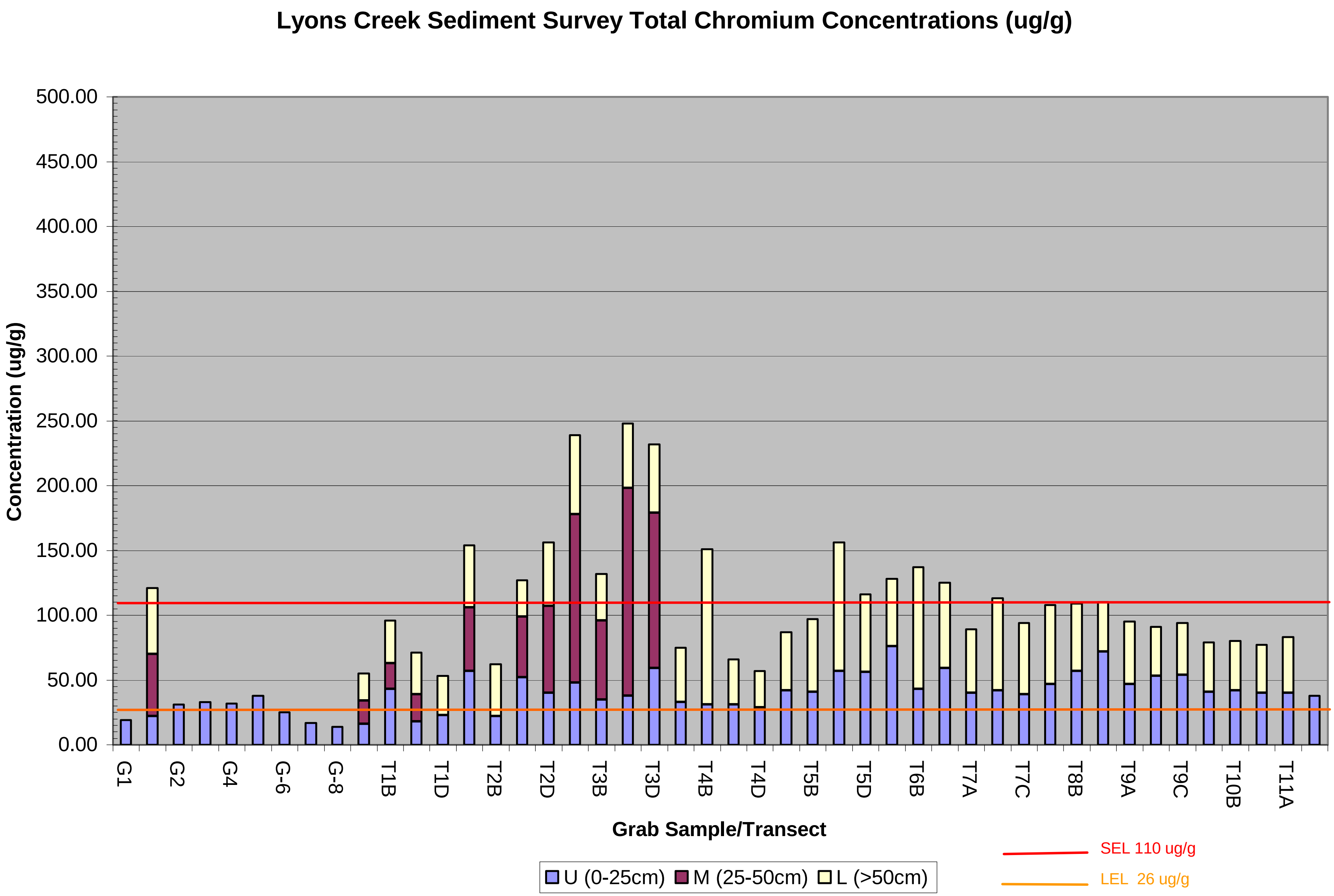

Lyons Creek Sediment Survey Total Beryllium Concentrations (ug/g)
Concentration (ug/g)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)



Lyons Creek Sediment Survey Total Cadmium Concentrations (ug/g)
Concentration (ug/g)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 10 ug/g
LEL 0.6 ug/g

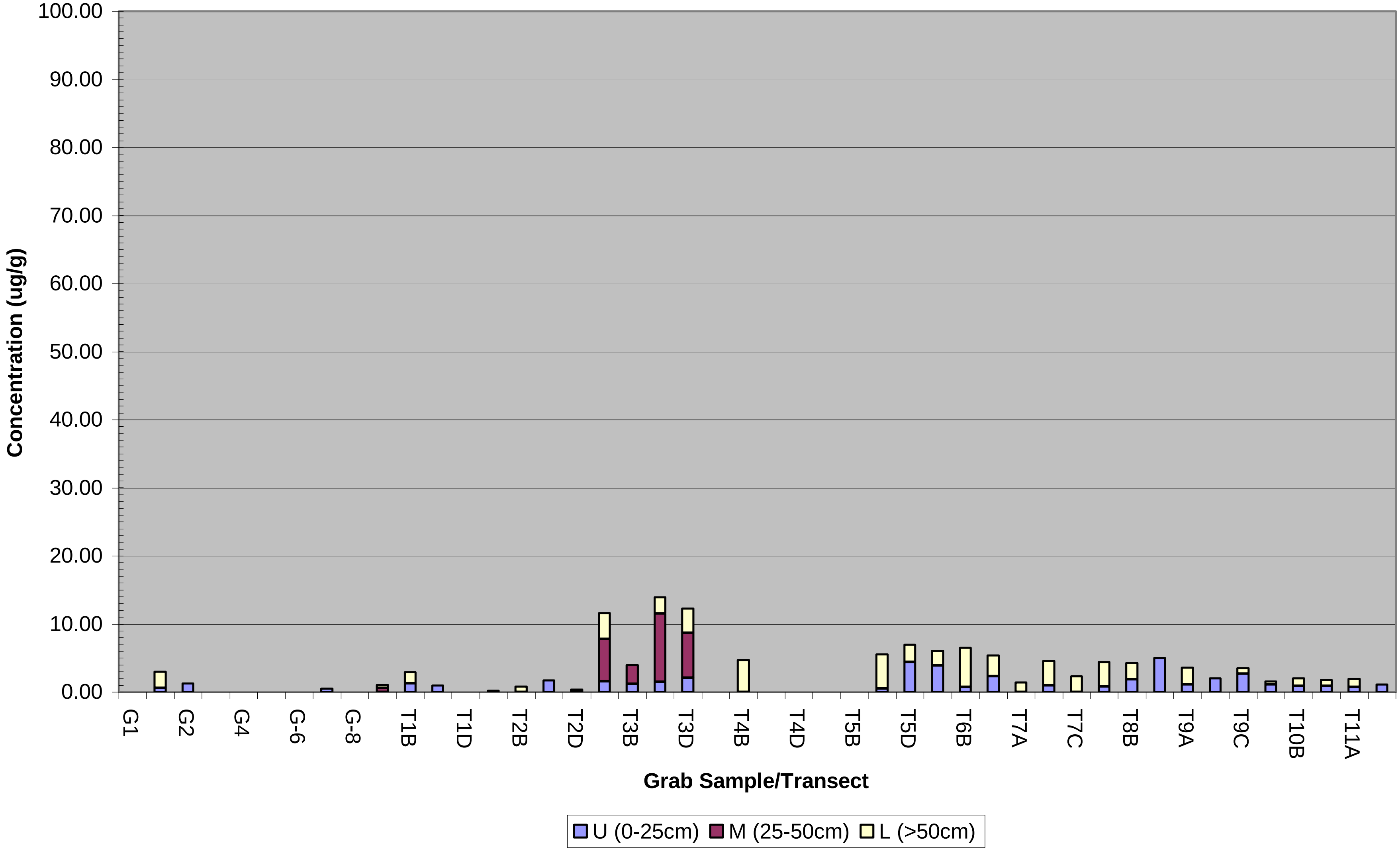
Lyons Creek Sediment Survey Total Cobalt Concentrations (ug/g)

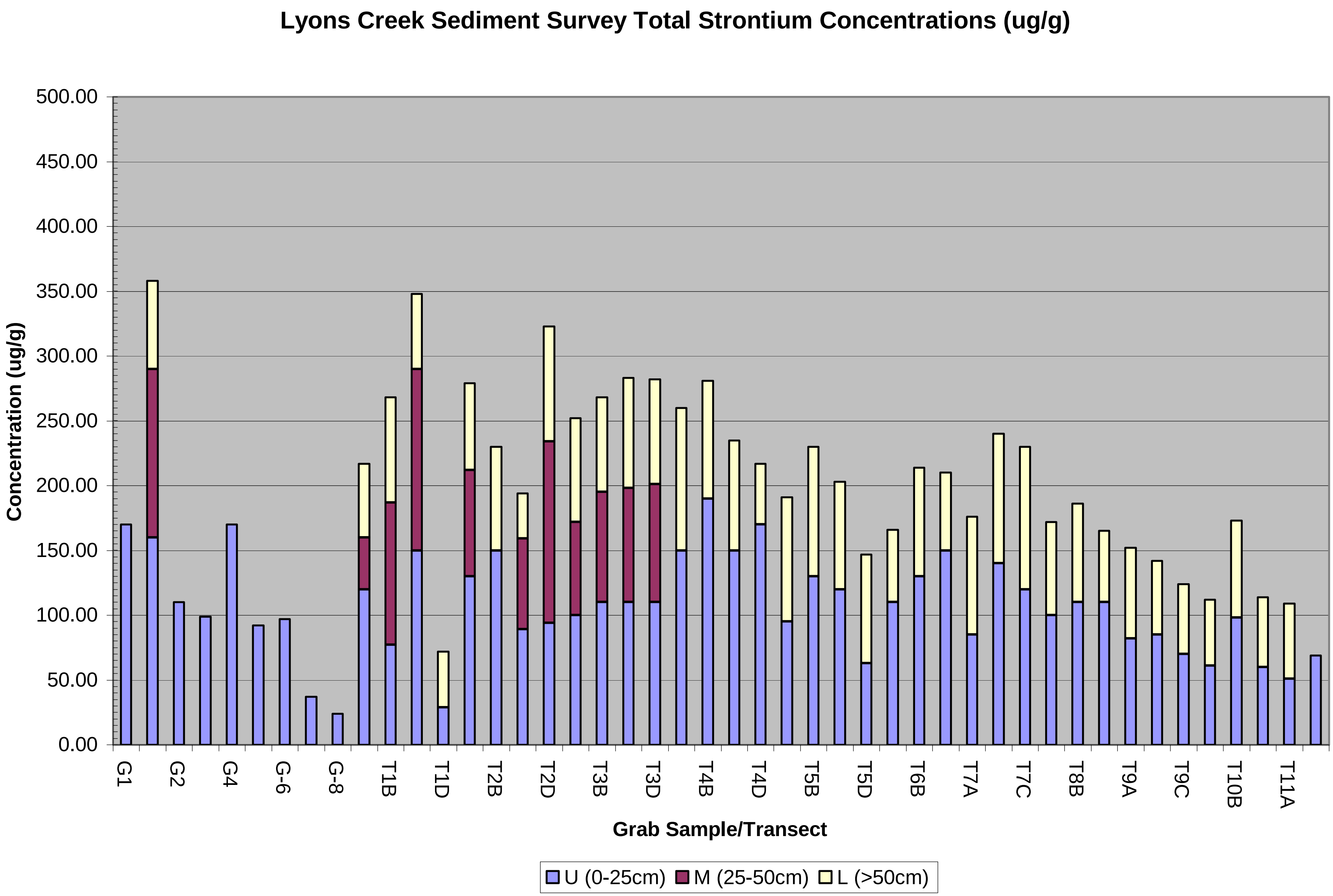




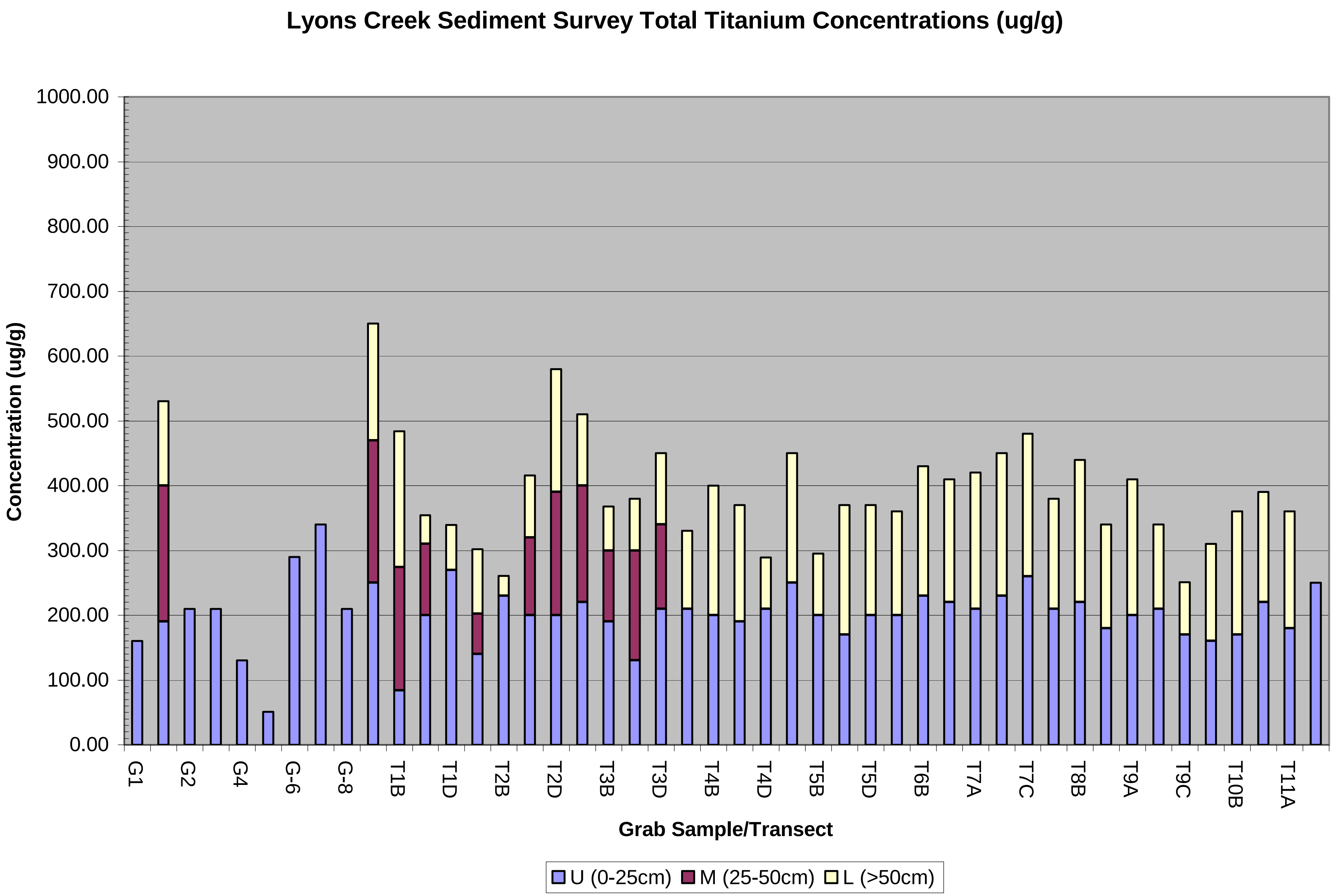
Lyons Creek Sediment Survey Total Chromium Concentrations (ug/g)
Concentration (ug/g)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)
SEL 110 ug/g
LEL 26 ug/g

Lyons Creek Sediment Survey Total Molybdenum Concentrations (ug/g)



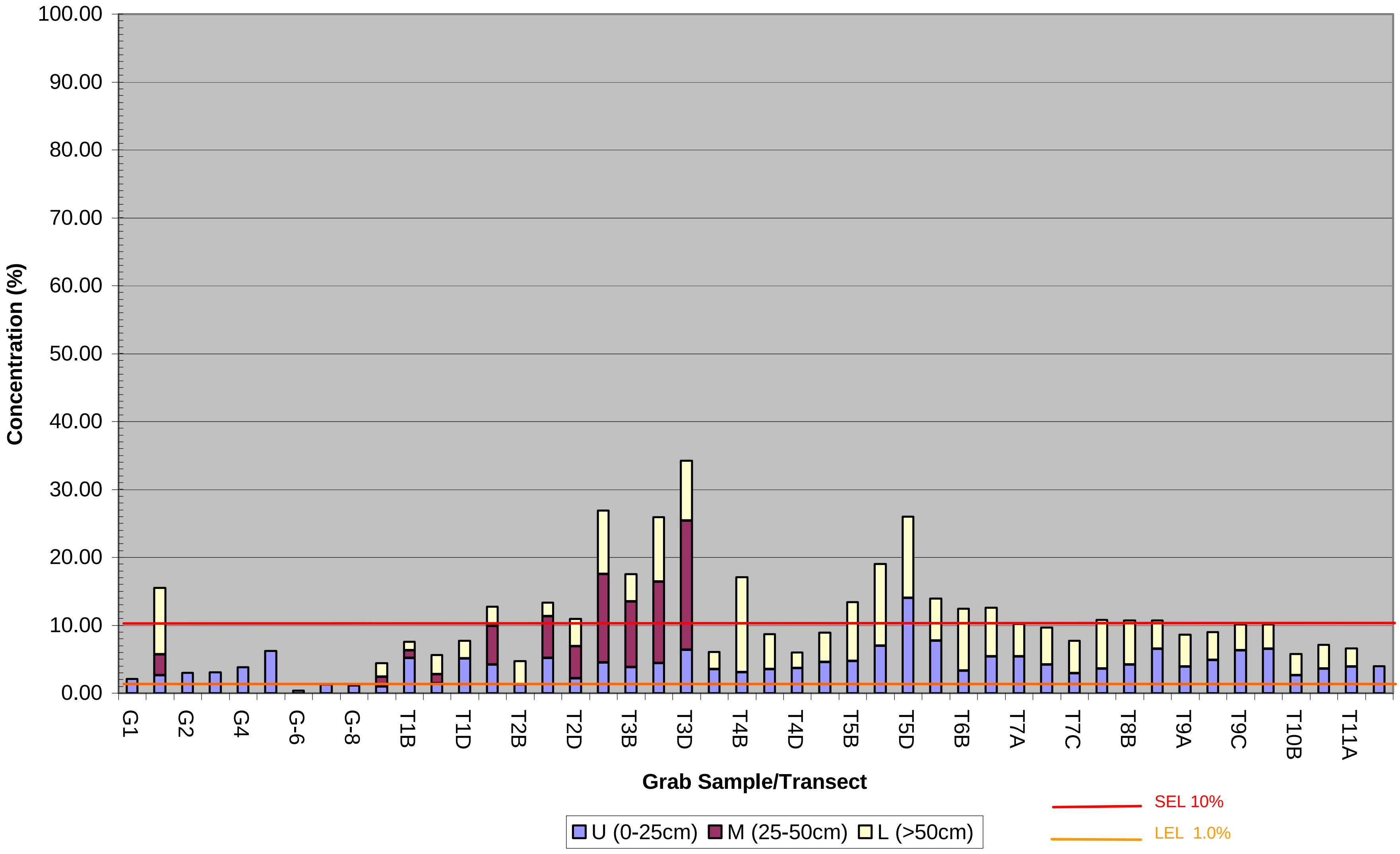


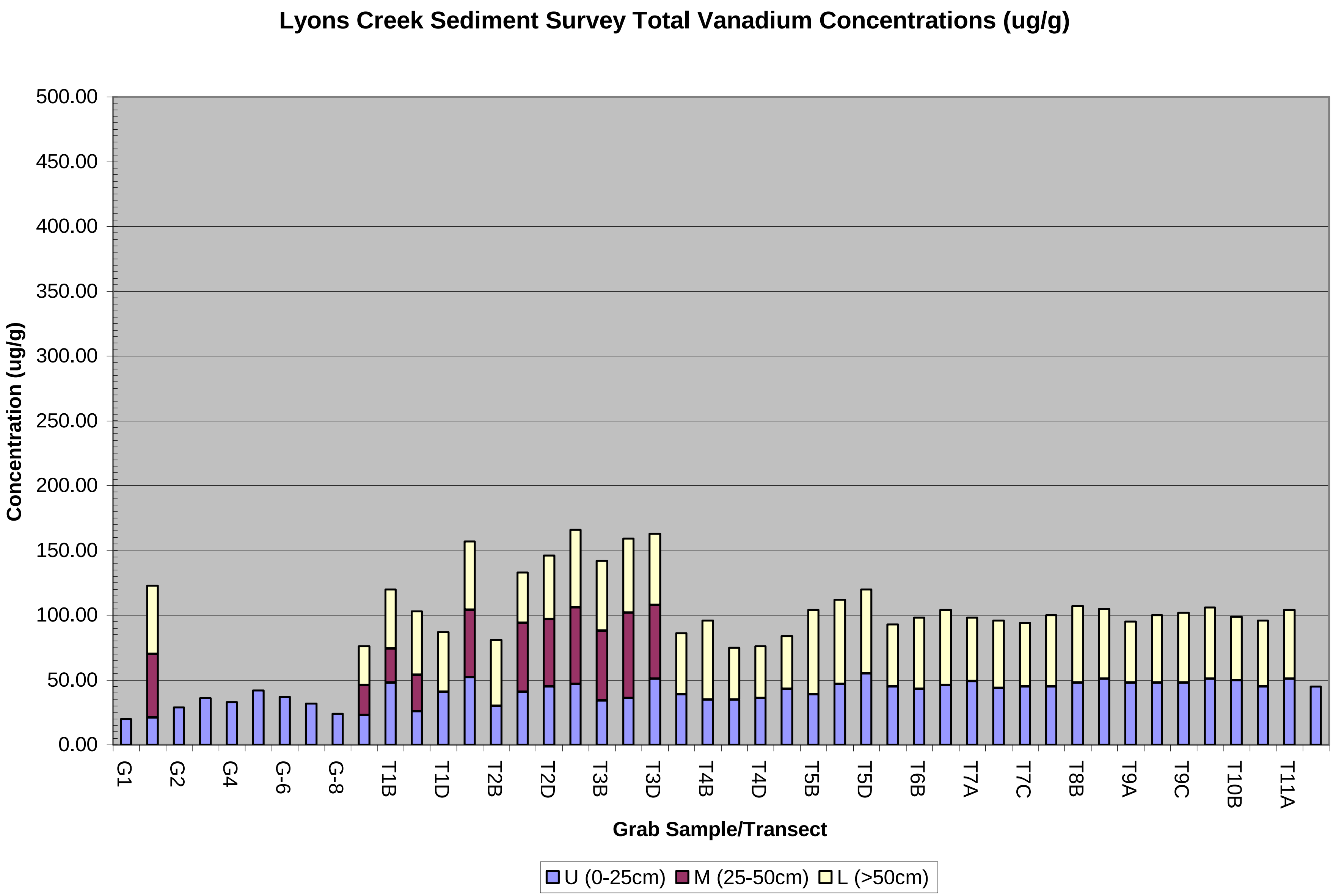
Lyons Creek Sediment Survey Total Strontium Concentrations (ug/g)
Concentration (ug/g)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)



Lyons Creek Sediment Survey Total Titanium Concentrations (ug/g)
Concentration (ug/g)
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)

Lyons Creek Sediment Survey Total Organic Carbon (TOC) Concentrations (%)





Lyons Creek Sediment Survey Total Vanadium Concentrations (ug/g)
Concentration (ug/g)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
G1
G2
G4
G-6
G-8
T1B
T1D
T2B
T2D
T3B
T3D
T4B
T4D
T5B
T5D
T6B
T7A
T7C
T8B
T9A
T9C
T10B
T11A
Grab Sample/Transect
U (0-25cm)
M (25-50cm)
L (>50cm)

Appendix F:
Juvenile Fish Monitoring

Juvenile Fish Monitoring

To identify areas of concern and monitor contaminant trends over time, the Ontario Ministry of Environment initiated a contaminant surveillance program using juvenile fish as biomonitors in 1975. This program's findings have been widely reported (e.g. Scheider *et al.* 1998).

A variety of organochlorine contaminants and metals are known to bioaccumulate in fish. Contaminates that are often undetectable in ambient water samples may be detected in young-of-the-year forage fish. Since these fish integrate spatial and temporal changes in water quality and in contaminant availability, body burdens provide a good basis for identifying contaminant sources and assessing environmental change.

For Great Lakes locations, a common forage fish, the spottail shiner (*Notropis hudsonius*), was selected as the principal biomonitor for assessing temporal trends in contaminant levels in near shore waters, determining the spatial extent of pollution, identifying sources of contamination and assessing the effectiveness of pollution control (Suns and Rees, 1978). Among the criteria used in selecting spottail shiners were its limited range in its first year of life, its undifferentiated food habits in early life stages, its importance as a forage fish (Scott and Crossman, 1973), and its presence throughout the Great Lakes. Forage fish also provide an important link in assessing contaminant transfer to higher trophic levels (e.g. fish-eating birds, mammals).

At inland locations, and sites where spottail shiners are not present, the preferred alternatives have been young-of-the-year or yearling yellow perch (*Perca flavescens*), emerald shiner *(Notropis atherinoides*), bluntnose minnow (*Pimephales notatus*) and fathead minnow *(Pimephales promelas*). Although the ranges of these species in the first year of life may be greater than a spottail shiner, results have been useful for assessing spatial and temporal trends in contaminants.

Guidelines used for assessing levels of PCBs in juvenile fish are the IJC Aquatic Life Guideline (IJC, 1988) and the NYSDEC Fish Flesh Criteria (Newell *et al.* 1987) both of which use a wildlife protection guideline of 100 ng/g for the protection of piscivorous wildlife. The greater the level above 100 ng/g, the greater the risk for piscivorous wildlife.

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