JERICHO DIAMOND PROJECT
2007 AQUATIC EFFECTS MONITORING PROGRAM REPORT

Prepared for

Tahera Diamond Corporation
Toronto, Ontario

By

Mainstream Aquatics Ltd.
6956 Roper Road
Edmonton, Alberta
T6B 3H9

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mainstream
AQUATICS LTD

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The individuals associated with Mainstream Aquatics Ltd. who participated in the study were as follows:

Rick Pattenden	Senior Biologist, Primary Author
Steph Neufeld	Project Biologist, Co-author
Chantal Pattenden	Senior Technician
Trish Boorman	Technician
Shaun Potvin	Technician
Jessica Parker	Technician
Todd Sherstone	Technician

Responsibilities during the 2007 Jericho Aquatic Effects Monitoring (AEM) Program were as follows:

Mainstream Aquatics Ltd.	- collection of zooplankton, phytoplankton, benthic macroinvertebrates, sediment, sediment deposition data, dissolved oxygen and temperature profiles - data analyses and reporting
Tahera Diamond Corporation	- collection of water chemistry samples - collection of winter dissolved oxygen profiles
ALS- Envirotest Laboratories (Edmonton AB)	- water chemistry analyses (nutrients)
Dave Beliveau	- phytoplankton identification, chlorophyll estimates - sediment deposition total weight and ashed weight
Emil Dratnal	- benthic macroinvertebrate identification and sorting
Barbara Dratnal	- zooplankton identification

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page #

1.0 INTRODUCTION

1.1 BACKGROUND

The Jericho Diamond Project was initiated in 1995 based on the discovery of a kimberlite pipe adjacent to the southern shore of an unnamed lake (locally known as Carat Lake). The Jericho Diamond Project has undergone environmental review by the Nunavut Impact Review Board (NIRB), which recommended that the Project be approved, subject to several terms and conditions. NIRB issued a Project Certificate on 20 July 2004, after receiving approval from the Minister of Indian and Northern Affairs. The conditions included development and implementation of a comprehensive environmental monitoring program, part of which included an Aquatic Effects Monitoring Plan (AEMP). The Nunavut Water Board (NWB) issued Water License NWBJER0410 on 22 December 2004 pursuant to DIAND Ministerial Approval which was received on 26 January 2005. The NWB adopted the NIRB recommendations regarding the AEMP.

General baseline studies of the aquatic environment in the Jericho study area have been ongoing since 1995. Structured pre-development monitoring studies occurred in 2004 and 2005. The Jericho Diamond Mine became fully operational in January 2006.

This document presents the majority of results of the 2007 Aquatic Effects Monitoring (AEM) Program; water chemistry is presented under separate cover. A detailed discussion of the rationale and design of the AEM Program is presented in Mainstream and AMEC (2005).

1.2 PURPOSE AND OBJECTIVES

The purpose of the 2007 AEM Program was to monitor the potential effects of the Jericho Diamond Project on the aquatic environment. The goals of the program were to:

- Protect the health and integrity of the aquatic environment.
- Confirm impact predictions.
- Ascertain whether mitigation measures are effective.
- Adjust mitigation where appropriate.

The primary objective of the 2007 Jericho AEM Program was to continue collections of data that describe selected components of the aquatic environment. Where appropriate, comparisons were made to historical baseline data (1995-2000), 2004, 2005, and 2006 data. Data for the fish community monitoring component are presented under separate document (Mainstream 2007).

1.3 STUDY AREA

The ore bearing deposit and mine infrastructure is located immediately south of Carat Lake (Figure 1.1). Potential contaminant sources that could affect the aquatic environment, the mode of transport, and the receiving waterbodies are listed in Table 1.1. The modes of transport are licensed discharge, surface runoff, and airborne dust. In general the constituents of concern are nutrients, contaminants, and sediments.

Licensed discharge from the Processed Kimberlite Containment Area (PKCA) is released into Lake C3 via Stream C3. Surface runoff and airborne contaminants have the potential to enter lakes and streams.

Table 1.1 Discharge sources, potential mode of entry, and receiving waterbodies, Jericho Diamond Project.

Source	Mode[a]	Receiving Waterbodies
• Discharge from PKCA	• Discharge	• Stream C3 and Lake C3
• Stream C1 Diversion	• Runoff[b]	• Stream C1 and Carat Lake
• Drainage ditch to Lake C4	• Runoff[b]	• Stream C4, Lake C4, and Carat Lake
• Waste rock dump	• Airborne	• Lynne Lake, Key Lake, Ash Lake

[a] Discharge - licensed discharge into receiving waterbodies; Runoff – surface runoff; Airborne - dust.
[b] Mine site runoff will be collected and directed to the PKCA for release.

Receiving waterbodies are placed into two groups based on location and flow direction. The Jericho River group is part of the Jericho River system, which flows in a northerly direction to the Kathawachaga River system situated approximately 15 km downstream of the Project. Waterbodies monitored in this group include Lake C1, Lake C3, Lake C4, Carat Lake, Jericho Lake, Jericho River, Stream C1, Stream C3, and Stream C4.

The Lynne Lake group consists of a series of small waterbodies and ephemeral watercourses situated immediately east and north of the Project, which drain into Contwoyto Lake. Waterbodies monitored in this group include Ash Lake, Key Lake, and Lynne Lake.

Two control lakes are incorporated in the AEM Program to provide data from nonaffected waterbodies. These include Control Lake located immediately upstream of Lake C3 and Cigar Lake located outside the watershed, 10 km west of the Project.

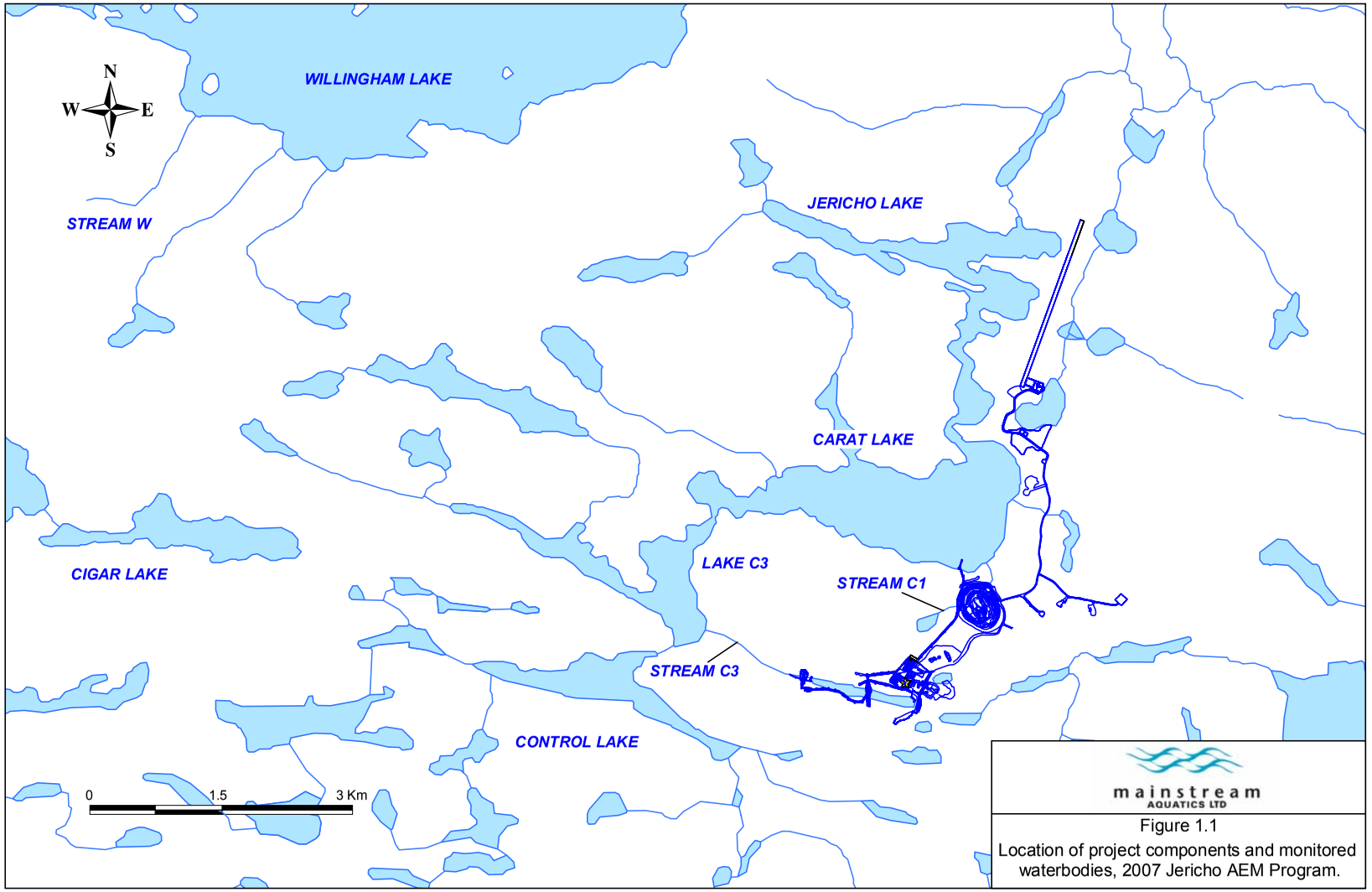

Figure 1.1
Location of project components and monitored waterbodies, 2007 Jericho AEM Program.

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2.0 DESIGN

Components monitored during the 2007 AEM Program were as follows:

- water chemistry
- sediment chemistry
- dissolved oxygen and temperature; secchi depth
- sediment deposition
- phytoplankton
- zooplankton
- benthic macroinvertebrates

2.1 WATER CHEMISTY

2.1.1 Parameters

Table 2.1 provides a list of water chemistry parameters that were analysed and the detection limits. Both total and dissolved metals were analysed.

Table 2.1 Water chemistry monitoring parameters and detection limits, 2007 Jericho AEM Program.

Water Quality Parameter	Detection Limits (mg/L or parameter units)
Physical Tests	
Conductivity (µS/cm) (field and lab)	2
Hardness ($CaCO_3$)	6
pH (field and lab)	0.01
Hydroxide	0.01
Total Suspended Solids	3
Total Dissolved Solids	10
Turbidity (NTU)	1
Temperature (°C)	1
Dissolved Anions	
Alkalinity-Total $CaCO_3$	5
Acidity ($CaCO_3$)	1
Carbonate (CO_3)	1
Bicarbonate (HCO_3)	1
Chloride (Cl)	1
Sulphate (SO_4)	0.5

Table 2.1 Water chemistry monitoring parameters and detection limits, 2007 Jericho AEM Program.

Water Quality Parameter	Detection Limits (mg/L or parameter units)
Nutrients	
Nitrate (NO_3)	0.05
Nitrite (NO_2)	0.05
Ammonia (NH_3)	0.10
Total Dissolved Phosphorus	0.005
Total Phosphorus	0.050
Orthophosphate	0.2
Total & Dissolved Metals	
Aluminum (Al)	0.02
Arsenic (As)	0.0004
Barium (Ba)	0.0005
Beryllium (Be)	0.0005
Boron (B)	0.01
Cadmium (Cd)	0.0001
Calcium (Ca)	0.05
Chromium (Cr)	0.0009
Cobalt (Co)	0.0001
Copper (Cu)	0.001
Iron (Fe)	0.03
Lead (Pb)	0.0001
Magnesium (Mg)	0.05
Manganese (Mn)	0.01
Mercury (Hg)	0.0001
Molybdenum (Mo)	0.0005
Nickel (Ni)	0.0006
Potassium (K)	0.5
Selenium (Se)	0.0008
Sodium (Na)	0.5
Strontium (Sr)	0.0001
Uranium (U)	0.00005
Vanadium (Va)	0.0001
Zinc (Zn)	0.002
Organic Parameters	
Total Organic Carbon (TOC)	0.01
Total Inorganic Carbon (TIC)[a]	1
Biological Parameters	
Biological Oxygen Demand (BOD) [a]	
Fecal Coliform[a]	

[a] Parameters added to the original Aquatic Effects Monitoring Plan parameters as per NWB conditions.

Parameters measured in the field for each station were as follows:

- Sampler's name
- Station number
- Single or replicate samples
- Date and time
- Type and number of sample bottles filled
- pH
- Water temperature
- Conductivity
- Dissolved oxygen

All information was kept in a field log book and data entered into a water quality database.

2.1.2 Stations and Locations

A list of water chemistry monitoring stations and locations, as well as the purpose for monitoring is presented in Table 2.2. Figure 2.1 depicts locations of water chemistry monitoring stations.

Table 2.2 Water chemistry monitoring stations and purpose, 2007 Jericho AEM Program.

Station	Location	Purpose
JER-WQ1	Freshwater Intake	Monitor potable water quality
JER-WQ2	PKCA Discharge	Compliance with water license
JER-WQ3	Stream C3 above Mouth	Near field PKCA discharge
JER-WQ4	Lake C3 South Basin	Near field PKCA discharge
JER-WQ5	Lake C3 Outlet	Far field PKCA discharge
JER-WQ6	Carat Lake Centre Basin	Near field; near mine, non-discharge effects[a]
JER-WQ7	Carat Lake Outlet	Far field; near mine, non-discharge effects
JER-WQ8	Jericho Lake North Basin	Far field
JER-WQ9	Jericho River Downstream of Jericho Lake	Far field on IOL
JER-WQ10	Control Lake	Upstream control
JER-WQ11	Cigar Lake (2nd Control)	Outside basin control
JER-WQ12	Stream C1 above Mouth	Near mine, non-discharge effects
JER-WQ13	Lake C1	Near mine, non-discharge effects
JER-WQ14	Lake C4	Near mine, non-discharge effects
JER-WQ15	Stream C4 above Mouth	Near mine, non-discharge effects
JER-WQ16	Lynne Lake	Near mine, non-discharge effects
JER-WQ17	Key Lake	Near mine, non-discharge effects
JER-WQ18	Ash Lake	Near mine, non-discharge effects
JER-WQ19[b]	Stream C1 outlet in Carat Lake	Near field; near mine discharge
JER-WQ20[b]	Stream C3 outlet in Lake C3	Near field PKCA discharge
JER-WQ21[c]	Stream C6 inlet to Carat Lake	Upstream control stream.

[a] Non-discharge includes surface runoff, accidental spill, and airborne dust.

[b] Not sampled in 2007.

[c] Added to program in 2007.

2.1.3 Frequency and Replication

Table 2.3 lists the water chemistry monitoring frequency at each station. A single replicate was collected from each station during each sampling event.

Table 2.3 Water chemistry frequency of sampling dates, 2007 Jericho AEM Program.

Station	Location	Frequency Class	2007 Sampling Dates
JER-WQ1	Carat Lake Freshwater Intake	M2	July, August
JER-WQ2	PKCA Discharge	W, M2	June (2), July (3), August (4)
JER-WQ3	Stream C3 Upstream of Lake C3	M2	June, July
JER-WQ4	Lake C3 South Basin	M1	July
JER-WQ5	Lake C3 Outlet	M2	June, July
JER-WQ6	Carat Lake Centre Basin	M1	July
JER-WQ7	Carat Lake Outlet	M2	June, July
JER-WQ8	Jericho Lake North Basin	M1	July
JER-WQ9	Jericho River Downstream of Jericho Lake	M1	July
JER-WQ10	Control Lake	M1	July
JER-WQ11	Cigar Lake (2nd Control)	M1	July
JER-WQ12	Stream C1 Upstream of Carat Lake	M2	June, July, August
JER-WQ13	Lake C1	M1	July
JER-WQ14	Lake C4	M2	July
JER-WQ15	Stream C4 Upstream of Carat Lake	M2	June, July
JER-WQ16	Lynne Lake	A2	July, August
JER-WQ17	Key Lake	A2	July
JER-WQ18	Ash Lake	A2	July, August
JER-WQ19	Stream C1 outlet in Carat lake	A2	-
JER-WQ20	Stream C3 outlet in Lake C3	A2	-
JER-WQ21	Stream C6 inlet to Carat Lake	M2	July, August (dry)

A1: Annual Once in Winter M1: Monthly: Mid-Apr, Jun, Jul, Aug, Sep, Mid-Dec W: Weekly
A2: Annual Once in Summer M2: Monthly: Jun, Jul, Aug, Sep D: Daily

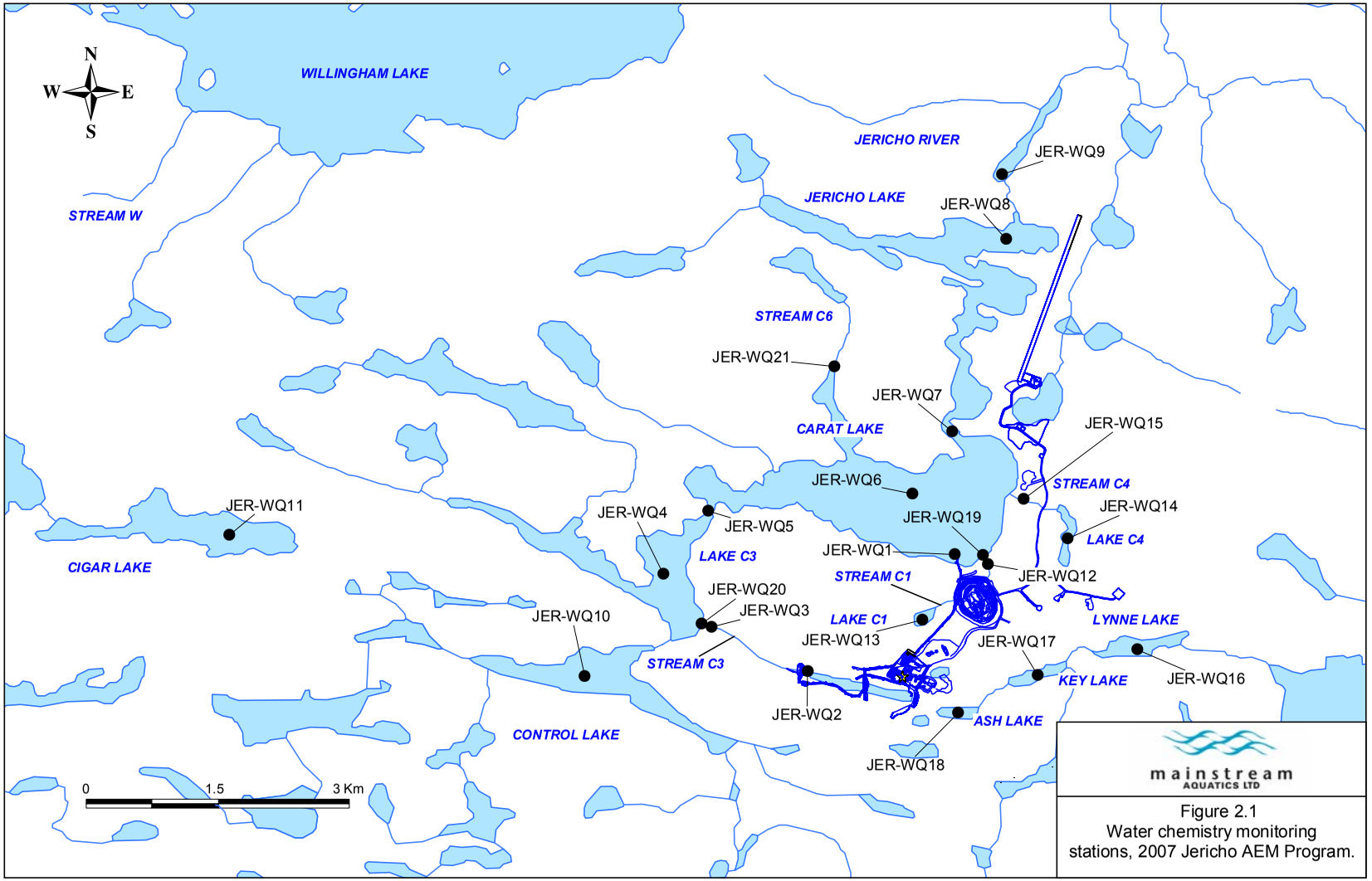


Figure 2.1
Water chemistry monitoring stations, 2007 Jericho AEM Program.

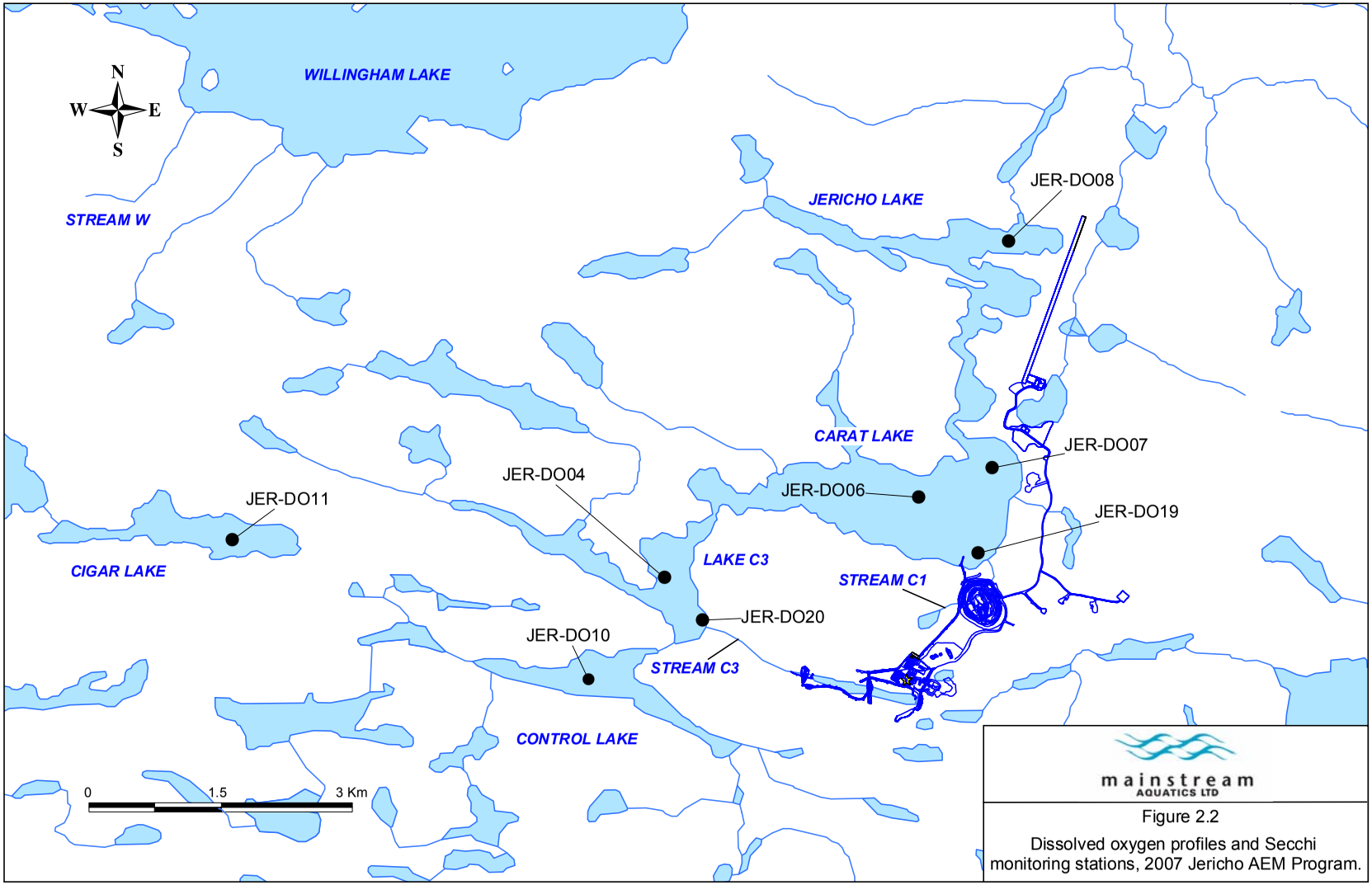


Figure 2.2

Dissolved oxygen profiles and Secchi monitoring stations, 2007 Jericho AEM Program.

2.2.3. Frequency and Replication

Data were collected once during the summer sampling period.

2.3 SEDIMENT DEPOSITION

2.3.1 Parameters

Parameters investigated included weight of sediment deposited and sediment deposition rate.

2.3.2 Stations and Locations

A list of sediment deposition monitoring stations and locations, as well as the purpose for monitoring are presented in Table 2.4 and illustrated in Figure 2.3.

Table 2.4 Sediment deposition monitoring stations and locations, purpose, and sample dates, 2007 Jericho AEM Program.

Station	Location	Purpose	Dates	
			Set	Retrieve
JER-SD23	Control Lake	Upstream control	03-Aug-06	28-Jul-07
JER-SD25	Cigar Lake	Outside basin control	04-Aug-06	27-Jul-07
JER-SD20	Lake C3 at Stream C3	Near-field; PKCA discharge	27-Jul-06	30-July-07
JER-SD05	Lake C3 outlet	Far-field; PKCA discharge	27-Jul-06	30-Jul-07
JER-SD19	Carat Lake at Stream C1	Near-field; Stream C1 discharge	24-Jul-06	02-Aug-07
JER-SD21	Carat Lake west of causeway	Near-field; causeway effects	26-Jul-06	02-Aug-07
JER-SD22	Carat Lake east of causeway	Near-field; causeway effects	24-Jul-06	02-Aug-07
JER-SD07	Carat Lake outlet	Far-field; Stream C1 discharge	24-Jul-06	02-Aug-07
JER-SD26	Jericho Lake	Far-field	05-Aug-06	29-Jul-07

2.3.3 Frequency and Replication

One sediment deposition sample was collected from each station in summer 2007 and the traps reset. Set and retrieval dates for the 2007 results are presented in Table 2.4

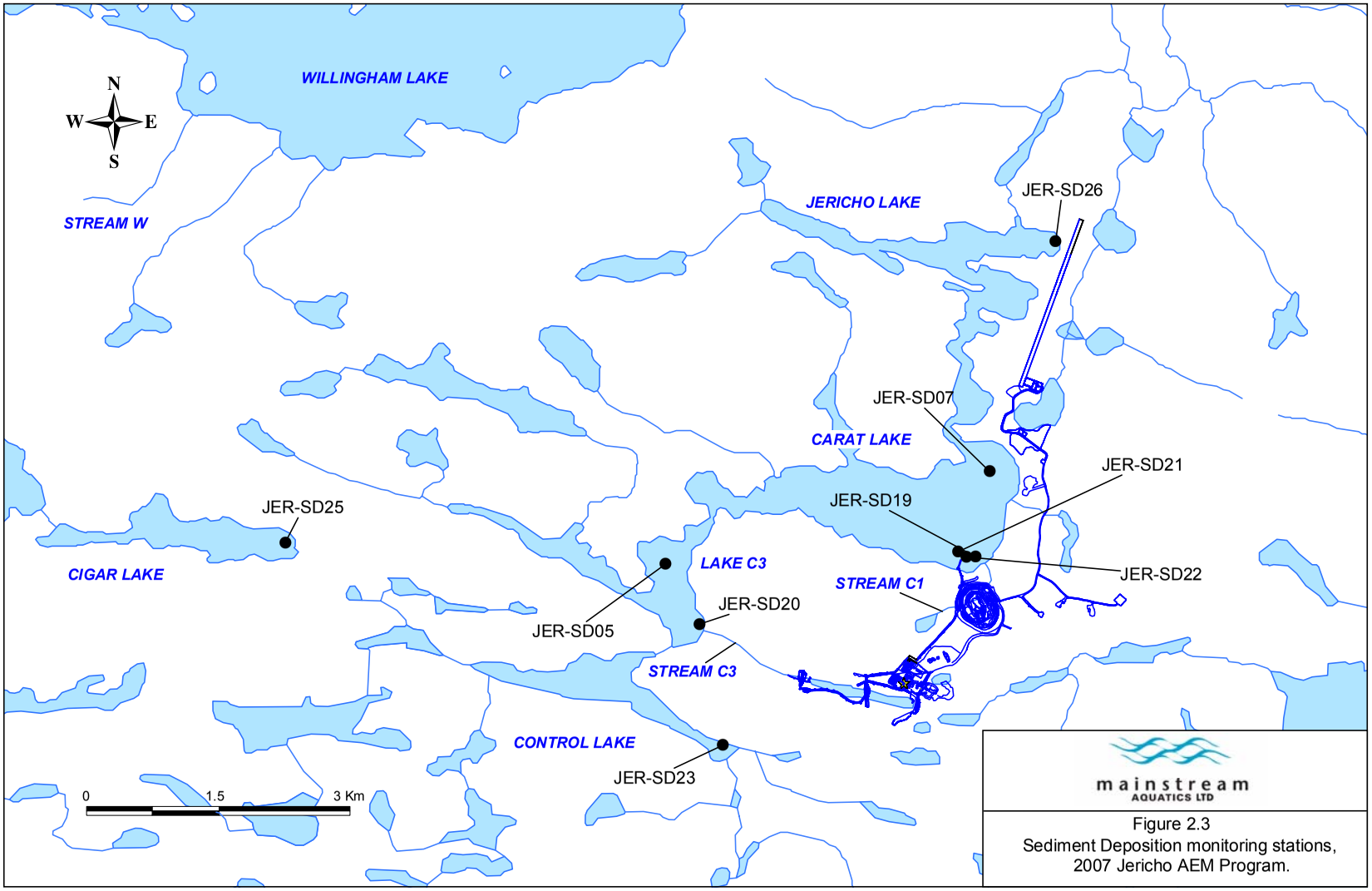


Figure 2.3
Sediment Deposition monitoring stations,
2007 Jericho AEM Program.

2.4 NONVERTEBRATE AQUATIC BIOTA

2.4.1 Parameters

Parameters monitored for aquatic biota are listed in Table 2.5.

Table 2.5 Monitored indicators and parameters, 2007 Jericho AEM Program.

Indicator	Parameter
Phytoplankton	Taxa richness; taxa diversity; density; biovolume; biovolume index (Chl. *a*)
Zooplankton	Taxa richness; taxa diversity; density; biomass
Benthic macroinvertebrates	Taxa richness; taxa diversity; density

2.4.2 Stations and Locations

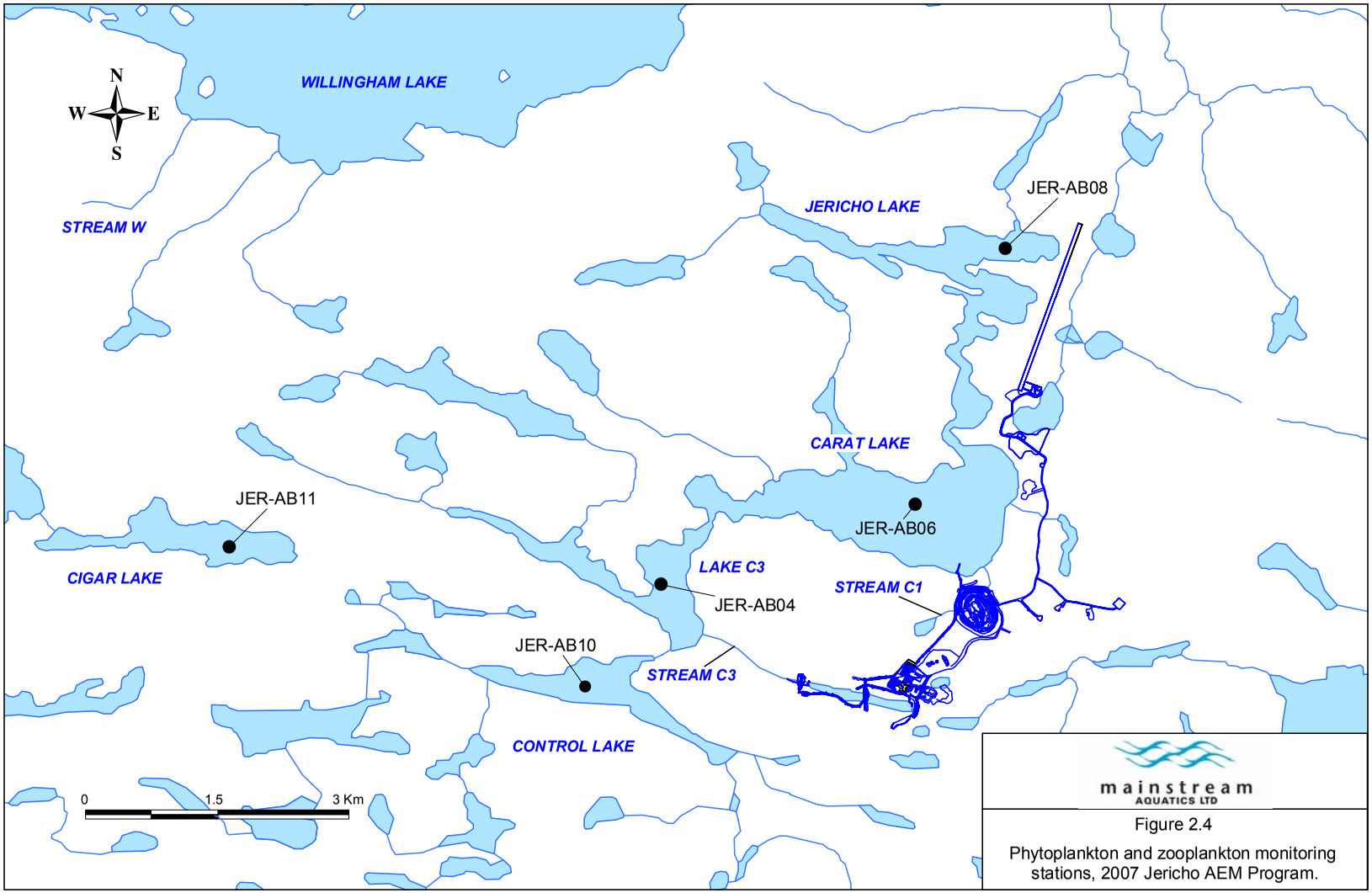
A list of aquatic biota monitoring stations and locations, as well as the purpose for monitoring is presented in Table 2.6 and illustrated in Figure 2.4 (phytoplankton and zooplankton) and Figure 2.5 (benthic macroinvertebrates).

Station location was based on the type of indicator monitored. These were sedentary indicators (benthic macroinvertebrates) and nonsedentary indicators (phytoplankton and zooplankton).

Table 2.6 Aquatic biota monitoring stations, locations, and purpose, 2007 Jericho AEM Program.

Station	Location	Phytoplankton	Zooplankton	Benthic Invertebrates	Purpose
JER-AB10	Control Lake	✓	✓		Upstream control
JER-AB23	Control Lake			✓	Upstream control
JER-AB11	Cigar Lake	✓	✓		Outside basin control
JER-AB25	Cigar Lake			✓	Outside basin control
JER-AB04	Lake C3 South Basin	✓	✓		Near-field; PKCA discharge
JER-AB20	Lake C3 at Stream C3			✓	Near-field; PKCA discharge
JER-AB05	Lake C3 outlet			✓	Far-field; PKCA discharge
JER-AB06	Carat Lake Center Basin	✓	✓		Near-field; Stream C1 discharge
JER-AB19	Carat Lake at Stream C1			✓	Near-field; Stream C1 discharge
JER-AB07	Carat Lake outlet			✓	Far-field; Stream C1 discharge
JER-AB08	Jericho Lake	✓	✓		Far field
JER-AB26	Jericho Lake			✓	Far field

Figure 2.4 Phytoplankton and zooplankton monitoring stations, 2006 Jericho AEM Program.



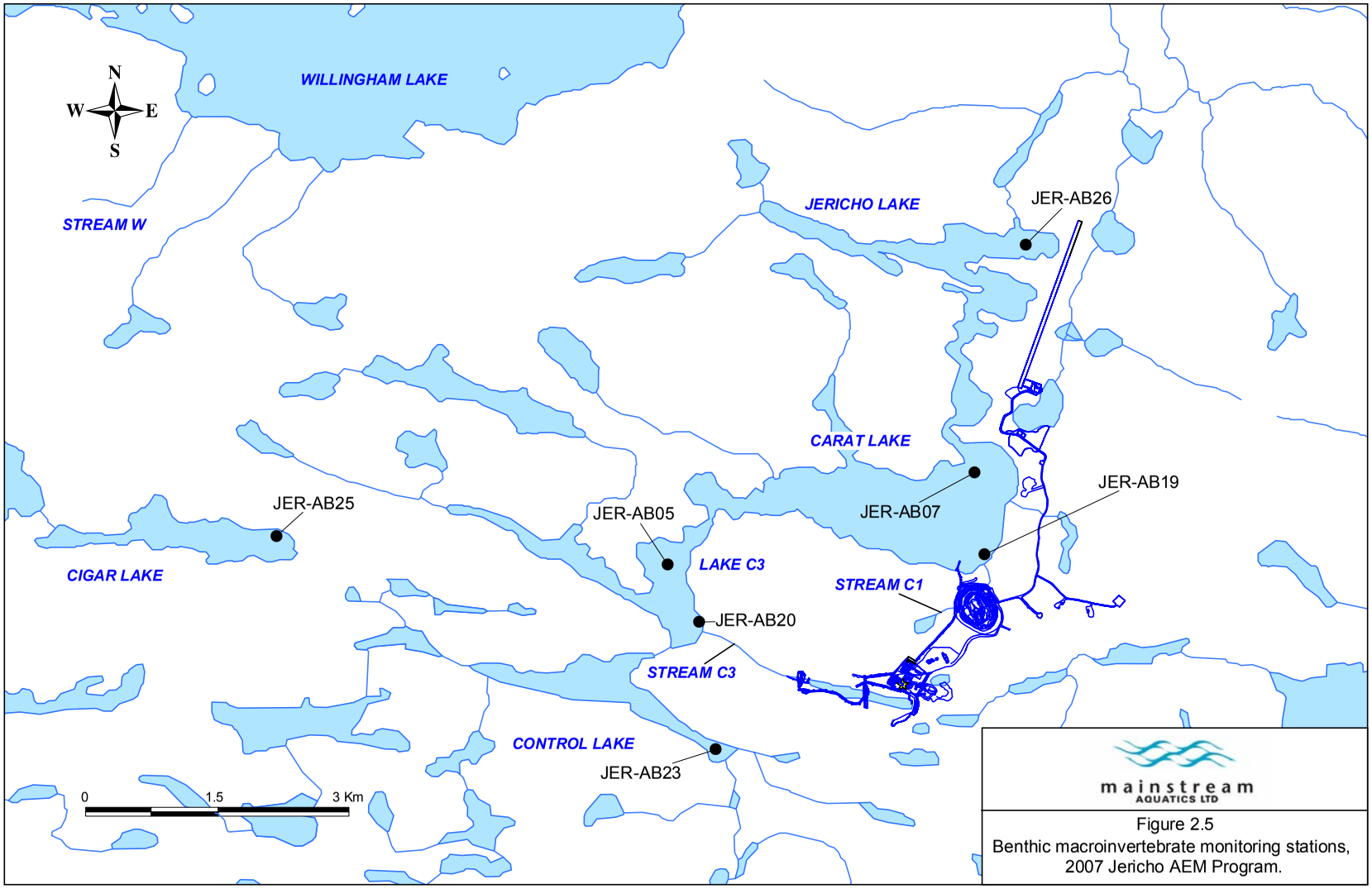


Figure 2.5
Benthic macroinvertebrate monitoring stations, 2007 Jericho AEM Program.

2.4.3 Frequency and Replication

The timing of sample collection and number of replicates are listed in Table 2.7.

Table 2.7 Sampling timing and replication for aquatic biota, 2007 Jericho AEM Program.

Indicator	Sample Timing	No. Replicates
Phytoplankton	26 to 30 July	7
Zooplankton	26 to 30 July	7
Benthic macroinvertebrates	5 to 9 July	5

3.0 METHODS

3.1 WATER CHEMISTRY

3.1.1 Field

Tahera Diamond Corporation was responsible for collection of water quality samples. The following description is based on AEM Program protocols (Mainstream 2005). Prior to sampling raw water, sample bottles were rinsed three times; pre-treated sample bottles were not rinsed. Water was collected using a Kemmerer sampler by immersing the sample bottle 1 m below the surface. During periods of ice cover (i.e., the April and December sampling periods), holes were drilled through the ice cover by a gas powered ice auger for the collection of grab water samples. Samples were collected approximately 1.0 m below the water surface exposed in the holes using a Kemmerer sampler. Rinsing of sample containers with in-situ water was impractical due to the cold weather; consequently, laboratory prepared sample containers were used. All samples were kept cool during storage and were air transported to the analytical laboratory. All filtering was done in the laboratory. Chain of custody forms were used to track samples.

3.1.2 Laboratory

General water parameters (physical parameters (e.g. pH, conductivity), dissolved anions, nutrients, and metals) were analyzed in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (United States Environmental Protection Agency 1983), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (British Columbia Ministry of the Environment), and/or "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association 1992).

Total and dissolved metals and organic parameter samples were analyzed in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association, 1992). Several methods were employed for metals analysis, including Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and Atomic Absorption Spectrophotometry (AA) to obtain the required detection limit for each element. Organic parameters were analyzed using a gas chromatograph - flame ionization detector (GC/FID). Mercury was analyzed by cold vapour AA.

3.2 LAKE PROFILE PARAMETERS

Dissolved oxygen concentration (± 0.1 mg/L) and water temperature (± 0.1 C°) were measured in the field using an Oxyguard Handy Beta dissolved oxygen-temperature meter. Depth profile measurements were collected at 1.0 m intervals. Water transparency was measured using a standard 20 cm diameter Secchi disk to the nearest 0.1 m.

3.3 SEDIMENT DEPOSITION

Methodology and analysis procedures generally followed those described in DDMI (2003).

3.3.1 Field

The design of the traps was similar to those described in the CRC Handbook of Techniques for Aquatic Sediments Sampling (Mudroch and MacKnift 1991). Sediment deposition traps consisted of a flotation and retrieval apparatus, a dacron rope, an anchor, and a 500 mL plastic sediment deposition collection bottle suspended in the water column (Figure 3.1). The bottle position and orientation was maintained by placing the bottle inside a PVC pipe (30.5 cm long x 10 cm diameter) that was secured to the rope.

Traps were located at stations having an approximate depth of 6 m (range 6.0 m to 6.3 m). The sediment deposition collection bottle was located 1.2 m above the lake bottom. The flotation and retrieval apparatus was positioned 2.5 m below the water surface to prevent disturbance from ice.

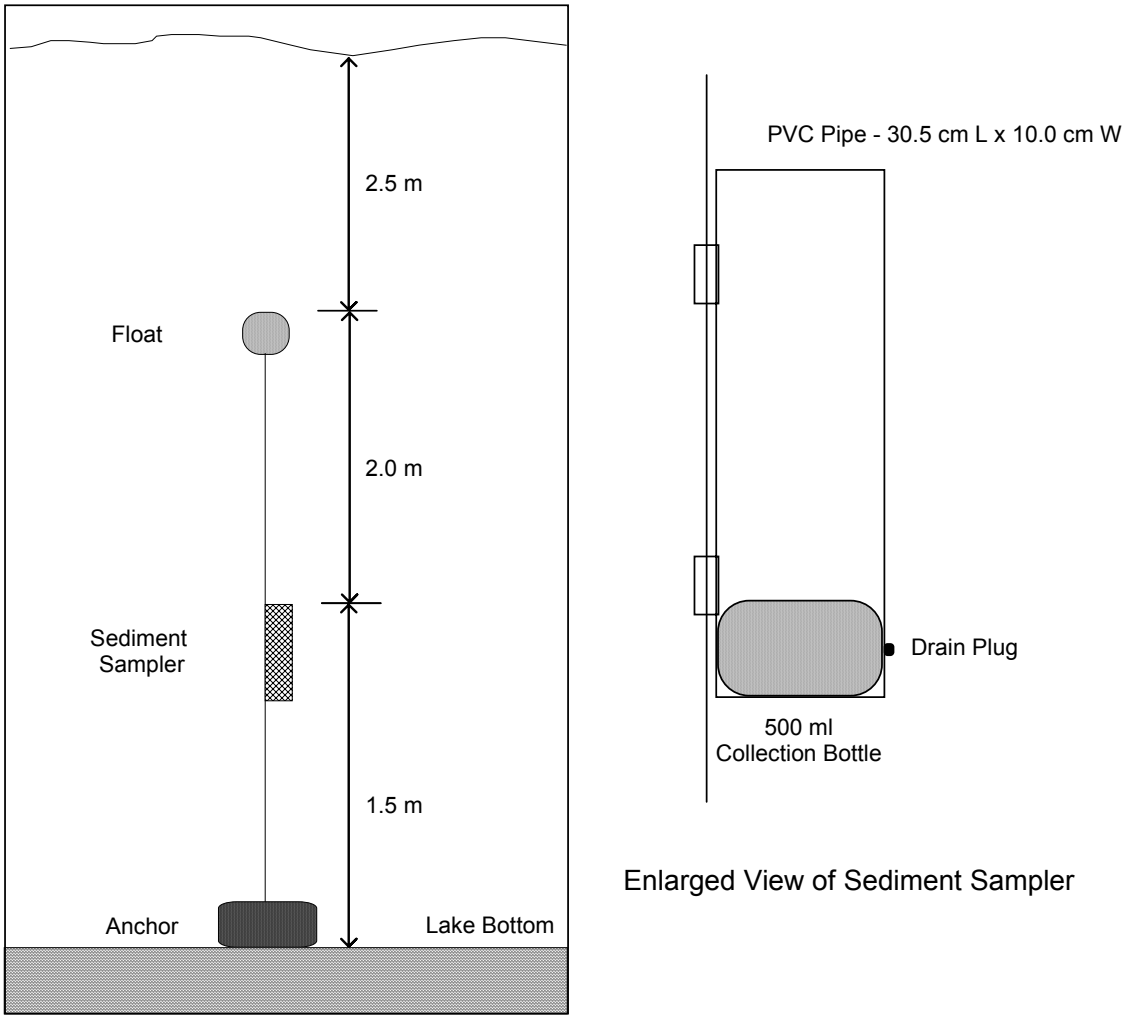


Figure 3.1 Sediment deposition traps used during the 2007 Jericho AEM Program.

Sediment deposition traps were set in July/August 2006 and left for a period of approximately one year before retrieval in 2007. Retrieval entailed gently lifting the trap until the PVC pipe reached the surface, releasing water within the pipe by removing the drain plug, and then securely capping the collection bottle before removal from the PVC pipe.

Water and sediment from the sediment deposition collection bottle were sent to the designated contractor for processing.

3.3.2 Laboratory

The sediment deposition sample was thoroughly mixed and then filtered onto pre-weighed #47 Gelman GF/AE filters (nominal pore size 1 micron recommended for testing dissolved and suspended solids in water as described in Standard Methods for the Examination of Water and Wastewater) utilizing a Millipore filter funnel and hand vacuum pump. The entire volume of each sample was filtered utilizing successive filters as required. Filters were air dried, folded inward (in half) and individually stored in numbered foil packs.

Once all samples were processed, filters were dried, weighed, and ashed as follows.

1. Oven dried for 24 hours at 105°C.
2. Weighed utilizing a Mettler M58A airlock/mechanical weight pan insertion balance (± 5 µg).
3. Ashed in a muffle furnace for one hour at 550°C, cooled and reweighed.

3.4 PHYTOPLANKTON

3.4.1 Field

Phytoplankton was collected following procedures described in Findlay and Kling (2003). Samples were collected from the water column within the euphotic zone, which was assumed to be a water depth equal to two times the Secchi depth. In lakes that were shallower than two times the Secchi depth, samples encompassed the entire water column to 1 m above the lake bottom to avoid contamination with sediment.

Each replicate consisted of a composite of five samples from the euphotic zone collected using an integrated sampler. The integrated sampler consisted of a weighted 3 cm diameter polyethylene tube. The tube was gently lowered vertically into the water column and the top capped off before being lifted out of the water and drained into a bucket. The composite sample in the bucket was thoroughly mixed and a 970 mL volume subsample collected as a replicate. The process was repeated for each replicate.

Each replicate was placed in pre-labeled 1000 mL container and preserved with a combination acid-Lugol's solution (0.5% by volume; 10 mL) and a formaldehyde acetic acid solution (2% by volume; 20 mL). All replicates were stored in the dark.

Replicates destined specifically for chlorophyll *a* analysis were collected separately. A pre-determined 300 mL volume of subsample from the mixed compostation sample was filtered onto Whatman GF/C filter paper, covered with anhydrous $MgCO_3$, and frozen.

Equipment was thoroughly rinsed before and after sampling at each station to prevent contamination. All samples were labeled with the station and replicate identifier, time, date, depth, volume sampled, preservative amount, and name of the collector.

3.4.2 Laboratory

Phytoplankton samples were processed by a qualified phytoplankton taxonomist using procedures outlined in Lund *et al.* (1958). Prior to analyses, samples were gently inverted and a 10 to 100 mL subsample was dispensed into sedimentation chambers (Lund *et al.*1958). Subsample volume was dependant on the ability to count a minimum of 200 phytoplankton cells or units (colonies, chains or filaments). Samples were processed after a 24 h sedimentation period. A species list was developed by scanning the entire basal area of the chamber with an inverted microscope (Wild™ M-40). Diatom identification was accomplished by concentrating a subsample onto a coverslip, clearing utilizing a muffle furnace and then mounting in Styrax. These were then examined under a compound microscope. Taxonomic keys used for identification included Prescott (1970), Taft and Taft (1971), and Webber (1971).

To calculate cell density (cells/mL), individual cells were enumerated within a specified area of the sedimentation chamber. This was accomplished by counting the number of cells along horizontal transects placed across the specified area. One or more transects were processed until the minimum number of 200 cells or units were counted. To calculate the cell density, the number of cells within the specified area was extrapolated to the subsample and then to the entire sample.

Cell biovolume ($\mu m^3/m^3$) was calculated by first measuring the physical dimensions (length, width, and depth) of 10 to 30 cells of each species in the sample. Representative cell biovolume were then generated by calculating individual cell volumes for all cells measured (utilizing the nearest geometric shape[s]) and averaging these to produce an estimated cell biovolume for each species. The cell biovolume estimate for

the subsample was then extrapolated to the entire sample (note: averaging cell dimensions rather than individual cell volume estimates to produce a representative cell volume can seriously underestimate the representative cell volume used). Species that were encountered during the qualitative assessment, but not enumerated (i.e., very low numbers, nonviable, or located outside the enumeration transects) were recorded as present and included in the total taxa present for that sample.

Chlorophyll *a* analysis was conducted using the spectrophotometric-acetone extraction method described by Moss (1967a, 1967b). This method corrects for the presence of phaeophytin *a*, which may be present in decaying algal cells. This is achieved by acidification of the sample after initial measurement and referencing results to predetermined calibration curves.

3.5 ZOOPLANKTON

3.5.1 Field

Zooplankton was collected following the general procedures described in Paterson (2003). Each zooplankton sample consisted of a composite of five vertical hauls, each of which included two times the euphotic zone (i.e., four times the Secchi depth). In lakes that were shallower than four times the Secchi depth, hauls encompassed the entire water column to 1 m above the lake bottom to avoid contamination with sediment. Zooplankton were collected with a Wisconsin plankton net constructed with Nitex® mesh (net mouth diameter 130 mm; 0.064 x 0.064 mm mesh). For each haul, the net was lowered to the desired depth and then retrieved at a constant rate of 1.0 m/s. Samples were preserved immediately in 5% formaldehyde and stored in labeled 500 mL polyethylene bottles. All samples were labeled with a station identifier, time, date, depth, and name of the collector. Equipment was thoroughly rinsed before and after sampling at each station to prevent contamination.

In 2007, to determine the influence of diurnal migration of zooplankton (movement to the lake bottom during the day to avoid predation) on zooplankton biomass additional sampling done at two sites where the euphotic zone did not extend to the lake bottom. The additional sampling consisted of taking 5 additional replicates through the entire water column.

3.5.2 Laboratory

Prior to enumeration, all taxa found in the sample were identified to the lowest possible taxonomic level under a compound microscope. All the identified taxa were then examined under a stereomicroscope to determine the capability of their identification at 50x magnification. The taxonomic keys and papers used for identification include the following: Brandlowa *et al.*1972, Brooks 1957, Chengalath *et al.*1971,

Clifford 1991, Deevey and Deevey 1971, Dodson and Frey 1991, Elliot 1977, Grothe and Grothe 1977, Pennak 1978, Ruttner-Kolisko 1974, Stemberger 1979, Wilson 1959, and Yeatman 1959.

Following identification, each sample was thoroughly mixed by stirring and shaking, and a sub-sample was withdrawn using a wide mouth Gilson pipette. The sub-sample was placed in a counting trough, which was secured to the stage of a stereomicroscope, to count the number of individuals of each species encountered in the sub-sample. To ensure a complete transfer of all organisms from the Gilson pipette to the trough, the tip of the pipette was washed, the wash water examined microscopically, and organisms, if found, were added to the sub-sample.

The round counting trough, constructed of polished Plexiglas, allows the analysis of 1 – 25 mL volume sub-samples. The trough was thoroughly tested for use in the analysis of zooplankton samples at the University of Calgary and was judged superior to the Sedwick-Rafter counting cell for macro-zooplankton. It was used primarily because it allows the processing of a relatively large volume of sub-samples, shows a great resistance to ambient vibrations, and allows the processing of samples without a cover. If further examination of a particular specimen was necessary with a compound microscope, it was easily extracted from the trough. For each sample three sub-sample replicates of 5 to 25 mL were examined.

The density of enumerated zooplankton was eventually calculated per 1 m^3 using the following equation:

$$\mathbf{s\ (m^3) = \Sigma\ s\ in\ subsample * (sample\ volume / total\ volume\ of\ subsamples) * (1 / field\ volume\ in\ m^3)}$$

where: **s** = number of individuals (density)

3.6 BENTHIC MACROINVERTEBRATES

3.6.1 Field

Benthic macroinvertebrates were sampled following general procedures described in Rosenberg *et al.* (2003) immediately following ice-out in early July. Sampling during the early open water period was deemed appropriate for two reasons. First, it is logistically more feasible to sample during open water compared to winter when ice limits access to stations. Second, collections made during the open water period before emergence (transformation of larvae/pupae into adults) provides a good representation of the benthic macroinvertebrate community.

Stations were located in water depths of approximately 5 m. A Standard Ekman Bottom Grab Sampler (13.5 cm x 13.5 cm x 20.5 cm) with an aperture area equal to 0.023 m^2 was used to collect five replicates at each station. To address the issue of high within-station variation caused by clumped benthic macroinvertebrate distribution, and to increase the probability of encountering rare taxa, each replicate consisted of a composite of three Ekman grabs. The quality of the sample was examined (i.e., jaws were closed and the grab was full) before it was processed. If deemed of poor quality, the sample was rejected and the procedure repeated. Immediately after collection with the Ekman grab sampler each replicate was sieved through a 243 µm mesh net (34 cm wide x 66 cm long x 34 cm deep). This mesh size was selected prior to the commencement of baseline monitoring and was based on consultation with a benthic specialist. The purpose of this sieving device was to remove as much sediment as possible in the field prior to preservation, while preventing the loss of benthic macroinvertebrates from the sample. The collected material was moved back and forth along the lake surface water to remove excess sediments. Each replicate was then placed in a labelled polyethylene sample bag and preserved in 10% formalin.

3.6.2 Laboratory

Sorting of benthic macroinvertebrate samples, preservation of sorted animals, identification and enumeration of macroinvertebrates follow procedures recommended by Alberta Environment (1990) and Environment Canada (2002a, 2002b).

Benthic macroinvertebrates were removed from the accompanying debris using a dissecting microscope at 10x magnification. Rose Bengal stain was added to the samples first to improve sorting efficiency. Each sample was then separated into coarse and fine fractions by washing thoroughly through two sieves, with mesh sizes of 1000 µm and 200 µm. The content of each sieve was transferred to a large beaker where warm water was added to separate organic material from sand. The contents were swirled the floating organic matter was decanted into a 200 µm sieve. The process was repeated until all the organic matter was separated from the sand.

Each separated fraction of the sample was examined, portion by portion, on a gridded Petri dish under a dissecting microscope until all benthic macroinvertebrates were removed. Sorted macroinvertebrates were stored in vials and preserved in 80% ethanol.

For samples containing large numbers of macroinvertebrates the fine fraction was subsampled, following the procedure outlined in Wrona *et al.*(1982). Samples were divided into two components for processing: elutriated and sediment. The organisms were collected by repeatedly rinsing and elutriating the sample

until organisms were no longer observed. The entire elutriated and sediment components of the sample were then processed.

Macroinvertebrates were sorted by major taxonomic group and identified to the lowest practical taxonomic level (genus where possible) using a dissecting microscope (6-42x magnification). Chironomids were identified to family or tribe. Identifications were performed using the following taxonomic keys and papers: Brinkhurst 1986, Clifford 1991, McAlpine *et al.*1981, Merritt and Cummins 1984, Oliver and Roussel 1983, Pennak 1989, Stewart and Stark 1988, Thorp and Covich 1991, Wiggins 1977. Once processing was completed samples were preserved in 80% ethanol.

3.7 MONITORNG QUALITY ASSURANCE

3.7.1 Water Chemistry

Field

Duplicate water samples were submitted to the analytical laboratory for quality control and quality assurance; these samples were submitted as blinds and were labeled so that the lab would not know which sample they represented. In addition, split samples were taken (the water was collected simultaneously) in order to test the laboratories precision. Splits and blinds were collected for 10% of the total number of samples per sampling session. To ascertain sample contamination due to handling of the samples, field blanks were incorporated into the sampling process. A field blank consisted of a set of bottles filled with demineralized, de-ionized water (supplied by the lab). Blanks were processed in the same manner as a collected water sample. These blanks were used for each sampling session.

A YSI-556 multiprobe was used to obtain field water quality parameters. The YSI was calibrated for all parameters it measured, except temperature, prior to use.

Laboratory

Laboratory analytical reports contain pertinent information regarding the sample (s) submitted for analyses. This information includes the date the sample was collected and received by the lab, date of analysis, technician's initials, parameters, methodology, method reference, method detection limit, and results. The report is reviewed by the lab QA/QC coordinator and lab manager for completeness and accuracy. All documentation associated with the analysis including raw data, chromatograms, calibration curves, calculations, etc. are kept in that file.

Instruments were calibrated prior to analyses using a series of high-purity standards that cover the working range of the instrument. Instrument responses were collated in an appropriate quality control sheet and this data was plotted regularly to monitor for inappropriate changes.

Duplicate analysis was performed on every tenth sample submitted to the lab. With every batch of samples, a method blank was prepared with deionized water and/or extraction solvent and was analyzed to verify the absence of interferences or contaminants associated with storage, preparation and instrumental analyses.

Quality control and assurance procedures followed those of the Canadian Association for Environmental Analytical Laboratories (CAEAL).

3.7.2 Nonvertebrate Aquatic Biota

The following QA/QC procedures were used for nonvertebrate data.

1. Strict sampling protocols were adhered to ensure consistency in technique for each parameter.
2. Consistency of identifications for each indicator was achieved by using the same taxonomist.
3. Ten percent of samples were analyzed by other qualified persons to ensure the accuracy of identifications and counts.
4. Split samples were collected from 5% of the samples using the following protocols.
    a. Benthic macroinvertebrates: Splits were not taken for benthic macroinvertebrates because of difficulty in collecting an unbiased, accurate split.
    b. Phytoplankton: Splits were collected and processed the same way as replicates. A replicate was collected by first thoroughly mixing the composite sample and then collecting a subsample. A split was generated by obtaining two replicate subsamples from the same composite sample. The information for the split was then compared to its associated replicate to determine precision of the subsample and accuracy of taxonomic identifications.
    c. Zooplankton: Splits were collected and processed the same way as replicates. A split was obtained by thoroughly mixing the replicate, dividing it into two equal volumes, and preserving in two separate bottles. The information for the split was compared to its associated replicate to determine the accuracy of taxonomic identifications. It was not used to evaluate precision of subsamples because subsampling of zooplankton does not occur in the field.
5. For benthic macroinvertebrates the residue of the sample was examined to determine sorting efficiency. If the residue contained a number of organisms that exceeded 10% of the entire sample, the sample was re-processed. A reference collection of more difficult taxa to identify was completed and verified by a qualified taxonomist.
6. All samples were archived for future reference.

3.7.3 Sampling Precision

Water and Sediment Chemistry

Precision in laboratory analyses of water and sediment chemistry samples was evaluated by comparing differences (percent error) in parameter values for replicates and split samples. Percent error was calculated as follows:

Percent Error = Absolute Value ([Replicate Value – Split Value]/Replicate Value) * 100

Measurements below detection for one or both samples (replicate and/or split) were excluded from the calculation. Summaries included median and maximum percent error.

Nonvertebtrates

Collecting small replicate samples may yield statistical inaccuracy due to the naturally heterogeneous dispersion of species and limitations of sampling techniques. Measuring the degree of precision for the collected replicates ensures that data retain acceptable statistical power. A standard error equal to 20% of the mean (D = 0.2) is considered a reasonable error and maintaining sampling precision within this error is recommended by Alberta Environment (1990) and Environment Canada (2002a). Precision of replicate samples was calculated using the formula (based on a Poisson distribution):

$$D = \frac{1}{\bar{x}}\sqrt{\frac{s^2}{n}}$$

where: $\bar{x}$ = mean value; s^2 = variance; and n = number of replicate samples.

In cases where the precision exceeded the recommended 0.2 the number of replicates (n) required to obtain $D \leq 0.2$, was determined by the following formula:

$$n = \frac{s^2}{D^2 \quad \bar{x}^2}$$

Precision was determined for all parameters where statistical analyses were done for benthic macroinvertebrate, zooplankton, and phytoplankton data.

3.8 DATA ANALYSES

3.8.1 Statistical Approach

General

Data analyses involved generating summary metrics (mean, standard deviation, minimum, and maximum) for each parameter. This was followed by evaluation of spatial differences among stations using univariate parametric statistical tests. Prior to summaries and statistical analyses the data for each parameter were examined to ensure appropriateness for evaluation.

Data analyses followed accepted protocols, where appropriate, that are described in Environment Canada (2002). Methods for evaluation involved the following:

- One-way Analysis of Variance (ANOVA)
- Kruskal-Wallis Test
- Visual (graphical) Analysis

Data were first explored in order to meet the assumptions required for parametric statistical analyses. When these assumptions were not met, nonparametric tests were employed.

Data that were significantly non-normal were identified using three methods:

1) The g1 and g2 statistic, where dividing either statistic (g1 or g2) by its standard error approximated a test of non-normality (i.e., skewed or kurtotic data). If the result of the test was greater than 2.0, then the data were deemed to be significantly skewed or kurtotic.
2) Histograms where normally distributed data resulted in the graph having a characteristic bell shape.
3) Use of probability plots to compare data distribution against that which would be expected given a normal or other theoretical distribution to determine if the two distributions were similar.

Where parametric ANOVA was completed assumptions of equality of variance was tested using Levene's Test for Homogeneity of Variances. When variances were similar, the F-statistic and corresponding Tukey's HSD post-hoc tests were used to determine differences among groups. In the case where the assumption of equal variances was violated, the Welch statistic replaced the F-statistic and post-hoc tests were limited to the Dunnett T3 post-hoc test. Statistical significance was accepted at $p \leq 0.05$.

Statistical Power

Power analysis was used for each parameter to determine if a statistical difference between stations could be identified using procedures outlined in Dallal *et al.* 2002. Power analysis is a standard analytical procedure based on the relationship between sample size and sample variation (Sokal and Rohlf 1981). A

One-way ANOVA design was employed and assumed independent samples unless otherwise specified. The test assumed an alpha level (α) of 0.05, and a power (1-β) of 0.8. All evaluations were completed using SYSTAT™ Version 10.2 software.

3.8.2 Water Chemistry

The approach to water quality analyses was different than the general analyses methods described above. The majority of parameters tested were below analytical detection, and therefore, the number of data points to allow for statistical comparisons were limited. Means were calculated for all parameters where one value was above detection limit for a given station. Where values were below analytical detection the value was assumed to be half the detection limit. In addition, comparisons were based on similar sampling periods only; if one station had samples taken in summer and winter and another station had samples taken only in summer only summer means were compared. Only total metals data were presented for this report; where values were above water quality guidelines dissolved metals data was also explored.

3.8.3 Sediment Deposition

Parameters investigated included total sediment weight, ashed weight (represented inorganic component of total sediment weight), percent ashed weight (ashed weight/total sediment weight) and sedimentation rate ($mg/cm^2/day$). Sedimentation rate was calculated as follows:

Sedimentation Rate = total sediment weight/aperture area of collection bottle/days-at-large

3.8.4 Lake Profile Parameters

Lake profile parameters were graphed and compared among stations and between years.

3.8.5 Nonvertebrate Aquatic Biota

Data analyses involved generating summary metrics (mean, standard deviation, minimum, and maximum) for each parameter. ANOVA was completed to test for between-station and between-year differences for each summary parameter. Summary parameters for phytoplankton included taxa richness, Simpson's Index of Diversity, total density, total biovolume, and chlorophyll *a* concentrations. Summary parameters for zooplankton included taxa richness, Simpson's Index of Diversity, total density, total copepod density, total rotifer density, and total cladoceran density. Summary parameters for benthic macroinvertebrates included taxa richness, Simpson's Index of Diversity, total density, chironomid density, and oligochaete density. Prior to summaries and statistical analyses the data for each parameter were examined to ensure appropriateness for evaluation.

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4.0 RESULTS

4.1 WATER CHEMISTRY

Presented under separate cover.

4.2 LAKE PROFILE PARAMETERS

In July 2007, lakes were sampled for temperature (°C) and dissolved oxygen (mg/L).

Surface dissolved oxygen levels at five stations ranged from 10.0 to 10.3 mg/L and 10.2 to 11.3 mg/L close to the lake bottom (Figure 4.1). Dissolved oxygen levels increased with depth at all stations except Lake C3 and Jericho Lake. In those two cases, dissolved oxygen decreased with depth. At all stations temperature decreased with increasing lake depth. The average temperature of all stations was 9.9°C ranging from 4.9 to 15.1°C, exhibiting high variation. With the exception of Carat Lake, all stations exhibited a strong thermocline between 8 m to 11 m. All lakes were stratified.

At all monitoring stations, Secchi depth ranged from 5.4 m to 7.4 m (Figure 4.1) with the deepest exhibited in Cigar Lake. Secchi depths in Carat Lake, Jericho Lake, and Lake C3 were all similar (5.4 m, 5.6 m and 5.7 m respectively). Control Lake had a Secchi depth of 6.8 m. The highest reading in July 2007 was in Control Lake (6.8 m) and the lowest in Jericho (5.6 m).

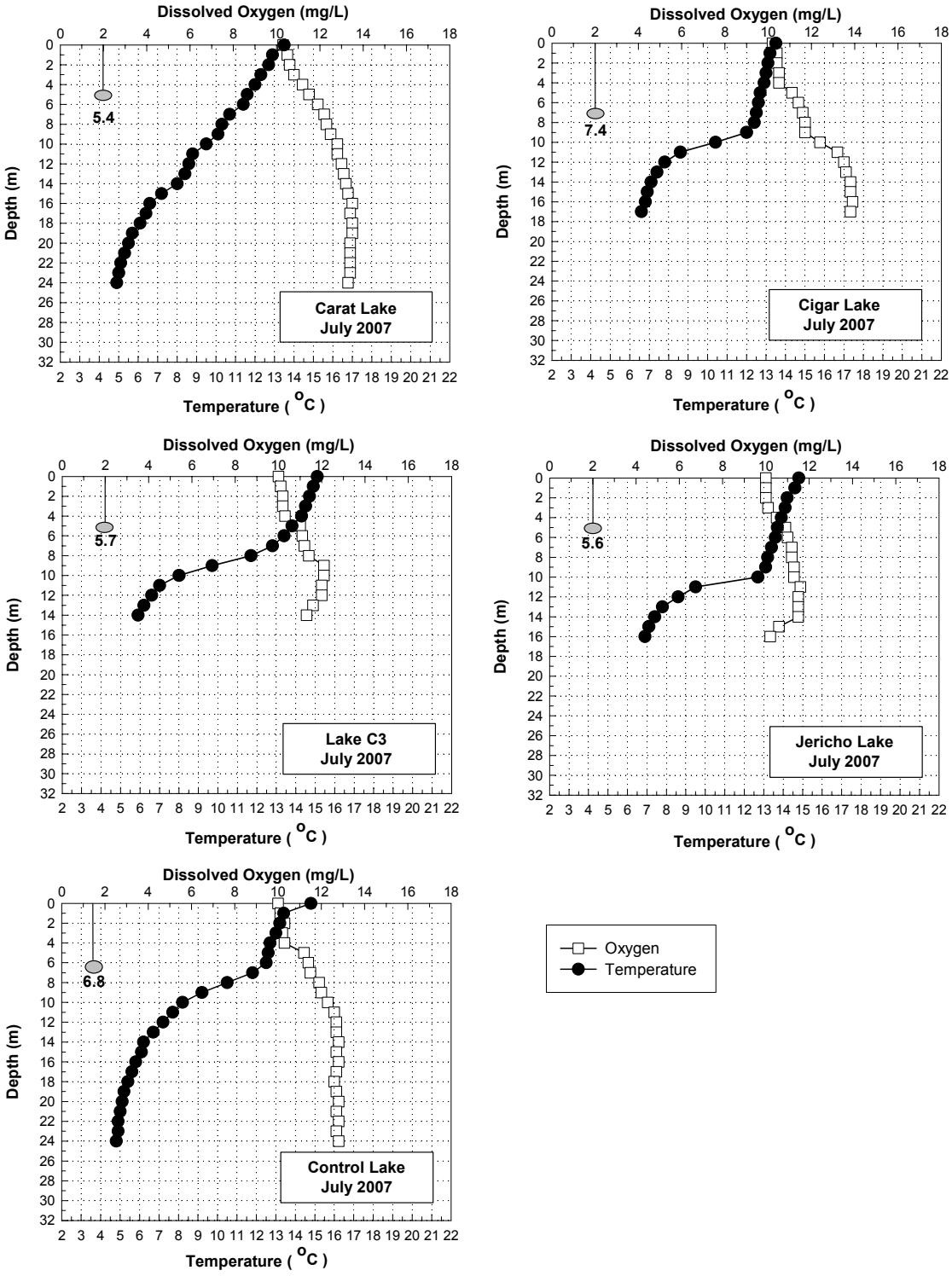

Figure 4.1 Dissolved oxygen and temperature profiles at monitoring stations, 2007 Jericho AEM Program.

4.3 SEDIMENT DEPOSITION

4.3.1 Comparisons among Stations

Summary information is presented in Table 4.5. The days at large for sediment deposition traps in 2007 ranged from 357 to 374 days.

Table 4.5 Sediment deposition data at stations monitored between 2006 and 2007, Jericho AEM Program.

Station	Location	Days at Large	Ashed Weight (mg)	Sedimentation Rate ($mg/cm^2/day$)
JER23	Control Lake	360	823.1	2.91×10^{-2}
JER25	Cigar Lake	357	82.3	2.94×10^{-3}
JER20	Lake C3 at Stream C3[a]	368	98.6	3.41×10^{-3}
JER05	Lake C3 outlet	368	108.6	3.76×10^{-3}
JER19	Carat Lake at Stream C1	374	368.5	1.26×10^{-2}
JER21	Carat Lake west of causeway	372	619.3	2.12×10^{-2}
JER22	Carat Lake east of causeway	374	933.3	3.18×10^{-2}
JER07	Carat Lake outlet	374	323.9	1.10×10^{-2}
JER26	Jericho Lake	358	148.6	5.29×10^{-3}

Ashed weight (nonorganic component of total sediment weight) varied among stations. The lowest ashed weight measurements occurred at Cigar Lake Station JER25 (82.3 mg) and the highest occurred at the station JER22 (933.3 mg) located on Carat Lake east of the causeway. A similar spatial pattern was recorded for sedimentation rate. The data indicate sediment deposition was higher in Carat Lake compared to other monitored waterbodies.

4.3.2 Historical Trends

Sediment deposition rate data collected from 2005 to 2007 indicate large annual differences (Figure 4.2). Sediment deposition rates at most stations were higher in 2005 and/or 2007 compared to 2006. With the exception of the very high values in Control Lake, the spatial pattern was consistent among years. Carat Lake stations exhibited elevated values compared to stations in other lakes.

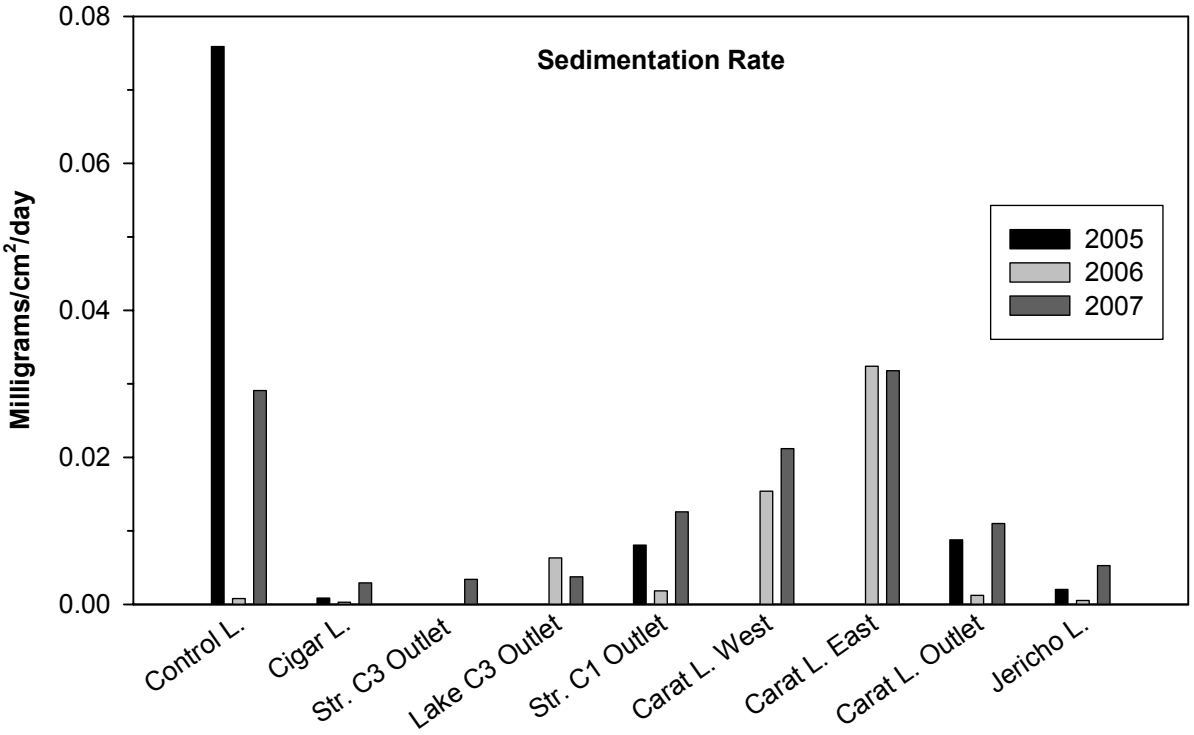

Figure 4.2 Comparisons of sediment deposition rate at stations monitored in 2005, 2006, and 2007, Jericho AEM Program.

4.4 PHYTOPLANKTON

Between-station differences in phytoplankton richness, Simpson's Index of Diversity values, total density, total biovolume, and chlorophyll *a* concentrations for samples collected in 2007 were investigated using ANOVA (One-way Analysis of Variance). Summaries of estimates, standard deviations, maximums, minimums, and statistical significance are found in Table 4.6. For the 2007 data, Levene's test for homogeneity of variances identified that variances were not equal between stations for total density (Levene's statistic=3.80, p=0.013), richness (Levene's statistic=6.60, p=0.001), and Simpson's Index of Diversity (Levene's statistic=2.77, p=0.045). As such, the Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests for mean comparisons among stations for these parameters. All other parameters did not have significantly different variances; therefore, the F-statistic and Tukey's post-hoc tests were used for comparisons.

Table 4.6 Phytoplankton parameter summary metrics at monitored stations, 2007 Jericho AEM Program.

Parameter	Lake	Station	Sample Size	Mean	Standard Deviation	Minimum	Maximum	Significance[a]
Richness (No. taxa)	Cigar	JER11	7	53.1	8.5	41	64	A
	Control	JER10	7	62.7	2.6	59	66	A
	C3	JER04	7	62.9	4.4	55	68	A
	Carat	JER06	7	60.4	1.4	59	63	A
	Jericho	JER08	7	59.0	3.3	53	63	A
Diversity (Simpson's D)	Cigar	JER11	7	0.85	0.08	0.69	0.93	A
	Control	JER10	7	0.90	0.02	0.88	0.92	A
	C3	JER04	7	0.84	0.06	0.72	0.91	A
	Carat	JER06	7	0.90	0.01	0.89	0.92	A
	Jericho	JER08	7	0.89	0.02	0.86	0.92	A
Total Density (cells/mL)	Cigar	JER11	7	960.0	291.3	594.6	1344.5	C
	Control	JER10	7	1877.7	611.3	1161.5	2787.1	ABC
	C3	JER04	7	2741.5	581.0	2044.5	3723.2	A
	Carat	JER06	7	1729.1	269.9	1425.4	2136.2	B
	Jericho	JER08	7	2889.0	757.7	2325.3	4171.8	A
Total Biovolume (μm^3/mL)	Cigar	JER11	7	210,730.5	44,477.1	163,356.8	294,298.9	B
	Control	JER10	7	538,368.5	163,580.2	408,948.6	862,966.0	A
	C3	JER04	7	417,696.3	60,363.0	316,181.2	480,352.0	A
	Carat	JER06	7	444,790.0	109,900.8	349,423.3	667,213.3	A
	Jericho	JER08	7	524,847.8	150,264.2	373,024.2	761,326.4	A
Chlorophyll *a* (mg/m^3)	Cigar	JER11	7	0.4	0.2	0.2	0.7	C
	Control	JER10	7	1.2	0.2	0.8	1.4	B
	C3	JER04	7	1.7	0.2	1.4	2.0	A
	Carat	JER06	7	1.1	0.4	0.4	1.5	B
	Jericho	JER08	7	1.0	0.2	0.7	1.3	B

[a] See Section 3.10 for description of statistical methods. Letters represent statistical differences among stations at p=0.05.

4.4.1 Taxa Richness

Mean taxa richness (# of different taxa) in 2007 ranged from 53.1 to 62.9 at all monitoring stations (Figure 4.3) and was not significantly different among sites (Welch statistic=2.98, p=0.056). The Lake C3 station had highest mean richness (62.7) followed by the Control Lake (62.7), Carat Lake (60.4), Jericho Lake (59.0), and Cigar Lake (53.1) monitoring stations.

In 2006, mean taxa richness (# of different taxa) in 2006 ranged from 54.9 to 63.4 at all monitoring stations. Although the Jericho Lake station had highest mean richness (63.4) followed by the Control Lake (60.9), Lake C3 (60.6), Cigar (55.4), and Carat Lake (54.9) monitoring stations, none of these relationships were statistically significant (F-statistic= 2.16, p=0.09). In 2005, mean taxa richness ranged from 59.4 to 75.0 at all stations. In addition, the Jericho Lake station had significantly higher mean richness (75.0) than all other stations (Mainstream 2006). The Control Lake station exhibited the next highest mean taxa richness (66.3) and had significantly higher taxa richness than both Lake C3 (53.6) and

Carat Lake (57.7). In 2004, mean taxa richness at individual stations demonstrated yearly variability (Mainstream 2005). For example, the mean taxa richness at the Control Lake station (26.5) was the lowest of all stations surveyed in 2004 whereas in 2005 this station had the second highest richness (66.3).

4.4.2 Simpson's Index of Diversity

In 2007, mean Simpson's Index of Diversity values ranged from 0.48 to 0.90 and values were not significantly different between monitoring stations (Welch statistic=2.44, p=0.095). Highest values were recorded at the Carat Lake station (0.90) and Control Lake station (0.90), followed by the Jericho Lake (0.89), Cigar Lake (0.85), and Lake C3 (0.48) stations. Simpson's Index of Diversity values at Lake C3 were significantly lower than at all other sites ($p<0.001$); all other relationships were not significant. Diversity values in 2007 were high compared to 2006 but similar to other sampling years (2004 and 2005).

In 2006, mean Simpson's Index of Diversity values ranged from 0.41 to 0.55 and values were not significantly different between monitoring stations (F-statistic=1.89, p=0.137). Highest values were recorded at the Carat Lake station (0.55), followed by the Cigar Lake (0.54), Jericho Lake (0.47), Control Lake (0.45), and Lake C3 (0.41) stations. These diversity values are low compared to other sampling years (2004 and 2005). The relationships between waterbodies, in terms of Simpson's Index of Diversity, were similar between the 2004, 2005, and 2006 sampling periods; mean Simpson's diversity was high at Cigar Lake, Control Lake, and Lake C3 stations and lower at Jericho Lake. However comparatively low values found at Carat Lake in 2004 and 2005 were not found in 2006. In addition Simpson's Index of Diversity values were similar between years in 2005 and 2004, mean Simpson's D value ranged from 0.51 to 0.75 in 2004 and 0.60 to 0.74 in 2005, but values were lower in 2006 (0.41 to 0.55).

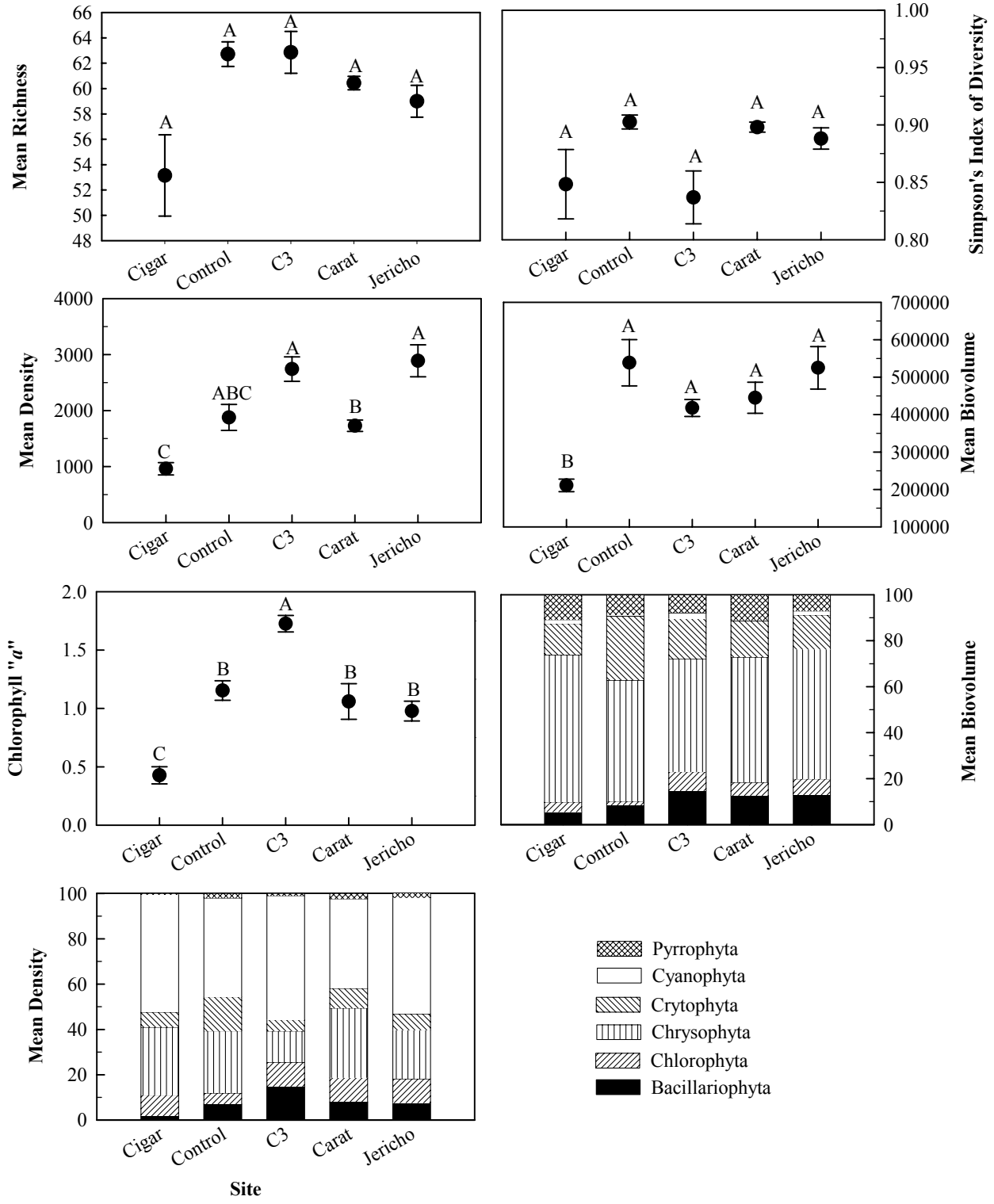

Figure 4.3 Phytoplankton parameter summary metrics monitored in 2007, Jericho AEM Program. Error bars represent 95% confidence intervals. Letter indicates statistical significance at p=0.05. Density units are in number of organisms per milliliter. Biovolume units are in micrometers cubed per milliliter. Chlorophyll "*a*" units are in milligrams per cubic meter.

4.4.3 Total Density

Mean total density in 2007 ranged from 960.0 organisms/mL to 2889.0 organisms/mL and were significantly different between sites (Welch statistic=18.45, $p<0.001$). Densities were significantly higher at the Jericho Lake station (2889.0 organisms/mL) and Lake C3 (2741.5 organisms/mL) compared to the Carat Lake (1729.1 organisms/mL) and Cigar Lake (960.0 organisms/mL) stations ($p<0.05$) but not the Control Lake station (1877.7 organisms/mL). Values at the Carat Lake station were also significantly greater than at the Cigar Lake station ($p=0.002$).

Mean total density in 2006 ranged from 7,081.9 organisms/mL to 11,284.9 organisms/mL and values were not significantly different among stations (Welch statistic=1.74, $p=0.195$). Highest densities occurred at the Lake C3 station (11,284.9 organisms/mL) followed by the Cigar Lake (9033.7 organisms/mL), Carat Lake (7865.0 organisms/mL), Jericho Lake (7588.7 organisms/mL), and Control Lake (7081.9 organisms/mL) stations. In 2005 densities were lower than in 2006. Specifically, mean total density was significantly higher at the Jericho Lake station (4778.9 organisms/mL) than all other stations (range 2911.1 to 3301.6 organisms/mL). But similar to 2006, there were no statistical differences in mean total densities between the remaining stations. Values in 2006 were also generally higher than in 2004. In 2004, densities at Lake C3 and Control Lake stations were within 10% of 2005 values whereas Carat Lake station were 23% higher. Jericho Lake station density was lower in 2005 than 2005 by 24% whereas Cigar Lake station density was 40% higher in 2005 compared to 2004. High yearly variation in densities at some stations may decrease the ability to detect spatial changes at these stations.

4.4.4 Total Biovolume

In 2007, mean biovolume was significantly different among sites (F-statistic= 9.03, $p<0.001$). More specifically, values at the Cigar Lake station (210,730.5 μm^3/mL) were significantly lower than at the Control Lake (538,368.5μm^3/mL), Jericho Lake (524,847.8 μm^3/mL), Carat Lake (444,790.0μm^3/mL), and Lake C3 (417,696.3μm^3/mL stations ($p<0.018$); all other relationships were not significant.

In 2006, mean biovolume was highest at the Jericho Lake station (373,928.2 μm^3/mL), followed by the Lake C3 (351,793.9 μm^3/mL), Carat Lake (277,951.4 μm^3/mL), Cigar Lake (262,849.8 μm^3/mL), and Control Lake (223,092.0 μm^3/mL) stations. Mean biovolume was significantly higher at the Jericho Lake and the Lake C3 monitoring stations than the Control Lake station ($p=0.01$ and 0.04, respectively) whereas all other relationships were not statistically significant. Mean biovolume comparisons between

stations did not follow the same pattern as found for mean density, likely due to differences in community composition between stations.

Similar to 2006, mean biovolume in 2005 was highest at the Jericho Lake station. However, in 2006, the Control Lake station had the lowest mean biovolume whereas in 2005 the Lake C3 station had lowest biovolume values. Interestingly, stations that had the lowest biovolumes in 2004 (Carat and Jericho) had the highest biovolumes in 2005 and 2006, likely due to natural yearly fluctuations in phytoplankton biovolume at each station.

4.4.5 Chlorophyll *a*

In 2007, mean chlorophyll *a* concentrations were significantly different among sites (F-statistic= 22.43, $p<0.001$). Values at the Lake C3 station (1.7 mg/m^3) were significantly higher than the Control Lake (1.2 mg/m^3), Carat Lake (1.1 mg/m^3), Jericho Lake (1.0 mg/m^3), and Cigar Lake (0.4 mg/m^3) stations ($p<0.002$). Moreover values at the Control Lake, Carat Lake, and Jericho Lake stations were significantly higher than at the Cigar Lake station ($p>0.003$).

In 2006, mean chlorophyll *a* concentrations were highest at the Carat Lake station (4.0 mg/m^3) followed by Lake C3 (2.5 mg/m^3), Cigar Lake (1.6 mg/m^3), Control Lake (1.5 mg/m^3), and Jericho Lake (0.9 mg/m^3) stations. Values at the Carat Lake station were significantly higher than the Jericho Lake station ($p=0.015$), whereas differences between all other stations were not statistically significant.

In 2005, on the other hand, mean values were highest at the Jericho Lake station (0.62 mg/m^3) followed by the Control Lake (0.56 mg/m^3) and Carat Lake (0.44 mg/m^3) stations and after that the Lake C3 (0.38 mg/m^3) and the Cigar Lake (0.32 mg/m^3) stations. In terms of statistical significance, the Jericho Lake station was significantly higher in chlorophyll *a* concentrations than the Cigar Lake and Lake C3 stations. In contrast to 2006, the Cigar Lake station had the lowest chlorophyll *a* concentration in both the 2004 (0.38 mg/m^3) and 2005 (0.32 mg/m^3). In general, patterns between stations were variable on a year to year basis. They did not indicate effects due to mining activity as values at exposure stations were within the range found at control stations.

4.4.6 Dominant Taxa

The phytoplankton data (density and biovolume) were summarized by major taxonomic group. In 2007, in terms of density, the dominant group in all waterbodies was Cyanophyta. Cyanophyta comprised

between 39% and 55% of the total density of phytoplankton for all stations. The next most prevalent group was Chrysophyta as this group comprised between 13% and 37% of the total density of phytoplankton for all stations. In terms of biovolume, in 2007, chrysophyta was the dominant group in all waterbodies; 52% to 64% of the total biovolume at each station was dominated by Chrysophyta. Bacillariophyta percent of total biovolume ranged from 5% to 15% for all. Cryptophyta made up between 14% and 28% of the total biovolume at all stations. All other groups (Bacillariophyta, Chlorophyta, and Pyrrophyta) made up less than 10% of the total biovolume at all stations.

In 2006, chrysophyta was the dominant group in all waterbodies based on biovolume; 34% to 55% of the total biovolume at each station was dominated by Chrysophyta. Bacillariophyta percent of total biovolume ranged from 13% to 35% for all stations and was highest at Cigar Lake (35%) and Carat Lake stations (27%). Chlorophyta percent of total biovolume ranged from 9% to 24% at all stations with the Control Lake station being highest. Pyrrophyta percent of total biovolume ranged from 7% to 17% at all stations. Cyanophyta and Cryptophyta made up less than 10% of the total biovolume at all stations. In terms of density, the dominant group in all waterbodies was Cyanophyta. Cyanophyta comprised over 77% of the total density of phytoplankton for all stations.

Data for 2007 were consistent with 2004, 2005, and 2006 data. In all years, Cyanophyta dominated in terms of density and Crysophyta was the dominant group based on biovolume.

4.5 ZOOPLANKTON

Summaries of estimates, standard deviations, maximums, minimum, and statistical significance for zooplankton are found in Table 4.6. For the 2007 data, Levene's test for homogeneity of variances identified that variances were not equal between stations for cladoceran density (Levene's statistic=11.73, $p<0.001$). As such Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests for comparisons among stations for this parameter. All other parameters did not have significantly different variances; therefore, the F-statistic and Tukey's post-hoc tests were used.

Table 4.6 Zooplankton parameter summary metrics at monitored stations, 2007 Jericho AEM Program.

Parameter	Lake	Station	Sample Size	Mean	SD	Min	Max	Significance[a]
Richness (No. taxa)	Lake C3	JER04	7	14.9	1.3	13.0	16.0	B
	Carat Lake	JER06	7	18.0	1.4	17.0	20.0	A
	Jericho Lake	JER08	7	15.6	1.6	14.0	18.0	B
	Control Lake	JER10	7	16.3	1.1	14.0	17.0	AB
	Cigar Lake	JER11	7	16.9	1.8	14.0	19.0	AB
Diversity Index (Simpson's D)	Lake C3	JER04	7	0.187	0.016	0.170	0.210	A
	Carat Lake	JER06	7	0.196	0.024	0.170	0.240	A
	Jericho Lake	JER08	7	0.177	0.011	0.160	0.190	A
	Control Lake	JER10	7	0.207	0.029	0.180	0.260	A
	Cigar Lake	JER11	7	0.189	0.015	0.170	0.210	A
Total Density (No./$m^{3)}$	Lake C3	JER04	7	19937.7	4815.6	9356.4	22992.6	B
	Carat Lake	JER06	7	13801.5	1358.1	12024.0	15942.2	C
	Jericho Lake	JER08	7	30495.1	1900.5	27530.6	32378.0	A
	Control Lake	JER10	7	12976.8	3479.4	6488.8	16177.2	C
	Cigar Lake	JER11	7	31606.6	1902.1	28934.5	34785.2	A
Cladocera Density (No./m^3)	Lake C3	JER04	7	10.2	13.6	0.0	31.5	C
	Carat Lake	JER06	7	111.1	61.6	59.8	239.3	B
	Jericho Lake	JER08	7	38.1	21.5	0.0	74.0	BC
	Control Lake	JER10	7	51.8	43.3	0.0	132.2	BC
	Cigar Lake	JER11	7	1096.7	250.2	851.0	1436.1	A
Copepoda Density (No./m^3)	Lake C3	JER04	7	13957.4	3200.3	6942.8	15937.4	A
	Carat Lake	JER06	7	4537.8	512.8	3738.8	5114.7	C
	Jericho Lake	JER08	7	14324.6	1849.0	12840.2	18383.3	A
	Control Lake	JER10	7	3966.5	1221.7	2389.8	5339.5	C
	Cigar Lake	JER11	7	6375.0	643.0	5638.0	7446.4	B
Rotifera Density (No./m^3)	Lake C3	JER04	7	5970.1	1674.8	2398.7	7349.2	D
	Carat Lake	JER06	7	9152.6	990.7	8225.4	11126.7	C
	Jericho Lake	JER08	7	16132.4	2848.7	10390.6	18279.7	B
	Control Lake	JER10	7	8958.4	2385.5	4053.6	10943.4	C
	Cigar Lake	JER11	7	24134.9	1489.7	22020.0	26009.1	A

[a] Different letter indicates statistical significance. Letters represent statistical differences among statistics at p=0.05

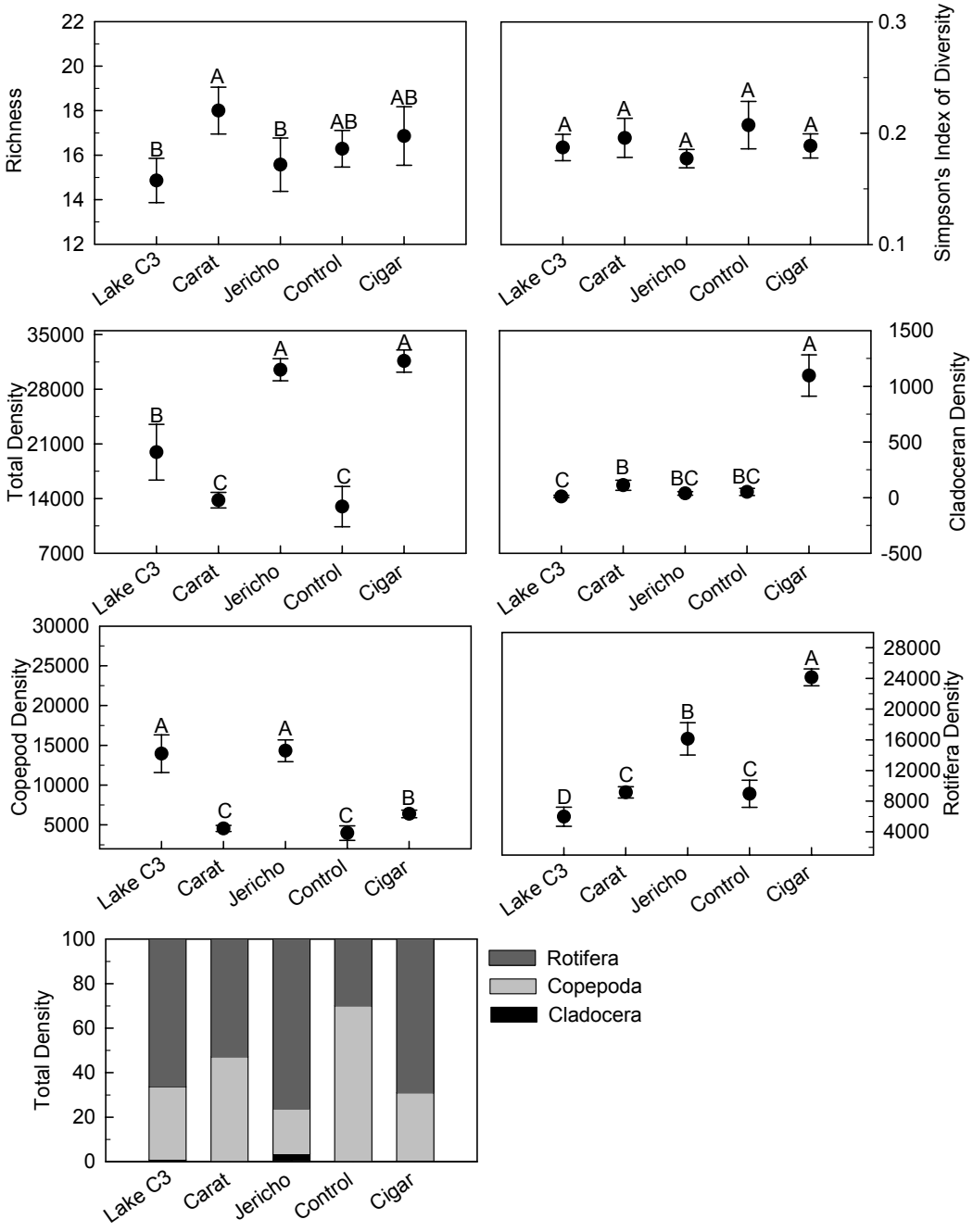

Figure 4.4 Zooplankton parameter summary metrics monitored in 2007, Jericho AEM Program. Error bars represent 95% confidence intervals. Letter indicates statistical significance at p=0.05. Density units are in number of organisms per cubic meter.

4.5.1 Taxa Richness

Zooplankton taxa richness (# of different taxa) was variable among waterbodies and mean richness ranged from 14.9 taxa (Lake C3) to 18.0 taxa (Carat Lake) (Figure 4.4). Mean taxa richness was significantly different between stations (F-statistic=4.71, p=0.005). Specifically Carat Lake had significantly greater mean richness than Jericho Lake (15.6, p=0.032) and Lake C3 (p=0.003) stations, but not significantly greater than Cigar Lake (16.9, p=0.599) or Control Lake (16.3, p=0.214) stations. All other relationships were not significantly different.

Mean richness values in 2007 were higher among waterbodies than those found in 2006 (Mainstream 2007), with the exception of Lake C3. In 2006, zooplankton taxa richness was variable among waterbodies and mean richness ranged from 13.3 taxa (Jericho Lake) to 15.3 taxa (Lake C3). In comparison to 2004 and 2005 data, richness was again variable among waterbodies; mean number of taxa ranged from 10.1 at the Cigar Lake station to 12.4 at the Control Lake station and from 14.6 at Jericho Lake to 19.0 at Control Lake respectively (Mainstream 2005). This suggests that species richness was variable between years.

4.5.2 Simpson's Index of Diversity

In 2007, zooplankton mean Simpson's Index of Diversity ranged from 0.177 (Jericho Lake) to 0.207 (Control Lake). Mean Simpson's Index of Diversity was not significantly different between stations (F-statistic=2.19, p=0.094).

In 2007, mean Simpson's Index of Diversity was significantly lower at all stations compared previous years (2004-2006). Moreover, mean Simpson's Index of Diversity values in 2005 were generally higher at all stations, however, in 2006 Carat Lake displayed higher mean Simpson;s Index of Diversity. In general, Jericho Lake station exhibited lower mean Simpson's Index of Diversity values compared to all other stations, with exception of Cigar Lake (0.776) in 2004.

4.5.3 Density

Total

In 2007, mean total density of zooplankton ranged from a low of 12,976.8 organisms/m^3 (Control Lake) to a high of 31,606.6 organims/m^3 (Cigar Lake). Mean density was significantly higher at the Cigar Lake (31,606.6 organisms/m^3) and Jericho Lake (30,495.1 organisms/m^3) stations than at the Lake C3 (19,937.7 organisms/m^3) , Carat Lake (13,801.5 organisms/m^3) and Control Lake (12,976.8 oganisms/m^3)

stations ($p<0.001$). Lake C3 also had significantly higher mean total densities than the Carat Lake ($p=0.005$) and Control Lake ($p=0.001$) stations. All other relationships were not significantly different. Specifically, Cigar and Jericho Lake ($p=0.941$) as well as Carat Lake and Lake C3 stations ($p=0.102$).

Mean values in 2004 and 2006 were generally higher than in 2007, with the exception of Cigar Lake in 2004. Moreover, mean values were higher in 2007 for the Jericho Lake station. Values ranged from 15,437.5 organims/m^3 (Carat Lake) to 23,977.2 organims/m^3 (Control Lake) in 2004 and from 21,408.3 organims/m^3 (Jericho Lake) to 34,654.1 organims/m^3 (Lake C3) in 2006. In 2005, mean total densities were lower than in 2007, with the exception of Carat Lake (29,051.2 organims/m^3) and Control Lake (20,553.4 organims/m^3).

Cladoceran Density

In 2007, mean cladoceran density was significantly higher at the Cigar Lake station (1,096.7 organisms/m^3) than at the Carat Lake (111.1 organisms/m^3), Control Lake (51.8 organisms/m^3), Jericho Lake (38.1 organisms/m^3) and Lake C3 (10.2 organisms/m^3) stations ($p<0.001$).

Dissimilar to the overall trend in total zooplankton density among waterbodies found in 2007, mean cladoceran density in 2004-06 was significantly higher at the Carat Lake station (429.0, 295.7 and 138.8 organisms/m^3 respectively) than at the Cigar Lake station (1096.7) in 2007. In general, Lake C3 station had low cladoceran densities in all years with the exception of Jericho and Control Lake (5.2 and 13.1 organisms/m^3 respectively) stations in 2006. Highest cladoceran densities were observed in 2004, with the exception of Cigar Lake in 2007. In general Carat Lake had highest cladoceran densities for all monitored years, with the exception of Cigar Lake in 2007.

Copepod Density

In 2007, copepod density ranged from 3,966.5 organisms/m^3 (Control Lake) to 14,324.6 organisms/m^3 (Jericho Lake). Mean copepod densities were significantly higher at Lake C3 (13,957.4 organisms/m^3) and Jericho Lake than at all other monitored stations. Mean density was also significantly higher at Cigar Lake (6,375.0 organisms/m^3) compared to Carat Lake (4,537.8 organisms/m^3) and Control Lake (3,966.5 organisms/m^3). All other relationships did not differ significantly.

Rotifer Density

In 2007, rotifer densities were variable among stations. Mean densities ranged from 5,970.1 (Lake C3) to 24,134.9 (Cigar Lake). Mean rotifer density was significantly higher at Cigar Lake than at all other

stations (p=0.002). Mean density was also higher at Jericho Lake (16,132.4 organisms/m^3) than at Carat Lake (9,152.6 organisms/m^3, p=0.003), Control Lake (8,958.4 organisms/m^3) and Lake C3 (p=0.002). Furthermore Carat Lake and Control Lake mean rotifer densities did not differ significantly from each other (p=0.655), although both were significantly higher than Lake C3 (p=0.002 and p=0.018 respectively).

4.5.7 Dominant Taxa

In 2007, the dominant taxonomic zooplankton groups in terms of density were rotifers and copepods. At the Lake C3, Cigar Lake and Jericho Lake stations rotifers dominated (≥66%) whereas at the Control Lake and Carat Lake and stations copepods comprised 56% and 30 % of the total density. In 2006, copepoda and rotifera dominance was split equally between these groups. In 2004, copepods (including cyclopoids) were the dominant taxonomic group. Cladocerans comprised ≤3% of all organisms present at all stations. Cladocerans remained a small component, in terms of relative density, of the zooplankton community in all years.

4.5.8 Historical Trends

Lake C3

Levene's test for homogeneity of variances identified that variances were not equal between years at the Lake C3 monitoring station for rotifer density (Levene's statistic=3.30, p=0.039) and Simpson's Index of Diversity values (Levene's statistic=5.17, p=0.007). As such, Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests for comparisons among stations for these parameters. All other parameters did not have significantly different variances; therefore, the F-statistic and Tukey's post-hoc tests were used for comparison.

Mean taxonomic richness had highest values in 2005 followed by 2006, 2007 and then 2004. Specifically, mean taxonomic richness was significantly higher in 2005 (17.5) than in 2006 (15.3, p=0.047), 2007 (14.9, p=0.013) and 2004 (11.9, p<0.001). Further, mean richness was significantly higher in 2006 and 2007 compared to 2004 (p=0.001). In 2006 and 2007 mean richness values were not significantly different (p=0.923). Similarly, mean Simpson's Index of Diversity values were higher in 2005 (0.831) than in 2006 (0.799), 2004 (0.736)(p=0.002) and 2007 (0.187) (p<0.001); mean values were significantly higher in 2006 compared to 2004 (p=0.013), and 2007 (p<0.001) as well as in 2004 compared to 2007 (p<0.001). Total zooplankton density, on the other hand, was significantly higher in 2006 (34,654.1 organisms/m^3) than in 2004 (19,697.3 organisms/m^3), 2007 (19,937.7 organisms/m^3) (p=0.002) and 2005

(9,627.1 organisms/m^3, p=0.004). Density was also significantly higher in 2004 and 2007 compared to 2005 (p=0.004 and p=0.0.012 respectively). Mean total zooplankton density values were not significantly different between 2004 and 2007 (p=0.949). Similar to previously monitored years cladoceran densities were low relative to rotifer and copepod densities as such would not significantly influence total density or diversity values. Further, mean cladoceran densities were lower in 2007 (10.2 organisms/m^3) than in 2006 (14.3 organisms/m^3) and 2005 (17.1 organisms/m^3), although values did not differ significantly (p=0.983 and p=0.946 respectively): mean densities were also significantly lower in 2007, 2006 and 2005 than in 2004 (85.8 organisms/m^3) (p<0.001). Mean copepod density was significantly different among all monitored years: mean values were significantly higher in 2006 (22,179.9 organisms/m^3) compared to 2007 (13,957.4 organisms/m^3), 2004 (7,719.6 organisms/m^3) (p=0.002) and 2005 (4,821.8 organisms/m^3, p=0.004). Densities were also significantly higher in 2007 than in 2004 (p=0.009) and 2005 (p=0.004), as well as in 2004 compared to 2005 (p=0.012). Mean rotifer density was significantly lower in 2007 (5,970.1 organisms/m^3) and 2005 (5,667.2 organisms/m^3) than in 2004 (12,275.3 organisms/m^3, p=0.007 and p=0.006 respectively) and 2006 (12,459.8 organisms/m^3, p<0.001). All other relationships were not significantly different. Specifically, densities in 2005 and 2007 (p=0.999) and in 2004 and 2006 (p=1.000).

Carat Lake

Levene's test for homogeneity of variances identified that variances were not equal between years at the Carat Lake monitoring station for Simpson's Index of Diversity values (Levene's statistic=3.43, p=0.036). As such, Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests for comparisons among stations. Variances for all other parameters were not significantly different and therefore the F-statistic and Tukey's post-hoc tests were used for comparisons among years.

Mean taxonomic richness was significantly higher in 2007 (18.0) than in 2005 (15.2, p=0.006), 2006 (15.0, p=0.002) or 2004 (10.3, p<0.001); mean richness was not significantly different in 2005 compared to 2006 (p=0.994), but were both significantly higher than 2004 (p<0.001). Mean Simpson's Index of Diversity values were significantly different for all monitored years; mean values in 2006 (0.841) were significantly higher than in 2005 (0.817, p=0.004), 2004 (0.776) and 2007 (0.196) (p<0.001). Mean values were significantly higher in 2005 compared to 2004 (p=0.005) and 2007 (p<0.001), as well as in 2004 compared to 2007 (p<0.001). Total zooplankton density at the Carat Lake monitoring station, although not significantly different 2005 (29,051.2 organisms/m^3) and 2006 (25,726.5 organisms/m^3) (p=0.172) were significantly higher than in 2004 (15,437.5 organisms/m^3, <0.001) and in 2007

(13,801.5 organisms/m^3, $p<0.001$). In 2004 and 2007 densities were not significantly different ($p=0.637$), and exhibited relatively low densities of zooplankton as well as low diversity, indicating that, in general, decreased densities may have been due to decreases in specific taxa. Results of comparisons between sampling years for major taxonomic groups are consistent with this. Mean cladoceran density was significantly lower in 2007 (111.1 organisms/m^3) and 2006 (138.8 organisms/m^3) than in 2005 (295.7 organisms/m^3, $p=0.006$ and $p=0.025$ respectively) or 2004 (428.0 organisms/m^3, $p<0.001$); mean cladoceran densities were not significantly different in 2005 and 2004 ($p=0.056$) or in 2007 and 2006 ($p=0.932$). Mean copepod density was significantly lower in 2007 (4,537.8 organisms/m^3) and 2004 (10,325.7 organisms/m^3) than in 2005 (13,987.3 organisms/m^3) and 2006 (15,040.1 organisms/m^3) ($p\leq0.001$). Values were also significantly lower in 2007 than in 2004 ($p<0.001$). All other relationships were not significantly different. Specifically, in 2005 and 2006 ($p=0.606$). Mean rotifer density was significantly lower in 2004 (4,682.8 organisms/m^3) than in 2007 (9,152.6 organisms/m^3), 2006 (10,547.6 organisms/m^3) and 2005 (14,768.2 organisms/m^3) ($p<0.001$). Mean rotifer densities, although not significantly different 2006 and 2007 ($p=0.388$) were significantly lower than in 2005 ($p\leq0.001$).

Jericho Lake

Levene's test for homogeneity of variances identified that variances were not equal between years at the Jericho Lake monitoring station for total density (Levene's statistic=4.59, $p=0.012$). As such, Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests for comparisons among stations for this parameter. Variances for all other parameters were not significantly different and therefore the F-statistic and Tukey's post-hoc tests were used for comparisons among years for these parameters.

Both mean taxonomic richness and total zooplankton density values were significantly higher in 2007 than 2004 and 2006, although not significantly different 2005. Specifically, mean taxonomic richness was significantly higher in 2007 (15.6) than in 2006 (13.3, $p=0.007$) and 2004 (11.1, $p=0.002$). Further, mean richness was significantly higher in 2006 compared to 2004 ($p=0.006$). Taxonomic richness in 2005 was not significantly different than 2007 ($p=0.317$) or 2006 ($p=0.068$). Similarly, total zooplankton density at the Jericho Lake monitoring station was significantly higher in 2007 (30,495.1 organisms/m^3) than in 2004 (21,871.6 organisms/m^3, $p=0.017$) and 2006 (21,408.3 organisms/m^3, $p<0.001$). Mean total density did not differ significantly among years 2005 (24,873.0 organisms/m^3), 2004 ($p=0.985$) and 2006 ($p=0.957$ and $p=1.000$ respectively) or in 2007 and 2005 ($p=0.773$). Opposite to this, mean Simpson's Index of Diversity values were significantly lower in 2007 (0.177) than in 2004 (0.750), 2006 (0.789) and 2005 (0.804) ($p<0.001$). Mean values were also significantly lower in 2004 compared to 2005 and 2006

($p<0.001$). Mean Simpson's Index of Diversity values did not differ significantly between 2005 and 2006 ($p=0.274$).

Opposite to rotifers, both cladoceran and copepod densities were significantly lower in 2006 (5.2 and 4,309.6 organisms/m^3 respectively). Mean cladoceran densities in 2007 (38.1 organisms/m^3) and 2005 (31.4 organisms/m^3) did not differ significantly from each other ($p=0.619$), however, were significantly higher than in 2006 (5.2 organisms/m^3) ($p=0.005$ and $p=0.037$ respectively) and lower than in 2004 (201.8 organisms/m^3) ($p=0.002$ and $p=0.004$ respectively). Mean copepod densities were significantly higher in 2007 (14,324.6 organisms/m^3) and 2005 (14,105.6 organisms/m^3) compared to 2004 (5,947.5 organisms/m^3, $p=0.002$ and $p=0.012$ respectively) and 2006 ($p=0.002$ and $p=0.004$ respectively). Copepod density values were also significantly higher in 2004 compared to 2006 ($p=0.048$). Neither 2007 or 2005 values differed significantly ($p=0.465$). Although rotifer densities were highest in 2006 (17,093.5 organisms/m^3), mean density values did not significantly differ from 2007 (16,132.4 organisms/m^3, $p=0.939$) or 2004 (15,722.4 organisms/m^3, $p=0.846$). Mean rotifer density at the Jericho monitoring station was significantly lower in 2005 (10,736.0 organisms/m^3) compared to 2004 ($p=0.057$), 2007 ($p=0.036$) and 2006 ($p=0.011$). It appears that lower populations of rotifers in 2005 were compensated for by higher populations of copepods.

Control Lake

Levene's test for homogeneity of variances identified that variances were not equal between years at the Control Lake monitoring station for Simpson's Index of Diversity values (Levene's statistic=8.23, $p=0.001$). As such, Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests. All other parameters did not have significantly different variances; therefore, the F-statistic and Tukey's post-hoc tests were used for comparisons among years.

Mean taxonomic richness was significantly higher in 2005 (19.0) than in 2007 (16.3, $p=0.005$), 2006 (14.4) and 2004 (12.4) ($p<0.001$); mean richness was significantly higher in 2006-07 compared to 2004 ($p=0.027$ and $p<0.001$ respectively). Simpson's Index of Diversity values were higher in 2005 (0.833) and 2006 (0.822) than in 2004 (0.703) ($p=0.003$ and $p=0.004$ respectively) and 2007 (0.207) ($p<0.001$); 2004 values were also significantly higher than 2007 ($p<0.00$). Total zooplankton densities, were not significantly different between 2004 (23,977.2 organisms/m^3), 2006 (21,695.0 organisms/m3)($p=0.821$) and 2005 (20,553.4 organisms/m^3)($p=0.640$ and $p=0.978$ respectively) or between 2005 and 2007 (12,976.8 organisms/m3)($p=0.067$). However, values were significantly different in 2007 than in 2004 ($p=0.002$) or 2006 ($p=0.015$). Although cladoceran densities were relatively low overall at the

Control Lake monitoring station, mean density was significantly higher in 2004 (168.7 organisms/m^3) than in 2005 (84.0 organisms/m^3) ($p=0.003$), 2007 (51.81 organisms/m^3) and 2006 (13.1 organisms/m^3) ($p<0.001$); mean density was also significantly higher in 2005 compared to 2006 ($p=0.021$). However, in 2007 cladoceran density was not significantly different than either 2005 ($p=0.488$) or 2006 ($p=0.257$). Mean copepod densities were significantly higher in 2005 (11,110.1 organisms/m^3) and 2004 (8,271.9 organisms/m^3) compared to 2007 (3,966.5 organisms/m^3) ($p<0.001$ and $p=0.007$ respectively). Moreover, mean copepod density was also significantly higher in 2005 than in 2006 ($p=0.005$; density in 2006 (6,186.7 organisms/m^3) was not significantly different than in either 2004 ($p=0.308$) or 2007 ($p=0.257$). Conversely, mean rotifer density was significantly higher in 2004 (15,530.7 organisms/m^3) and 2006 (15,495.2 organisms/m^3) compared to 2005 (9,359.3 organisms/m^3, $p=0.042$ and $p=0.004$ respectively) and 2007 (8.958.4 organisms/m^3, $p=0.018$ and $p=0.002$ respectively); mean densities were not significantly different in 2004 and 2006 ($p=0.749$) or in 2005 and 2007 ($p=0.808$).

Cigar Lake

Levene's test for homogeneity of variances identified that variances were not equal between years at the Carat Lake monitoring station for Simpson's Index of Diversity values (Levene's statistic=8.03, $p=0.001$) and cladoceran density values (Levene's statistic=7.22, $p=0.002$). As such, Welch statistic and Dunnett T3 post-hoc tests were used in place of the F-statistic and Tukey's post-hoc tests for comparisons among stations for these parameters. Variances of all other parameters were not significantly different between years and therefore the F-statistic and Tukey's post-hoc tests were used for comparisons.

Mean taxonomic richness was significantly lower in 2004 (10.1), in comparison to 2006 (14.7), 2005 (16.8), and 2007 (16.8) ($p<0.001$). All other relationships were not significantly different. Simpson's Index of Diversity values at the Cigar Lake monitoring station differed significantly among all monitored years and were highest in 2005 (0.825) followed by 2006 (0.801), 2004 (0.596) and 2007 (0.189). Specifically, values in 2005 were significantly higher than in 2006 ($p=0.020$), 2004 and 2007 ($p<0.001$). In 2006 values were significantly higher than in 2004 and 2007 ($p<0.001$). Furthermore, 2004 Simpson's Index of Diversity values were significantly higher than 2007 ($p<0.001$). Total zooplankton density at the Cigar Lake monitoring station was significantly higher in 2006 (33,104.9 organisms/m^3) and 2007 (31,606.6 organisms/m^3) compared to 2005 (19,875.4 organisms/m^3) and 2004 (18,587.5 organisms/m^3) ($p<0.001$). Total densities were not significantly different between 2006 and 2007 ($p=0.790$) or between 2005 and 2004 ($p=0.885$). Both cladoceran and rotifer densities were highest in 2007, indicating that both groups were driving the relationship of higher densities in 2007. Specifically, mean rotifer density was significantly higher in 2007 (24,134.8 organisms/m^3) than in 2006 (17,305.8 organisms/m^3), 2004

(11,746.7 organisms/m^3) and 2005 (9,214.5 organisms/m^3) ($p<0.001$) and mean cladocera density was significantly higher in 2007 (1096.7 organisms/m^3) in comparison to 2004 (190.9 organisms/m^3), 2005 (171.1 organisms/m^3) and 2006 (78.1 organisms/m^3) ($p<0.001$). Rotifer densities were also higher in 2006 compared to 2004 and 2005 ($p<0.001$). In 2004 and 2005 density values were not significantly different ($p=0.101$). Although cladoceran densities were highest in 2004 followed by 2005 ($p=0.998$) then 2006 ($p=0.051$ and $p=0.246$ respectively) they were not significantly different. Mean copepod densities were significantly higher in 2006 (15,720.9 organisms/m^3) than in 2005 (10,489.8 organisms/m^3), 2004 (6650.0 organisms/m^3) and 2007 (6,375.0 organisms/m^3) ($p<0.001$). Mean values were also significantly higher in 2005 compared to 2004 ($p=0.002$) and 2007 ($p=0.001$). There was no significant difference in density values in 2004 and 2007 ($p=0.987$).

4.6 BENTHIC MACROINVERTEBRATES

Summary information is presented in Table 4.8 and Figure 4.5.

4.6.1 Taxa Richness

Exploration of richness data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the data for each station was normally distributed and therefore was not in violation of this assumption of ANOVA tests. Moreover, Levene's test for homogeneity of variances resulted in this other assumption of ANOVA being met (Levene's statistic=1.92, $p=0.112$). ANOVA demonstrated the presence of significant differences in mean richness between stations (F-statistic=7.51, $p<0.001$). Further Tukey HSD post-hoc tests identified that mean richness was significantly higher at the Control Lake station (16.2) than at the near Lake C3 station (13.4, $p=0.032$), far Lake C3 station (11.4, $p<0.001$), far Carat Lake station (13.0, $p=0.010$), and Jericho Lake station (12.2, $p=0.001$). Mean richness was also significantly higher at the Cigar Lake station (14.6) and the near Carat Lake station (14.4) than at the far Lake C3 station (13.0) ($p=0.010$ and 0.018, respectively). In general, mean taxa richness was higher at control stations Cigar Lake, Control Lake, than at the far Lake C3, far Carat Lake station, and the Jericho Lake station.

4.6.2 Simpson's Index of Diversity

Mean Simpson's Index of Diversity values were found to be normally distributed (not significantly skewed or kurtotic). Levene's test for homogeneity of variance indicated that variances were statistically different between stations (Levene's statistic=3.16, $p=0.017$). Simpson's Index of Diversity values were

significantly different at stations (Welch-statistic=12.54, $p<0.001$). Dunnet's T3 post hoc tests revealed that mean Simpson's Index of Diversity values were significantly lower at the far Lake C3 station than all other stations ($p<0.014$) excluding the near and far Carat Lake stations ($p=0.632$ and 0.475, respectively). Moreover, the mean Simpson's Index of Diversity value at the far station on Carat Lake was significantly lower than at the Cigar Lake station, Control Lake station, and near Lake C3 station ($p<0.030$)

Table 4.8 Benthic macroinvertebrate parameter summary metrics at monitored stations, 2007 Jericho AEM Program.

Parameter	Lake	Station	Sample	Mean	SD	Minimum	Maximum	Significance[a]
Richness (No. taxa)	Cigar	JER-AB25	5	14.6	0.5	14	15	AB
	Control	JER-AB23	5	16.2	1.3	15	18	A
	C3 (near)	JER-AB20	5	13.4	1.3	12	15	BC
	C3 (far)	JER-AB05	5	11.4	2.1	9	14	C
	Carat (near)	JER-AB19	5	14.4	1.1	13	16	AB
	Carat (far)	JER-AB07	5	13	1.2	11	14	BC
	Jericho	JER-AB26	5	12.2	1.1	11	13	BC
Diversity (Simpson's D)	Cigar	JER-AB25	5	0.84	0.01	0.82	0.85	A
	Control	JER-AB23	5	0.84	0.01	0.82	0.85	A
	C3 (near)	JER-AB20	5	0.86	0.03	0.81	0.88	A
	C3 (far)	JER-AB05	5	0.72	0.03	0.68	0.75	C
	Carat (near)	JER-AB19	5	0.81	0.09	0.65	0.87	AB
	Carat (far)	JER-AB07	5	0.76	0.03	0.72	0.80	BC
	Jericho	JER-AB26	5	0.82	0.02	0.79	0.84	AB
Total Density (No./m^2)	Cigar	JER-AB25	5	8583.9	3854.3	4723.7	14837.8	B
	Control	JER-AB23	5	11389.1	3483.5	7491.3	15736.1	AB
	C3 (near)	JER-AB20	5	6132.2	1320.5	4158.6	7462.4	B
	C3 (far)	JER-AB05	5	17758.9	5742.1	10201.0	26313.8	A
	Carat (near)	JER-AB19	5	13064.2	3798.5	7418.9	16591.1	AB
	Carat (far)	JER-AB07	5	9838.7	4578.6	5940.9	15997.0	B
	Jericho	JER-AB26	5	9560.5	3310.7	6361.1	14634.9	B
Chironomid Density (No./m^2)	Cigar	JER-AB25	5	4639.7	1758.1	2622.7	7201.5	A
	Control	JER-AB23	5	4239.8	1468.2	2564.7	6404.6	A
	C3 (near)	JER-AB20	5	3031.3	776.2	1680.8	3521.1	A
	C3 (far)	JER-AB05	5	4851.3	2136.5	2115.5	8042.0	A
	Carat (near)	JER-AB19	5	4799.1	2002.0	1304.1	6013.4	A
	Carat (far)	JER-AB07	5	5477.2	2448.1	3463.1	9563.4	A
	Jericho	JER-AB26	5	5283.1	2327.7	3042.9	9201.2	A
Oligochaete Density (No./m^2)	Cigar	JER-AB25	5	313.0	153.9	130.4	478.2	A
	Control	JER-AB23	5	782.5	416.4	536.1	1521.5	A
	C3 (near)	JER-AB20	5	408.6	336.3	43.5	782.5	A
	C3 (far)	JER-AB05	5	173.9	162.3	29.0	449.2	A
	Carat (near)	JER-AB19	5	686.8	343.3	362.3	1086.8	A
	Carat (far)	JER-AB07	5	243.4	316.0	0.0	739.0	A
	Jericho	JER-AB26	5	104.3	62.7	14.5	173.9	A

[a] Different letter indicates statistical significance. Letters represent statistical differences among statistics at p=0.05.

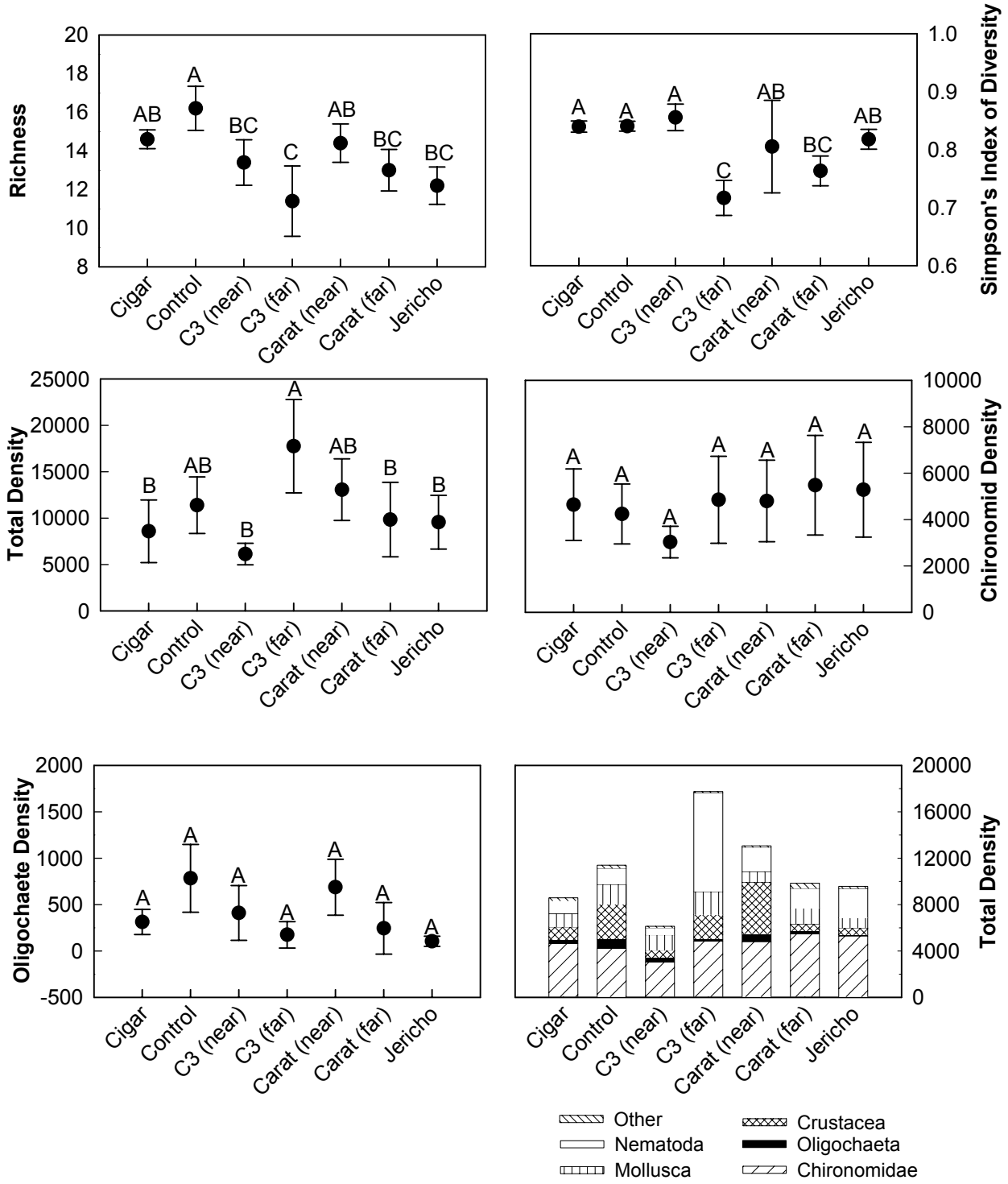

Figure 4.5 Benthic macroinvertebrate parameter summary metrics at monitored stations, 2007 Jericho AEM Program. Error bars represent 95% confidence intervals and black circles represent mean values. Letters indicate statistical significance at p=0.05. Density units are in number of organisms/m^2.

4.6.3 Total Density

Exploration of density data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the data for each station was normally distributed and therefore was not in violation of this assumption of ANOVA tests. Also, variances were found to not be different between stations, which is another assumption of the ANOVA test (Levene's statistic=0.97, p=0.461). ANOVA revealed that there were significant differences in mean density between stations (F-statistic=4.48, p=0.003). Tukey HSD post-hoc tests identified that mean density at the far Lake C3 station was significantly higher than at the far Carat Lake station (p=0.048), the Jericho Lake station (p=0.037), the Cigar Lake station (p=0.015) and the near Lake C3 station (p=0.001).

4.6.4 Chironomid Density

Exploration of density data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the data for each station was normally distributed and therefore was not in violation of this assumption of ANOVA. Also, variances were found to not to be different between stations, which is another assumption of the ANOVA test (Levene's statistic=0.50, p=0.802). ANOVA indicated that there were no significant difference in mean chironomid densities among stations (F-statistic=0.887, p=<0.517). In general, chironomid densities were lowest at the near station on Lake C3, followed by the Control Lake station and Cigar Lake station, compared to other monitored stations.

4.6.5 Oligochaete Density

Exploration of density data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the data for each station was normally distributed and therefore was not in violation of this assumption of ANOVA. Also, variances were found to be different between stations, which violated an assumption of the ANOVA test (Levene's statistic=2.88, p=0.026). The Welch test indicated significant differences among stations (Welch-statistic=4.50, p=0.014), whereas post hoc Dunnett's T3 tests indicated that there were not significant differences among site (p>0.05). In general oligochaete densities were highest at the Control Lake station and near Carat Lake station and lowest at the far Lake C3 station and Jericho Lake station.

4.6.6 Dominant Taxonomic Groups

Chironomids were the numerically dominant taxa at all stations (37% to 56%), excluding the far station in Lake C3, where nematodes dominated (48%). High total mean densities found at the far station on Lake C3 were the result of high relative number of nematodes, rather than a proportional increase in all taxa. In

contrast, high relative densities in Control Lake and the near station in Carat Lake were the result of high relative numbers of crustaceans (27% and 34% of total abundance, respectively) compared to other stations (<13%). Although oligochaetes can be numerically dominant in these systems, oligochaetes were found at the lowest densities compared to other major taxonomic groups at all stations (1% to 7%). Mollusca (7% to 21%) and Crustacea (6% to 34%) were important taxonomic groups at all stations. Overall, data suggest that 1) the importance of major taxonomic groups was not consistent among stations and 2) that increases in a single taxonomic group (nematodes or crustaceans) can lead to high overall station macroinvertebrate density.

4.6.7 Historical Trends

Taxa Richness

Exploration of richness data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the richness data for each monitored year at each station were normally distributed and therefore were not in violation of this assumption of ANOVA. Yearly variances were found to be different for the Cigar Lake (Levene's statistic=4.99, p=0.012) and Jericho Lake (Levene's statistic=3.99, p=0.027) stations, which violated an assumption of the ANOVA test. Yearly variances were similar for the remaining monitored stations.

In general, mean richness (# of different taxa) at monitoring stations did not demonstrate significant changes during the 1999 to 2007 monitoring periods, with the exception of the Carat Lake stations. Specifically, mean richness values at the Carat Lake far station were significantly higher in 2005 than in 2004 (p=0.047) and mean richness values at the Carat Lake near station were significantly higher in 2007 and 2006 than in 2004 (p=0.022 and 0.007, respectively). On the other hand, richness values at the Lake C3 near station (F-statistic=1.59, p=0.215), Lake C3 far station (F-statistic=1.20, p=0.336), Control Lake station (F-statistic=2.83, p=0.052), Cigar Lake station (Welch-statistic=1.06, p=0.418), and the Jericho Lake station (Welch-statistic=1.02, p=0.431) were not significantly different between years.

Simpson's Index of Diversity

Exploration of Simpson's Index of Diversity data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the Simpson's Index of Diversity data for each monitored year at each station were normally distributed and therefore were not in violation of this assumption of ANOVA. Yearly variances were not significantly different for any stations and therefore did not violate this assumption of the ANOVA test.

In general, mean Simpson's Index of Diversity values showed an increase from the 2004 to 2006 monitoring periods with a slight decrease in 2007. The exception to this trend was at the Carat Lake stations where peak values occurred in 2005. When 1999 data were included, there was a general linear increase in values through time at the near station on Lake C3 and at the station in Cigar Lake. Conversely, at the Control Lake station and Carat Lake near station, 1999 values were higher than most other years. These data trends indicated that local station factors were influencing diversity values, at some stations, and as such diversity values were less dependent on annual factors such as weather. Interestingly diversity remained low at the far station in Lake C3 in general.

In terms of statistical significance, at the Cigar Lake station, Simpson's Index of Diversity values were significantly higher in 2007 than in 2005 ($p=0.026$) and 2004 ($p=0.012$) but not 2006 ($p=0.380$). Between-year patterns for years 2004, 2005, and 2006 were not statistically significant, likely due to high within station variability. At the Control Lake station Simpson's Index of Diversity values were significantly higher during 1999 than all other years ($p<0.018$); all other relationships were not statistically significant. Although diversity values at the Lake C3 near station appeared greater in 2006 compared to other monitored years, this pattern was not statistically significant (ANOVA; F-statistic=1.62, $p=0.208$). At the Lake C3 far station however, Simpson's Index of Diversity values were significantly higher during 2006 than in 2007 ($p=0.045$) and 2005 ($p=0.004$); data were not collected during 1999 or 2004. At the Carat Lake far station Simpson's Index of Diversity values were significantly higher in 2005 than in 2007 ($p=0.014$); all other relationships were not statistically significant. At the Carat Lake near station and Jericho Lake station, Simpson's Index of Diversity values were not significantly different between years (F-statistic=1.98, $p=0.137$ and F-statistic=1.14, $p=0.364$, respectively).

Total Density

Exploration of total density data through probability plots, skewness and kurtosis evaluation, and histograms indicated that the total density data for each monitored year at each station were normally distributed and therefore were not in violation of this assumption of ANOVA. Yearly variances were significantly different for the Carat Lake stations, the near station in Lake C3, and the Control Lake station and therefore this assumption of the ANOVA test was violated. Yearly variances in total density were not significantly different at the far station on Lake C3, the Cigar Lake station, and the Jericho Lake station.

There were two temporal patterns that were apparent at benthic monitoring stations in regards to total density of benthic macroinvertebrates. At the Control Lake station and both Carat Lake stations mean densities increased from 2004 to 2007, whereas at the Cigar Lake, Lake C3 (near) and Jericho Lake stations densities were generally highest in 2005 and 2007 and lowest in 2004 and 2006. Mean densities during the 1999 sampling period were highest of all monitored years at the Control Lake and Lake C3 (near) than for all other years; at the Carat Lake stations, 1999 densities were within the range for other monitored years.

At the Cigar Lake station, mean densities in 2005 were significantly higher than in 2006 ($p=0.015$) and 2007 ($p=0.011$); all other relationships were not statistically significant. At the Control Lake station, mean densities of benthic macroinvertebrates were significantly higher in 1999 compared to all other years ($p<0.001$). In addition, mean densities were significantly lower in 2004 compared to 2007 ($p=0.045$); all other comparisons were not significant. At the near station in Lake C3, far station in Carat Lake, and Jericho Lake station mean densities were not significantly different among years (Welch-statistic=1.21, $p=0.367$; Welch-statistic=2.61, $p=0.067$; F-statistic=1.57, $p=0.237$, respectively). At the far station in Lake C3, mean densities were not recorded during 1999 and 2004; densities were significantly higher in 2007 compared to 2006 ($p=0.011$) whereas all other relationships were not statistically significant. At the near station in Carat Lake, values in 2007 were significantly higher than in 2004 ($p=0.018$) but although values in 2007 were higher than in all other years, relationships were not significant due to high variability in 2007. Mean total density at the near station in Carat Lake in 2006 was also significantly higher than in 2004 ($p=0.001$) and 2005 ($p=0.034$).

Chironomids

In general chironomid density was temporally variable at stations. At the controls (Cigar Lake and Control Lake) and Jericho Lake stations chironomid densities did not show any temporal patterns. Conversely, at the stations on Lake C3 and Carat Lake, chironomid densities appeared to increase through time. In terms of statistical significance, at the Cigar Lake station mean chironomid density was significantly higher in 2005 than in 2006 ($p=0.002$) and 2007 ($p=0.001$) but, due to high variability in 2004, not 2004 ($p=0.205$); all other relationships were not significant. At the Control Lake station mean chironomid density was significantly higher in 1999 than in 2004, 2005, and 2006 ($p<0.001$) but not than in 2007. Mean densities were also significantly higher in 2007 than in 2005 ($p=0.021$). At the near station in Lake C3 although the ANOVA model was significant overall ($F=2.96$, $p=0.045$), post-hoc tests were not strong enough to detect differences among years. At the far station in Lake C3, chironomid densities

did not significantly differ among monitored years (2005, 2006, and 2007) (F=2.99, p=0.088). At the Carat Lake near station mean chironomid density in 2006 was significantly higher than in 1999, 2004, and 2005 (p<0.001) but not 2007. Moreover, values in 2007 were significantly higher than in 1999 (p=0.006) and 2004 (p=0.014). Similarly, at the Carat Lake far station mean chironomid density in 2006 was significantly higher than in 1999 and 2004 (p=0.010 and 0.002, respectively). Moreover, values in 2007 were also significantly higher than in 2004 (p=0.017). At the Jericho Lake station, mean chironomid density was significantly higher in 2007 than in 2004 (p=0.016) and 2006 (p=0.038). Mean chironomid density was also significantly higher in 2005 than in 2004 (p=0.030); all other relationships were not significant.

Oligochaetes

Oligochaete density was temporally variable at some stations, with oligochaete densities in some years tripling densities in other years. Conversely, at other stations oligochaete densities were similar throughout sampling years. For example, oligochaete densities were consistently low at the Jericho Lake station and far station in Lake C3 (only three years of data). In general, oligochaete densities were higher at the Control Lake station, Carat Lake far station, and Lake C3 near station, and oligochaete densities were highly variable among years.

In terms of statistical significance, mean oligochaete density was not significantly different between years at the Cigar Lake station (F-statistic=0.307, p=0.820). At the Control Lake station, mean oligochaete density was significantly higher in 1999 than in 2004 (p=0.016), 2005 (p=0.018), and 2006 (p=0.020); none of the other relationships between years were statistically significant. Conversely, at the Lake C3 near station, mean oligochaete density was significantly higher in 2006 than in 1999 (p=0.001), 2004 (p=0.003), 2005 (p=0.022), and 2007 (p=0.016). At the far station on Lake C3, oligochaete densities were low overall and did not differ between monitored years (F-statistic=1.44, p=0.275). At the near station on Carat Lake, mean oligochaete density in 2006 was significantly higher than 2004 (p=0.027); despite mean values being highest overall in 2007 and 1999, due to high within site variability, all other relationships were not significant. At the far station in Carat Lake, mean oligochaete density in 1999 was significantly higher than in all other monitored years (p<0.001); all other relationships were not significant. At the Jericho Lake station, although mean oligochaete density was low overall, values in 2007 were significantly higher than in 2006 (p=0.018); all other relationships between years were not statistically significant.

5.0 SUMMARY

Indicators monitored in 2007 during the Jericho AEM Program included water chemistry, lake profile parameters (dissolved oxygen, temperature profiles, and secchi depth), sediment deposition, phytoplankton, zooplankton, and benthic macroinvertebrate communities. Parameter data were compared among monitoring stations in 2007 and to previously collected data, where possible.

Water Chemistry

Presented under separate cover.

Lake Profile

In July 2007, all lakes were stratified with most lakes displaying a strong thermocline between 8 m and 11 m; Carat Lake exhibited a weak thermocline. In summer dissolved oxygen concentrations were near saturation at the water surface in all monitored lakes. Dissolved oxygen concentrations decreased with depth, but remained high at all monitored stations.

Sediment Deposition

In 2007, the amount of sediment deposited and sediment deposition rate was higher at Carat Lake stations compared to stations in other lakes. Sediment deposition values in 2007 were generally higher than values recorded in 2006.

Phytoplankton

In 2007, phytoplankton density was generally similar among lakes. They were reduced in comparison to 2006, but comparable to 2004 and 2005. Overall, chlorophyll *a* levels were highly variable spatially. Near-field and far-field lakes did not have predictably higher or lower productivity than control lakes. Chlorophyll *a* also was highly variable from year to year. Community structure in terms of dominant taxonomic groups was consistent among lakes and among years, indicating that phytoplankton community structure was stable. In summary, high yearly variation in several parameters may decrease the ability to detect potential effects of mining on phytoplankton.

Zooplankton

Zooplankton densities were variable among lakes in 2007; total densities were highest in Cigar Lake and Jericho Lake. In 2006, highest densities occurred in Lake C3 and lowest densities in Jericho Lake. In contrast, 2005 densities were highest in Carat Lake and lowest densities in Lake C3. Community

composition was relatively consistent among lakes for the dominant taxonomic groups. However; there were differences for cladocerans. Cladocerans made up a very small proportion of the overall community in terms of density; numbers were very low in all lakes except Cigar Lake. In summary, between-year comparisons showed that zooplankton abundance was highly variable between years and patterns were not consistent between waterbodies. Again, high temporal and spatial variability may make it difficult to identify potential effects of mining activity on the zooplankton community.

Benthic Macroinvertebrates

In 2007, benthic macroinvertebrate community densities were variable among stations and there were no consistent patterns. In 2007, no lake demonstrated consistently highest densities. Although Cigar Lake had considerably higher densities than all other stations in both 2004 and 2005, in 2006 Carat Lake had the highest densities. This indicated that relationships between stations were temporally variable. In general, chironomids were the dominant taxonomic group in all waterbodies in 2007. This was generally similar to 2005 and 2006. Overall, these data demonstrated high between-year variations in benthic community characteristics.

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