KJB.

KNIGHT PIESOLD LTD.
RECORD OF TELEPHONE CONVERSATION

BETWEEN: Leslie Smith (UBC)

DATE: Aug. 9/96.

TIME: 3:30 pm.

AND: MDG.

FILE NO: Mt. Polley 1625.01

RE: Hydrogeology

Re: Groundwater Monitoring Program.
Expert Hydrogeologist Review.

L.S. Yes, can perform review of program but on Holidays all of next week (Aug. 12-16). Available on Aug. 19.

L.S. Also suggests Roger Beckie (UBC Prof.) who is back next wednesday (Aug. 14). Ph: 822-6462.

Tony Sperling has own firm - Sperling Engineering.
Formed partnership w/ mining person from Highland Valley.
May be competition. - ph: 986-7723.
→ may be Bruce Geotechnical?

Al Freeze?

Signed:

Copy to:

KNIGHT PIESOLD LTD.
IN/OUT 8/22/96

NAME	ROUTING	DATE READ	ACTION BY	REPLY DATE
JPH				
BSB				
KJB	KJB			
TFK				
MDG	1	MDG		
AH				
WJ				
SP				
FILE				

1625.014
6/2891
August 22, 1996

Dr. Leslie Smith, P. Eng.
University of British Columbia
Department of Geological Sciences
6336 Stores Road
Vancouver, B.C. V6T 1Z4

Dear Dr. Smith;

Re: Mt. Polley Project
Groundwater Monitoring Program

As per your discussion with Murray Gant we are sending you reference information and correspondence pertaining to the Groundwater Monitoring Program for the Mt. Polley Project in central British Columbia. Enclosed are the following:

- "Groundwater Monitoring Program (Ref. No. 1624/2)", dated June 3, 1996, by Knight Piesold Ltd.
- Copy of letter from the B.C. Ministry of Environment, Lands and Parks (MELP) Re: "Comments on the Imperial Metals Corporation Mount Polley Project Environmental Baseline Report 1995, Prepared by Hallam Knight Piesold and dated March 1996, and related Groundwater Monitoring Documents" (only pages relevant to responses to "Groundwater Monitoring Program (Ref. No. 1624/2)" prepared by Knight Piesold Ltd.).
- "Response to Review Comments on Groundwater Monitoring Program (Ref. No. 1625/7)" and "Requirements and Specifications for the 1996 Groundwater Monitoring Program (Ref. No. 1625/8)", both prepared by Knight Piesold Ltd., August 20, 1996 (pending review by third party expert hydrogeologist).

As requested by MELP, we require an independent review by a qualified expert hydrogeologist on the proposed groundwater monitoring program for the project. The scope of work includes a review of the existing reference information (listed above) as well as a review and recommendations on the proposed program, in particular with respect to groundwater well installations, well development procedures and methodology and protocol for groundwater sampling.

It is understood that you will be able to carry out this work sometime within the next two days at which time we will meet with you to discuss any questions and final recommendations you may have. The intent is that you will produce a letter summary report which includes your review comments and suggestions to Knight Piesold for submission along with the Knight Piesold documents (Ref. Nos. 1625/7 and 1625/8) to Imperial Metals Corporation and the Ministry of Environment, Lands and Parks for approval of the program.

Please call Murray Gant or myself if you require further information or have any questions.

Yours very truly,
KNIGHT PIESOLD LTD.

K.J. Brouwer, P.Eng.
Director

/mdg
Enclosures

cc: Brian Kynoch, Imperial Metals Corporation (excluding KP Report 1624/2)

Hallam Knight Piésold Ltd.
ENVIRONMENTAL CONSULTANTS

MEMORANDUM

Date: August 2, 1996

To: Ken Brouwer cc: Malcolm Swallow (MPMC)

From: Dan Royea **Reference::** H1221

Re: **Mount Polley Groundwater Baseline Reports**

Dear Ken,

We received commentary from Joe Negraeff of the Ministry of Environment (dated July 22, 1996) regarding the Environmental Baseline Report 1995 and "related Groundwater Monitoring Documents".

I have attached copies of the relevant pages of the Negraeff letter (Sections B and C; pp.20 - 25) concerning reports generated by KP. These reports are:

1624/~~1~~2 Groundwater Monitoring Program; June 3, 1996
1625/5 Manual on Sampling and Handlin~~k~~g Guidelines for Determination of Groundwater Quality; May 19, 11995

Mr. Negraeff's comments include general statements, requests for clarification on statements in the reports, and requests for additions and modifications to the program.

These items must be addressed in the very near term. MELP have stated that they will not process the Waste Management Permit until their questions etc. have been satisfactorally answered.

HKP is committed to responding to pp.1-19 statement for earliest possible submission. We can also assist you in the responses regarding report 1625/5. — have provided comments in margins

Please see me regarding this matter at your earliest convenience.

Yours truly,

D. Roye

P.S. We would like to have copies of the two reports referenced above for our Project files. Could you see that these are prepared for us? Thanks.

Suite 1450 - 750 West Pender Street, Vancouver, B.C., V6C 2T8
Telephone: (604) 685-0545 Facsimile: (604) 685-0541

Province of
British Columbia

MINISTRY OF
ENVIRONMENT,
LANDS AND PARKS

BC Environment

Cariboo Region

Environmental Protection
Ste. 400 - 640 Borland St.
Williams Lake, British Columbia

V2G 4T1
Telephone: (604) 398-4533
Facsimile: (604) 398-4214

July 22, 1996

RESPONSE

A.S.A.P.

- go through

RECEIVED JUL 2 6

Imperial Metals Corporation
Suite 700-815 West Hastings St.
Vancouver, B.C., V6C 1B4

Attention: Malcolm Swallow

Re: Comments on the Imperial Metals Corporation Mount Polley Project Environmental Baseline Report 1995, prepared by Hallam Knight Piésold and dated March 1996 and related Groundwater Monitoring Documents.

Please find below detailed comments on the above mentioned report brought to my attention by K.Andrews, Impact Assessment Biologist and E. Plain, Air Resources Officer, Environmental Protection, Williams Lake. I am concerned that the data collected and presented in this report deviated significantly in a number of areas that were in the attachment to the March 6, 1995 letter from K. Andrews to you (enclosed with this letter). In my opinion the incompleteness in the data collection process and the failure to follow the recommended collection methodology in specific instances may compromise the usefulness of the "pre-development" environmental database at Mt. Polley to provide a sound record for comparison to future conditions. In cases where baseline data is incomplete or of poor quality, you will be required to resubmit it as detailed below. Where development has already altered environmental conditions from baseline, and this information can no longer be collected, our Ministry will take a conservative approach in assessing mine impacts, requests for discharge and the setting of site specific water quality objectives, should they become necessary in the future.

B. || Where deficiencies are noted below, you are requested to provide the information to this office as soon as possible. This office will not conduct any further work on processing applications for a Waste Management Permit until the information is provided. Also be reminded that Mine Permit M-200 [page 5, Section 1 (a)] requires that the baseline environmental monitoring program be completed to the satisfaction of the Regional Managers of Environmental Protection, and Fish and Wildlife, Ministry of Environment and the Chief Inspector of Mines.

A. Imperial Metals Corporation Mount Polley Project Environmental Baseline Report 1995.

Page 2-1

Section 2.0 Creek Samples

p 6-2

Section 6.3 Results and Discussion

DJR

- The vegetation types reported in tables 6.1, 6.2 and 6.3 should be identified by the scientific (i.e.latin) names, in addition to the common names. Please report this information to us in writing.

p 7-1

Section 7.0 Groundwater Sampling

Section 7.1 Introduction

NOTED.

- Please note that the Guidelines for Minimum Standards in Water Well Construction for the Province of B.C. are directed at production wells ie. for development of water supplies. Optimal construction of monitoring wells differs somewhat from production wells in choice of well drilling machinery, well casing diameter, materials, and well development prior to sampling.

- should we be sampling production wells?
(MPMC had original intent ...)
check with Brian Kynoch or
Malcolm Swallow

NO.
"Brian"
Folley

p 7-2

Section 7.2 Methods and Materials

who knows; DM?

- Are joins in the PVC well casings in the 1995 wells, welded or threaded? Weld materials can contribute to metals contamination. PVC casing and screens should be threaded not welded to avoid potential for contamination from the weld compounds.

- Groundwater samples should be free of particulates and kept anaerobic as they would be in-situ in the ground ie. no air or head space in the sample container. It is desirable to collect dissolved metals samples in groundwater without exposure to air by using "in-line" filtration methods to ensure no oxidation of iron etc. to ferric iron, which in turn precipitates as particulate ferric hydroxide or oxyhydroxides scavenging other dissolved metals species such as arsenic, cadmium, lead and vanadium with it in the process. This will lead to underestimation of the dissolved concentration of any metal.

HKP
checking
on addi
to progra

- If there are lots of suspended solids in a groundwater sample as is the case of the '89 series wells around the tailings pond, this means either the well has not been properly developed prior to sampling, i.e. (a) the fines present after well development were not flushed or cleaned out of the well, (b) that regular maintenance is not performed prior to sampling the well to remove sediment or precipitates that have formed between samplings or (c) that precipitates (particulate matter) have formed in the sample due to exposure to air during the sampling process.

- do we need to have the
wells re-developed?

*

- We insist that the monitoring wells to be constructed in 1996 around the tailings pond and elsewhere as described below, meet acceptable monitoring well specifications as detailed in numerous EPA and CCME publications on groundwater sampling methodology e.g. EPA/625/6-87/016, EPA/625/6-90/016b, EPA/625/R-93/003a; and CCME EPC-NCSRP-48/E (March 1994) etc.

- It would be worthwhile contacting some industry experts with practical field experience in groundwater sampling for metals, to gain from their experience with pumps, well maintenance, sampling equipment, in-line filtration etc. for the objective of obtaining good quality groundwater chemistry result especially for dissolved metals.

p 7-2

Section 7.3.1 Open Pit/Mill Site

ted

- Please note in this and subsequent sections i.e. 7.3.2 etc., that there is no B.C. Water Quality Criteria (BCWQC) for "total" aluminium for aquatic life. The only BCWQC for aluminium for aquatic life is for the "dissolved" form of aluminium.

B. Imperial Metals Corporation Mt. Polley Project Groundwater Monitoring Program (Ref. No. 1624/2), June 3, 1996.

p 8

Section 2.1.3 Open Pits

Section 2.1.6

- At the bottom of the page it says the groundwater flows northeast towards NE Edney Creek Tributary. From the contours shown in Figure 2.3, it would seem that the groundwater flows would be to the east-southeast. Please clarify.

p 10

Section 2.3 1995 Monitoring Well Program

- The 110 mm diameter PVC wells installations sited around the pit area are ideal for production i.e. dewatering, but not necessarily for monitoring. They will take considerable effort to purge prior to collection of water quality samples when they are not in use for dewatering. By having multiple screened zones in one casing or borehole, there will be a lot of mixing and diluting of groundwater from the different aquifer zones intercepted by the one casing. The drill logs indicate there are very significant aquifers at different levels in the same boreholes. Multiple small diameter casings each sealed in the different aquifers in each borehole would give more valuable information as to groundwater quality, its source and potential problem in the discharge area if known.

suggestion noted – do we implement?

- Again please explain the rationale for the siting of two groundwater monitoring wells almost side by side (95-R-2 and 95-R-7) as indicated in Figure 2.4. It is assumed that these wells are situated and constructed primarily for dewatering purposes, with monitoring a secondary consideration. We would like to see installation of an additional well designed strictly for monitoring purposes, , to be located between the central pit and Bootjack Lake, possibly off the main road below the most south westerly corner of the central pit in the "draw" that is apparent from the contours in Fig 1.3. The siting of this well should be done in consultation with a qualified hydrogeologist to ensure it is optimally located for detection of contaminated groundwater migrating from the pit area to Bootjack Lake. This should be done as soon as possible so that baseline data may be collected prior to mining. |||.

- We are also concerned that only one monitoring well (95-R-5) was installed along the entire basal perimeter of the southeast waste rock dump (which is some 2.5 km in length) and that it is located at the extreme north end of the dump. We will require the installation of 2 -3 additional wells designed specifically for monitoring purposes to monitor contaminant migration in groundwater flow downgradient from the waste rock dump towards Polley Lake and Bootjack Ck. Again the siting of these wells should be done in consolation with a qualified hydrogeologist to ensure they are optimally located for the above mentioned purpose. |||.

- What was the groundwater level in the '95 series wells at the time of completion? This is not indicated in the Appendix B well log or the Appendix C borehole information. Please provide this information in writing to this office.

p 15

Section 3.2 Tailings Storage Area

Section 3.2.1 Baseline

This section states that the tailings area baseline groundwater quality is poor, however the poor quality of the groundwater in this area may be exaggerated by poor well construction and development technique, as recognized in Section 2.2 of this report and as documented by Marc Zubel, Senior Groundwater Engineer, Water Management Br. Victoria, B.C., in his Feb. 4, 1991 comments to A.P. Kohut on the Mt. Polley Copper/Gold Project Stage I Addendum Report (Oct 1990).

p 16

Section 3.2.2 Operational

- One of the objectives of the Mt. Polley groundwater monitoring program as required by BCMELP and identified on page 2 of this report was to locate the seepage collection pond and recovery wells to ensure optimal recycling of seepage from the tailings pond during operations. This objective does not appear to be addressed in this report. Please respond as to whether the seepage pond has been optimally located for tailings pond seepage recovery? Does it capture all of the potential "discharge" in the sandy area in the vicinity of the main tailings embankment, identified during the initial drilling in the tailings pond area?

- I do not have a copy of the Report referred to in this section ie. Report on Project Water Management, Ref.No 1624/1. Could you please provide me with a copy.

Section 3.2.3 Post Closure

- What is the basis for stating that the groundwater quality from the tailings impoundment will improve to levels better than baseline values? Is this due to a reduction in recharge for the drainage area due to change in permeability of surface material compared to pre-tailings pond conditions? or to better monitoring well installations, where the suspended sediment content, will be reduced or eliminated and therefore enhance the quality of the groundwater samples collected?

p 18

Section 4.0 Groundwater Monitoring Program

- The person who collects the groundwater samples, should not only be trained in environmental procedures, but be trained in and very familiar with proper groundwater quality monitoring procedures. → YES - HKP has trained technician in accordance with manual 1625/5

Figure 1.2

- How will the spring in the southwest corner of the tailings pond be capped off?

- Dam (except Appendix D-last page).

C. Imperial Metals Corporation Mt. Polley Project: Manual on Sampling and Handling Guidelines for Determination of Groundwater Quality (Ref. No. 1625/5), May 19, 1995

I am pleased to see this manual has been prepared for the Imperial Metals Mt. Polley Project. Except for some comments noted below, this manual should be followed for all groundwater monitoring to ensure standarization of procedures and maximize comparability and quality of results.

p 2

Section 2.1.1 Sample Collection

- The disposable latex gloves should be the non-powdered type, as the talc in the powdered type are a source of a number of metals that may contaminate the samples. Polyethylene gloves are preferable. - using polyethylene ✓
- What material is the bailer made from? Polyethylene.

p 4

Section 2.1.2 Sample Preparation and Preservation

- How is nitric acid dispensed? Single service vials? yes.

HKP investigating for 1996 implementation

- In-line filtration methods such as the Gelman high capacity filter should be employed for filtration of dissolved metals samples to ensure there is no exposure to air which oxidizes iron in the samples which in turn scavenges dissolved metals, thereby underestimating the dissolved portion of the metals. In groundwater situations there should be very little to no particulate in the water samples unless the well has not been properly developed or if oxidation occurs allowing precipitates to form on the inside of the well casing and immediate aquifer material around the well casing. Wells susceptible to such precipitate formation or sediment accumulation should be cleaned and pumped 2 to 3 weeks prior to sampling to remove the precipitates/sediment from the well prior to actually collecting samples.

p 8

Section 3.5 Step 5 - Collect Samples

- Are any of the bottles certified clean for a specific type of sample analysis e.g. are the metals bottles pre-cleaned (acid rinsed etc.) by the supplier? if so, they should not be rinsed in the field, prior to sampling, provided they are stored in a closed, contaminant free condition.

no. — all are supplied

- Hg samples should be collected in precleaned glass or preferably teflon bottles, not plastic. Hg readily moves into or out of plastic containers depending on the vapour gradient.

- Section 3.6 Step 6 - Filtration of Samples

- See comments above on filtration.

- Samples for "total" mercury analysis should not be filtered? Once a sample is filtered, it is considered "dissolved" ie. passing a 0.45 um filter pore size.

— they aren't (Typo?)

p 9

- A clean bottle should always be used to collect the filtered metals sample. Never reuse the same bottle used to collect the original sample. The saving in the price of a bottle is not worth the compromise in the quality of results.

— filtered ~~material~~ sample IS collected in a fresh bottle. (We should change the report wording to reflect this).

p 13

Section 4.0 Quality Control and Data Review

- It is very important to include field method blanks, sampler blanks, transportation blanks, and replicates in the groundwater quality monitoring program to assess the potential for sample contamination and to assess sampling precision and variability. Please add an appropriate number of the above types of QA/QC samples to the groundwater monitoring program up to at least 10% of total samples.

We currently have transport blanks + replicates. Will ask ASL re: field method + sampler blanks

Appendix A Record Sheets

- Please add a sampling "time" column to the Mt. Polley Project GW Sampling Quality Control Chain of Custody Record Sheet.

Will do.

Appendix D Baseline Groundwater Quality Data to the End of 1995

eed to
e
efore
umenting

- Where are the field test results and static water level data for these sampling dates and locations?

- Is there sampling data for well no. 95-R-2? If so, please report it to this office.

- Also please report appropriate QA/QC sample results if any are available.

- Suspended solids in wells MP 89-234 and MP89-236 are unacceptably high (i.e. 240-548 mg/L) and appear to have influenced the total iron (i.e. 4.42-15.3 mg/L) and therefore possibly other metals results. Suspended solids results are not reported for MP89-~~221~~ 231, MP89-232, MP89 233. This information should be reported in order to assess the total and dissolved metals data. Total iron in well no. MP89-~~321~~ (231) to 232 was 11.9 to 29.3 mg/L.

When the environmental baseline data has been completed/corrected in all areas, we would like in addition to a new corrected hard (paper) copy, an electronic copy, compatible with Excel 5.0. Any copies of the report under review that have been incorporated into other documents, such as the Reclamation Plan should be likewise corrected and replaced in the next edition of these documents.

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

RESPONSE TO REVIEW COMMENTS ON GROUNDWATER MONITORING PROGRAM
(REF. NO. 1625/7)

1.0 GENERAL

The following is a response to the review comments submitted by Mr. Joe Negraeff of the Ministry of Environment on July 22, 1996, with respect to the Environmental Baseline Report 1995 and related Groundwater Monitoring Documents. This document specifically contains only the relevant responses to the review comments pertaining to the groundwater monitoring program as originally documented in the following:

- "Imperial Metals Corporation Mount Polley Project Environmental Baseline Report 1995", by Hallam Knight Piesold Ltd. (Section 7.0 only);
- "Manual on Sampling and Handling Guidelines for Determination of Groundwater Quality (Ref. No. 1625/5)", dated May 19, 1995, by Knight Piesold Ltd.; and
- "Groundwater Monitoring Program (Ref. No. 1624/2)", dated June 3, 1996, by Knight Piesold Ltd.

This document is organized in a manner whereby the review comment is listed followed by the response. Reference numbers are provided as per the original Environmental Baseline Report (1995) submitted for review. In some instances the response may take the form of a reference or clarification of information originally submitted for agency review.

The groundwater wells installed at the proposed minesite in 1995 were installed by Imperial Metals Corporation (IMC) for the primary purpose of investigating open pit dewatering and water supply for mill process requirements. The 1995 wells were installed without the direction or supervision of Knight Piesold Ltd. The details of installation were provided to Knight Piesold Ltd. by IMC and were included in the Report Ref. No. 1624/2.

IMC has recently provided further details on the 1995 installations. Specifically, the wells comprise 5 inch diameter, flush jointed PVC pipe which were grouted inside 6 inch diameter steel casings to a minimum depth of 5 m or to bedrock. The PVC included slotted sections in the aquifers to maximize water recovery. The use of the 1995 wells as groundwater monitoring wells was considered to be a secondary objective and are intended to provide information on groundwater quality during operations.

Subsequent to the review comments and consideration of the importance of groundwater quality sampling and associated monitoring of potential hydrogeologic impacts on surrounding surface drainages, the 1996 groundwater monitoring program has been revised. Provisions have been included for the installation of a total of eight (8) additional wells (three new wells in addition to the five originally proposed for the tailings facility area, as documented in Report Ref. No. 1624/2) dedicated for the purpose of monitoring groundwater quality. The 1996 groundwater monitoring wells will be used to collect baseline groundwater quality and for monitoring groundwater quality during operations and at closure. Details on the proposed groundwater monitoring wells are included in the "Requirements and Specifications for the 1996 Groundwater Monitoring Program (Ref. No. 1625/8)" which accompanies this document.

2.0 RESPONSES TO REVIEW COMMENTS

The following are responses to review comments made by the Ministry of Environment, as documented on July 22, 1996, specifically relating to the groundwater monitoring program.

A. Imperial Metals Corporation Mount Polley Project Environmental Baseline Report 1995.

Section 7.0 Groundwater Sampling

Section 7.1 Introduction

Comment: *"Please note that the Guidelines for Minimum Standards in Water Well Construction for the Province of B.C. are directed at production wells i.e. for development of water supplies. Optimal construction of monitoring wells differs somewhat from production wells in choice of well drilling machinery, well casing diameter, materials, and well development prior to sampling"*.

Response: Additional groundwater monitoring wells will be installed in 1996 in accordance with accepted standard practice for groundwater monitoring wells, as per EPA, CCME and ASTM criteria (see accompanying Report Ref. No. 1625/8 for details).

Section 7.2 Methods and Materials

Comment: *"Are joins in the PVC well casings in the 1995 wells welded or threaded? Weld materials can contribute to metals contamination. PVC casing and screens should be threaded not welded to avoid potential for contamination from the weld compounds"*.

Response: The 1995 wells included 5 inch diameter Schedule 40 flush jointed, threaded PVC casing and screens, as per recent information provided by Imperial Metals Corporation. All PVC casing and screens for the 1996 wells are also to be flush jointed, threaded PVC.

Comment: *"Groundwater samples should be free of particulates and kept anaerobic as they would be in-situ in the ground (i.e. no air or head space in the sample container). It is desirable to collect dissolved metals samples in groundwater without* *exposure to air by using "in-line" filtration methods to ensure no oxidation of iron etc. to ferric iron, which in turn precipitates as particulate ferric hydroxide or oxyhydroxides scavenging other dissolved metals species such as arsenic, cadmium, lead and vanadium with it in the process. This will lead to underestimation of the dissolved concentration of any metal".*

Response: Agree that groundwater samples should be kept free of particulates and kept anaerobic. In-line filtration will be used for the collection of dissolved metals samples to prevent samples from becoming oxidized.

Comment: *"If there are lots of suspended solids in a groundwater sample as is the case of the '89 series wells around the tailings pond, this means either the well has not been properly developed prior to sampling i.e. (a) the fines present after well development were not flushed or cleaned out of the well, (b) that regular maintenance is not performed prior to sampling or (c) that precipitates (particulate matter) have formed in the sample due to exposure to air during the sampling process".*

Response: Agree. All proposed 1996 monitoring wells will be developed immediately following installation to remove all fine-grained sediment that may cause clogging. Some of the 1989 series wells will be plugged and decommissioned as part of the tailings facility construction program. However, existing 1989 series wells which are outside of the tailings basin will be salvaged or replaced. All wells will be re-developed as necessary during mine development if sediment is observed in the samples.

Comment: *"We insist that the monitoring wells to be constructed in 1996 around the tailings pond and elsewhere as described below, meet acceptable monitoring well specifications as detailed in numerous EPA and CCME publications on groundwater sampling methodology e.g. EPA/625/6-87/016, EPA/625/6-90/016b, EPA/625/R-93/003a; and CCME EPC-NCSRP-48/e (March 1994) etc.".*

Response: The specifications for the 1996 groundwater monitoring wells will meet the necessary EPA and CCME criteria and shall be consistent with ASTM D5092 for groundwater monitoring wells. Details of the proposed 1996 installations are included in the accompanying Report Ref. No. 1625/8. This revised installation procedure will mean that the wells cannot be converted to groundwater pumpback wells as originally intended.

Comment: *"It would be worthwhile contacting some industry experts with practical field experience in groundwater sampling for metals, to gain from their experience with pumps, well maintenance, sampling equipment, in-line filtration etc. for the objective of obtaining good quality groundwater chemistry result especially for dissolved metals".*

Response: Knight Piesold Ltd. has experience in groundwater monitoring well installation, groundwater sampling and well development. The monitoring well locations, installation methodology and sampling procedures have been reviewed by Mr. Leslie Smith, P. Eng. of the University of British Columbia (see letter report attached).

Section 7.3.1 Open Pit / Mill Site

Comment: *"Please note in this and subsequent sections i.e. 7.3.2 etc., that there is no B.C. Water Quality Criteria (BCWQC) for "total aluminum for aquatic life. The only BCWQA for aluminum for aquatic life is for the "dissolved" form of aluminum.*

Response: Comment noted. Response under separate cover by Dan Royea of Hallam Knight Piesold Ltd.

B. Imperial Metals Corporation Mt. Polley Project Groundwater Monitoring Program (Ref. No. 1624/2), June 3, 1996.

Section 2.1.6 Tailings Storage Area

Comment: *"At the bottom of the page it says the groundwater flows northeast towards NE Edney Creek Tributary. From the contours shown in Figure 2.3, it would seem that the groundwater flows would be to the east-southeast. Please clarify".*

Response: Correct. Groundwater flows do indeed flow east-southeast toward NE Edney Creek Tributary (as suggested) and not northeast as initially reported (typographical error).

Section 2.3 1995 Monitoring Well Program

Comment: *"The 110 mm diameter PVC well installations sited around the pit area are ideal for production i.e. dewatering, but not necessarily for monitoring. They will take considerable effort to purge prior to collection of water quality samples when they are not in use for dewatering. By having multiple screened zones in one casing or borehole, there will be a lot of mixing and diluting of groundwater from the different aquifer zones intercepted by the one casing. The drill logs indicate there are very significant aquifers at different levels in the same boreholes. Multiple small diameter casings each sealed in the different aquifers in each borehole would give more valuable information as to groundwater quality, its source and potential problem in the discharge area if known".*

Response: The 1995 wells installed around the minesite area are suitable for dewatering as this was the primary intent with these wells. Although the use of these wells for groundwater monitoring is not ideal as mixing and dilution of groundwater from the different aquifers may occur, they will still function as monitoring wells to identify any changes in groundwater quality. IMC intend to provide a dedicated pump for each well in order to allow well purging prior to collection of water quality samples.

The 1996 monitoring wells in the open pit area will be located below the groundwater table in relatively pervious fracture or fault systems (aquifers) in bedrock to provide baseline and on-going information. The installation of multiple small diameter casings in one hole is not practical since the diameter of the hole must be large to facilitate multiple installations of the minimum 50 mm diameter wells complete with the necessary filter pack and seal backfill materials. Consequently, only one monitoring well will be installed in each drill hole. If a significant aquifer at shallow depth is encountered during installation of the first well, IMC intend to drill an additional hole to enable a separate monitoring well to be completed at shallow depth. All attempts will be made during the 1996 groundwater monitoring program to locate the completion zones in the most significant aquifer systems, based on the available structural geologic information.

Comment: *"Again please explain the rationale for the siting of two groundwater monitoring wells almost side by side (95-R-2 and 95-R-7) as indicated in Figure 2.4. It is assumed that these wells are situated and constructed primarily for dewatering purposes, with monitoring a secondary consideration. We would like to see installation of an additional well designed strictly for monitoring purposes, to be located between the central pit and Bootjack Lake, possibly off the main road below the most south-westerly corner of the central pit in the "draw" that is apparent from the contours in Fig. 1.3. The siting of this well should be done in consultation with a qualified hydrogeologist to ensure it is optimally located for detection of contaminated groundwater migrating from the pit area to Bootjack Lake. This should be done as soon as possible so that baseline data may be collected prior to mining".*

Response: Groundwater wells 95-R-2 and 95-R-7 were constructed primarily for dewatering purposes, as suggested. One additional groundwater monitoring well, designated P_8 will be installed between the central pit and Bootjack Lake as part of the 1996 program, as shown on the attached Figure 1. This well will be located in the draw and adjacent to the access road as suggested.

Comment: *"We are also concerned that only one monitoring well (95-R-5) was installed along the entire basal perimeter of the southeast waste rock dump (which is some 2.5 km in length) and that it is located at the extreme north end of the dump. We will require the installation of 2-3 additional wells designed specifically for monitoring purposes to monitor contaminant migration in groundwater flow down-gradient from the waste rock dump towards Polley Lake and Bootjack Creek. Again the siting of these wells should be done in consultation with a qualified hydrogeologist to ensure they are optimally located for the above mentioned purpose".*

Response: Two additional monitoring wells, designated P_6 and P_7 will be installed east and south of the southeast waste dump between the dump and Polley Lake as part of the 1996 program. The proposed locations of the wells are shown on the attached Figure 1.

Comment: *"What was the groundwater level in the '95 series wells at the time of completion? This is not indicated in the Appendix B well log or the Appendix C borehole information. Please provide this information in writing to this office".*

Response: Groundwater levels for the 1995 wells were not provided to Knight Piesold Ltd., however this information may be available from Imperial Metals Corporation.

Section 3.2 Tailings Storage Area

Section 3.2.1 Baseline

Comment: *"This section states that the tailings area baseline groundwater quality is poor, however the poor quality of the groundwater in this area may be exaggerated by poor well construction and development technique, as recognized in Section 2.2 of this report and as documented by Marc Zubel, Senior Groundwater Engineer, Water Management Branch, Victoria, B.C., in his Feb. 4, 1991 comments to A.P. Kohut on the Mt. Polley Copper/Gold Project Stage I Addendum Report (Oct. 1990)".*

Response: Some of the 1989 wells at the tailings area will be plugged and abandoned during construction of the tailings facility. Remaining wells will be developed as necessary prior to continuing with groundwater sampling. The proposed 1996 wells will be installed in accordance with accepted standards for monitoring well installation and will be developed prior to sampling.

Section 3.2.2 Operational

Comment: *"One of the objectives of the Mt. Polley groundwater monitoring program as required by BCMELP and identified on page 2 of this report was to locate the seepage collection pond and recovery wells to ensure optimal recycling of seepage from the tailings pond during operations. This objective does not appear to be* *addressed in this report. Please respond as to whether the seepage pond has been optimally located for tailings pond seepage recovery? Does it capture all of the potential "discharge" in the sandy area in the vicinity of the main tailings embankment, identified during the initial drilling in the tailings pond area"?*

Response: The seepage collection pond at the main tailings embankment has been located at the low point in the valley to intercept runoff and near surface seepage from the embankment. A system of embankment foundation drains, which are also interconnected with foundation pressure relief holes, drain by gravity into the seepage collection pond. The primary function of the seepage collection pond is to provide a reservoir for seepage monitoring and containment prior to recycling to the tailings embankment as necessary. The geological sequence of glaciofluvial and glaciolacustrine sediments which underlie the glacial till materials in the valley are complex and it is highly unlikely that all groundwater will report directly to the seepage collection pond. However, an extensive groundwater recovery well system has not been incorporated into the design since the tailings water is projected to be of good quality and no adverse water quality impacts are anticipated.

IMC had previously intended that all new groundwater monitoring wells downgradient of the tailings impoundment comprise 5 inch diameter wells which could be converted to pump back wells if required to supplement any requirements for make-up water for the milling operation. However, the current groundwater monitoring program has been modified to be consistent with MOE requirements for monitoring well installations only. Therefore, any provisions for seepage recovery by pump back wells will be addressed during operations. Pump back wells will be installed if additional make-up water is required or if on-going groundwater quality monitoring indicates that groundwater chemistry is being adversely affected by excessive seepage from the tailings impoundment.

Comment: "I do not have a copy of the Report referred to in this section i.e. Report on Project Water Management, Ref. No. 1624/1. Could you please provide me with a copy".

Response: Copy of "Report on Project Water Management (Ref. No. 1624/1)" included with this document, as requested.

Section 3.2.3 Post-Closure

Comment: *"What is the basis for stating that the groundwater quality from the tailings impoundment will improve to levels better than baseline values? Is this due to a reduction in recharge for the drainage area due to change in permeability of surface material compared to pre-tailings pond conditions? or to better monitoring well installations, where the suspended sediment content, will be reduced or eliminated and therefore enhance the quality of the groundwater samples collected"?*

Response:
This statement should be modified from "improve to levels better than baseline values" to "return to levels similar to baseline values". During operations and for a period of time after closure, seepage from the impoundment will comprise process water which originates from the supernatant pond and from consolidation of the tailings mass. In the long term, the closure pond will contain surface runoff water Once consolidation of the tailings mass is complete and the seepage from the surface water pond reaches steady state conditions all groundwater impacts due to process water will cease. On-going seepage to the groundwater system would then be of similar water quality to the final surface runoff pond.

Section 4.0 Groundwater Monitoring Program

Comment: *"The person who collects the groundwater samples, should not only be trained in environmental procedures, but be trained in and very familiar with proper groundwater quality monitoring procedures".*

Response: Agree. IMC are currently relying on Hallam Knight Piesold Ltd., who have suitably qualified personnel trained in proper procedures in groundwater quality monitoring and sampling. Also, IMC are presently in the process of identifying a suitably qualified individual to assist with environmental monitoring, including on-going water quality monitoring and sampling during operations. The procedures and protocol for groundwater sampling and handling are included in Report Ref. No. 1625/5.

Figure 1.2

Comment: *"How will the spring in the southwest corner of the tailings pond be capped off"?*

Response: The spring, located in the southwest corner of the tailings facility, will be capped with a 50 mm diameter PVC pipe at surface to provide an additional permanent installation for groundwater quality monitoring. The pipe will be installed by excavating a shallow hole and installing a slotted PVC screen section complete with a filter sand pack and a bentonite seal at surface in order to facilitate regular water quality sampling of the spring.

C. Imperial Metals Corporation Mt. Polley Project: Manual on Sampling and Handling Guidelines for Determination of Groundwater Quality (Ref. No. 1625/5), May 19, 1995.

Note: Responses to other comments in Section C are addressed by Dan Royea of Hallam Knight Piesold Ltd. under separate cover.

Section 2.1.2 Sample Preparation and Preservation

Comment: *"In-line filtration methods such as the Gelman high capacity filter should be employed for filtration of dissolved metals samples to ensure there is no exposure to air which oxidizes iron in the samples which in turn scavenges dissolved metals, thereby underestimating the dissolved portion of the metals. In groundwater situations there should be very little to no particulate in the water samples unless the well has not been properly developed or if oxidation occurs allowing precipitates to form on the inside of the well casing and immediate aquifer material around the well casing. Wells susceptible to such precipitate formation or sediment accumulation should be cleaned and pumped 2 to 3 weeks prior to sampling to remove the precipitates/sediment from the well prior to actually collecting samples".*

Response: In-line filtration methods will be used to collect the dissolved metals samples. All wells will be developed following installation and at least 2 to 3 weeks prior to sampling to remove any sediment or precipitates, as suggested.

Appendix D: Baseline Groundwater Quality Data to the End of 1995

Note: Details on the results of the baseline groundwater quality program are included by Dan Royea of Hallam Knight Piesold Ltd. under separate cover.

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

REQUIREMENTS AND SPECIFICATIONS FOR THE 1996 GROUNDWATER MONITORING PROGRAM
(REF. NO. 1625/8)

1.0 GENERAL

The following is a summary of the recommendations and requirements for the installation of additional groundwater monitoring wells for the Mt. Polley Project. The objective of the wells is to provide high quality installations for the collection of groundwater samples for the evaluation of initial baseline conditions and groundwater quality during operations and at closure. The monitoring wells will also be used to monitor fluctuations in groundwater levels resulting from seasonal effects and influences resulting from mine development to confirm the hydrogeology of the minesite and tailings facility areas.

Specific details on the monitoring well supplies, installation procedures and drilling methods are provided along with recommendations for well development and sampling procedures. The locations of the proposed 1996 groundwater monitoring wells in addition to the existing wells are shown on the attached Figure 1. This figure is revised from the original Figure 2.4 previously submitted in the "Groundwater Monitoring Program (Ref. No. 1624/2)". The completion details and requirements for the 1996 groundwater monitoring wells are also shown on the attached Figure 2. The proposed schedule for groundwater monitoring is shown on Table 1.

2.0 WELL LOCATIONS

The 1996 groundwater monitoring wells will be installed in selected intervals and geologic units to characterize the groundwater quality at the minesite and tailings facility areas. The wells will be installed as dedicated groundwater quality sampling wells. The wells will be installed and developed as per standard practice and as outlined herein and will be maintained over the life of the project.

A total of eight (8) monitoring wells will be installed during the 1996 program, including five (5) at the tailings facility area, designated P_1 to P_5, and three (3) at the minesite area, designated P_6 to P_8. The monitoring wells are located outside the various development areas to provide initial baseline and background groundwater quality as well as for long-term groundwater quality monitoring. The locations of the proposed monitoring wells are shown on Figure 1.

3.0 COMPLETION ZONES

The completion zones for the monitoring wells will be located in the saturated zone below the existing groundwater table and below the groundwater surface predicted during operations. This will ensure that groundwater samples may be collected at any time during the year and at any time during operations and at closure. The wells will be installed in relatively pervious zones in overburden and bedrock, as these zones will provide the preferential paths for groundwater flow in addition to providing greater recoveries for well development and sampling.

The monitoring wells in the tailings facility area will be completed in the relatively permeable glaciofluvial sandy unit which underlies the glacial till, and in the heavily fractured bedrock (conglomerate) at the base of the overburden. Two holes will be drilled at each site for the installation of one well per hole in each of the relatively pervious overburden and fractured bedrock zones. The monitoring wells in the minesite area will be installed in fracture or fault systems within bedrock.

The actual locations of the completion zones and screened intervals will be assessed based on the geologic conditions intersected during drilling. Specifically, zones of high water take or flow will be targeted as completion zones for the wells. In the tailings area these zones will comprise the glaciofluvial overburden and the fractured bedrock. Completion zones in the minesite area, alternatively will target structural geologic features such as fracture and/or fault zones intersected during drilling.

4.0 DRILLING METHODS

Appropriate drilling methods will be utilized to prevent contamination of the surrounding formation water and to allow for the collection of representative groundwater samples. No drilling fluids or additives will be used for the drilling of the monitoring well holes as the fluids may affect the groundwater samples. Dry drilling methods shall be utilized for all holes.

Drilling methods for monitoring well holes in overburden in the tailings facility area include hollow stem auger, air-rotary with casing advancer, or dual-wall (reverse circulation) air rotary. Samples may be retrieved from auger flights, or from split-spoon or thin-walled sampling methods to identify permeable water-bearing zones for the selection of the screened intervals for the wells. No mud-rotary drilling will be permitted nor air-rotary utilizing the down-hole hammer as this method requires lubricating oil which may contaminate the hole.

Drilling methods for the monitoring well holes in bedrock in the minesite area include air-rotary or reverse circulation. The completion zones for these wells will be determined by sampling the cuttings and by identification of water bearing zones by observation and measuring water levels inside the hole during drilling. No mud-rotary or down-hole hammer methods shall be used for the monitoring well holes at the minesite.

5.0 INSTALLATION DETAILS

The groundwater monitoring wells will be installed in pre-drilled holes with a minimum diameter of 150 mm (6 inches). Only water (i.e. no drilling fluids) will be used during the drilling of the monitoring well holes. Details of installation are described below. A schematic diagram showing the typical completion details for the groundwater monitoring wells and record information required for installation are shown on Figure 2.

The groundwater monitoring wells will comprise decontaminated 50.8 mm (2 inch) diameter, flush jointed, threaded Schedule 40 PVC tubing. This will facilitate the installation of submersible pumps for groundwater sampling and pump systems for the development of the wells. Centralizers will be installed at designated spacings along the PVC to help centre the casing inside the drillhole. Well screens will be installed at the bottom of the well and will be 3.05 or 6.10 metres (10 or 20 feet) long with #20 (0.020 in. or 0.25 mm wide) slots. The screens will also be decontaminated, flush jointed, threaded Schedule 40 PVC as per the solid riser. Suitable slip caps, slip couplers and end plugs are also required, as shown on Figure 2.

Backfill materials will include a uniform silica sand, such as #16 (0.40 mm diameter) required as the filter pack around the well screens. Such sand shall be no coarser than #10 mesh and no finer than #40 mesh. The sand will be bounded by a low permeability seal zone comprised of approximately 1 metre minimum of fine (3/8" diameter or less) bentonite chips. The materials will be backfilled from the bottom up with a delivery (tremmie) pipe to prevent any bridging of backfill materials during installation.

Following the installation of the top bentonite seal, the holes will be backfilled with a cement-bentonite grout mixture around the annulus between the PVC casing and the wall of the hole. The grout will be mixed to a thick consistency and pumped down the hole with a delivery pipe from the bottom up to ensure a proper seal and to prevent surface water from entering the well. Under no circumstances will the holes be grouted by pouring grout into the open hole from surface to a depth greater than 3 metres inside the hole.

Following grouting, a surface bentonite seal and protective steel casing, complete with locking cap will be set in concrete around the PVC casing for protection and ease of sampling.

6.0 WELL DEVELOPMENT

The groundwater monitoring wells will be developed following installation to remove fine particulate matter, including fine silts and clays which may originate from the geologic formation or from cuttings generated during drilling. Well development techniques include pumping water down the well under positive and negative (suction) pressures to remove foreign matter and particulates from the filter sand pack around the screen. The result is clear and non-turbid water which is more representative of the in-situ groundwater conditions. This also makes it easier to filter the water samples (by in-line filtration methods) for the dissolved metals samples. Air-surging methods will not be permitted as this may disturb and significantly reduce the effectiveness of the filter sand pack.

Subsequent well development will also be carried out if during sampling the water is found to be turbid or contain foreign matter. The monitoring wells installed in 1989 will also be developed.

7.0 SAMPLING PROCEDURES

Groundwater samples may be recovered by the use of bailers or by submersible pump systems. The pump system is advantageous in decreasing the sampling time, minimizing labour costs and allowing for direct sampling from the screened interval and therefore is strongly recommended.

Bailers will also be available in the event that the pump system breaks down or is not available. To this end, one bailer will be dedicated to each well for sampling purposes. Bailers will not be utilized for more than one well as this will result in potential contamination of the samples.

Sampling procedures generally involve the removal of stagnant water from the well prior to collecting the sample. It is recommended that the equivalent of three well volumes of water be removed from the well prior to collecting the sample. This is achieved by measuring the static water level inside the well and calculating the volume of water inside the well, then bailing or pumping three times this volume from the well prior to sampling. This ensures that the sample is representative of the in-situ baseline groundwater within the formation. In the event that the recovery of the well is very slow and three well volumes cannot practically be removed from the well then the well should be pumped once and allowed to recover prior to collecting the sample.

The groundwater sampling program previously prescribed in the "Groundwater Monitoring Program (Ref. No. 1624/2)" indicates that groundwater samples will be collected on a quarterly basis (i.e. once every 3 months). This will allow any natural variations in the baseline or background water quality to be assessed. It is also recommended that rising head type slug tests be performed in each well, once at the completion of well development, and once per year thereafter. This will provide information for assessing the on-going performance of the well as well as provide information on the hydraulic conductivity and response of the geologic formation. The proposed schedule for groundwater monitoring is included in Table 1.

Details on the groundwater sampling methods and protocol, including sampling and chain of custody forms for sample collection as well as forms for rising head tests, are included in the "Manual on Sampling and Handling Guidelines for Determination of Groundwater Quality (Ref. No. 1625/5)" previously issued on May 19, 1995. A revised copy of this manual, incorporating comments from agency review, is also attached.

TABLE 1

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
GROUNDWATER MONITORING SCHEDULE

ng Monitoring for ent of Baseline Data|						|Construction|										|Mining|																																																											|Post-mining Monitoring|																									
1996								1997												1998												1999												2000								2007			2008												2009												2010												2011		
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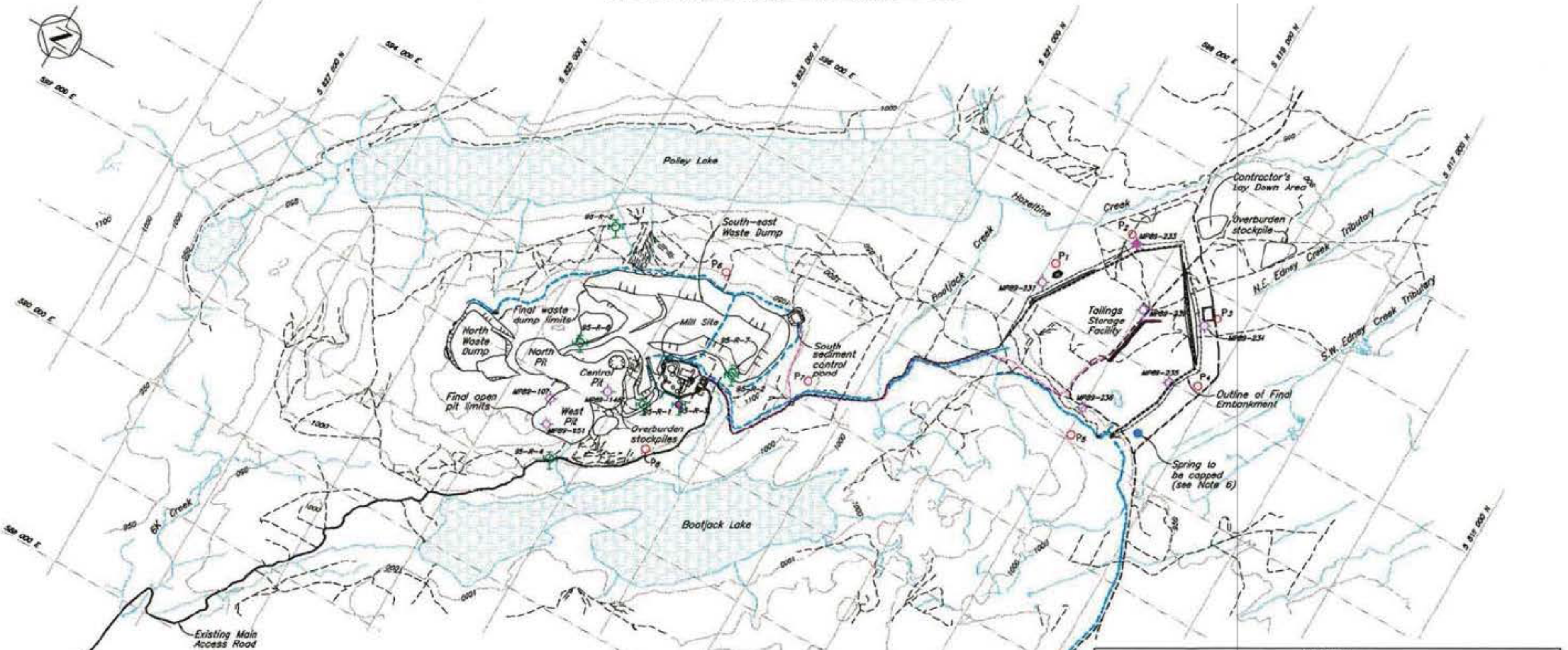
IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
GROUNDWATER MONITORING WELLS PLAN



LEGEND

MP89-107 ◇ Existing Groundwater Monitoring Well (1989)

○ P7 Proposed Additional Groundwater Monitoring Well (1996)

◆ Damaged Groundwater Well

95-R-4 ◇ Existing Groundwater Supply Well (1995)

Well Status		
Identification	Status	Monitoring Purpose
95-R-1	Good	Open pit and mine site, flows to Bootjack Lake.
95-R-2	Good	Mill site flows to Bootjack Lake.
95-R-3	Blocked	
95-R-4	Good	Open pit, flows to Bootjack Lake.
95-R-5	Good	South waste rock dump, flows to Polley Lake.
95-R-6	Good	Background.
95-R-7	Good	Mill site flows to Bootjack Lake.
MP89-107	Unknown	Open pit, background, will be lost.
MP89-146	Unknown	Open pit, background, will be lost.
MP89-151	Unknown	Open pit, background, will be lost.
MP89-231	Unknown	Tailings storage may flow to Hazeltine Creek.
MP89-232	Good	Tailings storage and background, will be lost.
MP89-233	Broken	
MP89-234	Broken, repairable	Tailings storage facility, flow to Northeast Edney Lake.
MP89-235	Unknown	Tailings storage facility, flow to Southwest Edney Lake.
MP89-236	Broken, repairable	Background for tailings storage facility.

Scale 1000 500 0 1000 2000 m

NOTES

1. This Figure is a revised version of the original Figure 2.4 presented in Report Ref. No. 1624/2, dated June 3, 1996.
2. Monitoring installations 95-R-X consist of 110mm I.D PVC well pipe installed primarily as a water supply source. Wells are screened at multiple intervals.
3. Monitoring installations MP89-X consist of 30 mm I.D PVC which have slotted screens.
4. Monitoring installation MP89-233 has been lost due to breakage of the PCV riser below the ground surface. No evidence of well location remains.
5. Monitoring installation 95-R-3 has been blocked at a depth of approximatly 70 metres below the collar. This installation is no longer operable as a screen interval is not accessible.
6. Groundwater spring to be capped with slotted PCV and filter sand pack for groundwater quality monitoring.

August 20, 1996
KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

FIGURE 1

1625.A40

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CONSULTING ENGINEERS

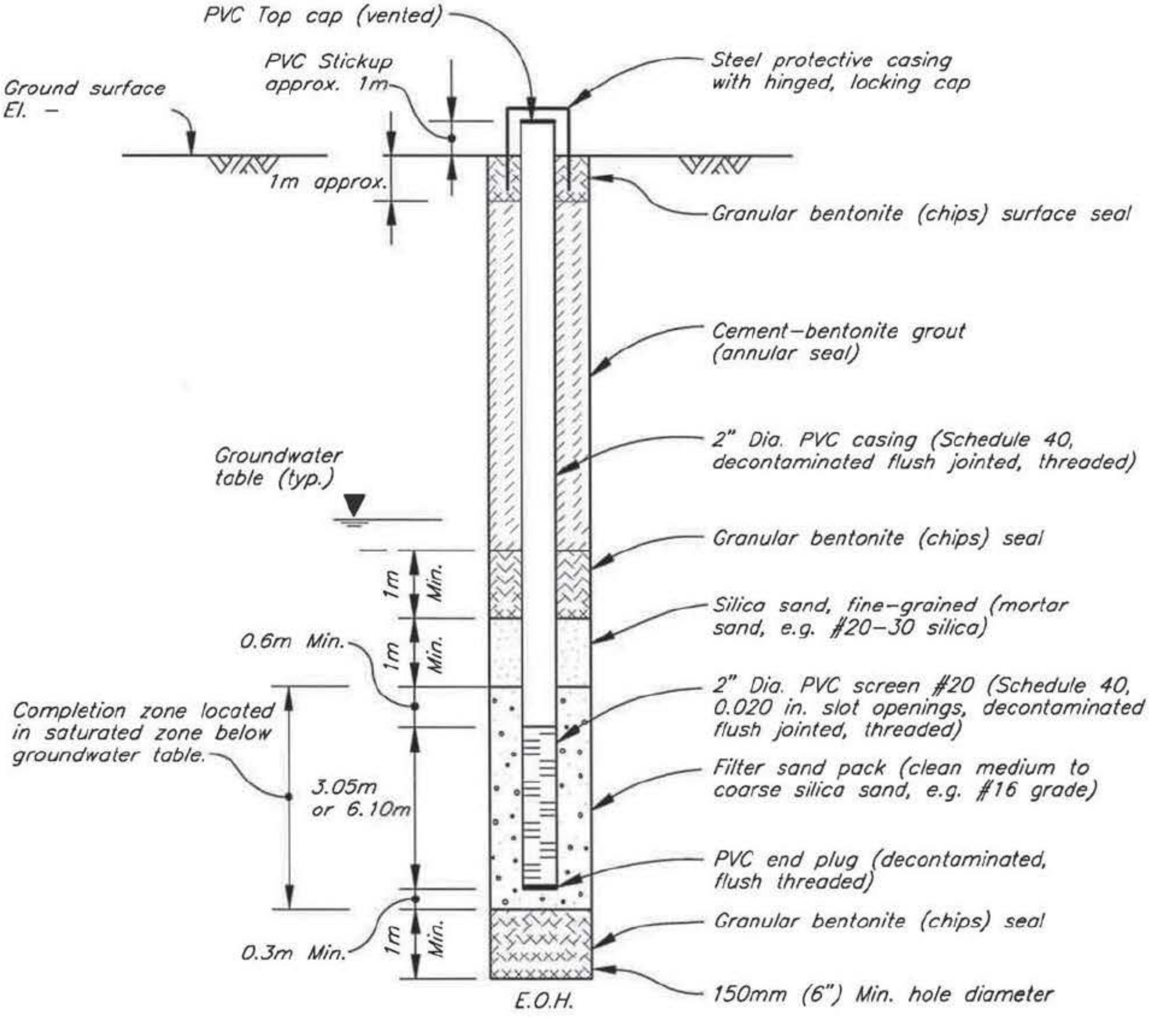
GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT MT. POLLEY PROJECT
LOCATION N: – E: –
COMPLETION DATE –

PROJECT No. 1625
HOLE No. –
GROUND ELEVATION –

PROPOSED 1996 GROUNDWATER MONITORING WELLS

SCHEMATIC DIAGRAM



NOTES

1. Record depths of hole, PVC and all backfill materials.
2. All backfill materials to be installed using 2" dia. tremmie pipe to prevent bridging.

CAD FILE: \1625\FIG\A40 Plot scale 1=1

FIGURE 2

THE UNIVERSITY OF BRITISH COLUMBIA
DEPARTMENT OF EARTH & OCEAN SCIENCES

6339 Stores Road
Vancouver, BC V6T 1Z4

Tel (604) 822-2449
Fax (604) 822-6088

To: Murray Gant
Company: Knight Piesold
Fax Number: 685 0147
City:
From: Leslie Smith
Phone: 822 4108
Date:
UBC Account #: Personal

Message: Murray:

Draft of my letter to Ken. See you at 2:00 PM today to discuss my comments.

Leslie Smith

updated

KNIGHT PIESOLD LTD.
IN/OUT 8/27/96

NAME	ROUTING	DATE READ	ACTION BY	REPLY DATE
JPH	2	JM		
BSB				
KIB	1	KJB		
TFK				
MOG	MOG			
AH				
WJ				
SP				
FILE	1625.01			

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If you do not receive all pages, please contact (604) 822-2449

FORMS 168

Leslie Smith
Hydrogeological Analysis • Groundwater Contamination Studies

August 28, 1996

Mr. Ken Brouwer
Knight Piesold Ltd.
Suite 1400
750 West Pender Street
Vancouver, B.C. V6C 2T8

Dear Ken,

Re: Mt. Polley Project - Groundwater Monitoring Program

I have reviewed the material that you have provided on the proposed groundwater monitoring program at Mt. Polley (Ref. No. 1624/2, 1625/8, comments from MELP and Response to Review Comments, 1625/7). My review of the monitoring plan is presented under two headings; one summarizing points of agreement with the monitoring plan, and the other presenting recommendations that should be considered in finalizing the monitoring program.

Points of Agreement

• I support the dual objectives underlying the 1996 monitoring program; to provide high-quality samples for monitoring of potential groundwater quality impacts, and to record water levels in the wells to characterize changes in the subsurface flow system at the minesite and in the tailings facility area. It will be important to monitor changes in the hydrologic regime in sufficient detail so that it will be possible to assess whether the monitoring program remains adequate in light of disturbances imposed by the mining operations.

• I agree that it is essential that the 1996 wells be installed as dedicated monitoring wells, with the sole intent of using these wells for monitoring purposes.

• The 1996 monitoring program recognizes the importance of locating monitoring intervals in zones of higher permeability. It is my view that this approach is critical to developing confidence in the reliability of the monitoring data to detect water quality impacts in a fractured rock setting. Completions in zones of higher permeability also make it more likely that issues related to limited sample volume and difficulties in purging of monitoring wells prior to sampling can be avoided.

4640 Mahood Drive, Richmond, British Columbia, Canada V7E 5C4
Office: (604) 822 4108 Fax: (604) 822 6088 Home: (604) 271 2799

- The 1996 monitoring plan recognizes that in selecting the depths of monitoring intervals in a borehole, it will be necessary to account for predicted changes in the depth to the water table and flow patterns that will occur during operations in the area of the open pits.

- I agree that the locations of the proposed wells P1 - P8 constitute a reasonable monitoring program to characterize baseline water quality, and to monitor for potential water quality impacts.

- I support the plan to install two separate monitoring wells at each monitoring location in the tailings area, one completed in the permeable sediments, and the other in a permeable horizon within the underlying bedrock. Multiple completions in single boreholes should be avoided for long-term monitoring.

- I support the plan to complete a monitoring well (S-1) in the area of the spring, this area is likely to mark the emergence of a preferential flow zone.

- Quarterly sampling of the monitoring wells should be sufficient to characterize baseline groundwater quality data and to detect any water-quality impacts.

- The proposed drilling methods to be used at the site are suitable in the construction of the monitoing wells. I support the idea of carrying out a rising head test on each monitoring well once a year, to check for possible well impairment.

- In my opinion, the sampling protocol, sample preservation, and QA/QC plan are adequate. I suspect that it will be necessary to rely on downhole pumps to collect the water samples, for the deeper installations proposed here, it will be impractical to purge 3 casing volumes using a bailer. I concur with the proposal to use dedicated pumps for each monitoring well.

- I concur with the design and completion details of the proposed monitoring wells (Figure 2 in 1625/8). However, the basis on which you will choose either a 3.05 or 6.10 m screen is not stated in the monitoring plan. My preference would favor a 3.05 m screen if you are confident that the monitoring interval is below the depth to which you expect the water table to decline. I would not recommend a screen length greater than 6.1 m.

Recommendations

- I am concerned that the plan for identifying monitoring intervals in the bedrock monitoring wells may not be adequate. I agree that for each monitoring site, it is not possible to specify the depth of the completion zone until the borehole is drilled. The report states that "structural geologic features" will be used to identify the completion zone, by sampling of cuttings or monitoring of water wells inside the hole during drilling. The basis for deciding upon the depth of each borehole is not specified. Because the key to success of a monitoring program in fractured rock is the identify the preferential pathways for solute migration, I recommend a greater effort be considered to identify the most permeable zones at each monitoring site. My approach would be to decide upon a target depth for each borehole, below which it is judged to be unlikely that any metals released to the flow system by mining activities could migrate. Boreholes for the monitoring wells should be drilled to this depth, rather than stopping at the first indication of a permeable horizon. A borehole flowmeter survey in each borehole could be used to identify the locations of the most permeable intervals. Alternately, dual packer hydraulic tests could be conducting along the length of the borehole. The most permeable zones (which could be small fracture zones, or zones interior to a more fractured interval) should then be selected for the monitoring intervals, and the borehole completed appropriately. This testing adds to the cost of installing the monitoring wells, but it will increase the confidence that the well is likely to detect any water quality impacts. This procedure is not necessary in the monitoring wells completed in the glaciofluvial deposits.

- I question whether it will be cost-effective to use the 1989 and 1995 wells as part of the monitoring program. Because of the nature of the well completions, any interpretations of chemical data obtained from the wells will be equivocal. I am not convinced that meaningful chemical samples can be obtained from a borehole with multi-level completions (the 1995 wells) simply by locating a pump adjacent to a particular screened interval and withdrawing water at a slow rate. The amount of mixing within the borehole that will have occurred during well purging, and during inflow through the casing during sampling, will remain indeterminant. I have the same concerns with the long completion intervals in the 1989 monitoring wells. Because the effect of mixing is likely to reduce the concentrations of metals in the water sample relative to that which could potentially occur within the bedrock units, the chance of false negatives is higher in multi-completion wells. With the proposed monitoring wells P1 - P4, it seems unnecessary to me to include wells MP89-231, -234, and -235 in the monitoring system.

- I have some concerns with the use of wells 95-R-5 and (especially) 95-R-6 as background monitoring wells in the area of the minesite. They have multiple completion zones at significantly different depths, and they are intended primarily to be used as dewatering wells (with, at present, an unknown pumping schedule?). It is not indicated on the installation logs whether or not a sandpack in present along the entire length of the boreholes. However, because the upper screened intervals will eventually be located above the water table as the open pits are developed, these installations are probably aceptable for long-term monitoring of background water quality in the area of the minesite.

- For the down-gradient monitoring locations, the multi-completion wells allow for the possibility of cross-contamination of fracture zones if a vertical hydraulic gradient is present in the surrounding rock mass. If this process occurs over the long-term, simply purging 3 well volumes from the monitoring well prior to sampling will not lead to resolute samples.

- During development of the monitoring wells, rather than continuing development efforts until there are indications of clear, non-turbid water, it may be worthwhile to also monitor a simple chemical parameter (e.g. pH and/or electrical conductivity) until stable values are observed.

- In the groundwater monitoring program described in the monitoring report dated June 3, 1996 (1624/2), it is stated that well 89-236 will be used as a background monitoring well until it is lost, at which time well P5 will be installed. Well P5 should be installed this Fall, at the same time the other P-series wells are installed. I think this is the intent stated in the later monitoring report (1625/8).

- It is important to recognize that the background monitoring wells are unlikely to be completed in the same permeable fracture zone as the downgradient wells. This difference may compromise to some degree a comparison of water quality parameters from background and downgradient wells. However, it is my view that this feature of the monitoring design is unavoidable.

- The schedule outlined in Table 1 indicates a yearly review of monitoring data. I assume from this that a report will be issued each January, but that the monitoring data itself will be reviewed as soon as practical following each sampling round.

Sincerely,

Leslie Smith, Ph.D.

IMPERIAL METALS CORPORATION

KJB
~~AT~~
KJG

DELIVERED

OFFICE COPY

TO: Mr. Ken Brouwer
Knight Piésold Ltd.

FROM: Sheila Colwill for Brian Kynoch

DATE: March 21, 1997

SUBJECT: **Mount Polley Project**
- Geotechnical Review, Drainage Aspects

Enclosed, please find one copy of the Geotechnical Review, Drainage Aspects Main Embankment Dam, Tailings Storage Facility Report generated by MAJM Corporation for Imperial Metals Corporation, concerning the Mount Polley Project.

Regards,

KNIGHT PIÉSOLD LTD.
IN/OUT 3/21/97

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Suite 420 - 355 Burrard Street, Vancouver, B.C., Canada V6C 2G8
Tel: (604) 669-8959 Fax: (604) 687-4030 E-mail: bkynoch@imperialmetals.com

MAJM Corporation Ltd.

79 Bywood Drive, Islington, Ont. M9A 1M2
Tel: (416)239-0821
Fax: (416)247-1071
(416)239-0798

MEMO TO: Mr. Ken Brouwer, P.Eng.
Knight Piésold Limited
Via Fax (604) 685-0147

FROM: Fred Matich

COPIES TO: Mr. Brian Kynoch, P.Eng.
Fax (604) 687-4030

Mr. George Headley, P.Eng.
Fax (604) 952-0481

RE: **Geotechnical Review, Drainage Aspects, Tailings Retention Structures, Mt. Polley Project, B.C.**

DATE: March 3, 1997

KNIGHT PIESOLD LTD.
IN/~~OUT~~ Mar 3

NAME	ROUTING	DATE READ	ACTION BY	REPLY DATE
JPH				
BSB				
KIB	3			
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Further to our discussions of today's date, this will confirm arrangements for a meeting in the morning of March 10, 1997. Mr. George Headley has indicated that he would be able to attend. It is understood that the Final Design Report is presently being finalized. It would be appreciated if a Draft copy plus additional documentation, as discussed below, (to the extent that they may be then available), could be left for me at the desk of the Vancouver Renaissance Hotel by the end of this week.

The Reference documentation previously available to this writer is listed in the attachments hereto (pages 19 and 20 excerpted from my Draft Report). The handout provided for discussion purposes during the meeting on February 28, 1997, identifies various additional programs with geotechnical components which have been carried out (with, in some cases, reports prepared) in the interval since the August, 1996 site visit. These include the following:

(i) Test Pit Excavations for a variety of objectives, particularly to delineate the extent of the basin liners.

(ii) Borehole investigations in borrow areas and also in conjunction with installation of instrumentation in the Main Embankment foundation soils.

(iii) Cone Penetration Test (CPT) investigations of the foundation soils at the Main Embankment. Results covered (presumably) in a Report by Knight Piésold, as well as in a "Cone Tec Field Report".

9.0 REFERENCES

9.8 Continued

(h) Work Sheet showing Section 2/1625.201, July 24, 25, 1996 (Section at 190° looking East through Swamp.)

(j) Work Sheet showing Section 1/1625.201. (Section at about 110°, located through swamp and main embankment.)

9.9 Knight Piésold Ltd. Memo from Mr. Ken Brouwer re Mt. Polley Tailings Facility. January 18, 1997.

Golder Associates Ltd.

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Burnaby, British Columbia, Canada V5C 6C6
Telephone (604) 298-6623
Fax (604) 298-5253

DRAFT REPORT ON

HYDROGEOLOGICAL INVESTIGATION
PROPOSED WISHBONE OPEN PIT
MT. POLLEY MINING CORPORATION
LIKELY, B.C.

Submitted to:

Imperial Metals Corporation
PO Box 12
Likely, BC
V0L 1N0

DISTRIBUTION:

1 Copy - Imperial Metals Corporation
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October 18, 2004

04-1413-027

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1.0 INTRODUCTION

The Mount Polley Mine site is located near the community of Likely, B.C., approximately 56km northeast of Williams Lake (Figure 1). Imperial Metals Corporation (Imperial) is currently assessing the feasibility of developing the "Northeast Zone" of the Wishbone Deposit at the mine site. Accordingly, Imperial has retained Golder Associates Ltd. (Golder) to investigate hydrogeological conditions within the Wishbone Pit.

A primary objective of the investigation was to examine the dewatering requirements for a sequence of surficial sediments that will be exposed in the upper portion of the east pit wall. The results of the hydrogeological investigation are presented in this report.

The hydrogeological investigation and assessment is a component of the overall feasibility-level pit design process. A pit stability assessment, with criteria for bedrock slope design in the Pit, has been provided in a separate report.

2.0 BACKGROUND

The Mt. Polley mine site is located in a region of rugged mountainous terrain. The proposed Wishbone Pit (the Pit) is located on the eastern flank of a north-south trending ridge positioned along the west side of Polley Lake (Figure 1). The Pit will be approximately 600 m long, in a northwest-southeast direction, and approximately 350 m wide. The pit will be excavated to a maximum depth of approximately 180 m and will be accessed by a single haul road located on the southeast wall of the pit.

Topographic relief in the vicinity of the proposed Pit is about 200 m, with elevations ranging from about 920 m-asl (metres above sea level) near the shoreline of Polley Lake to approximately 1120 m-asl along the southwest crest of the Pit. The summit of Mount Polley is the major local topographic feature and is located several hundred metres west and upslope of the Pit.

The Wishbone Deposit occurs in variably altered monzonite, plagioclase and potassium feldspar porphyry and plagioclase porphyry, which are intruded by mineralized hydrothermal breccia. Several fault zones will also intersect the proposed Pit area, including the main Wishbone Fault and Gully Fault. The surface traces of these major faults are shown schematically on Figure ~~1~~. 2

Previous exploratory drilling in the Pit area indicates that bedrock within the highwall (*i.e.*, western) portion of the Pit is overlain by a relatively thin veneer of coarse colluvium. Whereas, terrain adjacent to Polley Lake includes complex glacio-lacustrine and glacio-fluvial deposits extending up to 50 m-bg (meters below ground). These surficial sediments become progressively thinner in the upslope direction, but cover most of the eastern Pit area.

3.0 FIELD INVESTIGATION AND TESTING PROGRAMS

During May and June 2004, two drilling programs were undertaken to examine subsurface conditions at the proposed Pit. The results of these previous investigations are summarized in Golder's report "Pit Slope Stability Assessment of the Proposed Wishbone Open Pit, Mt. Polley Mining Corporation, Likely, BC". These investigations focused primarily on the characterization of bedrock structures that may influence pit slope stability. A brief summary of these investigations is included below.

Additional examination of subsurface conditions was required to assess the hydrogeology of sediments in the eastern Pit wall. However, data from the previous field programs have been utilized, where appropriate, to supplement the present hydrogeological investigation.

3.1 Bedrock Geotechnical Investigation

During May 2004, four inclined boreholes designated WB-04-75, WB-04-76, WB-04-77 and WB-04-78 were drilled at locations within the proposed Pit area, primarily for geotechnical purposes (*i.e.*, bedrock discontinuity data). All inclined boreholes were drilled using an NQ double tube system to depths ranging from 198 m to 243 m-bg. Borehole details and orientations are presented in Table I-1 (Appendix I). The locations of the inclined boreholes are shown on Figure 2.

Golder personnel supervised the installation of conventional vibrating wire piezometers in the four inclined boreholes, at positions within the bedrock. Boreholes WB-04-75 and WB-04-76 were completed with two piezometers in each hole, while boreholes WB-04-77 and WB-04-78 were outfitted with single piezometers. Installation details for the vibrating wire piezometers are presented in Table I-2 and the installation positions (*i.e.*, elevations) are shown on Figure 2.

Three vertically-aligned boreholes (WB-04-57, WB-04-62 and WB-04-67) were also drilled during the May 2004 geotechnical drilling program, but were not instrumented with piezometers. The borehole locations are shown on Figure 2 and completion details details are presented in Table I-3.

All geotechnical boreholes were logged by the drilling contractor. The contractor did not examine the overburden sediments; therefore, the driller's logs do not include overburden details. The logs did provide bedrock depth information, which is summarized in Tables I-1 and I-3.

3.2 Overburden Investigation

During the period of May 25 to June 22, 2004, Golder personnel supervised the drilling of five exploratory boreholes (BH04-01 to BH04-05) at locations between the Polley Lake shoreline and the proposed Pit (Figure 2). The main purpose of the drilling program was to examine surficial sediments (*i.e.*, overburden) adjacent ot the Pit and confirm the depth to bedrock. Boreholes BH04-1 to BH04-03 and BH04-05 were drilled using a sonic drilling system with 6-inch (15 cm) diameter casing. Borehole BH04-04 was drilled using an Odex system with 4½-inch (11 cm) diameter casing.

Sediments encountered during overburden drilling were sampled intermittently for visual classification. At the completion of the drilling program, samples considered to be representative of the range of sediment textures encountered were returned to Golder's laboratory for gradation analysis. Subsurface conditions encountered during drilling are summarized in detailed drilling logs (Appendix II). The results of the gradation testing are presented graphically in Appendix III.

Golder personnel also supervised the installation of vibrating wire piezometers in four of the overburden boreholes, at positions within the overburden sediments. Boreholes BH04-01 and BH04-03 were completed with two piezometers in each hole, while boreholes BH04-04 and BH04-05 were outfitted with single piezometers. Installation details for the vibrating wire piezometers are presented in Table II-1 (Appendix II).

3.3 Test Wells (TW04-01 and TW04-02)

Construction of prototype dewatering wells (Test Wells) within the overburden sediments was undertaken to examine the watertable response to operation of the wells and to assess the overall feasibility of implementing an dewatering program for the east side of the Pit.

3.3.1 Test Well Construction

Bedrock depth information from the geotechnical and overburden drilling programs was utilized to construct bedrock contours for the central and eastern Pit area (Figure 3). Two sites were then selected for construction of Test Wells (TW04-01 and TW04-02) near boreholes BH04-1 and BH04-04, where a relatively thick overburden profile was intrepreted.

Aqua Drilling Services Ltd. was contracted to construct two 8-inch (20 cm) diameter, steel-cased Test Wells using an air rotary drill rig. The Test Wells were completed during the period July 27 to August 9, 2004, under supervision of Golder personnel. Drill cuttings were examined continuously during drilling to characterize the texture of the sediments encountered and identify the major stratigraphic boundaries. Sixteen samples were obtained by Imperial personnel, from each Test Well borehole, and submitted to

Imperials' on-site laboratory for gradation analysis. The resulting laboratory data are presented graphically in Appendix IV. Empirical methods developed by Hazen (1911) and Kresic (1997) were utilized to estimate the hydraulic conductivity (*K*) of the overburden sediments. A summary of the resulting hydraulic conductivity estimates is presented in Table IV-1.

Subsurface conditions encountered during Test Well drilling are summarized in detailed logs in Appendix V. Sediment sample depths and well completion data are also provided in the logs. Geological cross-sections based on information from the Test Wells and the previous BH Series of boreholes is presented in Figures 4 and 5.

Both Test Wells were completed with single 3 m lengths of 8-inch (20 cm) diameter stainless steel screen. The screens were installed from 34.1 m to 37.1 m-bg in TW04-01 and 32.0 m to 35.0 m-bg in TW04-02. The screen in TW04-01 was placed near the bedrock contact (*i.e.*, 37.3 m-bg), within a 14 m thick stratum of gravel and coarse sand. Bedrock was not encountered during drilling of TW04-02; however, as drilling advanced to approximately 39.3 m-bg, the contractor advised that the casing was nearing bedrock. Accordingly, the well screen was installed within a relatively coarse stratum of sand/gravel located from 22.6 m to 35.0 m-bg. A solid 8-inch diameter "tail pipe" was attached to the bottom of the screen and extended to the full-depth explored (*i.e.*, 39.3 m-bg).

Both Test Well casings were withdrawn to the top of the screens to allow the adjacent strata to collapse against the screens. The wells were each developed for about 6 hours using air-lifting methods with the drilling stem located above the screens, followed by low-rate pumping. At the end of the development procedure, the contractor reported that water from both Test Wells had very slight colouration and trace suspended sediment.

3.4 Aquifer Pumping Tests

Conventional pumping tests were completed by Precision Service & Pumps Inc. from August 11 to 13, 2004. Flow rates were monitored during the pumping tests using a digital flow meter near the well head, combined with an orifice-type flow meter at the end of the wellhead discharge assembly hose.

A submersible pump was first installed in TW04-01 at a depth of 31.5 m-bg, or approximately 27 m below the pre-test static water level of 4 m-bg. Testing commenced at 11:30 a.m. on August 11, by applying progressively higher pumping rates of 6.3 L/s (litres per second), 12.6 L/s and 18.9 L/s (100 USgpm, 200 USgpm and 300 USgpm) at 30-minute intervals. After 90 minutes of pumping, the rate was increased to 25.1 L/s (398 USgpm) and maintained for 24 hours (1440 minutes). The pump was shut-off at 1:00 p.m. on August 12. During the test, water levels were measured manually using a graduated electric tape at TW04-01 and TW04-02. All drawdown observations are tabulated in Appendix VI (Tables VI-1 and VI-2) and are depicted graphically on Figure VI-1. At the end of the pumping test, the drawdown in TW04-01 was approximately 25 m, or approximately 9 m above the top of the screen, whereas, the drawdown measured at TW04-02 was approximately 0.6 m (Figure VI-1).

Following a six hour recovery period, the pumping test at TW04-02 commenced at 7:05 p.m. on August 12. A submersible pump was installed in TW04-02 at 30.5 m-bg, or approximately 15 m below the pre-test static water level of 16 m-bg. A 90-minute pumping interval using rates of 5.0 L/s, 10.5 L/s and 18.4 L/s (80 USgpm, 166 USgpm and 290 USgpm) was first completed. The rate was then increased to 25.7 L/s (407 USgpm) for 24 hours. Water levels were again measured at TW04-02 and TW04-01 during the test and the resulting drawdown data are summarized in Tables VI-3 and VI-4 and on Figure VI-2. The pump was shut-off at 8:35 p.m. on August 13. The drawdown measured in TW04-02 at the end of the test was approximately 9.6 m, or approximately 6 m above the top of the screen (Figure VI-2).

Prior to pumping at TW04-02, it was observed that the water level in TW04-01 had not fully recovered to the static water level measured prior to testing at TW04-01 (see Figure VI-2). Specifically, the water level in TW03-01 was approximately 3 m below the pre-test depth. During the pumping test at TW04-02, the water level in TW04-01 continued to recovery an additional 1.1 m to a position about 2 m below the pre-test depth (Figure VI-2).

Water level data was obtained intermittently from the vibrating wire piezometer sites, throughout the aqifer pumping tests. Water level trends during the period of August 11 to 13, 2004 are shown on Figure VI-3 and Figure VI-4 for the five bedrock piezometers and five overburden piezometers, respectively.

3.5 Overburden Summary

The results of the Test Well drilling program and the previous borehole (BH Series) program indicate that the entire east side of the proposed Pit is overlain by a highly variable sequence of sediments, ranging in texture from silt/clay to coarse sand/gravel (Figure 4). In general, there is a surfical mantle of low-permeability silts and clays extending to depths of 14 m-bg at BH04-03 to more than 20 m-bg near TW04-01 (Figure 4). Zones of relatively permeable sand and gravel occur within the surfical mantle; however, these granular zones are discontinuous and are very thin relative to the host silt/clay profile.

A sand and gravel aquifer is present below the surficial mantle. The aquifer horizon is distinct near both Test Wells and at borehole BH04-03, but has considerable variation in thickness elsewhere and, near BH04-02, includes zones of fine-textured silty sand, silt and clay (Figure 4). Water levels in TW04-01, measured prior to the pumping tests, indicate a piezometric gradient of approximately 14% between TW04-01 and Polley Lake (Figure 5). A similar gradient exists between TW04-02 and the Lake.

The interpreted contact between the overburden sediments and bedrock surface within the proposed east Pit wall is shown on Figure 2. The thickness of the overburden exposure is relatively consistent between TW04-01 and TW04-02, where the Pit is closest to the Lake shoreline. Figure 5 further illustrates the relationship between the current watertable postion and the bedrock contact in the Pit near TW04-01. In this area, the watertable in the Pit wall will need to be depressed to approximately 914m-asl to effectively dewater the exposed overburden.

4.0 DISCUSSION

4.1 Pumping Test Analysis

Drawdown observations during pumping tests conducted in wells TW04-1 and TW04-2 (Appendix VI) were used to estimate the hydrogeologic properties of the overburden along along the shoreline of Polley Lake (the Lake). The drawdown data also provides some direct indication of the hydraulic connection between the overburden and the Lake.

The drawdown data were analyzed using AQTESOLV (HydroSolv, 2003), which is a commercial software package for aquifer test analysis. The analysis was based on the Theis solution, using variable pumping rates and a constant-head boundary representing the Lake. The distance to this boundary was varied to consider the potential effects of low-permeability lakebed sediments and account for the effective distance to the location where the overburden could be hydraulically connected to the Lake. The analysis focused primarily on the data collected during pumping from TW04-01, largely because the piezometric heads had not fully recovered prior to commencing testing at TW04-02. The details of the complete analysis are presented in Appendix VII. The analysis results are summarized in the following table.

Pumping Well	Monitoring Site	Distance to Boundary (m)	Hydraulic Conductivity (*K*, m/s)	Specific Storage (1/m)	Analysis Method
TW04-01	TW04-01	30	6 x 10^{-5}	n/a	Theis
TW04-01	TW04-02	100	2 x 10^{-4}	2 x 10^{-4}	Theis
TW04-01	BH04-03 (9m)	200	7 x 10^{-5}	5 x 10^{-5}	Theis
TW04-01	BH04-01 (20m)	100	1 x 10^{-4}	7 x 10^{-4}	Theis
TW04-02	TW04-02	n/a	3 x 10^{-4}	n/a	Theis recovery
TW04-02	BH04-04 (28m)	n/a	6 x 10^{-5}	1 x 10^{-5}	Theis
Geometric Average			1 x 10^{-4}		

NOTE: It was assumed that the permeable portion of the overburden is 21 m near TW04-01 and 18 m near TW04-2.

Accordingly, the pumping test data suggest that the hydraulic conductivity (*K*) of the overburden ranges from 6 x 10^{-5} m/s to 3 x 10^{-4} m/s. The average hydraulic conductivity, calculated using the geometric average, is approximately 1 x 10^{-4} m/s. Empirical approaches (see Table VI-1) yielded estimates for *K* that averaged 1 x 10^{-3} m/s to 2 x 10^{-3} m/s. However, several samples from both Test Wells were excluded from this analysis, since the corresponding gradation data did not conform to the range of acceptable values for uniformity coefficient (*U*) and d_{10}. Therefore, the resulting *K* estimates are not considered representative of the bulk hydraulic conductivity of the overburden profile. Furthermore, the averaged *K* values from the empirical methods produced theoretical drawdown curves that could not be adequaetly matched to the observed drawdowns.

In general, the theoretical drawdown curves matched more closely to the field data when a constant-head boundary representing the Lake was included in the analysis. However, the best possible match was achieved when the assumed distance to the Lake "boundary" was larger than the actual distance from the Test Wells to the shoreline. This suggests that the hydraulic connection between the overburden and the Lake is somewhat impeded, possibly by the presence of low-permeability lakebed sediments and/or a gentle lakebed profile with the granular sediments subcropping at some distance from the shoreline. A cross-section perpendicular to the Lake shoreline (Figure 5) includes Lake bathymetry, which indicates that the Lake bottom slopes gently from the shoreline.

4.2 Preliminary Estimates of Pit Inflow

The stratigraphic information and drawdown data collected at the site were further utilized to estimate the potential groundwater inflow to the proposed Pit. The inflow was calculated using a numerical hydrogeologic model constructed using MODFLOW, which is a groundwater modelling code developed by the United States Geological Survey (Harbaugh, 2000). The model covers an plan area of 1200 m by 2600 m, and extends vertically from 700 m-asl to the observed pre-test watertable position. The resulting model grid is presented in Figure 6.

4.2.1 Model Assumptions and Calibration

The following assumptions were made in the hydrogeological model:

- Prior to mining the Pit, the groundwater flow in bedrock is directed from the summit of Mount Polley eastward toward Polley Lake;
- A layer of overburden up to 30 m thick extends from the shoreline to approximately 300 m inland where it becomes abruptly thinner;
- The surface elevation of Polley Lake is 922 m, as measured in August 2004;
- Lakebed sediments in Polley Lake may be comprised of relatively low-permeability silty sediments similar to the surficial mantle near the shoreline, which could impede groundwater flow;
- Two major faults, with bulk hydraulic conductivities potentially higher than the surrounding bedrock, intersect the Pit (Figure 2). One of these faults extends approximately through the centre of the Pit, whereas the second fault passes through the southern portion of the pit. Both of these faults were assumed to be sub-vertical and have a horizontal thickness of 5 m.

- The average hydraulic conductivity of the bedrock is assumed to be 9×10^{-8} m/s, which was measured in bedrock by Golder in the nearby Cariboo Pit (Golder, 2001). Faults were assigned a hydraulic conductivity of 5×10^{-6} m/s based on experience from similar sites. Overburden hydraulic conductivity was set to the average value of 1×10^{-4} m/s estimated from the pumping tests in TW04-1 and TW04-2.

- The ultimate Pit is approximately 600 m long and 400 m wide, and the Pit bottom is at 820 m-asl. During mining, the Pit will form a groundwater sink with flow directed radially towards it. The majority of inflow will orginate from the overburden, with significantly lesser inflows from bedrock discontinuities and major faults. This is because the overburden exposed along the east Pit wall is expected to have a significantly higher hydraulic conductivity than bedrock and the overburden will also be present at elevations below the Lake level (Figure 5).

Calibration of the model consisted of two stages. First, a steady-state simulation representing pre-mining conditions was prepared. In this simulation the hydraulic conductivities of bedrock and overburden were set to the values discussed above, and the recharge from precipitation was varied until the watertable elevation upgradient of the pit was a subdued replica of the topography. It was found that a recharge rate of 160 mm/yr, or approximately 25% of annual precipitation (Golder, 2001), resulted in a reasonable watertable configuration (Figure 7). Currently, watertable elevation data in the area immediately upgradient of the Pit is not available.

The model was then used to simulate the pumping test conducted in TW04-1. The values of hydraulic conductivity assigned to bedrock and overburden were held constant, and the conductance assigned to the Lake boundary was varied to improve the match between measured and observed drawdown at the monitoring locations (*i.e.*, piezometers). It was found that the conductance representing lakebed sediments of 10 m thickness and a hydraulic conductivity of 2×10^{-5} m/s resulted in the best match of observed drawdown. This is equivalent to a scenario where the lakebed sediments are not present and the overburden is hydraulically connected to the lake at a distance of approximately 50 m from the shoreline. Figure 8 presents contours of model predicted drawdown at the end of the pumping test in TW04-1. Figure 9 presents an x-y plot of model predicted drawdown versus measured drawdown that indicates a reasonably good model calibration. Although calibration data were not available for the bedrock and faults, the model is considered sufficient for predicting Pit inflows, primarily because the largest inflow component is expected to originate from the overburden where the calibration data are available.

4.2.2 Model Results

The groundwater model was used to predict inflows to the Pit for two scenarios: the Pit alone (Scenario 1) and the Pit with a series of dewatering wells installed in the overburden to mitigate the Pit inflow (Scenario 2). These results were based on the calibrated model and as such represent best estimates of inflows. Uncertainty in the predicted inflow is discussed in the following section.

The model results indicate that unmitigated inflows to the ultimate Pit (Scenario 1) could be approximately 8,500 m^3/day (1,500 USgpm). Approximately 80% of this inflow is predicted to originate from the overburden. The watertable contours predicted for Scenario 1 are presented in Figure 10.

In order to effectively dewater the overburden in the east Pit wall, the water table adjacent to the pit wall will need to be depressed and maintained at an elevation below the bedrock/overburden contact surface in the east wall. In model Scenario 2, it was found that four to six dewatering wells installed in the overburden between the east Pit crest and Lake shoreline can sufficiently lower the water table in the pit wall, while significantly reducing Pit inflow. Specifically, introducing the wells into the model reduced the inflow to the ultimate Pit to approximately 3,000 m^3/day (500 USgpm). The corresponding total pumping rate for the wells was 5,500 m^3/day (1,000 USgpm) and the pumping rates for individual wells were about 1,000 m^3/day (150 USgpm). The watertable contours predicted for Scenario 2 are presented in Figure 11.

An additional ultimate Pit model simulation was conducted to estimate the time required for the water table to recover after pumping from dewatering wells was discontinued. Model results suggest that the water table and hydraulic gradient near the Pit wall would be re-established in less than 6 hours following pumping cessation.

4.2.3 Sensitivity

Sensitivity analysis was conducted to assess the uncertainty in the predicted inflows resulting from the uncertainty in model input parameters. Preliminary model simulations suggested that the greatest uncertainty in model predictions was related to the degree of hydraulic connection between the overburden and Polley Lake. It is possible that, at some areas located at a distance from the existing pumping wells, that connection is much better than the one assumed in the model. This was addressed by re-running the model for each scenario, without the impediment associated with the low-permeability lakebed sediments and/or configuration of the lakebed. The results of this analysis suggested that the unmitigated inflow to the Pit (Scenario 1) could be as high as 13,000 m^3/day (2,500 USgpm), or about 1.7 times the best estimate inflow. The corresponding pit inflow in Scenario 2 (pumping wells in the overburden) was

5,500 m^3/day (1,000 USgpm) and the total pumping rates for the wells was 13,000 m^3/day (2,500 USgpm). This represents a factor of 2 to 2.5 increase from the best estimates.

It is considered unlikely that the actual inflows to the Pit could be significantly lower than the best estimates of inflows predicted by the model. This would require a presence of lake-bed sediments of much lower permeability and greater thickness than assumed in the model. Existence of such sediments is not supported by the results of the pumping tests conducted in TW04-1 and TW04-2.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the hydrogeological investigation indicate that dewatering of the overburden sediments exposed in the upper east wall of the proposed Wishbone Pit will be feasible. Based on the analysis of the field exploration/testing program results, we offer the following additional comments and recommendations.

1. The entire east side of the proposed Pit is overlain by overburden sediments ranging in texture from silt/clay to coarse sand/gravel. A surficial layer comprised of silt and clay extends to minimum depths of 14 m-bg. Discontinuous zones of permeable sand and gravel occur within the silt/clay.

2. Drilling of two Test Wells (TW04-01 and TW04-02) has confirmed the presence of a sand/gravel aquifer below the surficial silt/clay. The aquifer thickness varies considerably and ranges from 8 m near BH04-03 to more than 20 m near TW04-01. The aquifer profile is also quite variable and includes zones of fine-textured silty sand, silt and clay.

3. Static water levels measured in the Test Wells indicate that the watertable in the vicinity of the east Pit wall ranges from approximately 4m-bg to 16m-bg. The average piezometric gradient adjacent to the Polley Lake shoreline is approximately 14%, based on the pre-test water levels measurements.

4. Drawdown observations during two pumping tests, in TW04-01 and TW04-02, were analyzed to provide estimates of aquifer hydraulic properties. Water levels were recorded in both Test Wells and from ten vibrating wire piezometers installed in overburden and bedrock.

5. Analysis of the pumping test data suggested that the hydraulic conductivity (*K*) of the overburden ranges from 6×10^{-5} m/s to 3×10^{-4} m/s, with a geometric average of approximately 1×10^{-4} m/s.

6. Theretical drawdown curves closely matched the field data, using the average *K* of 1×10^{-4} m/s, coupled with a constant-head boundary representing Polley Lake. The analysis indicated that the hydraulic connection between the overburden and Polley Lake is likely impeded by the gently sloping Lake bottom profile with the granular sediment subcropping at a distance of about 50 m from the shoreline and, possibly, by the presence of low-permeability lakebed sediments.

7. A hydrogeological model was constructed to simulate the pumping test at Test Well TW04-01. It was determined that the simulated drawdowns exhibited a best-fit to observed drawdowns, by assuming that lakebed sediments with a K of 2 x 10^{-5} m/s and thickness of about 10 m are present in Polley Lake.

8. The model estimates that groundwater inflow to the ultimate Pit could be approximately 8,500 m^3/day (1,500 USgpm), in the absence of a dewatering effort. Also, approximately 80% of the water would orginate from the overburden and the remainder from bedrock exposures.

9. Effective dewatering of the overburden in the east Pit wall can be achieved by constructing four to six wells in the overburden between the east Pit crest and Lake shoreline. The corresponding total pumping rate for the wells would be approximately 5,500 m^3/day (1,000 USgpm) and the pumping rates for individual wells would be about 1,000 m^3/day (150 USgpm). The inflow to the ultimate Pit would then be reduced to approximately 3,000 m^3/day (500 USgpm).

10. The greatest uncertainty in model predictions relates to the hydraulic connection between the overburden and Polley Lake. If the low-permeability lakebed sediments are not present, the model predicts that the unmitigated inflow to the Pit could be about 1.7 times the best estimate of inflow. The corresponding increase in the combined pumping rates for the dewatering could be 2.0 to 2.5 times the best estimates.

6.0 CLOSURE

We trust this information is sufficient for your present needs. If you require clarification, or additional information, please contact the undersigned.

GOLDER ASSOCIATES LTD.

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Hydrogeologist

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Principal, Hydrogeologist

MM/WZ/DC/jc
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7.0 REFERENCES

Golder Associates, 2001. *Cariboo Pit Hydrogeological Study Mount Polley Mine Likely, British Columbia*. Project Number 012-1859

Golder Associates, 2004. *Pit Slope Sability Asessment of the Proposed Wishbone Open Pit, Mt. Polley Mining Corporation, Likely, BC.* Project 04-1413-027

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000. *MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process.* Open-File Report 00-92. U.S. Geol. Surv.

Hazen, A.. 1911. Discussion of "dams on soil foundations". *Trans. Amer. Soc. Civil Engrs*. 73,: 199.

HydroSolve Inc., 2003. *AQTESOLV for Windows v.3.5., User's Guide*. HydroSolve Inc., Reston, VA

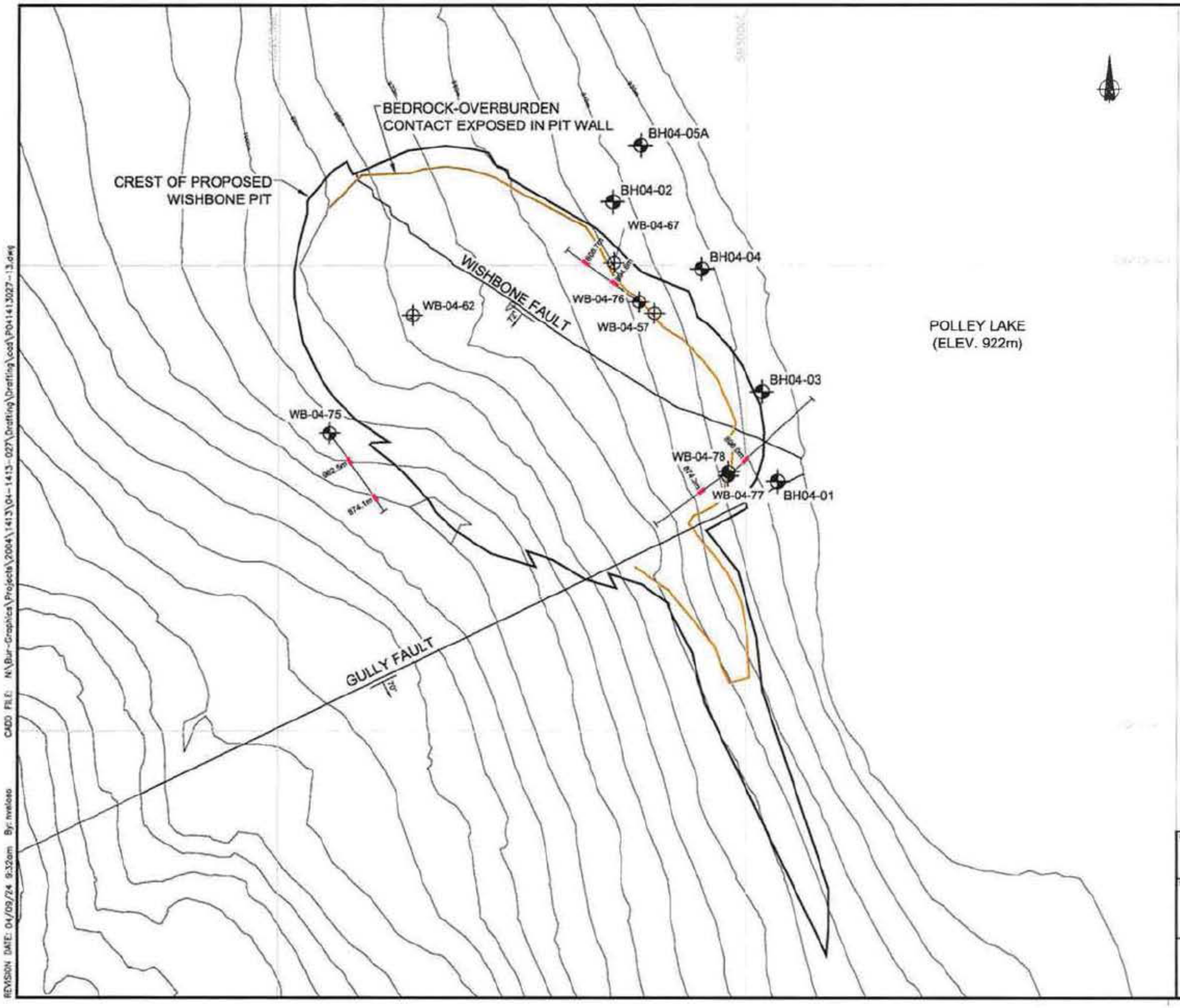
Kresic, N. 1997. *Quantitative Solutions in Hydrogeology and Groundwater Modeling*. Lewis, New York, 461 p.

PROJECT NO. 012-1859 DRAWN BY: GG REVIEWED BY: DATE: SEP-17-01 FILE LOCATION: N:\Work\1800\012-1859 Hydrogeology Mt Polley\Drawings\CONCEPTUAL.CDR

Golder Associates

LOCATION PLAN
Mount Polley Mine

Figure
1



LEGEND

BH04-04	Geotechnical Overburden Boreholes - Logged by Golder May-June, 2004 - All Boreholes Vertical
WB-04-75	Inclined Geotechnical Boreholes
874.1m	Vibrating Wire Piezometer with Elevation Shown
WB-04-62	Vertical Geotechnical Boreholes

NOTE

1) Mapping Based on AutoCad File "Polley-05metre.dwg" Received From Imperial Metals Corp. June 2004.
2) Datum is NAD83. Elevations are in Meters above Mean Sea Level.
3) Contour interval is 2m

0 80 160 240 320 400
Scale in Meters

PROJECT
IMPERIAL METALS CORPORATION
HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE
SITE PLAN

Golder Associates

PROJECT No. 04-1413-027			FILE No. P041413027-13	
DESIGN	MOM	24SEP04	SCALE AS SHOWN	REV -
CADD	AV	24SEP04	FIGURE 2	
CHECK	MOM	24SEP04		
REVIEW				

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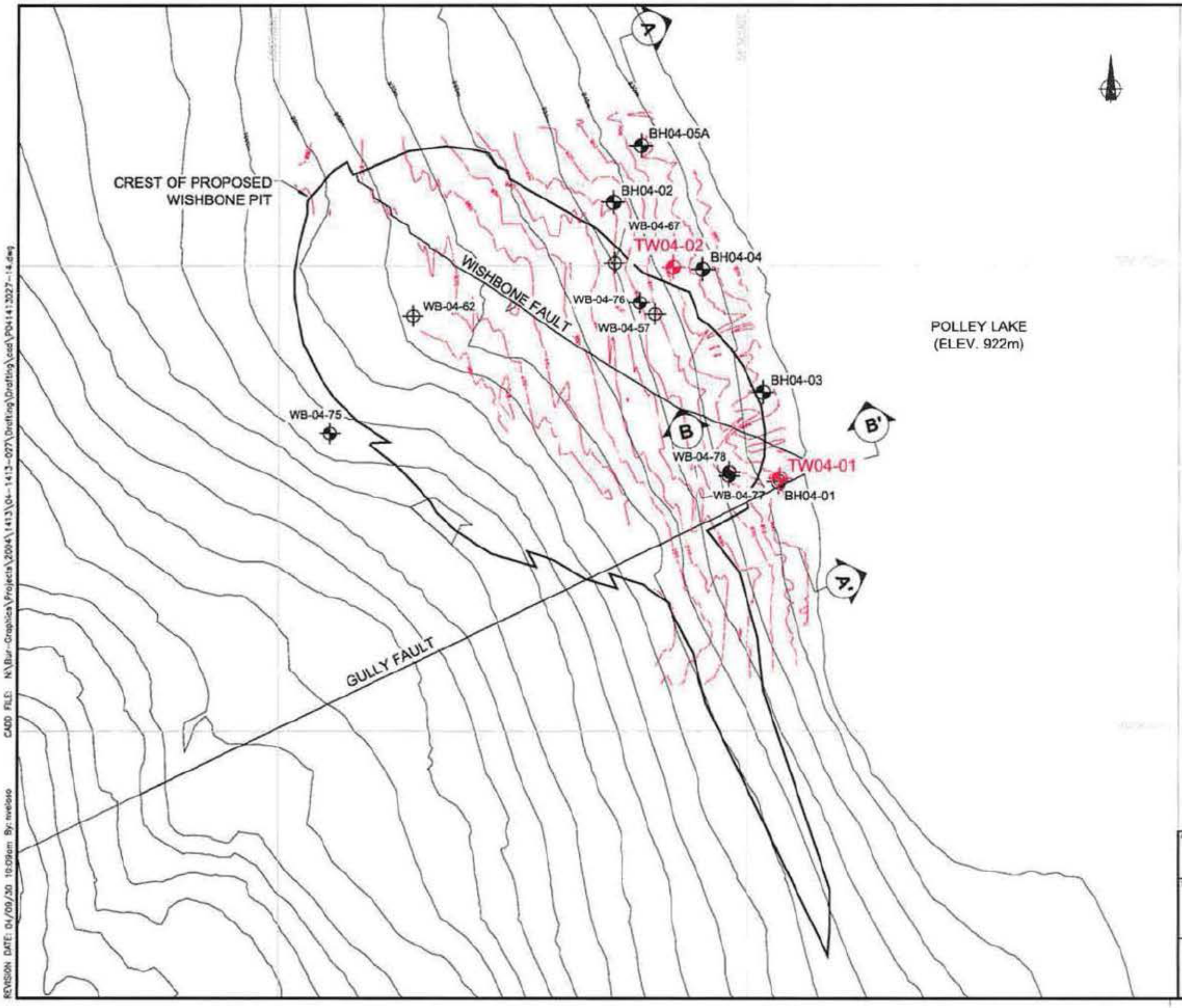

LEGEND

TW04-01	Test Well (200mm Ø Steel) - Logged by Golder July-August, 2004
BH04-04	Geotechnical Overburden Boreholes - Logged by Golder May-June, 2004 - All Boreholes Vertical
WB-04-75	Inclined Geotechnical Boreholes
WB-04-62	Vertical Geotechnical Boreholes
	Bedrock Elevation Contour

NOTE

1) Mapping Based on AutoCad File "Polley-05metre.dwg" Received From Imperial Metals Corp. June 2004.
2) Datum is NAD83. Elevations are in Meters above Mean Sea Level.
3) Topographic contour interval is 2m.
4) For hydrogeological cross-sections see Figures 4 and 5.
5) Bedrock contour interval is 10m.

0 80 160 240 320 400
Scale in Meters

PROJECT
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MT. POLLEY MINE, LIKELY, BC

TITLE
BEDROCK ELEVATION CONTOURS
(BASED ON GEOTECHNICAL DATA)

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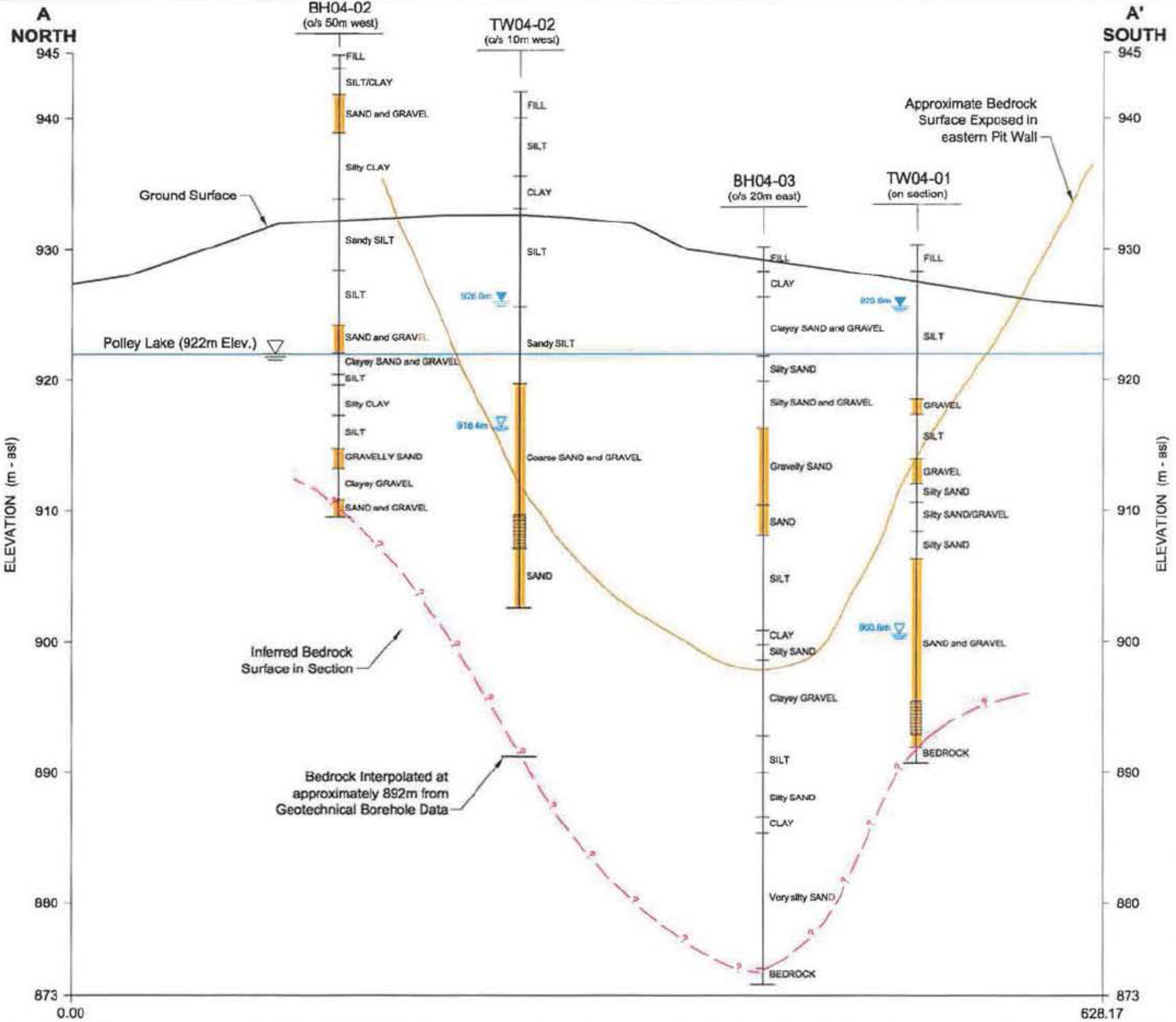
REVIEW				

REVISION DATE: 04/09/30 10:09am By: nveloso CADD FILE: N:\Burr-Graphics\Projects\2004\1413\04-1413-027\Drafting\Drafting\cad\P041413027-14.dwg



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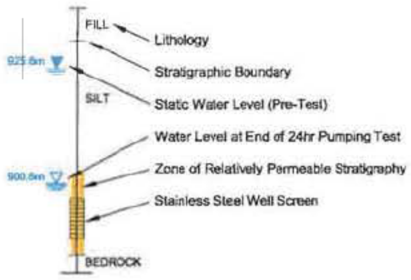

NOTE

1) Datum is NAD83. Elevations are in Meters above Mean Sea Level.
2) Section location shown on Figure 2.

PROJECT
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HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE
SECTION A-A'

Golder Associates

PROJECT No. 04-1413-027			FILE No. P0414130227-13	
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REVIEW				

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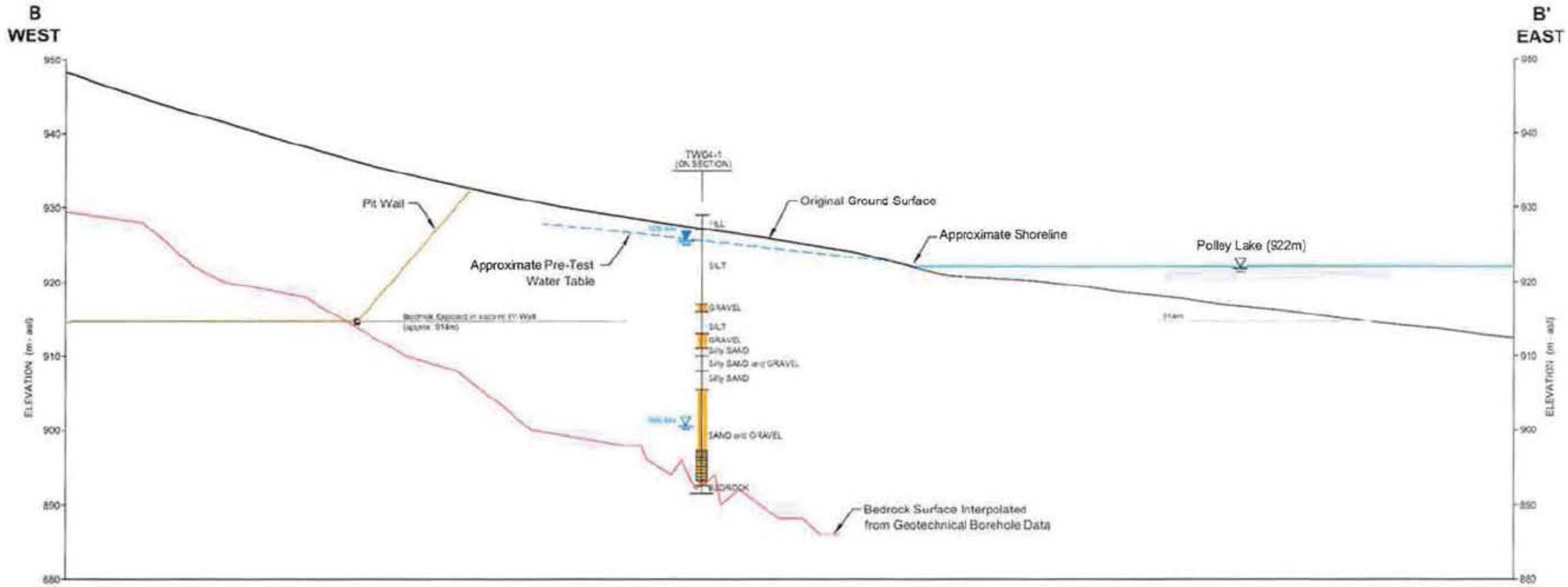

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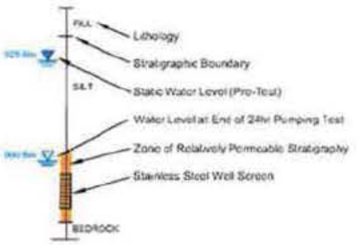
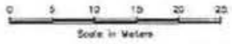


NOTE

1) Datum is NAD83. Elevations are in Meters above Mean Sea Level
2) Polley Lake bathymetry from Department of Enviroment, Fish and Wildlife Branch. Drawing dated June 20, 1973
3) Section location shown on Figure 2



PROJECT
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TITLE
SECTION B-B'

Golder Associates

PROJECT No. 04-1413-027			FILE No. P041413027-13
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CADD	MV	[illegible]	FIGURE 5
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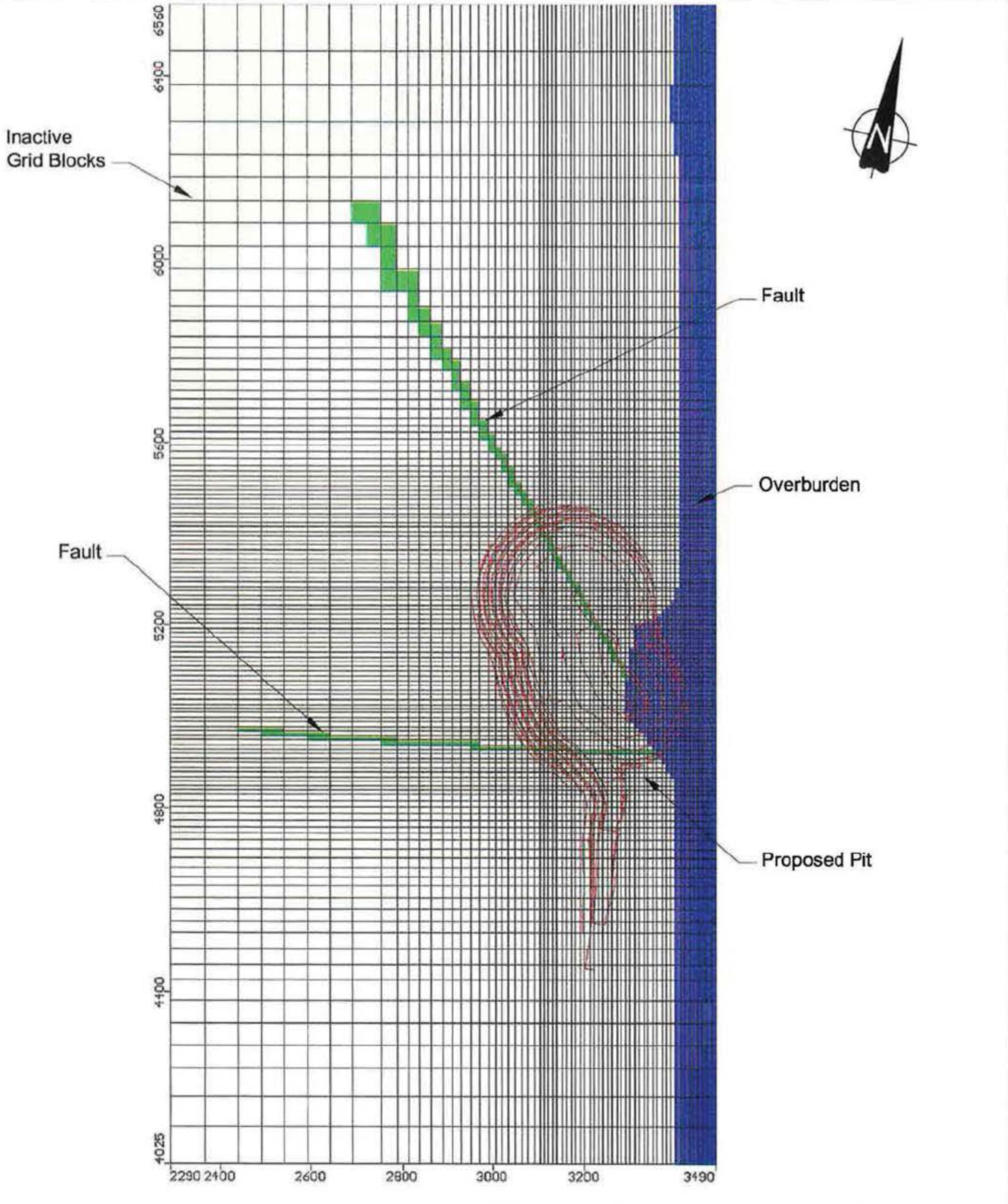

Scale Approximate - all distances are in meters

PROJECT

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HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE

EXTENT OF MODEL GRID

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PROJECT No. 03-1411-095		
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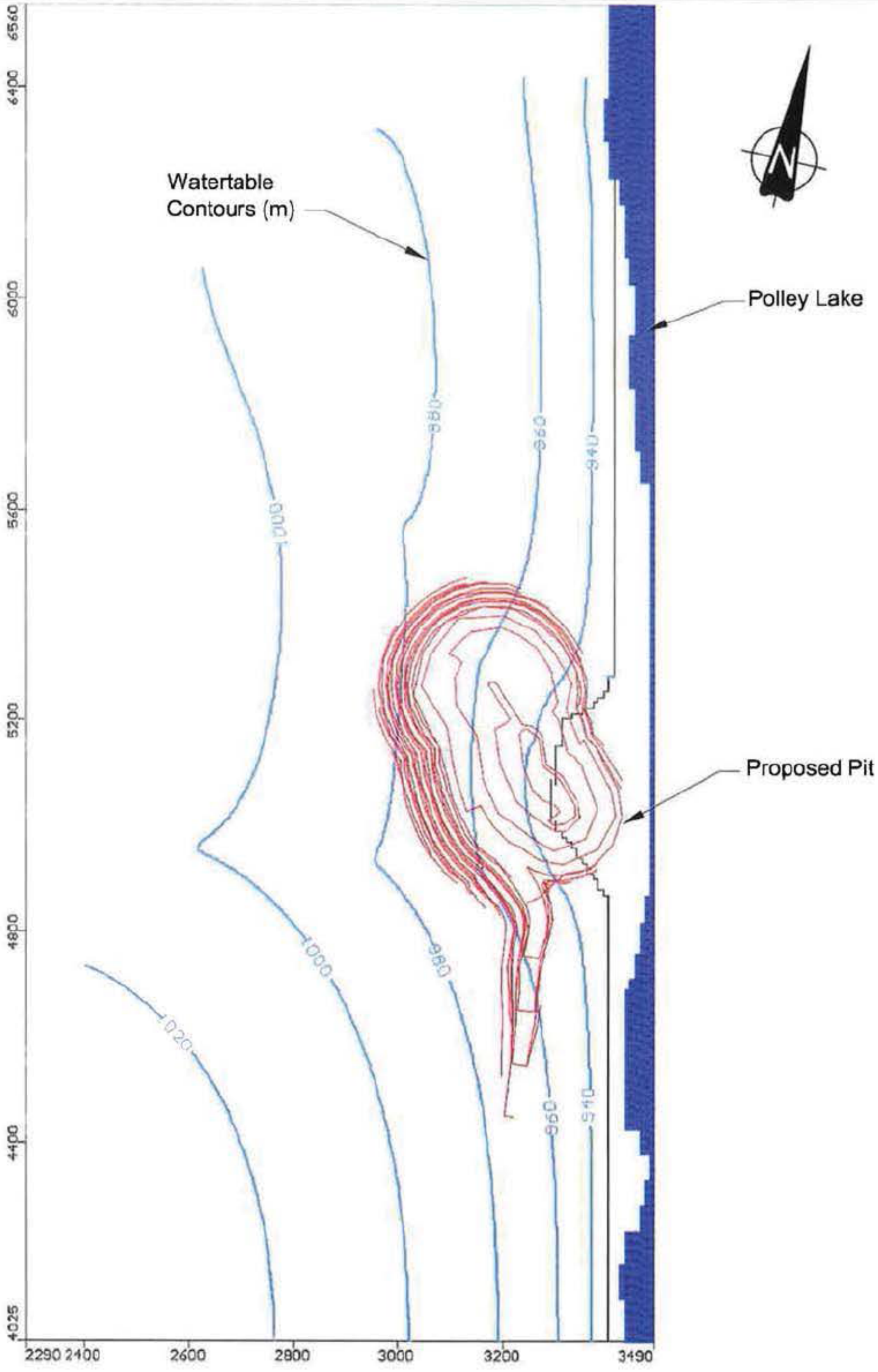
CHECK	WZ	01OCT04
REVIEW	WZ	01OCT04

FILE No. P041413027-15

SCALE AS SHOWN REV. -

FIGURE 6



Scale Approximate - all distances are in meters

PROJECT

IMPERIAL METALS CORPORATION
HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE

PREDICTED WATERTABLE PRIOR TO MINING

Golder Associates

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CHECK	WZ	01OCT04	**FIGURE 7**	
REVIEW	WZ	01OCT04		

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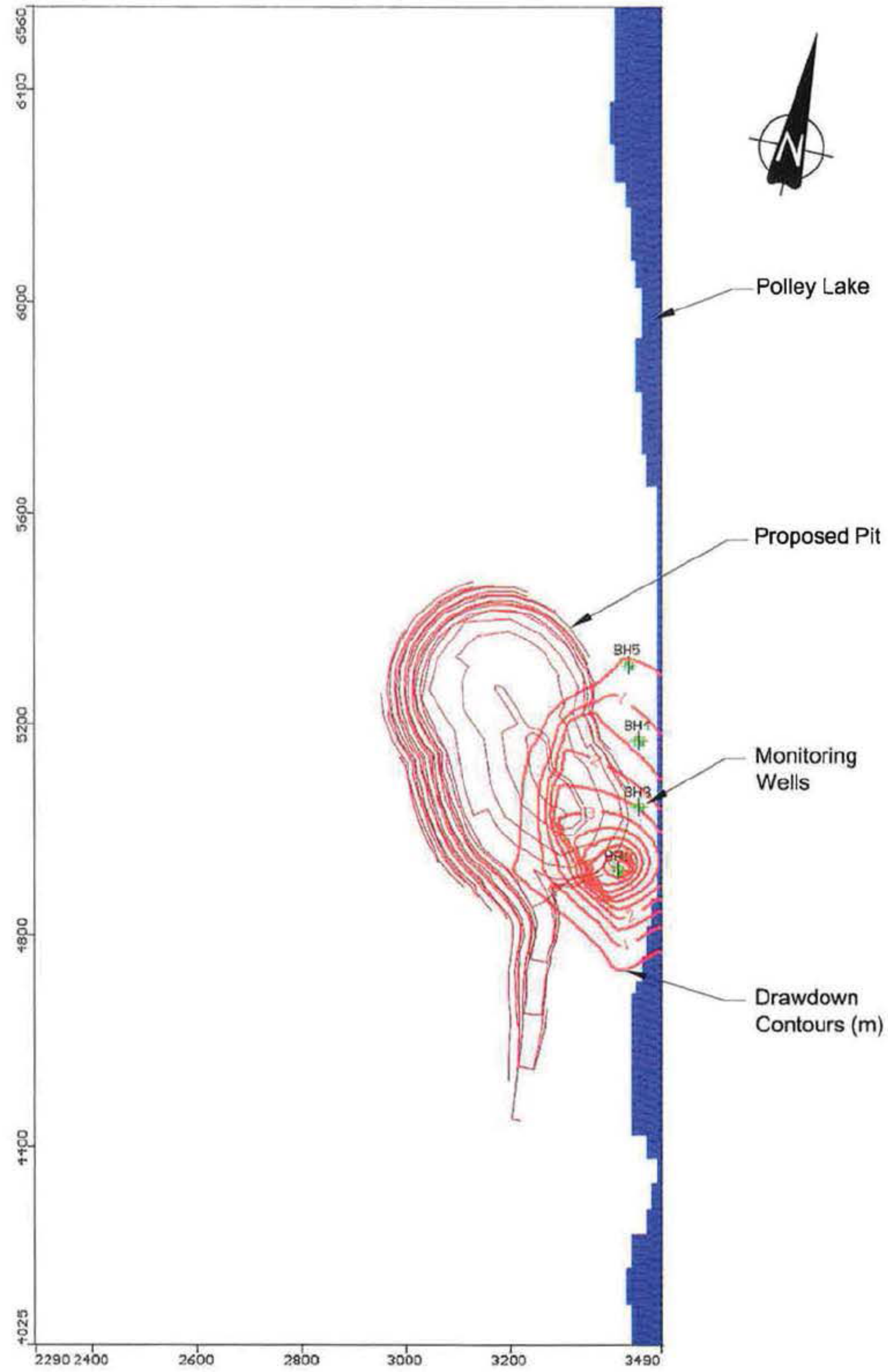

Scale Approximate - all distances are in meters

PROJECT

IMPERIAL METALS CORPORATION
HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE

MODEL PREDICTED DRAWDOWN PUMPING TEST IN TWO4-1

Golder Associates

PROJECT No. 03-1411-095		
DESIGN	WZ	01OCT04
CADD	SRR	01OCT04
CHECK	WZ	01OCT04
REVIEW	WZ	01OCT04

FILE No. P041413027-15

SCALE AS SHOWN REV. -

FIGURE 8

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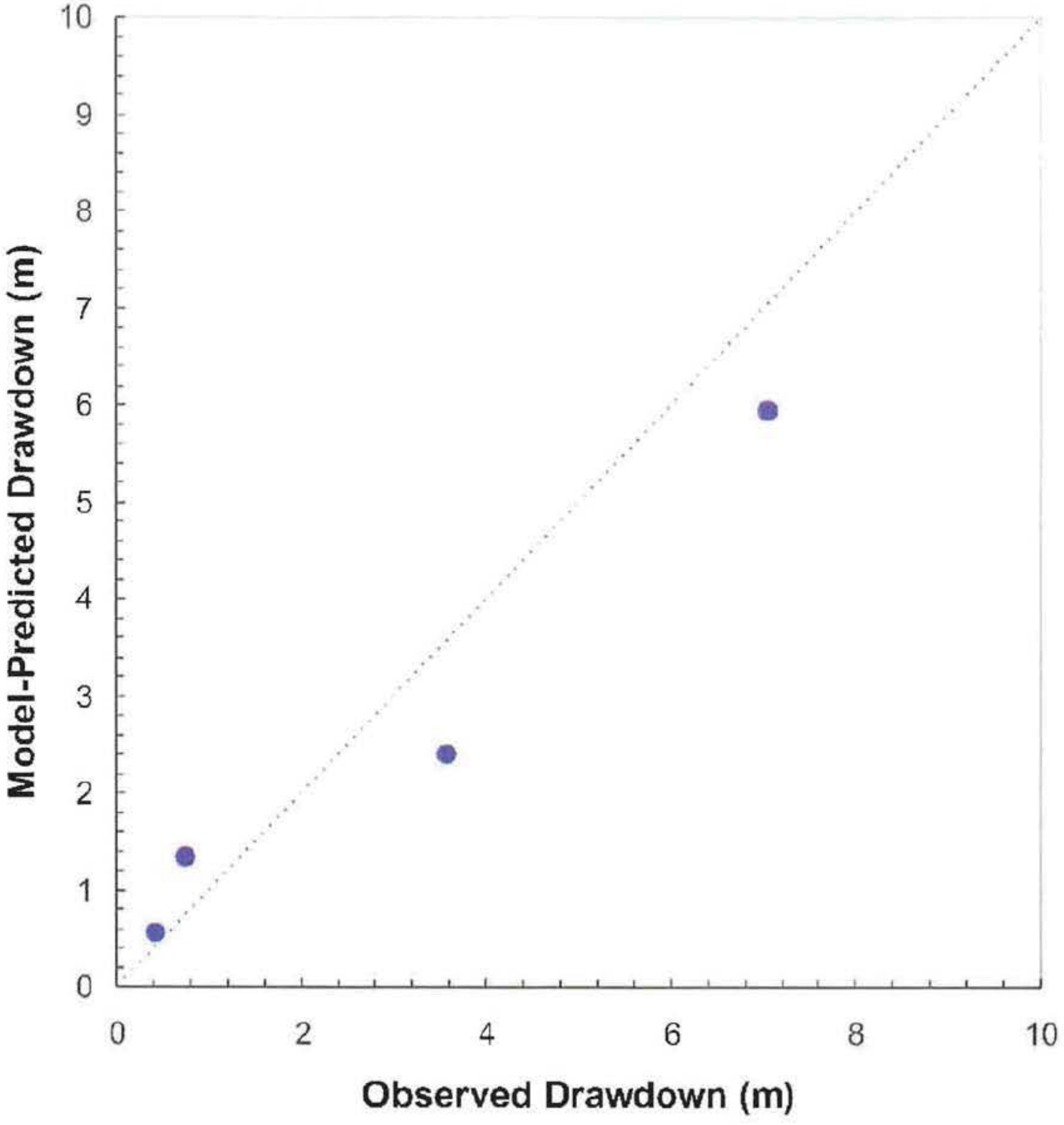

Scale Approximate - all distances are in meters

PROJECT

IMPERIAL METALS CORPORATION
HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE

MODEL PREDICTED DRAWDOWN VERSUS OBSERVED DRAWDOWN PUMPING TEST IN TWO4-1

Golder Associates

PROJECT No.	03-1411-095		FILE No.	P041413027-15
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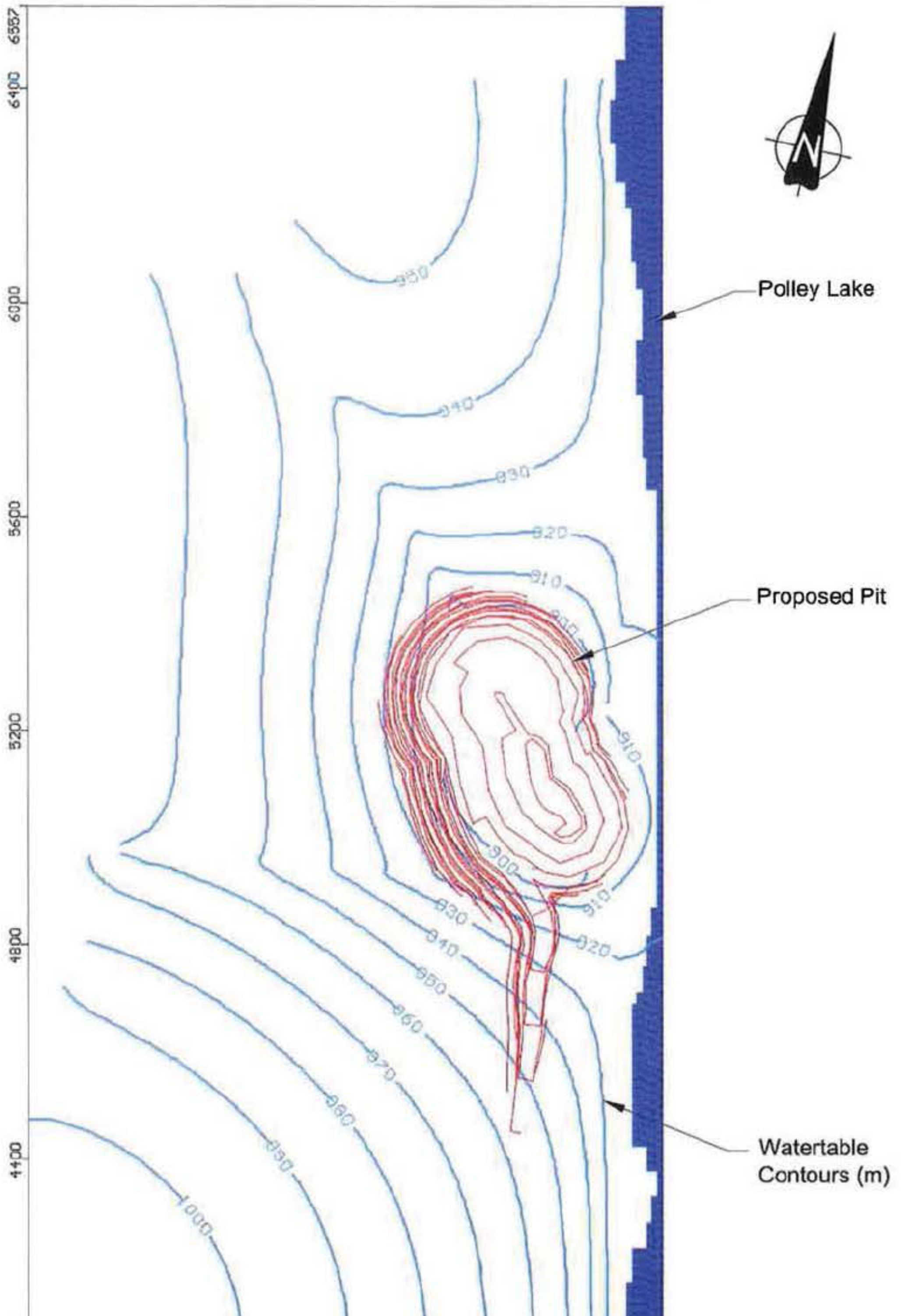
CADD	SRR	01OCT04		
CHECK	WZ	01OCT04	FIGURE 9	
REVIEW	WZ	01OCT04		



Scale Approximate - all distances are in meters

PROJECT
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HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE

SCENARIO 1 - WATERTABLE CONTOURS

Golder Associates

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REVIEW	WZ	01OCT04

FILE No. P041413027-15
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FIGURE 10

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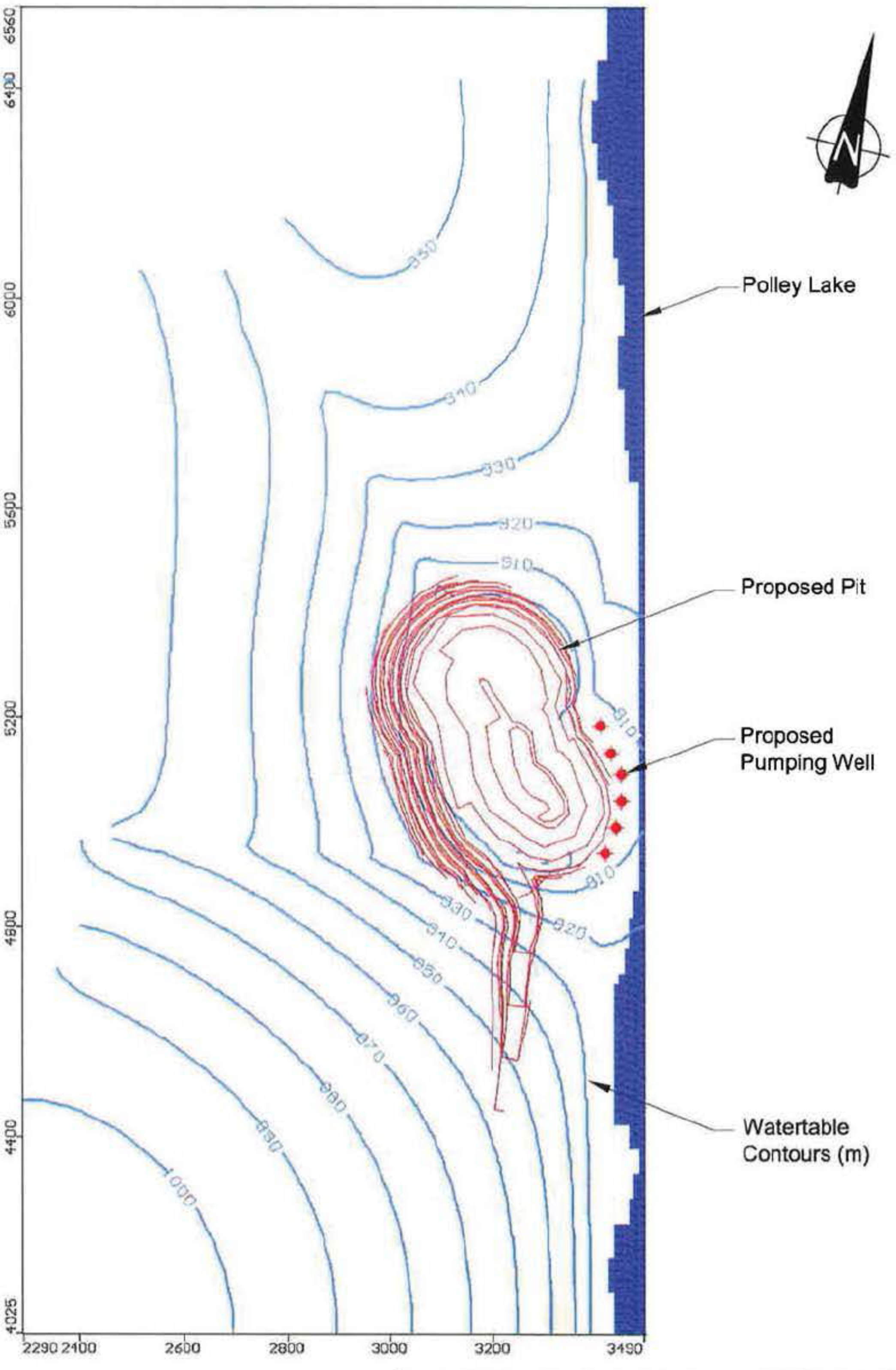

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PROJECT

IMPERIAL METALS CORPORATION
HYDROGEOLOGICAL INVESTIGATION
MT. POLLEY MINE, LIKELY, BC

TITLE

SCENARIO 2 - WATERTABLE CONTOURS

Golder Associates

PROJECT No.	03-1411-095		FILE No.	P041413027-15
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CHECK	WZ	01OCT04		
REVIEW	WZ	01OCT04		

APPENDIX I

GEOTECHNICAL BOREHOLE COMPLETION DATA (WB SERIES)

Table I-1
Summary of Inclined Geotechnical Borehole Data

Borehole ID	Borehole Collar Coordinates (NAD 83)			Average Borehole Orientation		Length (m)	Vertical Depth to Bedrock (m)
	Easting (m)	Northing (m)	Elevation (m)	Azimuth (degrees)	Inclination (degrees)		
WB-04-75	592554.41	5825319.68	1027.2	145	-61	209.09	1.55
WB-04-76	592884.62	5825460.46	950.5	306	-62	203.3	27.45
WB-04-77	592980.33	5825274.07	937.5	048	-60	242.93	42.76
WB-04-78	592980.83	5825278.66	937.5	234	-61	198.12	20.26

NOTE: Borehole locations shown on Figure 2.

Table I-2
Vibrating Wire Piezometer Completion Details - Inclined Geotechnical Boreholes

Borehole	Tip	Downhole Depth (m)	Vertical Depth (m)	North (m)	East (m)	Elevation (m)	Incl. (deg)	Az. (deg)
WB04-75	VW08-55	175	153	592554.41	5825319.68	1027.20	-61	145
	VW08-58	74	65					
WB04-76	VW08-54	63	56	592884.62	5825460.46	950.50	-62	306
	VW08-57	161	142					
WB04-77	VW08-56	48	42	592980.33	5825274.07	937.50	-60	48
WB04-78	VW08-59	72	63	592980.83	5825278.66	937.50	-61	234

NOTE: Piezometer depths (elevations) shown on Figure 2.

Table I-3
Summary of Vertical Geotechnical Borehole Data

Borehole ID	Collar Data (NAD 83 Coordinates)			Average Orientation		Length (m)	Approximate Vertical Depth to Bedrock (m)
	Easting (m)	Northing (m)	Elevation (m)	Az. (deg.)	Incl. (deg.)		
WB-04-57	592901.34	5825448.21	947.98	204.43	89.0	170.08	n/a
WB-04-62	592676.72	5825446.10	957.95	213.13	88.0	126.80	21
WB-04-67	592857.76	5825502.85	952.33	227.45	87.7	215.80	23

NOTE: Borehole locations shown on Figure 2.

APPENDIX II

OVERBURDEN BOREHOLE LOGS AND COMPLETION DATA (BH SERIES)

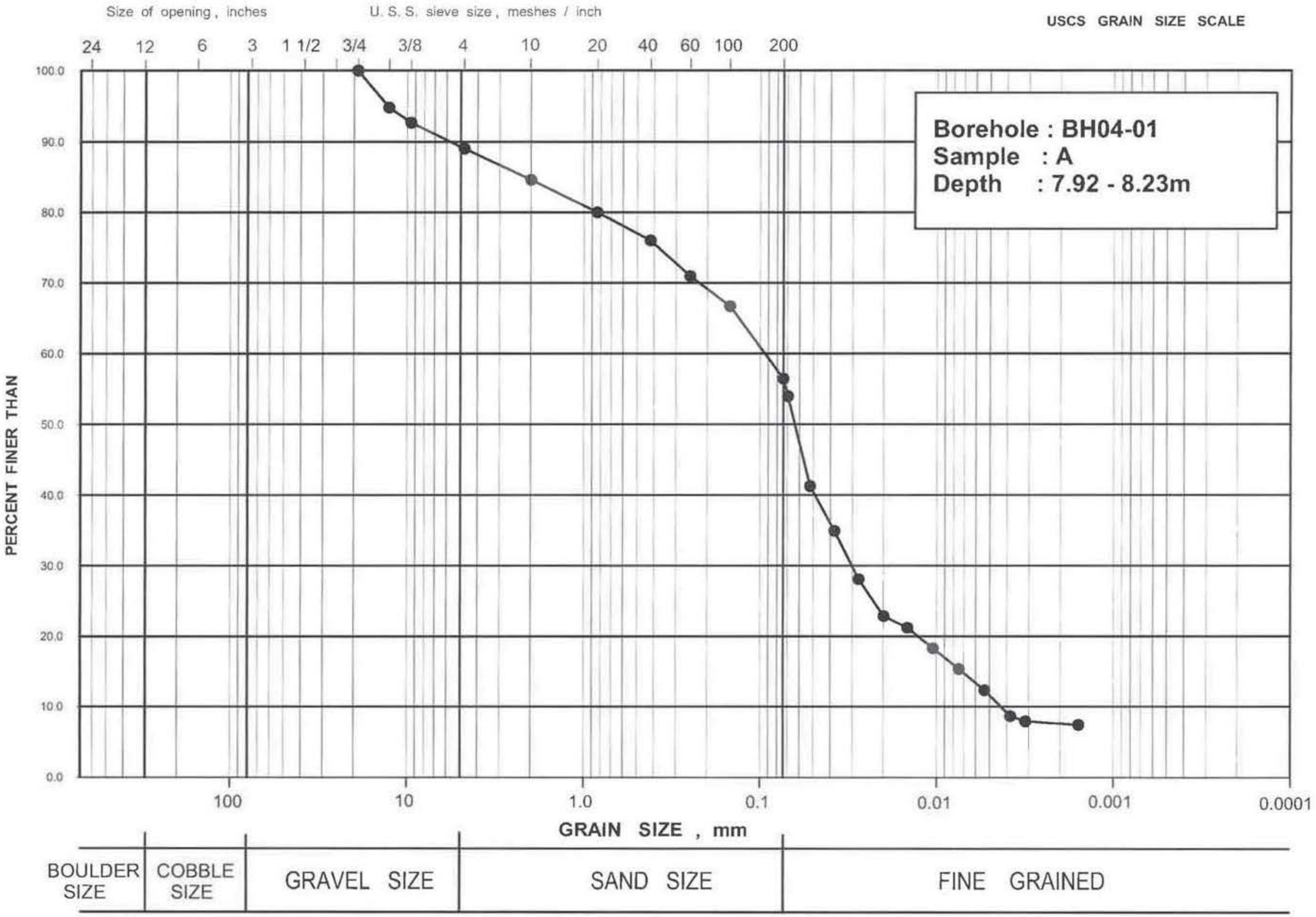
Table II-1
Vibrating Wire Piezometer Completion Details - Overburden Installations

Borehole	Tip	Downhole Depth (m)	Vertical Depth (m)	North (m)	East (m)	Elevation (m)	Bedrock Depth (m)	Incl. (deg)
BH04-01	VW08-49	20	20	593033.41	5825268.09	929.97	41	-90
	VW08-53	45	45					
BH04-02	n/a	n/a	n/a	592856.45	5825567.96	Approx. 944	35	-90
BH04-03	VW08-47	9	9	593016.49	5825363.74	930.65	54	-90
	VW08-52	48	48					
BH04-04	VW08-51	28	28	592951.68	5825496.19	933.00	>40	-90
BH04-05	VW08-50	25	25	592886.12	5825628.44	932.87	36	-90

NOTE: Borehole locations shown on Figure 2.

APPENDIX III

OVERBURDEN BOREHOLE GRADATION ANALYSIS

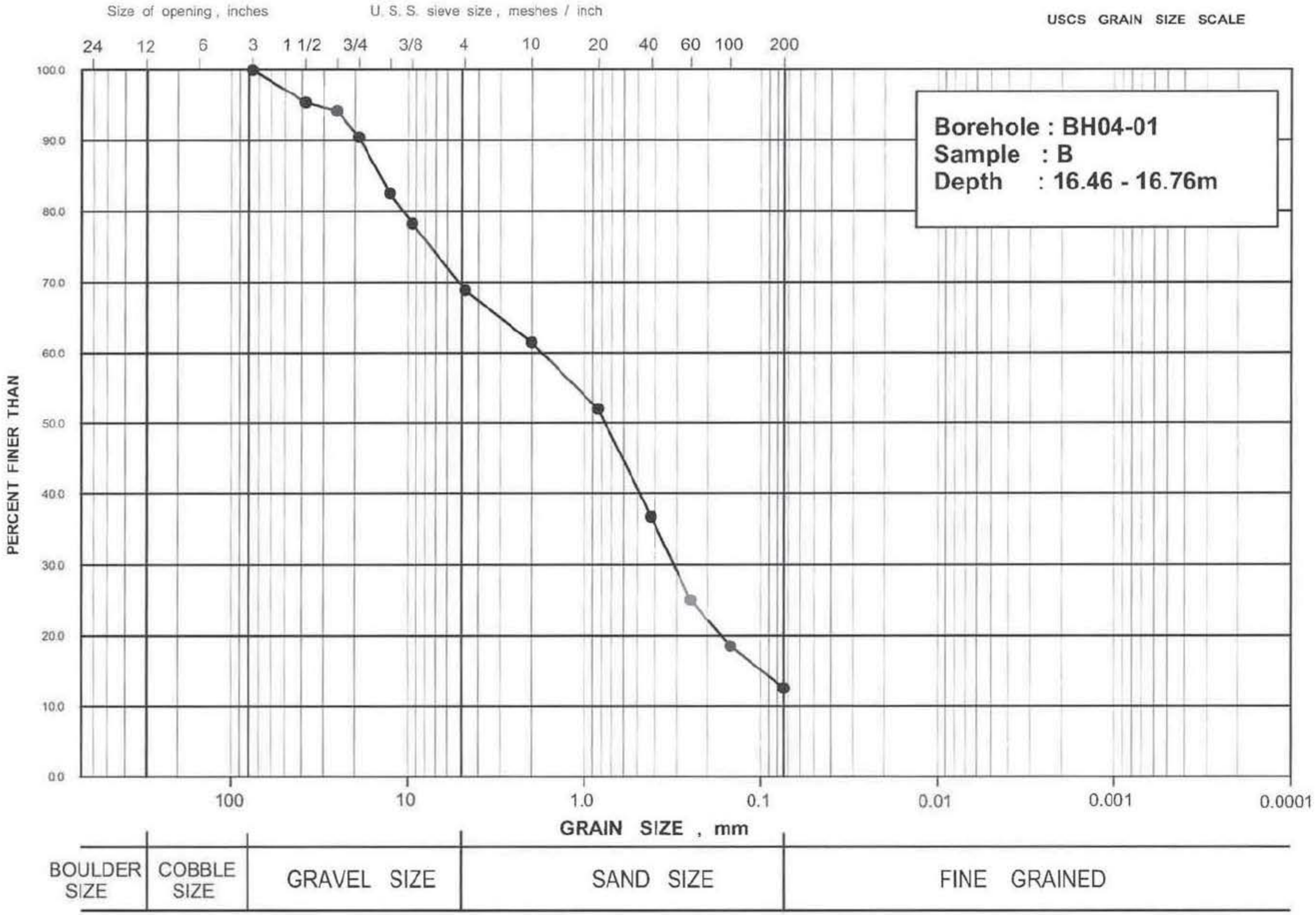


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Gradation Analysis

Figure III-1

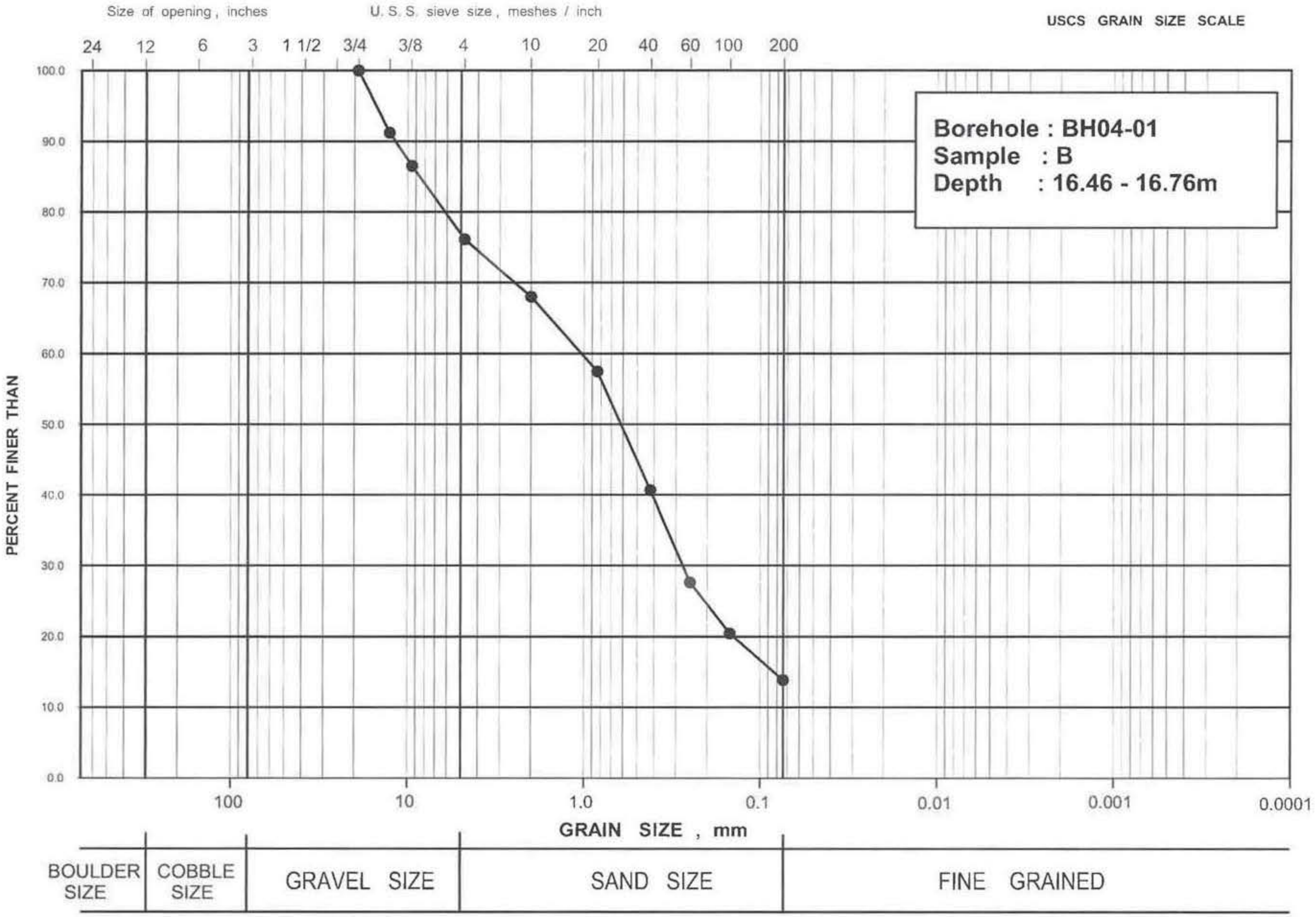


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Gradation Analysis

Figure III-2

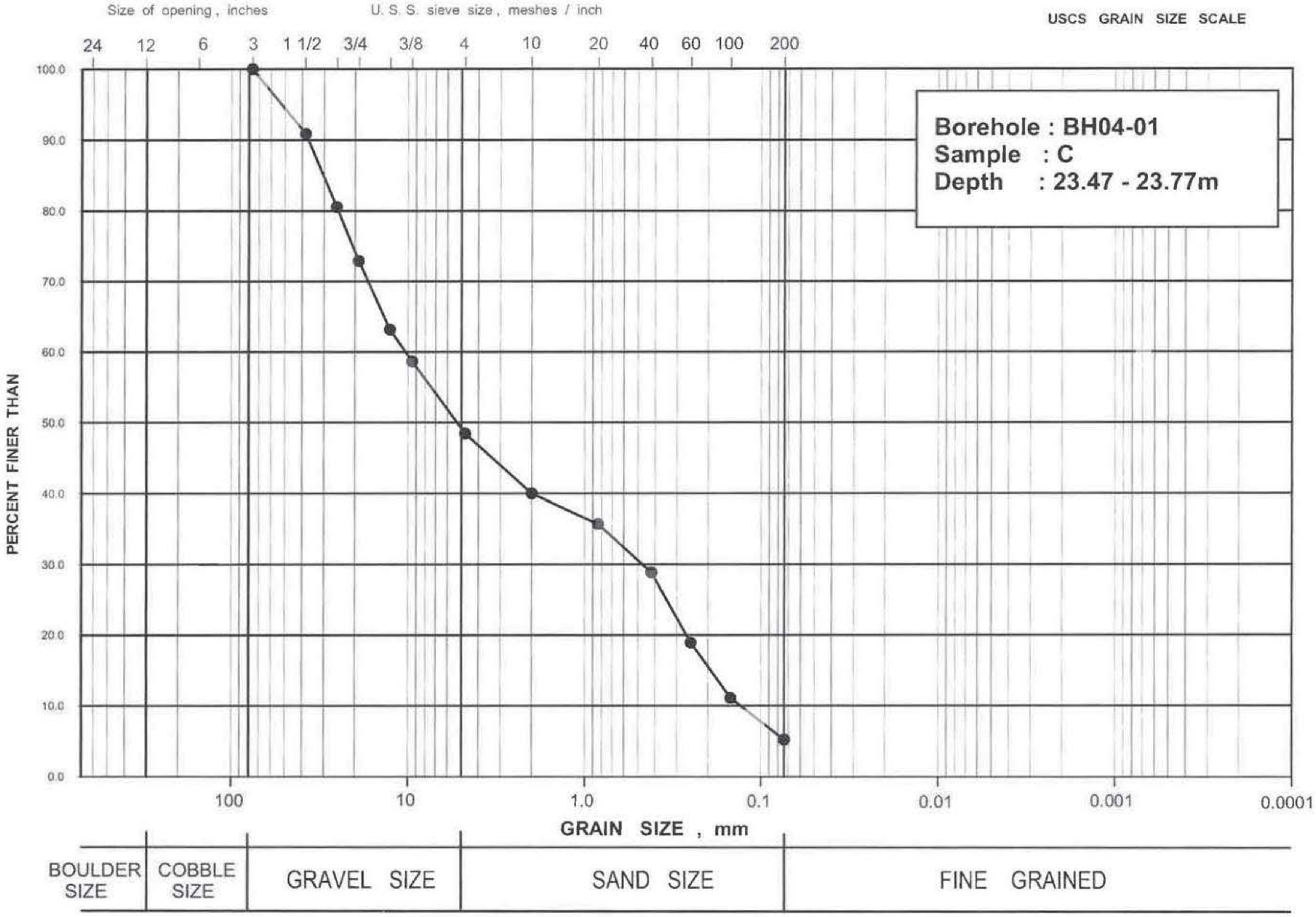


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Gradation Analysis

Figure III-3



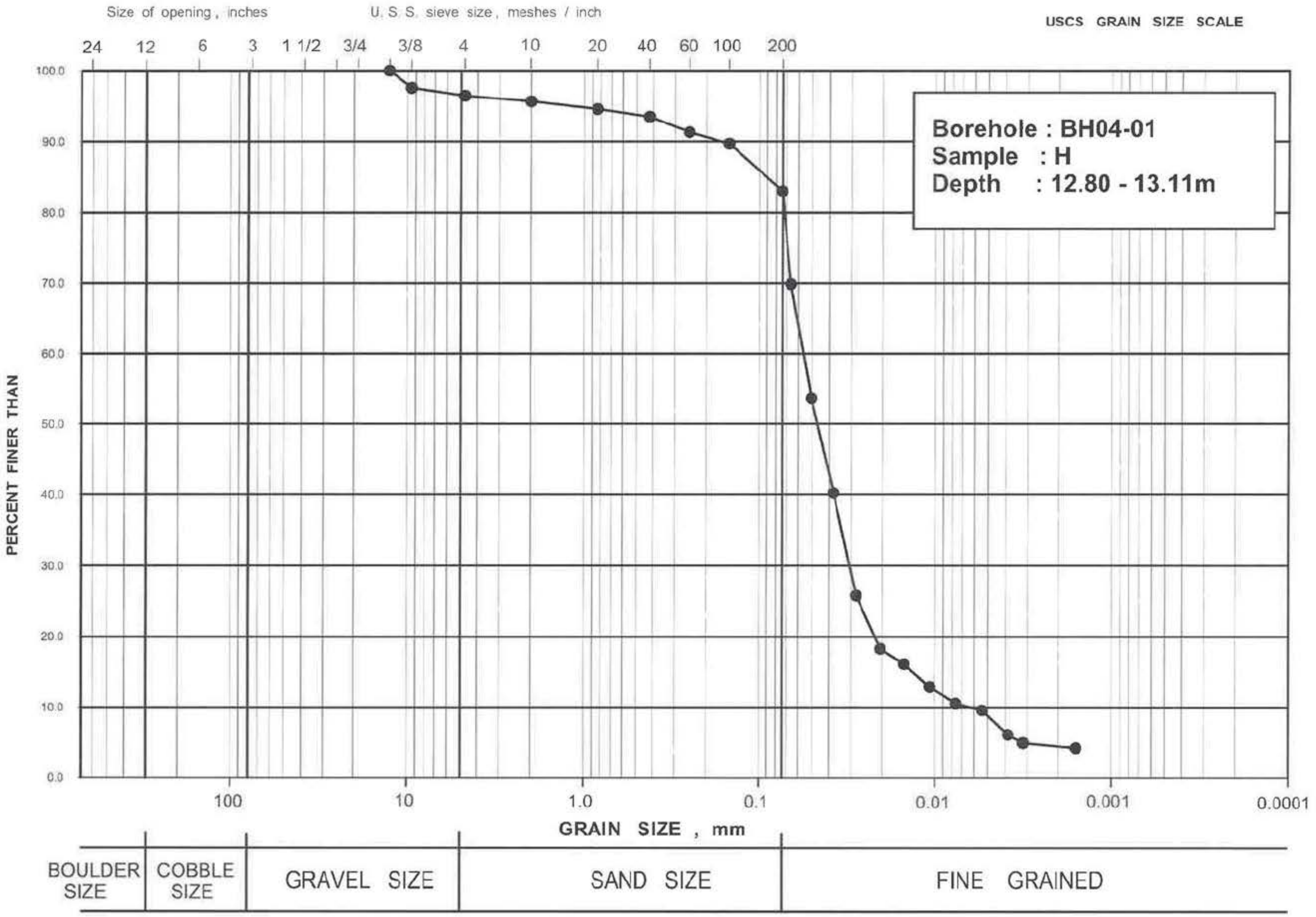
Borehole : BH04-01
Sample : C
Depth : 23.47 - 23.77m

Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Gradation Analysis

Figure III-4



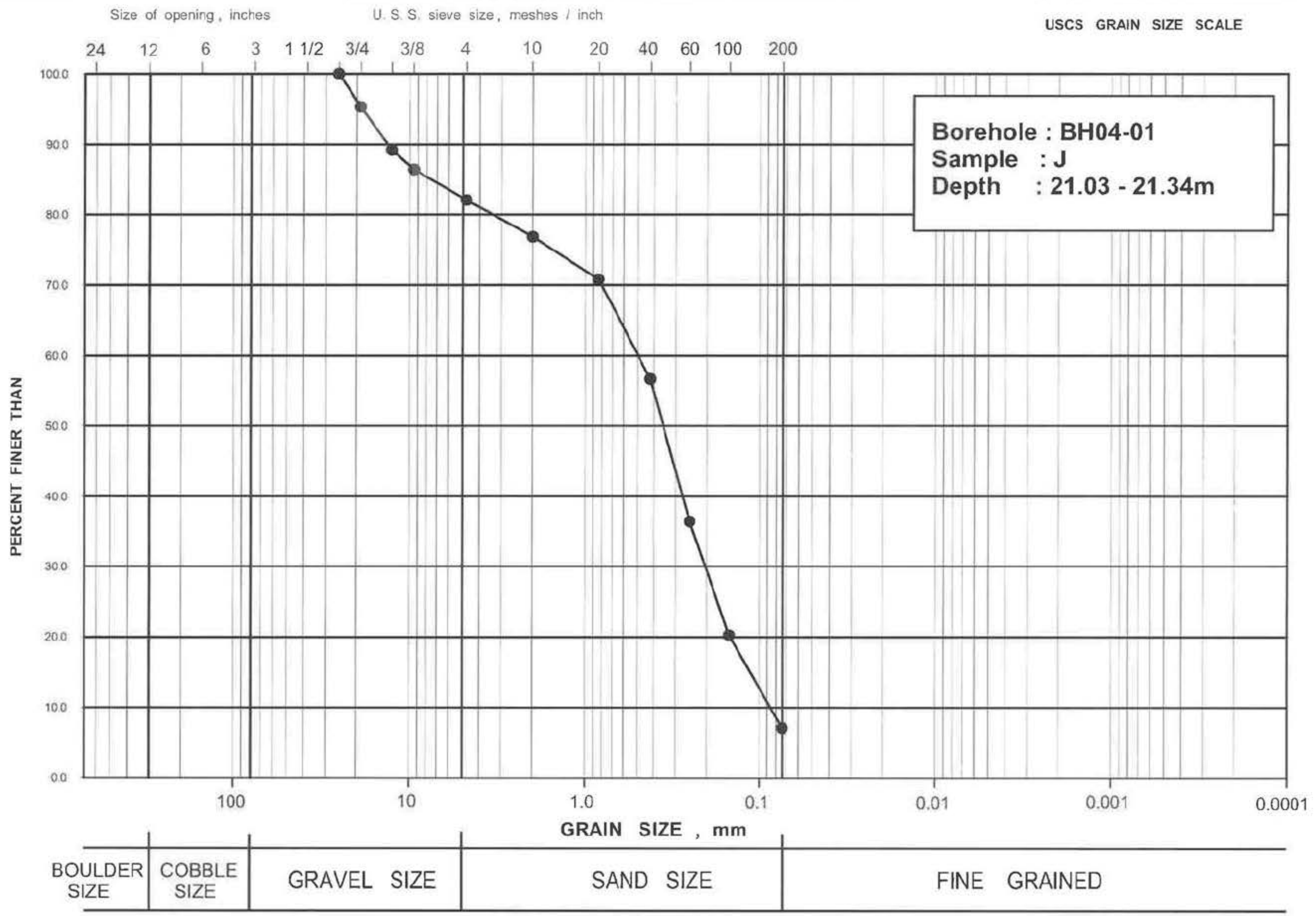
Borehole : BH04-01
Sample : H
Depth : 12.80 - 13.11m

Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Gradation Analysis

Figure III-5

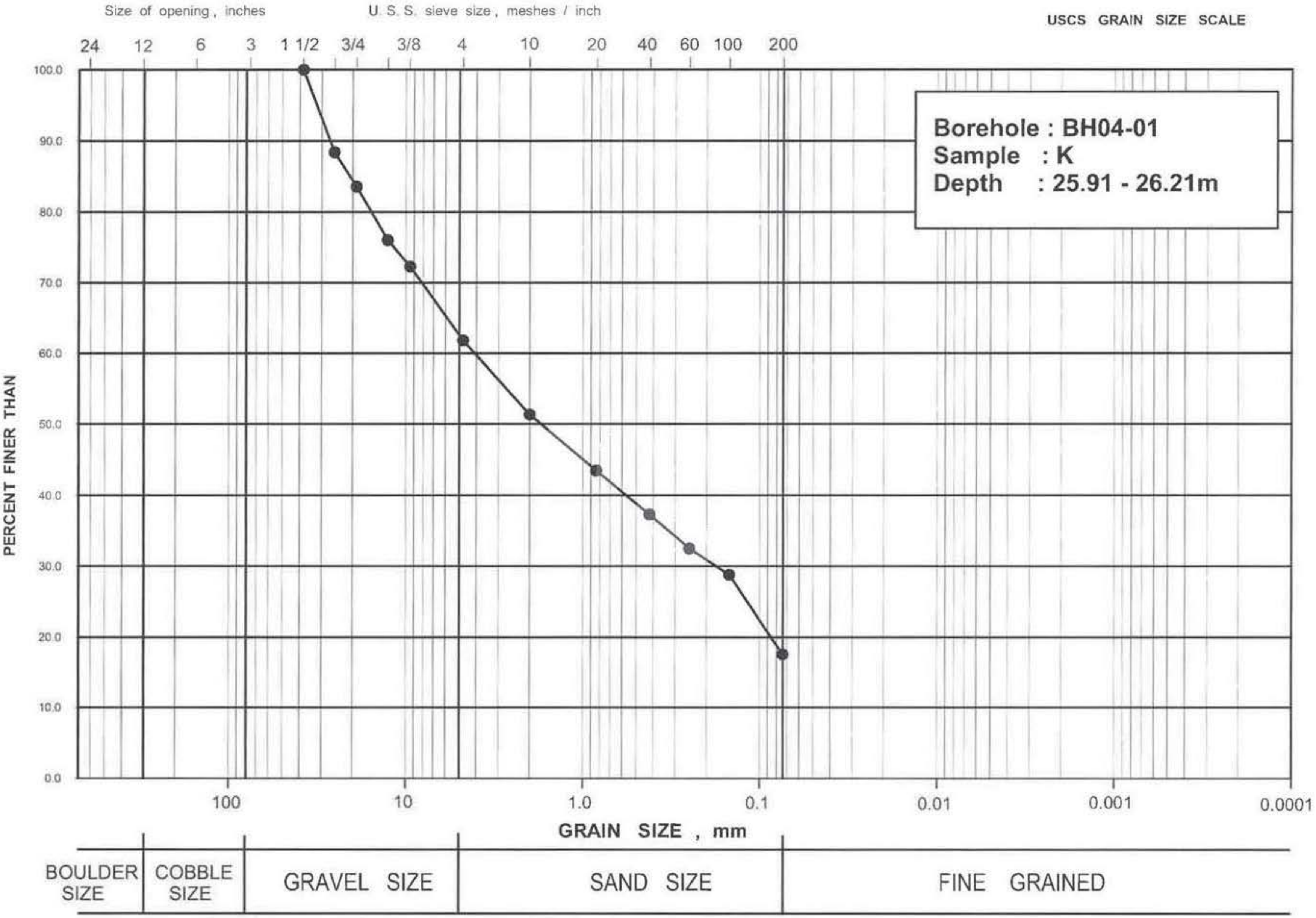


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Gradation Analysis

Figure III-6



Project No. 04-1413-027

Drawn TM

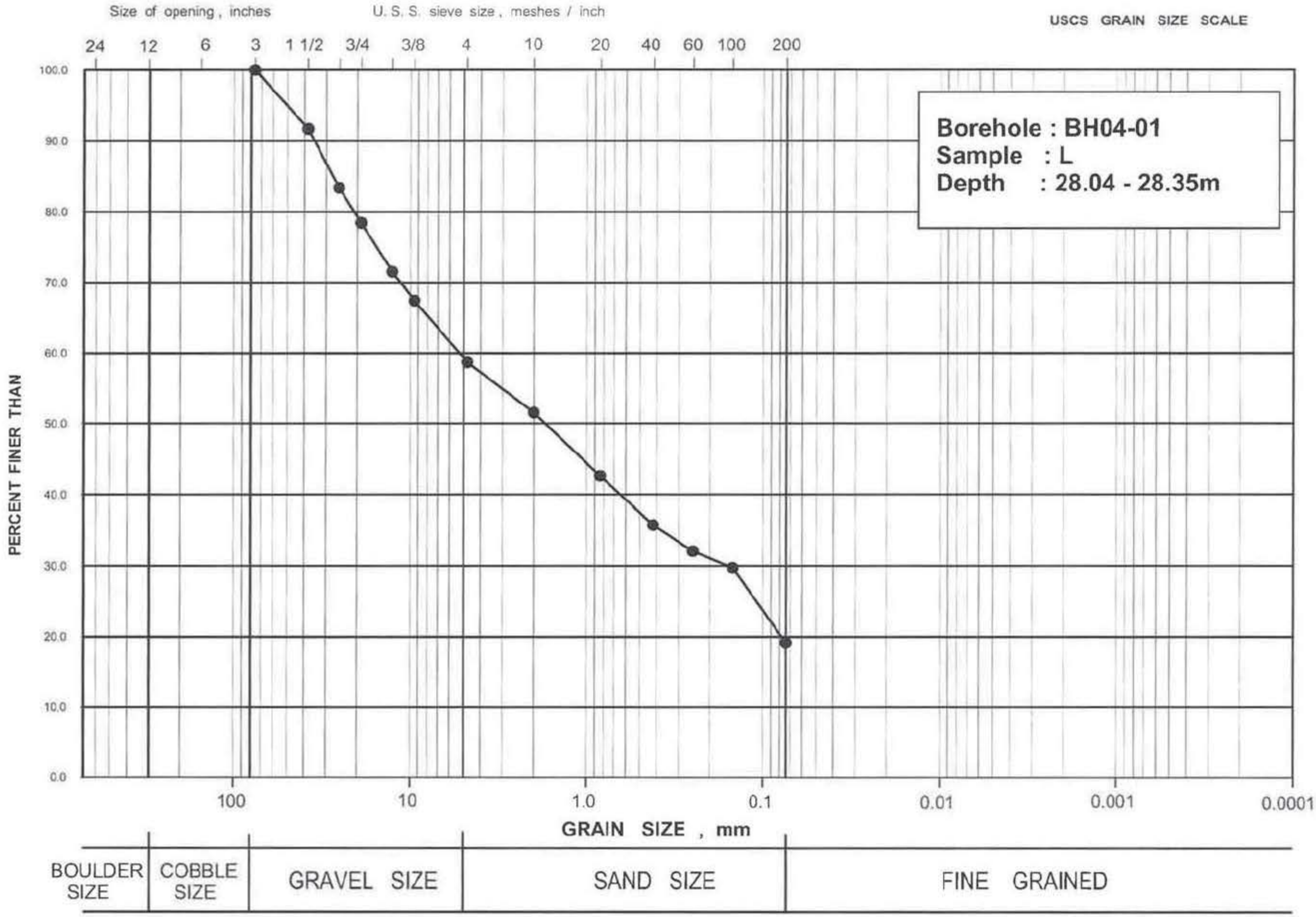
Reviewed LL

Date 11/21/05

Golder Associates

Borehole Overburden Grainsize Analysis

Figure III-7

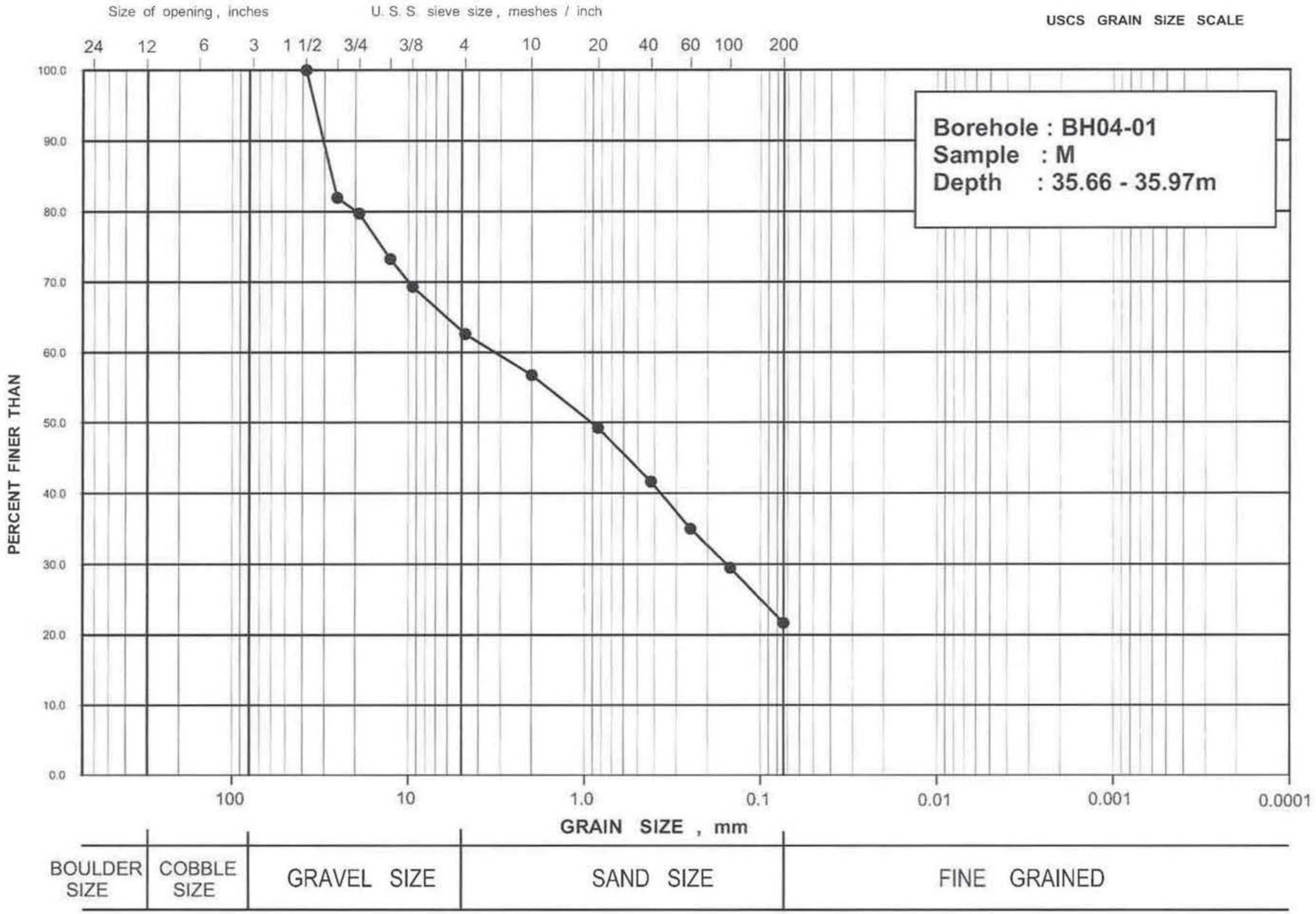


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Grainsize Analysis

Figure III-8



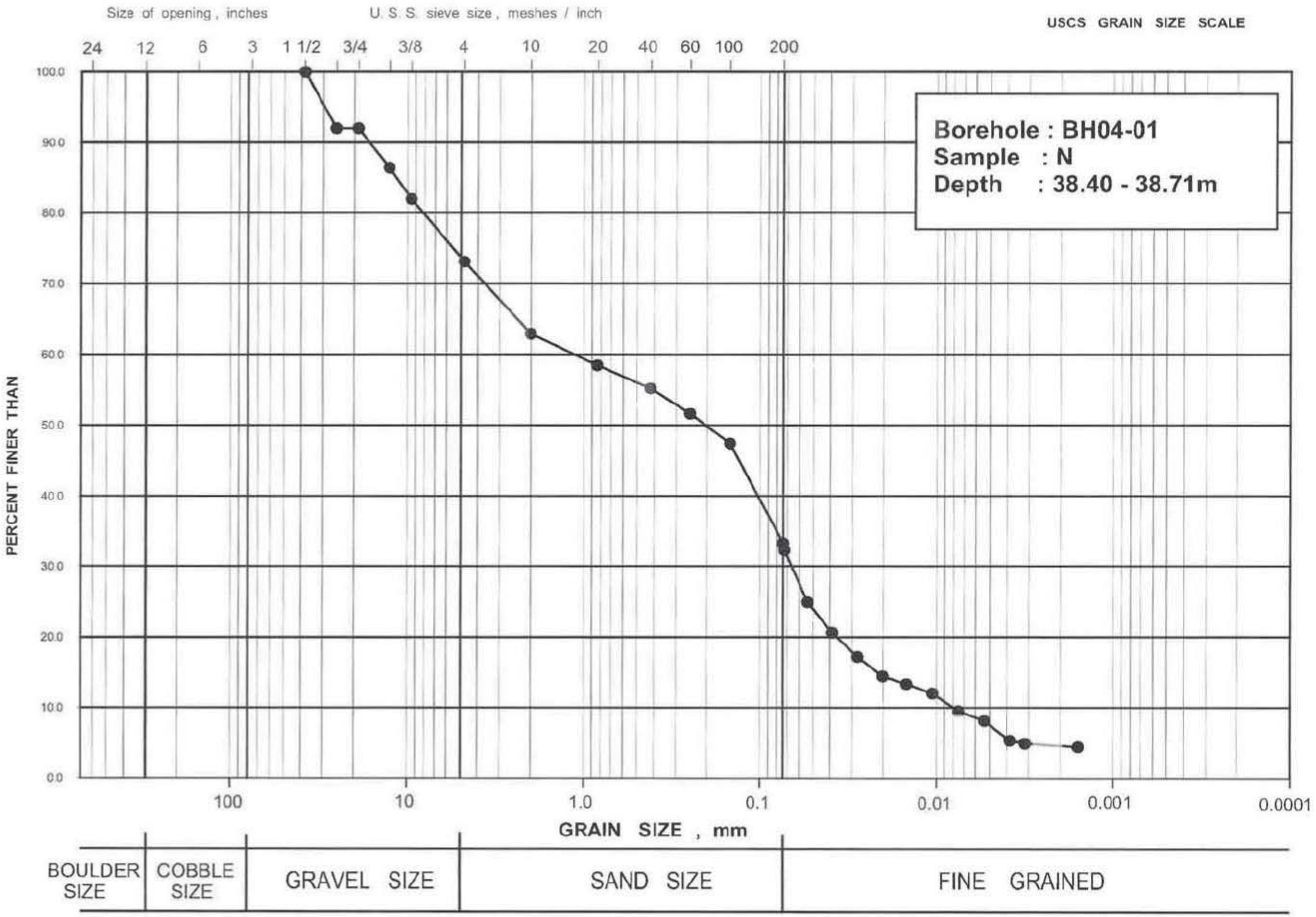
Borehole : BH04-01
Sample : M
Depth : 35.66 - 35.97m

Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Grainsize Analysis

Figure III-9

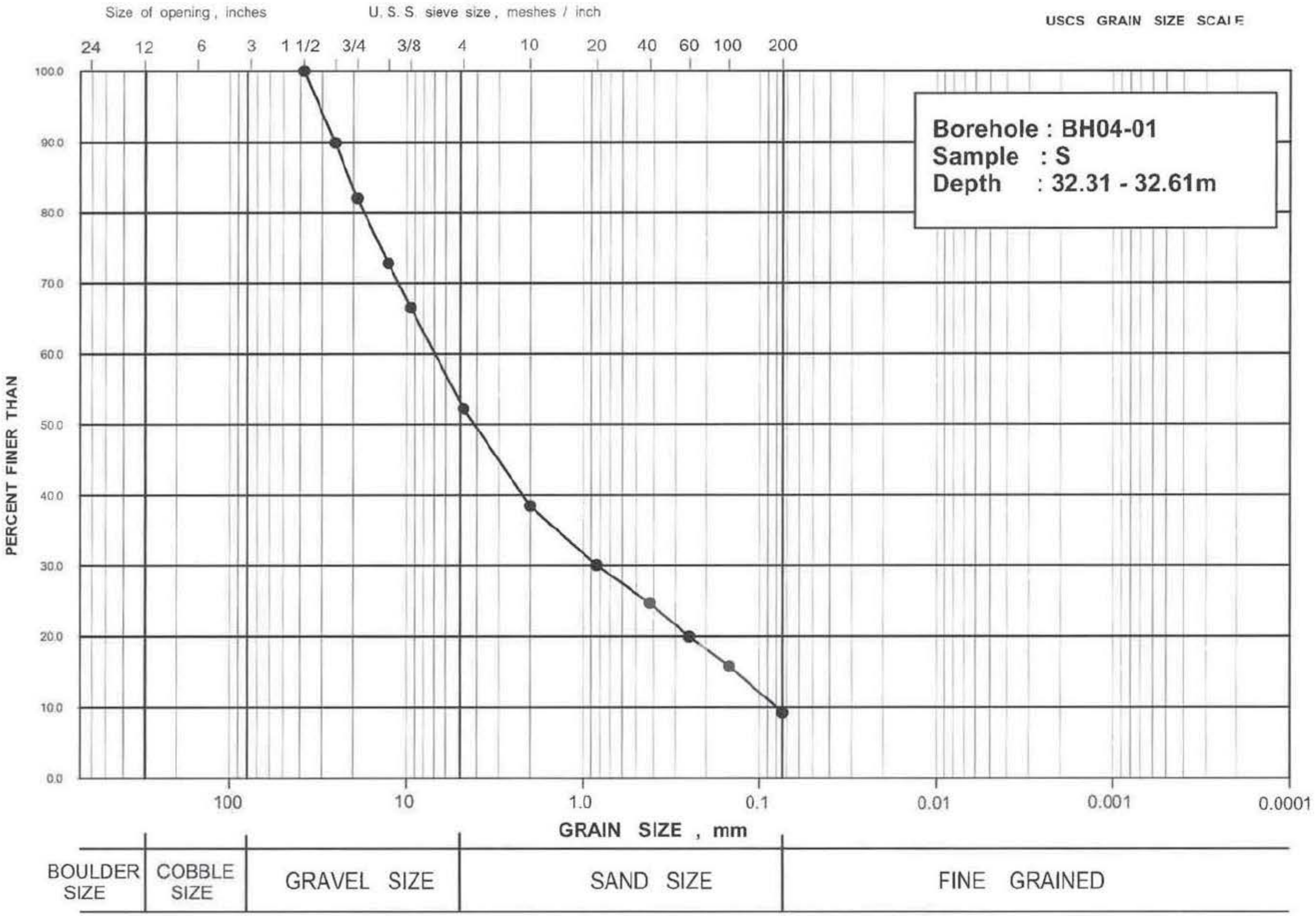


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Grainsize Analysis

Figure III-10

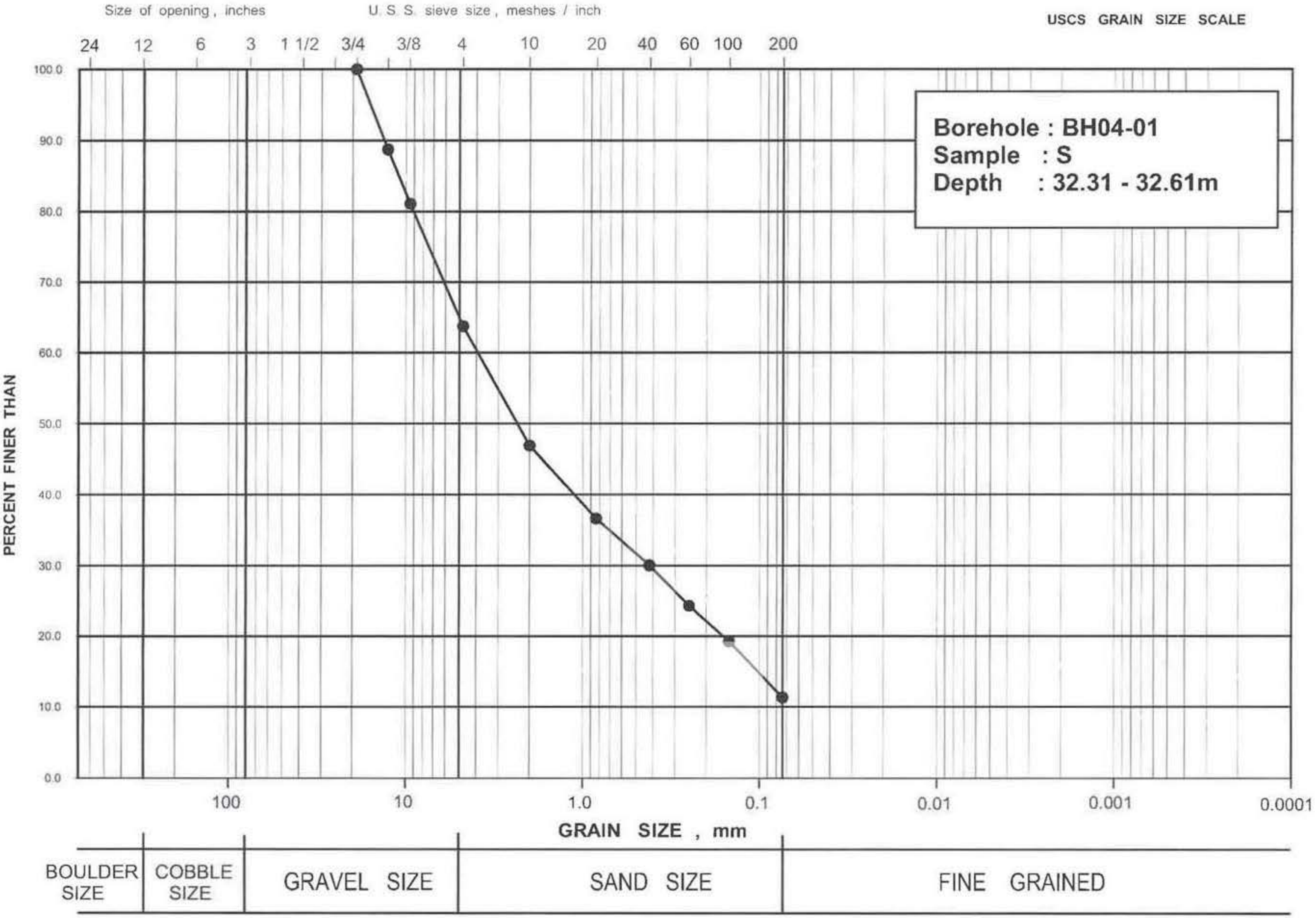


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 11/21/05

Golder Associates

Borehole Overburden Grainsize Analysis

Figure III-11



Project No.	04-1413-027
Drawn	TM
Reviewed	LL
Date	11/21/05

Golder Associates

Borehole Overburden Grainsize Analysis

Figure III-12

APPENDIX IV

TEST WELL GRADATION ANALYSIS

Date: 10/18/2004

04-1413-027

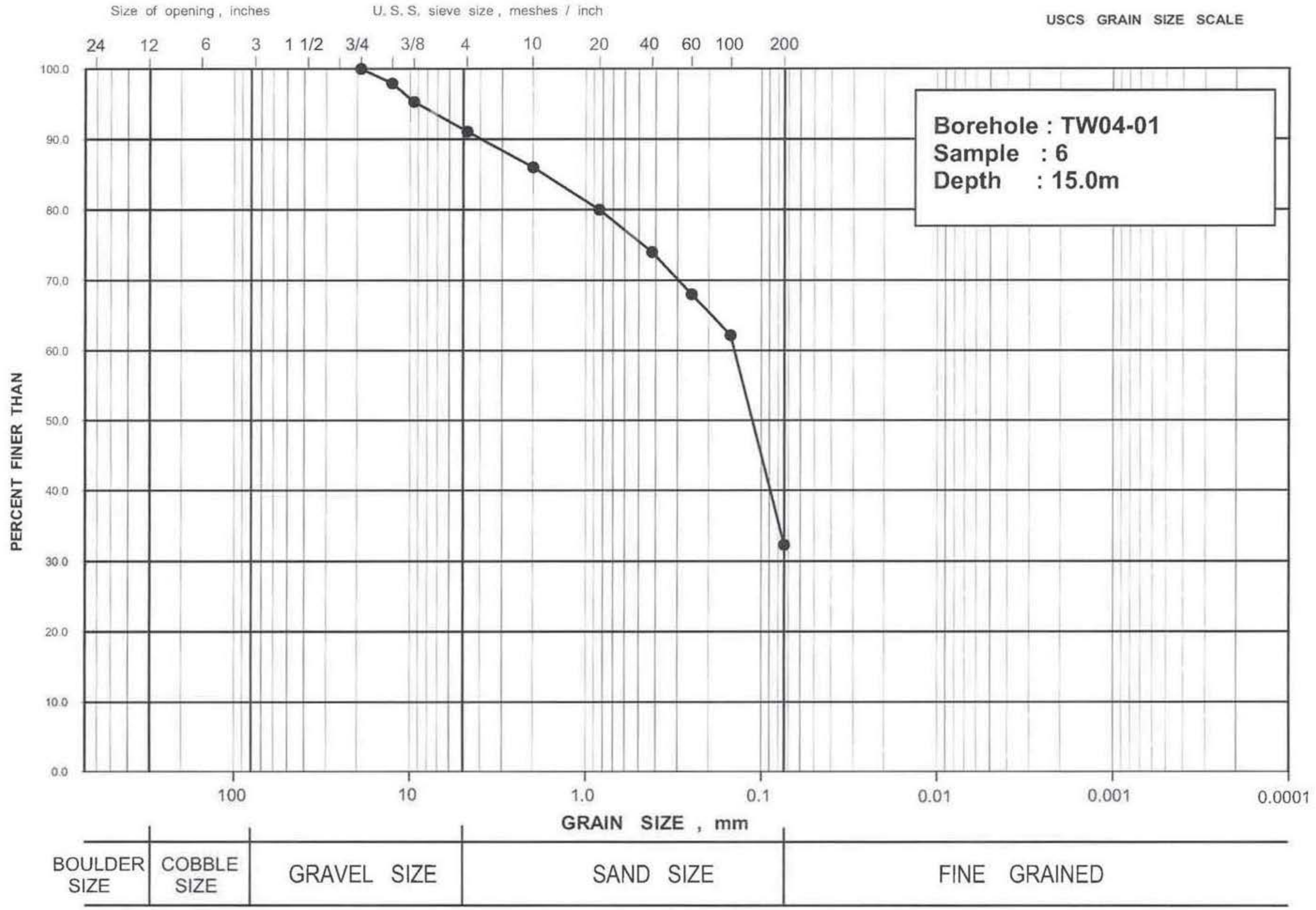
Table IV-1

Estimated Hydraulic Conductivity from Grain Size Analysis
Hydrogeological Investigation - Imperial Metals Corporation, Likely, BC

Borehole	Sample #	Depth (m)	d_{10} (mm)	d_{60} (mm)	U	K (m/s) [1]	K (m/s) [2]
TW04-01	07	16.5 - 16.8	0.430	6.20	14.4	-	1.5E-03
TW04-01	08	17.7 - 18	0.620	5.80	9.4	-	3.4E-03
TW04-01	09	20.0 - 20.3	0.190	3.00	15.8	-	2.8E-04
TW04-01	10	22.5 - 22.8	0.840	0.44	0.5	5.1E-03	-
TW04-01	12	27.3 - 27.6	0.400	5.50	13.8	-	1.3E-03
TW04-01	16	37.0 - 37.3	0.700	6.80	9.7	-	4.3E-03
					geometric average	**5.1E-03**	**1.5E-03**
					min	5.1E-03	2.8E-04
					max	5.1E-03	4.3E-03

Borehole	Sample #	Depth (m)	d_{10} (mm)	d_{60} (mm)	U	K (m/s) [1]	K (m/s) [2]
TW04-02	10	25.3 - 25.6	0.440	4.50	10.2	-	1.7E-03
TW04-02	11	27.4 - 27.7	0.460	4.90	10.7	-	1.8E-03
TW04-02	12	29.9 - 30.2	0.370	3.10	8.4	-	1.3E-03
TW04-02	13	32 - 32.3	2.500	7.40	3.0	4.5E-02	-
TW04-02	14	34.1 - 34.4	1.400	8.80	6.3	-	1.9E-02
TW04-02	15	35.7 - 38.4	0.320	3.80	11.9	-	8.6E-04
TW04-02	16	38.4 - .8.7	0.300	2.80	9.3	-	8.0E-04
					geometric average	**4.5E-02**	**1.9E-03**
					min	4.5E-02	8.0E-04
					max	4.5E-02	1.9E-02

NOTES:
1) Based on method of Hazen (1911)
2) Based on method of Breyer (Kresic, 1997)
3) Assumed porosity n = 0.3
4) Hazen applicable for: U < 5 and (0.1 mm < d10 < 3 mm)
5) Breyer applicable for: (1 < U < 20) and (0.06 mm < d10 < 0.6 mm)

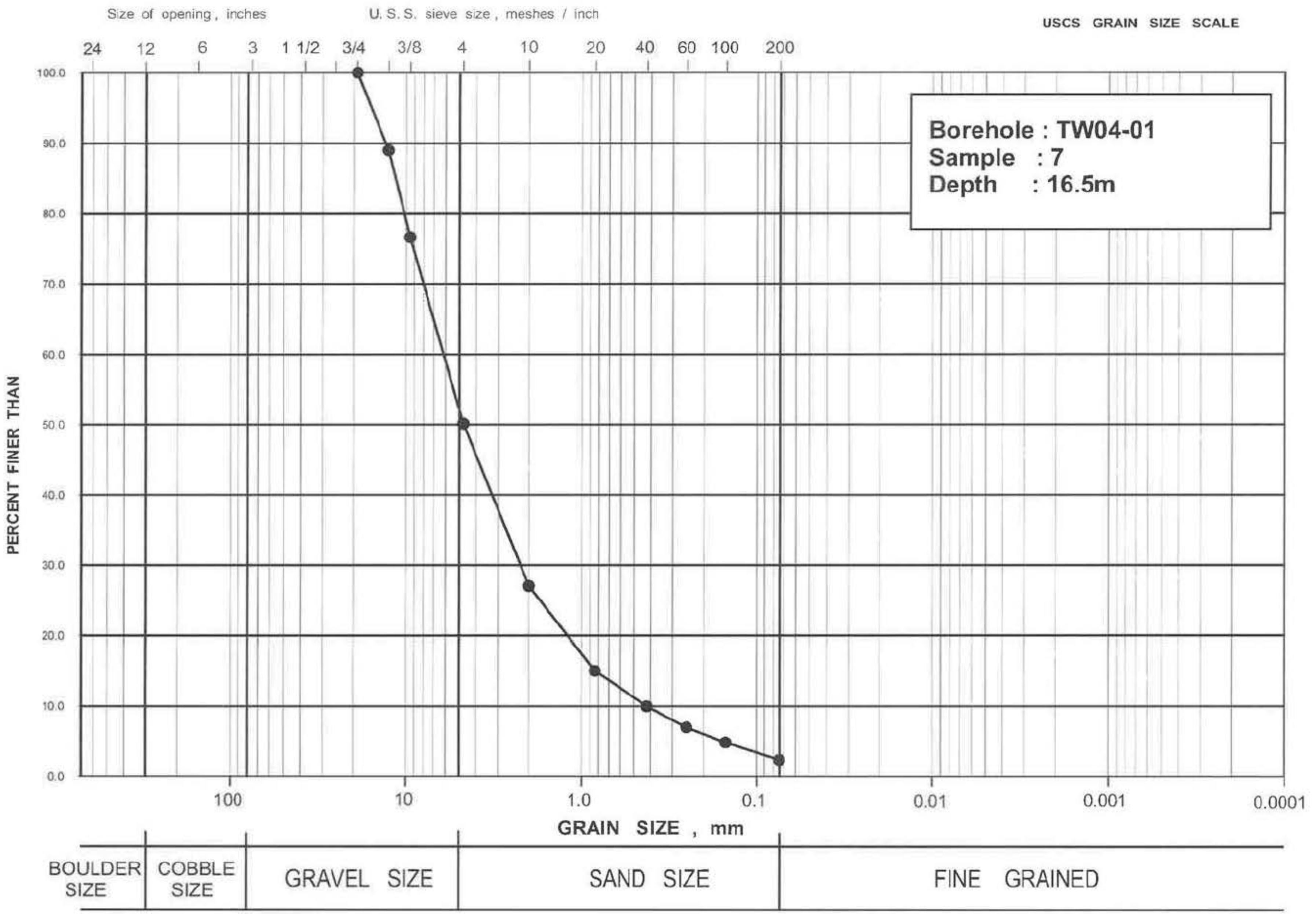


Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

Golder Associates

TEST WELL GRADATION ANALYSIS

Figure IV-1



Project No. 04-1413-027
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Reviewed LL
Date 10/01/04

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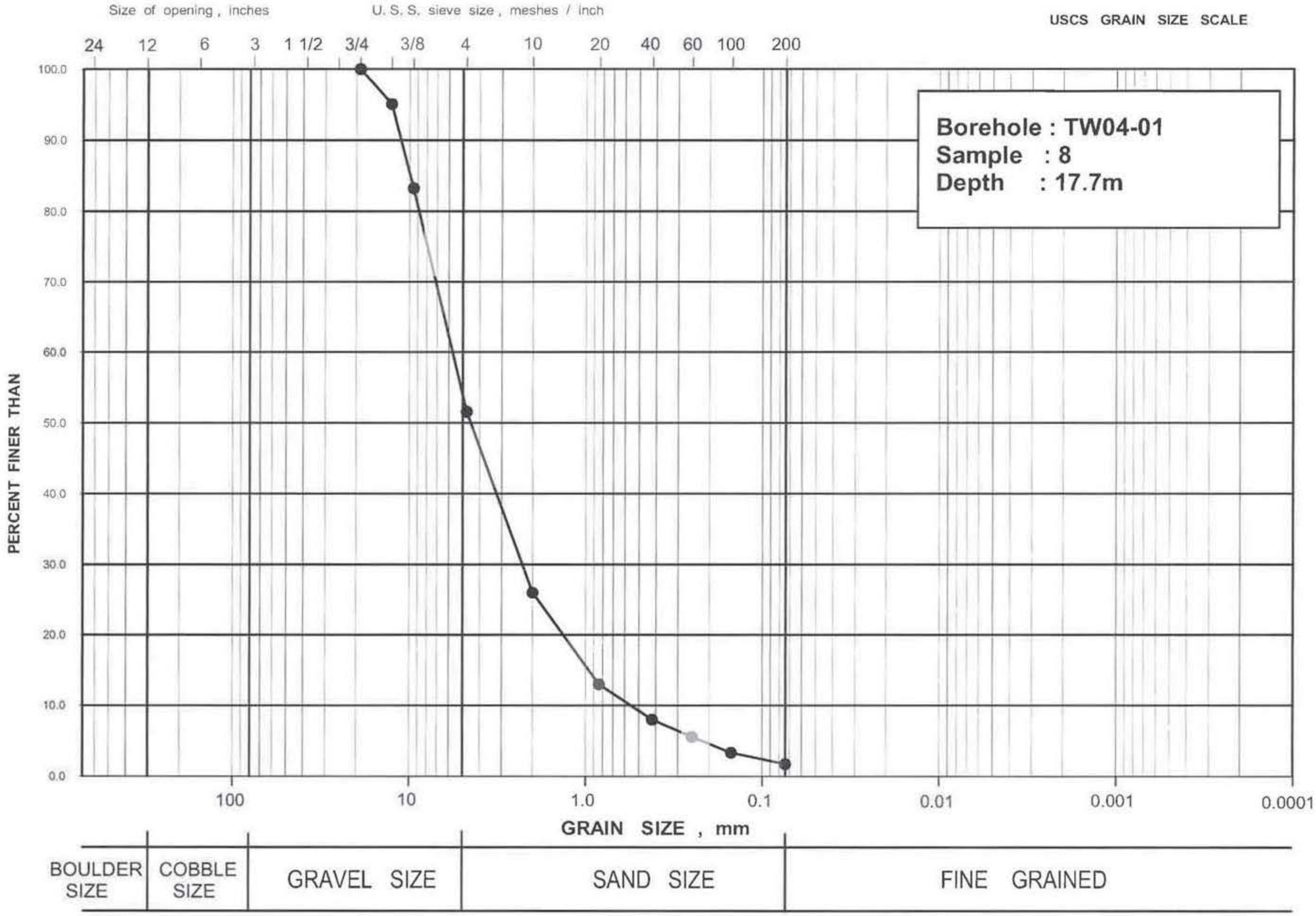
TEST WELL GRADATION ANALYSIS

Figure IV-2



Borehole : TW04-01
Sample : 8
Depth : 17.7m

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Drawn TM
Reviewed LL
Date 10/01/04

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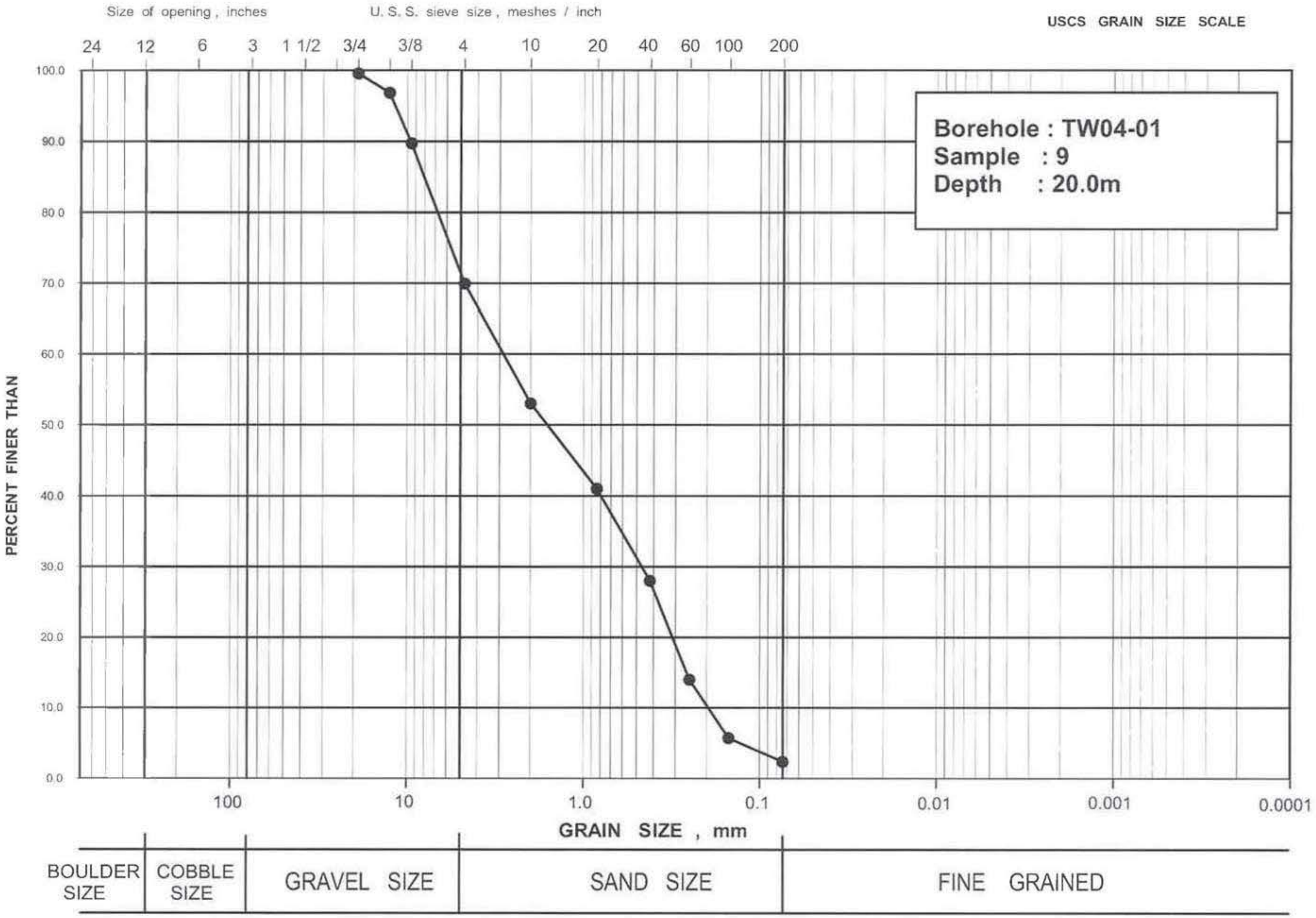
TEST WELL GRADATION ANALYSIS

Figure IV-3



Borehole : TW04-01
Sample : 9
Depth : 20.0m

Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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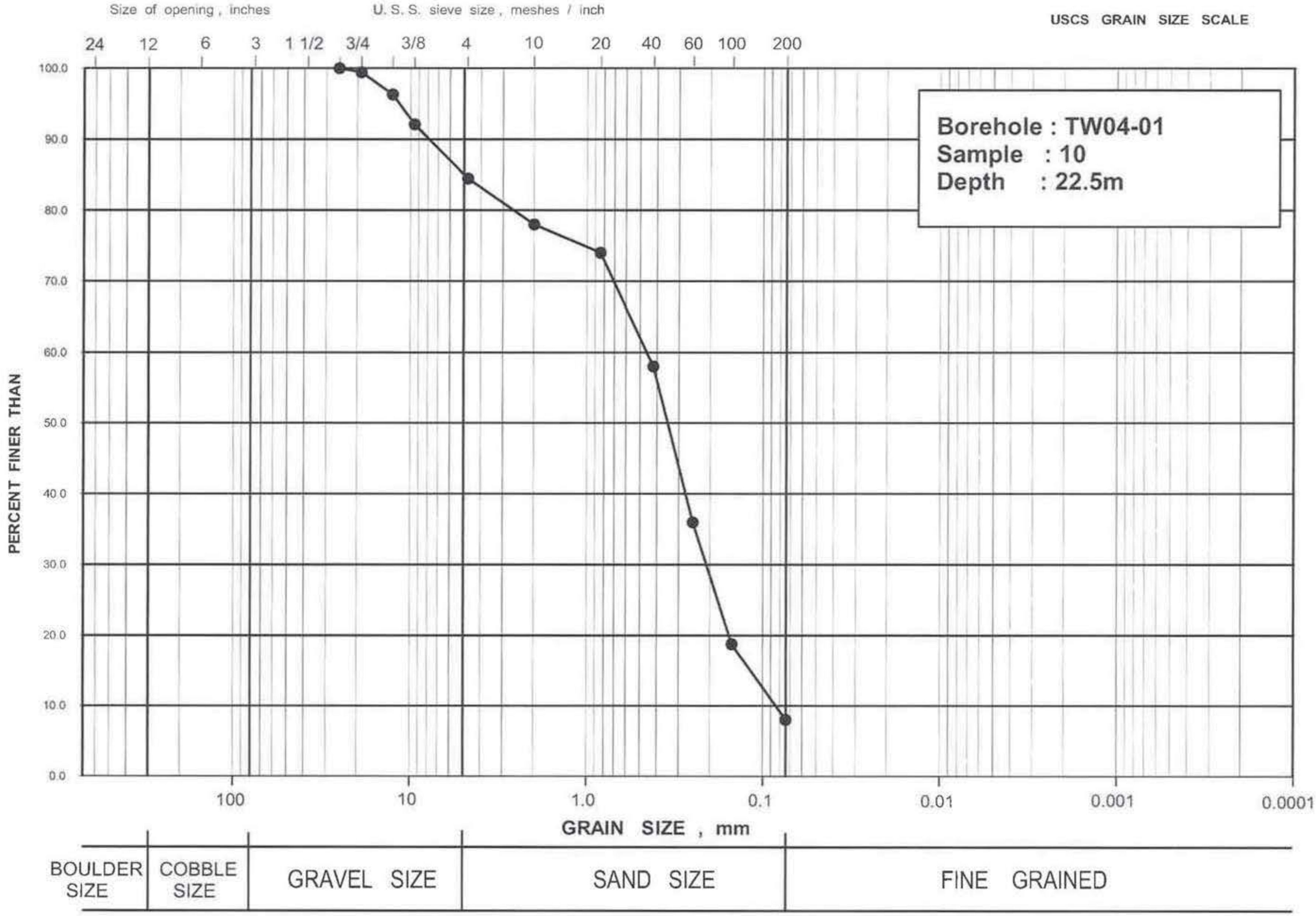
TEST WELL GRADATION ANALYSIS

Figure IV-4



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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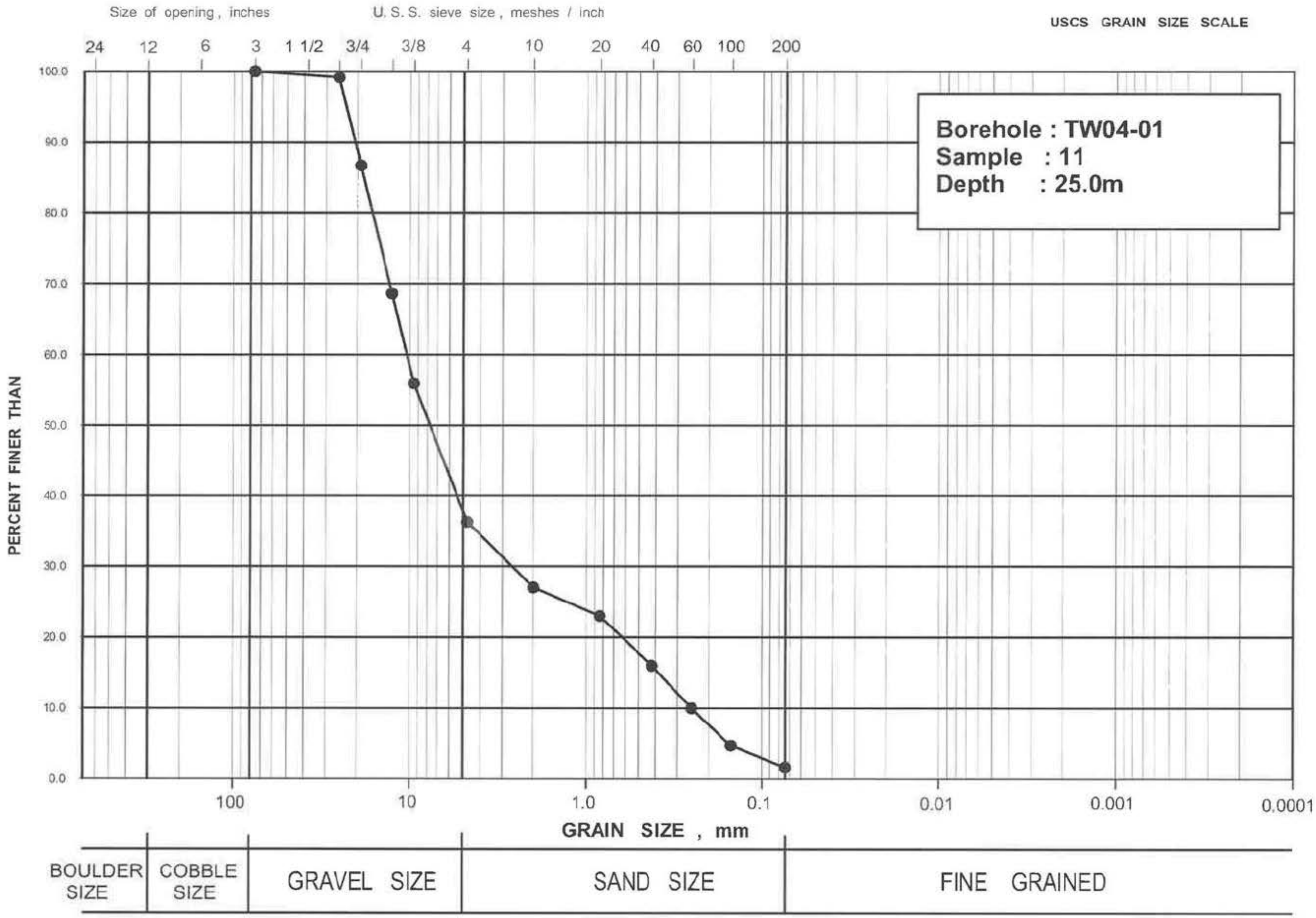
TEST WELL GRADATION ANALYSIS

Figure IV-5



Project No. 04-1413-027

Drawn TM

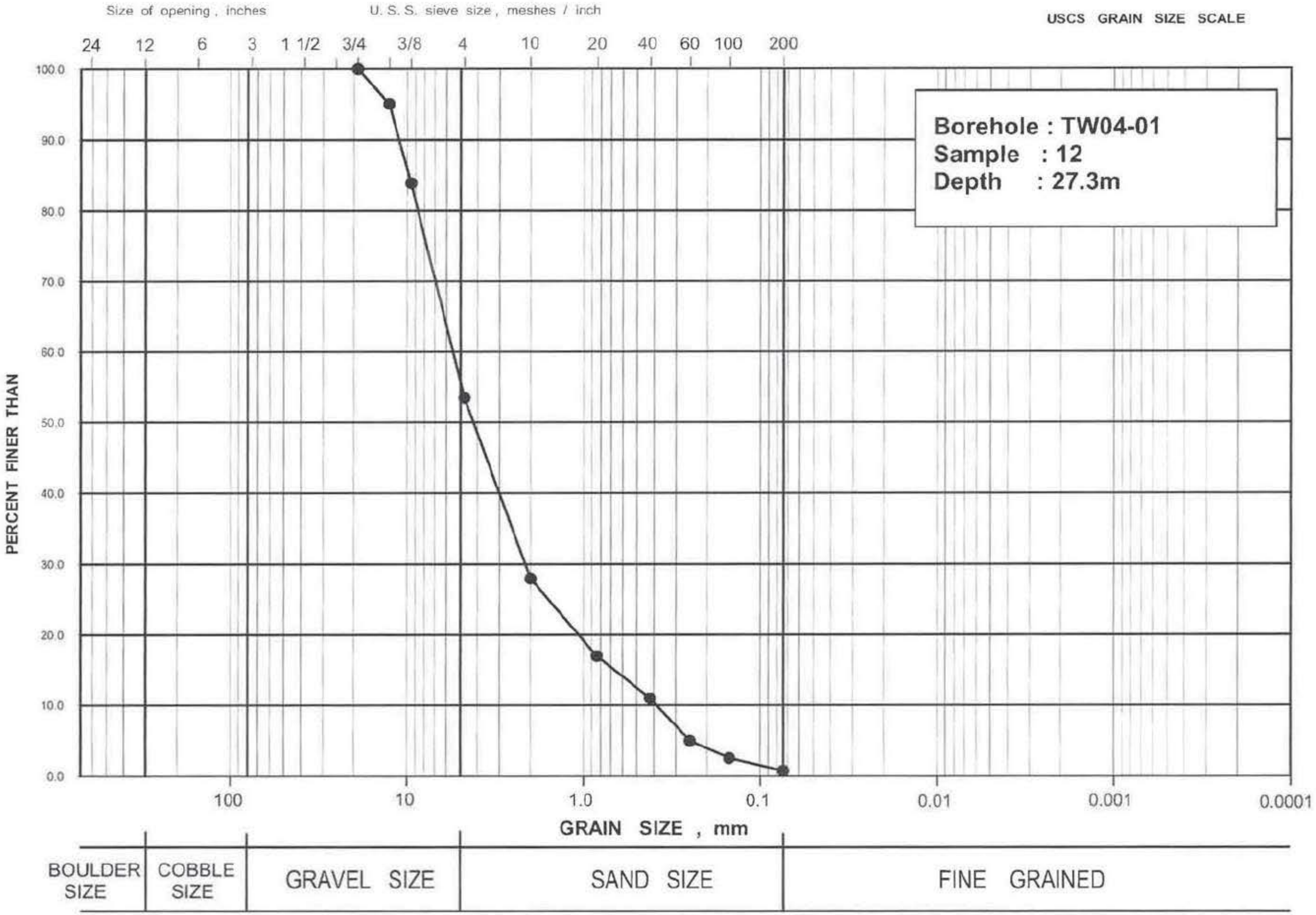
Reviewed LL

Date 10/01/04

Golder Associates

TEST WELL GRADATION ANALYSIS

Figure IV-6



Project No. 04-1413-027

Drawn TM

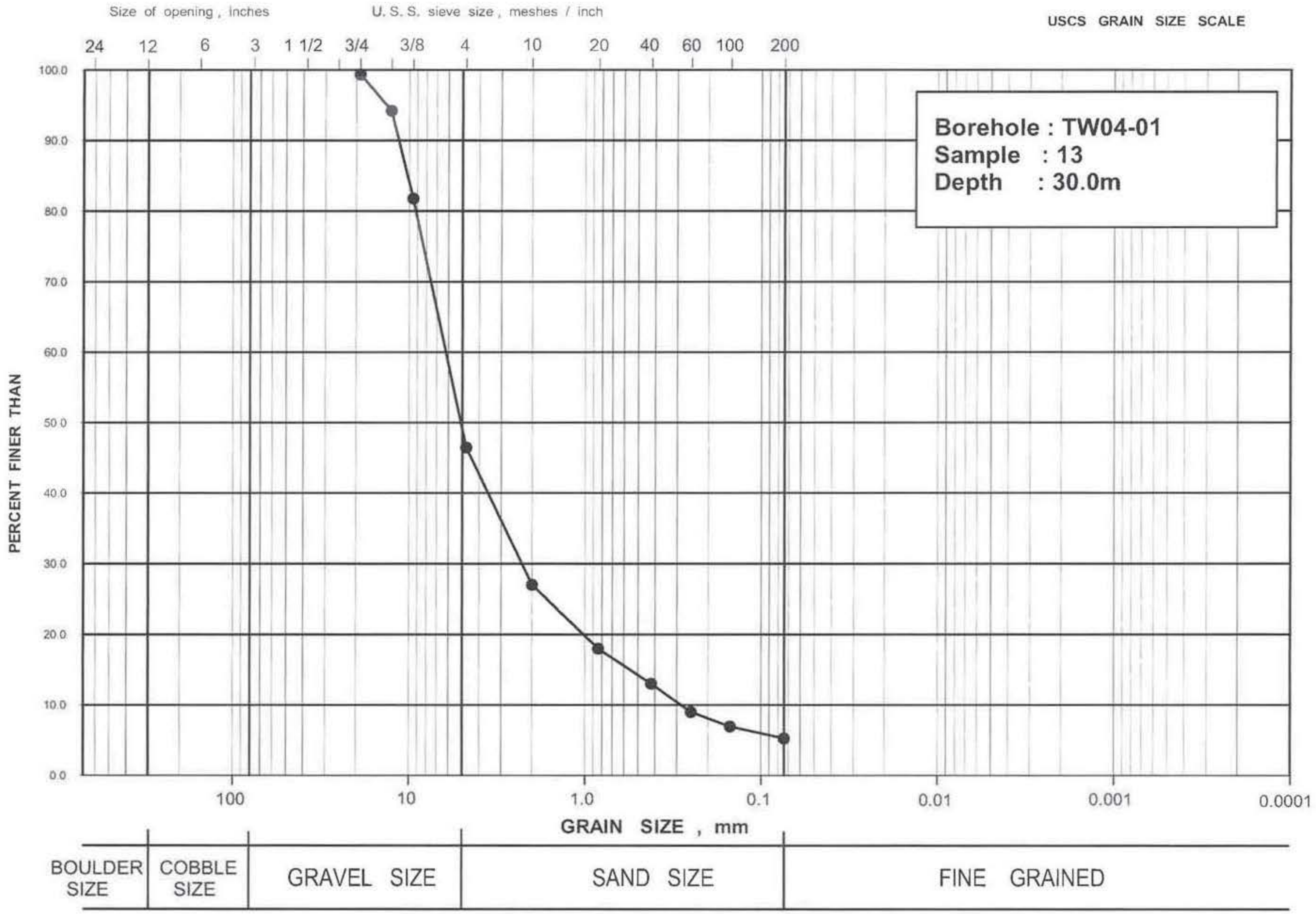
Reviewed LL

Date 10/01/04

Golder Associates

TEST WELL GRADATION ANALYSIS

Figure IV-7



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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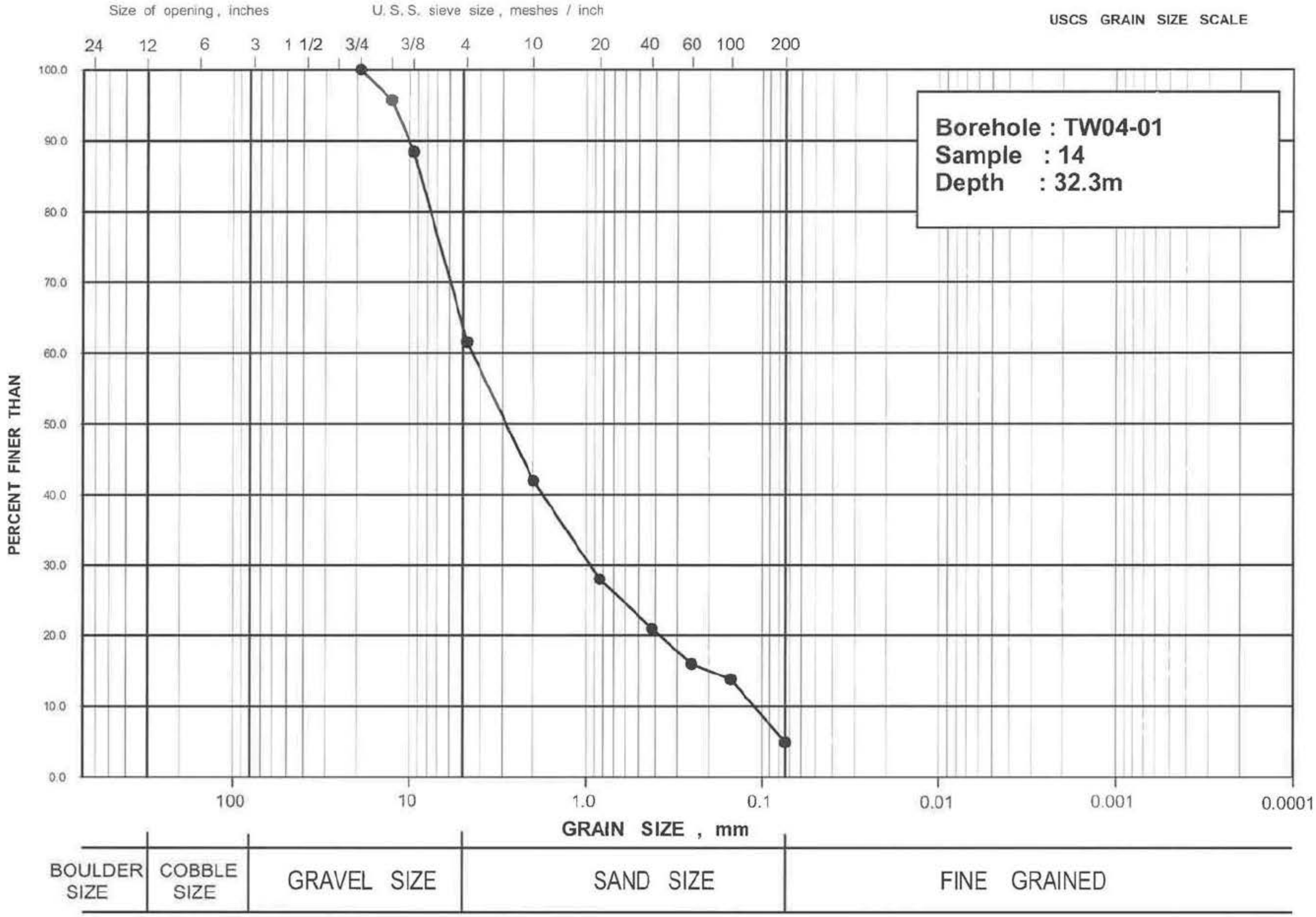
TEST WELL GRADATION ANALYSIS

Figure IV-8



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Drawn TM
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Date 10/01/04

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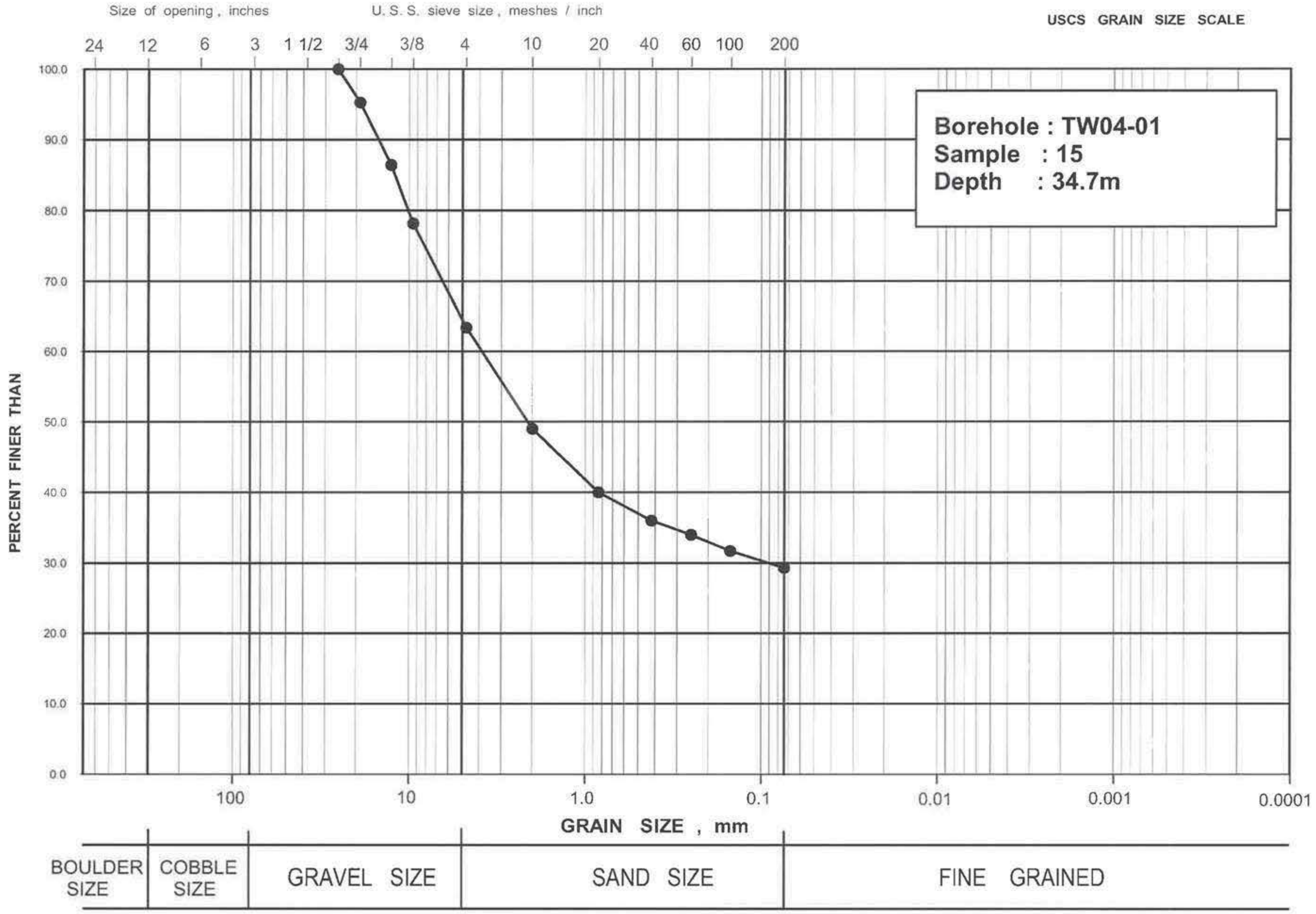
TEST WELL GRADATION ANALYSIS

Figure IV-9



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Drawn TM
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Date 10/01/04

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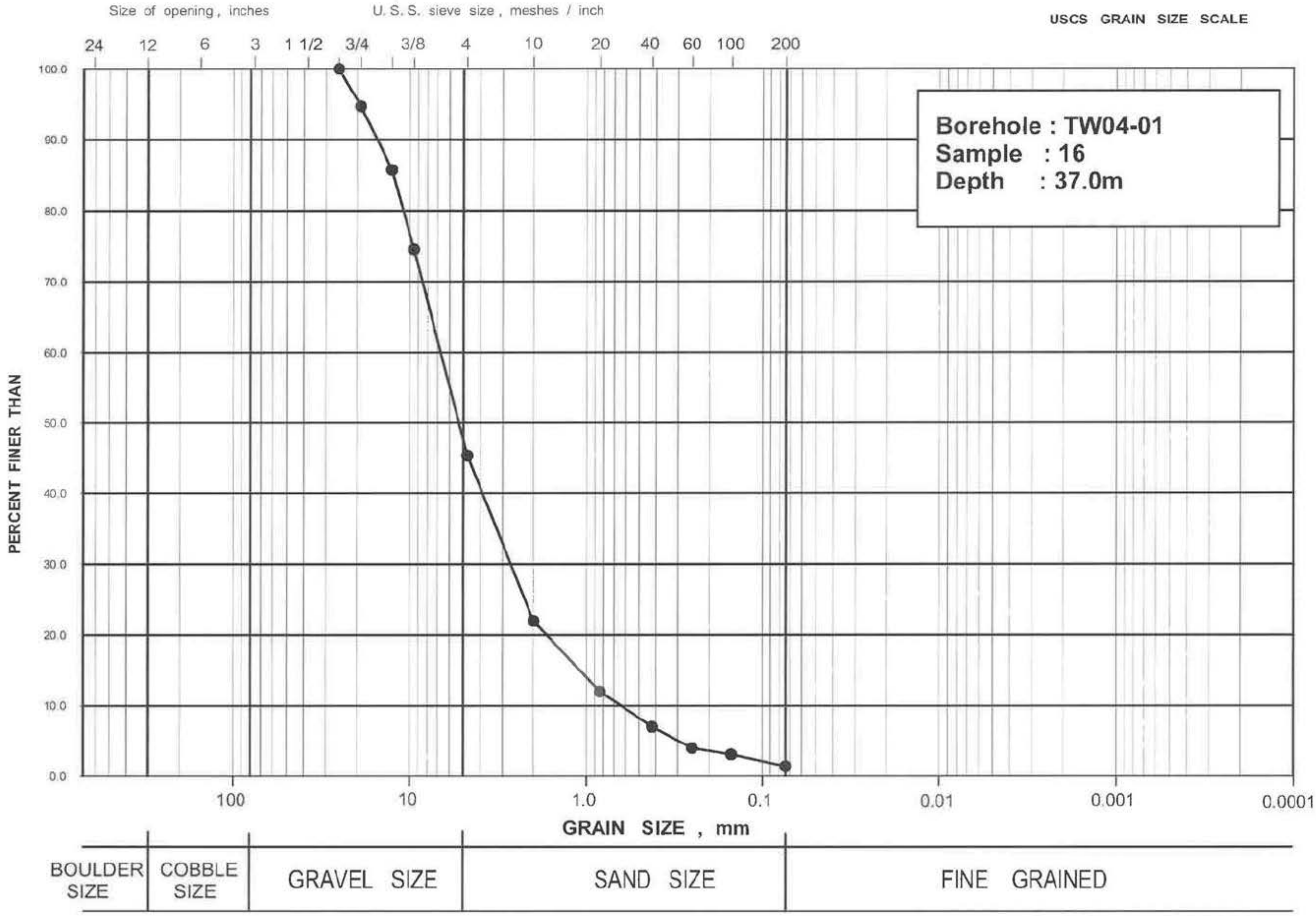
TEST WELL GRADATION ANALYSIS

Figure IV-10



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Date 10/01/04

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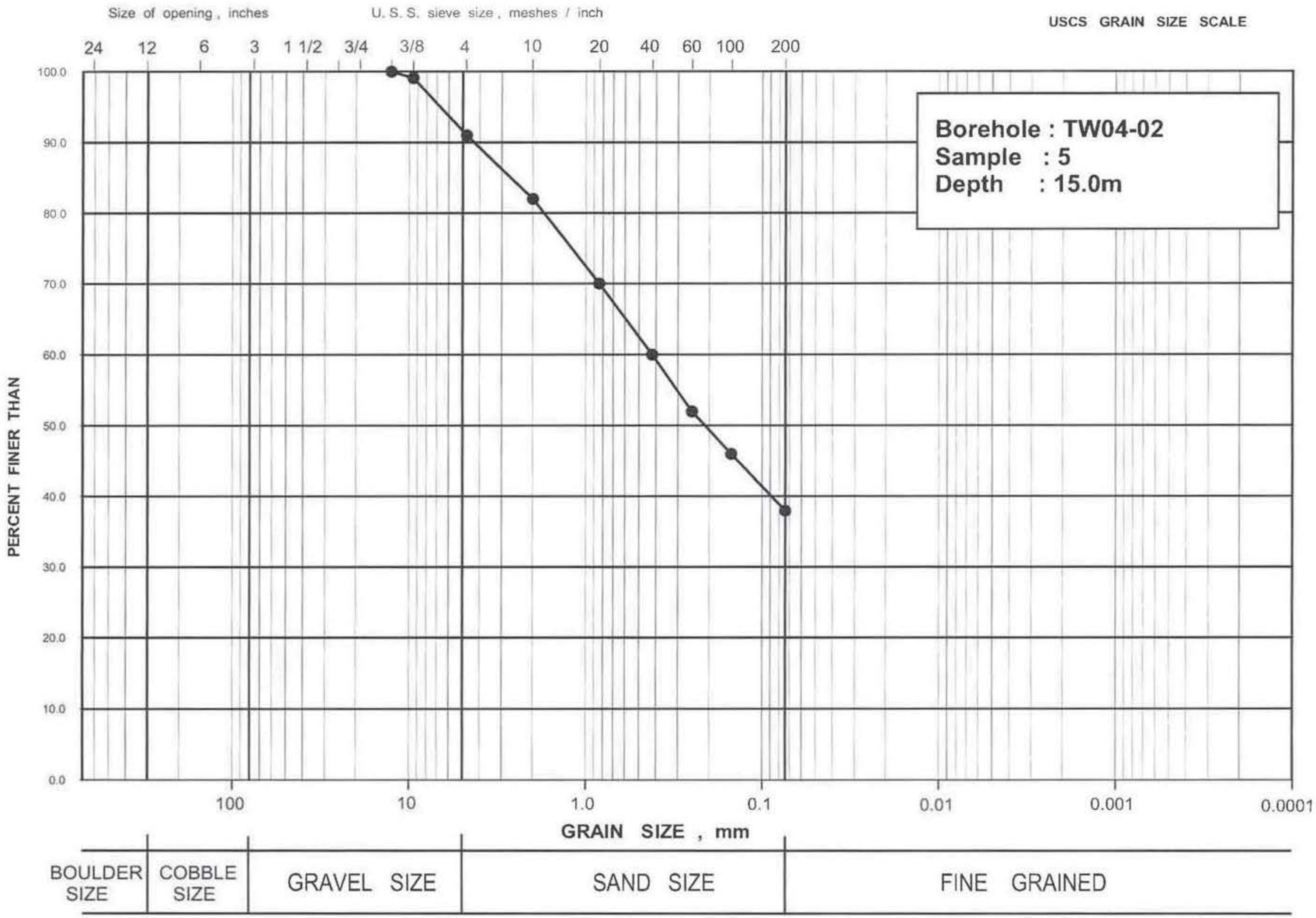
TEST WELL GRADATION ANALYSIS

Figure IV-11



Borehole : TW04-02
Sample : 5
Depth : 15.0m

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Date 10/01/04

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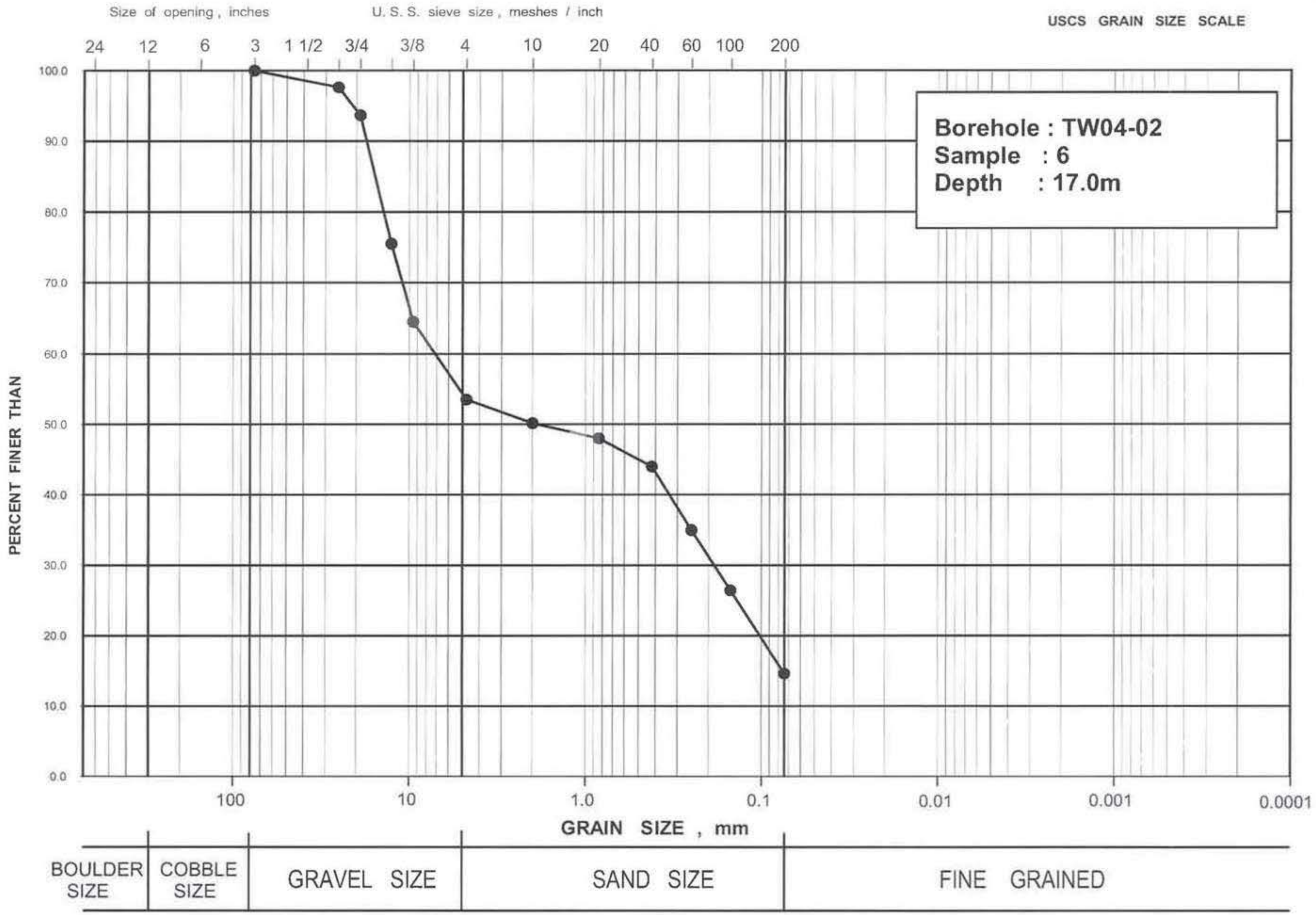
TEST WELL GRADATION ANALYSIS

Figure IV-12



Project No. 04-1413-027
Drawn TM
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Date 10/01/04

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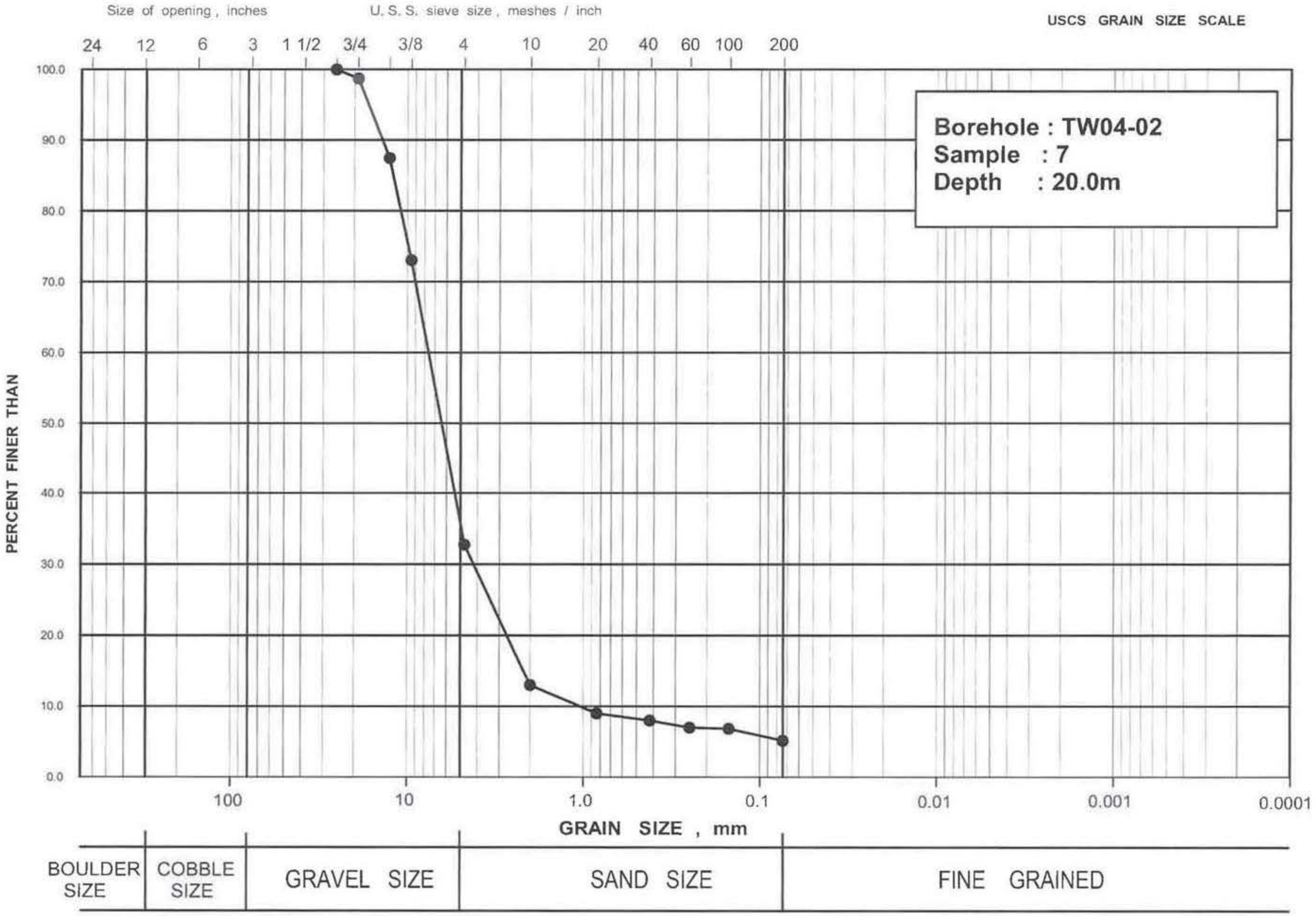
TEST WELL GRADATION ANALYSIS

Figure IV-13



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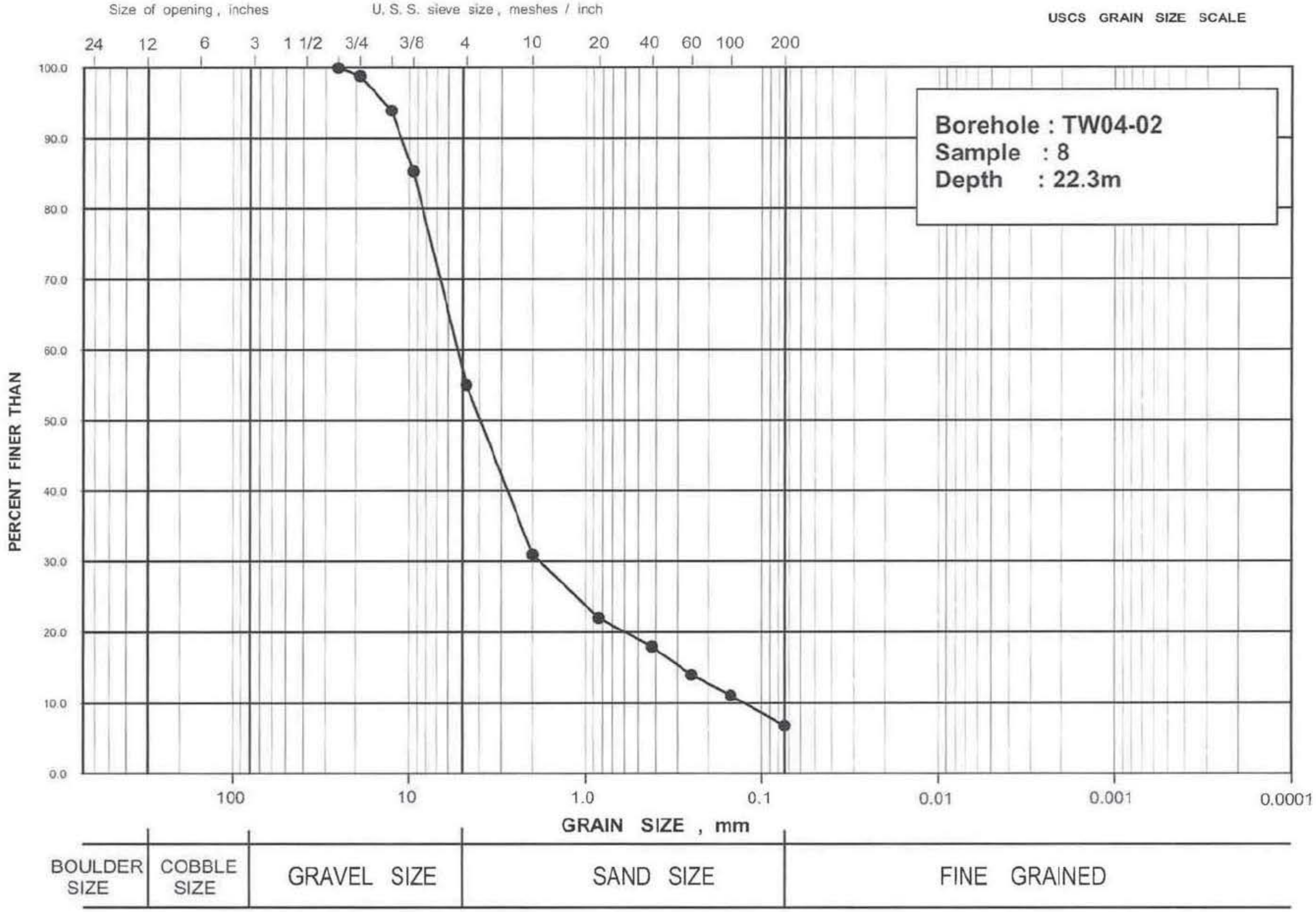
TEST WELL GRADATION ANALYSIS

Figure IV-14



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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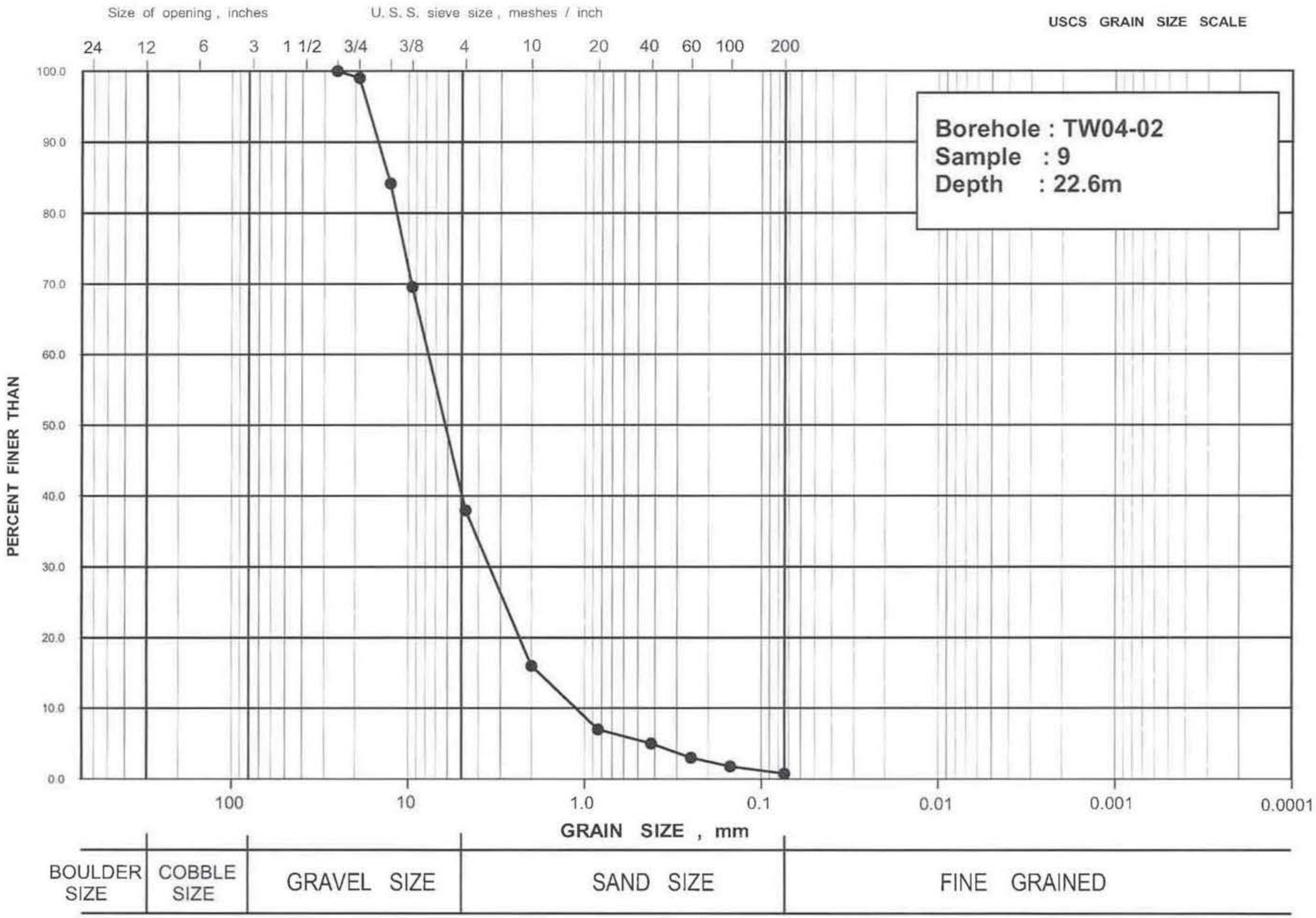
TEST WELL GRADATION ANALYSIS

Figure IV-15



Project No. 04-1413-027
Drawn TM
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Date 10/01/04

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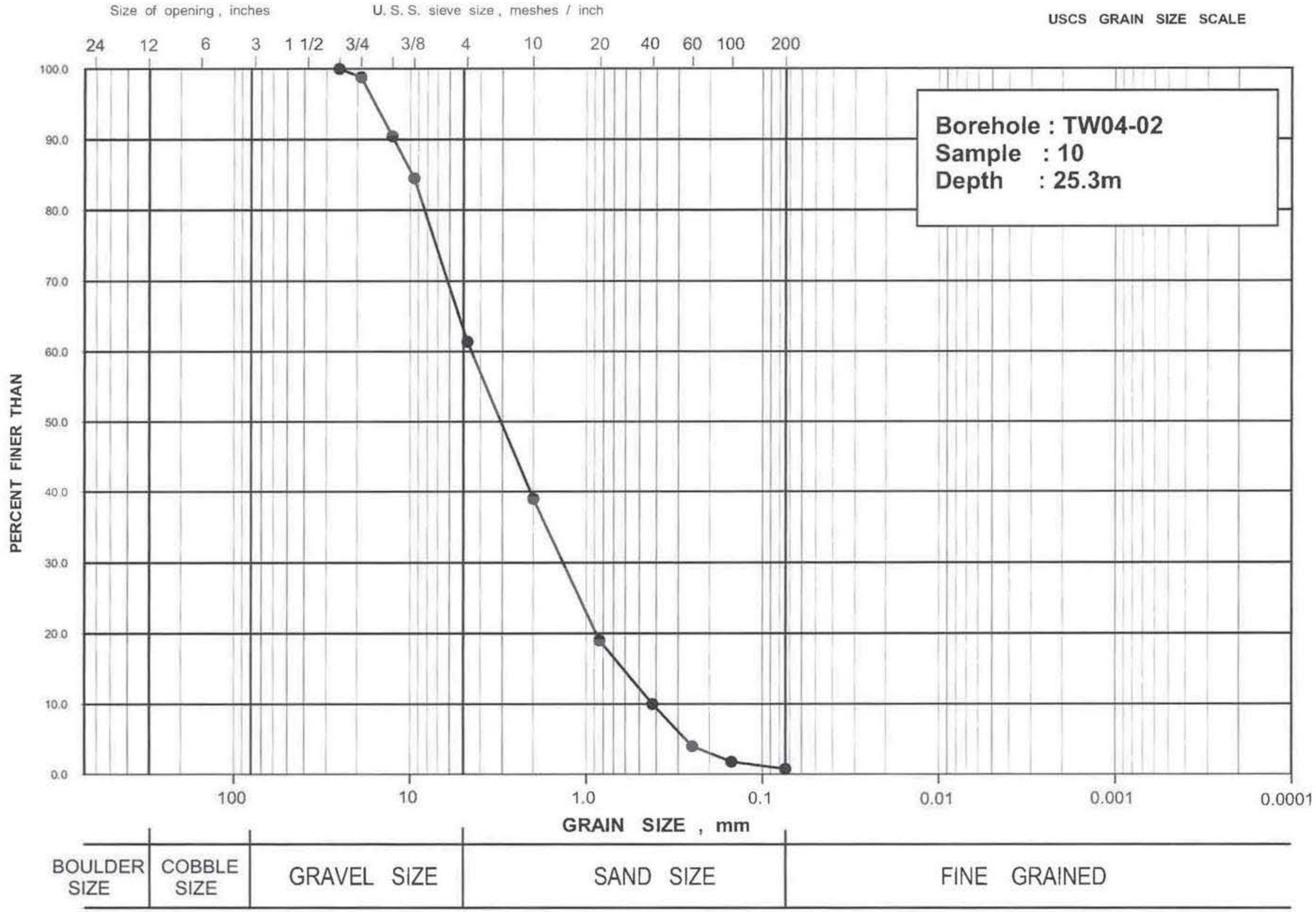
TEST WELL GRADATION ANALYSIS

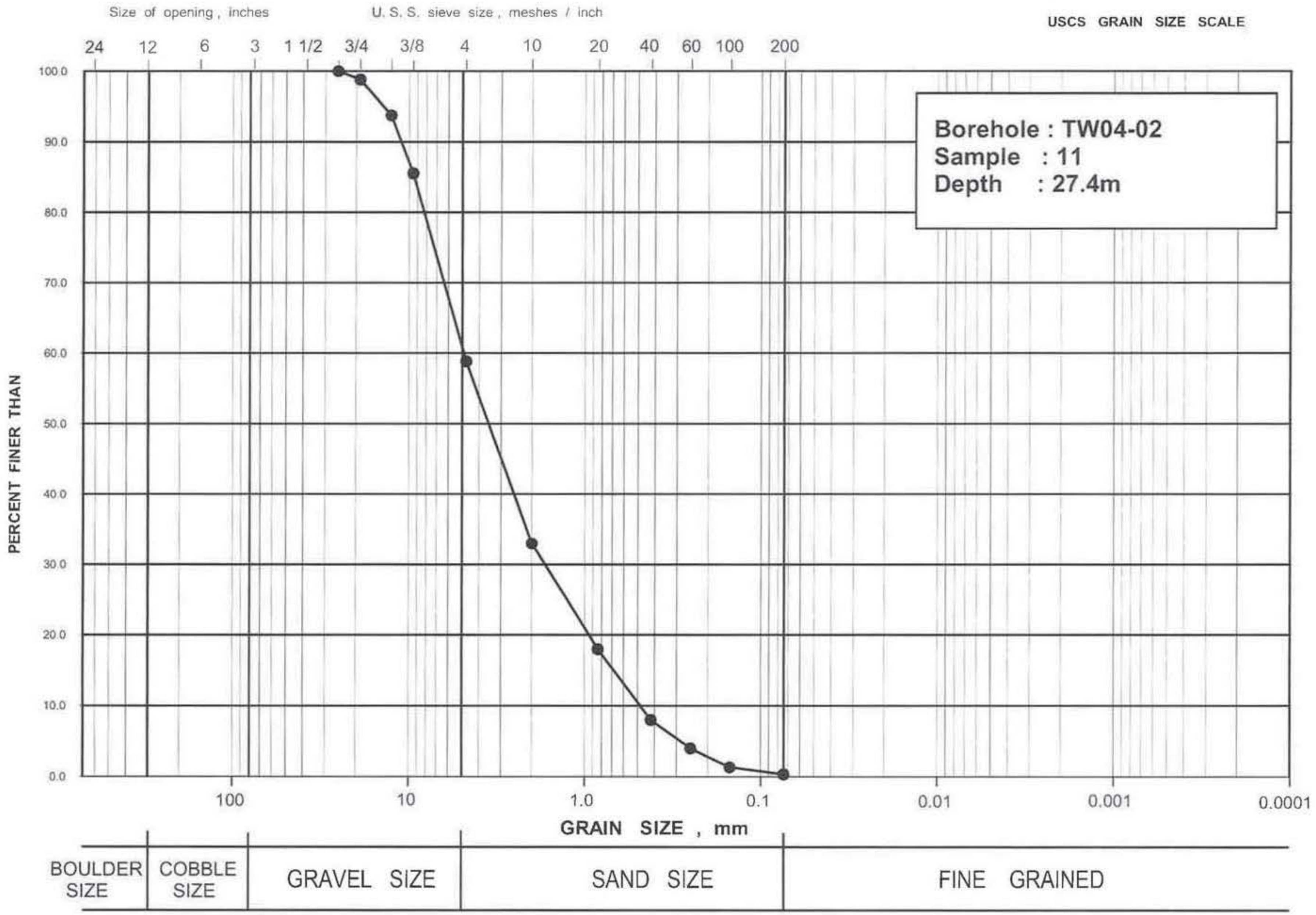
Figure IV-16



Borehole : TW04-02
Sample : 10
Depth : 25.3m

Project No. 04-1413-027 **Drawn** TM **Reviewed** LL **Date** 10/01/04	Golder Associates	**TEST WELL GRADATION ANALYSIS**

Figure IV-17



Project No. 04-1413-027
Drawn TM
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Date 10/01/04

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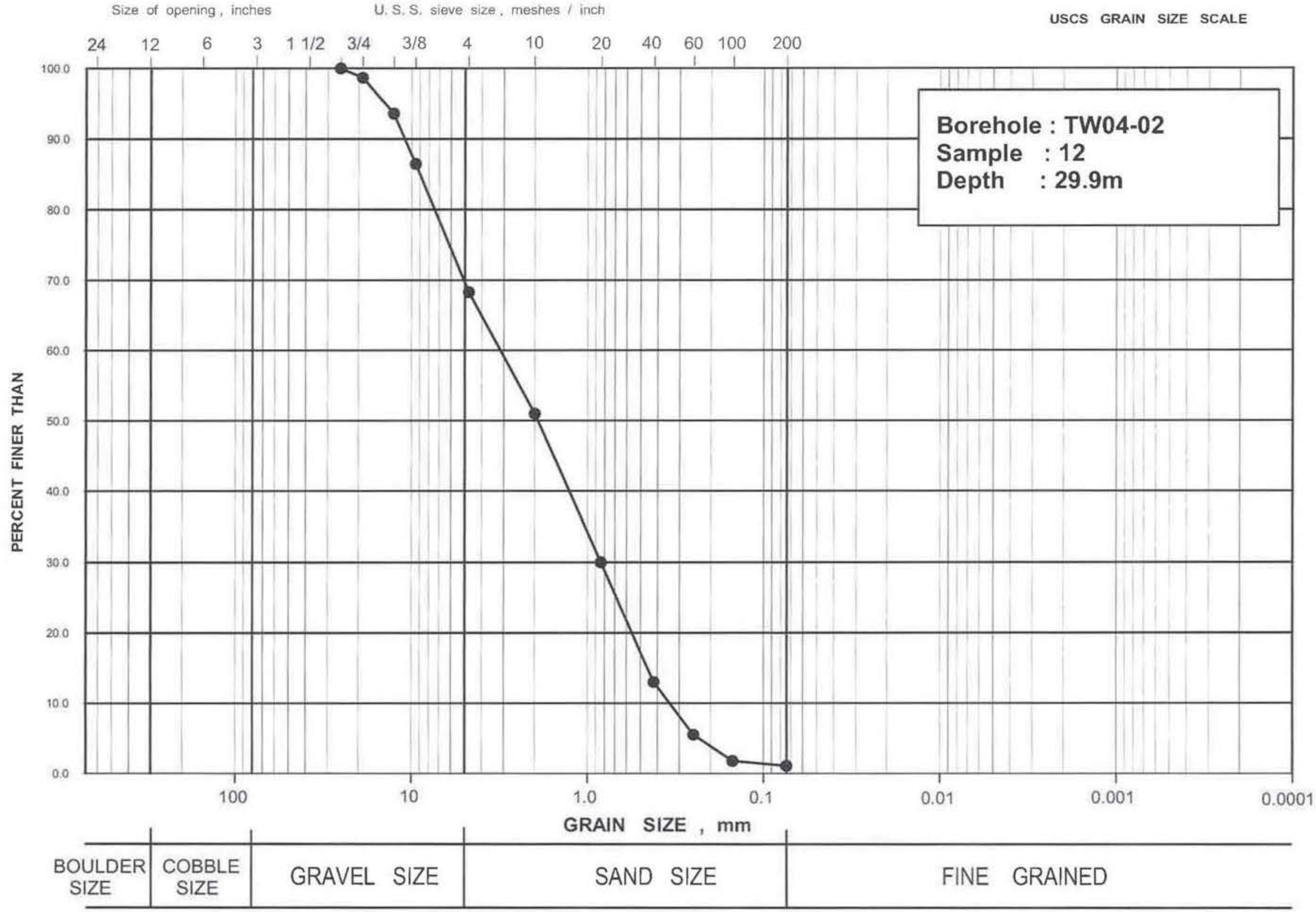
TEST WELL GRADATION ANALYSIS

Figure IV-18



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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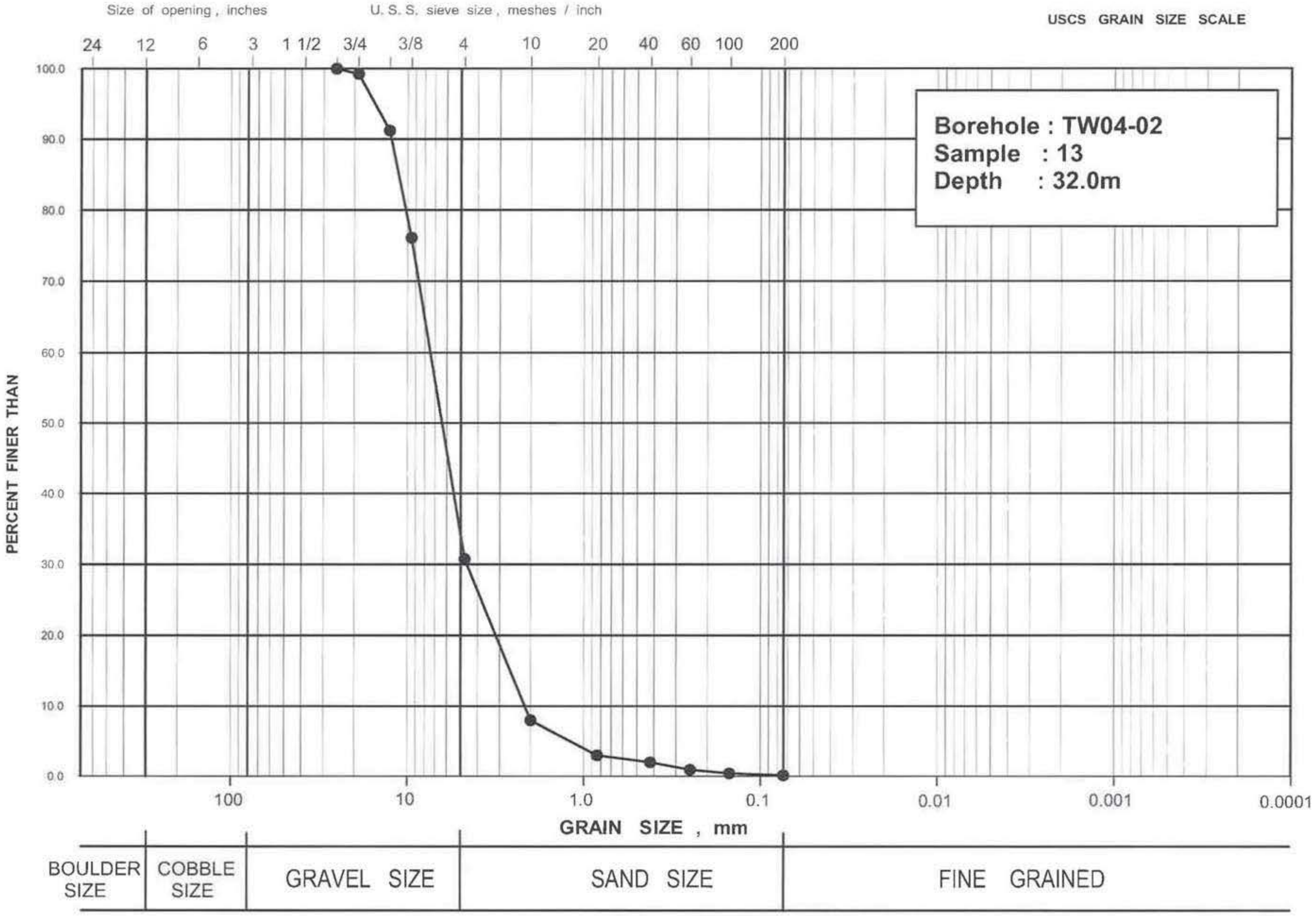
TEST WELL GRADATION ANALYSIS

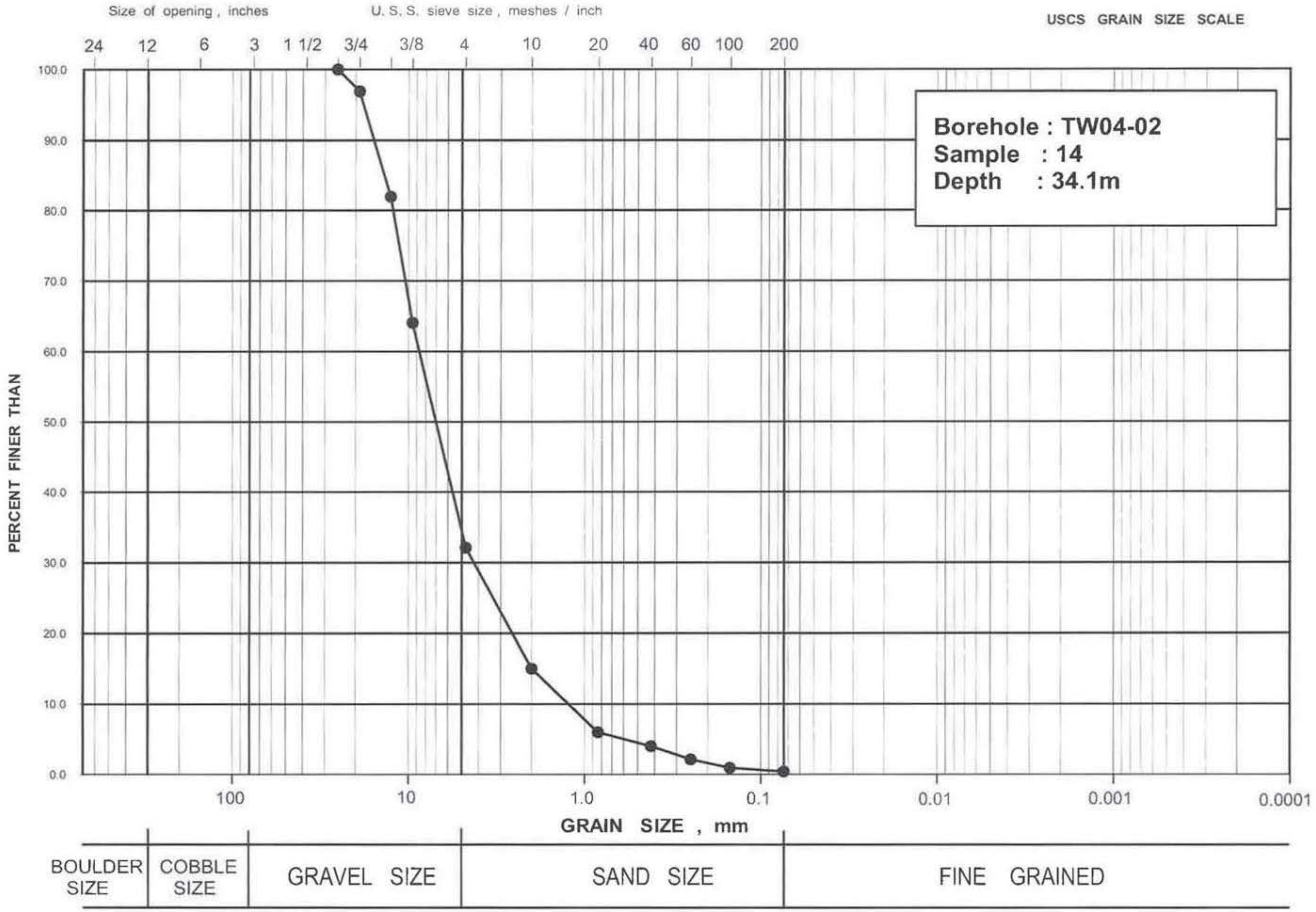
Figure IV-19



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

TEST WELL GRADATION ANALYSIS

Figure IV-20



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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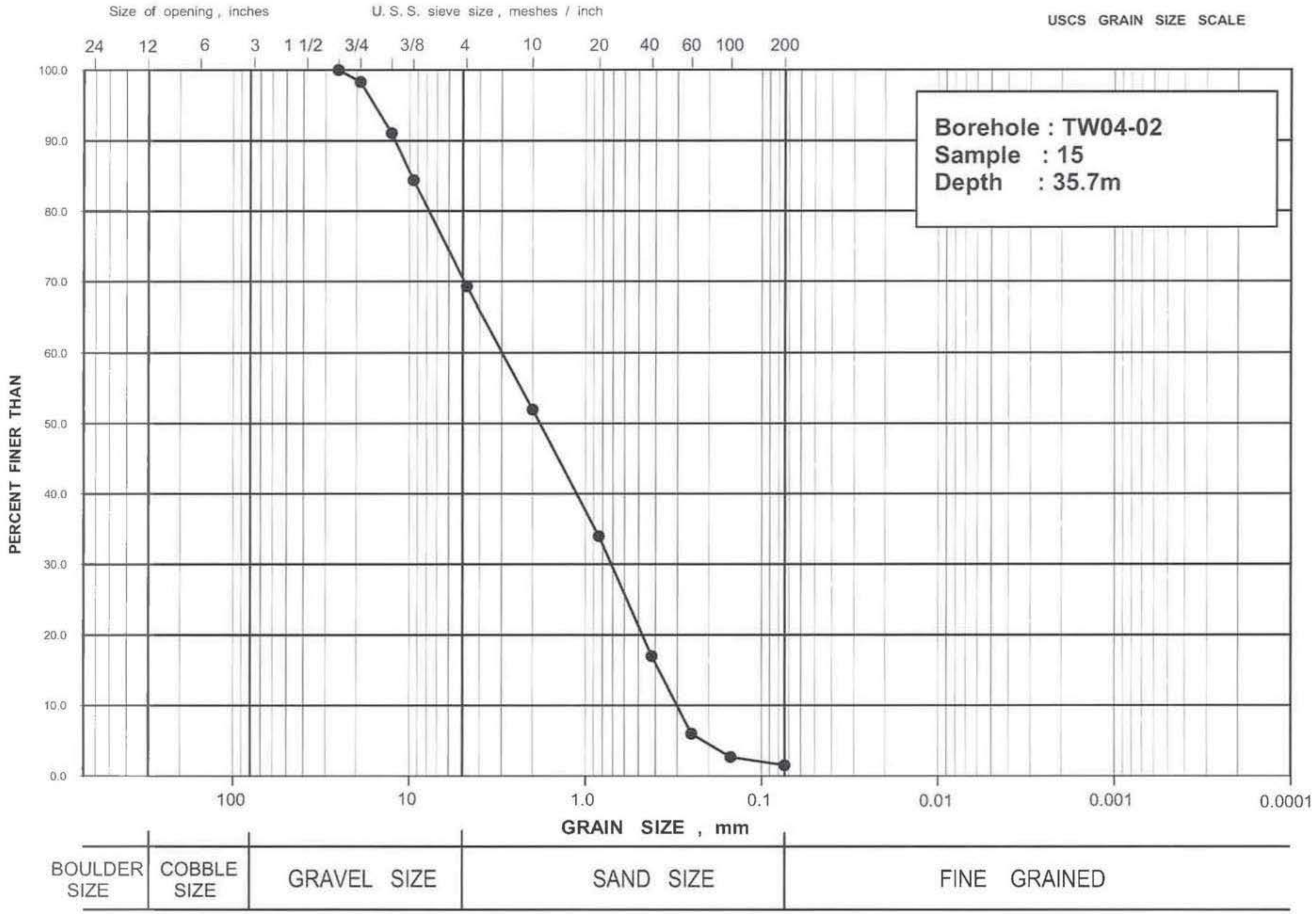
TEST WELL GRADATION ANALYSIS

Figure IV-21



Borehole : TW04-02
Sample : 15
Depth : 35.7m

Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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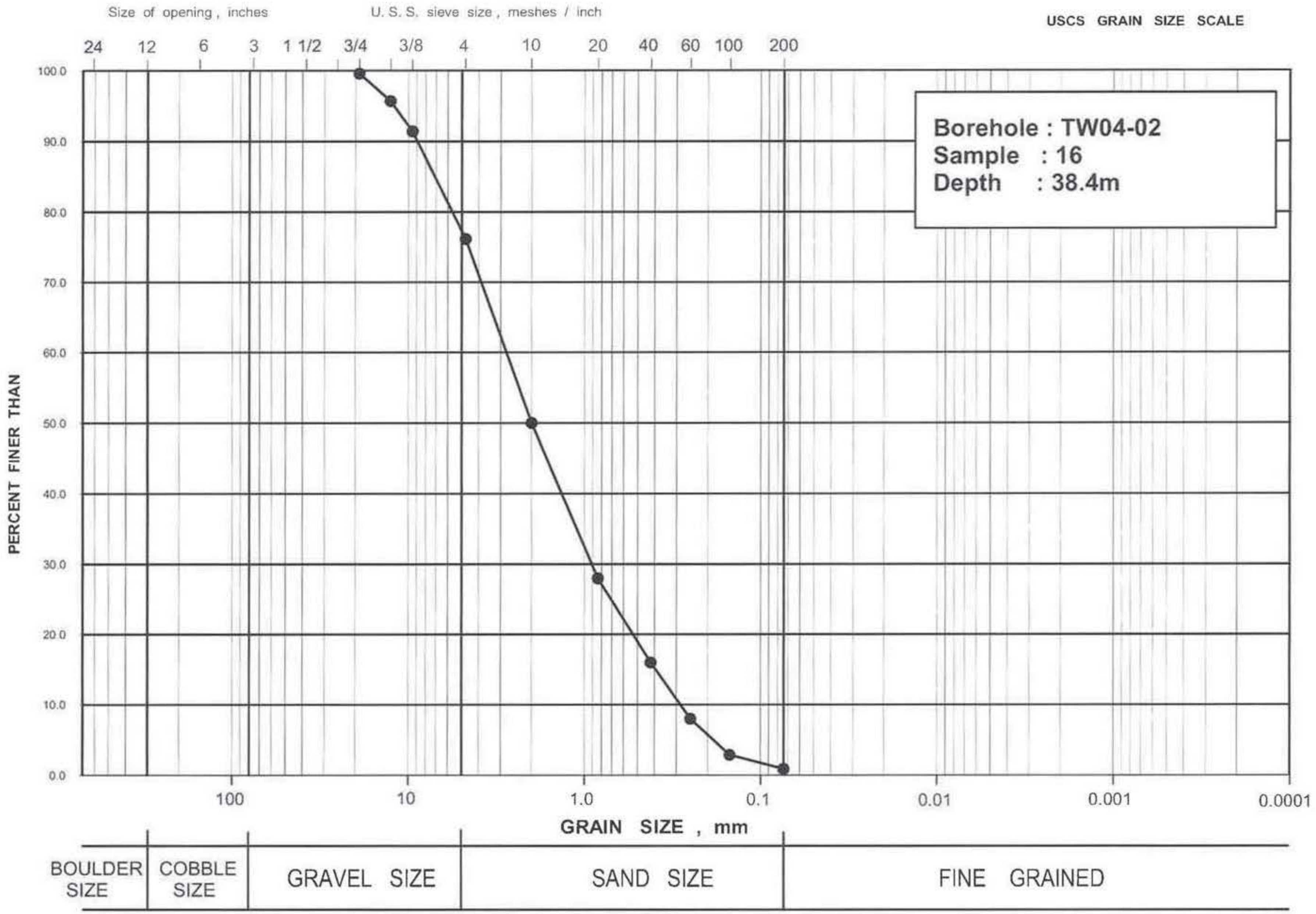
TEST WELL GRADATION ANALYSIS

Figure IV-22



Project No. 04-1413-027
Drawn TM
Reviewed LL
Date 10/01/04

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TEST WELL GRADATION ANALYSIS

Figure IV-23

APPENDIX V

TEST WELL LOGS (TW04-1 AND TW04-02)

PROJECT No.: 04-1413-027

RECORD OF BOREHOLE: TW04-01

SHEET 1 OF 2

LOCATION: 4m NE of BH04-01

BORING DATE: JULY 27 - AUGUST 5, 2004

DATUM: Ground Surface

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢ ⊖W ⊣ Wl 10 20 30 40	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		929.90 0.00							Stickup 0.64m
	AQUA DRILLING SERVICES LTD AIR ROTARY	FILL.		928.20 1.70							
2 – 12		Dark grey, clayey SILT, with trace gravel.		917.40 12.50	1 2 3						AUG 11, 04 ▽ 3.78m-bg 8" dia. Steel Casing
		GRAVEL, some silt.		916.80 13.10	4						
14 – 16		Grey, sandy SILT, with trace gravel.		913.40 16.50	5 6						
18		Coarse sandy GRAVEL.		911.60 18.30	7 8						
		Silty SAND.		910.40 19.50							
20		SAND and GRAVEL, increasing silt with depth.									

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 100

LOGGED: JAB

CHECKED:

BOREHOLE 04-1413-027.GPJ GLDR_CAN.GDT 18/10/04

PROJECT No.: 04-1413-027

LOCATION: 4m NE of BH04-01

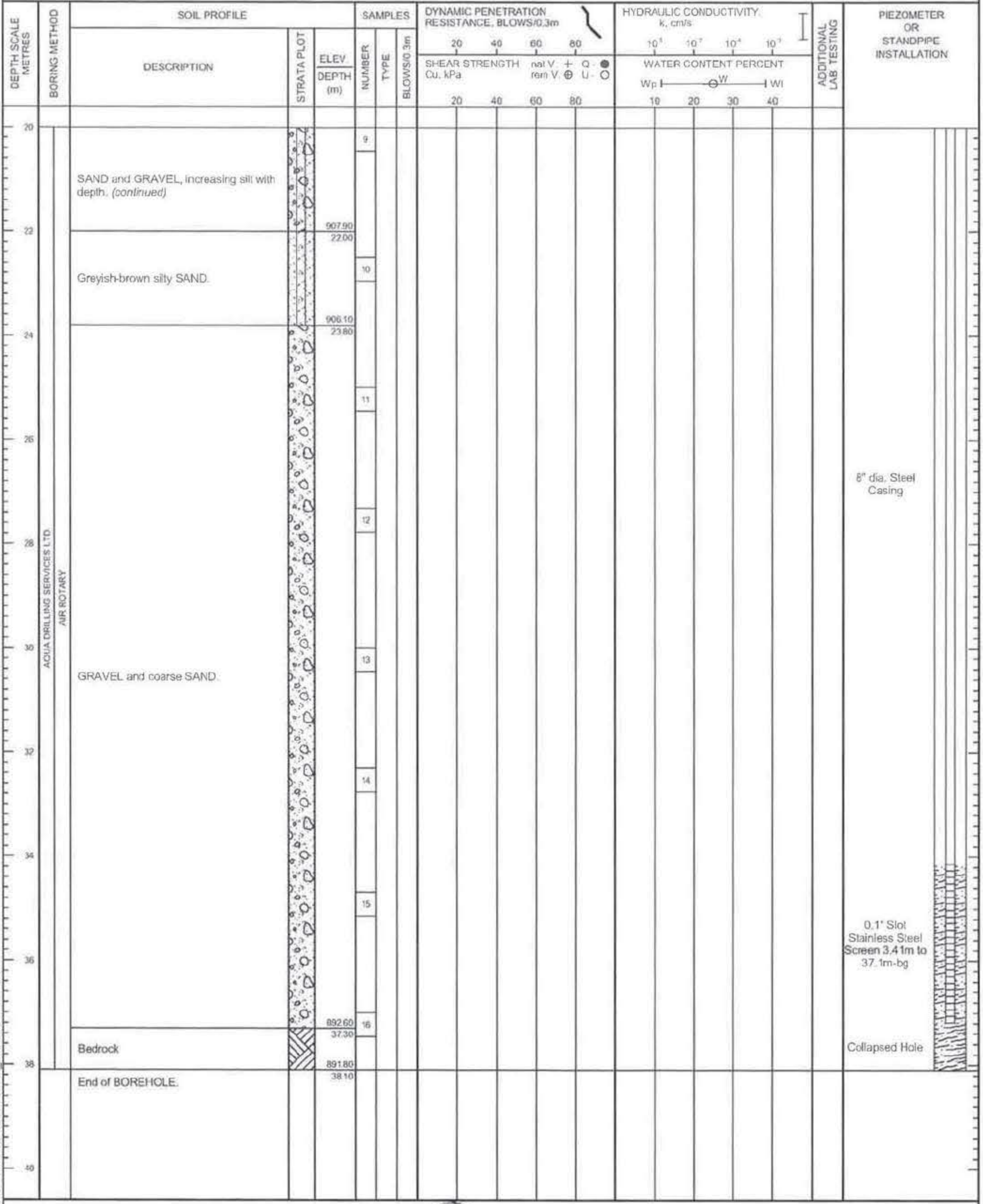
RECORD OF BOREHOLE: TW04-01

BORING DATE: JULY 27 - AUGUST 5, 2004

SHEET 2 OF 2

DATUM: Ground Surface

INCLINATION: -90°



DESCRIPTION	ELEV DEPTH (m)	SAMPLE NUMBER
SAND and GRAVEL, increasing silt with depth. *(continued)*	907.90 22.00	9
Greyish-brown silty SAND.	906.10 23.80	10
GRAVEL and coarse SAND.	892.60 37.30	11 12 13 14 15 16
Bedrock	891.80 38.10	
End of BOREHOLE.		

PIEZOMETER OR STANDPIPE INSTALLATION:

8" dia. Steel Casing

0.1" Slot Stainless Steel Screen 3.41m to 37.1m-bg

Collapsed Hole

BOREHOLE 04-1413-027.GPJ GLDR_CAN.GDT 18/10/04

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: JAB

CHECKED:

PROJECT No.: 04-1413-027

LOCATION: 30m West of BH04-04

RECORD OF BOREHOLE: TW04-02

BORING DATE: AUGUST 5 - AUGUST 9, 2004

INCLINATION: -90°

SHEET 1 OF 2

DATUM: Ground Surface

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢ ○W ⊣ Wl 10 20 30 40

ADDITIONAL LAB TESTING

BORING METHOD: AQUA DRILLING SERVICES LTD. AIR ROTARY

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV / DEPTH (m)	SAMPLES NUMBER	PIEZOMETER OR STANDPIPE INSTALLATION
0	Ground Surface	942.43 / 0.00		Stickup 0.60m
	FILL, silt, rock, boulders.			
2	Brown, clayey SILT.	940.33 / 2.10	1	
6	Grey, silty CLAY.	936.03 / 6.40	2	
9	Brown SILT, some gravel.	933.33 / 9.10	3 4 5	8" dia. Solid Casing AUG 11, 04 ▽ 15.82m-bg
16	Sandy SILT, some gravel.	925.93 / 16.50	6	
20				

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 100

Golder Associates

LOGGED: JAB

CHECKED:

PROJECT No.: 04-1413-027

LOCATION: 30m West of BH04-04

RECORD OF BOREHOLE: TW04-02

SHEET 2 OF 2

BORING DATE: AUGUST 5 - AUGUST 9, 2004

DATUM: Ground Surface

INCLINATION: -90°

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢ ○W ⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
20 - 22.60	AQUA DRILLING SERVICES LTD. AIR ROTARY	Sandy SILT, some gravel. *(continued)*		7 8			
22.60 - 35.00		Coarse SAND and GRAVEL.	919.83 22.60	9 10 11 12 13			8" dia. Solid Casing 0.12" Slot Stainless Steel Screen 32.0m to 35.0m-bg
35.00 - 39.30		Medium coarse grained SAND.	907.43 35.00	15 14 16			8" dia. Solid Pipe
39.30		End of BOREHOLE.	903.13 39.30				

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: JAB

CHECKED:

APPENDIX VI

PUMPING TEST RESULTS

Table VI-1
Summary of Variable-Rate Aquifer Pumping Test Data for Well TW04-01 (Pumped Well)

Date	Clock	Elapsed	Water Levels			Pumping		Comments
2004	Time	Time (t)	Depth btoc		Drawdn	Rate		
	(h:m:s)	(mins)	(ft)	(m)	(m)	(USgpm)	(L/s)	
11-Aug	11:30	0	14.56	4.42	0.00	0	0.0	Start Step #1 (100 Usgpm)
11-Aug	11:30:30	0.5	16.82	5.11	0.69	100	6.3	
11-Aug	11:31	1	17.01	5.17	0.75	100	6.3	
11-Aug	11:31:30	1.5	17.11	5.20	0.78	100	6.3	
11-Aug	11:32	2	17.78	5.40	0.98	100	6.3	
11-Aug	11:32:30	2.5	19.46	5.92	1.50	100	6.3	
11-Aug	11:33	3	20.16	6.13	1.71	100	6.3	
11-Aug	11:33:30	3.5	23.48	7.14	2.72	100	6.3	
11-Aug	11:34	4	25.18	7.66	3.24	100	6.3	
11-Aug	11:34:30	4.5	26.14	7.95	3.53	100	6.3	
11-Aug	11:35	5	26.63	8.10	3.68	100	6.3	
11-Aug	11:36	6	27.02	8.22	3.80	100	6.3	
11-Aug	11:37	7	27.25	8.29	3.87	100	6.3	
11-Aug	11:38	8	27.49	8.36	3.94	100	6.3	
11-Aug	11:39	9	27.65	8.41	3.99	100	6.3	
11-Aug	11:40	10	27.70	8.43	4.01	100	6.3	
11-Aug	11:42	12	28.03	8.53	4.11	100	6.3	
11-Aug	11:44	14	28.23	8.59	4.17	100	6.3	
11-Aug	11:46	16	28.39	8.64	4.22	100	6.3	
11-Aug	11:48	18	28.54	8.68	4.26	100	6.3	
11-Aug	11:50	20	28.66	8.72	4.30	100	6.3	
11-Aug	11:55	25	28.90	8.79	4.37	100	6.3	
11-Aug	12:00	30	29.11	8.86	4.44	100	6.3	
11-Aug	12:00:30	0.5	36.82	11.21	6.79	200	12.6	Start Step #2 (200 Usgpm)
11-Aug	12:01	1	40.83	12.43	8.01	200	12.6	
11-Aug	12:01:30	1.5	42.88	13.05	8.63	200	12.6	
11-Aug	12:02	2	43.53	13.25	8.83	200	12.6	
11-Aug	12:02:30	2.5	43.88	13.36	8.94	200	12.6	
11-Aug	12:03	3	44.11	13.43	9.01	200	12.6	
11-Aug	12:03:30	3.5	44.30	13.49	9.07	200	12.6	
11-Aug	12:04	4	44.39	13.51	9.09	200	12.6	
11-Aug	12:04:30	4.5	44.54	13.56	9.14	200	12.6	
11-Aug	12:05	5	44.68	13.60	9.18	200	12.6	
11-Aug	12:06	6	44.84	13.65	9.23	200	12.6	
11-Aug	12:07	7	45.12	13.74	9.32	200	12.6	
11-Aug	12:08	8	45.29	13.79	9.37	200	12.6	
11-Aug	12:09	9	45.38	13.82	9.40	200	12.6	
11-Aug	12:10	10	45.48	13.85	9.43	200	12.6	
11-Aug	12:12	12	45.78	13.94	9.52	200	12.6	
11-Aug	12:14	14	46.13	14.04	9.62	200	12.6	
11-Aug	12:16	16	46.38	14.12	9.70	200	12.6	
11-Aug	12:18	18	46.60	14.19	9.77	200	12.6	
11-Aug	12:20	20	46.72	14.22	9.80	200	12.6	
11-Aug	12:25	25	47.02	14.32	9.90	200	12.6	
11-Aug	12:30	30	47.33	14.41	9.99	200	12.6	

Table VI-1
Summary of Variable-Rate Aquifer Pumping Test Data for Well TW04-01 (Pumped Well)

Date	Clock	Elapsed	Water Levels			Pumping		Comments
2004	Time	Time (t)	Depth btoc		Drawdn	Rate		
	(h:m:s)	(mins)	(ft)	(m)	(m)	(USgpm)	(L/s)	
11-Aug	12:30:30	0.5	56.80	17.30	12.88	300	18.9	Start Step #3 (300 USgpm)
11-Aug	12:31	1	60.38	18.39	13.97	300	18.9	
11-Aug	12:31:30	1.5	62.25	18.96	14.54	300	18.9	
11-Aug	12:32	2	62.86	19.14	14.72	300	18.9	
11-Aug	12:32:30	2.5	63.70	19.40	14.98	300	18.9	
11-Aug	12:33	3	64.06	19.51	15.09	300	18.9	
11-Aug	12:33:30	3.5	64.33	19.59	15.17	300	18.9	
11-Aug	12:34	4	64.38	19.61	15.19	300	18.9	
11-Aug	12:34:30	4.5	64.44	19.63	15.21	300	18.9	
11-Aug	12:35:00	5	64.56	19.66	15.24	300	18.9	
11-Aug	12:36:00	6	64.78	19.73	15.31	300	18.9	
11-Aug	12:37	7	64.91	19.77	15.35	300	18.9	
11-Aug	12:38:00	8	65.07	19.82	15.40	300	18.9	
11-Aug	12:39	9	65.29	19.88	15.46	300	18.9	
11-Aug	12:40:00	10	65.30	19.89	15.47	300	18.9	
11-Aug	12:42	12	65.53	19.96	15.54	300	18.9	
11-Aug	12:44	14	65.76	20.03	15.61	300	18.9	
11-Aug	12:46	16	66.00	20.10	15.68	300	18.9	
11-Aug	12:48	18	66.18	20.16	15.74	300	18.9	
11-Aug	12:50	20	66.27	20.18	15.76	300	18.9	
11-Aug	12:55	25	66.50	20.25	15.83	300	18.9	
11-Aug	13:00	30	66.79	20.34	15.92	300	18.9	
11-Aug	13:00:30	0.5	75.55	23.01	18.59	398	25.1	Start Step #4 (398 USgpm)
11-Aug	13:01	1	78.80	24.00	19.58	398	25.1	
11-Aug	13:01:30	1.5	81.50	24.82	20.40	398	25.1	
11-Aug	13:02	2	82.65	25.18	20.76	398	25.1	
11-Aug	13:02	2.5	83.38	25.40	20.98	398	25.1	
11-Aug	13:03	3	83.70	25.50	21.08	398	25.1	
11-Aug	13:03	3.5	83.90	25.56	21.14	398	25.1	
11-Aug	13:04:00	4	84.08	25.61	21.19	398	25.1	
11-Aug	13:04	4.5	84.22	25.65	21.23	398	25.1	
11-Aug	13:05:00	5	84.32	25.68	21.26	398	25.1	
11-Aug	13:06	6	84.56	25.76	21.34	398	25.1	
11-Aug	13:07:00	7	84.77	25.82	21.40	398	25.1	
11-Aug	13:08:00	8	84.98	25.89	21.47	398	25.1	
11-Aug	13:09	9	85.14	25.93	21.51	398	25.1	
11-Aug	13:12	12	85.48	26.04	21.62	398	25.1	
11-Aug	13:14	14	85.65	26.09	21.67	398	25.1	
11-Aug	13:16	16	85.85	26.15	21.73	398	25.1	
11-Aug	13:18	18	86.53	26.36	21.94	398	25.1	
11-Aug	13:20	20	86.14	26.24	21.82	398	25.1	
11-Aug	13:25	25	86.34	26.30	21.88	398	25.1	
11-Aug	13:30	30	86.53	26.36	21.94	398	25.1	Reduce Pumping rate to 60 Usgpm
11-Aug	13:35	35	86.82	26.45	22.03	398	25.1	
11-Aug	13:40	40	86.96	26.49	22.07	398	25.1	
11-Aug	13:45	45	87.42	26.63	22.21	398	25.1	

Table VI-1
Summary of Variable-Rate Aquifer Pumping Test Data for Well TW04-01 (Pumped Well)

Date	Clock	Elapsed	Water Levels			Pumping		Comments
2004	Time	Time (t)	Depth btoc		Drawdn	Rate		
	(h:m:s)	(mins)	(ft)	(m)	(m)	(USgpm)	(L/s)	
11-Aug	13:50	50	87.72	26.72	22.30	398	25.1	
11-Aug	14:00	60	88.94	27.09	22.67	398	25.1	
11-Aug	14:10	70	89.25	27.19	22.77	398	25.1	
11-Aug	14:20	80	89.49	27.26	22.84	398	25.1	
11-Aug	14:40	100	89.91	27.39	22.97	398	25.1	
11-Aug	15:00	120	90.25	27.49	23.07	398	25.1	
11-Aug	15:20	140	90.56	27.59	23.17	398	25.1	
11-Aug	15:40	160	90.83	27.67	23.25	398	25.1	
11-Aug	16:00	180	91.63	27.91	23.49	398	25.1	
11-Aug	16:50	230	92.18	28.08	23.66	398	25.1	
11-Aug	17:40	280	92.59	28.20	23.78	398	25.1	
11-Aug	18:30	330	93.40	28.45	24.03	398	25.1	
11-Aug	19:20	380	93.66	28.53	24.11	398	25.1	
11-Aug	20:10	430	94.00	28.63	24.21	398	25.1	
11-Aug	21:00	480	94.20	28.70	24.28	398	25.1	
11-Aug	21:50	530	94.60	28.82	24.40	398	25.1	
11-Aug	22:40	580	94.85	28.89	24.47	398	25.1	
11-Aug	23:30	630	95.03	28.95	24.53	398	25.1	
11-Aug	0:20	680	95.21	29.00	24.58	398	25.1	
12-Aug	1:10	730	95.40	29.06	24.64	398	25.1	
12-Aug	2:00	780	95.58	29.12	24.70	398	25.1	
12-Aug	2:50	830	95.70	29.15	24.73	398	25.1	
12-Aug	3:40	880	95.82	29.19	24.77	398	25.1	
12-Aug	4:30	930	95.60	29.12	24.70	398	25.1	
12-Aug	5:20	980	96.06	29.26	24.84	398	25.1	
12-Aug	6:10	1030	95.98	29.24	24.82	398	25.1	
12-Aug	7:00	1080	96.08	29.27	24.85	398	25.1	
12-Aug	7:50	1130	96.15	29.29	24.87	398	25.1	
12-Aug	8:40	1180	96.23	29.31	24.89	398	25.1	
12-Aug	9:30	1230	96.31	29.34	24.92	398	25.1	
12-Aug	10:20	1280	96.41	29.37	24.95	398	25.1	
12-Aug	11:10	1330	96.53	29.41	24.99	398	25.1	
12-Aug	12:00	1380	96.61	29.43	25.01	398	25.1	
12-Aug	12:50	1430	96.73	29.47	25.05	398	25.1	
12-Aug	13:00	1480	96.74	29.47	25.05	398	25.1	

Table VI-2
Summary of Variable-Rate Aquifer Pumping Test Data for Well TPW04-02 (Observation Well)

Date 2004	Clock Time (h:m:s)	Elapsed Time (t) (mins)	Water Levels Depth btoc (ft)	Water Levels Depth btoc (m)	Water Levels Drawdn (m)	Manometer Height (in)	Pumping Rate (USgpm)	Pumping Rate (L/s)	Comments
11-Aug	10:45	0	53.88	16.42	0.00	-	-	-	Start Pumping at TW04-01 @ 11:30
11-Aug	16:07	307	54.28	16.54	0.12	-	-	-	
11-Aug	17:09	369	54.28	16.54	0.12	-	-	-	
11-Aug	18:56	476	54.62	16.65	0.23	-	-	-	
11-Aug	21:26	566	54.86	16.72	0.30	-	-	-	
12-Aug	0:15	795	55.08	16.79	0.37	-	-	-	
12-Aug	2:36	936	55.30	16.85	0.43	-	-	-	
12-Aug	4:55	1075	55.47	16.91	0.49	-	-	-	
12-Aug	8:10	1270	55.65	16.96	0.54	-	-	-	
12-Aug	9:39	1359	55.76	16.99	0.57	-	-	-	
12-Aug	11:15	1455	55.82	17.01	0.59	-	-	-	
12-Aug	12:18	1518	55.86	17.03	0.61				Shut-off Pump at TW04-01 @ 13:00

Table VI-3
Summary of Variable-Rate Aquifer Pumping Data for Well TW04-02 (Pumped Well)

Date	Clock	Elapsed	Water Levels			Pumping		Comments
2004	Time	Time (t)	Depth btoc		Drawdn	Rate		
	(h:m:s)	(mins)	(ft)	(m)	(m)	(USgpm)	(L/s)	
12-Aug	19:05	0	55.55	16.93	0.00	0	0.0	Start Step #1 (80 Usgpm)
12-Aug	19:05:30	0.5	55.97	17.06	0.13	80	5.0	
12-Aug	19:06	1	55.92	17.04	0.11	80	5.0	
12-Aug	19:06:30	1.5	56.12	17.10	0.17	80	5.0	
12-Aug	19:07	2	56.20	17.13	0.20	80	5.0	
12-Aug	19:07:30	2.5	56.25	17.14	0.21	80	5.0	
12-Aug	19:08	3	56.27	17.15	0.22	80	5.0	
12-Aug	19:08:30	3.5	56.35	17.17	0.24	80	5.0	
12-Aug	19:09	4	56.36	17.18	0.25	80	5.0	
12-Aug	19:09:30	4.5	56.38	17.18	0.25	80	5.0	
12-Aug	19:10	5	56.40	17.19	0.26	80	5.0	
12-Aug	19:11	6	56.42	17.20	0.27	80	5.0	
12-Aug	19:12	7	56.42	17.20	0.27	80	5.0	Orifice Flowing at t = 7 min.
12-Aug	19:13	8	57.40	17.49	0.56	80	5.0	
12-Aug	19:14	9	57.46	17.51	0.58	80	5.0	
12-Aug	19:15	10	57.53	17.53	0.60	80	5.0	
12-Aug	19:17	12	57.78	17.61	0.68	80	5.0	
12-Aug	19:19	14	57.95	17.66	0.73	80	5.0	
12-Aug	19:21	16	57.86	17.63	0.70	80	5.0	
12-Aug	19:23	18	57.89	17.64	0.71	80	5.0	
12-Aug	19:25	20	57.95	17.66	0.73	80	5.0	
12-Aug	19:30	25	58.04	17.69	0.76	80	5.0	
12-Aug	19:35	30	58.10	17.71	0.78	80	5.0	
12-Aug	19:35:30	0.5	60.28	18.37	1.44	166	10.5	Start Step #2 (166 Usgpm)
12-Aug	19:36	1	60.18	18.34	1.41	166	10.5	
12-Aug	19:36:30	1.5	60.16	18.34	1.41	166	10.5	
12-Aug	19:37	2	60.15	18.33	1.40	166	10.5	
12-Aug	19:37:30	2.5	60.15	18.33	1.40	166	10.5	
12-Aug	19:38	3	60.84	18.54	1.61	166	10.5	
12-Aug	19:38:30	3.5	60.81	18.53	1.60	166	10.5	
12-Aug	19:39	4	60.91	18.56	1.63	166	10.5	
12-Aug	19:39:30	4.5	60.95	18.58	1.65	166	10.5	
12-Aug	19:40	5	61.04	18.60	1.67	166	10.5	
12-Aug	19:41	6	61.08	18.62	1.69	166	10.5	
12-Aug	19:42	7	61.10	18.62	1.69	166	10.5	
12-Aug	19:43	8	61.14	18.63	1.70	166	10.5	
12-Aug	19:44	9	61.18	18.65	1.72	166	10.5	
12-Aug	19:45	10	61.22	18.66	1.73	166	10.5	
12-Aug	19:47	12	61.28	18.68	1.75	166	10.5	
12-Aug	19:49	14	61.34	18.70	1.77	166	10.5	
12-Aug	19:51	16	61.41	18.72	1.79	166	10.5	
12-Aug	19:53	18	61.45	18.73	1.80	166	10.5	
12-Aug	19:55	20	61.50	18.74	1.81	166	10.5	
12-Aug	20:00	25	61.69	18.80	1.87	166	10.5	
12-Aug	20:05	30	61.83	18.84	1.91	166	10.5	

Table VI-3
Summary of Variable-Rate Aquifer Pumping Data for Well TW04-02 (Pumped Well)

Date	Clock	Elapsed	Water Levels			Pumping		Comments
2004	Time	Time (t)	Depth btoc		Drawdn	Rate		
	(h:m:s)	(mins)	(ft)	(m)	(m)	(USgpm)	(L/s)	
12-Aug	20:05:30	0.5	64.70	19.72	2.79	291	18.4	Start Step #3 (291 USgpm)
12-Aug	20:06	1	65.80	20.05	3.12	291	18.4	
12-Aug	20:06:30	1.5	66.36	20.23	3.30	291	18.4	
12-Aug	20:07	2	66.31	20.21	3.28	291	18.4	
12-Aug	20:07:30	2.5	66.68	20.32	3.39	291	18.4	
12-Aug	20:08	3	66.75	20.34	3.41	291	18.4	
12-Aug	20:08:30	3.5	66.85	20.37	3.44	291	18.4	
12-Aug	20:09	4	66.91	20.39	3.46	291	18.4	
12-Aug	20:09:30	4.5	66.88	20.38	3.45	291	18.4	
12-Aug	20:10:00	5	66.94	20.40	3.47	291	18.4	
12-Aug	20:11:00	6	66.98	20.41	3.48	291	18.4	
12-Aug	20:12	7	67.03	20.43	3.50	291	18.4	
12-Aug	20:13:00	8	67.08	20.44	3.51	291	18.4	
12-Aug	20:14	9	67.14	20.46	3.53	291	18.4	
12-Aug	20:15:00	10	67.18	20.48	3.55	291	18.4	
12-Aug	20:17	12	67.20	20.48	3.55	291	18.4	
12-Aug	20:19	14	67.28	20.51	3.58	291	18.4	
12-Aug	20:21	16	67.32	20.52	3.59	291	18.4	
12-Aug	20:23	18	67.36	20.53	3.60	291	18.4	
12-Aug	20:25	20	67.40	20.54	3.61	291	18.4	
12-Aug	20:30	25	67.44	20.55	3.62	291	18.4	
12-Aug	20:35	30	67.50	20.57	3.64	291	18.4	
12-Aug	20:35:30	0.5	71.70	21.85	4.92	407	25.7	Start Step #4 (407 USgpm)
12-Aug	20:36	1	72.59	22.12	5.19	407	25.7	
12-Aug	20:36:30	1.5	73.09	22.28	5.35	407	25.7	
12-Aug	20:37	2	73.17	22.30	5.37	407	25.7	
12-Aug	20:37	2.5	73.26	22.33	5.40	407	25.7	
12-Aug	20:38	3	73.36	22.36	5.43	407	25.7	
12-Aug	20:38	3.5	73.38	22.37	5.44	407	25.7	
12-Aug	20:39:00	4	73.41	22.37	5.44	407	25.7	
12-Aug	20:39	4.5	73.45	22.39	5.46	407	25.7	
12-Aug	20:40:00	5	73.53	22.41	5.48	407	25.7	
12-Aug	20:41	6	73.58	22.43	5.50	407	25.7	
12-Aug	20:42:00	7	73.65	22.45	5.52	407	25.7	
12-Aug	20:43:00	8	73.71	22.47	5.54	407	25.7	
12-Aug	20:44	9	73.76	22.48	5.55	407	25.7	
12-Aug	20:45	10	73.84	22.51	5.58	407	25.7	
12-Aug	20:47	12	73.92	22.53	5.60	407	25.7	
12-Aug	20:49	14	74.00	22.55	5.62	407	25.7	
12-Aug	20:51	16	74.06	22.57	5.64	407	25.7	
12-Aug	20:53	18	74.15	22.60	5.67	407	25.7	
12-Aug	20:55	20	74.20	22.62	5.69	407	25.7	
12-Aug	21:00	25	74.33	22.65	5.72	407	25.7	
12-Aug	21:05	30	74.48	22.70	5.77	407	25.7	
12-Aug	21:10	35	74.62	22.74	5.81	407	25.7	
12-Aug	21:17	42	74.82	22.80	5.87	407	25.7	
12-Aug	21:20	45	74.86	22.82	5.89	407	25.7	

Table VI-3
Summary of Variable-Rate Aquifer Pumping Data for Well TW04-02 (Pumped Well)

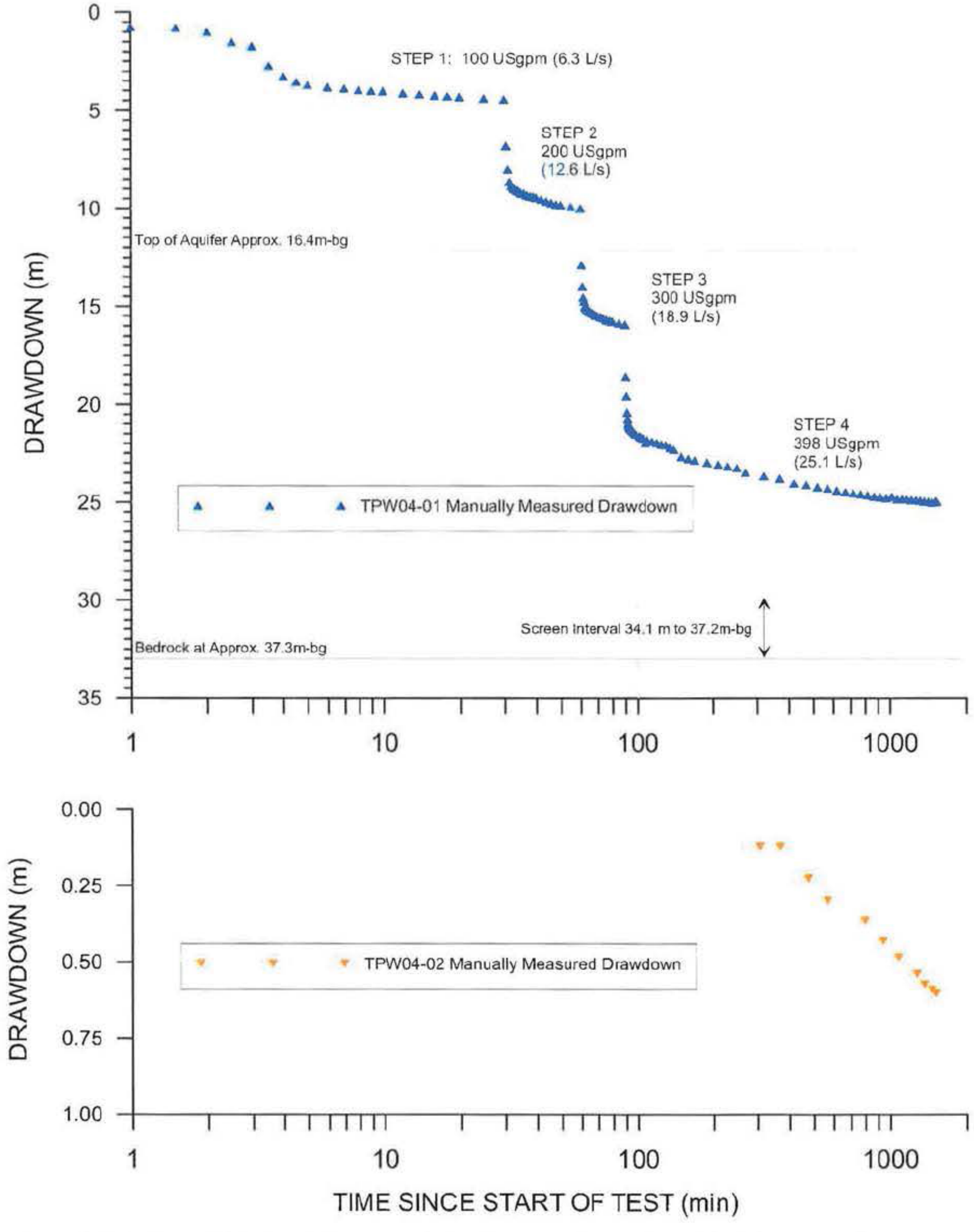
Date 2004	Clock Time (h:m:s)	Elapsed Time (t) (mins)	Water Levels Depth btoc (ft)	Water Levels Depth btoc (m)	Water Levels Drawdn (m)	Pumping Rate (USgpm)	Pumping Rate (L/s)	Comments
12-Aug	21:28	53	75.02	22.86	5.93	407	25.7	
12-Aug	21:35	60	75.18	22.91	5.98	407	25.7	
12-Aug	21:45	70	75.55	23.03	6.10	407	25.7	
12-Aug	21:55	80	75.72	23.08	6.15	407	25.7	
12-Aug	22:05	90	75.95	23.15	6.22	407	25.7	
12-Aug	22:15	100	76.11	23.20	6.27	407	25.7	
12-Aug	22:25	110	76.34	23.27	6.34	407	25.7	
12-Aug	22:35	120	76.51	23.32	6.39	407	25.7	
12-Aug	22:45	130	76.61	23.35	6.42	407	25.7	
12-Aug	22:55	140	76.85	23.42	6.49	407	25.7	
12-Aug	23:15	160	77.13	23.51	6.58	407	25.7	
12-Aug	23:35	180	77.40	23.59	6.66	407	25.7	
12-Aug	23:55	200	77.65	23.67	6.74	407	25.7	
13-Aug	0:15	220	77.90	23.74	6.81	407	25.7	
13-Aug	0:35	240	78.11	23.81	6.88	407	25.7	
13-Aug	1:25	290	78.86	24.04	7.11	407	25.7	
13-Aug	2:15	340	79.35	24.18	7.25	407	25.7	
13-Aug	3:05	390	79.96	24.37	7.44	407	25.7	
13-Aug	3:55	440	80.51	24.54	7.61	407	25.7	
13-Aug	4:45	490	80.97	24.68	7.75	407	25.7	
13-Aug	5:35	540	81.53	24.85	7.92	407	25.7	
13-Aug	6:25	590	81.97	24.98	8.05	407	25.7	
13-Aug	7:15	640	82.33	25.09	8.16	407	25.7	
13-Aug	8:05	690	82.69	25.20	8.27	407	25.7	
13-Aug	8:55	740	83.03	25.31	8.38	407	25.7	
13-Aug	9:45	790	83.33	25.40	8.47	407	25.7	
13-Aug	10:35	840	83.95	25.59	8.66	407	25.7	
13-Aug	11:25	890	84.20	25.66	8.73	407	25.7	
13-Aug	12:15	940	84.55	25.77	8.84	407	25.7	
13-Aug	13:05	990	84.79	25.84	8.91	407	25.7	
13-Aug	13:55	1040	85.05	25.92	8.99	407	25.7	
13-Aug	14:45	1090	85.29	26.00	9.07	407	25.7	
13-Aug	15:35	1140	85.85	26.17	9.24	407	25.7	
13-Aug	16:25	1190	85.83	26.16	9.23	407	25.7	
13-Aug	17:15	1240	86.00	26.21	9.28	407	25.7	
13-Aug	18:05	1290	86.25	26.29	9.36	407	25.7	
13-Aug	18:55	1340	86.65	26.41	9.48	407	25.7	
13-Aug	19:45	1390	86.93	26.49	9.56	407	25.7	
13-Aug	20:35	1440	87.08	26.54	9.61	407	25.7	

Table VI-3
Summary of Variable-Rate Aquifer Pumping Data for Well TW04-02 (Pumped Well)

Date 2004	Clock Time (h:m:s)	Elapsed Time (t) (mins)	Water Levels			Pumping Rate		Comments
			Depth btoc		Drawdn			
			(ft)	(m)	(m)	(USgpm)	(L/s)	
13-Aug	20:35	0	87.08	26.54	9.61	-	-	Start Recovery
13-Aug	20:35	0.5	74.70	22.77	5.84	-	-	
13-Aug	20:36	1	74.50	22.71	5.78	-	-	
13-Aug	20:36	1.5	74.36	22.66	5.73	-	-	
13-Aug	20:37	2	74.29	22.64	5.71	-	-	
13-Aug	20:37	2.5	74.21	22.62	5.69	-	-	
13-Aug	20:38	3	74.14	22.60	5.67	-	-	
13-Aug	20:38	3.5	74.07	22.58	5.65	-	-	
13-Aug	20:39	4	74.01	22.56	5.63	-	-	
13-Aug	20:39	4.5	73.96	22.54	5.61	-	-	
13-Aug	20:40	5	73.91	22.53	5.60	-	-	
13-Aug	20:41	6	73.82	22.50	5.57	-	-	
13-Aug	20:42	7	73.72	22.47	5.54	-	-	
13-Aug	20:43	8	73.65	22.45	5.52	-	-	
13-Aug	20:44	9	73.57	22.42	5.49	-	-	
13-Aug	20:45	10	73.50	22.40	5.47	-	-	
13-Aug	20:47	12	73.36	22.36	5.43	-	-	
13-Aug	20:49	14	73.21	22.31	5.38	-	-	
13-Aug	20:51	16	73.10	22.28	5.35	-	-	
13-Aug	20:53	18	72.99	22.25	5.32	-	-	
13-Aug	20:55	20	72.88	22.21	5.28	-	-	
13-Aug	21:00	25	72.61	22.13	5.20	-	-	
13-Aug	21:05	30	72.36	22.05	5.12	-	-	
13-Aug	21:10	35	72.17	22.00	5.07	-	-	
13-Aug	21:15	40	71.97	21.94	5.01	-	-	
13-Aug	21:20	45	71.79	21.88	4.95	-	-	
13-Aug	21:25	50	71.62	21.83	4.90	-	-	
13-Aug	21:35	60	71.30	21.73	4.80	-	-	
13-Aug	21:45	70	71.00	21.64	4.71	-	-	
13-Aug	21:55	80	70.73	21.56	4.63	-	-	
13-Aug	22:05	90	70.45	21.47	4.54	-	-	
13-Aug	22:15	100	70.21	21.40	4.47	-	-	
13-Aug	22:25	110	69.97	21.33	4.40	-	-	
13-Aug	22:35	120	69.73	21.25	4.32	-	-	
14-Aug	8:22	707	63.62	19.39	2.46	-	-	
14-Aug	10:06	811	62.98	19.20	2.27	-	-	87% recovery a 811 minutes

O:Active\2004\1413\04-1413-027\PumpingTests\Step_Constant_TW1.grf

VARIABLE-RATE AQUIFER PUMPING TEST
WELL TPW04-01
August 11-12, 2004



NOTE - 1) Test Well TW04-01 casing stick-up approx. 0.21 m. Pre-test static water level 4.42 m below top of casing.
2) Test Well TW04-02 casing stick-up approx. 0.60 m. Pre-test static water level 16.42 m below top of casing.

Project No. 04-1413-027
Drawn MDM
Reviewed
Date Aug 2004

Golder Associates

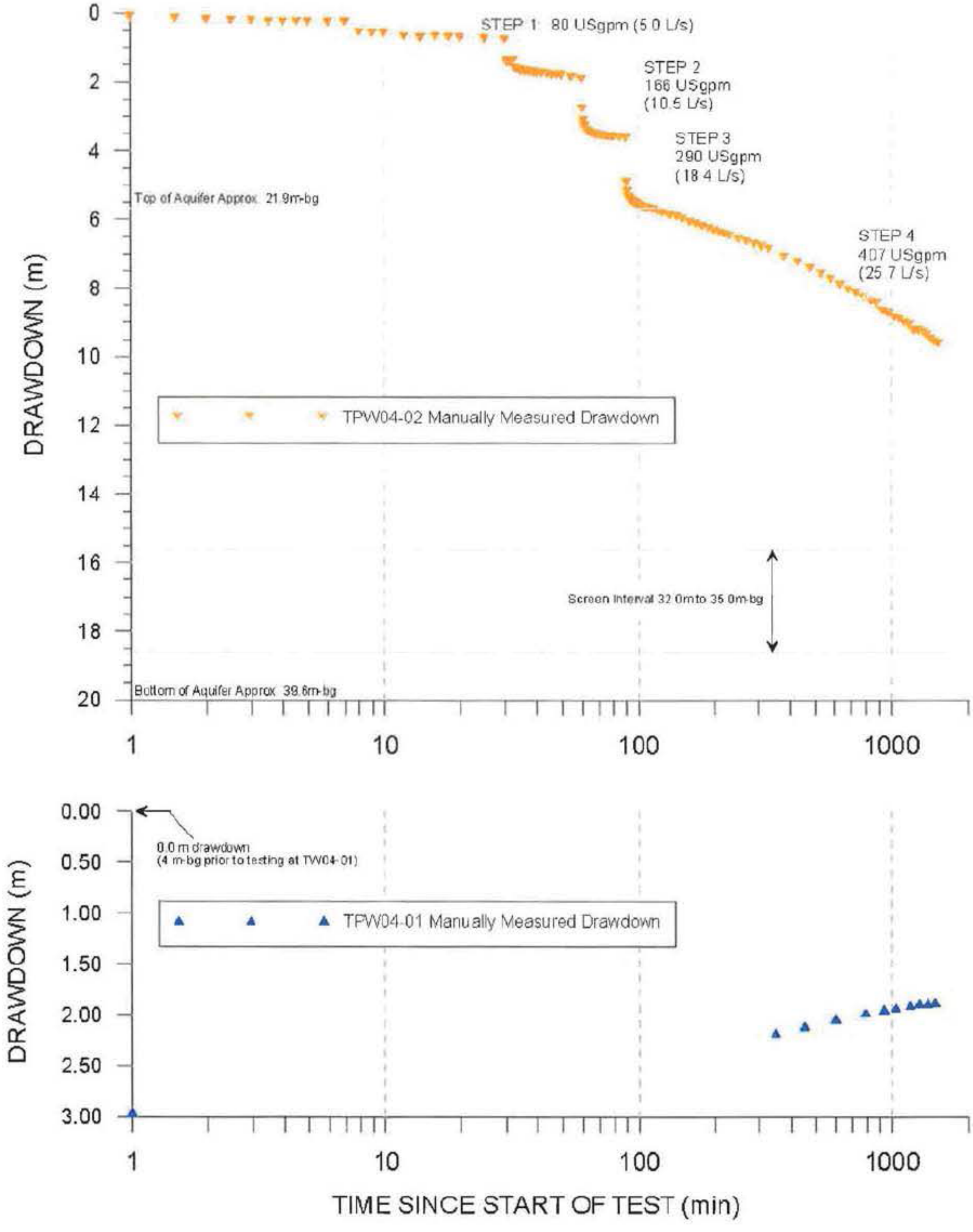
HYDROGEOLOGICAL INVESTIGATION
IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE, LIKELY, B.C.

AQUIFER PUMPING TEST AT TW04-01

Fig. VI-1

O:Active\2004\1413\04-1413-027\PumpingTests\Step_Constant_TW2b.grf

VARIABLE-RATE AQUIFER PUMPING TEST
WELL TW04-02
August 12-13, 2004



NOTE - 1) Test Well TW04-02 casing stick-up approx. 0.60 m. Pre-test static water level 16.93 m below top of casing.
2) Test Well TW04-01 casing stick-up approx. 0.21 m. Pre-test static water level approx. 7.4 m below top of casing.

Project No. 04-1413-027
Drawn MDM
Reviewed
Date Aug 2004

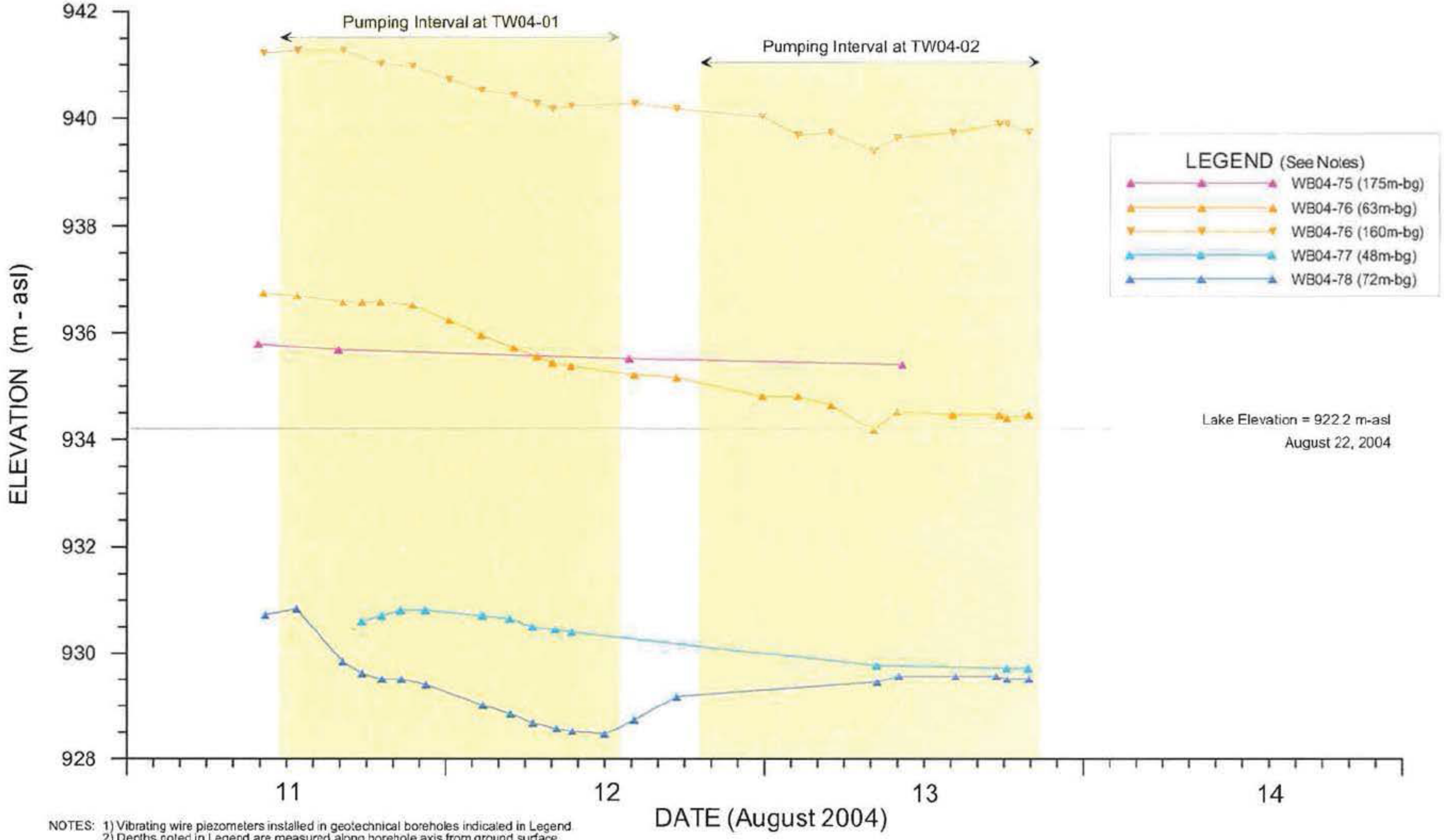
HYDROGEOLOGICAL INVESTIGATION
IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE, LIKELY, B.C.

AQUIFER PUMPING TEST AT TW04-02

Fig. VI-2

WATER TABLE ELEVATIONS - VW PIEZOMETERS LOCATED IN BEDROCK

August 11 TO 14, 2004



NOTES: 1) Vibrating wire piezometers installed in geotechnical boreholes indicated in Legend.
2) Depths noted in Legend are measured along borehole axis from ground surface.
3) Borehole locations shown on Figure 2.

Project No. 04-1413-027
Drawn MDM
Reviewed
Date

Golder Associates

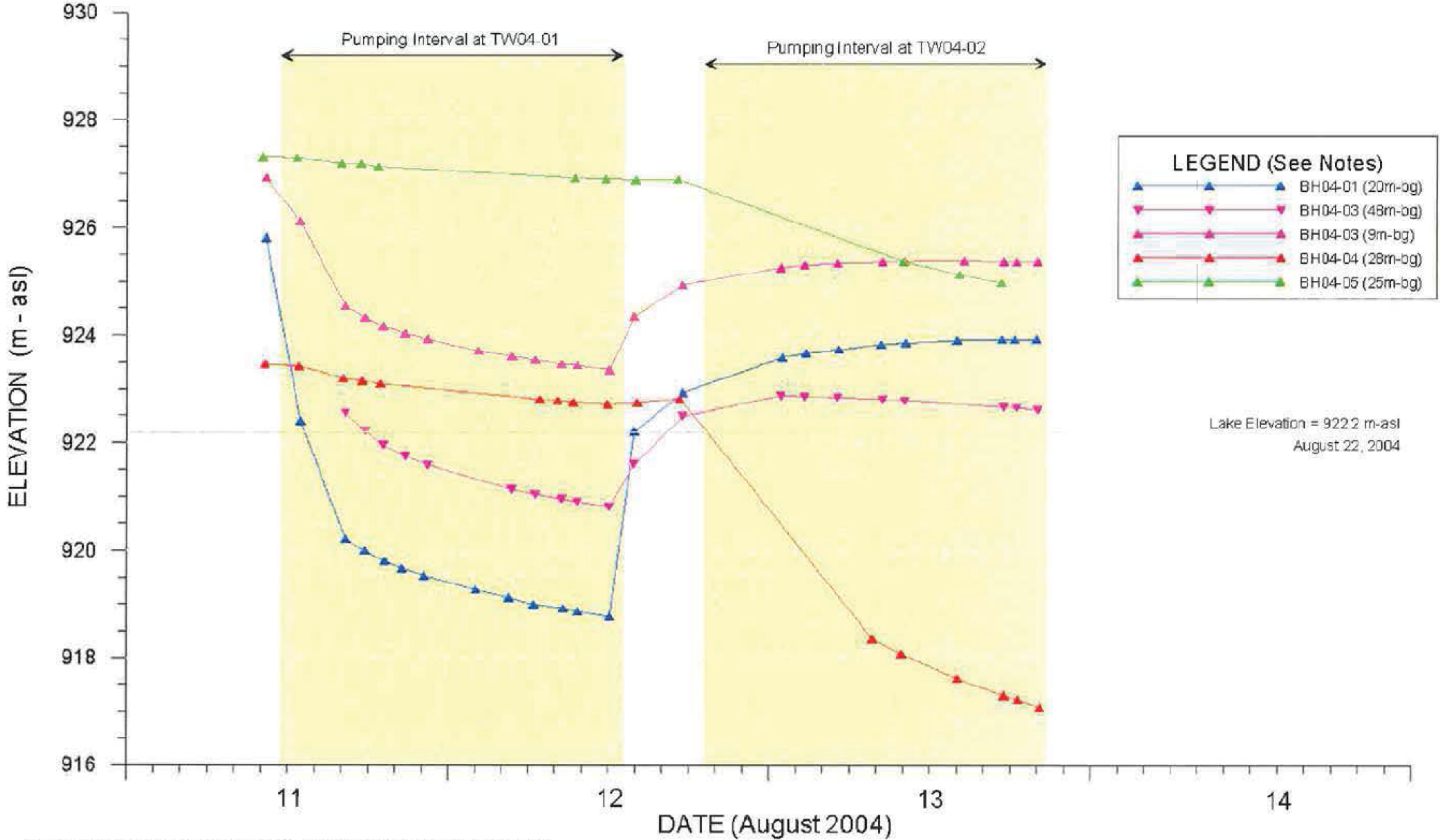
HYDROGEOLOGICAL INVESTIGATION
IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE, LIKELY, B.C.
AQUIFER PUMPING TESTS AT TW04-01 AND TW04-02

Fig. VI-3

O:\Active\2004\1413\04-1413-027\VW History\Sediment.grf

WATER TABLE ELEVATIONS - VW PIEZOMETERS LOCATED IN OVERBURDEN

August 11 TO 14, 2004



NOTES: 1) Vibrating wire piezometers installed in geotechnical boreholes indicated in Legend.
2) Depths noted in Legend are measured vertically from ground surface at borehole site.
3) Borehole locations shown on Figure 2

Project No. 04-1413-027
Drawn MDM
Reviewed
Date

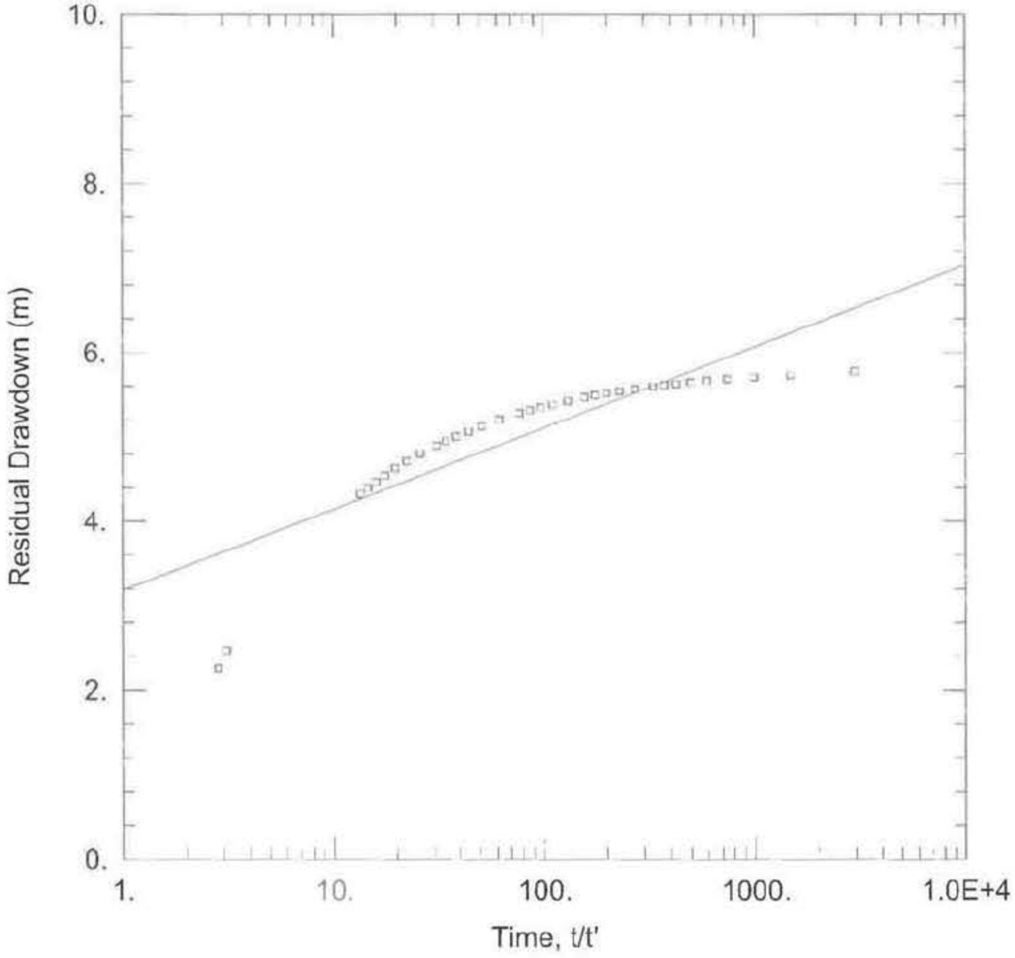
HYDROGEOLOGICAL INVESTIGATION
IMPERIAL METALS CORPORATION
MOUNT POLLEY MINE, LIKELY, B.C.

AQUIFER PUMPING TESTS AT TW04-01 AND TW04-02

Fig. VI-4

APPENDIX VII

PUMPING TEST ANALYSIS



WELL TEST ANALYSIS

Data Set: O:\...\Theis_TW2_recovery.aqt
Date: 10/19/04 Time: 09:49:31

AQUIFER DATA

Saturated Thickness: 18. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW04-02	592920.76	5825298.81

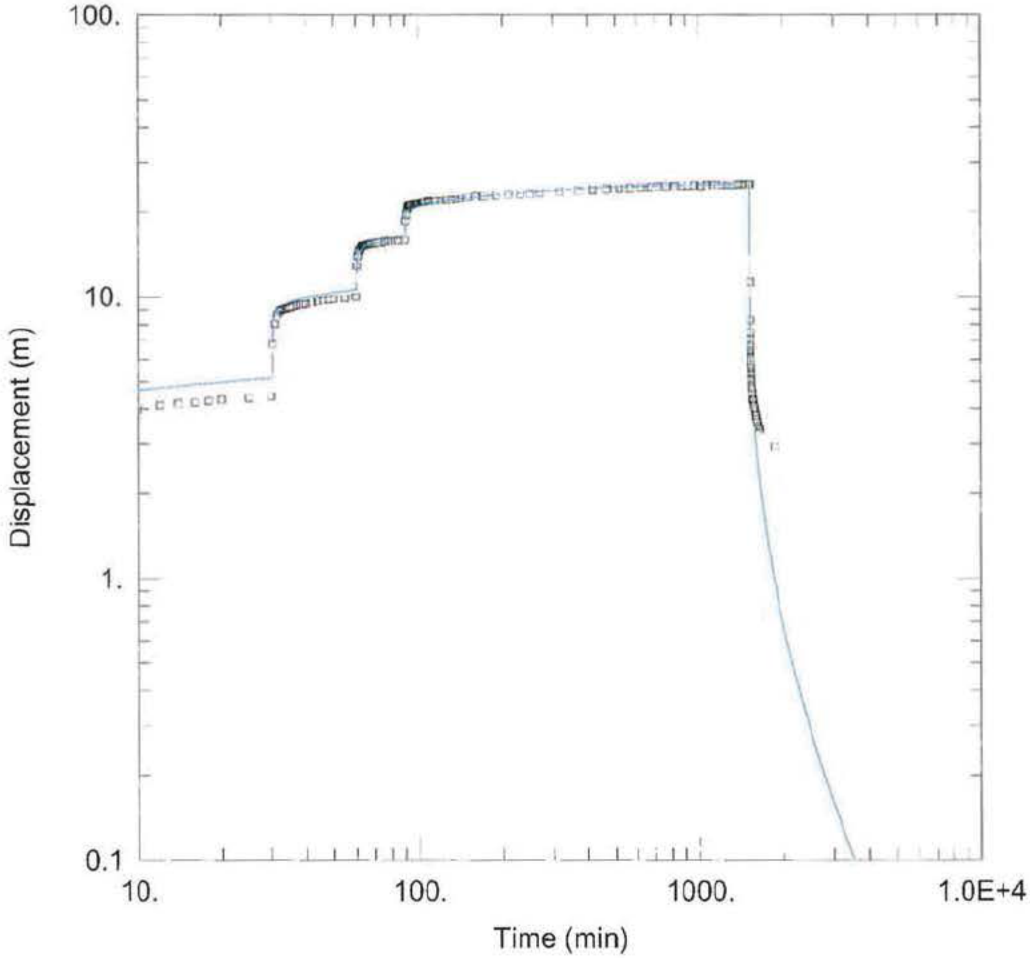
Observation Wells

Well Name	X (m)	Y (m)
▫ TW04-02	592920.76	5825298.91

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 0.004894 m^2/sec S/S' = 0.0004957



WELL TEST ANALYSIS

Data Set: O:\...\Theis_TW1_with_CH_boundary.aqt
Date: 10/19/04 Time: 09:41:48

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW04-01	0	0
CH bc @ 30m	200	0

Observation Wells

Well Name	X (m)	Y (m)
▫ TW04-01	0.1	0

SOLUTION

Aquifer Model: Confined

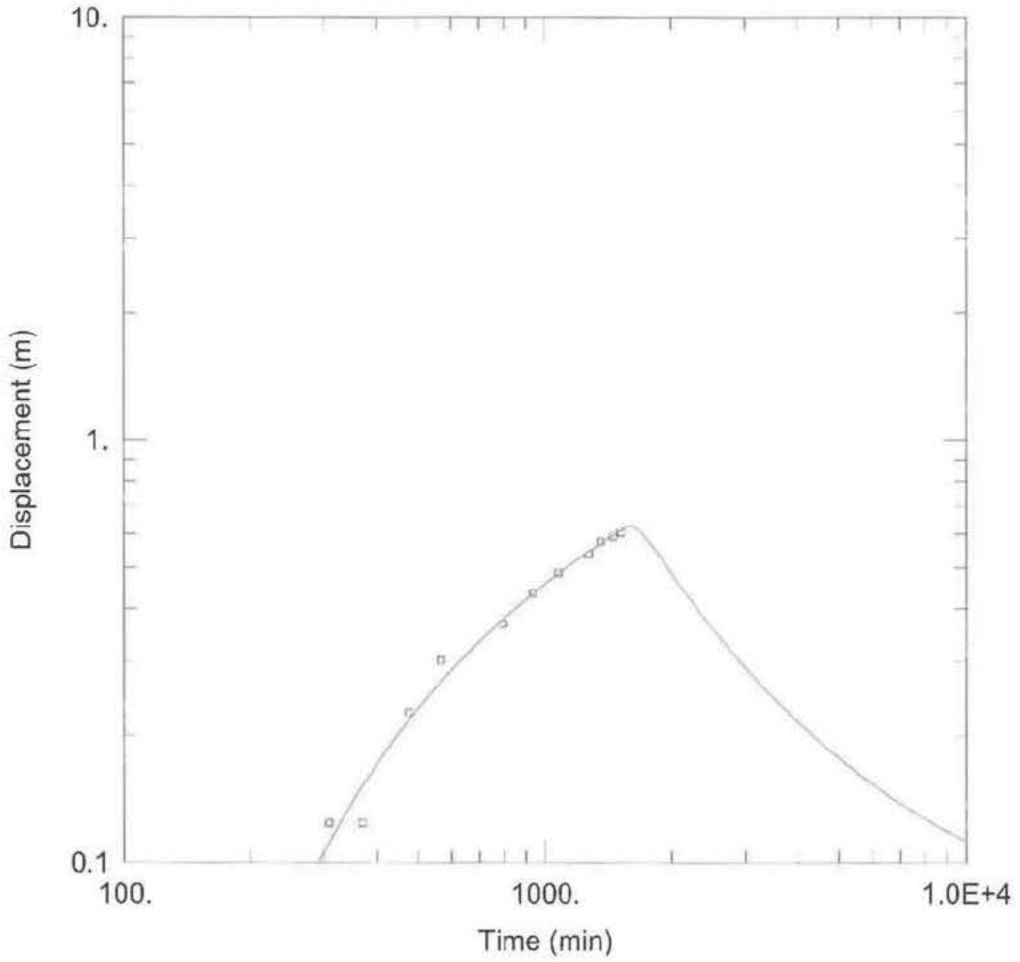
Solution Method: Theis

T = 0.001194 m^2/sec

S = 0.002206

Kz/Kr = 1.

b = 21. m



WELL TEST ANALYSIS

Data Set: O:\...\Theis_TW1_TW2_with_CH_boundary.aqt
Date: 10/19/04 Time: 09:45:33

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW04-01	0	0
CH bc @100 m	200	0

Observation Wells

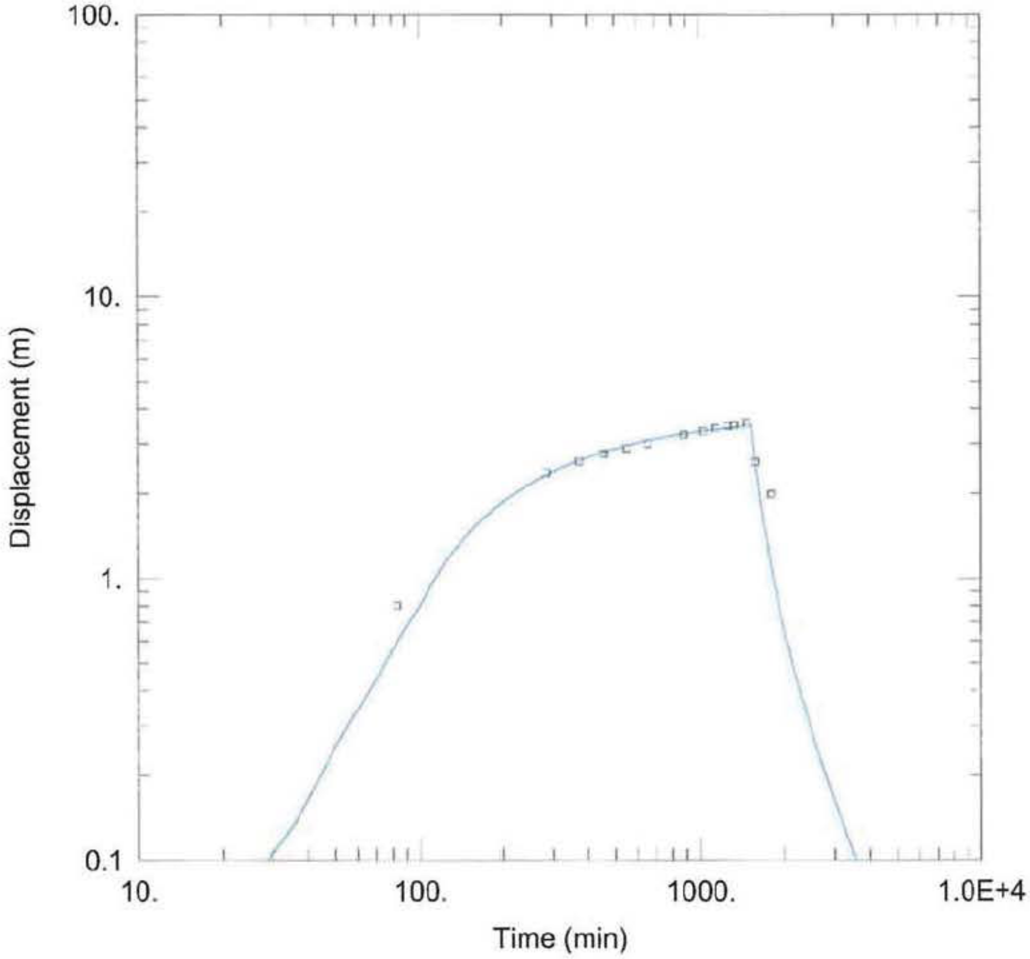
Well Name	X (m)	Y (m)
▫ TW04-02	0	254

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 0.0047 m^2/sec
Kz/Kr = 1.

S = 0.004172
b = 21. m



WELL TEST ANALYSIS

Data Set: O:\...\Theis_TW1_VW47_CH_boundary.aqt
Date: 10/19/04 Time: 09:47:08

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW04-01	0	0
CH bc @200m	400	0

Observation Wells

Well Name	X (m)	Y (m)
▫ VW8-47 (BH3)	0	94

SOLUTION

Aquifer Model: Confined

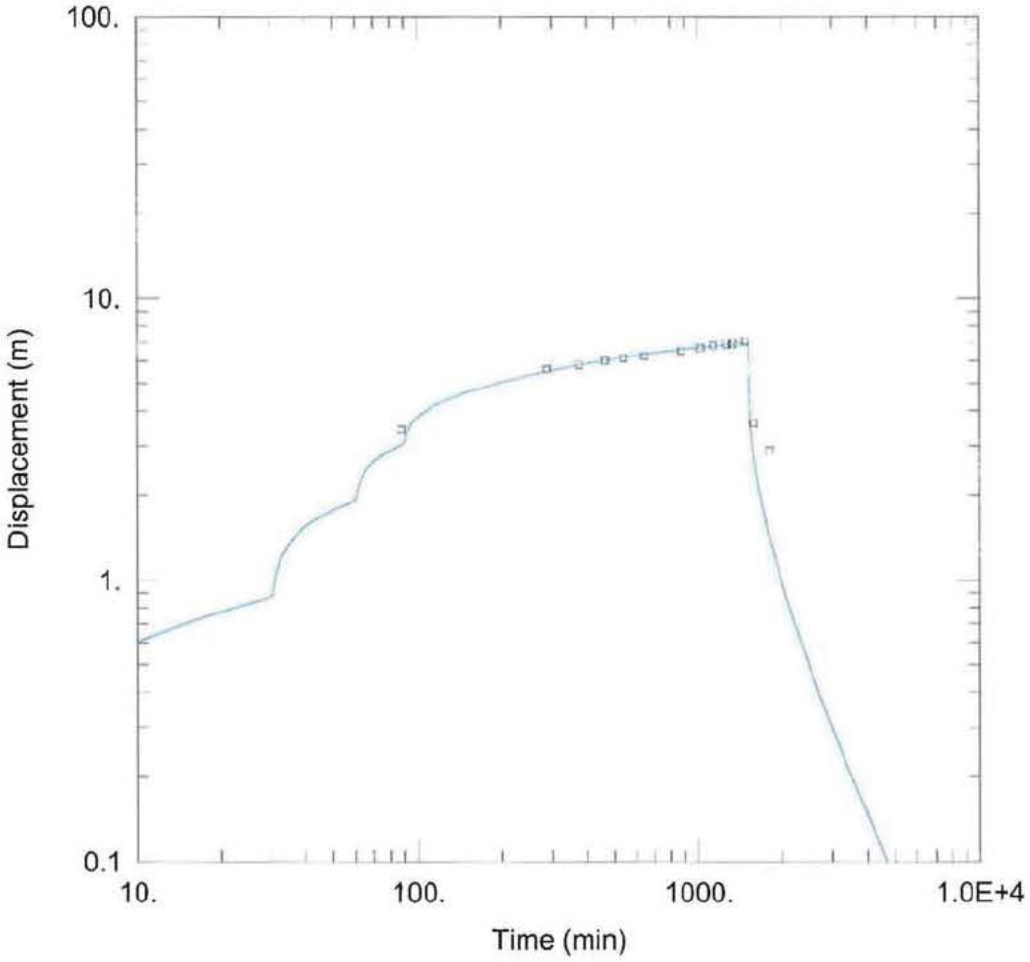
Solution Method: Theis

T = 0.001541 m^2/sec

S = 0.0009626

Kz/Kr = 1.

b = 21. m



WELL TEST ANALYSIS

Data Set: O:\...\Theis_TW1_VW49_with_CH_boundary.aqt
Date: 10/19/04 Time: 09:47:56

WELL DATA

Pumping Wells		
Well Name	X (m)	Y (m)
TW04-01	0	0
CH bc @ 100m	200	0

Observation Wells		
Well Name	X (m)	Y (m)
□ VW8-49 (BH1)	0	4

SOLUTION

Aquifer Model: Confined

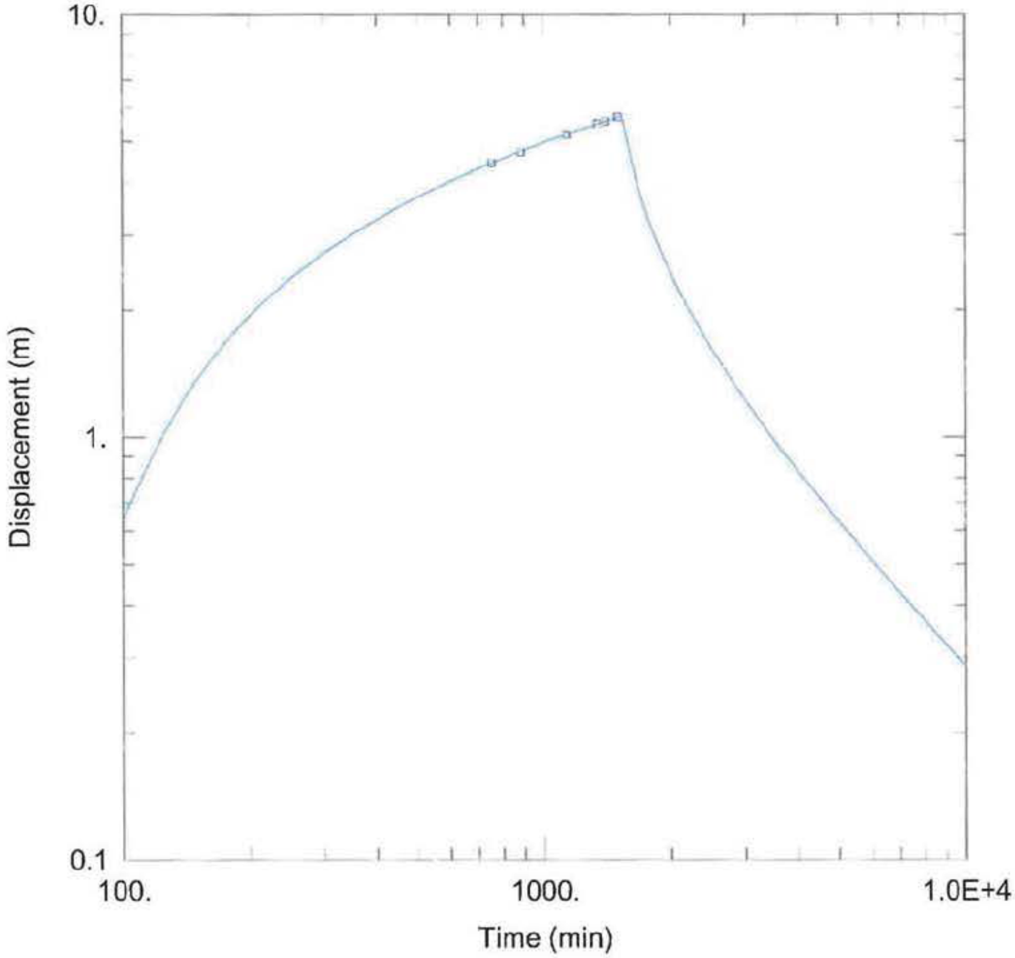
Solution Method: Theis

T = 0.002046 m^2/sec

S = 0.0148

Kz/Kr = 1.

b = 21. m



WELL TEST ANALYSIS

Data Set: O:\...\Theis_TW2_VW51.aqt
Date: 10/19/04 Time: 09:50:41

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW04-02	592920.76	5825298.81

Observation Wells

Well Name	X (m)	Y (m)
▫ VW8-51 (BH4)	592951.68	5825496.19

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 0.001134 m^2/sec

S = 0.0002404

Kz/Kr = 1.

b = 18. m

Hazeltine Creek Habitat Characterization

Report Prepared for:

Mount Polley Mining Corporation
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Likely, British Columbia
V0L 1N0

Report Prepared by:

Minnow Environmental Inc.
6800 Kitimat Road, Unit 13
Mississauga, Ontario
L5N 5M1

and

1627 Fort Street, Suite 305
Victoria, British Columbia
V8R 3J2

Hazeltine Creek Habitat Characterization

Report Prepared for:

Mount Polley Mining Corporation

Report Prepared by:

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April 2007

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1.0 INTRODUCTION

1.1 Background

The Mount Polley Mining Corporation, a division of the Imperial Metals Corporation, owns the Mount Polley copper-gold mine located 56 kilometers north-east of Williams Lake, BC (Figure 1.1). The mine, which historically operated from August 1997 to September 2001, was officially re-opened in March 2005 as a result of improved metal prices and the discovery of significant new ore reserves at the site. Mining is currently active at the Bell and Wight open pits, with two additional open pits (Springer Pit and Southeast Pit) identified as targets for future development (Figure 1.1). The Mount Polley Mine site also includes a crusher and mill (concentrator), a Tailings Storage Facility (TSF), a settling pond, a seepage pond, access roads, a surface water collection system and a former open pit mine (the Cariboo Pit). The projected mine life is currently about six and three-quarter years.

While operating, Mount Polley mill tailings and site water have been discharged into the environmentally-secure TSF, with supernatant from the TSF recycled for re-use in the milling process. In addition, site water was allowed to accumulate in the TSF during mine closure from 2001 to 2005. In accordance with the updated mine plan and water balance, mine water stored in the TSF will be treated and discharged to an appropriate receiving watercourse.

One of the options currently being considered for treatment of Mount Polley Mine effluent includes directing mine wastewater to a constructed polishing pond with subsequent discharge of treated effluent into Hazeltine Creek immediately east of the TSF (Figure 1.1). In anticipation of a Hazeltine Creek effluent discharge compliance point, priority mine-related parameters and site-specific water quality objectives (SSWQO) are currently being derived using actual chemical and biological data from the proposed receiving waters (Minnow 2006). Derived SSWQO will represent parameter levels considered protective of receiving water biota, and are intended to be used to develop effluent discharge limits for internal management and compliance purposes.

The SSWQO development process is critical to understanding the potential for adverse water quality effects to aquatic organisms that may result with discharge of Mount Polley Mine effluent into Hazeltine Creek. To further understand the biological implications associated with discharging treated effluent into Hazeltine Creek, the Mount Polley Mine also wishes to evaluate the potential for any adverse physical impacts related to increased stream flow. Increased flow can physically affect stream channel stability by

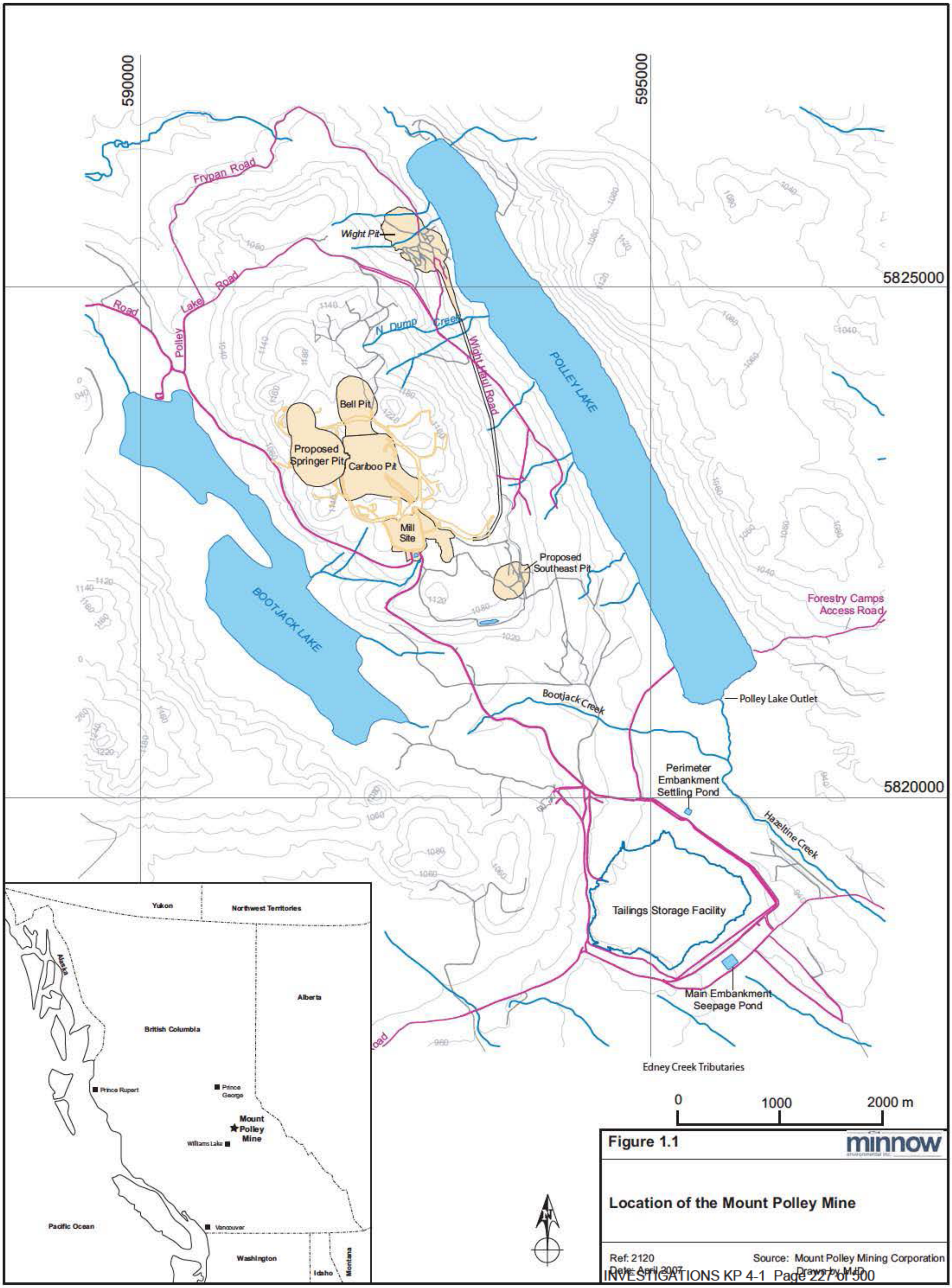


Figure 1.1

Location of the Mount Polley Mine

Ref: 2120
Date: April 2007
Source: Mount Polley Mining Corporation
Drawn by: MHD

causing stream bed and/or bank erosion, which in turn can severely limit aquatic life by altering available spawning and rearing habitat, in-stream cover, food chains and other structural and functional components of the system. Such influences may constitute a Harmful Alteration, Disruption or Destruction (HADD) of fish habitat as outlined under Section 35 of the Canadian *Fisheries Act* (DFO 1998). Any adverse effects to fish habitat is of particular concern in lower Hazeltine Creek, which is used by Quesnel Lake kokanee salmon (*Oncorhynchus nerka*) as spawning habitat.

Minnow Environmental Inc. (Minnow) was retained by the Mount Polley Mine to characterize the baseline habitat features of Hazeltine Creek and to consider the implications of increased flow regimes to channel stability and fish habitat. The information provided will be used to help determine optimal effluent management practices that minimize the potential for eliciting any adverse physical impacts to Hazeltine Creek.

1.2 Objectives

The objectives of the 2006 Hazeltine Creek Habitat Characterization were:

- to document baseline (i.e., pre-effluent discharge) physical habitat characteristics of Hazeltine Creek and to provide views on the potential for adverse effects to channel stability associated with increased flow related to effluent discharge; and,
- to identify and document fish habitat features in Hazeltine Creek with special focus on salmonid spawning habitat in lower reaches and to provide views on potential effects to fish habitat associated with effluent discharge.

1.3 Report Organization

This report is organized as follows. The methods utilized for characterization of physical and fish habitat features of Hazeltine Creek are presented in Section 2.0. Section 3.0 presents the results of the physical habitat characterization and provides views on the potential of mine-related impacts to channel stability associated with effluent discharge. Fish habitat information for Hazeltine Creek and views on the implications of increased discharge to fish habitat are presented in Section 4.0. A summary of the study findings and recommendations for future studies are provided in Section 5.0. Finally, references cited throughout this report are listed in Section 6.0.

2.0 METHODS

2.1 Characterization of Physical Habitat Features

The characterization of physical habitat conditions in Hazeltine Creek was implemented from the 22nd to 26th of October, 2006. Initially, the creek was spatially separated into representative reaches beginning at a location approximately 1.75 km downstream of Polley Lake and extending to the mouth of Hazeltine Creek at Quesnel Lake (i.e., the anticipated effluent-exposure area). By walking the stream bank, all of the lower approximately 7.3 km of Hazeltine Creek was visually assessed. Stream reaches were delineated according to dominant physical habitat characteristics including stream gradient and/or stream geomorphology. Within each reach, transects were established at areas with habitat considered characteristic of each reach. All reach boundaries and transect locations were marked using a hand-held Global Positioning System (GPS) unit according to 1983 North American Datum (NAD83). The number of transects evaluated per reach depended on reach length, with one or two transects established at short reaches (i.e., less than 300 m long) and three transects established at all others.

At each transect, stream channel dimensions (slope, width, depth) were measured and features associated with stream morphology, channel bed and bank material (substrate type and relative size), bank stability and angle, riparian vegetation (vegetation types, approximate root depth, overhead shading) and in-stream cover were quantified or documented based on the relative proportion each contributed in total stream surface area (Table 2.1). General habitat features, including locations of any groundwater seeps, tributaries etc., were also documented for each reach. Finally, several photographs were taken along each reach to further support habitat descriptions. Descriptions of physical features assessed as part of the habitat evaluation are provided in Table 2.1.

The potential for adverse effects to Hazeltine Creek channel stability (and relatedly, fish habitat) associated with Mount Polley effluent discharge was assessed by examination of bank erosion predictions in concert with the natural hydrology of the system. Based on higher average flow conditions in Hazeltine Creek as a result of mine effluent discharge, a greater potential for bank erosion likely represents the key mine-related influence to physical channel stability (e.g., see Rosgen 2001; Simon 1989). Accordingly, a Bank Erosion Hazard Index (BEHI) was used to provide an estimate of bank erodibility (Rosgen 2001). The BEHI procedure integrates seven bank integrity parameters into a numerical reach score that can be used to rank streambank erosion

Table 2.1: Summary of Physical Characteristics Examined as part of the Hazeltine Creek Habitat Characterization, October 2006

Physical Feature Evaluated			Feature Description	Measurement Method
Channel Hydrology	Width	Wetted (m)	Surface water distance across a stream measured from bank to bank, perpendicular to the direction of flow.	Tape measure
		Bankfull (m)	Channel distance across a stream measured from bank to bank, perpendicular to the direction of flow.	Tape measure
		Floodplain (m)	Distance across land immediately adjoining a stream which is inundated when the discharge exceeds the conveyance of the normal channel.	Rangefinder
	Depth	Mean (m)	Average vertical difference from the surface to bottom measured at a minimum of five points	Meter stick
		Bankfull (m)	Average vertical difference from bankfull height to the channel bottom measured at a minimum of five points	Meter stick
	Slope	Channel (°)	Longitudinal gradient of the stream, generally measured over a distance of approximately 25 m	Clinometer
		Left Bank (°)	Angle of the left bank (when looking upstream) at approximately bankfull height	Visual estimate
		Right Bank (°)	Angle of the right bank (when looking upstream) at approximately bankfull height	Visual estimate
	General Morphology	% Pool	Proportion of stream surface area covered by relatively stagnant and/or deep water	Visual estimate
		% Riffle	Proportion of stream surface area covered by fast-moving turbulent water	Visual estimate
		% Run	Proportion of stream surface area covered by relatively slow-moving water (no turbulence)	Visual estimate
Channel Bed and Bank Features	In-Stream Substrate & Bank Material	% Bedrock	Proportion of consolidated (solid) rock that generally underlies unconsolidated material	Visual estimate
		% Boulder	Proportion of unconsolidated inorganic material > 256 mm in diameter	Visual estimate
		% Cobble	Proportion of unconsolidated inorganic material 16 mm to 256 mm in diameter	Visual estimate
		% Gravel	Proportion of unconsolidated inorganic material 2.0 mm to 16 mm in diameter	Visual estimate
		% Sand	Proportion of unconsolidated inorganic material 0.0625 mm to 4.0 mm in diameter	Visual estimate
		% Silt & Finer	Proportion of unconsolidated inorganic material less than 0.0625 mm in diameter	Visual estimate
	Bank Condition	Unstable	Longitudinal distance of banks with high degree of visible erosion (e.g., slumping, undercutting)	Visual estimate
		Moderate	Longitudinal distance of banks with moderate degree of visible erosion (e.g., slumping, undercutting)	Visual estimate
		Stable	Longitudinal distance of banks with limited erosion (e.g., slumping, undercutting)	Visual estimate
Riparian Features	Riparian Vegetation	Description	Types of vegetation living on or adjacent to watercourse banks, listed in order of dominance	Not Applicable
	Overhead Canopy	% Dense	Stream shading > 70% of stream surface area	Visual estimate
		% Partially Open	Stream shading 10% to 70% of stream surface area	Visual estimate
		% Open	Stream shading < 10% of stream surface area	Visual estimate
	Root Density	% Root Penetration	Proportion of bank height with plant root materials	Visual estimate
	Bank Surface Protection	% Bank Cover	Proportion of bank height protected from flow as a result of plant roots, large woody debris or other materials	Visual estimate
In-stream Fish Habitat Features	In-stream Cover	% Deep Pool	Proportion of stream surface area covered by relatively deep water suitable for fish protection	Visual estimate
		% Boulder	Proportion of stream surface area occupied by boulder material suitable for fish cover	Visual estimate
		% Logs/Snags	Proportion of stream surface area occupied by large woody material suitable for fish cover	Visual estimate
		% Overhanging Veg.	Proportion of stream surface area covered by terrestrial vegetation suitable for fish cover	Visual estimate
		% Macrophytes	Proportion of stream surface area occupied by instream vegetation suitable for fish cover	Visual estimate
	In-stream Barriers	Description	Any obstacle found in a stream channel that prevents upstream migration of fish (e.g., dams, cascades, etc.)	Not Applicable

potential on a scale ranging from 0 (very low) to 50 (extreme; Table 2.2). The BEHI is calculated in relation to bankfull stage, which is defined as the incipient discharge that entirely fills a channel to the top of its bank(s) at a point just prior to overflow onto a floodplain. Bankfull discharge is generally associated with a short-term maximum flow that has an average recurrence interval of 1.5 years as determined using a flood frequency analysis (Dunne and Leopold 1978).

To understand the implications of and to put perspective on how increased flow resulting from mine effluent discharge could physically impact Hazeltine Creek, examination of the natural stream hydrology was required. Of particular relevance to the mine in terms of effluent discharge impacts was to determine a) what flow rate corresponds to 'peak' levels and at what time of the year are natural flows likely to be at these levels, and b) at what levels and at what corresponding period of the year are natural flows likely to cause only minimal bank erosion.

Seasonal high and low flow periods were identified from historical hydrological data (1995, 1997 to 2006) collected from a continuous analog stage recorder located on Hazeltine Creek (Station W7). Anticipated flow at bankfull and bottom-bank stages was determined by extrapolating gauging station depth-to-flow relationships at Station W7 to those at a field survey location approximately 20 m downstream of Station W7. It should be noted that this method only provides a rough approximation because cross-sectional channel geometry at the downstream transect did not exactly match the dimensions of the Station W7 weir.

Hazeltine Creek discharge during this survey was also calculated based on the area-velocity method using manual depth and water velocity measurement data. At a minimum of 10 points along a wetted-channel transect, water velocity measures were collected using a Marsh-McBirney Flo-Mate Model 2000 portable velocity meter (Marsh-McBirney Ltd., Frederick, MD) whereas depth was measured with a meter stick. Discharge was measured using this method near Station W7 as well as at a single location at all downstream reaches to provide spatial perspective on flow.

2.2 Fish Habitat Characterization

Important fish habitat features were identified and characterized in all Hazeltine Creek reaches during the October survey. This characterization included quantification of the relative proportion of functional in-stream cover (type and relative amount by wetted channel surface area) at transect locations in each reach. In addition, any barriers to upstream fish migration were identified and documented. As part of the fish habitat

Table 2.2: Bank Erosion Hazard Index (BEHI) Rating Guide

Hazard Rating		Bank Height to Bankfull Height	Root Depth to Bank Height	Root Density (%)	Bank Angle (degrees)	Surface Protection (%)	Bank Material	Stratification	Index Totals
Very Low	Value	1.0 - 1.1	1.0 - 0.9	100 - 80	0 - 20	100 - 80	Bedrock/Boulder - no adjustment Cobble - subtract 10 points unless 50% sand/gravel, then no adjustment Gravel - add 5 - 10 points Sand - add 10 points Silt/Clay - no adjustment	Add 5 - 10 points depending on position of unstable layers	5.0 - 9.5
	Index	1.0 - 1.9	1.0 - 1.9	1.0 - 1.9	1.0 - 1.9	1.0 - 1.9			
Low	Value	1.11 - 1.19	0.89 - 0.5	79 - 55	21 - 60	79 - 55			10 - 19.5
	Index	2.0 - 3.9	2.0 - 3.9	2.0 - 3.9	2.0 - 3.9	2.0 - 3.9			
Moderate	Value	1.2 - 1.5	0.49 - 0.3	54 - 30	61 - 80	54 - 30			20 - 29.5
	Index	4.0 - 5.9	4.0 - 5.9	4.0 - 5.9	4.0 - 5.9	4.0 - 5.9			
High	Value	1.6 - 2.0	0.29 - 0.15	29 - 15	81 - 90	29 - 15			30 - 39.5
	Index	6.0 - 7.9	6.0 - 7.9	6.0 - 7.9	6.0 - 7.9	6.0 - 7.9			
Very High	Value	2.1 - 2.8	0.14 - 0.05	14 - 5.0	91 - 119	14 - 10			40 - 45
	Index	8.0 - 9.0	8.0 - 9.0	8.0 - 9.0	8.0 - 9.0	8.0 - 9.0			
Extreme	Value	> 2.8	< 0.05	< 5	> 119	< 10			46 - 50
	Index	10	10	10	10	10			

characterization, the implication of increased flow to fish habitat was considered while conducting the field survey. Any key fish habitat features were photographically documented during the field survey.

An evaluation of salmonid spawning habitat in lower Hazeltine Creek was conducted on the 27th of October, 2006. Key habitat features important to salmonid spawning, including substrate composition (type and relative size), water depth, stream morphology, in-stream barriers and cover structure were recorded and mapped to as far as 525 m upstream of Quesnel Lake. Distances were measured relative to the mouth of Hazeltine Creek at Quesnel Lake using a handheld GPS unit. Several photographs were also taken to support spawning habitat observations. A visual survey of adult salmon (spawning adults and/or carcasses) and/or evidence of spawning (e.g., constructed redds) was also conducted. The observed habitat features were then evaluated relative to known spawning habitat requirements to determine the relative importance of lower Hazeltine Creek for (Quesnel Lake) salmon populations.

3.0 HAZELTINE CREEK HABITAT CHARACTERIZATION

3.1 Reach Descriptions

Hazeltine Creek was generally characterized by moderate stream gradient, riffle-run stream morphology with flow typically confined within a well-defined, meandering channel containing predominantly cobble-gravel substrate and bordered by relatively steep banks. The survey was conducted during the seasonal low flow period and as a result, approximately 25% of the stream bed was often exposed. Although some groundwater seeps were observed feeding into Hazeltine Creek at the time of the survey, the only surface water tributary was Edney Creek (Figure 3.1). No adverse anthropogenic influences to Hazeltine Creek were apparent, although potential influences associated with historical clear-cut forestry and current free-range livestock practices within the watershed were noted.

Based on predominant stream gradient and/or geomorphological breaks, Hazeltine Creek was divided into nine distinct reaches beginning at a point approximately 1,750 m downstream of the Polley Lake outlet (Figure 3.1). The following paragraphs highlight key physical features of each reach with progression downstream.

The upper-most reach (HC-R1) extended approximately 445 m and was characterized by relatively low gradient (1.2% slope) run habitat with gravel-sand substrate (Table 3.1). Mean channel wet width and depth were approximately 3.0 m and 10.3 cm, respectively (Table 3.1), with wider and shallower conditions typically observed upstream of a breached beaver dam located approximately mid-reach. Although the channel was generally stable, at some areas in the upper half of the reach the channel may have been unconfined (Photo B.1) as a result of altered stream flows associated with an historical forest fire and/or uprooted trees caused by blowdown. Bank material at HC-R1 was predominantly comprised of fines, but was considered relatively stable due to the occurrence of dense riparian alder (*Alnus* sp.) growth and low stream gradient (Photo B.2). At the time of the survey, stream discharge was approximately 0.006 m^3/s at HC-R1.

The second reach (HC-R2) in Hazeltine Creek was characterized by ponded flow associated with beaver activity (Figure 3.1). The ponded area was approximately 210 m long and often occupied the entire floodplain width of approximately 45 m (Photo B.3). Water depth in the ponded area often exceeded 100 cm. Stream habitat features relevant to the survey were generally not measurable at HC-R2 as a result of the ponded, deep water conditions.

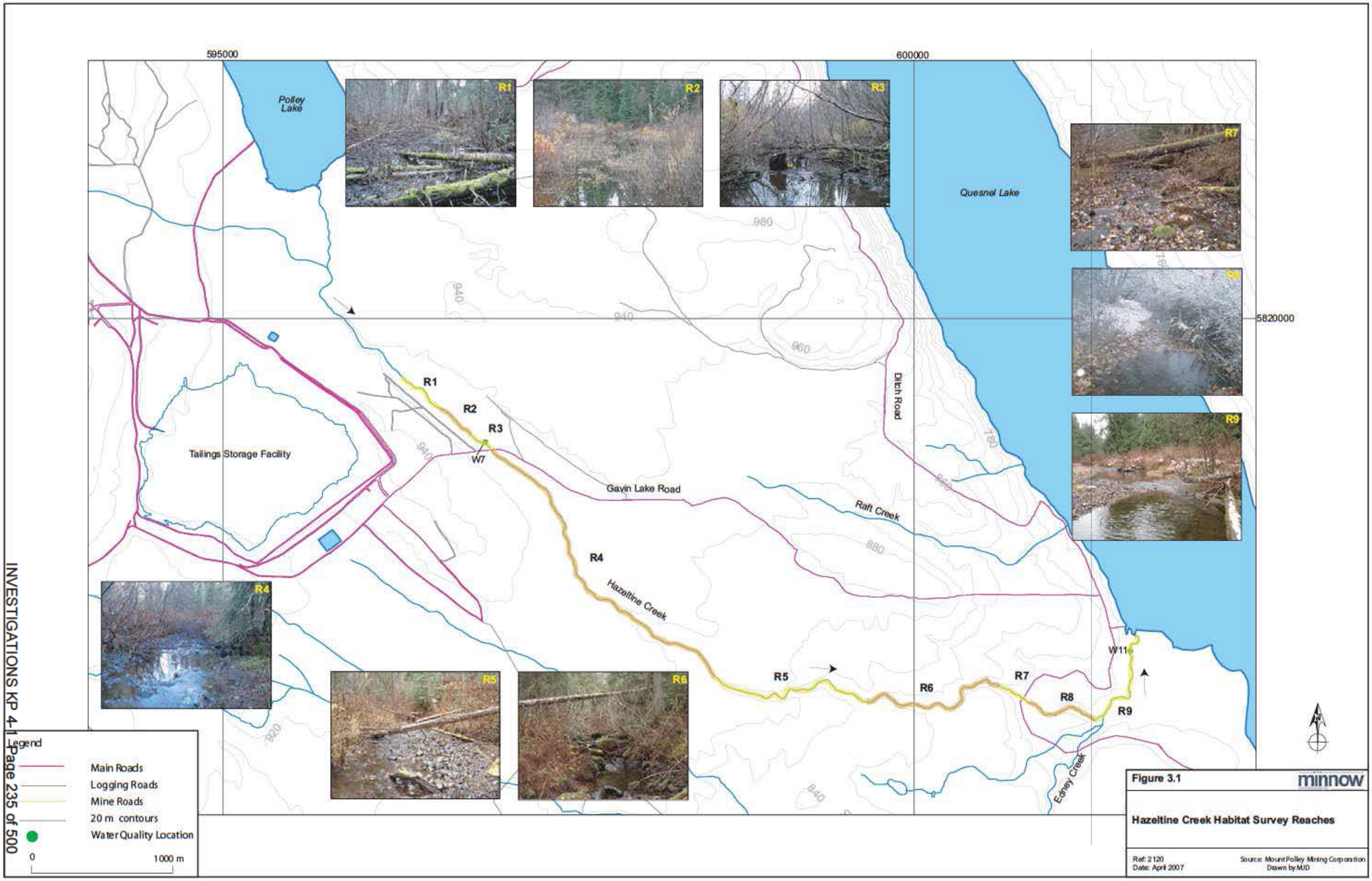


Figure 3.1

Hazeltine Creek Habitat Survey Reaches

Ref: 2120
Date: April 2007

Source: Mount Polley Mining Corporation
Drawn by MJD

Table 3.1: Summary of Physical Habitat Characteristics of Designated Reaches, Hazeltine Creek Habitat Characterization, October 2006

Feature		Measure	Hazeltine Creek Reach									
			R1	R2[b]	R3	R4	R5	R6	R7	R8	R9	Average[a]
Channel Hydrology	Reach Length	Length (m)	445	210	157	2,200	1,110	1,510	350	555	760	na
	Width	Wetted (m)	3.0	-	2.9	3.1	1.9	2.8	3.2	2.0	5.8	3.0
		Bankfull (m)	7.0	-	7.9	4.7	4.5	3.7	5.3	5	11 3	5.2
		Floodplain (m)	37	-	41	22	12	7.2	9.4	17	23	17
	Depth	Mean (cm)	10	-	12	5	7	8	6	13	14	8
		Bankfull (cm)	36	-	38	43	38	27	37	27	43	36
	Slope	Channel (%)	1.4%	-	0.8%	1.7%	3.7%	7.3%	2.7%	0.7%	1.0%	3.0%
		Left Bank (°)	64˚	-	65˚	77˚	67˚	90˚	83˚	70˚	63˚	73
		Right Bank (°)	64˚	-	65˚	83˚	90˚	83˚	52˚	85˚	87˚	79
	General Morphology	% Pool	20	-	20	33	13	33	8	27	17	25
		% Riffle	18	-	10	37	60	67	57	27	10	41
		% Run	63	-	70	30	27		35	47	73	31
	Flow	Discharge (m^3/s)	0.0059	-	na	0.0079	0.0137	0.0173	0.0143	0.0254	0.0630	na
Channel Bed & Bank Features	In-Stream Substrate	% Bedrock	-	-	-	-	-	10	-	-	-	2
		% Boulder	-	-	-	-	3	20	10	-	-	5
		% Cobble	-	-	-	43	78	53	80	33	43	47
		% Gravel	60	-	40	47	11	13	10	53	33	31
		% Sand	40	-	60	8	8	3	-	13	17	11
		% Silt & Finer	-	-	-	2	-	-	-	-	7	1
	Left Bank Material	% Bedrock	-	-	-	-	-	37	-	-	-	8
		% Boulder	-	-	-	-	-	20	7	-	-	4
		% Cobble	-	-	-	3	3	3	40	2	-	4
		% Gravel	10	-	5	2	5	10	13	13	-	6
		% Sand	20	-	25	30	47	15	23	43	60	32
		% Silt & Finer	70	-	70	65	45	15	17	42	40	43
	Left Bank Conditon	% Unstable	-	-	20	8	-	-	-	-	-	3
		% Moderate	40	-	20	35	50	5	20	23	15	26
		% Stable	60	-	60	57	50	95	80	77	52	64
	Right Bank Material	% Bedrock	-	-	-	-	-	2	-	-	-	0
		% Boulder	-	-	-	-	5	30	3	-	-	7
		% Cobble	-	-	-	5	18	25	60	7	5	13
		% Gravel	10	-	5	5	10	2	2	17	20	7
		% Sand	25	-	25	33	42	17	25	40	38	30
		% Silt & Finer	70	-	70	57	28	25	10	37	37	39
	Right Bank Condition	% Unstable	-	-	20	20	10	-	-	15	-	9
		% Moderate	35	-	20	47	57	33	10	45	30	39
		% Stable	65	-	60	33	33	67	90	40	70	49
	Root Density	% of Bank Depth	100	-	100	100	100	40	75	95	70	80
	Bank Surface Protection	% of Bank Depth	95	-	85	75	70	85	85	60	75	75
Riparian Features	Overhead Canopy	% Dense	30	-	40	30	8	10	28	60	10	22
		% Partially Open	35	-	20	27	47	23	20	20	18	27
		% Open	35	-	40	43	45	67	52	20	72	48
	Riparian Vegetation	Dominant Overstory (Type)	red cedar, fir, spruce	conifers	-	conifers (fir, spruce)	fir, spruce, red cedar	hemlock, red cedar, spruce	red cedar, spruce	conifers, cotton-wood	Red cedar	na
		Dominant Understory (Type)	alder, hardhack, dogwood	alder	alder, hardhack	alder, hardhack, forbs	alder, dogwood	hardhack, dogwood, alder	alder, dogwood	alder, hardhack	alder, willow	na

[a] Average value represents weighted average for all reaches except R2 (i.e., the ponded reach)

[b] Stream measures were not able to be collected at HC-R2 as a resulted of ponded conditions associated with beaver activity

The third reach (HC-R3) in Hazeltine Creek was bounded by the beaver dam at HC-R2 and by Gavin Lake Road at the upstream and downstream ends, respectively (Figure 3.1). The key features which influenced flow patterns in this relatively short reach (approximately 160 m long) included a combination of low gradient (0.8% slope) and the occurrence of multiple overflow points across the beaver dam. These features resulted in the formation of numerous islands and/or channel braids, particularly at the upper portion of the HC-R3 (Photo B.5). In-stream substrate at HC-R3 contained the highest proportion of sand relative to the remaining reaches, which likely reflected the high proportion of run habitat and relatively low stream gradient (Table 3.1; Photo B.4). In addition, HC-R3 channel stability was notably lower than at most remaining reaches, reflecting a higher proportion of unstable (slumping) banks (Table 3.1).

The fourth reach (HC-R4) extended from Gavin Lake Road at the Mount Polley Mine monitoring station W7 (Photo B.6) to approximately 2,200 m downstream (Figure 3.1). This reach was characterized by a slightly higher gradient (1.7% slope), a higher proportion of shallow riffle habitat (37%), an increased proportion of cobble substrate (43% of wetted surface area), narrower bankfull channel and floodplain widths, and steeper banks relative to upstream areas (Table 3.1; Photo B.7). Although some braiding was observed within HC-R4, the channel was generally confined. Subterranean flow was suspected at several areas of HC-R4 based on visual observation of variable surface water flow. Although bank stability was generally considered moderately stable to stable, a relatively high proportion of the stream bank exhibited undercutting (Photo B.8), resulting in an ‘unstable’ rating at some areas (Table 3.1). Discharge at this reach was approximately 0.008 m^3/s.

Reach five (HC-R5) was distinguished by a clear increase in stream gradient (3.7% slope) relative to upstream areas (Table 3.1). Spatially, this reach extended approximately 1,110 m (Figure 3.1) and was predominantly comprised of riffle habitat and cobble substrate, with flow confined within a narrow (wetted and bankfull) channel bordered by steep banks (Table 3.1; Photo B.10). The stream valley was notably more confined at HC-R5 relative to upstream areas, and at two locations the valley walls had recently (i.e., within the last five years) slumped into the creek (Photo B.12). Bank stability was generally considered moderately stable to stable, with the presence of some undercutting suggesting unstable conditions at certain areas of HC-R5 (Table 3.1). Discharge was notably higher at HC-R5 relative to upstream areas, which likely reflected resurfacing of water from groundwater sources as a result of rapid elevation drop through this reach.

With progression downstream, an approximately 1,510 m long gorge roughly demarcated the spatial extent of the sixth reach (HC-R6; Figure 3.1; Photo B.13). Mean stream gradient at this reach nearly doubled relative to upstream (i.e., 7.3% slope) with stream morphology shifting to riffle-pool (step-pool) sequences (Table 3.1; Photo B.14). Substrate was generally dominated by large, coarse material (cobble to bedrock; Table 3.1), with some areas exhibiting considerable build-up of small (5 cm to 10 cm diameter) cobble within the streambed which in turn resulted in some sub-surface flow (Photo B.16). Stream banks through HC-R6 contained a predominance of large substrate, resulting in a relatively high proportion of stable bank conditions (Table 3.1). Commensurate with the rapid elevation drop, groundwater resurfacing resulted in stream discharge approximately 25% higher at HC-R6 than at the preceding reach (Table 3.1).

Hazeltine Creek reach seven (HC-R7) was approximately 350 m long, extending from the bottom of the gorge to just below the Ditch Road crossing (Figure 3.1). This reach was characterized by moderate gradient (2.7% slope) riffle-run habitat with cobble substrate (Table 3.1; Photo B.17). Similar to areas in the gorge, aggraded areas consisting of small cobble substrate were observed at HC-R7. Because a relatively high proportion of bank material was comprised of cobble, the bank condition was generally considered stable in this reach. In contrast to conditions in the gorge, lower stream discharge at HC-R7 (Table 3.1) may have been related to the re-occurrence of subterranean flow associated with greater substrate porosity in this reach.

The eighth reach (HC-R8) extended from approximately 80 m downstream of Ditch Road to the Edney Creek confluence located approximately 555 m downstream (Figure 3.1). Low gradient (0.8% slope) run habitat with predominantly gravel substrate and greater depth characterized this stream reach (Table 3.1; Photo B.18). Bank materials at HC-R8 contained a higher proportion of fines, which likely accounted for the occurrence of some unstable bank conditions (Table 3.1). Similar to previous observations, substantially higher stream discharge at HC-R8 compared to the upstream-most reach may have been related to groundwater inputs associated with lower elevation; however, heavy overnight rain and snowfall (Photo B.19) prior to discharge measurement may have also accounted for higher flow.

Finally, reach nine (HC-R9) represented the lower portion of Hazeltine Creek between the Edney Creek confluence and the outlet to Quesnel Lake (approximate distance of 760 m; Figure 3.1). Just upstream of the confluence, Edney Creek was ponded as a result of beaver activity (Photo B.20), which subsequently resulted in two separate inlet channels to Hazeltine Creek. In general, HC-R9 was characterized by low gradient

(1.0% slope), run habitat with small cobble and gravel substrate (Table 3.1; Photos B.21 to B.27). In addition, the wetted channel was substantially wider than at any of the upstream reaches (Table 3.1). Although the bank material at HC-R9 consisted mainly of sand and fines, the banks were considered relatively stable. Based on stream discharge comparisons, Edney Creek constituted approximately 60% of the flow in lower Hazeltine Creek (Table 3.1).

3.2 Bank Erosion Hazard Index Results

The prediction of stream bank erosion under bankfull discharge conditions utilizing the BEHI indicated low to moderate erosion potential was expected for Hazeltine Creek (Table 3.2). Highest erosion potential was predicted for reaches located between Gavin Lake Road and the gorge (i.e., HC-R4 and HC-R5). The key attributes of these reaches which led to slightly higher BEHI scores included the composition of bank material (greater proportion of sand and gravel) and layering features of the bank material (i.e., stratification; Table 3.2). Lowest erosion potential was predicted for the upstream-most and gorge reaches (i.e., HC-R1, HC-R3 and HC-R6, respectively), which generally reflected either low stream gradient and high bank surface protection (HC-R1 and HC-R3) or the presence of stable bedrock, boulder and cobble bank material (HC-R6; Table 3.2).

3.3 Hazeltine Creek Hydrology

The natural high flow period in Hazeltine Creek is driven by snowmelt, with the majority of annual runoff generally occurring from late April to early May (Figure 3.2). In contrast, lowest flows can be expected from late September to early October (Figure 3.2). Discharge calculations based on manual discharge measurements indicated that flow generally increases with progression downstream despite the lack of any surface water drainages feeding into Hazeltine Creek upstream of the Edney Creek confluence (Table 3.1). This suggested that groundwater is a key contributor to stream baseflow, which becomes particularly important during low flow periods.

Streamflow to water depth ratios at the continuous analog stage recorder on Hazeltine Creek (Station W7) were used to extrapolate peak flow (i.e., bankfull stage) at the first transect of HC-R4. The results indicated that the flow rate at which water levels begin to flood the banks at this location was approximately 1.243 m^3/s. This level corresponded to a stream gauge depth of approximately 0.51 m. On average, peak flows observed during spring freshet generally do not exceed bankfull stage; over the past 12 years, bankfull stage has been exceeded only in 1995, 1997, 1999 and 2002 (Figure 3.2) and

Table 3.2: Summary of Bank Erosion Hazard Index (BEHI) Scores for Designated Reaches, Hazeltine Creek Habitat Characterization, October 2006

Measure	**Hazeltine Creek Reach**									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	Average
Bank Height to Bankfull Height	1.0	-	5.0	5.9	1.0	1.1	7.0	1.1	6.5	3.6
Root Depth to Bank Height	2.7	-	3.4	4.4	5.1	6.3	5.6	3.9	6.0	4.7
Root Density (%)	1.0	-	1.0	1.0	1.0	5.1	2.3	1.2	2.4	1.9
Bank Angle (degrees)	5.5	-	5.5	5.9	5.8	7.2	5.6	5.9	5.8	5.9
Surface Protection (%)	1.2	-	1.7	2.3	2.7	1.7	1.7	3.5	2.3	2.1
Bank Material	3.0	-	3.0	5.0	7.0	-5.0	-1.0	5.0	0.0	2.1
Stratification	0.0	-	0.0	5.0	5.0	0.0	0.0	0.0	0.0	1.3
Index Totals	14.4	-	19.5	29.5	27.6	16.4	21.1	20.6	23.0	21.5

🟦 Denotes low bank erosion potential at bankfull stage

🟩 Denotes moderate bank erosion potential at bankfull stage

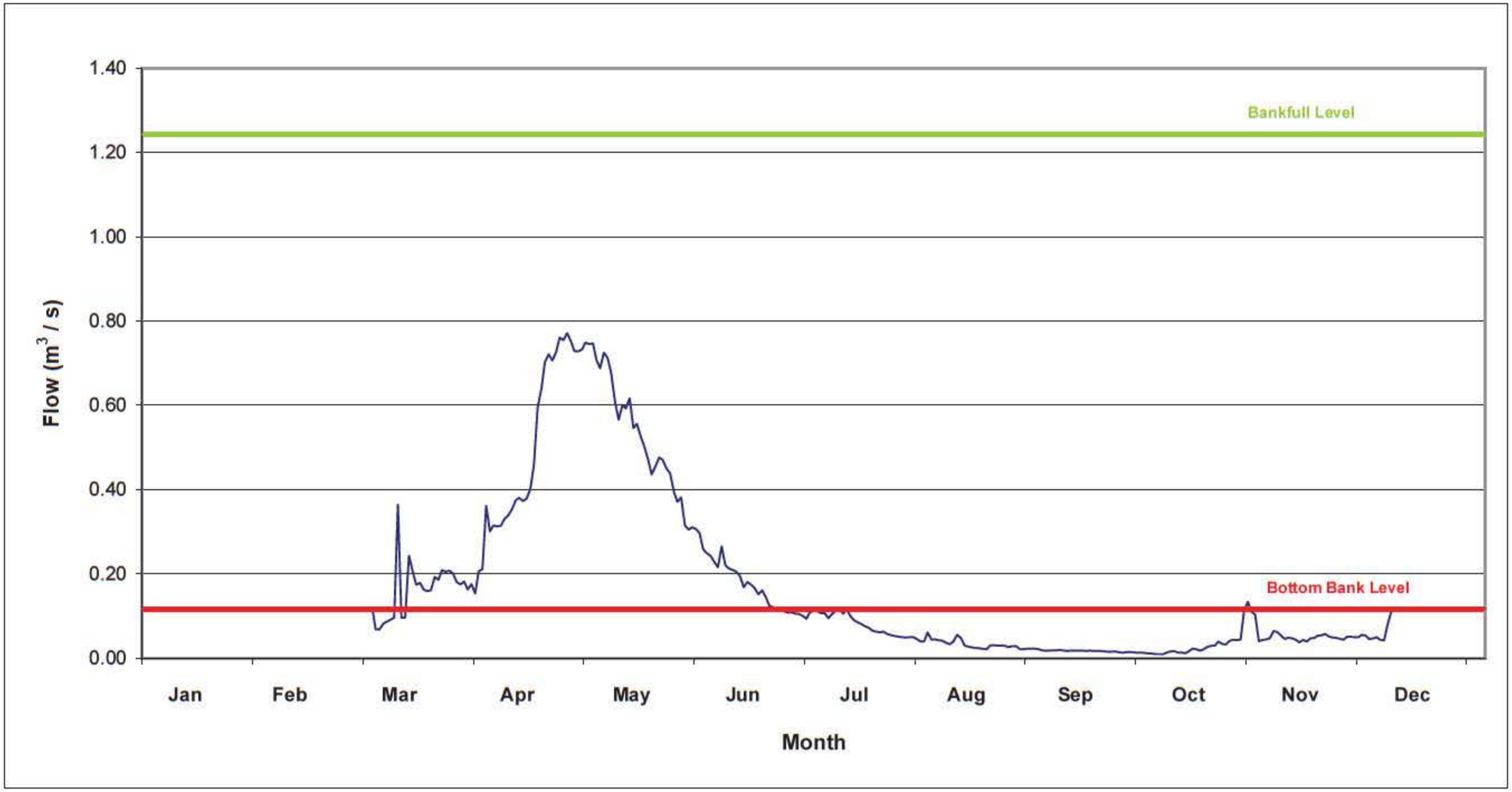


Figure 3.2: Hazeltine Creek Mean Daily Discharge at Station W7 (1995, 1997 to 2006) Relative to Bankfull and Bottom-bank Stages

since 2003 peak flow levels have been well below bankfull stage. In general, annual variability in peak flow levels of the Hazeltine Creek system appears to be relatively high (Appendix Figure A.1). Maximum flow in Hazeltine Creek was recorded in April 1997, with levels as high as 1.95 m^3/s observed (Appendix Figure A.1).

The bottom-bank water level in Hazeltine Creek was estimated to be approximately 15 cm higher than the October 2007 survey water levels (Photo B.5). The extrapolated streamflow that would be expected to reach the bottom-bank level was approximately 0.116 m^3/s, corresponding to a stream gauge depth of approximately 0.247 m. Streamflow levels below this threshold value would not be expected to result in any appreciable bank erosion. In Hazeltine Creek, natural streamflow levels generally exceed this threshold value only from early March to late June (Figure 3.2), at which time natural streambank erosion (e.g., undercut and/slumping banks) is expected to be greatest.

3.4 Physical Habitat & Effluent Discharge Considerations

In consideration of the preceding habitat characterization, BEHI estimates and natural hydrological regime, the potential physical effects that may be associated with discharge of Mount Polley mine effluent into Hazeltine Creek can be summarized as follows:

1) Erosion potential under natural high flow (bankfull) conditions is generally considered low to moderate in Hazeltine Creek, which is partly related to a high proportion of bank protection and/or the presence of large, stable bank substrate. Reaches exhibiting the greatest bank erosion potential were HC-R4 and HC-R5, directly downstream of the anticipated effluent discharge location. Relative to other areas in Hazeltine Creek, these reaches exhibited a higher proportion of naturally occurring undercut and slumping banks, which supported the ‘moderate’ BEHI rating. Therefore, it is expected that Reaches HC-R4 and HC-R5 could be susceptible to greater erosion than other reaches in Hazeltine Creek under certain discharge scenarios.

2) The discharge level above which relatively high erosion potential was expected (i.e., bankfull stage) was 1.243 m^3/s. Once effluent discharge commences, an upper threshold value should be established and used as an approximate guide to assist with effluent discharge management in order to meet the objective of reducing the potential of any mine-related erosion in Hazeltine Creek. Historically, discharge at or above bankfull stage was uncommon in Hazeltine Creek and when encountered, was typically limited to snowmelt periods in late

April to early May. Furthermore, the frequency at which natural flow levels attained or exceeded bankfull stage over the past 12 years was below the ‘expected’ 1.5 year return period. Because flow was often well below bankfull stage, actual bank erosion in Hazeltine Creek may have been somewhat lower than predicted by the BEHI. Therefore, it is likely that an effective effluent discharge management plan can be implemented to limit effluent discharge to periods when combined flows would not be expected to adversely affect physical channel stability.

3) The bottom-bank discharge level in Hazeltine Creek was conservatively estimated as 0.116 m^3/s. Through much of the summer, autumn and winter, natural discharge levels in Hazeltine Creek are at or below this level. The potential for any mine-related erosion in Hazeltine Creek would almost be non-existent if the combined effluent discharge and natural flow levels could be maintained below this threshold level. However, periods of low flow may not offer sufficient natural dilution to ensure that receiving water chemistry would meet anticipated regulatory requirements, potentially precluding any significant effluent discharge during these low flow periods.

4.0 HAZELTINE CREEK FISH HABITAT

4.1 Fish Habitat Summary

Hazeltine Creek stream morphology was generally dominated by shallow riffle-run habitat with pool habitat limited to an average of 25% of the total stream area (excludes ponded reach HC-R2). Within flowing portions of the stream, only approximately 35% of this available pool habitat (or 8.5% of the total stream area) was considered functional (i.e., deep enough to offer fish cover) during autumn low flow conditions (Table 4.1). In total, functional in-stream cover averaged 31% of the wetted surface area of Hazeltine Creek, of which large woody debris (LWD), overhanging vegetation and deep pool habitat were the most important components (Table 4.1). The lowest amount of functional in-stream was observed at lower Hazeltine Creek reaches HC-R7 and HC-R9 (Table 4.1). During the habitat evaluation, key seasonal barriers to upstream fish migration within Hazeltine Creek included beaver dams at the lower end of HC-R2 and HC-R9, a cascade at the lower end of HC-R5 and numerous cascades and/or log jams within the gorge (HC-R6). These barriers were generally greater than 1 m high and therefore were likely to represent physical barriers under low to moderate flow conditions. Two beaver dams constructed in lower Hazeltine Creek likely limited upstream fish migration (particularly adult salmon) from Quesnel Lake (Figure 4.1).

Rainbow trout (*Oncorhyncus mykiss*) fry and juveniles were commonly sighted at reaches upstream of the gorge (HC-R5) during the habitat characterization. Trout of these age groups were most often observed in slow-flowing shallows containing a high proportion of functional LWD and/or overhanging vegetation. No fish were observed below the gorge, although greater flow and deeper water at these reaches may have provided greater opportunity for fish to avoid observation. Deep pool habitat important for sub-adult and adult trout was generally limited at most reaches throughout Hazeltine Creek. Although the amount of functional pool habitat is important for these stages throughout much of the year, it is particularly important as overwintering habitat (Raleigh et al. 1984). Therefore, the beaver ponds located at HC-R2 and lower Edney Creek likely represent important overwintering refuges for the Hazeltine Creek trout population.

Although no adult salmon, salmon carcasses or redds were observed in lower Hazeltine Creek, the survey had been conducted later than the expected fall salmon run (i.e., normally to early October) and outside of the dominant sockeye salmon (*O. nerka*) cycle years (‘odd’ year [2001, 2003, 2005 etc.] dominant cycle). As indicated above, two beaver dams constructed approximately 215 m and 250 m upstream of Quesnel Lake

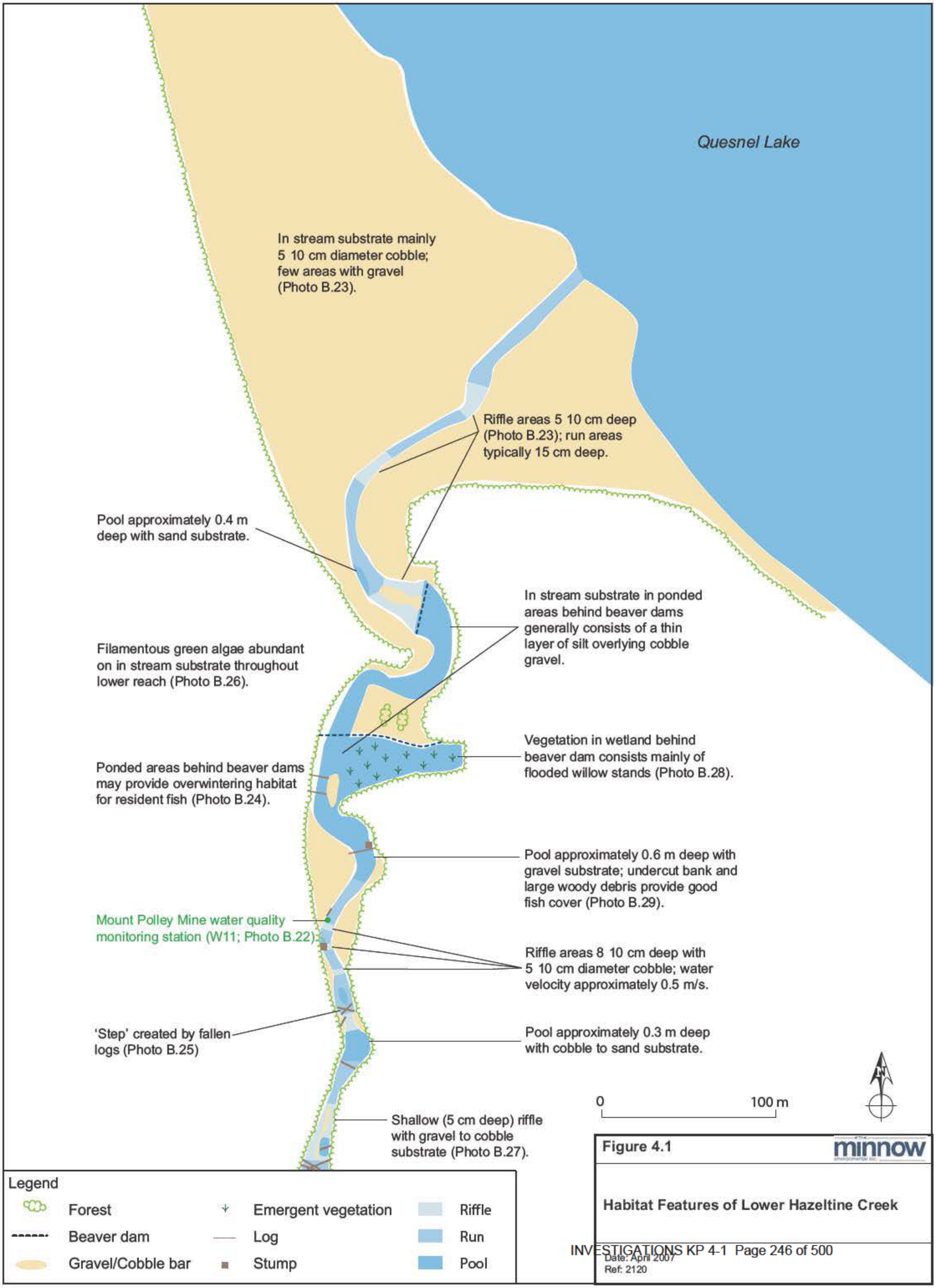
Table 4.1: Summary of Fish Habitat Characteristics of Designated Reaches, Hazeltine Creek Habitat Characterization, October 2006

Feature		Measure	Hazeltine Creek Reach									
			R1	R2	R3	R4	R5	R6	R7	R8	R9	Average[a]
In-stream Fish Habitat Features	In-stream cover	% Deep Pool	8	100	5	8	7	13	3	10	7	8.5
		% Boulder	-	-	-	2	-	7	3	-	-	2.0
		% Logs/Snags	10	-	15	20	13	7	3	6	2	11.2
		% Overhanging Veg.	15	-	10	15	5	2	5	27	-	9.0
		% Macrophytes	-	-	trace	-	-	-	-	-	-	0
		% Other	5	-	-	0	-	-	-	-	-	0
	In-stream barriers[b]	No. and type[c]	-	1 bd	-	-	1 c	several c, a, lj	-	-	2 bd	0

[a] Average value represents weighted average for all reaches except R2 (i.e., the ponded reach)

[b] All barriers observed in Hazeltine Creek were considered seasonal (i.e., impediments to upstream fish migration only during certain times of year [e.g., low flow] for certain fish species and/or fish sizes); impassable barriers (i.e., those not able to be ascended during any time of year for all fish species and fish sizes) were not observed in Hazeltine Creek

[c] Letters denote aggraded area (a), beaver dam (bd), cascade (c) and log jam (lj) barriers



In stream substrate mainly 5 10 cm diameter cobble; few areas with gravel (Photo B.23).

Riffle areas 5 10 cm deep (Photo B.23); run areas typically 15 cm deep.

Pool approximately 0.4 m deep with sand substrate.

In stream substrate in ponded areas behind beaver dams generally consists of a thin layer of silt overlying cobble gravel.

Filamentous green algae abundant on in stream substrate throughout lower reach (Photo B.26).

Vegetation in wetland behind beaver dam consists mainly of flooded willow stands (Photo B.28).

Ponded areas behind beaver dams may provide overwintering habitat for resident fish (Photo B.24).

Pool approximately 0.6 m deep with gravel substrate; undercut bank and large woody debris provide good fish cover (Photo B.29).

Mount Polley Mine water quality monitoring station (W11; Photo B.22).

Riffle areas 8 10 cm deep with 5 10 cm diameter cobble; water velocity approximately 0.5 m/s.

'Step' created by fallen logs (Photo B.25)

Pool approximately 0.3 m deep with cobble to sand substrate.

Shallow (5 cm deep) riffle with gravel to cobble substrate (Photo B.27).

Figure 4.1

minnow

Habitat Features of Lower Hazeltine Creek

Date: April 2007
Ref: 2120

would likely prevent any adult salmon from ascending Hazeltine Creek (Figure 4.1). Moreover, stream flow was quite low at the time of the survey and as a result, water depth at riffle areas below the beaver dams of less than 10 cm (Figure 4.2) may have also limited creek ascension by spawning adults. Pea-sized gravel substrate at water depths suitable for salmon spawning were uncommon within the lower 525 m of Hazeltine Creek, with cobble-gravel mixtures predominant (Figure 4.1). However, under higher flow conditions than those observed during the 2006 survey, the availability of substrate ideal for salmon spawning would likely increase dramatically. Overall, based on the presence of barriers posed by beaver dams and low flow conditions, as well as marginal substrate availability at depths required for spawning, lower Hazeltine Creek would not likely have represented an important spawning habitat for salmon in 2006; however, the lower reaches of Hazeltine Creek provide very good potential as salmon spawning habitat.

4.2 Fish Habitat & Effluent Discharge Considerations

Based on the fish habitat evaluation, the key limitations to greater fish productivity in Hazeltine Creek appeared to be a relatively low pool-to-riffle ratio and the general absence of slow, deep water during low flow periods. From a fish habitat perspective, any discharges that augmented seasonal low flow periods in Hazeltine Creek would likely improve fisheries resources by increasing the amount of functional habitat available to fish and their invertebrate food base, as well as potentially improving accessibility. Taking the stream characterization information into consideration, the optimal minimum discharge level in Hazeltine Creek likely corresponds to the level that maintains deepest baseflow conditions without compromising channel stability. Based on the stream characterization analysis, a minimum baseflow of approximately 0.116 m^3/s would substantially augment the amount of functional habitat available to fish in Hazeltine Creek while avoiding any appreciable bank erosion.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The physical characterization of Hazeltine Creek resulted in the identification of nine separate reaches based on stream gradient and/or geomorphological features. Low to moderate erosion potential was identified for all reaches, which was generally a reflection of dense riparian/root cover and large, stable bank materials affording good bank protection. Of the identified reaches, those located immediately downstream of the anticipated Mount Polley Mine effluent discharge location (HC-R4 and HC-R5) exhibited the greatest potential for bank erosion and accordingly, channel instability, under a high flow (i.e., bankfull stage) scenario. In general, highest erosion potential in Hazeltine Creek was expected at discharge greater than 1.243 m^3/s, which would normally occur during the annual snowmelt period (late April to early May). Minimal erosion potential was estimated at discharge below 0.116 m^3/s, which normally occurs from late summer through mid-winter under natural flow conditions.

The fish habitat characterization of Hazeltine Creek indicated a relatively low proportion of functional in-stream cover at the flow levels encountered. In particular, the amount of productive deep-pool habitat, suitable as either low flow period and/or overwintering refuge was limiting throughout Hazeltine Creek. Natural seasonal barriers to upstream fish migration in Hazeltine Creek include beaver dams and several cascades. Despite these characteristics, rainbow trout appeared to be relatively abundant in the upper reaches. No evidence of salmon spawning activity was observed at downstream reaches of Hazeltine Creek, although the survey was conducted relatively late in the salmon spawning season and in an ‘off-cycle’ year for sockeye salmon. In general, access to salmon spawning habitat in lower Hazeltine Creek would likely have been restricted by beaver dams and low flow conditions in 2006. Overall, augmentation of Hazeltine Creek discharge during periods of low flow would likely improve fish habitat, mainly by increasing the amount of available functional pool habitat and increasing the amount of available substrate for salmon spawning.

5.2 Recommendations

Recommendations stemming from the habitat characterization of Hazeltine Creek are associated with the need to confirm channel discharge capacities to ensure that any figures used to develop effluent management plans adequately represent values considered protective of physical channel stability and fish habitat integrity. Specific recommendations for the Mount Polley Mining Corporation include:

1. During the development of an effluent discharge mitigation plan, a certified hydrologist/geomorphologist should be consulted to assist with determination of a combined discharge level that would reasonably be expected to result in minimal bank erosion. Based on the current assessment, we propose that Mount Polley develop and implement a conservative ‘critical’ limit for effluent discharge that takes into consideration streambank erosion potential associated with combined natural and effluent flows in Hazeltine Creek. This critical limit would ensure that any potential physical impacts to channel stability would not be excessive and/or outside of levels that occur naturally. Development of this value, as well as confirmation of bankfull and bottom-bank levels (1.243 m^3/s and 0.116 m^3/s, respectively) in this study, should be conducted by a certified hydrologist/ geomorphologist before any specific values are incorporated into a mitigation plan. Because erosion potential was highest immediately downstream of the proposed effluent discharge, confirmation of these values should be conducted for this reach (i.e., HC-R4).

2. From a fish habitat perspective, Mount Polley Mine may wish to consider conducting quantitative fish community sampling prior to effluent discharge to document baseline fish productivity values. The survey, which should be conducted during a period of low flow, would be used to examine relationships among fish community structure (i.e., species, density and biomass) and flow-related parameters (e.g., amount of available functional habitat, stream surface area). Provided mine effluent quality does not adversely affect fish populations, the baseline fish survey can be used to demonstrate that flow augmentation has increased overall fish productivity in Hazeltine Creek.

3. With the initiation of effluent discharge to Hazeltine Creek, Mount Polley Mine may wish to consider implementing a monitoring program to track streambank erosion at select areas within Hazeltine Creek to assess whether the established critical limit (described above) is effective. A relatively simple monitoring program, involving measurement of streambank distance from (or to) a fixed point over time at stations located upstream (reference) and downstream (exposure) of the effluent discharge to Hazeltine Creek can be developed which, when considered with biological monitoring, can provide information important to understanding potential physical impacts associated with effluent discharge.

6.0 REFERENCES

DFO (Department of Fisheries and Oceans). 1998. Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction of Fish Habitat. Department of Fisheries and Oceans Habitat Management and Environmental Science Habitat Management Branch. Communications Directorate. Ottawa, ON. 22 pp.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman. San Francisco, CA. 818 pp.

Minnow (Minnow Environmental Inc.). 2006. Identification of Priority Parameters at the Mount Polley Mine and Development of Site-Specific Water Quality Objectives. Report prepared for Mount Polley Mining Corporation, Likely, BC. April 2006.

Raleigh, R.F., T. Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat Suitability Information: Rainbow trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60. 64 pp.

Rosgen, D.L. 2001. A practical method of computing streambank erosion rate. 7th Federal Interagency Sediment Conference, March 24th to 29 h, Reno, NV.

Simon, A. 1989. A model of channel response in disturbed alluvial channels. Earth Surface Processes and Landforms, 14: 11 – 26.

APPENDIX A

HABITAT CHARACTERIZATION DATA

Table A.1: Hazeltine Creek Reach Transect Coordinates (based on UTM NAD83 datum)

Transect	Eastings	Northings
HC-R1a Transect 1	596 316	5 819 542
HC-R1a Transect 2	596 383	5 819 502
HC-R1a Transect 3	596 469	5 819 453
HC-R1b Transect 1	596 487	5 819 398
HC-R1b Transect 2	596 573	5 819 332
HC-R1b Transect 3	596 659	5 819 266
HC-R3 Transect 1	596 852	5 819 104
HC-R3 Transect 2	596 914	5 819 047
HC-R4 Transect 1	596 659	5 819 266
HC-R4 Transect 2	597 948	5 817 857
HC-R4 Transect 3	598 410	5 817 571
HC-R5 Transect 1	598 548	5 817 407
HC-R5 Transect 2	599 036	5 817 249
HC-R5 Transect 3	599 428	5 817 315
HC-R6 Transect 1	599 720	5 817 232
HC-R6 Transect 2	600 321	5 817 152
HC-R6 Transect 3	600 494	5 817 326
HC-R7 Transect 1	600 647	5 817 318
HC-R7 Transect 2	600 728	5 817 251
HC-R7 Transect 3	600 835	5 817 215
HC-R8 Transect 1	600 928	5 817 155
HC-R8 Transect 2	601 105	5 817 174
HC-R8 Transect 3	601 347	5 817 166
HC-R9 Transect 1	601 463	5 817 240
HC-R9 Transect 2	601 556	5 817 360
HC-R9 Transect 3	601 559	5 817 494

Table A.2: Physical Habitat Characteristics at Reach Transects, Hazeltine Creek Habitat Characterization, October 2006

Feature			Hazeltine Creek Reach																									
			R1a			R1b			R3		R4			R5			R6			R7			R8			R9		
		Transect	U01-1	U01-2	U01-3	U02-1	U02-2	U02-3	U04-1	U04-2	HC1-1	HC1-2	HC1-3	HC2-1	HC2-2	HC2-3	HC3-1	HC3-2	HC3-3	HC4-1	HC4-2	HC4-3	HC5-1	HC5-2	HC5-3	HC6-1	HC6-2	HC6-3
Channel Hydrology	Reach Length	Stream distance (m)	210			235			157		2,200			1,110			1,510			350			555			760		
	Width	Wetted (m)	2.95	4.7	3.75	1.35	2.5	2.8	2.75	3.1	3.4	2.25	3.75	1.15	2.25	2.15	2.15	2.2	4	2.5	4.85	2.1	1.6	1.95	2.45	3.65	7.4	6.4
		Bankfull (m)	7.6	6.95	7.2	7.3	5.7	7.1	6	9.8	3.85	5.2	4.9	3.8	4.2	5.45	3.2	3.6	4.3	6.3	5.0	4.6	5.4	5	4.2	11.85	10.8	11.1
		Floodplain (m)	20.8	22.6	38	32	65	43	46	35	22	22	21	12.5	13	11	4.9	8.3	8.5	10.7	9.2	8.35	7	17	26	22	26	22
	Depth	Mean (m)	7	7	13	6.69	14	14	11	12	4	5	6	7.9	5	6.9	8	9	8	3	7	8	11	23	7	15	19	8
		Bankfull (m)	36	32	39	32	37	39	36.67	40	36	37	56	45	35	33	22	33	26	26	33	52	37	27	18	34	47	49
	Slope	Channel (°)	2.5%	0.5%	1.5%	1.5%	2.0%	0.5%	1.0%	0.5%	0.5%	2.5%	2.0%	3%	3%	5%	5%	6%	11%	2%	2%	4%	1%	0.5%	0.5%	1.5%	1%	0.5%
		Left Bank (°)	90°	45°	90°	40°	60°	60°	40°	90°	70°	80°	80°	60°	50°	90°	90°	90°	90°	70°	90°	90°	30°	90°	90°	90°	70°	30°
		Right Bank (°)	90°	90°	30°	20°	60°	90°	40°	90°	70°	90°	90°	90°	90°	90°	90°	70°	90°	20°	45°	90°	90°	75°	90°	90°	80°	90°
	General Morphology	% Pool	30			10			20		40	30	30	20	10	10	20	30	50	20	-	5	30	30	20	10	20	20
		% Riffle	15			20			10		20	40	50	60	60	60	80	70	50	60	40	70	50	20	10	10	10	10
		% Run	55			70			70		40	30	20	20	30	30	-	-	-	20	60	25	20	50	70	80	70	70
	Flow	Discharge (m^3/s)	0.0050			0.0068			na		0.0082			0.0137			0.0173			0.0143			0.0254			0.0630		
Channel Bed & Bank Features	In-Stream Substrate	% Bedrock	-			-			-		-	-	-	-	-	-	-	5	25	-	-	-	-	-	-	-	-	-
		% Boulder	-			-			-		-	-	-	5	5		10	15	35	20	5	5	-	-	-	-	-	-
		% Cobble	-			-			-		60	20	50	80	80	75	85	45	30	80	80	80	70	20	10	20	50	60
		% Gravel	50			70			40		20	80	40	10	7.5	15	-	30	10	-	15	15	30	60	70	60	20	20
		% Sand	50			30			60		20	-	5	5	7.5	10	5	5	-	-	-	-	-	20	20	10	20	20
		% Silt & Finer	-			-			-		-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	10	10	-
	Left Bank Material	% Bedrock	-			-			-		-	-	-	-	-	-	100	5	5	-	-	-	-	-	-	-	-	-
		% Boulder	-			-			-		-	-	-	-	-	-	-	15	45	20	-	-	-	-	-	-	-	-
		% Cobble	-			-			-		10	-	-	5	5	-	-	5	5	30	60	30	5	-	-	-	-	-
		% Gravel	10			10			5		-	5	-	5	10	-	-	20	10	20	10	10	40	-	-	-	-	-
		% Sand	20			20			25		30	30	30	60	30	50	-	30	15	15	15	40	40	50	40	40	50	90
		% Silt & Finer	70			70			70		60	65	70	30	55	50	-	25	20	15	15	20	15	50	60	60	50	10
	Left Bank Conditon	% Unstable	-			-			20		-	15	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		% Moderate	40			40			20		40	35	30	30	20	50	-	5	10	-	60	-	20	20	30	40	5	-
		% Stable	60			60			60		60	50	60	70	80	50	100	95	90	100	40	100	80	80	70	60	95	-
	Right Bank Material	% Bedrock	-			-			-		-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
		% Boulder	-			-			-		-	-	-	5	5	5	5	20	65	5	5	-	-	-	-	-	-	-
		% Cobble	-			-			-		-	-	15	10	40	5	40	10	25	80	60	40	20	-	-	-	5	10
		% Gravel	-			10			5		-	15	-	10	15	5	-	5	-	-	5	-	40	10	-	10	10	40
		% Sand	30			20			25		20	30	50	40	40	45	10	40	-	10	15	50	40	40	40	40	35	40
		% Silt & Finer	70			70			70		80	55	35	35	10	40	40	25	10	5	15	10	-	50	60	50	50	10
	Right Bank Condition	% Unstable	-			-			20		-	30	30	10	20	-	-	-	-	-	-	-	10	10	25	-	-	-
		% Moderate	30			40			20		20	70	50	60	50	60	50	10	40	-	20	10	50	30	55	60	-	30
		% Stable	70			60			60		80	-	20	30	30	40	50	90	60	100	80	90	40	60	20	40	100	70
Riparian Features	Overhead Canopy	% Dense	50			10			40		60	10	20	10	10	5	10	20	-	50	30	5	30	70	80	20	10	-
		% Partially Open	30			40			20		40	10	30	40	60	40	20	20	30	30	20	10	20	20	20	20	30	5
		% Open	20			50			40			80	50	50	30	55	70	60	70	20	50	85	50	10	-	60	60	95
	Riparian Vegetation	Dominant Overstory (Type)	fir, spruce			red cedar, fir			-		fir, spruce, some cottonwoods			fir, spruce, red cedar			hemlock, cedar, spruce			red cedar, spruce			spruce, cottonwood, red cedar			red cedar		
		Dominant Understory (Type)	alder, hardhack, red-osier dogwood, forbs			alder, hardhack, twinberry			alder, hardhack		alder, hardhack, forbs			alder, dogwood			hardhack, red-osier dogwood, alder			alder, red-osier dogwood			hardhack, alder			alder, willow		
In-stream Fish Habitat Features	In-stream cover	% Deep Pool	5			10			5		-	-	25	10	5	5	5	10	25	5	-	5	-	10	20	-	-	20
		% Boulder	-			-			-		-	-	5	-	-	-	-	10	10	10	-	-	-	-	-	-	-	-
		% Logs/Snags	10			10			15		20	30	10	15	10	15	10	5	5	-	5	5	7.5	5	5	-	-	5
		% Overhanging Veg.	20			10			10		30	10	5	5	5	5	5	-	-	5	5	5	5	60	15	-	-	-
		% Macrophytes	-			trace			trace		-	-	-	-	-	-	-	-	-	trace	trace	-	trace	-	-	-	-	-
		% Undercut bank	-			5					-	-	5	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-

Table A.3a: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R1a

Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		4.200	Stream Width (m):		4.700	Stream Width (m):		3.750
	Initial Dist to Bank (m)		0.700	Initial Dist to Bank (m)		0.670	Initial Dist to Bank (m)		0.625
	VSS* Distance (m):		0.700	VSS* Distance (m):		0.670	VSS* Distance (m):		0.625
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.700	0.05	0.035	0.670	0.08	0.054	0.625	0.06	0.038
2	1.400	0.10	0.0665	1.340	0.07	0.0469	1.250	0.09	0.0563
3	2.100	0.07	0.0490	2.010	0.07	0.0469	1.875	0.13	0.0813
4	2.800	0.09	0.0630	2.680	0.06	0.0402	2.500	0.18	0.1125
5	3.500	0.04	0.0280	3.350	0.05	0.0335	3.125	0.21	0.1313
6	4.200	0.10	0.0700	4.020	0.09	0.0603	3.750	0.12	0.0750
7	4.900		0.0000	4.690	0.09	0.0603	4.375		0.0000
8	5.600		0.0000	5.360		0.0000	5.000		0.0000
9	6.300		0.0000	6.030		0.0000	5.625		0.0000
10	7.000		0.0000	6.700		0.0000	6.250		0.0000
11	7.700		0.0000	7.370		0.0000	6.875		0.0000
12	8.400		0.0000	8.040		0.0000	7.500		0.0000
13	9.100		0.0000	8.710		0.0000	8.125		0.0000
14	9.800		0.0000	9.380		0.0000	8.750		0.0000
15	10.500		0.0000	10.050		0.0000	9.375		0.0000
	Total Area (m^2)		0.3115	Total Area (m^2)		0.3417	Total Area (m^2)		0.4938

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		7.600	Bankfull Width (m):		6.950	Bankfull Width (m):		7.200
	Initial Dist to Bank (m)		1.090	Initial Dist to Bank (m)		0.993	Initial Dist to Bank (m)		1.040
	VSS* Distance (m):		1.090	VSS* Distance (m):		0.993	VSS* Distance (m):		1.040
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	1.090	0.37	0.403	0.993	0.23	0.228	1.040	0.36	0.374
2	2.180	0.37	0.4033	1.986	0.30	0.2979	2.080	0.27	0.2808
3	3.270	0.33	0.3597	2.979	0.38	0.3773	3.120	0.51	0.5304
4	4.360	0.23	0.2507	3.972	0.33	0.3277	4.160	0.50	0.5200
5	5.450	0.40	0.4360	4.965	0.35	0.3476	5.200	0.41	0.4264
6	6.540	0.37	0.4033	5.958	0.32	0.3178	6.240	0.39	0.4056
7	7.630	0.45	0.4905	6.951	0.30	0.2979	7.280	0.32	0.3328
8	8.720		0.0000	7.944		0.0000	8.320		0.0000
9	9.810		0.0000	8.937		0.0000	9.360		0.0000
10	10.900		0.0000	9.930		0.0000	10.400		0.0000
11	11.990		0.0000	10.923		0.0000	11.440		0.0000
12	13.080		0.0000	11.916		0.0000	12.480		0.0000
13	14.170		0.0000	12.909		0.0000	13.520		0.0000
14	15.260		0.0000	13.902		0.0000	14.560		0.0000
15	16.350		0.0000	14.895		0.0000	15.600		0.0000
	Total Area (m^2)		2.7468	Total Area (m^2)		2.1945	Total Area (m^2)		2.8704

Table A.3b: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R1b

Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		1.350	Stream Width (m):		2.500	Stream Width (m):		2.800
	Initial Dist to Bank (m)		0.100	Initial Dist to Bank (m)		0.357	Initial Dist to Bank (m)		0.400
	VSS* Distance (m):		0.100	VSS* Distance (m):		0.357	VSS* Distance (m):		0.400
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.100		0.000	0.357	0.10	0.036	0.400	0.09	0.036
2	0.200		0.0000	0.714	0.11	0.0393	0.800	0.15	0.0600
3	0.300		0.0000	1.071	0.13	0.0464	1.200	0.20	0.0800
4	0.400		0.0000	1.428	0.15	0.0536	1.600	0.19	0.0760
5	0.500		0.0000	1.785	0.15	0.0536	2.000	0.19	0.0760
6	0.600		0.0000	2.142	0.17	0.0607	2.400	0.13	0.0520
7	0.700		0.0000	2.499	0.15	0.0536	2.800	0.06	0.0240
8	0.800		0.0000	2.856		0.0000	3.200		0.0000
9	0.900		0.0000	3.213		0.0000	3.600		0.0000
10	1.000		0.0000	3.570		0.0000	4.000		0.0000
11	1.100		0.0000	3.927		0.0000	4.400		0.0000
12	1.200		0.0000	4.284		0.0000	4.800		0.0000
13	1.300		0.0000	4.641		0.0000	5.200		0.0000
14	1.400		0.0000	4.998		0.0000	5.600		0.0000
15	1.500		0.0000	5.355		0.0000	6.000		0.0000
	Total Area (m^2)		0.0000	Total Area (m^2)		0.3427	Total Area (m^2)		0.4040

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		7.300	Bankfull Width (m):		5.700	Bankfull Width (m):		7.100
	Initial Dist to Bank (m)		1.040	Initial Dist to Bank (m)		0.814	Initial Dist to Bank (m)		1.010
	VSS* Distance (m):		1.040	VSS* Distance (m):		0.814	VSS* Distance (m):		1.010
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	1.040	0.17	0.177	0.814	0.29	0.236	1.010	0.15	0.152
2	2.080	0.23	0.2392	1.628	0.20	0.1628	2.020	0.36	0.3636
3	3.120	0.35	0.3640	2.442	0.36	0.2930	3.030	0.16	0.1616
4	4.160	0.36	0.3744	3.256	0.51	0.4151	4.040	0.52	0.5252
5	5.200	0.47	0.4888	4.070	0.53	0.4314	5.050	0.51	0.5151
6	6.240	0.31	0.3224	4.884	0.51	0.4151	6.060	0.43	0.4343
7	7.280	0.32	0.3328	5.698	0.20	0.1628	7.070	0.31	0.3131
8	8.320		0.0000	6.512		0.0000	8.080		0.0000
9	9.360		0.0000	7.326		0.0000	9.090		0.0000
10	10.400		0.0000	8.140		0.0000	10.100		0.0000
11	11.440		0.0000	8.954		0.0000	11.110		0.0000
12	12.480		0.0000	9.768		0.0000	12.120		0.0000
13	13.520		0.0000	10.582		0.0000	13.130		0.0000
14	14.560		0.0000	11.396		0.0000	14.140		0.0000
15	15.600		0.0000	12.210		0.0000	15.150		0.0000
	Total Area (m^2)		2.2984	Total Area (m^2)		2.1164	Total Area (m^2)		2.4644

Table A.3c: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R3 Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		2.750	Stream Width (m):		3.100	Stream Width (m):		
	Initial Dist to Bank (m)		0.458	Initial Dist to Bank (m)		0.388	Initial Dist to Bank (m)		
	VSS* Distance (m):		0.458	VSS* Distance (m):		0.388	VSS* Distance (m):		
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.458	0.18	0.082	0.388	0.12	0.047	0.000		0.000
2	0.916	0.19	0.0870	0.775	0.15	0.0581	0.000		0.0000
3	1.374	0.13	0.0595	1.163	0.16	0.0620	0.000		0.0000
4	1.832	0.07	0.0321	1.550	0.17	0.0659	0.000		0.0000
5	2.290	0.06	0.0275	1.938	0.18	0.0698	0.000		0.0000
6	2.748	0.05	0.0229	2.325	0.11	0.0426	0.000		0.0000
7	3.206		0.0000	2.713	0.06	0.0233	0.000		0.0000
8	3.664		0.0000	3.100	0.02	0.0078	0.000		0.0000
9	4.122		0.0000	3.488		0.0000	0.000		0.0000
10	4.580		0.0000	3.875		0.0000	0.000		0.0000
11	5.038		0.0000	4.263		0.0000	0.000		0.0000
12	5.496		0.0000	4.650		0.0000	0.000		0.0000
13	5.954		0.0000	5.038		0.0000	0.000		0.0000
14	6.412		0.0000	5.425		0.0000	0.000		0.0000
15	6.870		0.0000	5.813		0.0000	0.000		0.0000
	Total Area (m^2)		0.3114	Total Area (m^2)		0.3759	Total Area (m^2)		0.0000

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		6.000	Bankfull Width (m):		9.800	Bankfull Width (m):		
	Initial Dist to Bank (m)		0.857	Initial Dist to Bank (m)		1.225	Initial Dist to Bank (m)		
	VSS* Distance (m):		0.857	VSS* Distance (m):		1.225	VSS* Distance (m):		
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.857	0.17	0.146	1.225	0.36	0.441	0.000		0.000
2	1.714	0.21	0.1800	2.450	0.41	0.5023	0.000		0.0000
3	2.571	0.36	0.3085	3.675	0.47	0.5758	0.000		0.0000
4	3.428	0.38	0.3257	4.900	0.51	0.6248	0.000		0.0000
5	4.285	0.42	0.3599	6.125	0.47	0.5758	0.000		0.0000
6	5.142	0.58	0.4971	7.350	0.30	0.3675	0.000		0.0000
7	5.999	0.46	0.3942	8.575	0.31	0.3798	0.000		0.0000
8	6.856		0.0000	9.800	0.38	0.4655	0.000		0.0000
9	7.713		0.0000	11.025		0.0000	0.000		0.0000
10	8.570		0.0000	12.250		0.0000	0.000		0.0000
11	9.427		0.0000	13.475		0.0000	0.000		0.0000
12	10.284		0.0000	14.700		0.0000	0.000		0.0000
13	11.141		0.0000	15.925		0.0000	0.000		0.0000
14	11.998		0.0000	17.150		0.0000	0.000		0.0000
15	12.855		0.0000	18.375		0.0000	0.000		0.0000
	Total Area (m^2)		2.2111	Total Area (m^2)		3.9323	Total Area (m^2)		0.0000

Table A.3d: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R4

Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		3.400	Stream Width (m):		2.250	Stream Width (m):		3.750
	Initial Dist to Bank (m)		0.486	Initial Dist to Bank (m)		0.321	Initial Dist to Bank (m)		0.535
	VSS* Distance (m):		0.486	VSS* Distance (m):		0.321	VSS* Distance (m):		0.535
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.486	0.01	0.005	0.321	0.04	0.013	0.535	0.03	0.016
2	0.972	0.01	0.0049	0.642	0.04	0.0128	1.070	0.04	0.0214
3	1.458	0.04	0.0194	0.963	0.05	0.0161	1.605	0.06	0.0321
4	1.944	0.07	0.0340	1.284	0.04	0.0128	2.140	0.05	0.0268
5	2.430	0.07	0.0340	1.605	0.05	0.0161	2.675	0.08	0.0428
6	2.916	0.06	0.0292	1.926	0.06	0.0193	3.210	0.08	0.0428
7	3.402	0.02	0.0097	2.247	0.05	0.0161	3.745	0.05	0.0268
8	3.888		0.0000	2.568		0.0000	4.280		0.0000
9	4.374		0.0000	2.889		0.0000	4.815		0.0000
10	4.860		0.0000	3.210		0.0000	5.350		0.0000
11	5.346		0.0000	3.531		0.0000	5.885		0.0000
12	5.832		0.0000	3.852		0.0000	6.420		0.0000
13	6.318		0.0000	4.173		0.0000	6.955		0.0000
14	6.804		0.0000	4.494		0.0000	7.490		0.0000
15	7.290		0.0000	4.815		0.0000	8.025		0.0000
	Total Area (m^2)		0.1361	Total Area (m^2)		0.1059	Total Area (m^2)		0.2087

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		3.850	Bankfull Width (m):		5.200	Bankfull Width (m):		4.900
	Initial Dist to Bank (m)		0.550	Initial Dist to Bank (m)		0.650	Initial Dist to Bank (m)		0.700
	VSS* Distance (m):		0.550	VSS* Distance (m):		0.650	VSS* Distance (m):		0.700
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.550	0.31	0.171	0.650	0.22	0.143	0.700	0.56	0.392
2	1.100	0.35	0.1925	1.300	0.43	0.2795	1.400	0.66	0.4620
3	1.650	0.36	0.1980	1.950	0.41	0.2665	2.100	0.64	0.4480
4	2.200	0.40	0.2200	2.600	0.44	0.2860	2.800	0.56	0.3920
5	2.750	0.37	0.2035	3.250	0.45	0.2925	3.500	0.57	0.3990
6	3.300	0.36	0.1980	3.900	0.43	0.2795	4.200	0.51	0.3570
7	3.850	0.39	0.2145	4.550	0.31	0.2015	4.900	0.42	0.2940
8	4.400		0.0000	5.200	0.30	0.1950	5.600		0.0000
9	4.950		0.0000	5.850		0.0000	6.300		0.0000
10	5.500		0.0000	6.500		0.0000	7.000		0.0000
11	6.050		0.0000	7.150		0.0000	7.700		0.0000
12	6.600		0.0000	7.800		0.0000	8.400		0.0000
13	7.150		0.0000	8.450		0.0000	9.100		0.0000
14	7.700		0.0000	9.100		0.0000	9.800		0.0000
15	8.250		0.0000	9.750		0.0000	10.500		0.0000
	Total Area (m^2)		1.3970	Total Area (m^2)		1.9435	Total Area (m^2)		2.7440

Table A.3e: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R5 Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		1.150	Stream Width (m):		2.250	Stream Width (m):		2.150
	Initial Dist to Bank (m)		0.164	Initial Dist to Bank (m)		0.375	Initial Dist to Bank (m)		0.307
	VSS* Distance (m):		0.164	VSS* Distance (m):		0.375	VSS* Distance (m):		0.307
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.164	0.03	0.005	0.375	0.02	0.008	0.307	0.04	0.012
2	0.328	0.10	0.0164	0.750	0.07	0.0263	0.614	0.07	0.0215
3	0.492	0.09	0.0148	1.125	0.06	0.0225	0.921	0.11	0.0338
4	0.656	0.13	0.0213	1.500	0.08	0.0300	1.228	0.12	0.0368
5	0.820	0.12	0.0197	1.875	0.05	0.0188	1.535	0.07	0.0215
6	0.984	0.06	0.0098	2.250	0.02	0.0075	1.842	0.04	0.0123
7	1.148	0.02	0.0033	2.625		0.0000	2.149	0.03	0.0092
8	1.312		0.0000	3.000		0.0000	2.456		0.0000
9	1.476		0.0000	3.375		0.0000	2.763		0.0000
10	1.640		0.0000	3.750		0.0000	3.070		0.0000
11	1.804		0.0000	4.125		0.0000	3.377		0.0000
12	1.968		0.0000	4.500		0.0000	3.684		0.0000
13	2.132		0.0000	4.875		0.0000	3.991		0.0000
14	2.296		0.0000	5.250		0.0000	4.298		0.0000
15	2.460		0.0000	5.625		0.0000	4.605		0.0000
	Total Area (m^2)		0.0902	Total Area (m^2)		0.1125	Total Area (m^2)		0.1474

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		3.800	Bankfull Width (m):		4.200	Bankfull Width (m):		5.450
	Initial Dist to Bank (m)		0.543	Initial Dist to Bank (m)		0.700	Initial Dist to Bank (m)		0.606
	VSS* Distance (m):		0.543	VSS* Distance (m):		0.700	VSS* Distance (m):		0.606
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.543	0.38	0.206	0.700	0.18	0.126	0.606	0.21	0.127
2	1.086	0.42	0.2281	1.400	0.28	0.1960	1.212	0.16	0.0970
3	1.629	0.57	0.3095	2.100	0.37	0.2590	1.818	0.26	0.1576
4	2.172	0.55	0.2987	2.800	0.35	0.2450	2.424	0.29	0.1757
5	2.715	0.47	0.2552	3.500	0.43	0.3010	3.030	0.47	0.2848
6	3.258	0.43	0.2335	4.200	0.42	0.2940	3.636	0.45	0.2727
7	3.801	0.31	0.1683	4.900		0.0000	4.242	0.43	0.2606
8	4.344		0.0000	5.600		0.0000	4.848	0.37	0.2242
9	4.887		0.0000	6.300		0.0000	5.454	0.37	0.2242
10	5.430		0.0000	7.000		0.0000	6.060		0.0000
11	5.973		0.0000	7.700		0.0000	6.666		0.0000
12	6.516		0.0000	8.400		0.0000	7.272		0.0000
13	7.059		0.0000	9.100		0.0000	7.878		0.0000
14	7.602		0.0000	9.800		0.0000	8.484		0.0000
15	8.145		0.0000	10.500		0.0000	9.090		0.0000
	Total Area (m^2)		1.6996	Total Area (m^2)		1.4210	Total Area (m^2)		1.8241

Table A.3f: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R6

Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		1.900	Stream Width (m):		2.200	Stream Width (m):		4.000
	Initial Dist to Bank (m)		0.475	Initial Dist to Bank (m)		0.370	Initial Dist to Bank (m)		0.500
	VSS* Distance (m):		0.475	VSS* Distance (m):		0.370	VSS* Distance (m):		0.500
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.475	0.08	0.038	0.370	0.06	0.022	0.500	0.07	0.035
2	0.950	0.05	0.0238	0.740	0.08	0.0296	1.000	0.01	0.0050
3	1.425	0.11	0.0523	1.110	0.15	0.0555	1.500	0.15	0.0750
4	1.900	0.11	0.0523	1.480	0.11	0.0407	2.000	0.09	0.0450
5	2.375		0.0000	1.850	0.10	0.0370	2.500	0.11	0.0550
6	2.850		0.0000	2.220	0.03	0.0111	3.000	0.06	0.0300
7	3.325		0.0000	2.590		0.0000	3.500	0.05	0.0250
8	3.800		0.0000	2.960		0.0000	4.000	0.08	0.0400
9	4.275		0.0000	3.330		0.0000	4.500		0.0000
10	4.750		0.0000	3.700		0.0000	5.000		0.0000
11	5.225		0.0000	4.070		0.0000	5.500		0.0000
12	5.700		0.0000	4.440		0.0000	6.000		0.0000
13	6.175		0.0000	4.810		0.0000	6.500		0.0000
14	6.650		0.0000	5.180		0.0000	7.000		0.0000
15	7.125		0.0000	5.550		0.0000	7.500		0.0000
	Total Area (m^2)		0.1663	Total Area (m^2)		0.1961	Total Area (m^2)		0.3100

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):			Bankfull Width (m):		3.600	Bankfull Width (m):		4.300
	Initial Dist to Bank (m)			Initial Dist to Bank (m)		0.450	Initial Dist to Bank (m)		0.538
	VSS* Distance (m):			VSS* Distance (m):		0.450	VSS* Distance (m):		0.538
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.000		0.000	0.450	0.24	0.108	0.538	0.29	0.156
2	0.000		0.0000	0.900	0.26	0.1170	1.075	0.24	0.1290
3	0.000		0.0000	1.350	0.35	0.1575	1.613	0.24	0.1290
4	0.000		0.0000	1.800	0.36	0.1620	2.150	0.19	0.1021
5	0.000		0.0000	2.250	0.42	0.1890	2.688	0.29	0.1559
6	0.000		0.0000	2.700	0.37	0.1665	3.225	0.26	0.1398
7	0.000		0.0000	3.150	0.37	0.1665	3.763	0.25	0.1344
8	0.000		0.0000	3.600	0.30	0.1350	4.300	0.29	0.1559
9	0.000		0.0000	4.050		0.0000	4.838		0.0000
10	0.000		0.0000	4.500		0.0000	5.375		0.0000
11	0.000		0.0000	4.950		0.0000	5.913		0.0000
12	0.000		0.0000	5.400		0.0000	6.450		0.0000
13	0.000		0.0000	5.850		0.0000	6.988		0.0000
14	0.000		0.0000	6.300		0.0000	7.525		0.0000
15	0.000		0.0000	6.750		0.0000	8.063		0.0000
	Total Area (m^2)		0.0000	Total Area (m^2)		1.2015	Total Area (m^2)		1.1019

Table A.3g: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R7 Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		2.100	Stream Width (m):		4.850	Stream Width (m):		2.500
	Initial Dist to Bank (m)		0.350	Initial Dist to Bank (m)		0.606	Initial Dist to Bank (m)		0.500
	VSS* Distance (m):		0.350	VSS* Distance (m):		0.606	VSS* Distance (m):		0.500
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.350	0.07	0.025	0.606	0.04	0.024	0.500	0.09	0.045
2	0.700	0.07	0.0245	1.212	0.07	0.0424	1.000	0.07	0.0350
3	1.050	0.08	0.0280	1.818	0.05	0.0303	1.500	0.07	0.0350
4	1.400	0.11	0.0385	2.424	0.13	0.0788	2.000	0.04	0.0200
5	1.750	0.11	0.0385	3.030	0.10	0.0606	2.500	0.03	0.0150
6	2.100	0.06	0.0210	3.636	0.05	0.0303	3.000		0.0000
7	2.450		0.0000	4.242	0.05	0.0303	3.500		0.0000
8	2.800		0.0000	4.848	0.07	0.0424	4.000		0.0000
9	3.150		0.0000	5.454		0.0000	4.500		0.0000
10	3.500		0.0000	6.060		0.0000	5.000		0.0000
11	3.850		0.0000	6.666		0.0000	5.500		0.0000
12	4.200		0.0000	7.272		0.0000	6.000		0.0000
13	4.550		0.0000	7.878		0.0000	6.500		0.0000
14	4.900		0.0000	8.484		0.0000	7.000		0.0000
15	5.250		0.0000	9.090		0.0000	7.500		0.0000
	Total Area (m^2)		0.1750	Total Area (m^2)		0.3394	Total Area (m^2)		0.1500

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		4.600	Bankfull Width (m):		5.000	Bankfull Width (m):		6.300
	Initial Dist to Bank (m)		0.657	Initial Dist to Bank (m)		0.625	Initial Dist to Bank (m)		0.525
	VSS* Distance (m):		0.657	VSS* Distance (m):		0.625	VSS* Distance (m):		0.525
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.657	0.40	0.263	0.625	0.31	0.194	0.525	0.21	0.110
2	1.314	0.55	0.3614	1.250	0.33	0.2063	1.050	0.34	0.1785
3	1.971	0.58	0.3811	1.875	0.29	0.1813	1.575	0.31	0.1628
4	2.628	0.56	0.3679	2.500	0.37	0.2313	2.100	0.32	0.1680
5	3.285	0.60	0.3942	3.125	0.33	0.2063	2.625	0.28	0.1470
6	3.942	0.52	0.3416	3.750	0.38	0.2375	3.150	0.27	0.1418
7	4.599	0.46	0.3022	4.375	0.32	0.2000	3.675	0.25	0.1313
8	5.256		0.0000	5.000	0.41	0.2563	4.200	0.28	0.1470
9	5.913		0.0000	5.625		0.0000	4.725	0.27	0.1418
10	6.570		0.0000	6.250		0.0000	5.250	0.28	0.1470
11	7.227		0.0000	6.875		0.0000	5.775	0.22	0.1155
12	7.884		0.0000	7.500		0.0000	6.300	0.13	0.0683
13	8.541		0.0000	8.125		0.0000	6.825		0.0000
14	9.198		0.0000	8.750		0.0000	7.350		0.0000
15	9.855		0.0000	9.375		0.0000	7.875		0.0000
	Total Area (m^2)		2.4112	Total Area (m^2)		1.7125	Total Area (m^2)		1.6590

Table A.3h: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R8 Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		1.600	Stream Width (m):		1.950	Stream Width (m):		2.450
	Initial Dist to Bank (m)		0.320	Initial Dist to Bank (m)		0.390	Initial Dist to Bank (m)		0.350
	VSS* Distance (m):		0.320	VSS* Distance (m):		0.390	VSS* Distance (m):		0.350
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.320	0.10	0.032	0.390	0.25	0.098	0.350	0.02	0.007
2	0.640	0.08	0.0256	0.780	0.33	0.1287	0.700	0.03	0.0105
3	0.960	0.17	0.0544	1.170	0.30	0.1170	1.050	0.10	0.0350
4	1.280	0.13	0.0416	1.560	0.21	0.0819	1.400	0.11	0.0385
5	1.600	0.05	0.0160	1.950	0.07	0.0273	1.750	0.10	0.0350
6	1.920		0.0000	2.340		0.0000	2.100	0.07	0.0245
7	2.240		0.0000	2.730		0.0000	2.450	0.03	0.0105
8	2.560		0.0000	3.120		0.0000	2.800		0.0000
9	2.880		0.0000	3.510		0.0000	3.150		0.0000
10	3.200		0.0000	3.900		0.0000	3.500		0.0000
11	3.520		0.0000	4.290		0.0000	3.850		0.0000
12	3.840		0.0000	4.680		0.0000	4.200		0.0000
13	4.160		0.0000	5.070		0.0000	4.550		0.0000
14	4.480		0.0000	5.460		0.0000	4.900		0.0000
15	4.800		0.0000	5.850		0.0000	5.250		0.0000
	Total Area (m^2)		0.1696	Total Area (m^2)		0.4524	Total Area (m^2)		0.1610

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		5.400	Bankfull Width (m):		5.000	Bankfull Width (m):		4.200
	Initial Dist to Bank (m)		0.675	Initial Dist to Bank (m)		0.625	Initial Dist to Bank (m)		0.420
	VSS* Distance (m):		0.675	VSS* Distance (m):		0.625	VSS* Distance (m):		0.420
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.675	0.42	0.284	0.625	0.43	0.269	0.420	0.16	0.067
2	1.350	0.37	0.2498	1.250	0.49	0.3063	0.840	0.22	0.0924
3	2.025	0.45	0.3038	1.875	0.48	0.3000	1.260	0.24	0.1008
4	2.700	0.41	0.2768	2.500	0.42	0.2625	1.680	0.22	0.0924
5	3.375	0.34	0.2295	3.125	0.31	0.1938	2.100	0.20	0.0840
6	4.050	0.28	0.1890	3.750	0.13	0.0813	2.520	0.21	0.0882
7	4.725	0.21	0.1418	4.375	0.09	0.0563	2.940	0.22	0.0924
8	5.400	0.44	0.2970	5.000	0.12	0.0750	3.360	0.15	0.0630
9	6.075		0.0000	5.625		0.0000	3.780	0.16	0.0672
10	6.750		0.0000	6.250		0.0000	4.200	0.04	0.0168
11	7.425		0.0000	6.875		0.0000	4.620		0.0000
12	8.100		0.0000	7.500		0.0000	5.040		0.0000
13	8.775		0.0000	8.125		0.0000	5.460		0.0000
14	9.450		0.0000	8.750		0.0000	5.880		0.0000
15	10.125		0.0000	9.375		0.0000	6.300		0.0000
	Total Area (m^2)		1.9710	Total Area (m^2)		1.5438	Total Area (m^2)		0.7644

Table A.3i: Summary of Wetted and Bankfull Cross-sectional Areas, Hazeltine Creek Habitat Characterization, October 2006

Stream Name: **Hazeltine Creek**

Reach Number: HC-R9

Date: Oct 23, 2006

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Stream Width (m):		3.650	Stream Width (m):		7.400	Stream Width (m):		6.400
	Initial Dist to Bank (m)		0.520	Initial Dist to Bank (m)		1.060	Initial Dist to Bank (m)		1.067
	VSS* Distance (m):		0.520	VSS* Distance (m):		1.060	VSS* Distance (m):		1.067
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.520	0.02	0.010	1.060	0.07	0.074	1.067	0.03	0.032
2	1.040	0.18	0.0936	2.120	0.25	0.2650	2.134	0.09	0.0960
3	1.560	0.29	0.1508	3.180	0.08	0.0848	3.201	0.18	0.1921
4	2.080	0.28	0.1456	4.240	0.05	0.0530	4.268	0.13	0.1387
5	2.600	0.18	0.0936	5.300	0.32	0.3392	5.335	0.05	0.0534
6	3.120	0.08	0.0416	6.360	0.35	0.3710	6.402	0.02	0.0213
7	3.640	0.03	0.0156	7.420	0.20	0.2120	7.469		0.0000
8	4.160		0.0000	8.480		0.0000	8.536		0.0000
9	4.680		0.0000	9.540		0.0000	9.603		0.0000
10	5.200		0.0000	10.600		0.0000	10.670		0.0000
11	5.720		0.0000	11.660		0.0000	11.737		0.0000
12	6.240		0.0000	12.720		0.0000	12.804		0.0000
13	6.760		0.0000	13.780		0.0000	13.871		0.0000
14	7.280		0.0000	14.840		0.0000	14.938		0.0000
15	7.800		0.0000	15.900		0.0000	16.005		0.0000
	Total Area (m^2)		0.5512	Total Area (m^2)		1.3992	Total Area (m^2)		0.5335

Vertical Sampling Station	Transect 1			Transect 2			Transect 3		
	Bankfull Width (m):		11.850	Bankfull Width (m):		10.800	Bankfull Width (m):		11.100
	Initial Dist to Bank (m)		0.988	Initial Dist to Bank (m)		1.200	Initial Dist to Bank (m)		1.010
	VSS* Distance (m):		0.988	VSS* Distance (m):		1.200	VSS* Distance (m):		1.010
	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)	Dist. from Initial Point (m)	Stream Depth (m)	Area (m^2)
1	0.988	0.45	0.444	1.200	0.44	0.528	1.010	0.59	0.596
2	1.975	0.59	0.5826	2.400	0.59	0.7080	2.020	0.57	0.5757
3	2.963	0.67	0.6616	3.600	0.41	0.4920	3.030	0.53	0.5353
4	3.950	0.64	0.6320	4.800	0.34	0.4080	4.040	0.53	0.5353
5	4.938	0.52	0.5135	6.000	0.18	0.2160	5.050	0.59	0.5959
6	5.925	0.42	0.4148	7.200	0.36	0.4320	6.060	0.52	0.5252
7	6.913	0.38	0.3753	8.400	0.65	0.7800	7.070	0.44	0.4444
8	7.900	0.26	0.2568	9.600	0.70	0.8400	8.080	0.43	0.4343
9	8.888	0.12	0.1185	10.800	0.58	0.6960	9.090	0.44	0.4444
10	9.875	0.06	0.0593	12.000		0.0000	10.100	0.33	0.3333
11	10.863	0.12	0.1185	13.200		0.0000	11.110	0.39	0.3939
12	11.850	0.25	0.2469	14.400		0.0000	12.120		0.0000
13	12.838		0.0000	15.600		0.0000	13.130		0.0000
14	13.825		0.0000	16.800		0.0000	14.140		0.0000
15	14.813		0.0000	18.000		0.0000	15.150		0.0000
	Total Area (m^2)		4.4240	Total Area (m^2)		5.1000	Total Area (m^2)		5.4136

Velocity Data and Stream Discharge Calculations

Sampling Site #: R1a
Stream Name: **Hazeltine Creek**
Stream Width (m): 0.75
Initial Point to Stream Edge (m) 0.1
Distance Between VSS* (m): 0.100

Date: Oct 22, 2006
Area (m^2): 0.0385
***** Discharge (m^3/s): 0.0050**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.100	0.05			0.020	0.01			0.010	0.003	0.0000
2	0.200	0.06			0.024	0.03			0.030	0.0060	0.0002
3	0.300	0.08			0.032	0.1			0.100	0.0080	0.0008
4	0.400	0.08			0.032	0.16			0.160	0.0080	0.0013
5	0.500	0.06			0.024	0.19			0.190	0.0060	0.0011
6	0.600	0.05			0.020	0.25			0.250	0.0050	0.0013
7	0.700	0.03			0.012	0.12			0.120	0.0030	0.0004
8	0.800	0.00			0.000	0			0.000	0.0000	0.0000
9	0.900				0.000				0.000	0.0000	0.0000
10	1.000				0.000				0.000	0.0000	0.0000
11	1.100				0.000				0.000	0.0000	0.0000
12	1.200				0.000				0.000	0.0000	0.0000
13	1.300				0.000				0.000	0.0000	0.0000
14	1.400				0.000				0.000	0.0000	0.0000
15	1.500				0.000				0.000	0.0000	0.0000
16	1.600				0.000				0.000	0.0000	0.0000
17	1.700				0.000				0.000	0.0000	0.0000
18	1.800				0.000				0.000	0.0000	0.0000
19	1.900				0.000				0.000	0.0000	0.0000
20	2.000				0.000				0.000	0.0000	0.0000
21	2.100				0.000				0.000	0.0000	0.0000
22	2.200				0.000				0.000	0.0000	0.0000
23	2.300				0.000				0.000	0.0000	0.0000
24	2.400				0.000				0.000	0.0000	0.0000
25	2.500				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R1b

Stream Name: **Hazeltine Creek**

Stream Width (m): 1.05

Initial Point to Stream Edge (m) 0.1

Distance Between VSS* (m): 0.100

Date: Oct 23, 2006

Area (m^2): 0.0645

***** Discharge (m^3/s): 0.0068**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.100	0.09			0.036	0.01			0.010	0.005	0.0000
2	0.200	0.09			0.036	0.03			0.030	0.0090	0.0003
3	0.300	0.10			0.040	0.11			0.110	0.0100	0.0011
4	0.400	0.10			0.040	0.11			0.110	0.0100	0.0011
5	0.500	0.08			0.032	0.14			0.140	0.0080	0.0011
6	0.600	0.06			0.024	0.18			0.180	0.0060	0.0011
7	0.700	0.06			0.024	0.17			0.170	0.0060	0.0010
8	0.800	0.04			0.016	0.14			0.140	0.0040	0.0006
9	0.900	0.04			0.016	0.09			0.090	0.0040	0.0004
10	1.000	0.03			0.012	0.05			0.050	0.0030	0.0002
11	1.100	0.00			0.000	0			0.000	0.0000	0.0000
12	1.200				0.000				0.000	0.0000	0.0000
13	1.300				0.000				0.000	0.0000	0.0000
14	1.400				0.000				0.000	0.0000	0.0000
15	1.500				0.000				0.000	0.0000	0.0000
16	1.600				0.000				0.000	0.0000	0.0000
17	1.700				0.000				0.000	0.0000	0.0000
18	1.800				0.000				0.000	0.0000	0.0000
19	1.900				0.000				0.000	0.0000	0.0000
20	2.000				0.000				0.000	0.0000	0.0000
21	2.100				0.000				0.000	0.0000	0.0000
22	2.200				0.000				0.000	0.0000	0.0000
23	2.300				0.000				0.000	0.0000	0.0000
24	2.400				0.000				0.000	0.0000	0.0000
25	2.500				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: W7
Stream Name: **Hazeltine Creek**
Stream Width (m): 1.2
Initial Point to Stream Edge (m) 0.1
Distance Between VSS* (m): 0.100

Date: Oct 23, 2006
Area (m^2): 0.0655
***** Discharge (m^3/s): 0.0094**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.100	0.05			0.020	0.04			0.040	0.003	0.0001
2	0.200	0.06			0.024	0.06			0.060	0.0060	0.0004
3	0.300	0.07			0.028	0.01			0.010	0.0070	0.0001
4	0.400	0.07			0.028	0.2			0.200	0.0070	0.0014
5	0.500	0.07			0.028	0.17			0.170	0.0070	0.0012
6	0.600	0.08			0.032	0.15			0.150	0.0080	0.0012
7	0.700	0.06			0.024	0.12			0.120	0.0060	0.0007
8	0.800	0.06			0.024	0.07			0.070	0.0060	0.0004
9	0.900	0.06			0.024	0.32			0.320	0.0060	0.0019
10	1.000	0.05			0.020	0.26			0.260	0.0050	0.0013
11	1.100	0.05			0.020	0.14			0.140	0.0050	0.0007
12	1.200	0.00			0.000	0			0.000	0.0000	0.0000
13	1.300				0.000				0.000	0.0000	0.0000
14	1.400				0.000				0.000	0.0000	0.0000
15	1.500				0.000				0.000	0.0000	0.0000
16	1.600				0.000				0.000	0.0000	0.0000
17	1.700				0.000				0.000	0.0000	0.0000
18	1.800				0.000				0.000	0.0000	0.0000
19	1.900				0.000				0.000	0.0000	0.0000
20	2.000				0.000				0.000	0.0000	0.0000
21	2.100				0.000				0.000	0.0000	0.0000
22	2.200				0.000				0.000	0.0000	0.0000
23	2.300				0.000				0.000	0.0000	0.0000
24	2.400				0.000				0.000	0.0000	0.0000
25	2.500				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: W7
Stream Name: **Hazeltine Creek**
Stream Width (m): 0.85
Initial Point to Stream Edge (m) 0.1
Distance Between VSS* (m): 0.100

Date: Oct 23, 2006
Area (m^2): 0.0335
***** Discharge (m^3/s): 0.0073**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.100	0.07			0.028	0.1			0.100	0.004	0.0004
2	0.200	0.15			0.060	0.26			0.260	0.0150	0.0039
3	0.300	0.02			0.008	0.26			0.260	0.0020	0.0005
4	0.400	0.03			0.012	0.17			0.170	0.0030	0.0005
5	0.500	0.03			0.012	0.28			0.280	0.0030	0.0008
6	0.600	0.03			0.012	0.19			0.190	0.0030	0.0006
7	0.700	0.02			0.008	0.12			0.120	0.0020	0.0002
8	0.800	0.02			0.008	0.18			0.180	0.0020	0.0004
9	0.900	0.00			0.000	0			0.000	0.0000	0.0000
10	1.000				0.000				0.000	0.0000	0.0000
11	1.100				0.000				0.000	0.0000	0.0000
12	1.200				0.000				0.000	0.0000	0.0000
13	1.300				0.000				0.000	0.0000	0.0000
14	1.400				0.000				0.000	0.0000	0.0000
15	1.500				0.000				0.000	0.0000	0.0000
16	1.600				0.000				0.000	0.0000	0.0000
17	1.700				0.000				0.000	0.0000	0.0000
18	1.800				0.000				0.000	0.0000	0.0000
19	1.900				0.000				0.000	0.0000	0.0000
20	2.000				0.000				0.000	0.0000	0.0000
21	2.100				0.000				0.000	0.0000	0.0000
22	2.200				0.000				0.000	0.0000	0.0000
23	2.300				0.000				0.000	0.0000	0.0000
24	2.400				0.000				0.000	0.0000	0.0000
25	2.500				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m
*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R4

Stream Name: **Hazeltine Creek**

Stream Width (m): 1.65

Initial Point to Stream Edge (m) 0.15

Distance Between VSS* (m): 0.150

Date: Oct 25, 2006

Area (m^2): 0.1253

***** Discharge (m^3/s): 0.0079**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.150	0.07			0.028	0			0.000	0.005	0.0000
2	0.300	0.07			0.028	0			0.000	0.0105	0.0000
3	0.450	0.11			0.044	0.05			0.050	0.0165	0.0008
4	0.600	0.11			0.044	0.13			0.130	0.0165	0.0021
5	0.750	0.09			0.036	0.18			0.180	0.0135	0.0024
6	0.900	0.10			0.040	0.1			0.100	0.0150	0.0015
7	1.050	0.11			0.044	0.06			0.060	0.0165	0.0010
8	1.200	0.08			0.032	0			0.000	0.0120	0.0000
9	1.350	0.08			0.032	0			0.000	0.0120	0.0000
10	1.500	0.05			0.020	0			0.000	0.0075	0.0000
11	1.650	0.00			0.000	0			0.000	0.0000	0.0000
12	1.800				0.000				0.000	0.0000	0.0000
13	1.950				0.000				0.000	0.0000	0.0000
14	2.100				0.000				0.000	0.0000	0.0000
15	2.250				0.000				0.000	0.0000	0.0000
16	2.400				0.000				0.000	0.0000	0.0000
17	2.550				0.000				0.000	0.0000	0.0000
18	2.700				0.000				0.000	0.0000	0.0000
19	2.850				0.000				0.000	0.0000	0.0000
20	3.000				0.000				0.000	0.0000	0.0000
21	3.150				0.000				0.000	0.0000	0.0000
22	3.300				0.000				0.000	0.0000	0.0000
23	3.450				0.000				0.000	0.0000	0.0000
24	3.600				0.000				0.000	0.0000	0.0000
25	3.750				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R5
Stream Name: **Hazeltine Creek**
Stream Width (m): 1.55
Initial Point to Stream Edge (m) 0.15
Distance Between VSS* (m): 0.150

Date: Oct 25, 2006
Area (m^2): 0.0863
***** Discharge (m^3/s): 0.0137**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.150	0.13			0.052	0.16			0.160	0.010	0.0016
2	0.300	0.06			0.024	0.09			0.090	0.0090	0.0008
3	0.450	0.07			0.028	0.2			0.200	0.0105	0.0021
4	0.600	0.11			0.044	0.35			0.350	0.0165	0.0058
5	0.750	0.08			0.032	0.14			0.140	0.0120	0.0017
6	0.900	0.06			0.024	0.05			0.050	0.0090	0.0005
7	1.050	0.05			0.020	0.04			0.040	0.0075	0.0003
8	1.200	0.04			0.016	0.07			0.070	0.0060	0.0004
9	1.350	0.03			0.012	0.13			0.130	0.0045	0.0006
10	1.500	0.01			0.004	0.03			0.030	0.0015	0.0000
11	1.650	0.00			0.000	0			0.000	0.0000	0.0000
12	1.800				0.000				0.000	0.0000	0.0000
13	1.950				0.000				0.000	0.0000	0.0000
14	2.100				0.000				0.000	0.0000	0.0000
15	2.250				0.000				0.000	0.0000	0.0000
16	2.400				0.000				0.000	0.0000	0.0000
17	2.550				0.000				0.000	0.0000	0.0000
18	2.700				0.000				0.000	0.0000	0.0000
19	2.850				0.000				0.000	0.0000	0.0000
20	3.000				0.000				0.000	0.0000	0.0000
21	3.150				0.000				0.000	0.0000	0.0000
22	3.300				0.000				0.000	0.0000	0.0000
23	3.450				0.000				0.000	0.0000	0.0000
24	3.600				0.000				0.000	0.0000	0.0000
25	3.750				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m
*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R6
Stream Name: **Hazeltine Creek**
Stream Width (m): 1.75
Initial Point to Stream Edge (m) 0.1
Distance Between VSS* (m): 0.150

Date: Oct 25, 2006
Area (m^2): 0.1058
***** Discharge (m^3/s): 0.0173**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.100	0.03			0.012	0.04			0.040	0.002	0.0001
2	0.250	0.04			0.016	0.1			0.100	0.0060	0.0006
3	0.400	0.05			0.020	0.16			0.160	0.0075	0.0012
4	0.550	0.05			0.020	0.13			0.130	0.0075	0.0010
5	0.700	0.07			0.028	0.1			0.100	0.0105	0.0011
6	0.850	0.08			0.032	0.24			0.240	0.0120	0.0029
7	1.000	0.07			0.028	0.21			0.210	0.0105	0.0022
8	1.150	0.08			0.032	0.23			0.230	0.0120	0.0028
9	1.300	0.10			0.040	0.2			0.200	0.0150	0.0030
10	1.450	0.09			0.036	0.16			0.160	0.0135	0.0022
11	1.600	0.06			0.024	0.04			0.040	0.0090	0.0004
12	1.750	0.00			0.000	0			0.000	0.0000	0.0000
13	1.900				0.000				0.000	0.0000	0.0000
14	2.050				0.000				0.000	0.0000	0.0000
15	2.200				0.000				0.000	0.0000	0.0000
16	2.350				0.000				0.000	0.0000	0.0000
17	2.500				0.000				0.000	0.0000	0.0000
18	2.650				0.000				0.000	0.0000	0.0000
19	2.800				0.000				0.000	0.0000	0.0000
20	2.950				0.000				0.000	0.0000	0.0000
21	3.100				0.000				0.000	0.0000	0.0000
22	3.250				0.000				0.000	0.0000	0.0000
23	3.400				0.000				0.000	0.0000	0.0000
24	3.550				0.000				0.000	0.0000	0.0000
25	3.700				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R7

Stream Name: **Hazeltine Creek**

Stream Width (m): 1.7

Initial Point to Stream Edge (m) 0.15

Distance Between VSS* (m): 0.150

Date: Oct 25, 2006

Area (m^2): 0.1418

***** Discharge (m^3/s): 0.0143**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.150	0.06			0.024	0			0.000	0.005	0.0000
2	0.300	0.09			0.034	0			0.000	0.0128	0.0000
3	0.450	0.07			0.028	0.39			0.390	0.0105	0.0041
4	0.600	0.09			0.036	0.13			0.130	0.0135	0.0018
5	0.750	0.09			0.036	0.11			0.110	0.0135	0.0015
6	0.900	0.09			0.036	0.03			0.030	0.0135	0.0004
7	1.050	0.08			0.032	0			0.000	0.0120	0.0000
8	1.200	0.09			0.036	0.01			0.010	0.0135	0.0001
9	1.350	0.13			0.052	0.14			0.140	0.0195	0.0027
10	1.500	0.12			0.048	0.19			0.190	0.0180	0.0034
11	1.650	0.07			0.028	0.03			0.030	0.0105	0.0003
12	1.800	0.00			0.000	0			0.000	0.0000	0.0000
13	1.950				0.000				0.000	0.0000	0.0000
14	2.100				0.000				0.000	0.0000	0.0000
15	2.250				0.000				0.000	0.0000	0.0000
16	2.400				0.000				0.000	0.0000	0.0000
17	2.550				0.000				0.000	0.0000	0.0000
18	2.700				0.000				0.000	0.0000	0.0000
19	2.850				0.000				0.000	0.0000	0.0000
20	3.000				0.000				0.000	0.0000	0.0000
21	3.150				0.000				0.000	0.0000	0.0000
22	3.300				0.000				0.000	0.0000	0.0000
23	3.450				0.000				0.000	0.0000	0.0000
24	3.600				0.000				0.000	0.0000	0.0000
25	3.750				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R8
Stream Name: **Hazeltine Creek**
Stream Width (m): 2.45
Initial Point to Stream Edge (m) 0.15
Distance Between VSS* (m): 0.150

Date: Oct 26, 2006
Area (m^2): 0.1883
***** Discharge (m^3/s): 0.0254**

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.150	0.05			0.020	0.01			0.010	0.004	0.0000
2	0.300	0.09			0.036	0.14			0.140	0.0135	0.0019
3	0.450	0.11			0.044	0.31			0.310	0.0165	0.0051
4	0.600	0.11			0.044	0.31			0.310	0.0165	0.0051
5	0.750	0.10			0.040	0.29			0.290	0.0150	0.0044
6	0.900	0.09			0.036	0.23			0.230	0.0135	0.0031
7	1.050	0.10			0.040	0.22			0.220	0.0150	0.0033
8	1.200	0.11			0.044	0.13			0.130	0.0165	0.0021
9	1.350	0.10			0.040	0.04			0.040	0.0150	0.0006
10	1.500	0.09			0.036	0			0.000	0.0135	0.0000
11	1.650	0.09			0.036	0.01			0.010	0.0135	0.0001
12	1.800	0.08			0.032	-0.01			-0.010	0.0120	-0.0001
13	1.950	0.07			0.028	-0.01			-0.010	0.0105	-0.0001
14	2.100	0.03			0.012	-0.01			-0.010	0.0045	0.0000
15	2.250	0.05			0.020	-0.01			-0.010	0.0075	-0.0001
16	2.400	0.01			0.004	0			0.000	0.0015	0.0000
17	2.550	0.00			0.000	0			0.000	0.0000	0.0000
18	2.700				0.000				0.000	0.0000	0.0000
19	2.850				0.000				0.000	0.0000	0.0000
20	3.000				0.000				0.000	0.0000	0.0000
21	3.150				0.000				0.000	0.0000	0.0000
22	3.300				0.000				0.000	0.0000	0.0000
23	3.450				0.000				0.000	0.0000	0.0000
24	3.600				0.000				0.000	0.0000	0.0000
25	3.750				0.000				0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0.5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

Velocity Data and Stream Discharge Calculations

Sampling Site #: R9 Confluence
Stream Name: Edney Creek
Stream Width (m): 2.65
Initial Point to Stream Edge (m) 0.1
Distance Between VSS* (m): 0.100

Date: Oct 23, 2006
Area (m^2): 0.3240
*** Discharge (m^3/s): 0.0369

Vertical Sampling Station	Dist. from Initial Point (m)	Stream Depth (m)	0.2 of Depth from Surface		0.6 of Depth from Surface		0.8 of Depth from Surface		Mean** Velocity (m/s)	Area (m^2)	Discharge (m^3/s)
			Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)	Depth from Bottom (m)	Velocity (m/sec)			
1	0.100	0.15			0.060	0.02			0.020	0.008	0.0002
2	0.200	0.15			0.060	0.03			0.030	0.0150	0.0005
3	0.300	0.18			0.072	0.07			0.070	0.0180	0.0013
4	0.400	0.21			0.084	0.14			0.140	0.0210	0.0029
5	0.500	0.22			0.088	0.16			0.160	0.0220	0.0035
6	0.600	0.28			0.112	0 2			0.200	0.0280	0.0056
7	0.700	0.29			0.116	0.22			0.220	0.0290	0.0064
8	0.800	0.27			0.108	0.18			0.180	0.0270	0.0049
9	0.900	0.25			0.100	0.09			0.090	0.0250	0.0023
10	1.000	0.22			0.088	0.05			0.050	0.0220	0.0011
11	1.100	0.17			0.068	0.03			0.030	0.0170	0.0005
12	1.200	0.17			0.068	0.02			0.020	0.0170	0.0003
13	1.300	0.13			0.052	0.01			0.010	0.0130	0.0001
14	1.400	0.11			0.044	0.01			0.010	0.0110	0.0001
15	1.500	0.03			0.012	0.03			0.030	0.0030	0.0001
16	1.600	0.05			0.020	0.1			0.100	0.0050	0.0005
17	1.700	0.06			0.024	0.12			0.120	0.0060	0.0007
18	1.800	0.05			0.020	0.13			0.130	0.0050	0.0007
19	1.900	0.05			0.020	0.15			0.150	0.0050	0.0008
20	2.000	0.05			0.018	0.15			0.150	0.0045	0.0007
21	2.100	0.04			0.016	0.15			0.150	0.0040	0.0006
22	2.200	0.05			0.020	0.17			0.170	0.0050	0.0009
23	2.300	0.07			0.028	0.19			0.190	0.0070	0.0013
24	2.400	0.07			0.028	0.16			0.160	0.0070	0.0011
25	2.500	0.06			0.024	0.11			0.110	0.0060	0.0007
26	2.600	0.05			0.018	0.02			0.020	0.0045	0.0001
	2.700	0.00			0.000	0			0.000	0.0000	0.0000

** Mean Velocity = V@0.6d for d < or = 0 5 m or (V@0.2d + 2xV@0.6d + V@0.8d)/4 for d > 0.5 m

*** Total Discharge = sum of discharges calculated at each Vertical Sampling Station

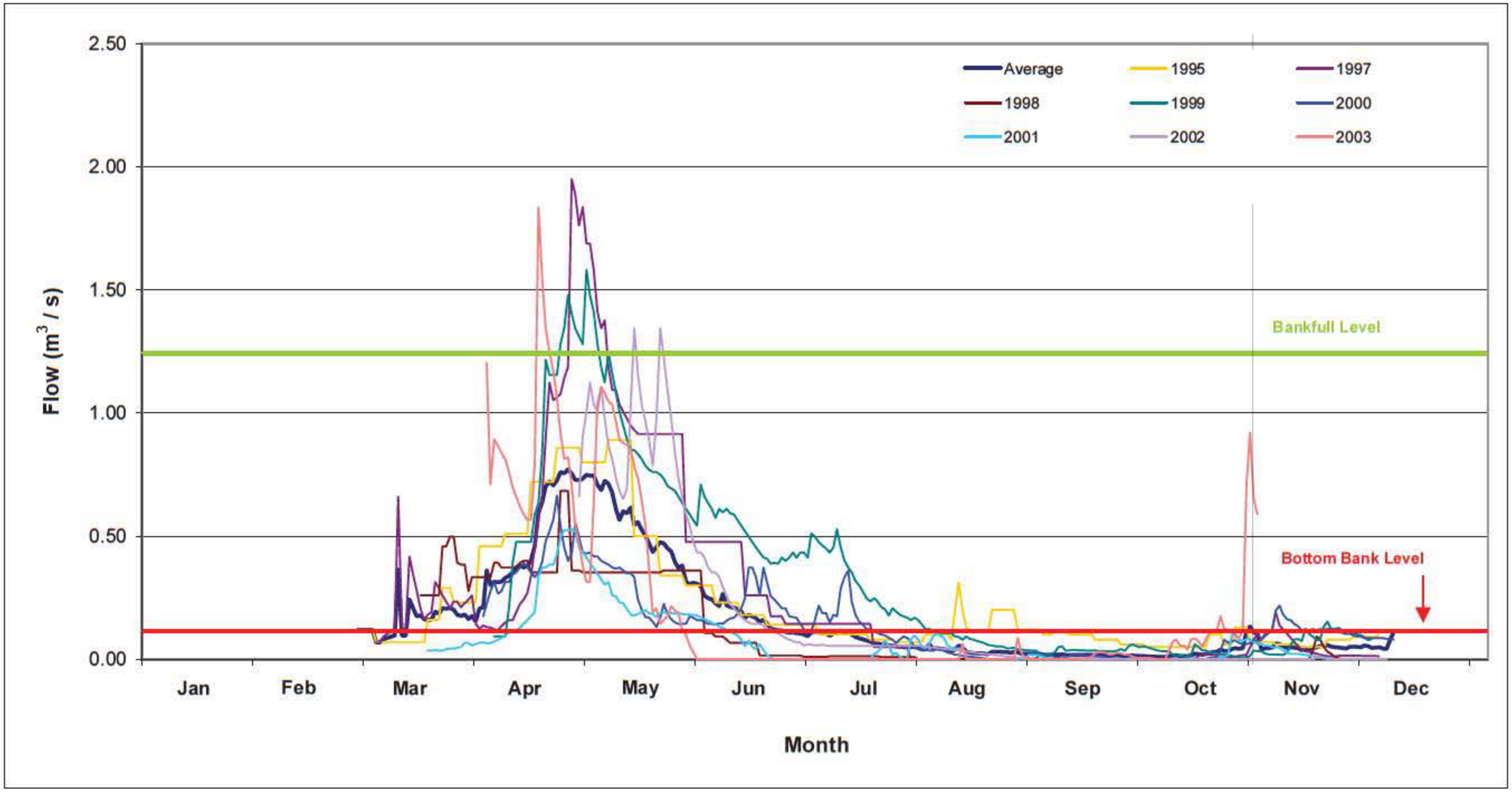


Figure A.1: Hazeltine Creek Annual Daily Discharge at Station W7 (1995 & 1997 to 2003) Relative to Bankfull and Bottom-bank Stages

APPENDIX B

HAZELTINE CREEK PHOTOGRAPHS

Photo B.1: Downstream view characteristically unconfined channel conditions at HC-R1 Substrate at such areas was typically fine gravel to sand.

Photo B.2: Upstream view of channel at HC-R1 illustrating low gradient and densely vegetated riparian zone. 'Run' habitat was the dominant morphology type.

Photo B.3: View across ponded area at the lower portion of Reach HC-R2. This pond likely provides important overwintering habitat for the Hazeltine Creek fish.

Photo B.4: Habitat at Reach HC-R3 was characterized by low gradient, run morphology with predominantly sand substrate.

Photo B.5: Side channels and the occurrence of unstable banks were more prevalent at Reach HC-R3, likely as a result of multiple overflow points across a beaver dam that marked the upper boundary of the reach.

Photo B.6: Upstream view towards the Mount Polley Mine water gauge station on Hazeltine Creek at Gavin Lake Road. This location marked the upper boundary of Reach 4 (HC-R4).

Photo B.7: Upstream view of general stream conditions through Reach HC-R4. Low water levels at the time of the survey often resulted in greater than 25% stream-bed exposure. In-stream substrate typically consisted of cobble-gravel.

Photo B.8: Example of an undercut bank observed in Reach HC-R4. Although undercut banks were common through this reach, overall bank stability was generally considered moderate.

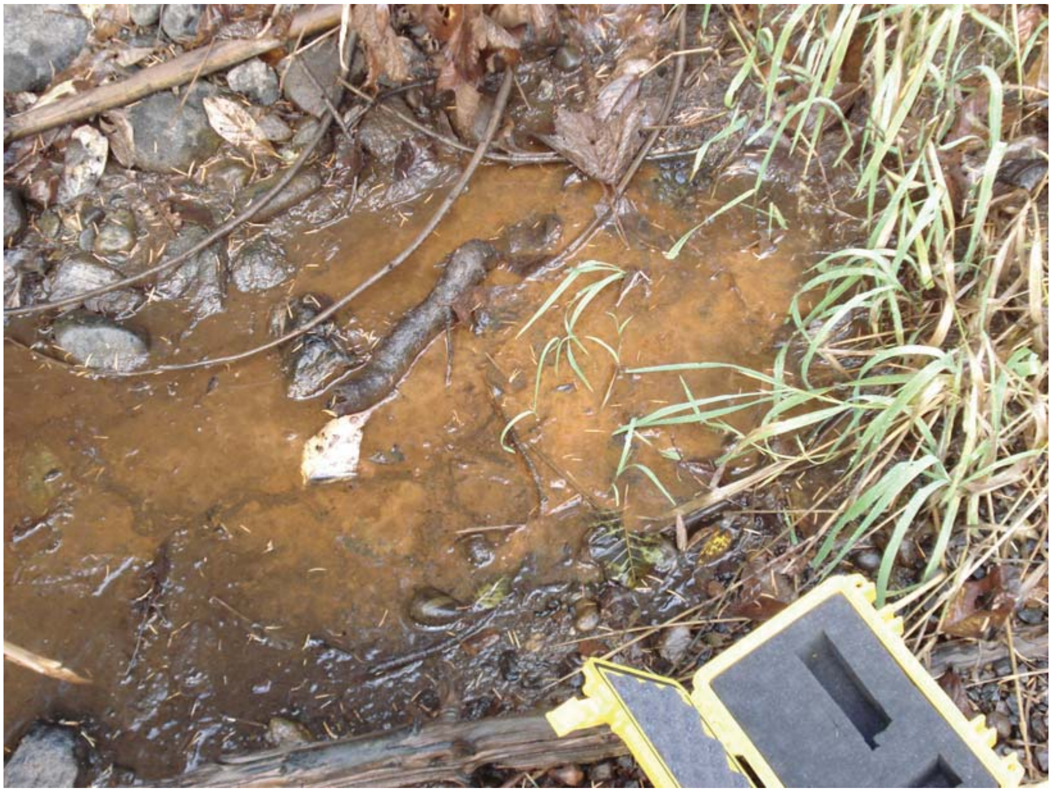


Photo B.9: Although Edney Creek was the only surface water tributary feeding Hazeltine Creek, groundwater seeps containing high iron content were occasionally observed. This small seep was found along the bank of HC-R4.

Photo B.10: Downstream view of typical channel through Reach HC-R5. This reach was characterized by a clear gradient shift (mean 3.7%) relative to upstream areas.

Photo B.11: Upstream view of an approximately 1.2 m high cascade found in the lower portion of Reach HC-R5. This cascade likely acted as a barrier to upstream fish migration, particularly during low flow periods.

Photo B.12: Slumping valley walls such as the one illustrated above were observed at two locations along Hazeltine Creek, both of which were within Reach HC-R5.

Photo B.13: Reach HC-R6 represented that portion of Hazeltine Creek which passed through a steep-walled gorge. Bank stability was considered good at HC-R6 as a result of a high proportion of bedrock/cobble in the banks.

Photo B.14: Step-pools with cobble substrate characterized HC-R6 habitat. Mean gradient through this reach was approximately 7%.

Photo B.15: In-stream barriers, such as this large debris jam, were common through Reach HC-R6, likely preventing upstream fish migration at all but highest flows.

Photo B.16: In-stream barriers at Reach HC-R6 also included areas of aggraded cobble over log debris, which resulted in short sections of subterranean flow.

Photo B.17: Downstream view of typical Reach HC-R7 habitat. Moderate gradient, riffle-run stream morphology and cobble substrate were key features of this reach.

Photo B.18: Downstream view of Reach HC-R8 in its upper portion. Low gradient run habitat with gravel substrate and dense overhanging vegetation were dominant features of this reach.

Photo B.19: Downstream view of Reach HC-R8 in its lower portion. At this area, the creek flows through cedar lowland habitat and some bank undercutting occurs. Stream flow increases substantially at HC-R8 relative to upstream areas.

Photo B.20: Edney Creek, just upstream of the confluence with Hazeltine Creek, was ponded as a result of a beaver dam (bottom of photo). Flow from Edney Creek represents approximately 60% of the total in lower Hazeltine Creek.

Photo B.21: Upstream view of Reach HC-R9 in its upper portion. Low gradient run habitat and cobble-gravel substrate characterized this reach.

Photo B.22: Upstream view of Reach HC-R9 approximately 385 m upstream of the outlet of Hazeltine Creek. Water samples are routinely sampled by Mount Polley Mine at this location (Station W11).

Photo B.23: Upstream view of Hazeltine Creek from its outlet to Quesnel Lake. The creek outlet occurs across a small delta. At the time of the survey, water depth along the ‘delta’ portions of Hazeltine Creek was typically less than 10 cm.

Photo B.24: Two beaver dams constructed at the downstream end of Reach HC-R9 would likely act as key barriers for any upstream migration of spawning kokanee in lower Hazeltine Creek. No kokanee, or evidence of kokanee spawning, were observed in lower Hazeltine Creek.

Photo B.25: Hazeltine Creek approximately 440 m upstream of Quesnel Lake (HC-R9). Fish habitat included some pool and woody debris in lower Hazeltine Creek, although the relative amount of functional habitat was considered low.

Photo B.26: Hazeltine Creek approximately 340 m upstream of Quesnel Lake. Substrate generally consisted of small cobble (5 cm diameter) in much of lower Hazeltine Creek. Filamentous green algae were conspicuously abundant on in-stream substrate at locations below the Edney Creek confluence.

Photo B.27: Riffle habitat in lower Hazeltine Creek (HC-R9) was generally shallow (i.e., less than 10 cm deep) and likely to restrict upstream movement of large fish.

Photo B.28: View of ponded area in lower Hazeltine Creek approximately 300 m upstream of Quesnel Lake. The flooded area, which may provide overwintering habitat for resident fish, is occupied by submerged willow stands.

Photo B.29: Downstream view of pool habitat in lower Hazeltine Creek. This pool was approximately 0.6 m deep and contained undercut bank and large woody debris cover, providing good cover opportunities for fish.

Mount Polley Mine
Evaluation of the Water Quality of Polley and Bootjack Lakes

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July, 2010

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1.0 INTRODUCTION

1.1 Background

The Mount Polley Mining Corporation, a division of the Imperial Metals Corporation, owns and operates the Mount Polley copper-gold mine located 56 kilometres north-east of Williams Lake, British Columbia (Figure 1.1). The mine operated from August 1997 to September 2001, was placed on care and maintenance from September 2001 to March 2005, and was officially re-opened in March 2005 in response to improved metal prices and the discovery of significant new ore reserves. Currently, the projected mine life is expected to extend to late 2015. Since March 2005, mining has been active at five open pits (the Bell, Springer, Southeast, Wight and Pond Zone pits; Figure 1.2), with an additional area (the Boundary Zone) identified as a target for future development. The Mount Polley Mine site also includes a crusher and mill (concentrator), a Tailings Storage Facility (TSF), seepage collection ponds, a surface water collection system, a settling pond, access roads, and a mined-out open pit (the Cariboo Pit).

Mount Polley mill tailings and site water are discharged into the environmentally-secure TSF, with supernatant from the TSF recycled for re-use in the milling process. Due to the significant accumulation of water within the TSF, the Mount Polley Mine is in the process of seeking approval, under the Waste Discharge Regulation of the British Columbia *Environmental Management Act*, to discharge polished TSF supernatant to Hazeltine Creek.

The Mount Polley Mine has implemented a comprehensive water quality monitoring program since mine start-up in 1997 that includes sampling of source areas, surface drainages and the creeks and lakes located adjacent to the mine. In addition to water quality monitoring data, baseline data (collected in 1989, 1995 and 1996) are available for most of the creeks and lakes adjacent to the mine. Water quality of two lakes located adjacent to the mine has been monitored less intensively than in source areas, surface drainages and creeks, but has also been monitored in both baseline and operational periods. Although the mine has not had a direct discharge to either Polley Lake or Bootjack Lake, site disturbances adjacent to both lakes have the potential to influence water quality (see Figure 1.2). No comprehensive examination of baseline and operational water quality monitoring data has been conducted to date for these lakes to evaluate whether any potential mine influences have occurred. Accordingly, the Mount Polley Mine retained Minnow Environmental Inc. to compile and evaluate the existing water quality data from Polley and Bootjack lakes in order to characterize lake water quality and identify any potential influence of the Mount Polley Mine.

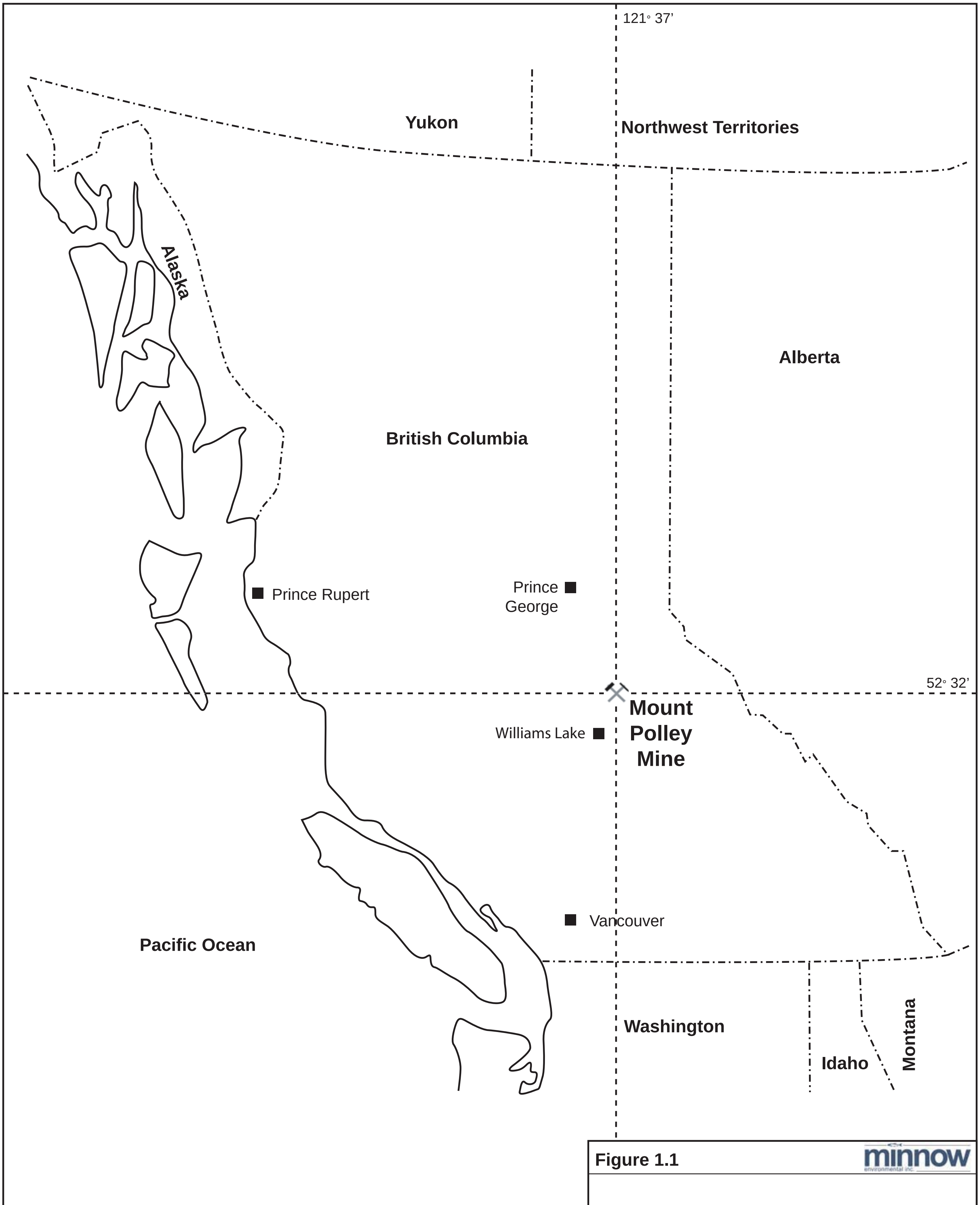

Figure 1.1

minnow environmental inc.

Location of the Mount Polley mine.

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Date: July 2010

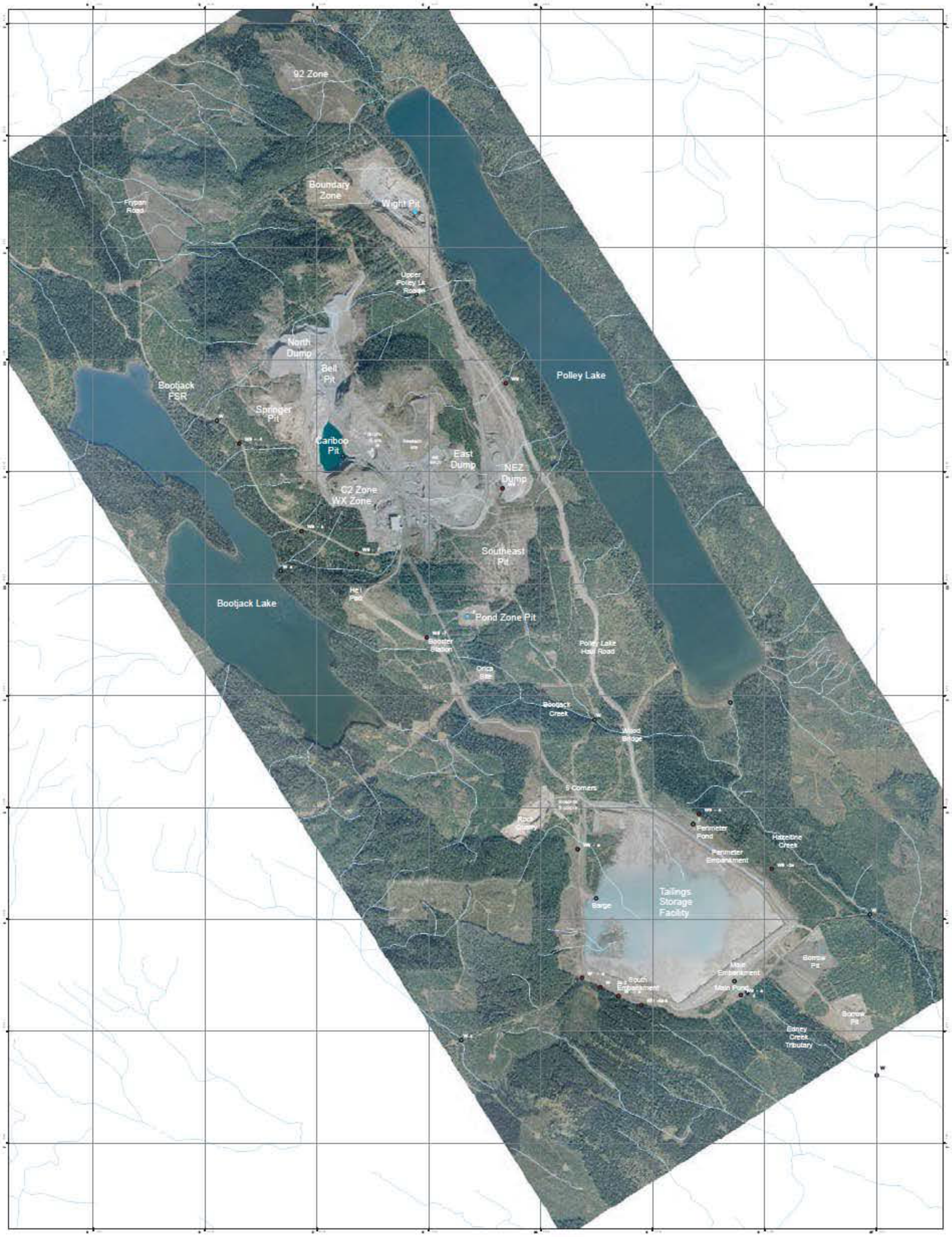

Figure 1.2

Overview of the Mount Polley mine site.

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Date July 2010

Source Mount Polley Mining Corporation

1.2 Project Objectives

The objectives of this study were to: 1) compile and present existing water quality data from Polley and Bootjack lakes; and 2) evaluate the influence of the Mount Polley Mine on the water quality of these lakes.

1.3 Report Organization

Methods associated with the compilation and analysis of water quality data are provided in Section 2.0 of this report. Section 3.0 provides a summary of the *in-situ* water quality monitoring data collected from Polley and Bootjack lakes. Section 4.0 provides a summary and interpretation of water chemistry data collected from Polley and Bootjack lakes. Conclusions of the evaluation and recommendations for ongoing monitoring are provided in Section 5.0. All references cited throughout this report are listed in Section 6.0.

2.0 METHODS

2.1 Data Compilation

The Mount Polley Mine provided water quality monitoring data for Polley Lake and Bootjack Lake in digital format. Data were available for the baseline period (1985 to 1996) and from 2001 to present (data to the end of 2009 are included in this report) for two stations within each of Polley and Bootjack lakes (Figures 2.1 and 2.2). The available data included *in-situ* measurements of water temperature, dissolved oxygen, conductivity and pH collected by field meter at regular depth intervals to create vertical profiles. *In-situ* water clarity data, as represented by Secchi depth, measured using a standard secchi disc, were also provided for the operational period. Finally, water chemistry data were provided for a substantial list of analytes (Table 2.1), which were generally collected from near the surface and bottom of the water column at each station in both study lakes. Upon receipt of the data, the data were organized by lake, station and sampling depth. Organized data were then used as the basis for analysis of *in-situ* and water chemistry as described below.

2.2 Analysis of *In-Situ* Data

Profiles of water temperature, dissolved oxygen, conductivity and pH were recorded at all stations in Polley and Bootjack lakes during both pre-operational (baseline) and the second operational period. These data were plotted and then visually assessed to qualitatively characterize seasonal patterns of mixing within the lakes and evaluate any changes in mixing over time. *In-situ* measurements were also used to estimate the typical depth of seasonal thermo- or chemo-clines and any associated conditions that could constrain biological productivity (e.g., hypolimnetic oxygen depletion). Water clarity data were plotted monthly to identify seasonal trends. For *in-situ* parameters with British Columbia Water Quality Guidelines for the protection of aquatic life (BCWQG; BCMOE 2006a,b), comparisons were made to these guidelines to determine the potential for any biological limitations.

2.3 Analysis of Water Chemistry Data

Following the organization of the water quality monitoring data as described above, water chemistry data were examined to determine whether sampling was conducted at appropriate time intervals and consistent depths. Specifically, an effort was made to ensure that the database was not biased by examination of functionally pseudo-replicated data (e.g., Hurlbert 1984). This resulted in the exclusion of some data that were collected at depths other than surface and bottom because even if these could be assigned to either surface or bottom, doing so would result in pseudo-replication (omitted data are presented in Appendix

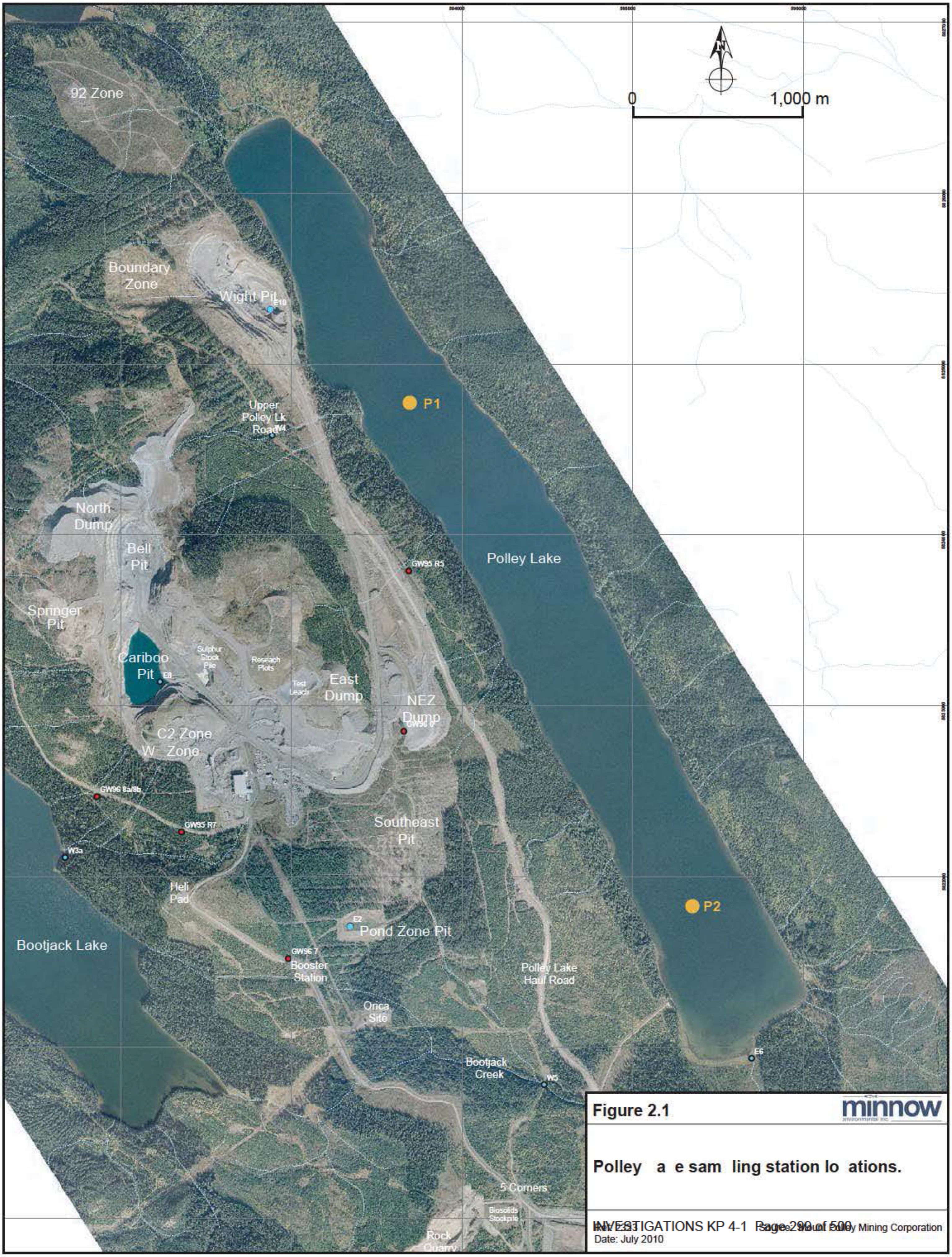

Figure 2.1

Polley Lake sampling station locations.

Ref: 2.3.3 Source: Mount Polley Mining Corporation
Date: July 2010

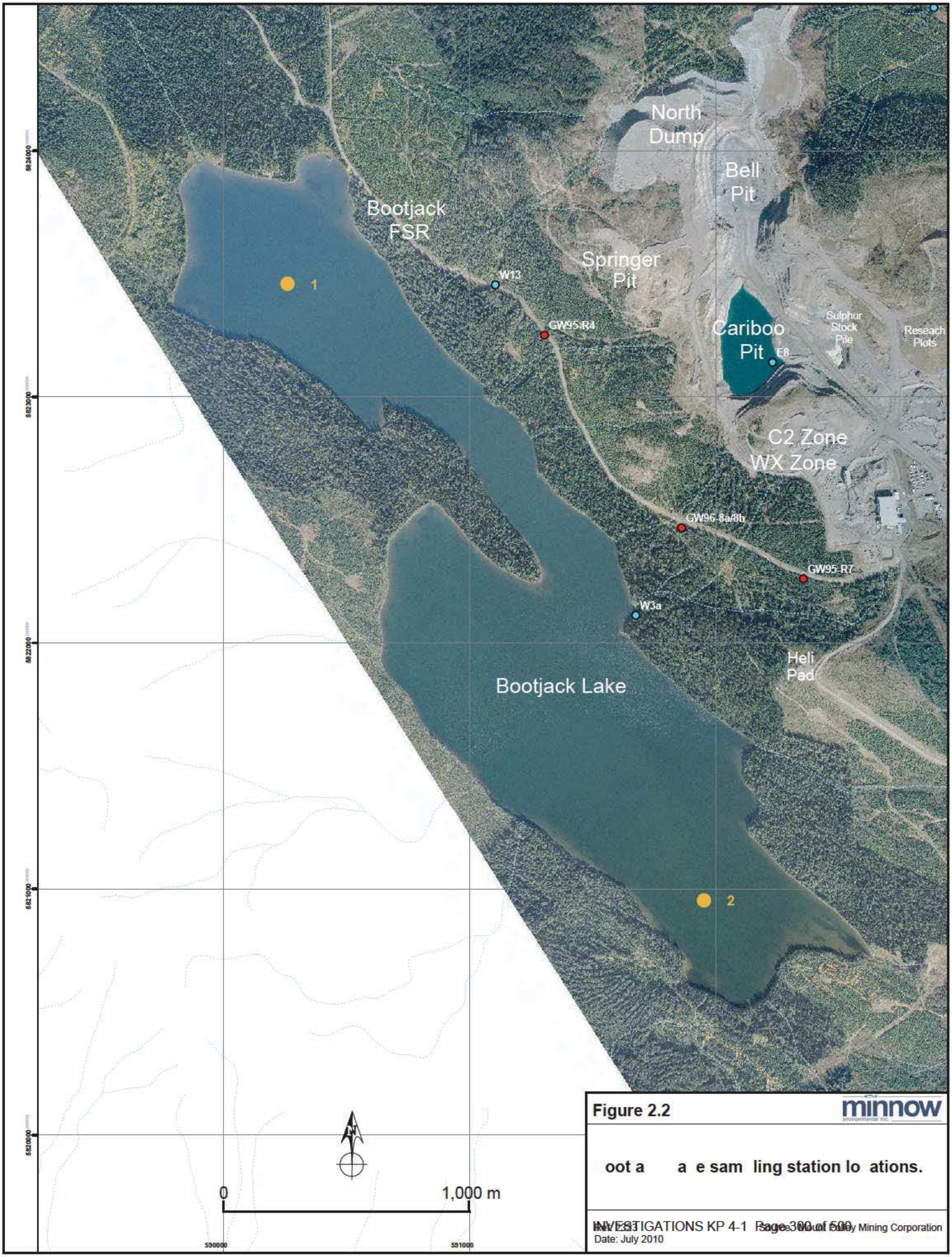

Figure 2.2

Bootjack Lake sampling station locations.

Rev 2.33
Date: July 2010
Source: Mount Polley Mining Corporation

Table 2.1: List of analytes assessed in water samples collected by the Mount Polley Mine

Total and Dissolved Metals	Other Parameters
Aluminum	Alkalinity (phenolphthalein)
Antimony	Alkalinity (total)
Arsenic	Ammonia Nitrogen
Barium	Bicarbonate
Beryllium	Carbonate
Bismuth	Cyanide (total)
Cadmium	Dissolved Organic Carbon
Calcium	Fluoride
Chromium	Hardness
Cobalt	Hydroxide
Copper	Nitrate
Iron	Nitrate + Nitrite
Lead	Nitrite
Lithium	Ortho-Phosphate (dissolved)
Magnesium	Ortho-Phosphate (total)
Manganese	Phosphate
Mercury	Phosphorus (dissolved)
Molybdenum	Phosphorus (total)
Nickel	Sulphate
Potassium	Total Dissolved Solids
Selenium	Total Kjeldahl Nitrogen
Silicon	Total Nitrogen
Silver	Total Organic Nitrogen
Sodium	Total Suspended Solids
Strontium	Turbidity
Tellerium	
Thallium	
Tin	
Titanium	
Uranium	
Vanadium	
Zinc	

Table B.14). Once data were assigned to appropriate groups, summary statistics were calculated. In all cases where an analyte was not detected (i.e., less than the Method Detection Limit; MDL), a value of half the detection limit was substituted for calculations of mean, median, standard deviation, and 95th percentile.

Water quality data were interpreted relative to both baseline water quality data and BCWQG. Baseline data were used to calculate a benchmark for comparison to operational data. Data from 1995/1996 from Polley Lake and 1985 to 1996 from Bootjack Lake were used to calculate the 95th percentile of baseline concentrations. If the 95th percentile value was less than the MDL, the MDL was used as the benchmark concentration. Due to the limited quantity of baseline data, concentrations from the two stations within each lake were combined to calculate benchmarks. Accordingly, four benchmark concentrations were calculated which included a surface and bottom value for each of Polley and Bootjack Lakes. Operational data for each station/depth combination were screened against the baseline benchmarks and against BCWQG. Concentrations above the respective benchmark and/or BCWQG were highlighted and counted for each site. These counts were then used to calculate a frequency of elevation (i.e., the number of elevations divided by the total number of observations). In addition, the magnitude of elevation was calculated for each site by dividing the maximum operational period concentration by the benchmark (providing a worst-case assessment). In order to identify analytes of concern and reduce the number of analytes subject to further investigation, analytes with more than 20% of the samples above the benchmark and a magnitude of increase of 1.5 times or more were selected for further investigation. Only total metal concentrations were included in the reduced list, but if the total concentrations did not get flagged and the dissolved concentration did, that metal was included in the reduced list. Any analyte that had a concentration above the BCWQG was also included in the reduced list. The reduced analyte list was applied to all sites/depths for each lake, resulting in two lists, one for Polley Lake and one for Bootjack Lake.

In order to gain additional perspective on potential changes in water quality over time, non-parametric trend analysis (Spearman's) was performed on the reduced analyte lists for each lake at each site (operational data) using SPSS (version 12.0, SPSS Inc., Chicago, Il). Analytes with significant trends (i.e., correlation coefficient > 0.6 or < -0.6 and a p-value of <0.05) at each site within the lake were plotted. Correlation analysis (Spearman's) was performed on the same analyte lists to identify which analytes were significantly correlated with one another (i.e., correlation coefficient > 0.6 or < -0.6 and a p-value of <0.05).

3.0 *IN-SITU* WATER QUALITY

3.1 Polley Lake

Polley Lake profiles of water temperature and dissolved oxygen collected in the spring, summer and fall were similar through baseline and mine operation periods (Figure 3.1; Appendix Tables A.2 and A.3), suggesting no mine-related influence on water column stratification. A pronounced thermocline was apparent during summer months, occurring at a depth between 5 and 15 m. Water column temperature was generally consistent with depth at other times of the year, typically ranging from 3 to 8 degrees Celsius. Dissolved oxygen concentrations generally decreased gradually with depth at all times of the year, although distinct step changes in dissolved oxygen levels occurred on occasion (e.g., October 2007; Figure 3.1; Appendix Tables A.2 and A.3). However, dissolved oxygen concentrations never reached hypoxic or anoxic levels at any time or any depth (Figure 3.1), and were similar between baseline and operational periods, suggesting no mine-related influence.

Conductivity and pH profiles were not conducted during Polley Lake baseline surveys. Conductivity measurements collected during the operational period varied substantially among sampling dates ranging between 100 and 250 μS/cm (Figure 3.1). However, with the exception of the October 2008 data at Station P1 (Appendix Table A.2), conductivity was fairly constant with depth for any given sampling date. Temporal comparisons indicated that higher conductivity was generally observed in more recent years (2008 and 2009, Appendix Tables A.2 and A.3), suggesting a potential mine influence over time (evaluated in greater detail Section 4.0). Aqueous pH measurements were variable with depth, with highest pH generally reached in the 3 to 10 m depth range, especially in summer months (Figure 3.1, Appendix Tables A.2 and A.3). Changes in pH with depth likely reflected slight changes in redox state as reflected by dissolved oxygen profiles. All pH values were slightly basic, generally between 7.0 and 8.5 pH units (Figure 3.1), well within the BCWQG range of 6.5 to 9.0. No trends were observed for pH, suggesting no mine-related influence.

Secchi depth, which was recorded only during the operational period, ranged from 3.15 to 7.90 meters in Polley Lake (Figure 3.2, Appendix Table A.1). Water clarity was generally lowest (i.e., shallowest Secchi depth) in the spring (May), likely associated with the spring melt, and increased through the summer and into the fall (Figure 3.2). No changes over time were apparent.

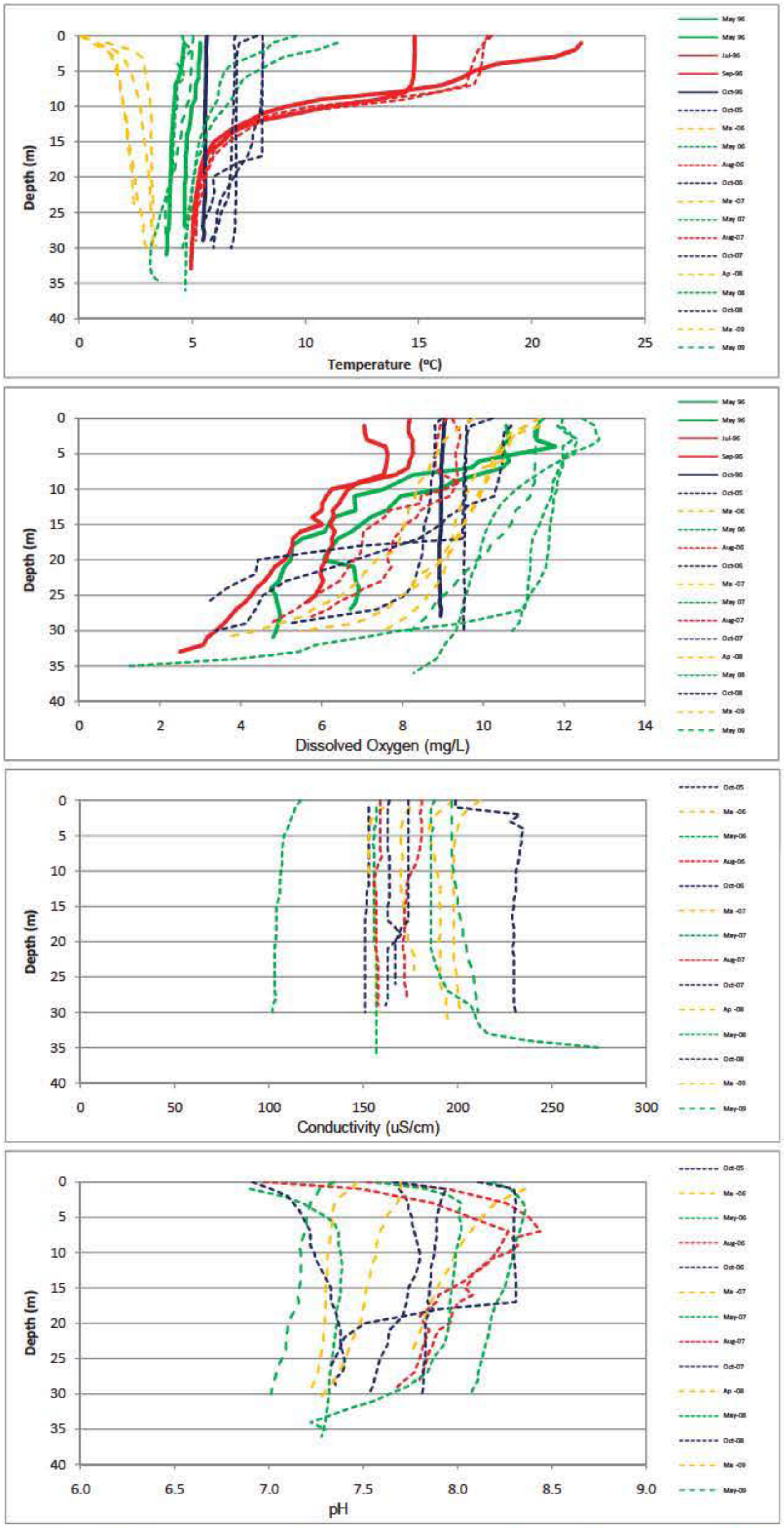

Figure 3.1: Profile Measurements of Temperature, Dissolved Oxygen, Conductivity and pH at Station P1 , Polley Lake (1996-2009)(yellow - winter, green - spring, red - summer, blue - fall)

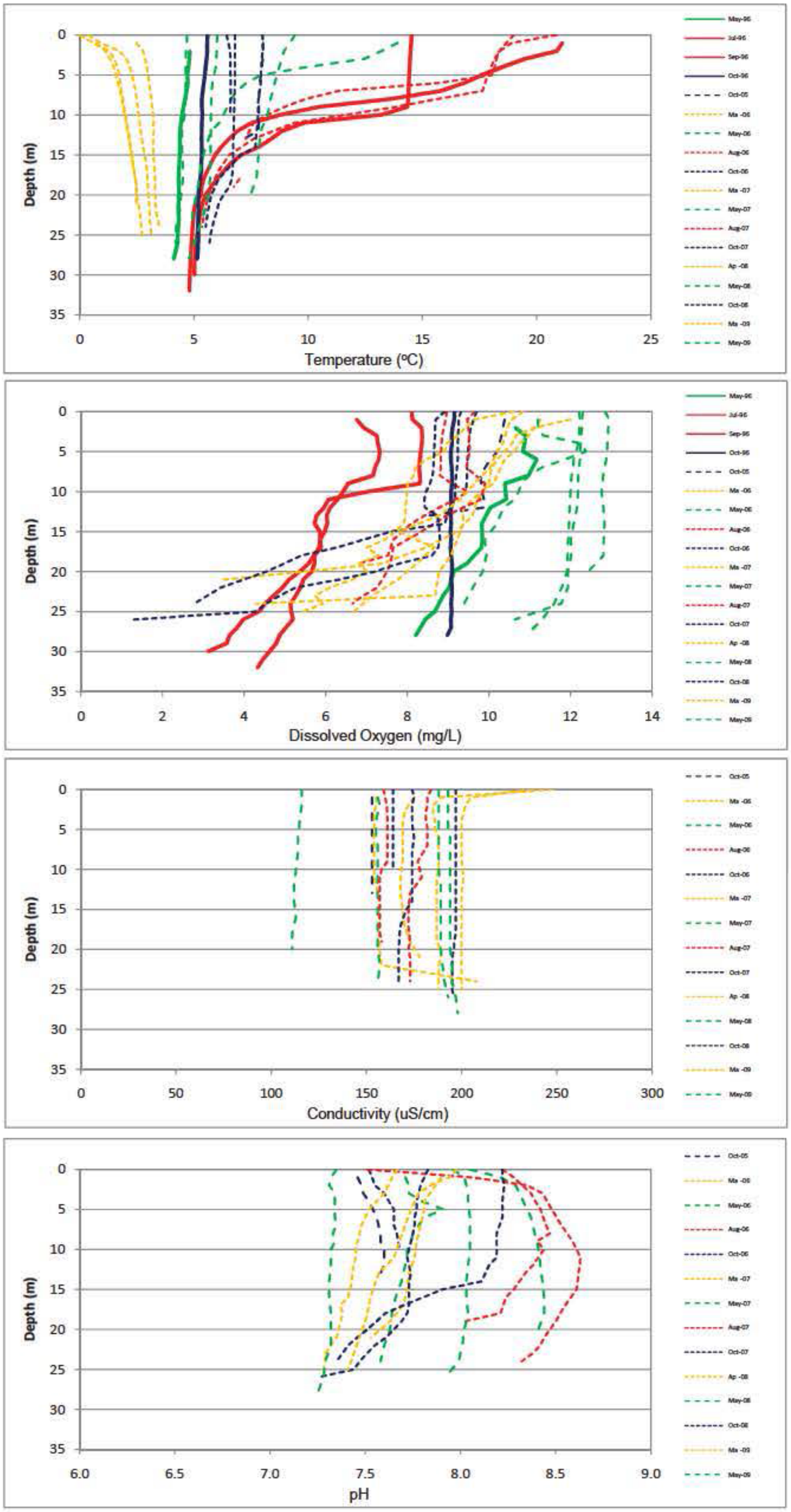

Figure 3.1: Profile Measurements of Temperature, Dissolved Oxygen, Conductivity and pH at Station P2 , Polley Lake (1996-2009)(yellow - winter, green - spring, red - summer, blue - fall)

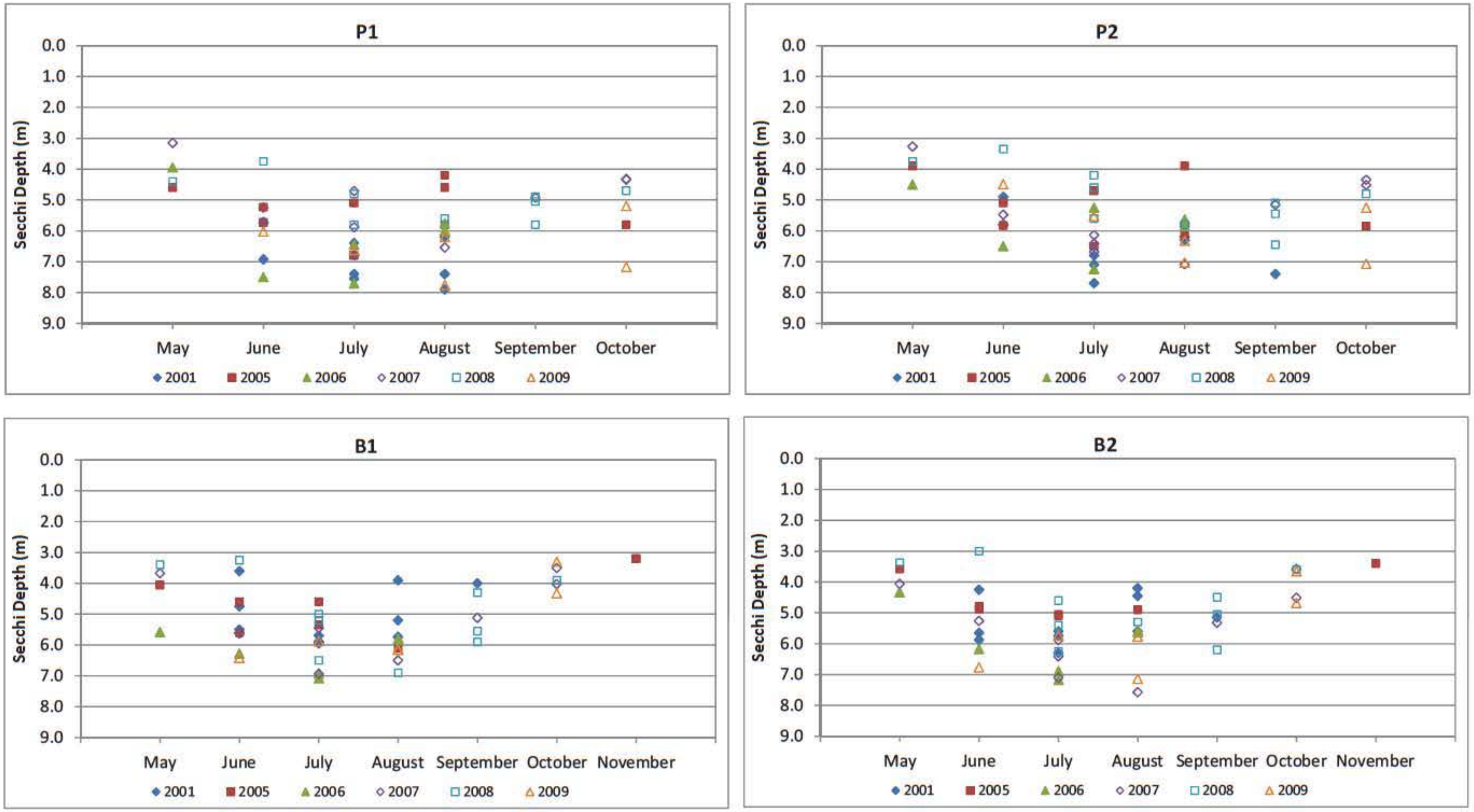

Figure 3.2: Secchi depth measurements recorded in Polley Lake (P1 & P2) and Bootjack Lake (B1 & B2) from 2001 through 2009.

3.2 Bootjack Lake

Bootjack Lake profiles of temperature and dissolved oxygen were similar between baseline and operational periods in both spring and fall (Figure 3.3; Appendix Tables A.4 and A.5). No temperature or dissolved oxygen profiles were collected in summer months during operational periods. Based on the limited available data, thermocline development appears to occur in spring and summer at depths between approximately 4 and 12 m in Bootjack Lake. Thermocline development likely occurs earlier in Bootjack Lake than in Polley Lake as a result of much the shallower depth of Bootjack Lake. Dissolved oxygen profiles generally showed dramatic decreases at depths between 8 and 10 m during the summer, fall and winter, often reaching hypoxic to anoxic states (Figure 3.3). Conversely, spring sampling generally showed relatively minor decreases in dissolved oxygen concentrations with depth, presumably due to mixing (Figure 3.3). Generally, dissolved oxygen profiles were similar between baseline and operational periods, suggesting no mine related influence.

Conductivity and pH profiles were not conducted during Bootjack Lake baseline surveys. Conductivity measurements collected during the operational period varied only slightly among sampling events, ranging from approximately 80 and 100 μS/cm (Figure 3.3), with the exception of profiles conducted in May 2007 and October 2008. Unusually low conductivity profiles (May 2007) and unusually high conductivity (October 2008, Station B2) were observed, likely reflecting outliers from the norm, perhaps associated with field meter calibration (Figure 3.3; Appendix Tables A.4 and A.5). Aqueous pH measurements generally showed only slight variability with depth, although notable decreases in pH with depth occurred on occasion during the winter. Aqueous pH generally ranged between 6.8 and 8.1, with the exception of profiles conducted in November 2005 (Figure 3.3; Appendix Tables A.4 and A.5), which showed unusually high pH, suggesting that this difference reflected an inaccurate meter. Excluding the high pH measurements in November 2005, all pH measurements were within the BCWQG range of 6.5 to 9.0. No clear trends were observed, suggesting no mine-related influence.

Bootjack Lake Secchi depth ranged from 3.00 to 7.57 meters during the operational period (Figure 3.2, Appendix Table A.1). Water clarity was generally lowest (i.e., shallowest Secchi depth) in the spring (May) and fall periods, and greatest (i.e., deepest Secchi depth) in the summer (Figure 3.2). Lower Secchi depth in the spring and fall likely reflected runoff associated with spring freshet and autumnal mixing, respectively.

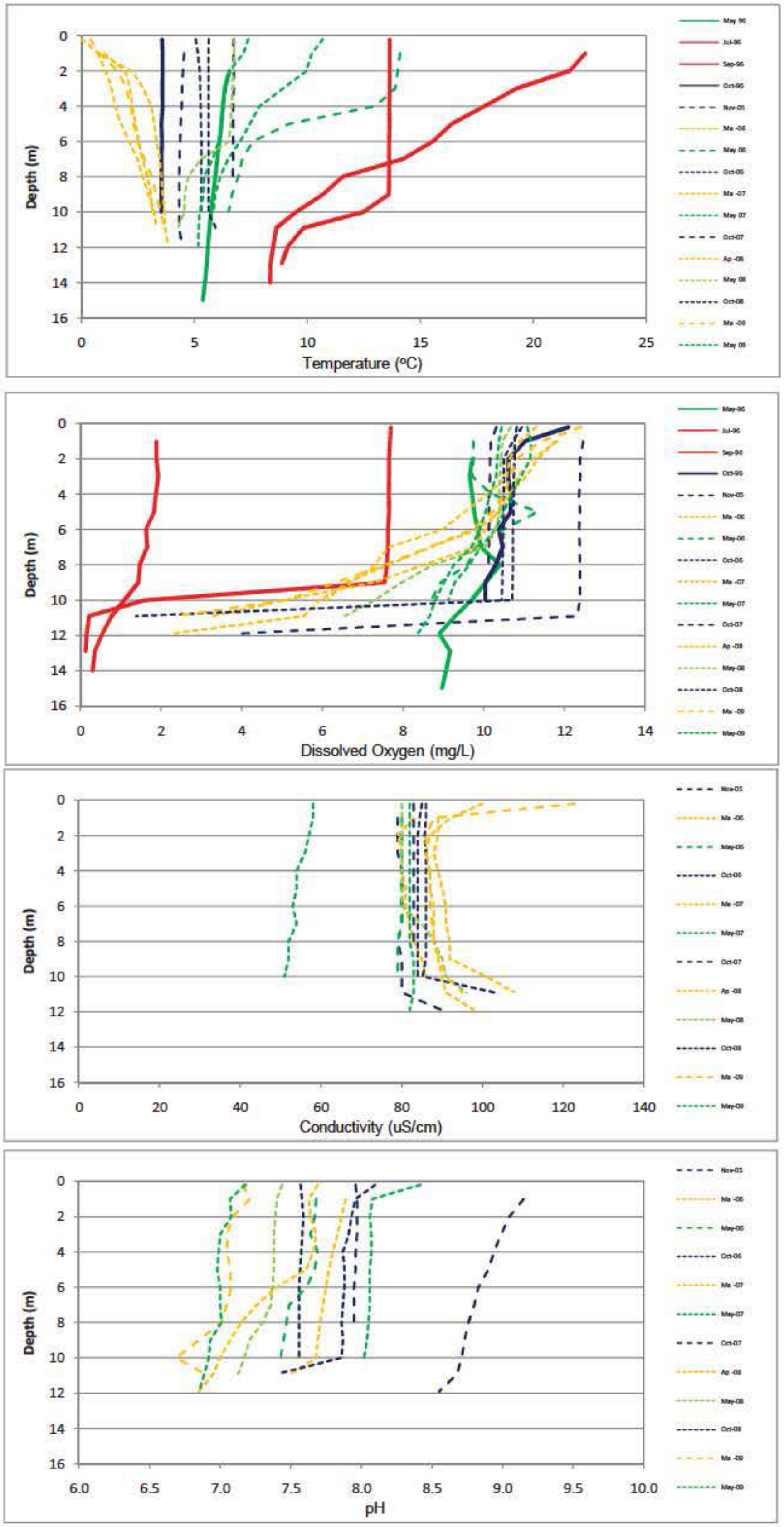

Figure 3.3: Profile Measurements of Temperature, Dissolved Oxygen, Conductivity and pH at Station B1 , Bootjack Lake (1996-2009)(yellow - winter, green - spring, red - summer, blue - fall)

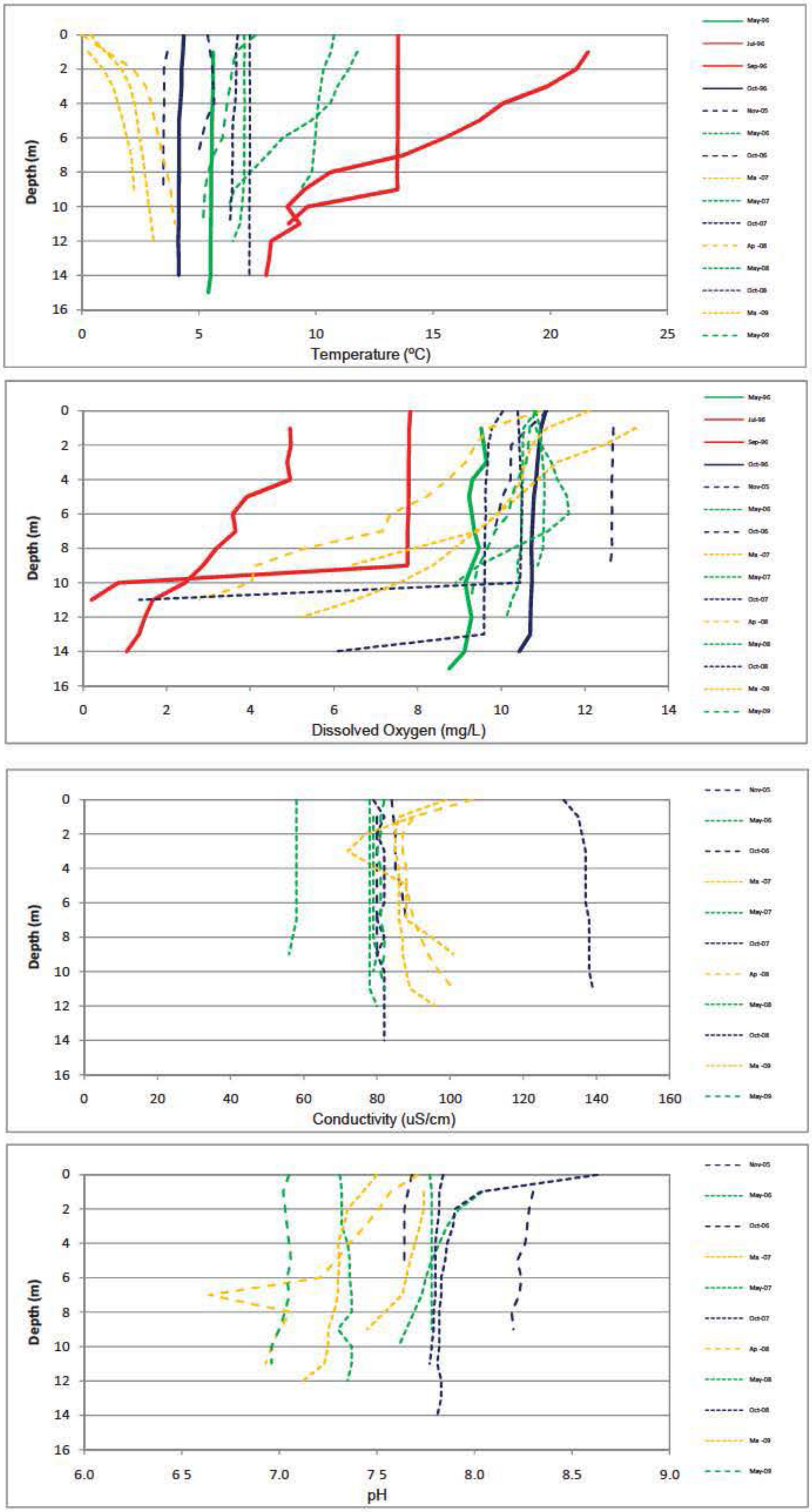

Figure 3.3: Profile Measurements of Temperature, Dissolved Oxygen, Conductivity and pH at Station B2, Bootjack Lake (1996-2009)(yellow - winter, green - spring, red - summer, blue - fall)

4.0 WATER CHEMISTRY

4.1 Polley Lake

Water chemistry of Polley Lake was evaluated relative to baseline water chemistry and BCWQG. Concentrations of numerous analytes were greater than baseline during the operational period (Appendix Tables B.2 and B.3). Although the magnitude of increase was generally less than two times the baseline concentration for most analytes, sulphate concentrations showed an average magnitude of increase close to four times baseline, and mean concentrations of ammonia, phosphorous, selenium and strontium were generally around twice baseline concentrations (Appendix Tables B.2 and B.3). At both sampling depths and both sampling stations in Polley Lake, baseline copper concentrations exceeded BCWQG (Appendix Table B.1), suggesting naturally high copper concentrations in this lake. Within the water column, operational period copper concentrations were greater than baseline at the surface in approximately 30% of samples, whereas at the bottom, copper concentrations never exceeded baseline levels (Appendix Tables B.2 and B.3). The magnitude of increase for surface stations exceeding baseline was generally less than 1.5 times, with the exception of two samples at P1 (0.0316 mg/L on March 6, 2007 and 0.0074 mg/L on March 13, 2009). While all baseline copper concentrations were above BCWQG, only about half of the samples collected during the operational period had copper concentrations exceeding BCWQG (Appendix Tables B.2 and B.3). Other than copper, BCWQG were only exceeded on four occasions (Polley surface, zinc three times and total suspended solids once, Appendix Tables B.2 and B.3). Selenium concentrations were below BCWQG on all sampling dates, and were often below detection (method detection limit is 0.0005 mg/L; Figure 4.1).

Trend analysis was conducted on analytes that exceeded baseline concentrations at a frequency of 20 percent or more and at a maximum magnitude greater than 1.5-times, as well as analytes with concentrations greater than BCWQG. Copper and selenium were also included in the trend analysis regardless of screening results as these metals are of particular interest to the mine (e.g., MPMC 2009). Based on these criteria, a total of 20 analytes were considered in trend analysis for Polley Lake (Table 4.1). Of these analytes, only total dissolved solids (TDS), hardness, magnesium, sulphate, molybdenum, sodium and strontium showed significant temporal increases at all stations (Table 4.1). The increase in TDS concentrations over time was consistent with the temporal increases in Polley Lake *in-situ* conductivity measurements (Section 3.1). Of the seven analytes for which significant temporal increases were indicated, hardness and magnesium were significantly correlated

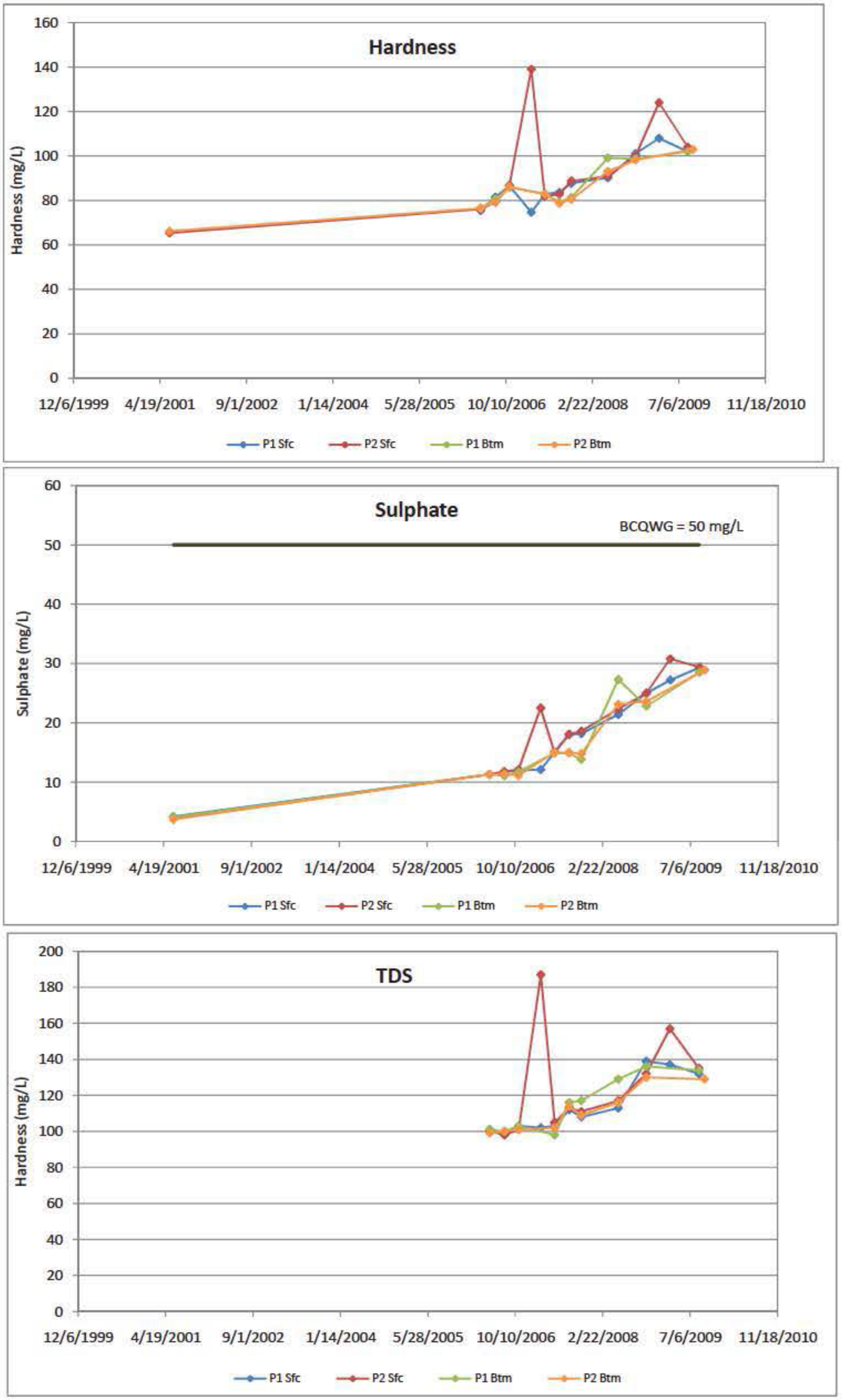

Figure 4.1: Concentrations of parameters with significant temporal trends at all stations or of interest over time in Polley Lake.
(hollow data points reflect concentrations less than detection limit)

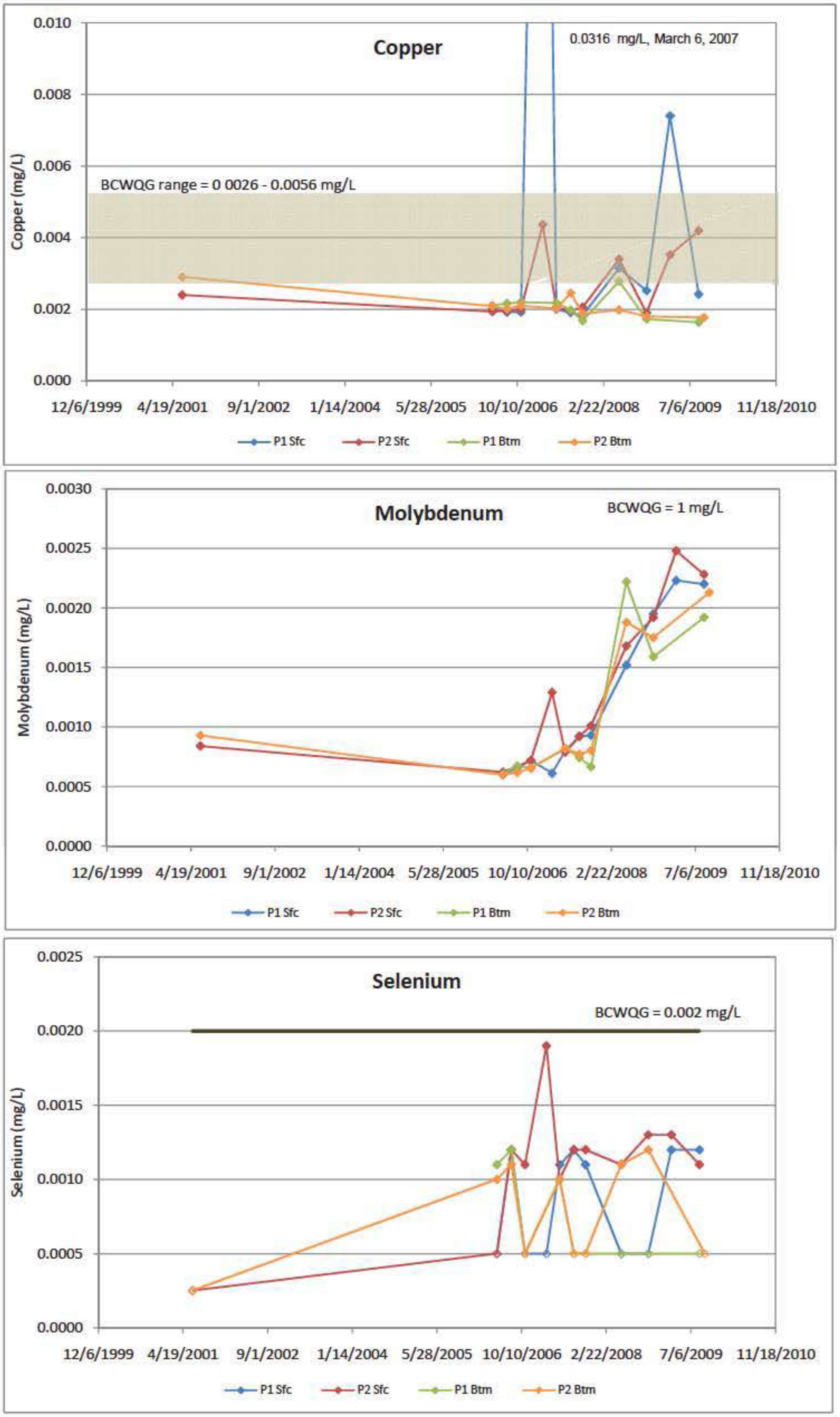

Figure 4.1: Concentrations of parameters with significant temporal trends at all stations or of interest over time in Polley Lake.
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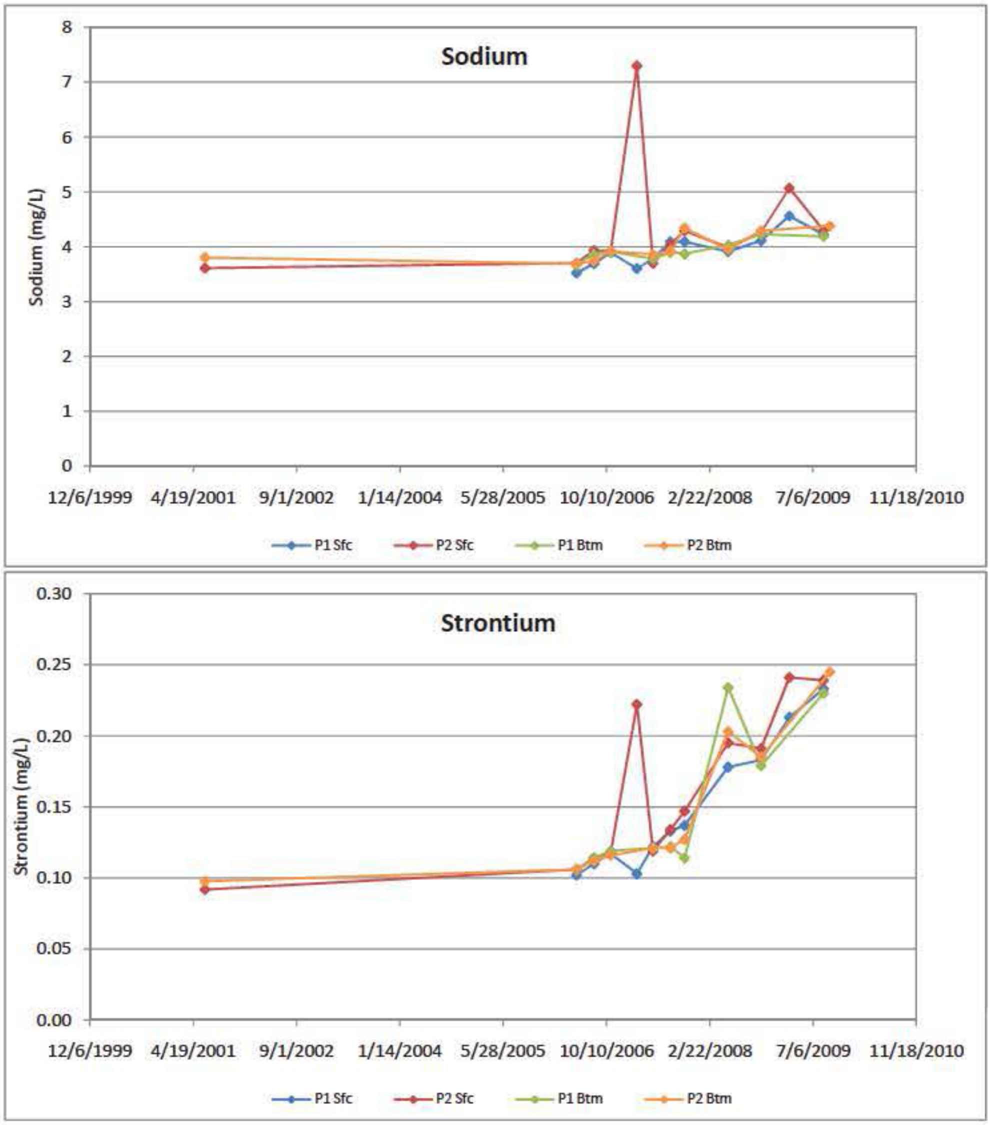


Figure 4.1: Concentrations of parameters with significant temporal trends at all stations or of interest over time in Polley Lake.
(hollow data points reflect concentrations less than detection limit)

Table 4.1: Trend analysis results for parameters exceeding baseline concentrations in greater than 20% of samples and at a maximum magnitude of increase greater than 1.5 times baseline in Polley and Bootjack lakes.

Parameter	Statistic	Polley Lake				Bootjack Lake			
		Stn P1 Surface	Stn P2 Surface	Stn P1 Bottom	Stn P2 Bottom	Stn B1 Surface	Stn B2 Surface	Stn B1 Bottom	Stn B2 Bottom
Conductivity	Correlation Coefficient	0.096	0.500	0.400	0.400	0.283	-0.268	0.214	0.036
	Sig. (2-tailed)	0.780	0.117	0.286	0.286	0.460	0.486	0.645	0.939
	N	11	11	9	9	9	9	7	7
Alkalinity	Correlation Coefficient	0.758	0.343	0.709	0.406				
	Sig. (2-tailed)	0.004	0.276	0.022	0.244				
	N	12	12	10	10				
Sulphate	Correlation Coefficient	1.000	0.923	0.936	0.924				
	Sig. (2-tailed)	.	0.000	0.000	0.000				
	N	12	12	10	10				
Ammonia	Correlation Coefficient	-0.634	-0.610	0.394	0.370				
	Sig. (2-tailed)	0.027	0.035	0.259	0.292				
	N	12	12	10	10				
Orthophosphate	Correlation Coefficient	0.050	0.153	0.309	0.042				
	Sig. (2-tailed)	0.878	0.634	0.385	0.907				
	N	12	12	10	10				
Phosphate	Correlation Coefficient	-0.118	-0.173	0.367	0.200	0.158	-0.559	0.359	0.024
	Sig. (2-tailed)	0.729	0.612	0.332	0.606	0.663	0.093	0.382	0.955
	N	11	11	9	9	10	10	8	8
TDS	Correlation Coefficient	0.929	0.711	0.867	0.967	0.351	0.119	0.786	0.364
	Sig. (2-tailed)	0.000	0.014	0.002	0.000	0.354	0.760	0.036	0.423
	N	11	11	9	9	9	9	7	7
Turbidity	Correlation Coefficient					0.394	0.212	0.643	0.405
	Sig. (2-tailed)					0.260	0.556	0.086	0.320
	N					10	10	8	8
Hardness	Correlation Coefficient	0.891	0.762	0.783	0.855	0.432	-0.233	0.060	-0.054
	Sig. (2-tailed)	0.000	0.004	0.013	0.002	0.213	0.546	0.888	0.908
	N	11	12	9	10	10	9	8	7
Arsenic	Correlation Coefficient	0.331	0.444	0.611	0.428	0.091	0.017	0.476	0.252
	Sig. (2-tailed)	0.320	0.149	0.081	0.217	0.802	0.966	0.233	0.585
	N	11	12	9	10	10	9	8	7
Barium	Correlation Coefficient					0.220	-0.083	-0.738	-0.185
	Sig. (2-tailed)					0.542	0.831	0.037	0.691
	N					10	9	8	7
Calcium	Correlation Coefficient	0.900	0.739	0.633	0.842	0.146	-0.100	0.395	-0.559
	Sig. (2-tailed)	0.000	0.006	0.067	0.002	0.688	0.797	0.333	0.192
	N	11	12	9	10	10	9	8	7
Copper	Correlation Coefficient	0.333	0.315	-0.467	-0.806	0.261	0.233	-0.238	0.631
	Sig. (2-tailed)	0.318	0.318	0.205	0.005	0.467	0.546	0.570	0.129
	N	11	12	9	10	10	9	8	7
Iron	Correlation Coefficient	-0.260	-0.096	0.252	-0.613	0.371	0.237	0.548	0.054
	Sig. (2-tailed)	0.440	0.767	0.512	0.060	0.291	0.539	0.160	0.908
	N	11	12	9	10	10	9	8	7
Magnesium	Correlation Coefficient	0.852	0.711	0.667	0.888	0.200	-0.167	0.048	-0.829
	Sig. (2-tailed)	0.001	0.010	0.050	0.001	0.580	0.668	0.911	0.021
	N	11	12	9	10	10	9	8	7
Manganese	Correlation Coefficient					0.212	-0.183	0.527	0.750
	Sig. (2-tailed)					0.556	0.637	0.180	0.052
	N					10	9	8	7
Molybdenum	Correlation Coefficient	0.964	0.874	0.800	0.697	0.600	0.217	0.714	0.357
	Sig. (2-tailed)	0.000	0.000	0.010	0.025	0.067	0.576	0.047	0.432
	N	11	12	9	10	10	9	8	7
Potassium	Correlation Coefficient	0.041	0.193	0.075	0.340				
	Sig. (2-tailed)	0.905	0.549	0.847	0.336				
	N	11	12	9	10				
Selenium	Correlation Coefficient	0.319	0.465	-0.753	0.277				
	Sig. (2-tailed)	0.339	0.127	0.019	0.439				
	N	11	12	9	10				
Silicon	Correlation Coefficient	0.618	0.427	0.817	0.515	0.612	0.101	0.810	0.775
	Sig. (2-tailed)	0.043	0.167	0.007	0.128	0.060	0.796	0.015	0.041
	N	11	12	9	10	10	9	8	7
Sodium	Correlation Coefficient	0.916	0.708	0.833	0.906				
	Sig. (2-tailed)	0.000	0.010	0.005	0.000				
	N	11	12	9	10				
Strontium	Correlation Coefficient	0.973	0.881	0.820	0.985				
	Sig. (2-tailed)	0.000	0.000	0.007	0.000				
	N	11	12	9	10				
Zinc	Correlation Coefficient	0.178	0.239	0.306	-0.522	-0.071	-0.261	-0.268	-0.148
	Sig. (2-tailed)	0.600	0.454	0.423	0.122	0.845	0.497	0.520	0.751
	N	11	12	9	10	10	9	8	7

🟦 Shading indicates significant temporal trend based on coefficient >0.6 or <-0.6 and p-value <0.05.

with each other (Appendix Tables B.4 to B.7). This inter-relatedness is expected as hardness is a product of calcium and magnesium, and therefore hardness was considered to be representative of all three analytes. Polley Lake sulphate, molybdenum and strontium concentrations showed the greatest temporal changes, with 2009 concentrations two to six fold higher than in 2001 (Figure 4.1). On the other hand, sodium concentrations increased only slightly over the operational period (Figure 4.1). Neither copper nor selenium concentrations showed any significant temporal trend (Figure 4.1). Visual evaluation of plotted data for the ten remaining analytes for which trend analysis was completed confirmed the absence of any significant increases in concentrations of these analytes over time (Appendix Figure B.1). It is notable that a spike in the concentrations of most analytes at Station P2 (surface) was observed on March 6, 2007 (Figure 4.1). The absence of any other unusual sample characteristics (e.g., elevated suspended solids) suggests that the elevations in mine-related analytes were real.

4.2 Bootjack Lake

Water quality in Bootjack Lake was evaluated in the same manner as in Polley Lake. Similar to Polley Lake, concentrations of numerous analytes in Bootjack Lake were elevated above baseline during the operational period (Appendix Tables B.8 and B.9). However, unlike Polley Lake, the magnitude of increase was generally less than two for most analytes, and no analytes showed a maximum magnitude of increase of two or greater in both surface and bottom samples (Appendix Tables B.8 and B.9). At both sampling depths and both sampling stations in Bootjack Lake, baseline copper concentrations exceeded BCWQG, which, similar to Polley Lake, suggested aqueous copper concentrations were naturally high. Bootjack Lake operational period copper concentrations were typically greater than BCWQG. However, it is notable that copper concentrations in only three of thirty-four samples were greater than the baseline 95th percentile concentration, and only at the surface, with copper concentrations at the bottom consistently less than baseline. No other analytes were observed at concentrations greater than BCWQG in Bootjack Lake during either baseline or operational periods.

The Bootjack Lake trend analysis included a total of 16 analytes, with most analytes screened from surface stations. No analytes showed significant trends at all surface and bottom stations (Table 4.1, Appendix Figure B.2), suggesting that no substantial changes in water chemistry have occurred in Bootjack Lake over time.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The objectives of this study were to: 1) compile and present existing water quality data from Polley and Bootjack lakes; and 2) evaluate the influence of the Mount Polley Mine on the water quality of these lakes. The principal conclusions of the evaluation of existing water quality data for Polley and Bootjack lakes are as follows:

1. In Polley Lake, there is no evidence that the Mount Polley Mine has influenced water column stratification, pH or water clarity (i.e. secchi depth) over time, based on evaluation of existing *in-situ* data. However, evaluation of conductivity profiles and water chemistry data showed clear changes between baseline and operational periods, suggesting that Polley Lake water quality has been affected by mine operations. Trend analysis indicated substantial (i.e. two to six fold) and statistically significant increases in concentrations of sulphate, molybdenum and strontium concentrations over time, with slight, but also significant increases in TDS, hardness (including calcium and magnesium), and sodium. Despite these increases, with the exception of copper, very few analyte concentrations exceeded BCWQG. Copper concentrations exceeded BCWQG during the baseline period, indicating naturally high background concentrations. Overall, Polley Lake water quality appears to have been affected by mine operations, but at analyte concentrations that are below BCWQG.

2. In Bootjack Lake, no clear changes were observed in *in-situ* water quality profile measurements or in water clarity data over time, suggesting no mine-related influence on this lake. Although operational period water chemistry data suggested some minor increases in analyte concentrations relative to baseline conditions, trend analysis did not indicate that any of the observed increases were significant. Similar to Polley Lake, Bootjack Lake copper concentrations were elevated above BCWQG during the baseline period, further indicating that relatively high copper levels in this lake largely reflected natural background conditions. Overall, water quality in Bootjack Lake does not appear to have been affected by mine operations.

Based on the findings of the Mount Polley Lake Water Quality Study, three recommendations for future monitoring include:

1. *In-situ* water quality profiling and secchi depth monitoring should be conducted bi-monthly through the ice free period on Polley and Bootjack lakes to allow seasonal and temporal evaluation of the development of any thermal or chemical stratification.

Water chemistry samples should be collected twice per year, spring and fall, on the same day that in-situ water quality profiles and secchi depths are collected.

2. Water chemistry samples should only be collected at surface and bottom, unless any clear occurrence of chemical stratification becomes apparent. This will eliminate pseudo-replication and thus the collection of data that are of limited use in interpretation. Evidence of chemical stratification can be monitored through *in-situ* water quality profiles of conductivity and pH. In the event that chemical stratification is suspected based on the evaluation of *in-situ* water quality profile data, water chemistry sampling at additional depths could be considered.
3. Field conductivity measures should be recorded as both conductivity and specific conductance (i.e., conductivity corrected to a standard temperature, generally 25 °C) and the latter should be used in data interpretation to avoid the modifying influence of temperature on conductivity. In addition, the mine should consider whether measurement of dissolved metals is warranted as it added little to this analysis of water quality despite considerable analytical expense.

6.0 REFERENCES

BCMOE (British Columbia Ministry of Environment). 2006a. British Columbia Approved Water Quality Guidelines 2006 Edition. Updated August 2006.

BCMOE (British Columbia Ministry of Environment). 2006b. A Compendium of Working Water Quality Guidelines for British Columbia. Updated August 2006.

Hurlbert, S.H. 1984. Pseudoreplication and the Design of Ecological Field Experiments. Ecol. Monog. 54:187-211.

MPMC (Mount Polley Mining Corporation). 2009. Mount Polley Mine Technical Assessment Report for a Proposed Discharge of Mine Effluent. Report Prepared by the Mount Polley Mining Corporation. July 2009.

APPENDIX A

In-Situ Water Quality Data

Table A.1: Secchi depth (m) in Polley and Bootjack Lakes, 2001-2009

Polley Lake			**Bootjack Lake**		
Date	**P1**	**P2**	**Date**	**B1**	**B2**
2001					
13-Jun-01	5.25	4.90	7-Jun-01	3.60	
19-Jun-01	5.75	5.80	14-Jun-01	4.75	4.25
28-Jun-01	6.93	5.80	19-Jun-01	5.60	5.88
3-Jul-01	7.40	7.10	28-Jun-01	5.50	5.65
10-Jul-01	7.55	7.70	3-Jul-01	5.90	5.75
25-Jul-01	6.40	6.80	10-Jul-01	5.90	6.30
8-Aug-01	6.20	5.85	25-Jul-01	5.70	5.60
16-Aug-01	7.90	6.30	8-Aug-01	3.90	4.45
27-Aug-01	7.40	6.20	16-Aug-01	5.74	5.60
5-Sep-01		7.40	27-Aug-01	5.20	4.20
			5-Sep-01	4.00	5.15
Average	**6.75**	**6.39**	**Average**	**5.07**	**5.28**
2005					
2-May-05	4.6	3.9	2-May-05	4.06	3.58
15-Jun-05	5.23	5.1	15-Jun-05	4.6	4.88
29-Jun-05	5.73	5.83	29-Jun-05	5.6	4.8
11-Jul-05	5.1	4.7	11-Jul-05	5.35	5.05
21-Jul-05	6.8	6.5	20-Jul-05	4.6	5.1
8-Aug-05	5.8	6.1	19-Aug-05	6.1	4.9
24-Aug-05	4.6	3.9	10-Nov-05	3.2	3.4
30-Aug-05	4.2	3.9			
26-Oct-05	5.8	5.85			
Average	**5.32**	**5.09**	**Average**	**4.79**	**4.53**
2006					
18-May-06	3.95	4.5	23-May-06	5.58	4.33
13-Jun-06	7.5	6.5	13-Jun-06	6.28	6.17
4-Jul-06	7.71	7.24	4-Jul-06	6.93	7.17
19-Jul-06	6.45	5.25	20-Jul-06	7.08	6.89
2-Aug-06	6	5.63	2-Aug-06	5.82	5.63
11-Aug-06	5.76	5.85	22-Aug-06	5.8	5.57
Average	**6.23**	**5.83**	**Average**	**6.25**	**5.96**
2007					
23-May-07	3.15	3.27	23-May-07	3.67	4.06
20-Jun-07	5.71	5.48	20-Jun-07	5.63	5.26
5-Jul-07	6.79	6.69	5-Jul-07	6.94	7.1
17-Jul-07	4.71	6.42	17-Jul-07	5.95	6.41
31-Jul-07	5.88	6.14	31-Jul-07	5.45	5.88
15-Aug-07	6.54	7.09	15-Aug-07	6.5	7.57
7-Sep-07	4.92	5.16	24-Sep-07	5.12	5.32
16-Oct-07	4.34	4.35	16-Oct-07	4.02	4.51
23-Oct-07	4.32	4.52	23-Oct-07	3.5	3.58
Average	**5.15**	**5.46**	**Average**	**5.20**	**5.52**
2008					
21-May-08	4.4	3.75	21-May-08	3.4	3.37
10-Jun-08	3.75	3.35	10-Jun-08	3.25	3
2-Jul-08	5.8	4.2	2-Jul-08	6.5	6.25
17-Jul-08	4.8	5.6	17-Jul-08	5	5.4
31-Jul-08	4.8	4.6	31-Jul-08	5.2	4.6
14-Aug-08	5.6	5.8	14-Aug-08	6.9	5.3
2-Sep-08	5.05	5.45	2-Sep-08	5.55	5.05
11-Sep-08	5.8	6.45	11-Sep-08	4.3	4.5
29-Sep-08	4.9	5.1	29-Sep-08	5.9	6.2
8-Oct-08	4.7	4.8	8-Oct-08	3.9	3.6
Average	**4.96**	**4.91**	**Average**	**4.99**	**4.73**
2009					
16-Jun-09	6.03	4.49	16-Jun-09	6.42	6.77
15-Jul-09	6.62	5.53	15-Jul-09	5.88	5.73
12-Aug-09	6.2	6.32	12-Aug-09	6.15	5.77
26-Aug-09	7.76	7.03	26-Aug-09	6.15	7.14
1-Oct-09	7.17	7.07	1-Oct-09	4.32	4.68
18-Oct-09	5.2	5.25	18-Oct-09	3.3	3.65
Average	**6.50**	**5.95**	**Average**	**5.37**	**5.62**

Table A.2: Water quality profiles for Polley Lake station P1, 1995-2009.

A) Temperature (°C)

Depth (m)	Baseline					Operational													
	5/10/96	5/12/96	7/1/96	9/1/96	10/1/96	10/26/05	3/13/06	5/18/06	8/11/06	10/31/06	3/6/07	5/24/07	8/15/07	10/23/07	4/1/08	5/21/08	10/28/08	3/13/09	5/20/09
0				14.83	5.65				18.07	6.91		9.60	18.25	8.11	0.03	4.56	7.87	0.19	5.04
1	4.65	5.35	22.20	14.83	5.63	8.12	1.19	11.42	17.89	6.82	0.82	8.54	17.90	8.11	0.55	4.65	7.09	0.71	5.02
2	4.61	5.34	21.93	14.84	5.61	8.15	2.31	10.51	17.86	6.89	1.26	8.26	17.65	8.11	1.18	4.97	7.00	1.55	5.00
3	4.57	5.33	21.01	14.83	5.63	8.13	2.77	9.05	17.83	6.89	1.43	7.59	17.51	8.11	1.55	4.70	6.98	1.92	4.98
4	4.55	5.28	18.45	14.81	5.61	8.12	2.85	8.46	17.79	6.88	1.57	6.76	17.40	8.11	1.68	4.34	6.97	2.10	4.96
5	4.48	5.28	17.46	14.79	5.61	8.10	2.92	7.85	17.75	6.88	1.65	6.43	17.29	8.10	1.73	4.59	6.97	2.27	4.94
6	4.40	5.28	16.87	14.76	5.61	8.10	2.98	7.29	17.60	6.87	1.73	6.32	17.20	8.10	1.78	4.63	6.97	2.37	4.94
7	4.24	5.15	16.03	14.68	5.60	8.09	3.03	7.09	17.44	6.86	1.78	6.20	17.10	8.10	1.83	4.34	6.95	2.47	4.93
8	4.24	5.14	13.94	14.42	5.60	8.06	3.08	6.91	15.82	6.84	1.82	6.17	15.78	8.10	1.88	4.28	6.96	2.56	4.89
9	4.22	5.13	10.67	13.22	5.58	8.05	3.13	6.74	13.30	6.82	1.90	6.13	14.46	8.10	1.92	4.35	6.96	2.64	4.87
10	4.19	4.97	9.17	11.01	5.58	8.02	3.15	6.49	10.36	6.82	1.98	5.96	11.85	8.09	1.99	4.31	6.94	2.69	4.74
11	4.16	4.95	8.11	9.62	5.58	8.00	3.18	6.23	8.73	6.81	2.04	5.78	9.24	8.09	2.01	4.25	6.95	2.74	4.70
12	4.15	4.91	7.55	8.07	5.56	7.91	3.21	5.97	7.62	6.79	2.10	5.65	8.11	8.09	2.03	4.24	6.94	2.78	4.55
13	4.14	4.87	6.83	7.17	5.56	7.76	3.19	5.80	7.02	6.76	2.11	5.51	7.59	8.09	2.10	4.22	6.93	2.81	4.51
14	4.11	4.77	6.41	6.65	5.58	7.68	3.17	5.62	6.58	6.75	2.11	5.41	7.10	8.09	2.18	4.20	6.93	2.85	4.51
15	4.09	4.76	5.97	6.35	5.58	7.67	3.18	5.53	6.34	6.74	2.14	5.31	6.58	8.09	2.19	4.18	6.93	2.89	4.44
16	4.07	4.75	5.77	5.94	5.58	7.56	3.19	5.43	6.00	6.74	2.17	5.25	6.27	8.09	2.26	4.17	6.93	2.94	4.36
17	4.06	4.70	5.65	5.53	5.58	7.44	3.20	5.31	5.87	6.73	2.23	5.18	5.94	8.09	2.32	4.16	6.94	2.98	4.31
18	4.07	4.70	5.51	5.45	5.58	7.23	3.21	5.18	5.75	6.72	2.28	5.15	5.85	7.00	2.37	4.15	6.94	3.02	4.27
19	4.06	4.70	5.44	5.36	5.58	7.02	3.21	5.13	5.62	6.70	2.32	5.11	5.68	6.46	2.42	4.14	6.94	3.05	4.22
20	4.04	4.72	5.33	5.30	5.58	6.84	3.21	5.08	5.51	6.68	2.36	5.06	5.59	5.91	2.47	4.07	6.93	3.09	4.09
21	4.02	4.67	5.29	5.25	5.58	6.65	3.23	5.03	5.40	6.65	2.36	5.00	5.53	5.95	2.50	3.99	6.94	3.13	4.03
22	4.02	4.67	5.23	5.20	5.58	6.47	3.24	4.98	5.34	6.62	2.36	4.99	5.48	5.98	2.53	3.91	6.93	3.14	4.01
23	4.01	4.67	5.18	5.15	5.56	6.28	3.26	4.93	5.28	6.59	2.40	4.97	5.40	5.91	2.58	3.82	6.93	3.14	3.92
24	4.01	4.67	5.15	5.10	5.53	6.19	3.28	4.87	5.25	6.43	2.43	4.96	5.28	5.84	2.64	3.71	6.92	3.16	3.82
25	3.99	4.67	5.13	5.10	5.51	6.10	3.29	4.83	5.21	6.27		4.94	5.22	5.70	2.75	3.60	6.90	3.18	3.82
26	3.98	4.67	5.00	5.07	5.50	6.08	3.30	4.78	5.20	6.21		4.83	5.19	5.55	2.79	3.54	6.89	3.20	3.81
27	3.97	4.65		5.03	5.47	6.06	3.33	4.77	5.18	6.14		4.78	5.17		2.84	3.48	6.90	3.21	3.82
28	3.91			5.02	5.54	6.02	3.35	4.75	5.17	5.98		4.75	5.13		2.82	3.36	6.86	3.24	3.83
29	3.91			5.00	5.47	5.97	3.38	4.74	5.16	5.81		4.66			2.89	3.23	6.81	3.27	
30	3.91			4.98		5.94	3.40	4.73				4.55			2.98	3.18	6.71	3.34	3.70
31	3.85			4.97				4.73							3.05	3.16			
32				4.95				4.72								3.14			
33				4.95				4.71								3.15			
34								4.70								3.25			
35								4.70								3.62			
36								4.69											

Red values indicate average of measurements above and below that depth.

Table A.2: Water quality profiles for Polley Lake station P1, 1995-2009.

B) Dissolved Oxygen (mg/L)

Depth (m)	Baseline					Operational													
	5/10/96	5/12/96	7/1/96	9/1/96	10/1/96	10/26/05	3/13/06	5/18/06	8/11/06	10/31/06	3/6/07	5/24/07	8/15/07	10/23/07	4/1/08	5/21/08	10/28/08	3/13/09	5/20/09
0				8.18	9.06				9.11	8.97		12.44	9.23	9.71	9.79	11.97	10.23	11.41	11.50
1	11.35	10.57	7.06	8.15	9.03	10.70	11.41	11.83	8.94	8.80	11.09	12.76	9.32	9.58	9.47	11.92	9.71	11.06	11.29
2	11.33	10.61	7.07	8.15	9.02	10.52	10.90	12.03	8.90	8.81	10.81	12.79	9.44	9.58	9.25	12.14	9.61	10.71	11.27
3	11.31	10.65	7.12	8.25	9.01	10.49	10.70	12.34	8.86	8.81	10.68	12.88	9.42	9.58	9.06	12.22	9.59	10.54	11.27
4	11.79	10.44	7.58	8.25	9.00	10.50	10.61	12.26	8.84	8.80	10.53	12.62	9.37	9.57	8.92	11.97	9.58	10.42	11.30
5	10.86	10.55	7.63	8.26	8.98	10.48	10.29	12.26	8.82	8.80	10.43	12.07	9.31	9.56	8.85	11.97	9.57	10.30	11.29
6	9.92	10.65	7.62	8.18	8.98	10.48	10.50	11.90	8.82	8.79	10.33	11.98	9.33	9.55	8.72	11.99	9.57	10.23	11.29
7	9.70	10.47	7.59	8.14	8.96	10.45	9.99	11.58	8.81	8.78	10.26	11.89	9.34	9.54	8.67	11.95	9.57	10.16	11.28
8	8.26	9.85	7.53	7.82	8.96	10.40	9.80	11.32	9.00	8.75	10.18	11.81	9.36	9.53	8.58	11.88	9.56	10.10	11.27
9	7.90	9.22	6.93	7.03	8.97	10.37	9.70	11.06	9.40	8.71	10.09	11.72	9.38	9.53	8.42	11.83	9.56	10.03	11.28
10	7.54	8.94	6.66	6.25	8.95	10.31	9.64	10.82	9.07	8.71	9.99	11.71	9.28	9.52	8.34	11.83	9.57	9.94	11.19
11	6.81	7.96	6.54	6.12	8.95	10.27	9.56	10.64	8.46	8.70	9.93	11.69	9.17	9.52	8.33	11.75	9.56	9.85	11.16
12	6.83	7.79	6.44	6.02	8.96	9.76	9.47	10.45	8.46	8.68	9.86	11.61	8.73	9.51	8.25	11.74	9.56	9.78	11.01
13	6.85	7.61	6.27	6.01	8.96	9.38	9.40	10.34	7.69	8.66	9.74	11.53	8.45	9.51	8.14	11.72	9.56	9.71	10.80
14	6.27	7.21	6.31	5.76	8.95	9.09	9.33	10.23	7.55	8.60	9.61	11.46	8.34	9.50	8.13	11.69	9.54	9.61	10.75
15	6.18	6.98	6.21	6.02	8.96	8.95	9.30	10.15	7.29	8.54	9.54	11.39	8.06	9.50	8.05	11.66	9.53	9.51	10.68
16	6.08	6.74	6.33	5.48	8.95	8.67	9.26	10.06	7.03	8.53	9.47	11.31	7.96	9.49	7.98	11.65	9.55	9.42	10.56
17	5.52	6.40	6.25	5.29	8.93	8.39	9.23	10.01	7.02	8.51	9.39	11.22	7.77	9.49	7.94	11.63	9.54	9.32	10.36
18	5.28	6.27	6.27	5.28	8.91	7.88	9.19	9.95	7.00	8.51	9.31	11.20	7.75	6.96	7.88	11.62	9.54	9.17	10.18
19	5.26	6.13	6.16	5.20	8.91	7.36	9.15	9.92	6.97	8.50	9.18	11.17	7.67	5.70	7.73	11.61	9.53	9.02	10.10
20	5.24	6.04	6.11	5.08	8.91	6.83	9.11	9.88	6.82	8.45	9.04	11.17	7.63	4.43	7.37	11.58	9.53	8.93	9.85
21	5.08	6.80	6.01	4.84	8.91	6.30	9.06	9.80	6.67	8.39	8.74	11.17	7.73	4.40	7.21	11.55	9.52	8.83	9.69
22	5.01	6.83	5.98	4.72	8.91	5.71	9.01	9.72	6.56	8.35	8.44	11.15	7.59	4.36	7.03	11.47	9.53	8.68	9.50
23	4.94	6.85	6.04	4.58	8.92	5.12	8.90	9.68	6.45	8.30	8.30	11.12	7.49	4.01	6.92	11.39	9.53	8.52	9.36
24	4.75	6.93	5.94	4.39	8.93	4.84	8.79	9.63	6.15	8.19	8.16	11.11	7.06	3.65	6.70	11.27	9.54	8.26	9.22
25	4.86	6.89	5.85	4.26	8.94	4.55	8.65	9.58	5.84	8.07		11.10	6.78	3.42	6.49	11.14	9.55	7.99	9.03
26	4.90	6.84	5.64	4.10	8.92	4.46	8.50	9.52	5.60	7.72		11.07	6.41	3.19	6.14	11.08	9.53	7.79	8.83
27	4.94	6.71		3.89	8.96	4.36	8.32	9.48	5.36	7.36		10.96	6.16		5.78	11.01	9.53	7.59	8.72
28	4.98			3.74	8.94	4.25	8.13	9.44	5.05	6.28		10.94	5.75		5.52	10.24	9.51	7.22	8.61
29	4.93			3.58		4.13	7.84	9.39	4.73	5.19		10.88			4.97	9.46	9.52	6.84	8.41
30	4.88			3.39		3.39	7.54	9.33				10.72			4.41	7.93	9.52	5.48	8.21
31	4.79			3.17				9.19							3.55	6.99			
32				3.08				9.05								5.88			
33				2.49				8.95								5.43			
34								8.84								3.91			
35								8.56								1.25			
36								8.28											

Red values indicate average of measurements above and below that depth.

Table A.2: Water quality profiles for Polley Lake station P1, 1995-2009.

C) Conductivity (μS/cm)

Depth (m)	Baseline					Operational													
	5/10/96	5/12/96	7/1/96	9/1/96	10/1/96	10/26/05	3/13/06	5/18/06	8/11/06	10/31/06	3/6/07	5/24/07	8/15/07	10/23/07	4/1/08	5/21/08	10/28/08	3/13/09	5/20/09
0									159	164		117	181	174	198	188	199	212	197
1						153	161	157	159	163	175	114	181	174	193	186	199	207	197
2						153	156	157	159	163	172	113	180	174	189	186	233	203	197
3						153	154	157	159	163	171	111	181	174	186	186	228	201	197
4						153	154	156	159	163	170	110	181	174	185	187	235	200	197
5						153	153	156	159	163	170	108	181	174	186	186	234	199	197
6						153	153	155	159	163	170	108	181	174	186	186	234	199	197
7						153	153	156	159	163	171	107	180	174	187	186	233	198	197
8						153	153	156	160	164	171	107	179	174	188	186	233	198	197
9						153	153	156	158	164	171	107	178	174	188	186	232	198	197
10						153	153	156	157	164	170	107	176	174	189	186	231	198	198
11						153	155	156	156	164	170	106	174	174	190	186	231	197	198
12						153	156	156	156	164	170	106	173	174	191	186	231	198	199
13						152	156	156	157	164	171	106	173	174	191	186	231	198	200
14						152	156	156	157	164	171	105	173	174	190	186	230	198	200
15						152	156	156	157	163	172	104	172	174	191	186	230	198	200
16						152	156	156	157	163	172	104	172	174	191	186	229	198	201
17						151	156	156	157	163	173	104	172	174	191	186	229	198	202
18						151	156	156	157	167	173	104	172	171	191	186	230	198	203
19						151	157	156	157	170	174	104	172	169	191	186	230	198	203
20						151	157	156	157	167	174	104	171	167	190	186	230	198	204
21						151	157	157	157	163	176	103	171	167	191	186	229	198	205
22						151	157	157	158	163	177	103	172	167	191	187	230	198	205
23						151	157	157	158	163	177	103	172	167	191	188	230	198	207
24						151	157	157	158	163	177	103	172	167	191	190	230	199	208
25						151	157	157	158	163		103	172	167	190	191	230	200	209
26						151	157	157	158	163		103	172	167	191	193	230	200	209
27						151	157	157	158	163		103	173		192	195	230	200	210
28						151	157	157	158	163		104	173		194	201	230	201	210
29						151	158	157	158	162		102			194	207	230	201	211
30						151	159	157				102			194	209	231	202	211
31								157							195	210			
32								157								212			
33								157								216			
34								157								237			
35								157								275			
36								157											

Red values indicate average of measurements above and below that depth.

Table A.2: Water quality profiles for Polley Lake station P1, 1995-2009.

D) pH (pH units, BCWQG 6.5 - 9.0)

Depth (m)	Baseline					Operational													
	5/10/96	5/12/96	7/1/96	9/1/96	10/1/96	10/26/05	3/13/06	5/18/06	8/11/06	10/31/06	3/6/07	5/24/07	8/15/07	10/23/07	4/1/08	5/21/08	10/28/08	3/13/09	5/20/09
0									7.52	6.91		8.18	6.97	8.11	7.70	7.57	7.66	7.47	7.35
1						7.69		6.90	7.95	7.01	8.36	8.28	7.49	8.30	7.70	7.83	7.94	7.44	7.27
2						7.72		7.07	8.11	7.10	8.28	8.32	7.68	8.31	7.70	7.96	7.92	7.38	7.25
3						7.74		7.18	8.26	7.13	8.20	8.35	7.87	8.31	7.68	8.02	7.91	7.35	7.22
4						7.74		7.24	8.32	7.16	8.16	8.36	7.97	8.31	7.65	8.01	7.90	7.34	7.21
5						7.76		7.31	8.38	7.18	8.13	8.35	8.07	8.30	7.62	8.01	7.89	7.34	7.20
6						7.76		7.35	8.41	7.20	8.10	8.34	8.17	8.30	7.61	8.02	7.89	7.34	7.20
7						7.77		7.37	8.44	7.22	8.07	8.33	8.27	8.30	7.59	8.02	7.89	7.33	7.19
8						7.78		7.37	8.29	7.22	8.04	8.32	8.25	8.30	7.58	8.01	7.89	7.33	7.18
9						7.79		7.37	8.32	7.22	8.02	8.30	8.23	8.30	7.57	8.00	7.88	7.32	7.16
10						7.80		7.38	8.27	7.24	7.99	8.30	8.21	8.30	7.58	7.99	7.88	7.32	7.17
11						7.80		7.39	8.17	7.25	7.98	8.29	8.18	8.30	7.56	7.99	7.87	7.31	7.17
12						7.79		7.39	8.13	7.27	7.96	8.28	8.14	8.31	7.54	7.99	7.86	7.31	7.17
13						7.78		7.39	8.08	7.29	7.94	8.27	8.08	8.31	7.54	7.98	7.86	7.31	7.17
14						7.76		7.38	8.04	7.31	7.91	8.26	8.07	8.31	7.53	7.98	7.86	7.31	7.17
15						7.74		7.38	7.97	7.33	7.90	8.25	8.04	8.31	7.52	7.97	7.85	7.30	7.16
16						7.74		7.38	7.90	7.33	7.88	8.23	8.08	8.31	7.51	7.97	7.85	7.30	7.15
17						7.73		7.37	7.89	7.33	7.86	8.21	8.01	8.31	7.51	7.96	7.84	7.30	7.16
18						7.72		7.36	7.85	7.35	7.84	8.20	7.98	7.91	7.50	7.96	7.87	7.30	7.14
19						7.71		7.36	7.80	7.36	7.83	8.18	7.97	7.71	7.50	7.96	7.84	7.30	7.12
20						7.68		7.36	7.83	7.37	7.82	8.18	7.96	7.51	7.48	7.96	7.83	7.30	7.10
21						7.64		7.36	7.85	7.38	7.81	8.17	7.90	7.46	7.46	7.95	7.83	7.29	7.10
22						7.64		7.35	7.84	7.38	7.79	8.16	7.88	7.40	7.45	7.94	7.83	7.29	7.09
23						7.63		7.35	7.82	7.38	7.78	8.15	7.87	7.39	7.43	7.93	7.83	7.29	7.09
24						7.61		7.34	7.81	7.39	7.76	8.14	7.85	7.37	7.42	7.90	7.83	7.28	7.09
25						7.59		7.34	7.80	7.40		8.13	7.84	7.35	7.41	7.87	7.83	7.27	7.07
26						7.58		7.33	7.79	7.40		8.12	7.83	7.33	7.39	7.86	7.82	7.27	7.05
27						7.57		7.33	7.77	7.39		8.11	7.81		7.37	7.84	7.82	7.26	7.04
28						7.56		7.32	7.73	7.34		8.11	7.80		7.35	7.79	7.82	7.25	7.03
29						7.55		7.32	7.68	7.36		8.09			7.32	7.73	7.82	7.23	7.02
30						7.53		7.32				8.07			7.29	7.64	7.81	7.21	7.01
31								7.32							7.26	7.56			
32								7.31								7.43			
33								7.31								7.33			
34								7.30								7.22			
35								7.29								7.30			
36								7.28											

Red values indicate average of measurements above and below that depth.

Table A.3: Water quality profiles for Polley Lake station P2, 1995-2009

A) Temperature (°C)

Depth (m)	Baseline				Operational													
	5/10/96	7/1/96	9/1/96	10/1/96	10/26/05	3/13/06	5/18/06	8/11/06	10/31/06	3/6/07	5/23/07	8/15/07	10/23/07	4/1/08	5/21/08	10/28/08	3/13/09	5/20/09
0			14.53	5.60				19.00	6.43		9.43	20.86	8.00	0.01	4.69	6.79	0.39	6.03
1		21.13	14.51	5.58	8.03	2.48	13.91	18.67	6.51	0.74	9.19	18.91	8.02	0.59	4.70	6.80	0.90	6.01
2	4.83	20.88	14.48	5.58	8.02	2.77	13.22	18.38	6.59	1.12	8.95	18.39	8.01	1.28	4.66	6.80	1.74	6.00
3	4.80	19.46	14.46	5.56	8.01	2.87	12.46	18.24	6.60	1.33	8.85	18.16	7.98	1.52	4.65	6.80	2.05	5.99
4	4.76	18.51	14.44	5.51	7.97	2.94	9.95	18.16	6.60	1.49	8.74	18.01	7.95	1.65	4.64	6.79	2.20	5.96
5	4.72	17.62	14.43	5.48	7.94	2.99	7.94	18.04	6.60	1.58	8.64	17.85	7.94	1.72	4.65	6.79	2.30	5.87
6	4.74	16.85	14.41	5.43	7.88	3.04	7.29	15.75	6.61	1.67	8.53	17.74	7.92	1.77	4.65	6.79	2.38	5.81
7	4.68	15.79	14.40	5.38	7.86	3.09	6.90	11.34	6.61	1.77	8.45	17.63	7.88	1.83	4.64	6.78	2.45	5.78
8	4.62	13.60	14.38	5.35	7.85	3.14	6.62	9.92	6.61	1.84	8.36	15.72	7.83	1.90	4.63	6.77	2.50	5.77
9	4.54	10.47	14.35	5.35	7.84	3.17	6.46	8.95	6.60	1.90	8.30	13.81	7.82	1.95	4.62	6.77	2.54	5.77
10	4.49	8.78	13.19	5.37	7.84	3.23	6.30	8.19	6.60	1.97	8.23	11.59	7.81	2.02	4.60	6.76	2.59	5.75
11	4.44	7.54	9.82	5.35	7.84	3.23	6.10	7.60		2.04	8.08	9.37	7.80	2.07	4.54	6.75	2.63	5.75
12	4.39	6.90	8.85	5.35	7.83	3.24	5.77	7.43		2.10	7.93	8.50	7.75	2.13	4.47	6.74	2.68	5.74
13	4.39	6.53	8.38	5.33	7.18	3.23	5.65	7.27		2.16	7.89	7.62	7.72	2.18	4.47	6.72	2.72	5.74
14	4.39	6.21	7.84	5.35		3.22	5.52			2.21	7.85	7.09	7.69	2.24	4.47	6.72	2.79	5.73
15	4.38	5.93	7.09	5.35		3.24	5.42		6.18	2.26	7.83	6.55	7.05	2.29	4.50	6.72	2.85	5.73
16	4.37	5.76	6.63	5.32		3.26	5.32			2.32	7.80	6.31	6.72	2.34	4.52	6.71	2.90	5.72
17	4.34	5.58	6.30	5.32		3.28	5.28			2.38	7.77	6.07	6.40	2.39	4.52	6.70	2.95	5.72
18	4.34	5.43	6.01	5.27		3.30	5.23	7.00		2.43	7.74	5.93	6.09	2.45	4.52	6.66	2.97	5.71
19	4.34	5.34	5.76	5.22		3.31	5.17	6.74		2.48	7.61	5.78	5.93	2.49	4.48	6.55	2.99	5.67
20	4.34	5.31	5.51	5.20		3.31	5.10		6.06	2.48	7.47	5.67	5.77	2.51	4.44	6.29	3.02	5.63
21	4.33	5.07	5.38	5.20		3.32	5.03			2.48		5.57	5.70	2.56	4.41	6.10	3.04	5.55
22	4.32	5.00	5.28	5.20		3.33	4.96					5.47	5.62	2.62	4.38	6.01	3.06	5.47
23	4.34	4.97	5.23	5.18		3.41	4.93					5.41	5.57	2.67	4.30	5.89	3.08	5.36
24	4.32	4.94	5.17	5.20		3.49	4.90					5.36	5.52	2.70	4.22	5.81	3.11	5.24
25	4.29	4.93	5.15	5.18										2.74	4.21	5.73	3.14	5.13
26	4.29	4.90	5.08	5.18											4.20	5.69		5.01
27	4.21	4.87	5.07	5.17														4.90
28	4.12	4.85	5.04	5.15														4.78
29		4.84	5.03															
30		4.82	5.03															
31		4.81																
32		4.81																

Red values indicate average of measurements above and below that depth.

Table A.3: Water quality profiles for Polley Lake station P2, 1995-2009

B) Dissolved Oxygen (mg/L)

Depth (m)	Baseline				Operational													
	05/10/96	07/01/96	09/01/96	10/01/96	10/26/05	03/13/06	05/18/06	08/11/06	10/31/06	03/06/07	05/23/07	08/15/07	10/23/07	04/01/08	05/21/08	10/28/08	03/13/09	05/20/09
0			8.11	9.16				8.97	9.70		12.85	9.66	9.32	10.62	12.30	8.92	10.84	12.21
1		6.76	8.13	9.15	10.39	11.27	11.20	8.94	9.63	12.00	12.95	9.47	9.26	9.64	12.29	8.70	10.56	12.23
2	10.65	6.93	8.35	9.11	10.35	11.11	11.21	8.90	9.56	11.14	12.93	9.50	9.26	9.42	12.28	8.68	10.46	12.22
3	10.91	7.25	8.37	9.09	10.31	10.98	11.33	8.86	9.53	10.67	12.92	9.52	9.25	9.25	12.27	8.68	10.40	12.22
4	10.88	7.28	8.36	9.10	10.26	10.76	12.30	8.85	9.51	10.56	12.91	9.53	9.24	8.96	12.25	8.67	10.34	12.19
5	10.84	7.33	8.33	9.07	10.21	10.62	12.37	8.83	9.49	10.39	12.90	9.53	9.24	8.92	12.24	8.66	10.20	12.15
6	11.18	7.30	8.32	9.07	10.04	10.39	11.86	8.83	9.48	10.21	12.88	9.49	9.24	8.46	12.23	8.65	10.12	12.08
7	11.08	7.21	8.30	9.09	9.91	10.29	11.30	8.82	9.47	10.07	12.84	9.45	9.22	8.20	12.21	8.64	10.03	12.07
8	10.97	7.16	8.31	9.10	9.80	10.21	10.98	8.80	9.46	10.03	12.80	9.68	9.20	8.16	12.19	8.62	9.84	12.03
9	10.39	6.55	8.32	9.10	9.81	10.12	10.80	9.10	9.46	9.99	12.78	9.91	9.19	8.01	12.19	8.56	9.65	12.01
10	10.41	6.43	7.06	9.08	9.83	9.81	10.73	9.49	9.45	9.85	12.76	9.85	9.18	8.00	12.19	8.46	9.47	12.00
11	10.43	6.29	6.07	9.08	9.88	9.60	10.63	9.18		9.71	12.79	9.79	9.17	7.98	12.18	8.42	9.29	11.99
12	10.04	6.11	5.96	9.08	9.89	9.38	10.36	8.79		9.66	12.81	9.38	9.05	7.95	12.16	8.43	9.04	11.98
13	9.94	6.03	5.78	9.07	8.55	9.38	10.28	8.43		9.60	12.83	8.97	8.98	7.97	12.12	8.73	8.79	11.98
14	9.83	6.04	5.73	9.08		9.37	10.20	8.10		9.41	12.84	8.66	8.92	7.91	12.08	8.78	8.29	11.97
15	9.84	5.98	5.86	9.06		9.30	10.05	7.88	5.71	9.22	12.83	8.35	7.60	7.71	12.05	8.79	7.79	11.96
16	9.84	5.87	5.87	9.08		9.23	9.90	7.66		8.84	12.82	8.01	6.94	7.45	12.01	8.80	8.23	11.95
17	9.82	5.89	5.84	9.06		9.15	9.92	7.60		8.46	12.82	7.66	6.28	7.01	12.02	8.76	8.66	11.94
18	9.64	5.73	5.71	9.08		9.07	9.94	7.53		7.92	12.81	7.63	5.42	7.29	12.02	8.61	8.45	11.93
19	9.46	5.73	5.58	9.10		8.93	9.90	6.79		7.38	12.62	7.59	4.98	6.82	11.98	7.80	8.23	11.93
20	9.14	5.66	5.37	9.10		8.79	9.85		5.20	5.44	12.43	7.50	4.55	7.01	11.94	7.21	8.00	11.92
21	9.09	5.46	5.11	9.08		8.75	9.73			3.49		7.39	4.00	6.67	11.94	6.34	7.77	11.86
22	9.03	5.38	4.94	9.10		8.71	9.61					7.27	3.44	6.11	11.94	5.27	7.46	11.79
23	8.88	5.27	4.73	9.09		8.69	9.50					6.93	3.11	5.73	11.86	4.89	7.15	11.70
24	8.78	5.14	4.52	9.08		4.30	9.39					6.66	2.78	5.94	11.77	4.54	6.92	11.60
25	8.68	5.16	4.37	9.09										5.44	11.21	4.28	6.69	11.45
26	8.44	5.20	3.98	9.07											10.64	1.29		11.30
27	8.33	5.03	3.83	9.08														11.12
28	8.21	4.87	3.64	8.98														10.93
29		4.79	3.57															
30		4.63	3.12															
31		4.46																
32		4.33																

Red values indicate average of measurements above and below that depth.

Table A.3: Water quality profiles for Polley Lake station P2, 1995-2009

C) Conductivity (μS/cm)

Depth (m)	Baseline				Operational													
	5/10/96	7/1/96	9/1/96	10/1/96	10/26/05	03/13/06	05/18/06	08/11/06	10/31/06	03/06/07	05/23/07	08/15/07	10/23/07	04/01/08	05/21/08	10/28/08	03/13/09	5/20/09
0								159	164		116	184	174	248	188	197	237	193
1					153	155	156	160	164	175	116	182	175	189	188	197	205	193
2					153	155	157	161	164	172	116	182	174	185	188	197	202	193
3					153	154	156	161	164	170	116	181	174	185	188	197	201	193
4					153	154	155	161	164	169	115	182	174	186	188	197	200	193
5					153	154	155	161	164	169	115	182	175	186	188	197	200	193
6					153	154	155	161	164	169	114	182	175	188	188	197	200	194
7					153	154	156	161	164	169	114	182	175	188	188	197	200	194
8					153	154	156	161	164	169	114	180	174	188	188	197	200	194
9					153	154	156	161	164	169	114	177	174	188	188	197	200	194
10					153	154	156	158	164	169	113	178	174	188	188	197	201	194
11					153	154	156	157		168	113	179	174	187	189	197	201	194
12					153	155	156	157		168	112	176	174	187	189	197	201	194
13					153	156	156	157		168	112	173	174	187	189	197	200	194
14						157	156	157		169	112	173	174	187	189	197	200	194
15						157	156	157	161	169	113	172	171	187	189	197	200	194
16						157	156	157		170	113	172	170	187	189	197	200	194
17						157	156	157		170	112	172	168	187	189	197	200	194
18						157	156	157		172	111	173	168	187	189	197	200	194
19						157	156	158		173	111	173	167	187	189	196	200	194
20						157	156		161	176	111	172	167	189	189	196	200	194
21						158	157			178		173	167	189	190	195	200	195
22						158	157					173	167	188	190	195	200	195
23						183	157					173	167	188	191	195	200	195
24						208	156					173	167	188	191	195	200	195
25														188	192	195	200	196
26															193	196		197
27																		198
28																		198
29																		
30																		
31																		
32																		

Red values indicate average of measurements above and below that depth.

Table A.3: Water quality profiles for Polley Lake station P2, 1995-2009

D) pH (pH units, BCWQG 6.5 - 9.0)

Depth (m)	Baseline				Operational													
	5/10/96	7/1/96	9/1/96	10/1/96	10/26/05	3/13/06	5/18/06	8/11/06	10/31/06	3/6/07	5/23/07	8/15/07	10/23/07	4/1/08	5/21/08	10/28/08	3/13/09	5/20/09
0								8.22	7.52		8.05	7.51	8.22	7.67	7.96	7.83	7.98	7.35
1					7.46		7.71	8.28	7.54	7.90	8.21	8.06	8.22	7.64	8.02	7.81	7.94	7.32
2					7.48		7.73	8.33	7.55	7.87	8.29	8.35	8.23	7.62	8.03	7.79	7.84	7.31
3					7.49		7.73	8.37	7.60	7.84	8.31	8.43	8.23	7.60	8.04	7.78	7.78	7.34
4					7.52		7.80	8.40	7.63	7.81	8.33	8.46	8.22	7.56	8.04	7.77	7.76	7.34
5					7.54		7.91	8.42	7.65	7.81	8.35	8.48	8.22	7.52	8.05	7.77	7.74	7.34
6					7.56		7.81	8.44	7.65	7.80	8.37	8.51	8.22	7.50	8.05	7.76	7.73	7.34
7					7.57		7.78	8.45	7.65	7.79	8.38	8.53	8.21	7.48	8.05	7.76	7.71	7.35
8					7.58		7.75	8.47	7.67	7.78	8.39	8.56	8.19	7.47	8.05	7.75	7.70	7.33
9					7.58		7.74	8.40	7.67	7.77	8.40	8.59	8.19	7.46	8.05	7.74	7.68	7.34
10					7.60		7.72	8.44	7.68	7.77	8.41	8.61	8.19	7.45	8.05	7.73	7.67	7.32
11					7.60		7.72	8.41		7.76	8.42	8.63	8.19	7.45	8.05	7.72	7.65	7.32
12					7.60		7.71	8.38		7.75	8.42	8.63	8.15	7.44	8.04	7.73	7.61	7.32
13					7.58		7.70	8.34		7.73	8.43	8.62	8.13	7.43	8.04	7.74	7.57	7.32
14							7.69	8.31		7.73	8.43	8.62	8.11	7.43	8.03	7.73	7.56	7.31
15							7.68	8.28	7.63	7.72	8.44	8.61	7.91	7.42	8.03	7.73	7.54	7.31
16							7.66	8.24		7.71	8.44	8.58	7.80	7.41	8.03	7.73	7.53	7.31
17							7.65	8.23		7.70	8.44	8.55	7.70	7.37	8.04	7.73	7.52	7.32
18							7.64	8.21		7.67	8.44	8.53	7.61	7.38	8.04	7.72	7.51	7.32
19							7.64	8.02		7.63	8.43	8.50	7.56	7.37	8.03	7.69	7.50	7.32
20							7.63		7.30	7.58	8.41	8.47	7.51	7.36	8.02	7.65	7.49	7.32
21							7.62			7.53		8.44	7.46	7.35	8.02	7.61	7.47	7.32
22							7.60					8.42	7.41	7.32	8.01	7.55	7.46	7.32
23							7.59					8.38	7.38	7.29	8.00	7.51	7.44	7.31
24							7.58					8.32	7.35	7.29	7.99	7.47	7.43	7.29
25														7.28	7.96	7.44	7.41	7.29
26															7.92	7.25		7.28
27																		7.27
28																		7.25
29																		
30																		
31																		
32																		

Red values indicate average of measurements above and below that depth.

Table A.4: Water quality profiles for Bootjack Lake station B1, 1995-2009

A) Temperature (°C)

Depth (m)	Baseline				Operational											
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	3/14/06	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0			13.65	3.56				5.06		10.70	6.74	0.00	6.78	5.64	0.38	7.38
1		22.32	13.65	3.59	4.55	1.00	14.10	5.15	0.71	10.20	6.73	0.76	6.75	5.62	0.79	7.18
2	6.55	21.62	13.65	3.59	4.49	1.93	14.00	5.24	1.08	9.96	6.74	2.22	6.70	5.62	1.60	6.55
3	6.34	19.27	13.65	3.57	4.45	2.15	13.89	5.26	1.33	8.93	6.74	2.75	6.69	5.63	1.99	6.39
4	6.27	17.84	13.64	3.59	4.44	2.24	13.01	5.28	1.50	7.88	6.72	3.09	6.64	5.63	2.17	6.30
5	6.19	16.39	13.65	3.54	4.39	2.40	9.20	5.29	1.74	7.46	6.72	3.22	6.62	5.62	2.31	6.21
6	6.10	15.56	13.63	3.56	4.37	2.54	7.59	5.31	2.11	7.03	6.72	3.33	6.53	5.62	2.49	6.07
7	6.01	14.23	13.63	3.54	4.35	2.69	7.12	5.31	2.47	6.48	6.72	3.46	5.28	5.62	2.80	5.80
8	5.92	11.55	13.63	3.54	4.33	2.93	6.95	5.31	2.72	6.15	6.71	3.53	4.72	5.62	3.11	5.43
9	5.83	10.70	13.61	3.54	4.33	3.08	6.67	5.30	2.97	5.92		3.60	4.57	5.62	3.31	5.40
10	5.73	9.48	12.45	3.54	4.32	3.15	6.51	5.30	3.22	5.86		3.68	4.54	5.62	3.51	5.24
11	5.67	8.63	9.83		4.33				3.33			3.71	4.27	5.94	3.67	5.19
12	5.60	8.50	9.16		4.46							3.83				5.18
13	5.55	8.37	8.87													
14	5.46	8.35														
15	5.37															

Red values indicate average of measurements above and below that depth.

B) Dissolved Oxygen (mg/L)

Depth (m)	Baseline				Operational											
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	3/14/06	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0			7.70	12.11				10.95		11.08	10.32	11.31	10.68	10.82	12.42	10.45
1		1.89	7.68	11.03	12.47	11.84	9.75	10.73	11.77	11.18	10.18	10.90	10.47	10.77	11.43	10.38
2	9.72	1.89	7.66	10.62	12.39	11.20	9.75	10.50	11.35	11.16	10.16	10.65	10.43	10.77	10.81	10.34
3	9.66	1.93	7.66	10.61	12.40	10.84	9.73	10.50	11.05	10.93	10.16	10.58	10.40	10.75	10.66	10.31
4	9.72	1.87	7.65	10.68	12.37	10.70	10.19	10.50	10.62	10.70	10.13	10.10	10.40	10.75	10.52	10.16
5	9.77	1.83	7.66	10.67	12.39	10.40	11.34	10.49	10.33	10.50	10.13	9.53	10.40	10.74	10.22	10.05
6	9.85	1.63	7.63	10.38	12.37	9.85	10.50	10.49	10.05	10.29	10.13	8.98	10.29	10.73	9.72	9.90
7	9.93	1.66	7.63	10.47	12.38	8.69	9.80	10.48	9.76	9.93	10.13	7.65	10.04	10.73	8.65	9.70
8	10.40	1.48	7.60	10.30	12.39	7.65	9.60	10.47	8.53	9.65	10.12	7.30	8.75	10.73	7.57	9.27
9	10.05	1.44	7.55	10.04	12.39	6.60	8.94	10.46	7.30	9.29		6.75	7.98	10.72	6.34	9.02
10	9.70	1.09	1.60	10.04	12.39	6.11	8.70	10.45	5.05	9.12		5.92	7.30	10.71	5.11	8.80
11	9.30	0.78	0.22		12.32				3.27			5.54	6.56	1.37	2.34	8.66
12	8.90	0.55	0.16		3.90							2.27				8.37
13	9.17	0.36	0.13													
14	9.07	0.30														
15	8.97															

Red values indicate average of measurements above and below that depth.

Table A.4: Water quality profiles for Bootjack Lake station B1, 1995-2009

C) Conductivity (μS/cm)

Depth (m)	Baseline				Operational											
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	3/14/06	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0								85		58	83	100	80	86	123	82
1					79	83	80	85	89	58	83	92	80	86	88	82
2					79	79	80	84	89	57	83	87	80	85.7	86	82
3					79	80	80	84	88	56	83	86	80	86	86	82
4					80	80	80	84	89	54	83	87	80	86	87	82
5					80	81	80	84	90	54	83	87	80	86	87	82
6					80	81	80	84	91	53	83	88	80	86	87	82
7					80	82	80	84	91	54	83	88	85	86	88	82
8					79	83	79	84	92	52	83	88	88	86	88	82
9					80	85	79	84	92	52		89	90	86	90	83
10					80	86	79	84	101	51		90	91	85.2	91	83
11					80				108			91	96	103	95	83
12					90							98				82
13																
14																
15																

Red values indicate average of measurements above and below that depth.

D) pH (pH units, BCWQG 6.5 - 9.0)

Depth (m)	Baseline				Operational											
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	3/14/06	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0								7.57		8.42	7.96	7.69	7.44	8.10	7.16	7.18
1					9.15		7.68	7.58	7.89	8.08	7.97	7.63	7.40	7.96	7.21	7.07
2					9.05		7.67	7.59	7.86	8.06	7.97	7.64	7.39	7.93	7.09	7.08
3					8.99		7.64	7.58	7.83	8.07	7.97	7.68	7.38	7.91	7.05	7.00
4					8.94		7.69	7.58	7.80	8.07	7.96	7.66	7.38	7.87	7.05	6.99
5					8.90		7.67	7.57	7.77	8.06	7.96	7.61	7.38	7.88	7.07	6.98
6					8.83		7.61	7.56	7.75	8.06	7.95	7.40	7.37	7.88	7.08	7.00
7					8.80		7.49	7.56	7.73	8.06	7.95	7.26	7.36	7.87	7.05	7.00
8					8.76		7.47	7.56	7.71	8.05	7.95	7.15	7.30	7.86	7.01	7.01
9					8.73		7.45	7.56	7.69	8.04		7.07	7.21	7.87	6.85	6.93
10					8.71		7.43	7.56	7.68	8.02		7.00	7.17	7.86	6.69	6.92
11					8.68				7.50			6.95	7.13	7.41	6.89	6.89
12					8.55							6.85				6.85
13																
14																
15																

Red values indicate average of measurements above and below that depth.

Table A.5: Water quality profiles for Bootjack Lake station B2, 1995-2009

A) Temperature (°C)

Depth (m)	Baseline				Operational										
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0			13.50	4.36			5.38		10.78	7.18	0.01	6.94	6.67	0.39	7.44
1	5.61	21.62	13.50	4.32	3.66	11.76	5.48	0.29	10.64	7.17	1.07	6.95	6.59	1.01	6.58
2	5.61	21.12	13.50	4.27	3.51	11.40	5.58	0.92	10.32	7.17	2.19	6.94	6.61	1.71	6.42
3	5.61	19.88	13.50	4.27	3.52	10.92	5.62	1.34	10.21	7.18	2.73	6.94	6.59	2.07	6.34
4	5.59	17.98	13.50	4.22	3.52	10.61	5.65	1.55	10.09	7.18	2.98	6.96	6.56	2.26	6.21
5	5.56	16.97	13.49	4.16	3.50	9.80	5.31	1.76	10.03	7.18	3.12	6.95	6.46	2.37	6.11
6	5.56	15.49	13.49	4.16	3.50	8.59	5.13	1.94	9.97	7.18	3.30	6.94	6.44	2.48	6.02
7	5.56	13.77	13.49	4.16	3.49	7.91	4.96	2.12	9.90	7.18	3.45	6.94	6.45	2.60	5.63
8	5.53	10.62	13.47	4.16	3.49	7.20		2.18	9.83	7.17	3.63	6.94	6.42	2.70	5.40
9	5.53	9.51	13.49	4.14	3.49	6.52		2.24	9.35	7.17	3.80	6.91	6.42	2.79	5.27
10	5.53	8.78	9.64	4.14		6.28				7.16	3.85	6.84	6.36	2.88	5.22
11	5.51	9.30	8.82	4.14						7.16	4.00	6.76	6.34	2.98	5.19
12	5.50	8.09		4.12						7.17		6.46		3.07	
13	5.50	8.00		4.14						7.16					
14	5.50	7.87		4.15						7.16					
15	5.41														

Red values indicate average of measurements above and below that depth.

B) Dissolved Oxygen (mg/L)

Depth (m)	Baseline				Operational										
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0			7.83	11.06			11.10		10.83	10.04	10.94	10.84	10.39	12.10	10.81
1	9.52	4.95	7.80	10.95	12.68	10.83	10.67	13.22	10.92	9.78	9.72	10.53	10.42	11.10	10.68
2	9.59	4.97	7.80	10.91	12.66	10.95	10.24	12.45	10.95	9.69	9.38	10.52	10.43	10.73	10.65
3	9.65	4.88	7.79	10.87	12.66	11.20	10.23	11.33	10.99	9.68	9.15	10.51	10.45	10.56	10.60
4	9.31	4.96	7.79	10.83	12.64	11.34	10.22	10.87	11.03	9.64	8.73	10.51	10.47	10.49	10.39
5	9.23	3.92	7.79	10.78	12.64	11.58	10.03	10.41	11.03	9.62	8.22	10.49	10.50	10.25	10.25
6	9.30	3.58	7.78	10.76	12.65	11.61	9.94	9.93	11.02	9.63	7.36	10.48	10.49	9.92	10.18
7	9.36	3.65	7.76	10.74	12.64	11.12	9.84	9.44	11.01	9.61	7.15	10.48	10.48	9.40	9.85
8	9.47	3.19	7.76	10.72	12.65	10.28		7.91	11.00	9.60	5.31	10.48	10.47	8.88	9.67
9	9.31	2.87	7.76	10.73	12.60	9.47		6.38	10.87	9.60	4.13	10.38	10.46	8.36	9.46
10	9.14	2.44	0.84	10.73		8.91				9.60	4.02	10.44	10.45	7.56	9.34
11	9.21	1.67	0.20	10.71						9.59	2.78	10.25	1.34	6.51	9.27
12	9.29	1.48		10.70						9.59		10.13		5.23	
13	9.21	1.34		10.69						9.59					
14	9.12	1.04		10.43						6.03					
15	8.75														

Red values indicate average of measurements above and below that depth.

Table A.5: Water quality profiles for Bootjack Lake station B2, 1995-2009

C) Conductivity (µS/cm)

Depth (m)	Baseline				Operational										
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0							84		58	79	106	78	131	99	82
1					80	79	85	90	58	82	90	78	135	86	81
2					80	79	85	77	58	80	87	78	136	85	81
3					80	79	85	72	58	82	87	78	137	85	80
4					80	79	85	80	58	82	88	78	137	86	81
5					80	79	87	88	58	82	88	78	137	86	81
6					80	79	87	88	58	82	89	78	137	86	81
7					80	79	88	88	58	80	90	78	138	86	81
8					80	79		95	57	82	92	78	138	87	82
9					80	80		101	56	80	94	78	138	87	82
10						79				82	97	78	138	88	81
11										82	101	78	139	89	82
12										82		80		96	
13										82					
14										82					
15															

Red values indicate average of measurements above and below that depth.

D) pH (pH units, BCWQG 6.5 - 9.0)

Depth (m)	Baseline				Operational										
	5/1/96	7/1/96	9/1/96	10/1/96	11/10/05	5/23/06	10/31/06	3/6/07	5/23/07	10/23/07	4/1/08	5/21/08	10/27/08	3/13/09	5/21/09
0							7.68		7.77	8.63	7.71	7.31	7.84	7.50	7.05
1					8.30	8.04	7.66	7.74	7.78	8.03	7.57	7.32	7.82	7.43	7.02
2					8.28	7.92	7.64	7.74	7.78	7.90	7.51	7.32	7.82	7.35	7.03
3					8.27	7.86	7.64	7.72	7.78	7.89	7.44	7.32	7.81	7.33	7.04
4					8.26	7.82	7.64	7.70	7.78	7.86	7.36	7.35	7.80	7.30	7.05
5					8.22	7.78	7.64	7.67	7.78	7.85	7.29	7.36	7.80	7.31	7.06
6					8.24	7.75		7.65	7.78	7.83	7.21	7.36	7.80	7.30	7.04
7					8.23	7.73	7.61	7.63	7.78	7.83	6.64	7.37	7.80	7.30	7.05
8					8.19	7.69		7.54	7.78	7.82	7.06	7.37	7.79	7.28	7.03
9					8.20	7.65		7.45	7.78	7.82	7.00	7.30	7.79	7.25	7.00
10						7.61				7.82	6.96	7.37	7.78	7.25	6.96
11										7.81	6.93	7.37	7.77	7.23	6.96
12										7.83		7.35		7.12	
13										7.83					
14										7.81					
15															

Red values indicate average of measurements above and below that depth.

APPENDIX B

Water Chemistry Data

Table B.1: Baseline data and calculation of screening criteria for Polley and Bootjack Lakes.

Parameter	Units	BCWQG[a]	MDLs	Polley Surface									Polley Bottom								
				P1-1 metre 5/15/1995	P1-1 metre 5/9/1996	P2-1 metre 5/15/1995	P2-1 metre 5/9/1996	n	Mean[b]	St Dev	95th Percentile	Baseline 95th or MDL	P1-30 metre 5/15/1995	P1-32 metre 5/9/1996	P2-30 metre 5/15/1995	P2-26 metre 5/9/1996	n	Mean[b]	St Dev	95th Percentile	Baseline 95th or MDL
Field pH	pH units			7.74	7.50	7.67	7.5	4	7.60	0.12	7.73		7.3	7.49	7.41	7 5	4	7.43	0 09	7.50	
Field Temperature	degrees C																				
Field Conductivity	uS/cm			122	127	124	124	4	124 3	2.1	126 6	126 6	129	127	128	123	4	126.8	2.6	128.9	128 9
Alkalinity Total	mg/l			60.6	61	59.6	57.8	4	59.8	1.4	60.9	60.9	59.4	60 6	62.1	57.3	4	59 9	2.0	61 9	61.9
Sulfate	mg/l	50	<1.0	2 8	4.4	3 5	4.2	4	3.7	0.7	4.4	4.37	3.3	4	3 2	4.4	4	3.7	0.6	4.3	4.34
N+N LL	mg/l																				
Ortho Phosporus	mg/l		<0.001	0 003	0 007	0 003	0.006	4	0 005	0 002	0 007	0 007	0.003	0.014	0 003	0 006	4	0.007	0.005	0 013	0 013
N-Total	mg/l																				
Ammonia Nitrogen (N)	mg/l	1 85	<0.005	<0 005	0 031	<0.005	<0.005	4	0.0096	0.0143	0.0267	0 027	0.019	0.006	0 013	<0.005	4	0.0101	0 0074	0.0181	0 018
Phosphorus-T	mg/l			0.01	0 015	0 011	0.022	4	0.0145	0.0054	0.0210	0 021	0.028	0 0210	0.03	0 014	4	0.0233	0 0073	0.0297	0 030
Phosphorus-D	mg/l			0 008	0 009	0 005	0.006	4	0.0070	0.0018	0.0089	0 009	0.007	0.014	0 006	0 013	4	0.0100	0 0041	0.0139	0 014
TSS	mg/l	baseline + 25	<1.0	<1	4	<1	1	4	1 5	1.7	3 6	3.55	3	2	5	3	4	3.3	1.3	4.7	4.70
TDS	mg/l			79	80	79	77	4	78.8	1 3	79.9	79.9	79	79	82	77	4	79 3	2.1	81 6	81.6
Turbidity	NTU	baseline + 5	<1.0	1.1	1	0.68	0.9	4	0.92	0.18	1.09	1.09	2 52	1 00	2.42	1.1	4	1.76	0 82	2.51	2.51
Dissolved Organic Carbon	mg/l																				
Hardness	mg/l			59.6	56.5	60.3	57.5	4	58.5	1 8	60.2	60.2	61 3	58 8	62.9	58.2	4	60 3	2.2	62.7	62.7
Aluminum Dissolved	mg/l	0 05	<0.005	0 009	0 007	0.01	0.006	4	0.0080	0.0018	0.0099	0 010	0.008	0.005	0 011	0 005	4	0.0073	0 0029	0.0106	0 011
Aluminum Total	mg/l		<0.005	0 026	0 017	0.0290	0 0170	4	0.0223	0.0062	0.0286	0 029	0.027	0.012	0 028	0 016	4	0.0208	0 0080	0.0279	0 028
Arsenic Dissolved	mg/l		<0 0001	<0.0001	0.0003	<0 0001	0 0003	4	0 00018	0 00014	0 00030	0.0003	0 0002	0 0003	0.0001	0.0003	4	0.00023	0.00010	0 00030	0.0003
Arsenic Total	mg/l	0.005	<0 0001	0 00010	0 00030	0.0001	0 0003	4	0 00020	0 00012	0 00030	0.0003	0 0002	0 0003	0.0002	0.0003	4	0.00025	0.00006	0 00030	0.0003
Barium Dissolved	mg/l		<0 01	<0 010	<0.010	<0.010	<0.010	4	0 00500	0 00000	0 00500	0 010	<0 010	<0 010	<0 010	<0.010	4	0.00500	0.00000	0 00500	0 010
Barium Total	mg/l	1	<0 01	<0 010	<0.010	<0.010	<0.010	4	0 00500	0 00000	0 00500	0 010	<0 010	<0 010	<0 010	<0.010	4	0.00500	0.00000	0 00500	0 010
Calcium Dissolved	mg/l			19 2	18.8	19.4	18.3	4	18.9	0 5	19.4	19.4	19 8	18.7	20.3	18.4	4	19 3	0.9	20 2	20.2
Calcium Total	mg/l			19.2	18.1	19.5	18.5	4	18.8	0 6	19.5	19.5	19 8	18 9	20.5	18.7	4	19 5	0.8	20.4	20.4
Copper Dissolved	mg/l			0 002	0 002	0 002	0.002	4	0 00200	0 00000	0 00200	0 002	0.002	0.003	0 002	0 002	4	0.00225	0.00050	0 00285	0 003
Copper Total	mg/l	0.002		0 002	0 003	0 002	0.003	4	0 00250	0 00058	0 00300	0 003	0.002	0.003	0 002	0 003	4	0.00250	0.00058	0 00300	0 003
Iron Dissolved	mg/l		<0 03	<0 030	<0.030	<0.030	<0.030	4	0 015	0 000	0 015	0 030	<0 030	<0 030	<0.030	<0.030	4	0.015	0.000	0 015	0 030
Iron Total	mg/l	1	<0 03	<0 030	<0.030	<0.030	<0.030	4	0 015	0 000	0 015	0 030	0.061	0.032	0 059	0 041	4	0.048	0.014	0 061	0 061
Lead Dissolved	mg/l	0 35	<0.001	<0 001	<0.001	<0.001	<0.001	4	0 00050	0 00000	0 00050	<0.001	<0 001	<0 001	<0 001	<0.001	4	0.00050	0.00000	0 00050	<0.001
Lead Total	mg/l	0.004	<0.001	<0 001	<0.001	<0.001	<0.001	4	0 00050	0 00000	0 00050	<0.001	0.002	<0 001	<0 001	<0.001	4	0.00088	0.00075	0 00178	<0.002
Magnesium Dissolved	mg/l			2.83	2.84	2.87	2.77	4	2.83	0.04	2.87	2.87	2 91	2.8	2.98	2.79	4	2 87	0 09	2 97	2.97
Magnesium Total	mg/l			2.83	2.75	2.87	2.75	4	2.80	0.06	2.86	2.86	2 91	2 83	3.01	2.79	4	2 89	0.10	3 00	3.00
Manganese Dissolved	mg/l		<0.005	<0 005	0 016	<0.005	<0.005	4	0 00588	0 00675	0 01398	0 014	0.092	0 02	0 032	0 015	4	0.03975	0.03556	0 08300	0 083
Manganese Total	mg/l	0.756	<0.005	0 006	0 035	0 006	0.016	4	0 01575	0 01367	0 03215	0 032	0.258	0.064	0.138	0 038	4	0.12450	0.09857	0 24000	0 240
Molybdenum Dissolved	mg/l		<0.001	<0 001	<0.001	<0.001	<0.001	4	0 00050	0 00000	0 00050	<0.001	<0 001	<0 001	<0 001	<0.001	4	0.00050	0.00000	0 00050	<0.001
Molybdenum Total	mg/l	1	<0.001	<0 001	<0.001	<0.001	<0.001	4	0 00050	0 00000	0 00050	<0.001	<0 001	<0 001	<0 001	<0.001	4	0.00050	0.00000	0 00050	<0.001
Nickel Dissolved	mg/l		<0.001	<0 001	<0.001	<0.001	<0.001	4	0 00050	0 00000	0 00050	<0.001	0.001	<0 001	<0 001	<0.001	4	0.00063	0.00025	0 00093	<0.001
Nickel Total	mg/l	0.025	<0.001	<0 001	<0.001	<0.001	<0.001	4	0 00050	0 00000	0 00050	<0.001	0.007	<0 001	<0 001	<0.001	4	0.00213	0.00325	0 00603	<0.006
Potassium Dissolved	mg/l			0.39	0.32	0.4	0.3	4	0 353	0 050	0 399	0.40	0.43	0.032	0.400	0 290	4	0.288	0.181	0.426	0.43
Potassium Total	mg/l																				
Selenium Dissolved	mg/l		<0 0005	<0.0005	<0 0005	<0 0005	<0.0005	4	0.0003	0.0000	0.0003	<0 0005	<0.0005	<0.0005	<0 0005	<0 0005	4	0.0003	0 0000	0.0003	<0 0005
Selenium Total	mg/l	0.002	<0 0005	<0.0005	<0 0005	<0 0005	<0.0005	4	0.0003	0.0000	0.0003	<0 0005	<0.0005	<0.0005	<0 0005	<0 0005	4	0.0003	0 0000	0.0003	<0 0005
Silicon Dissolved	mg/l			2.73	2.96	2.77	2 87	4	2.83	0.10	2.95	2.95	3 29	3 03	3.21	2.98	4	3.13	0.15	3.28	3.28
Silicon Total	mg/l			2.73	2.81	2.77	2 81	4	2.78	0.04	2.81	2.81	3 29	3 05	3.27	2.88	4	3.12	0.19	3.29	3.29
Sodium Dissolved	mg/l			3.87	3.65	3.92	3.70	4	3.79	0.13	3.91	3.91	3 97	3 59	4.02	3.78	4	3 84	0 20	4.01	4.01
Sodium Total	mg/l																				
Strontium Dissolved	mg/l			0 087	0 093	0 089	0.089	4	0 090	0 003	0 092	0.09	0 09	0.087	0.09	0 089	4	0.089	0.001	0 090	0.09
Strontium Total	mg/l			0 087	0 089	0 089	0.089	4	0 089	0 001	0 089	0.09	0 09	0.088	0.09	0.09	4	0.090	0.001	0 090	0.09
Zinc Dissolved	mg/l		<0.005	<0 005	<0.005	<0.005	<0.005	4	0.0025	0.0000	0.0025	<0.005	<0 005	<0 005	<0.005	<0.005	4	0.0025	0 0000	0.0025	<0.005
Zinc Total	mg/l	0 0075	<0.005	<0 005	<0.005	<0.005	<0.005	4	0.0025	0.0000	0.0025	<0.005	<0 005	<0 005	<0 005	<0.005	4	0.0025	0 0000	0.0025	<0.005

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

Table B.1: Baseline data and calculation of screening criteria for Polley and Bootjack Lakes.

Parameter	Units	BCWQG[a]	MDLs	Bootjack Surface													
				B1-Surface	B1-Surface	B1-3 metre	B1-4 metre	B1-1 metre	B1-1 metre	B2 -3 metre	B2-1 metre	B2-1 metre	n	Mean[b]	St Dev	95th Percentile	Baseline 95th or MDL
				8/18/1985	6/1/1989	8/18/1989	10/19/1989	5/15/1995	5/9/1996	8/18/1989	5/15/1995	5/9/1996					
Field pH	pH units			7.18	6.98	7.18	7.4	7.29	7.16	7.38	7 21	7.27	9	7 23	0.13	7 39	
Field Temperature	degrees C																
Field Conductivity	uS/cm			74.4	74.9	74.4	74.5	71.6	72 5	74.1	70.4	71.1	9	73.1	1.7	74.7	74.7
Alkalinity Total	mg/l			35 8	39	35 8	38.1	34	34	34	34.4	33.2	9	35.4	2.0	38 6	38 6
Sulfate	mg/l	50	<1.0	2.5	<1.0	2.5	2.3	3	3.3	2 3	3.2	3.4	9	2.6	0.9	3.4	3 36
N+N LL	mg/l																
Ortho Phosporus	mg/l		<0.001	<0 001	0 004	<0 001	0.009	<0.001	0.011	0 003	0.005	0 006	9	0.004	0.004	0.010	0.010
N-Total	mg/l																
Ammonia Nitrogen (N)	mg/l	1 85	<0.005	0.009	<0.005	0.009	0.013	0 005	0.007	0 016	0.007	<0.005	9	0 0079	0 0045	0 0148	0.015
Phosphorus-T	mg/l			0.016	0 007	0.016		0.01	0.015	0.01	0.009	0 014	8	0 0121	0 0035	0 0160	0.016
Phosphorus-D	mg/l							0 007	0.011		0.005	0 008	4	0 0078	0 0025	0 0106	0.011
TSS	mg/l	baseline + 25	<1.0	4	3 3	4	7.8	2	4	2	1	<1	9	3.2	2.2	6.3	6 28
TDS	mg/l			60	56.1	60	60	47	48	60	47	46	9	53 8	6.6	60 0	60 0
Turbidity	NTU	baseline + 5	<1.0	<1 0	<1.0	<1 0	1.4	0.89	1.5	<1.0	0.8	1 2	9	0 87	0.41	1.46	1.46
Dissolved Organic Carbon	mg/l					7	7.6			7 3			3	7 30	0 30	7 57	
Hardness	mg/l					34.4	34.3	34	33 6	33.5	33 3	32.1	7	33 6	0.8	34.4	34.4
Aluminum Dissolved	mg/l	0 05	<0.005	0.014		0.014	<0.005	0 021	0.014	0.0080	0 0180	0.0540	8	0 0182	0 0156	0 0425	0.042
Aluminum Total	mg/l		<0.005	0.017		0.017	0 01	0 038	0.079	0 008	0.037	0 068	8	0 0343	0 0268	0 0752	0.075
Arsenic Dissolved	mg/l		<0 0001	<0.0001	<0 0001	<0.0001	0 0002	<0 0001	0 0003	<0 0001	<0.0001	0.00030	9	0.00012	0.00011	0.00030	0 0003
Arsenic Total	mg/l	0.005	<0 0001	0 0002	<0 0001	0.0002	0 0002	0 00010	0.00030	0.0001	0 0001	0.0003	9	0.00017	0.00009	0.00030	0 0003
Barium Dissolved	mg/l		<0 01					0 011	0.013		0.011	0.01	4	0.01125	0.00126	0.01270	0.013
Barium Total	mg/l	1	<0 01					0 014	0.013		0.015	0 011	4	0.01325	0.00171	0.01485	0.015
Calcium Dissolved	mg/l					10 5		10.4	10 5	10.2	10 2	9.73	6	10 3	0.3	10 5	10 5
Calcium Total	mg/l							10.4	10 3		10 2	9.82	4	10 2	0.3	10.4	10.4
Copper Dissolved	mg/l			0.003	0 003	0.003	0.004	0 004	0.003	0 002	0.003	0 003	9	0.00311	0.00060	0.00400	0.004
Copper Total	mg/l	0.002		0.003	0 003	0.003	0.004	0 004	0.004	0 004	0.003	0 003	9	0.00344	0.00053	0.00400	0.004
Iron Dissolved	mg/l		<0 03	<0.03	<0 03	<0.03	0 04	0 037	0.038	<0 03	0.039	<0.030	9	0.025	0.012	0.040	0.040
Iron Total	mg/l	1	<0 03	<0.03	<0 03	<0.03	0 09	0 065	0.127	<0 03	0.061	0.103	9	0.056	0.044	0.117	0.117
Lead Dissolved	mg/l	0 35	<0.001	<0 001	<0.001	<0 001	<0.001	<0.001	<0 001	<0.001	<0 001	<0.001	9	0.00050	0.00000	0.00050	<0 001
Lead Total	mg/l	0.004	<0.001	<0 001	<0.001	<0 001	<0.001	<0.001	<0 001	<0.001	<0 001	<0.001	9	0.00050	0.00000	0.00050	<0 001
Magnesium Dissolved	mg/l					1 98		1.96	2.17	1.94	1 92	1.89	6	1 98	0.10	2.12	2.12
Magnesium Total	mg/l							1.95	1 92		1 92	1.85	4	1 91	0 04	1 95	1 95
Manganese Dissolved	mg/l		<0.005					0.007000	<0 005		0 01	0 008	4	0.00688	0.00317	0.00970	0.010
Manganese Total	mg/l	0.756	<0.005					0 021	0.044		0.019	0 045	4	0.03225	0.01417	0.04485	0.045
Molybdenum Dissolved	mg/l		<0.001					<0 001	<0 001		<0 001	<0.001	4	0.00050	0.00000	0.00050	<0 001
Molybdenum Total	mg/l	1	<0.001					<0 001	<0 001		<0 001	<0.001	4	0.00050	0.00000	0.00050	<0 001
Nickel Dissolved	mg/l		<0.001					<0 001	<0 001		<0 001	<0.001	4	0.00050	0.00000	0.00050	<0 001
Nickel Total	mg/l	0.025	<0.001					0 001	<0 001		<0 001	<0.001	4	0.00063	0.00025	0.00093	<0 001
Potassium Dissolved	mg/l					0 64		0.58	0.46	0.65	0 56	0.46	6	0.558	0.084	0.648	0 65
Potassium Total	mg/l																
Selenium Dissolved	mg/l		<0 0005					<0.0005	<0.0005		<0.0005	<0 0005	4	0 0003	0 0000	0 0003	<0.0005
Selenium Total	mg/l	0.002	<0 0005					<0.0005	<0.0005		<0.0005	<0 0005	4	0 0003	0 0000	0 0003	<0.0005
Silicon Dissolved	mg/l							1.93	2.14		1 89	1.99	4	1 99	0.11	2.12	2.12
Silicon Total	mg/l							1.93	2 07		1 89	1.98	4	1 97	0 08	2 06	2 06
Sodium Dissolved	mg/l					2 37		2.33	2 25	2.52	2 39	2.29	6	2 36	0 09	2.49	2.49
Sodium Total	mg/l																
Strontium Dissolved	mg/l							0.102	0.109		0.103	0.106	4	0.105	0.003	0.109	0.11
Strontium Total	mg/l							0.102	0.106		0.103	0.106	4	0.104	0.002	0.106	0.11
Zinc Dissolved	mg/l		<0.005	<0 005	<0.005	<0 005	<0.005	<0.005	<0 005	<0.005	<0 005	<0.005	9	0 0025	0 0000	0 0025	<0 005
Zinc Total	mg/l	0 0075	<0.005	<0 005	<0.005	<0 005	<0.005	<0.005	<0 005	<0.005	<0 005	<0.005	9	0 0025	0 0000	0 0025	<0 005

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

Table B.1: Baseline data and calculation of screening criteria for Polley and Bootjack Lakes.

Parameter	Units	BCWQG[a]	MDLs	Bootjack Bottom									n	Mean[b]	St Dev	95th Percentile	Baseline 95th or MDL
				B1-8 metre	B1-7 metre	B1-10 metre	B1-8 metre	B1-8 metre	B2 -9 metre	B2-10 metre	B2-8 metre	B2-7 metre					
				6/1/1989	8/18/1989	10/19/1989	5/15/1995	5/9/1996	8/18/1989	10/19/1989	5/15/1995	5/9/1996					
Field pH	pH units			7.12	7 5	7 52	7.01	7.21	7.15	7.45	7.13	7.16	9	7 25	0.19	7 51	
Field Temperature	degrees C																
Field Conductivity	uS/cm			75.1	74.9	75 6	72.8	72.4	74 2	75.3	70.4	71.6	9	73 6	1.9	75 5	75 5
Alkalinity Total	mg/l			37 8	34.6	38 6	35.2	33.8	35	36.5	34	33	9	35.4	1.9	38 3	38 3
Sulfate	mg/l	50	<1.0	2.1	2 3	2.2	2.4	3 3	2.5	2 2	2.6	3.4	9	2.6	0.5	3.4	3 36
N+N LL	mg/l																
Ortho Phosporus	mg/l		<0.001	0.007	<0.001	0.011	0.002	0 009	<0 001	0 008	<0 001	0 004	9	0.005	0.004	0.010	0.010
N-Total	mg/l																
Ammonia Nitrogen (N)	mg/l	1 85	<0.005	<0 005	<0.005	0.012	0.005	0 007	0.005	<0.005	<0 005	0.135	9	0 0193	0 0435	0 0858	0.086
Phosphorus-T	mg/l			0.008	0 014		0.014	0 017	0.014		0 01	0 015	7	0 0131	0 0031	0 0164	0.016
Phosphorus-D	mg/l						0.006	0 009			0.002	0 009	4	0 0065	0 0033	0 0090	0.009
TSS	mg/l	baseline + 25	<1.0	3.3	5	7.3	1	<1	1	7.1	2	1	9	3.1	2.7	7.2	7 22
TDS	mg/l			58 2	60	60	47	45	60	60	46	45	9	53 5	7.4	60 0	60 0
Turbidity	NTU	baseline + 5	<1.0	<1 0	<1.0	2.1	1.31	1 5	1.1	1 6	1.1	1 2	9	1 21	0 51	1 90	1 90
Dissolved Organic Carbon	mg/l				7 8	7 06			7.2	8 5			4	7 64	0 66	8.40	
Hardness	mg/l				36.5	33 8	34	33.1	33.4	34.8	33 9	31.5	8	33 9	1.4	35 9	35 9
Aluminum Dissolved	mg/l	0 05	<0.005		0 016	<0 005	0.032	0 048	0.015	<0.005	0.018	0 066	8	0 0250	0 0224	0 0597	0.060
Aluminum Total	mg/l		<0.005		0 016	0.005	0.044	0.07	0.019	<0.005	0.034	0 067	8	0 0322	0 0263	0 0690	0.069
Arsenic Dissolved	mg/l		<0 0001	<0.0001	<0 0001	0 0002	<0 0001	0.0003	<0.0001	0.0002	<0.0001	0.0003	9	0.00014	0.00011	0.00030	0.0003
Arsenic Total	mg/l	0.005	<0 0001	<0.0001	<0 0001	0 0002	0.00010	0 00030	0 0001	0.0002	0 0001	0.0003	9	0.00016	0.00010	0.00030	0.0003
Barium Dissolved	mg/l		<0 01				0.011	0 011			0.012	0 011	4	0.01125	0.00050	0.01185	0.012
Barium Total	mg/l	1	<0 01				0.014	0 014			0.012	0 013	4	0.01325	0.00096	0.01400	0.014
Calcium Dissolved	mg/l				11.3		10.4	9.56	10 2	10.5	10.4	9.53	7	10 3	0.6	11.1	11.1
Calcium Total	mg/l						10.4	10 2			10 5	9.67	4	10 2	0.4	10 5	10 5
Copper Dissolved	mg/l			0.003	0 004	0.004	0.004	0 003	0.002	0 003	0.003	0 003	9	0.00322	0.00067	0.00400	0.004
Copper Total	mg/l	0.002		0.003	0 004	0.005	0.003	0 004	0.002	0 013	0.004	0 003	9	0.00456	0.00328	0.00980	0.010
Iron Dissolved	mg/l		<0 03	<0.03	<0 03	0 05	0.051	0 048	0 03	0.03	0.038	0 033	9	0.034	0.014	0.051	0.051
Iron Total	mg/l	1	<0 03	0 04	0.04	0.090	0.119	0.114	0 06	0.07	0.085	0 099	9	0.080	0.029	0.117	0.117
Lead Dissolved	mg/l	0 35	<0.001	<0 001	<0.001	<0 001	<0.001	<0 001	<0 001	<0.001	<0 001	<0.001	9	0.00050	0.00000	0.00050	<0 001
Lead Total	mg/l	0.004	<0.001	<0 001	<0.001	<0 001	<0.001	<0 001	<0 001	<0.001	<0 001	<0.001	9	0.00050	0.00000	0.00050	<0 001
Magnesium Dissolved	mg/l				2		1.94	1.79	1 93	2.04	1 95	1.75	7	1 91	0.11	2 03	2 03
Magnesium Total	mg/l						1.94	1.85			1 95	1.78	4	1 88	0 08	1 95	1 95
Manganese Dissolved	mg/l		<0.005				<0.005	0.009000			<0 005	<0.005	4	0.00413	0.00325	0.00803	0.008
Manganese Total	mg/l	0.756	<0.005				0.042	0 047			0.027	0 048	4	0.04100	0.00970	0.04785	0.048
Molybdenum Dissolved	mg/l		<0.001				<0.001	<0 001			<0 001	<0.001	4	0.00050	0.00000	0.00050	<0 001
Molybdenum Total	mg/l	1	<0.001				<0.001	<0 001			<0 001	<0.001	4	0.00050	0.00000	0.00050	<0 001
Nickel Dissolved	mg/l		<0.001				<0.001	<0 001			<0 001	<0.001	4	0.00050	0.00000	0.00050	<0 001
Nickel Total	mg/l	0.025	<0.001				<0.001	<0 001			0.002	<0.001	4	0.00088	0.00075	0.00178	<0 002
Potassium Dissolved	mg/l				0.63		0.57	0.44	0 66	0.62	0 57	0.47	7	0.566	0.083	0.651	0 65
Potassium Total	mg/l																
Selenium Dissolved	mg/l		<0 0005				<0 0005	<0.0005			<0.0005	<0 0005	4	0 0003	0 0000	0 0003	<0.0005
Selenium Total	mg/l	0.002	<0 0005				<0 0005	<0.0005			<0.0005	<0 0005	4	0 0003	0 0000	0 0003	<0.0005
Silicon Dissolved	mg/l						2.11	2.04			1 95	1.94	4	2 01	0 08	2.10	2.10
Silicon Total	mg/l						2.05	2.08			1 96	1.99	4	2 02	0 05	2 08	2 08
Sodium Dissolved	mg/l				2.44		2.32	2.04	2 53	2.11	2 37	2.15	7	2 28	0.18	2 50	2 50
Sodium Total	mg/l																
Strontium Dissolved	mg/l						0.103	0 096			0.105	0 097	4	0.100	0.004	0.105	0.10
Strontium Total	mg/l						0.103	0 098			0.107	0 097	4	0.101	0.005	0.106	0.11
Zinc Dissolved	mg/l		<0.005	<0 005	<0.005	<0 005	<0.005	<0 005	<0 005	<0.005	<0 005	<0.005	9	0 0025	0 0000	0 0025	<0 005
Zinc Total	mg/l	0 0075	<0.005	<0 005	<0.005	<0 005	<0.005	<0 005	<0 005	0 006	<0 005	<0.005	9	0 0029	0 0012	0 0046	<0 005

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

Table B.2: Water quality data for surface stations on Polley Lake (P1 and P2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	P1 Surface												Count	Mean[b]	Median	% > BCWQG	% > Baseline	Magnitude of Increase[c]
				P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface	P1-Surface						
				6/13/2001	5/18/2006	8/11/2006	10/31/2006	3/6/2007	5/24/2007	8/15/2007	10/23/2007	5/21/2008	10/28/2008	3/13/2009	8/26/2009						
Field pH	pH units			7.89	6.9	7.52	6.91	8.36	8.18	6.97	8.28	7.57	7.6	7.47	9	12	7.72	7.59			
Field Temperature	degrees C			12.4	11.42	18.07	6.97	0.82	9.6	18.25	8.11	4.56	7.87	0.19	17.8	12	9.67	8.86			
Field Conductivity	uS/cm	126.6		144	157	159	164	175	117	181	174	114		114	206	11	155.0	159.0		73%	1.6
Alkalinity Total	mg/l	60.9		67	70.4	64.7	85.2	67.9	72.3	74.0	74	76.5	76.5	81.4	103	12	76.1	74.0		100%	1.7
Sulfate	mg/l	4.37	50	4.2	11.3	11.7	12.0	12.1	15.0	18.0	18.2	21.4	25.0	27.2	29.3	12	17.1	16.5	0%	92%	6.7
N+N LL	mg/l			<0.005	<0.0050	<0.0050	0.0237	0.0885	<0.0050	<0.0050	<0.0050	0.0402	0.0486	0.140	0.003	12	0.030	0.003		0%	
Ammonia Nitrogen (N)	mg/l	0.007		0.008	0.0313	<0.020	0.028	0.0123	0.0056	0.0144	<0.0050	0.0256	<0.0050	<0.0050	0.0005	12	0.012	0.009		50%	4.6
N-Total	mg/l			<0.12	0.140	0.273	0.283	0.33	0.30	0.35	0.37	0.2	0.18	0.33	0.18	12	0.25	0.28		0%	
Ortho Phosporus	mg/l	0.027	1.85	0.043	0.0016	<0.0010	0.0050	0.0123	<0.0010	<0.0010	<0.0010	0.0011	0.0063	0.0193	0.0057	12	0.0080	0.0033	0%	8%	1.6
Phosphorus-T	mg/l	0.021		0.043		0.0083	0.0142	0.0227	0.0122	0.0094	0.0101	0.0217	0.0261	0.0257	0.0046	11	0.0180	0.0142		45%	2.1
Phosphorus-D	mg/l	0.009		0.043	0.0051	0.0040	0.0075	0.0152	0.0038	0.0042	0.0038	0.005	0.0100	0.0219	0.001	12	0.0104	0.0051		33%	4.9
TSS	mg/l	3.6	28.6	<4	**46.9**	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	5.5	12	5.7	1.5	8%	17%	13.2
TDS	mg/l	79.90			100	98	103	102	103	112	108	113	139.0	137	132	11	113.4	108.0		100%	1.7
Turbidity	NTU	1.09	9.09	0.4	0.55	0.62	0.87	4.81	0.88	0.92	0.98	0.86	1.12	0.59	0.54	12	1.10	0.87	0%	17%	4.4
Dissolved Organic Carbon	mg/l	0.0		15.3	6.50	4.90	5.26	5.15	5.72	5.49	6.34	5.08	5.05	5.18	5.48	12	6.29	5.37		100%	
Hardness	mg/l	60.2			75.5	81.5	86.6	74.7	82.9	83.7	87.7	90.2	101	108	102	11	88.5	86.6		100%	1.8
Aluminum Dissolved	mg/l	0.010	0.05		0.0018	0.0020	0.0010	0.0036	0.0019	0.0021	<0.0010	0.0011	<0.0010	0.0013	0.0024	11	0.0017	0.0018	0%	0%	0.4
Aluminum Total	mg/l	0.029			0.0081	0.0054	0.0113	0.112	0.0087	0.0057	0.0061	0.0158	<0.013	0.0554	0.0035	11	0.0217	0.0081		18%	3.9
Arsenic Dissolved	mg/l	0.0003			0.00031	0.00036	0.00037	0.00035	0.00034	0.00035	0.00034	0.00035	0.00038	0.00042	0.00039	11	0.00036	0.00035		100%	1.4
Arsenic Total	mg/l	0.0003	0.005		0.00033	0.00037	0.00037	0.00058	0.00035	0.00037	0.00036	0.00045	0.00035	0.00044	0.0004	11	0.00040	0.00037	0%	100%	1.9
Barium Dissolved	mg/l	<0.01			0.00447	0.00507	0.00570	0.00640	0.00596	0.00631	0.00642	0.00654	0.00663	0.00729	0.00706	11	0.00617	0.00640		0%	0.7
Barium Total	mg/l	<0.01	1		0.00482	0.00517	0.00591	0.00757	0.00648	0.00635	0.00681	0.00726	0.00698	0.00917	0.00742	11	0.00672	0.00681	0%	0%	0.9
Calcium Dissolved	mg/l	19.4			24.2	26.3	27.7	23.7	26.2	26.6	28.3	29	33.0	35.3	32.7	11	28.5	27.7		100%	1.8
Calcium Total	mg/l	19.5			24.8	26.6	28.0	25.0	26.5	29.7	28.4	28.8	31.4	33.7	35.4	11	28.9	28.4		100%	1.8
Copper Dissolved	mg/l	0.002			0.00175	0.00199	0.00176	0.0101	0.00195	0.00252	0.00159	0.00171	0.00163	0.00225	0.00204	11	0.00266	0.00195		36%	5.1
Copper Total	mg/l	0.003	0.002		0.00201	0.00192	0.00192	**0.0316**	0.00200	0.00191	0.00183	**0.00315**	0.00252	**0.00740**	0.00242	11	0.00533	0.00201	55%	27%	10.5
Iron Dissolved	mg/l	<0.03			<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.015	11	0.015	0.015		0%	0.5
Iron Total	mg/l	<0.03	1		0.088	<0.030	<0.030	0.094	<0.030	<0.030	<0.030	<0.030	<0.030	0.046	0.015	11	0.032	0.015	0%	27%	3.1
Lead Dissolved	mg/l	<0.001	0.35		<0.000050	<0.000050	<0.000050	0.000064	<0.000050	<0.000050	<0.000050	0.000148	<0.000050	<0.000050	<0.000050	11	0.00004	0.00003	0%	0%	0.1
Lead Total	mg/l	<0.001	0.005		<0.000050	<0.000050	<0.000050	0.000338	<0.000050	<0.000050	<0.000050	0.000115	<0.000050	0.000056	<0.000050	11	0.00006	0.00003	0%	0%	0.3
Magnesium Dissolved	mg/l	2.87			3.65	3.82	4.24	3.78	4.22	4.18	4.1	4.28	4.42	4.87	4.85	11	4.22	4.22		100%	1.7
Magnesium Total	mg..	2.86			3.70	3.84	4.25	3.56	4.24	4.25	4.12	4.26	4.38	4.79	4.97	11	4.21	4.25		100%	1.7
Manganese Dissolved	mg/l	0.014			0.00147	0.000457	0.000418	0.00345	0.0221	0.000446	0.000111	0.000898	0.000509	0.000312	0.000122	11	0.00275	0.00046		9%	1.6
Manganese Total	mg/l	0.032	0.870		0.00918	0.00496	0.0195	0.00772	0.0378	0.00541	0.0122	0.0139	0.0221	0.00260	0.00594	11	0.01285	0.00918	0%	9%	1.2
Molybdenum Dissolved	mg/l	<0.001			0.000596	0.000673	0.000744	0.000688	0.000845	0.000894	0.000936	0.00151	0.00199	0.00205	0.00228	11	0.00120	0.00089		36%	2.3
Molybdenum Total	mg/l	<0.001	1		0.000597	0.000660	0.000717	0.000611	0.000801	0.000922	0.00093	0.00152	0.00195	0.00223	0.0022	11	0.00119	0.00092	0%	36%	2.2
Nickel Dissolved	mg/l	<0.001			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	11	0.00025	0.00025		0%	0.0
Nickel Total	mg/l	<0.001	0.025		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	11	0.00025	0.00025	0%	0%	0.0
Potassium Dissolved	mg/l	0.40			<2.0	0.327	0.357	0.392	0.356	0.366	0.348	0.324	0.394	0.426	0.423	11	0.428	0.366		18%	1.1
Potassium Total	mg/l				0.334	<2.0	<2.0	0.402	0.364	0.366	0.359	0.343	0.380	0.475	0.405	11	0.493	0.380		0%	
Selenium Dissolved	mg/l	<0.0005			<0.0010	0.0011	0.0011	<0.0010	0.0011	0.0011	0.001	<0.0010	0.0011	0.0013	0.0011	11	0.0009	0.0011		73%	2.6
Selenium Total	mg/l	<0.0005	0.002		<0.0010	0.0012	<0.0010	<0.0010	0.0011	0.0012	0.0011	<0.0010	<0.0010	0.0012	0.0012	11	0.0009	0.0011	0%	55%	2.4
Silicon Dissolved	mg/l	2.95			3.21	2.81	3.56	3.26	3.48	2.91	3.42	3.63	3.66	4.28	3.41	11	3.42	3.42		82%	1.5
Silicon Total	mg/l	2.81			3.28	2.86	3.59	3.43	3.51	2.94	3.48	3.64	3.58	4.21	3.55	11	3.46	3.51		100%	1.5
Sodium Dissolved	mg/l	3.91			3.6	3.77	3.97	3.68	3.75	4.08	4.04	3.8	4.17	4.46	4.33	11	3.97	3.97		55%	1.1
Sodium Total	mg/l				3.52	3.69	3.89	3.60	3.79	4.09	4.09	3.91	4.11	4.56	4.22	11	3.95	3.91		0%	
Strontium Dissolved	mg/l	0.09			0.103	0.110	0.117	0.114	0.120	0.131	0.133	0.175	0.186	0.206	0.237	11	0.148	0.131		100%	2.6
Strontium Total	mg/l	0.09			0.102	0.110	0.117	0.103	0.122	0.133	0.137	0.178	0.183	0.213	0.233	11	0.148	0.133		100%	2.6
Zinc Dissolved	mg/l	<0.005			0.0010	<0.0010	<0.0010	0.0080	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0016	<0.0010	11	0.0013	0.0005		9%	1.6
Zinc Total	mg/l	<0.005	0.0075		0.0011	<0.0010	<0.0010	**0.0110**	<0.0010	<0.0010	<0.0010	0.0016	0.0013	<0.0060	<0.0010	11	0.0019	0.0005	9%	9%	2.2

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

[d] value not included in summary calculations (> 3 standard deviations).

Table B.2: Water quality data for surface stations on Polley Lake (P1 and P2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	P2 Surface												Count	Mean[b]	Median	% > BCWQG	% > Baseline	Magnitude of increase[c]
				P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface	P2-Surface						
				6/14/2001	5/18/2006	8/11/2006	10/31/2006	3/6/2007	5/23/2007	8/15/2007	10/23/2007	5/21/2008	10/28/2008	3/13/2009	8/26/2009						
Field pH	pH units			8.19	7.71	8.22	7.52	7.9	8.05	7.51	8.22	7.96	7.83	7.98	8.94	12	8.00	7.97			
Field Temperature	degrees C			12.4	13.91	19	6.43	0.74	9.43	20.86	8	4.69	6.79	0.39	18	12	10.05	8.72			
Field Conductivity	uS/cm	126.6		141	156	159	64	175	116	184	174	115		1260	207	11	250.1	159.0		73%	10.0
Alkalinity Total	mg/l	60.9		66	73.9	76.8	87.5	128	72	74.5	74.4	83.8	76.3	92.6	76.6	12	81.9	76.5		100%	2.1
Sulfate	mg/l	4.37	50	3.8	11.3	11.8	12.1	22.5	15.1	18.1	18.6	22.3	25.0	30.8	29.4	12	18.4	18.4	0%	92%	7.0
N+N LL	mg/l			<0.005	<0.0050	<0.0050	0.0133	0.0383	<0.0050	<0.0050	0.0089	0.0408	0.0543	0.144	0.013	12	0.027	0.011		0%	
Ammonia Nitrogen (N)	mg/l	0.007		0.011	0.016	<0.020	<0.020	<0.0050	0.0083	0.0086	<0.0050	0.0211	<0.0050	0.0051	0.0005	12	0.008	0.008		42%	3.1
N-Total	mg/l			<0.12	0.184	0.218	0.296	0.53	0.38	0.34	0.37	0.22	0.15	0.4	0.14	12	0.27	0.26		0%	
Ortho Phosporus	mg/l	0.027	1.85	0.026	0.0011	<0.0010	0.0020	0.0053	<0.0010	<0.0010	0.0011	<0.0010	0.0076	0.0169	0.0148	12	0.0064	0.0016	0%	0%	1.0
Phosphorus-T	mg/l	0.021		0.027		0.0084	0.0113	0.0219	0.0149	0.0069	0.0104	0.0152	0.0195	0.0247	0.0066	11	0.0152	0.0149		27%	1.3
Phosphorus-D	mg/l	0.009		0.032	0.0048	0.0043	0.0053	0.0099	0.0042	0.0034	0.0036	0.0048	0.0117	0.023	0.001	12	0.0090	0.0048		33%	3.6
TSS	mg/l	3.6	28.6	<4	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	4.5	12	1.8	1.5	0%	8%	1.3
TDS	mg/l	79.90			101	98	101	187	105	113	111	117	132.0	157	135	11	123.4	113.0		100%	2.3
Turbidity	NTU	1.09	9.09	0.57	0.35	0.61	1.14	1.31	1.02	0.73	0.96	0.83	0.88	1.06	0.78	12	0.85	0.86	0%	17%	1.
Dissolved Organic Carbon	mg/l	0.0		14.1	6.50	5.00	5.33	9.48	5.46	5.59	6.26	5.18	4.82	5.79	5.89	12	6.62	5.69		100%	
Hardness	mg/l	60.2		65.3	76.1	79.3	86.8	139	81.9	82.8	88.7	90.9	99.9	124	104	12	93.2	87.8		100%	2.3
																0					
Aluminum Dissolved	mg/l	0.010	0.05	0.0037	0.0037	0.0023	0.0015	0.001	0.0018	0.0018	<0.0010	0.0012	0.0016	<0.0010	0.0039	12	0.0020	0.0017	0%	0%	0.4
Aluminum Total	mg/l	0.029		0.0062	0.0043	0.0052	0.0097	0.0076	0.0105	0.0048	0.0106	0.0316	0.0045	0.0108	0.011	12	0.0097	0.0087		8%	1.1
Arsenic Dissolved	mg/l	0.0003		0.0003	0.00031	0.00039	0.00035	0.00065	0.00032	0.00036	0.00036	0.00033	0.00038	0.00046	0.00038	12	0.00038	0.00036		92%	2.2
Arsenic Total	mg/l	0.0003	0.005	0.0004	0.00034	0.00036	0.00037	0.00071	0.00034	0.00037	0.0004	0.00047	0.00042	0.00047	0.00039	12	0.00042	0.00040	0%	100%	2.4
Barium Dissolved	mg/l	<0.01		0.00461	0.00425	0.00534	0.00581	0.01040	0.00615	0.00618	0.0065	0.00658	0.00683	0.00788	0.00715	12	0.00647	0.00634		8%	1.0
Barium Total	mg/l	<0.01	1	0.00389	0.00465	0.00529	0.00605	0.0111	0.00668	0.00645	0.00706	0.00747	0.00693	0.00861	0.00725	12	0.00679	0.00681	0%	8%	1.1
Calcium Dissolved	mg/l	19.4		21.3	24.5	25.6	27.7	43.7	25.9	26.4	28.7	29.3	32.6	40.4	33.6	12	30.0	28.2		100%	2.3
Calcium Total	mg/l	19.5		20.8	24.6	26.2	27.8	48.8	26.2	26.6	29	29.3	32.8	38.2	31.1	12	30.1	28.4		100%	2.5
Copper Dissolved	mg/l	0.002		0.0027	0.00179	0.00221	0.00179	0.00339	0.00185	0.00179	0.00174	0.00165	0.00164	0.00216	0.00392	12	0.00222	0.00182		42%	2.0
Copper Total	mg/l	0.003	0.002	0.0024	0.00194	0.00196	0.002	**0.00436**	0.00205	0.00196	0.00206	**0.0034**	0.0019	**0.00352**	**0.00419**	12	0.00265	0.00206	58%	33%	1.5
Iron Dissolved	mg/l	<0.03		<0.005	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.015	12	0.014	0.015		0%	0.5
Iron Total	mg/l	<0.03	1	0.076	<0.030	<0.030	<0.030	0.037	0.097	<0.030	<0.030	<0.030	<0.030	0.085	0.015	12	0.035	0.015	0%	33%	3.2
Lead Dissolved	mg/l	<0.001	0.35	0.00006	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000051	12	0.00003	0.00003	0%	0%	0.1
Lead Total	mg/l	<0.001	0.005	0.00002	<0.000050	<0.000050	<0.000050	0.000077	<0.000050	<0.000050	<0.000050	0.000147	<0.000050	<0.000050	0.000055	12	0.00004	0.00003	0%	0%	0.1
Magnesium Dissolved	mg/l	2.87		2.94	3.62	3.73	4.25	7.18	4.18	4.12	4.17	4.33	4.49	5.56	4.86	12	4.45	4.22		100%	2.5
Magnesium Total	mg..	2.86		3.12	3.69	3.8	4.22	6.99	4.21	4.19	4.19	4.29	4.61	5.38	4.74	12	4.45	4.22		100%	2.4
Manganese Dissolved	mg/l	0.014		0.00113	0.00214	0.000521	0.00105	0.00054	0.0213[d]	0.000614	0.000107	0.0016	0.000266	0.00064	0.000187	12	0.00080	0.00061		0%	0.2
Manganese Total	mg/l	0.032	0.870	0.00501	0.008	0.0051	0.0115	0.00167	0.0401[d]	0.00491	0.0153	0.0151	0.0243	0.00171	0.00614	12	0.00898	0.00614	0%	0%	0.8
Molybdenum Dissolved	mg/l	<0.001		0.00079	0.000646	0.000712	0.000715	0.00131	0.000839	0.000927	0.00105	0.00172	0.00199	0.00232	0.00222	12	0.00127	0.00099		50%	2.3
Molybdenum Total	mg/l	<0.001	1	0.00084	0.00062	0.000666	0.000719	0.00129	0.000788	0.000921	0.00101	0.00168	0.00192	0.00248	0.00228	12	0.00127	0.00097	0%	50%	2.5
Nickel Dissolved	mg/l	<0.001		<0.0005	<0.00050	<0.00050	<0.00050	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	12	0.00027	0.00025		0%	0.5
Nickel Total	mg/l	<0.001	0.025	<0.0005	<0.00050	<0.00050	<0.00050	0.00052	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	12	0.00027	0.00025	0%	0%	0.5
Potassium Dissolved	mg/l	0.40		0.43	<2.0	0.352	0.358	0.715	0.347	0.349	0.369	0.349	0.394	0.522	0.464	12	0.471	0.382		33%	1.8
Potassium Total	mg/l			0.33	0.339	<2.0	<2.0	0.728	0.364	0.372	0.378	0.357	0.396	0.562	0.414	12	0.520	0.387		0%	
Selenium Dissolved	mg/l	<0.0005		<0.0005	0.0010	0.0012	0.0011	0.0016	0.0011	0.0012	<0.0010	0.0012	0.0011	0.0014	0.0011	12	0.0011	0.0011		83%	3.2
Selenium Total	mg/l	<0.0005	0.002	<0.0005	<0.0010	0.0012	0.0011	0.0019	0.001	0.0012	0.0012	0.0011	0.0013	0.0013	0.0011	12	0.0011	0.0012	0%	83%	3.8
Silicon Dissolved	mg/l	2.95		3.46	3.22	2.74	3.43	6.05	3.47	2.91	3.52	3.57	3.69	5.02	3.46	12	3.71	3.47		83%	2.1
Silicon Total	mg/l	2.81		3.4	3.28	2.8	3.45	6.5	3.51	2.94	3.56	3.57	3.77	4.83	3.31	12	3.74	3.48		92%	2.3
Sodium Dissolved	mg/l	3.91		3.61	3.7	3.93	3.92	7.3	3.7	4.03	4.29	3.98	4.27	5.07	4.3	12	4.34	4.01		75%	1.9
Sodium Total	mg/l			5.5	3.67	3.84	4	7.46	3.75	4.13	4.33	3.95	4.28	5.36	4.31	12	4.55	4.21		0%	
Strontium Dissolved	mg/l	0.09		0.0908	0.104	0.115	0.116	0.213	0.116	0.129	0.142	0.193	0.189	0.233	0.234	12	0.156	0.136		92%	2.5
Strontium Total	mg/l	0.09		0.0918	0.106	0.114	0.118	0.222	0.119	0.134	0.147	0.195	0.191	0.241	0.239	12	0.160	0.141		100%	2.7
Zinc Dissolved	mg/l	<0.005		0.0065	<0.0010	<0.0010	0.0013	0.0194	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0432	0.0031	12	0.0064	0.0005		25%	8.6
Zinc Total	mg/l	<0.005	0.0075	0.0045	0.001	<0.0010	<0.0010	**0.0296**	<0.0010	<0.0010	<0.0010	0.0042	0.0016	**0.0599**	0.0017	12	0.0088	0.0013	17%	17%	12.0

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

[d] value not included in summary calculations (> 3 standard deviations).

Table B.3: Water quality data for bottom stations on Polley Lake (P1 and P2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG^a	P1 Bottom										Count	Mean^b	Median	% > BCWQG	% > Baseline	Magnitude of increase^c
				P1-30 metre	P1-30 metre	P1-30 metre	P1-30 metre	P1 at Bottom	P1 at Bottom	P1 at Bottom	P1 at Bottom	P1 at Bottom	P1-30 metre						
				6/13/2001	5/18/2006	8/11/2006	10/31/2006	5/24/2007	8/15/2007	10/23/2007	5/21/2008	10/28/2008	8/26/2009						
Field pH	pH units			7.51	7.3	7.68	7.39	8.09	7.8	7.33	7.22	7.81	7.97	10	7.61	7.60			
Field Temperature	degrees C			9.6	4.7	5.16	6.14	4.66	5.13	5.55	3.25	6.71	5.6	10	5.65	5.36			
Field Conductivity	uS/cm	128.9		141	157	158	163	102	173	167	139		207	9	156.3	158.0		89%	1.6
Alkalinity Total	mg/l	61.9		66	70.8	71.7	90.9	72.3	73.6	74.2	80.7	76.4	76.5	10	75.3	73.9		100%	1.5
Sulfate	mg/l	4.34	50	4.1	11.3	11.1	11.7	14.9	14.9	13.8	27.3	22.8	28.5	10	16.0	14.4	0%	90%	6.6
N+N LL	mg/l			0.0200	0.0509	0.0774	0.0390	0.0434	0.1240	0.1800	0.2660	0.2130	0.2510	10	0.126	0.101		0%	
Ammonia Nitrogen (N)	mg/l	0.013		<0.005	<0.0050	<0.020	0.02	0.0277	<0.0050	<0.0050	0.0383	<0.0050	0.0645	10	0.017	0.006		40%	5.0
N-Total	mg/l			0.230	0.161	0.391	0.269	0.360	0.450	0.520	0.440	0.790	0.330	10	0.39	0.38		0%	
Ortho Phosporus	mg/l	0.018	1.85	0.041	0.0052	0.0199	0.0085	0.0069	0.0286	0.0583	0.0234	0.0522	0.0126	10	0.0257	0.0217	0%	60%	3.2
Phosphorus-T	mg/l	0.030		0.029		0.0667	0.0193	0.0218	0.0467	0.0677	0.0397	0.0632	0.059	9	0.0459	0.0467		67%	2.3
Phosphorus-D	mg/l	0.014		0.031	0.0078	0.0239	0.0119	0.0101	0.0312	0.0569	0.0253	0.0564	0.0551	10	0.0310	0.0282		70%	4.1
TSS	mg/l	4.7	29.7	<4	<3.0	8	<3.0	3	3.3	<3.0	3.2	<3.0	3.5	10	2.9	2.5	0%	10%	1.7
TDS	mg/l	81.60			101	100	103	98	116	117	129	136	134	9	114.9	116.0		100%	1.7
Turbidity	NTU	2.51	10.51	0.63	1.26	4.6	1.46	1.64	1.16	2.34	3.69	1.77	1.6	10	2.06	1.71	0%	20%	1.8
Dissolved Organic Carbon	mg/l	0.0		6.10	6.18	4.90	5.26	5.44	5.14	6.26	5.01	4.70	4.99	10	5.40	5.20		100%	
Hardness	mg/l	62.7			76.6	80.6	85.9	82.8	79.2	81.3	99.1	98.8	102	9	87.4	82.8		100%	1.6
Aluminum Dissolved	mg/l	0.011	0.05		<0.0010	<0.0010	0.001	0.0017	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	9	0.0007	0.0005	0%	0%	0.2
Aluminum Total	mg/l	0.028			0.0147	0.0071	0.0185	0.0293	0.0065	0.0052	0.021	<0.0090	0.0035	9	0.0123	0.0071		11%	1.1
Arsenic Dissolved	mg/l	0.0003			0.0003	0.00034	0.00036	0.00034	0.00037	0.00046	0.0004	0.00043	0.00046	9	0.00038	0.00037		89%	1.5
Arsenic Total	mg/l	0.0003	0.005		0.00033	0.00039	0.00039	0.00035	0.00036	0.00046	0.00037	0.00042	0.00044	9	0.00039	0.00039	0%	100%	1.5
Barium Dissolved	mg/l	<0.01			0.00625	0.00636	0.00564	0.00755	0.00678	0.00437	0.00583	0.00521	0.00502	9	0.00589	0.00583		0%	0.8
Barium Total	mg/l	<0.01	1		0.00691	0.00534	0.00608	0.00804	0.00728	0.00552	0.00794	0.00622	0.00558	9	0.00655	0.00622	0%	0%	0.8
Calcium Dissolved	mg/l	20.2			24.6	26.1	27.5	26.2	25.3	26.1	31.9	32.3	32.9	9	28.1	26.2		100%	1.6
Calcium Total	mg/l	20.4			23.5	26.8	27.7	25.7	24.9	25.6	31.6	31.5	30.1	9	27.5	26.8		100%	1.5
Copper Dissolved	mg/l	0.003			0.00178	0.00193	0.0018	0.00195	0.00172	0.00145	0.00153	0.00143	0.00142	9	0.00167	0.00172		0%	0.7
Copper Total	mg/l	0.003	0.002		0.00211	0.00216	0.0022	0.00218	0.00198	0.00168	0.00278	0.00173	0.00164	9	0.00205	0.00211	56%	0%	0.9
Iron Dissolved	mg/l	<0.03			<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	9	0.015	0.015		0%	0.0
Iron Total	mg/l	0.061	1		<0.030	<0.030	0.031	0.065	<0.030	0.037	0.063	0.035	0.015	9	0.032	0.031	0%	22%	1.1
Lead Dissolved	mg/l	<0.001	0.35		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	9	0.00003	0.00003	0%	0%	0.0
Lead Total	mg/l	0.0018	0.005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	9	0.00003	0.00003	0%	0%	0.0
Magnesium Dissolved	mg/l	2.97			3.66	3.76	4.2	4.2	3.92	3.93	4.74	4.42	4.88	9	4.19	4.20		100%	1.6
Magnesium Total	mg/l	3.00			3.49	3.90	4.25	4.10	3.86	3.82	4.09	4.28	4.51	9	4.10	4.10		100%	1.5
Manganese Dissolved	mg/l	0.083			0.00168	0.00522	0.00092	0.0969	0.000376	<0.00020	0.000174	0.000223	0.000176	9	0.01175	0.00038		11%	1.2
Manganese Total	mg/l	0.240	0.881		0.0542	0.00526	0.03	0.122	0.0462	0.165	0.282	0.129	0.101	9	0.10385	0.10100	0%	11%	1.2
Molybdenum Dissolved	mg/l	<0.001			0.000598	0.000618	0.00074	0.000789	0.000756	0.000698	0.00223	0.00173	0.00193	9	0.00112	0.00076		33%	2.2
Molybdenum Total	mg/l	<0.001	1		0.000603	0.000672	0.000656	0.00082	0.000743	0.000666	0.00222	0.00159	0.00192	9	0.00110	0.00074	0%	33%	2.2
Nickel Dissolved	mg/l	<0.001			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	9	0.00025	0.00025		0%	0.0
Nickel Total	mg/l	0.0060	0.025		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00060	9	0.00029	0.00025	0%	0%	0.1
Potassium Dissolved	mg/l	0.43			<2.0	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	9	0.453	0.384		11%	1.1
Potassium Total	mg/l				0.341	<2.0	<2.0	0.365	0.386	0.38	0.349	0.418	0.442	9	0.520	0.386		0%	
Selenium Dissolved	mg/l	<0.0005			0.0010	0.0010	0.0010	0.0011	<0.0010	<0.0010	0.0012	<0.0010	<0.0010	9	0.0008	0.0010		56%	2.4
Selenium Total	mg/l	<0.0005	0.002		0.0011	0.0012	<0.0010	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	9	0.0007	0.0005	0%	33%	2.4
Silicon Dissolved	mg/l	3.28			3.48	3.79	3.75	3.67	3.93	5.09	4.58	4.68	4.92	9	4.21	3.93		100%	1.6
Silicon Total	mg/l	3.29			3.49	2.88	3.76	3.6	3.92	4.95	4.57	4.58	4.5	9	4.03	3.92		89%	1.5
Sodium Dissolved	mg/l	4.01			3.7	3.7	3.93	3.75	3.91	3.99	4.22	4.24	4.11	9	3.95	3.93		33%	1.1
Sodium Total	mg/l				3.67	3.86	3.91	3.78	3.9	3.87	4.03	4.23	4.19	9	3.94	3.90		0%	
Strontium Dissolved	mg/l	0.09			0.105	0.11	0.117	0.118	0.12	0.116	0.253	0.181	0.231	9	0.150	0.118		100%	2.8
Strontium Total	mg/l	0.09			0.106	0.114	0.119	0.121	0.122	0.114	0.234	0.179	0.23	9	0.149	0.121		100%	2.6
Zinc Dissolved	mg/l	<0.005			0.0010	0.0013	<0.0010	0.0015	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	9	0.0008	0.0005		0%	0.3
Zinc Total	mg/l	<0.005	0.0075		0.0012	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.0020	0.002	0.0012	9	0.0009	0.0010	0%	0%	0.4

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

Table B.3: Water quality data for bottom stations on Polley Lake (P1 and P2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	P2 Bottom										Count	Mean[b]	Median	% > BCWQG	% > Baseline	Magnitude of increase[c]
				P2-22 metre	P2-22 metre	P2-22 metre	P2-22 metre	P2 at bottom	P2 at bottom	P2 at bottom	P2 at bottom	P2 at bottom	P2-20 metre						
				6/14/2001	5/18/2006	8/11/2006	10/31/2006	5/23/2007	8/15/2007	10/23/2007	5/21/2008	10/28/2008	9/26/2009						
Field pH	pH units			7.77	7.58	8.02	7.3	8.41	8.38	7.51	7.92	7.44	8.06	10	7.84	7.85			
Field Temperature	degrees C			8.2	4.9	6.74	6.06	7.47	5.41	5.77	4.2	5.73	6.3	10	6.08	5.92			
Field Conductivity	uS/cm	128.9		144	156	158	161	111	173	167	116		206	9	154.7	158.0		78%	1.6
Alkalinity Total	mg/l	61.9		67	67.8	80.3	76.9	72.5	73.3	73.9	77.8	76.4	75.4	10	74.1	74.7		100%	1.3
Sulfate	mg/l	4.34	50	3.7	11.3	11.4	11.1	15	15	14.8	23.1	23.6	28.9	10	15.8	14.9	0%	90%	6.7
N+N LL	mg/l			<0.005	0.0271	<0.0050	0.0894	<0.0050	0.0904	0.1280	0.0732	0.1660	0.1650	10	0.075	0.081		0%	
Ammonia Nitrogen (N)	mg/l	0.013		<0.005	<0.0050	<0.020	<0.020	0.0313	0.005	<0.0050	0.0155	<0.0050	0.0337	10	0.012	0.008		30%	2.6
N-Total	mg/l			0.280	0.220	0.213	0.321	0.330	0.420	0.460	0.180	0.260	0.250	10	0.29	0.27		0%	
Ortho Phosporus	mg/l	0.018	1.85	0.035	0.0037	0.001	0.0235	0.0014	0.0144	0.0251	0.0018	0.0365	0.0025	10	0.0145	0.0091	0%	40%	2.0
Phosphorus-T	mg/l	0.030		0.033		0.0109	0.0348	0.019	0.0246	0.0342	0.0179	0.047	0.0321	9	0.0282	0.0321		56%	1.6
Phosphorus-D	mg/l	0.014		0.036	0.0067	0.0038	0.0261	0.0048	0.0169	0.0261	0.0053	0.0405	0.0279	10	0.0194	0.0215		60%	2.9
TSS	mg/l	4.7	29.7	<4	4.4	<3.0	<3.0	<3.0	<3.0	<3.0	4.2	<3.0	4	10	2.4	1.5	0%	0%	0.9
TDS	mg/l	81.60			99	100	101	102	114	109	116	130	129	9	111.1	109.0		100%	1.6
Turbidity	NTU	2.51	10.51	1.17	1.83	0.72	1.46	1.23	1.06	1.3	1.38	1.35	0.96	10	1.25	1.27	0%	0%	0.7
Dissolved Organic Carbon	mg/l	0.0		16.90	6.60	5.10	5.22	5.55	5.16	6.08	5.26	4.87	4.85	10	6.56	5.24		100%	
Hardness	mg/l	62.7		66.2	76.5	79.3	86.1	83	78.8	80.5	93	98.2	103	10	84.5	81.8		100%	1.6
Aluminum Dissolved	mg/l	0.011	0.05	0.003	0.0024	0.0028	<0.0010	0.0018	0.0011	<0.0010	0.0019	0.0012	0.0005	10	0.0016	0.0015	0%	0%	0.3
Aluminum Total	mg/l	0.028		0.0351	0.0274	0.0079	0.0135	0.0109	0.0246	0.0076	0.0171	0.0053	0.004	10	0.0153	0.0122		10%	1.3
Arsenic Dissolved	mg/l	0.0003		0.0003	0.00029	0.00033	0.00037	0.00032	0.00034	0.00041	0.00032	0.00042	0.0004	10	0.00035	0.00034		80%	1.4
Arsenic Total	mg/l	0.0003	0.005	0.0004	0.00033	0.00036	0.00039	0.00033	0.00034	0.00045	0.00034	0.00045	0.00043	10	0.00038	0.00038	0%	100%	1.5
Barium Dissolved	mg/l	<0.01		0.00488	0.00658	0.00579	0.00538	0.00614	0.0071	0.00588	0.00688	0.00575	0.00673	10	0.00611	0.00601		0%	0.7
Barium Total	mg/l	<0.01	1	0.0056	0.00734	0.00626	0.00596	0.00669	0.00774	0.0064	0.00706	0.00633	0.00716	10	0.00665	0.00655	0%	0%	0.8
Calcium Dissolved	mg/l	20.2		21.6	24.6	25.7	27.5	26.3	25.1	25.9	30	32	33.3	10	27.2	26.1		100%	1.6
Calcium Total	mg/l	20.4		21.9	24.6	25.6	27.7	25.4	24.9	26.4	29.7	33.2	30.8	10	27.0	26.0		100%	1.6
Copper Dissolved	mg/l	0.003		0.0029	0.00177	0.00187	0.00174	0.00186	0.00172	0.00187	0.00167	0.00156	0.00146	10	0.00184	0.00176		10%	1.0
Copper Total	mg/l	0.003	0.002	0.0029	0.00209	0.00201	0.0021	0.00202	0.00245	0.00188	0.00198	0.0018	0.00177	10	0.00210	0.00202	60%	0%	1.0
Iron Dissolved	mg/l	<0.03		<0.005	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	10	0.014	0.015		0%	0.0
Iron Total	mg/l	0.061	1	0.127	0.061	<0.030	0.048	<0.030	0.06	0.041	0.035	<0.030	<0.030	10	0.043	0.038	0%	20%	2.1
Lead Dissolved	mg/l	<0.001	0.35	0.000080	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	10	0.00003	0.00003	0%	0%	0.1
Lead Total	mg/l	0.0018	0.005	0.000140	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	10	0.00004	0.00003	0%	0%	0.1
Magnesium Dissolved	mg/l	2.97		2.97	3.66	3.69	4.21	4.22	3.9	3.87	4.38	4.44	4.83	10	4.02	4.06		100%	1.6
Magnesium Total	mg/l	3.00		3.09	3.57	3.67	4.22	4.07	3.85	3.94	4.42	4.51	4.71	10	4.02	4.01		100%	1.6
Manganese Dissolved	mg/l	0.083		0.0017	0.0138	0.00194	0.000269	0.0223	0.000706	0.000305	0.00593	0.000278	0.000276	10	0.00475	0.00120		0%	0.3
Manganese Total	mg/l	0.240	0.881	0.0318	0.0731	0.0103	0.0578	0.0443	0.0363	0.0683	0.0317	0.0798	0.0365	10	0.04699	0.04040	0%	0%	0.3
Molybdenum Dissolved	mg/l	<0.001		0.00062	0.000604	0.000678	0.000686	0.00081	0.000786	0.000833	0.00182	0.00182	0.00203	10	0.00107	0.00080		30%	2.0
Molybdenum Total	mg/l	<0.001	1	0.00093	0.000599	0.000619	0.000652	0.000818	0.000771	0.000802	0.00188	0.00175	0.00213	10	0.00110	0.00081	0%	30%	2.1
Nickel Dissolved	mg/l	<0.001		<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	10	0.00025	0.00025		0%	0.0
Nickel Total	mg/l	0.0060	0.025	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	10	0.00025	0.00025	0%	0%	0.0
Potassium Dissolved	mg/l	0.43		0.4	<2.0	0.3	0.4	0.3	0.4	0.4	0.3	0.4	0.4	10	0.437	0.374		0%	1.0
Potassium Total	mg/l			0.33	0.338	<2.0	<2.0	0.368	0.374	0.399	0.349	0.424	0.444	10	0.503	0.387		0%	
Selenium Dissolved	mg/l	<0.0005		<0.0005	<0.0010	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	0.0010	<0.0010	10	0.0006	0.0005		30%	2.0
Selenium Total	mg/l	<0.0005	0.002	<0.0005	0.0010	0.0011	<0.0010	0.0010	<0.0010	<0.0010	0.0011	0.0012	<0.0010	10	0.0008	0.0008	0%	50%	2.4
Silicon Dissolved	mg/l	3.28		3.73	3.5	3.24	4.25	3.49	3.79	4.49	3.63	4.33	4.47	10	3.89	3.76		90%	1.4
Silicon Total	mg/l	3.29		3.8	3.53	3.25	4.32	3.4	3.82	4.61	3.7	4.44	4.28	10	3.92	3.81		90%	1.4
Sodium Dissolved	mg/l	4.01		3.62	3.7	3.73	3.98	3.77	3.96	4.39	3.94	4.26	4.1	10	3.95	3.95		30%	1.1
Sodium Total	mg/l			3.8	3.69	3.74	3.92	3.86	3.92	4.34	3.95	4.29	4.38	10	3.99	3.92		0%	
Strontium Dissolved	mg/l	0.09		0.0954	0.105	0.111	0.116	0.118	0.119	0.127	0.199	0.184	0.234	10	0.141	0.119		100%	2.6
Strontium Total	mg/l	0.09		0.0976	0.106	0.112	0.116	0.121	0.121	0.127	0.203	0.185	0.245	10	0.143	0.121		100%	2.7
Zinc Dissolved	mg/l	<0.005		0.0027	0.0022	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	<0.0010	<0.0010	10	0.0010	0.0005		0%	0.5
Zinc Total	mg/l	<0.005	0.0075	0.0033	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	10	0.0008	0.0005	0%	0%	0.7

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

Table B.4 Correlation analysis results for station P1 surface on Polley Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Alkalinity	Sulphate	Ammonia	Ortho Phosphorus	Phosphorus	TDS	Hardness	Arsenic	Calcium	Copper	Iron	Magnesium	Molybdenum	Potassium	Selenium	Silicon	Sodium	Strontium	Zinc
Conductivity	Correlation Coefficient	1.000	0.123	0.096	-0.107	-0.131	-0.590	-0.037	-0.152	0.049	0.176	-0.299	-0.127	-0.067	-0.103	0.207	0.234	-0.438	0.104	0.000	-0.397
	Sig. (2-tailed)	.	0.718	0.780	0.753	0.702	0.073	0.920	0.675	0.893	0.626	0.402	0.726	0.854	0.776	0.565	0.515	0.206	0.776	1.000	0.256
	N	11	11	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Alkalinity	Correlation Coefficient	0.123	1.000	0.758	-0.279	0.146	-0.091	0.760	0.854	0.210	0.776	0.124	-0.337	0.881	0.749	0.233	0.074	0.781	0.769	0.767	-0.060
	Sig. (2-tailed)	0.718	.	0.004	0.380	0.650	0.789	0.007	0.001	0.535	0.005	0.717	0.311	0.000	0.008	0.490	0.829	0.005	0.006	0.006	0.861
	N	11	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Sulphate	Correlation Coefficient	0.096	0.758	1.000	-0.634	0.050	-0.118	0.929	0.891	0.331	0.900	0.333	-0.260	0.852	0.964	0.041	0.319	0.618	0.916	0.973	0.178
	Sig. (2-tailed)	0.780	0.004	.	0.027	0.878	0.729	0.000	0.000	0.320	0.000	0.318	0.440	0.001	0.000	0.905	0.339	0.043	0.000	0.000	0.600
	N	11	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Ammonia	Correlation Coefficient	-0.107	-0.279	-0.634	1.000	-0.201	0.055	-0.566	-0.606	-0.065	-0.633	-0.101	0.239	-0.506	-0.706	-0.257	-0.525	-0.220	-0.703	-0.725	0.085
	Sig. (2-tailed)	0.753	0.380	0.027	.	0.532	0.872	0.070	0.048	0.849	0.037	0.767	0.479	0.112	0.015	0.445	0.098	0.515	0.016	0.012	0.804
	N	11	12	12	12	12	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Ortho Phosphorus	Correlation Coefficient	-0.131	0.146	0.050	-0.201	1.000	0.744	0.417	0.349	0.412	0.293	0.804	0.574	0.343	0.302	0.343	-0.246	0.549	0.298	0.274	0.715
	Sig. (2-tailed)	0.702	0.650	0.878	0.532	.	0.009	0.202	0.293	0.208	0.382	0.003	0.065	0.302	0.366	0.302	0.466	0.080	0.373	0.414	0.013
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Phosphorus	Correlation Coefficient	-0.590	-0.091	-0.118	0.055	0.744	1.000	0.365	0.224	0.111	-0.006	0.650	0.510	0.134	0.176	-0.091	-0.623	0.576	0.097	0.079	0.792
	Sig. (2-tailed)	0.073	0.789	0.729	0.872	0.009	.	0.300	0.533	0.761	0.987	0.042	0.132	0.713	0.627	0.802	0.054	0.082	0.789	0.829	0.006
	N	10	11	11	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10
TDS	Correlation Coefficient	-0.037	0.760	0.929	-0.566	0.417	0.365	1.000	0.902	0.173	0.893	0.308	-0.272	0.888	0.934	-0.002	0.140	0.688	0.913	0.925	0.229
	Sig. (2-tailed)	0.920	0.007	0.000	0.070	0.202	0.300	.	0.000	0.611	0.000	0.356	0.418	0.000	0.000	0.995	0.681	0.019	0.000	0.000	0.499
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Hardness	Correlation Coefficient	-0.152	0.854	0.891	-0.606	0.349	0.224	0.902	1.000	0.189	0.918	0.178	-0.370	0.934	0.964	0.169	0.284	0.755	0.938	0.955	0.055
	Sig. (2-tailed)	0.675	0.001	0.000	0.048	0.293	0.533	0.000	.	0.579	0.000	0.601	0.263	0.000	0.000	0.620	0.397	0.007	0.000	0.000	0.873
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Arsenic	Correlation Coefficient	0.049	0.210	0.331	-0.065	0.412	0.111	0.173	0.189	1.000	0.285	0.530	0.216	0.203	0.248	0.369	0.131	0.303	0.198	0.239	0.459
	Sig. (2-tailed)	0.893	0.535	0.320	0.849	0.208	0.761	0.611	0.579	.	0.395	0.094	0.523	0.550	0.462	0.265	0.700	0.364	0.559	0.479	0.156
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Calcium	Correlation Coefficient	0.176	0.776	0.900	-0.633	0.293	-0.006	0.893	0.918	0.285	1.000	0.114	-0.410	0.925	0.936	0.269	0.471	0.518	0.966	0.945	-0.025
	Sig. (2-tailed)	0.626	0.005	0.000	0.037	0.382	0.987	0.000	0.000	0.395	.	0.739	0.210	0.000	0.000	0.424	0.144	0.102	0.000	0.000	0.942
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Copper	Correlation Coefficient	-0.299	0.124	0.333	-0.101	0.804	0.650	0.308	0.178	0.530	0.114	1.000	0.585	0.212	0.223	0.050	-0.302	0.483	0.078	0.196	0.884
	Sig. (2-tailed)	0.402	0.717	0.318	0.767	0.003	0.042	0.356	0.601	0.094	0.739	.	0.059	0.531	0.509	0.883	0.366	0.132	0.821	0.564	0.000
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Iron	Correlation Coefficient	-0.127	-0.337	-0.260	0.239	0.574	0.510	-0.272	-0.370	0.216	-0.410	0.585	1.000	-0.423	-0.358	-0.087	-0.253	-0.081	-0.359	-0.410	0.706
	Sig. (2-tailed)	0.726	0.311	0.440	0.479	0.065	0.132	0.418	0.263	0.523	0.210	0.059	.	0.195	0.279	0.799	0.454	0.813	0.278	0.210	0.015
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Magnesium	Correlation Coefficient	-0.067	0.881	0.852	-0.506	0.343	0.134	0.888	0.934	0.203	0.925	0.212	-0.423	1.000	0.911	0.231	0.312	0.706	0.888	0.920	-0.010
	Sig. (2-tailed)	0.854	0.000	0.001	0.112	0.302	0.713	0.000	0.000	0.550	0.000	0.531	0.195	.	0.000	0.495	0.350	0.015	0.000	0.000	0.977
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Molybdenum	Correlation Coefficient	-0.103	0.749	0.964	-0.706	0.302	0.176	0.934	0.964	0.248	0.936	0.223	-0.358	0.911	1.000	0.114	0.383	0.673	0.961	0.991	0.094
	Sig. (2-tailed)	0.776	0.008	0.000	0.015	0.366	0.627	0.000	0.000	0.462	0.000	0.509	0.279	0.000	.	0.739	0.246	0.023	0.000	0.000	0.783
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Potassium	Correlation Coefficient	0.207	0.233	0.041	-0.257	0.343	-0.091	-0.002	0.169	0.369	0.269	0.050	-0.087	0.231	0.114	1.000	0.371	0.109	0.219	0.105	-0.124
	Sig. (2-tailed)	0.565	0.490	0.905	0.445	0.302	0.802	0.995	0.620	0.265	0.424	0.883	0.799	0.495	0.739	.	0.261	0.749	0.517	0.759	0.716
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Selenium	Correlation Coefficient	0.234	0.074	0.319	-0.525	-0.246	-0.623	0.140	0.284	0.131	0.471	-0.302	-0.253	0.312	0.383	0.371	1.000	-0.226	0.462	0.383	-0.431
	Sig. (2-tailed)	0.515	0.829	0.339	0.098	0.466	0.054	0.681	0.397	0.700	0.144	0.366	0.454	0.350	0.246	0.261	.	0.505	0.153	0.246	0.186
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Silicon	Correlation Coefficient	-0.438	0.781	0.618	-0.220	0.549	0.576	0.688	0.755	0.303	0.518	0.483	-0.081	0.706	0.673	0.109	-0.226	1.000	0.569	0.636	0.377
	Sig. (2-tailed)	0.206	0.005	0.043	0.515	0.080	0.082	0.019	0.007	0.364	0.102	0.132	0.813	0.015	0.023	0.749	0.505	.	0.067	0.035	0.253
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Sodium	Correlation Coefficient	0.104	0.769	0.916	-0.703	0.298	0.097	0.913	0.938	0.198	0.966	0.078	-0.359	0.888	0.961	0.219	0.462	0.569	1.000	0.952	-0.015
	Sig. (2-tailed)	0.776	0.006	0.000	0.016	0.373	0.789	0.000	0.000	0.559	0.000	0.821	0.278	0.000	0.000	0.517	0.153	0.067	.	0.000	0.965
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Strontium	Correlation Coefficient	0.000	0.767	0.973	-0.725	0.274	0.079	0.925	0.955	0.239	0.945	0.196	-0.410	0.920	0.991	0.105	0.383	0.636	0.952	1.000	0.030
	Sig. (2-tailed)	1.000	0.006	0.000	0.012	0.414	0.829	0.000	0.000	0.479	0.000	0.564	0.210	0.000	0.000	0.759	0.246	0.035	0.000	.	0.931
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Zinc	Correlation Coefficient	-0.397	-0.060	0.178	0.085	0.715	0.792	0.229	0.055	0.459	-0.025	0.884	0.706	-0.010	0.094	-0.124	-0.431	0.377	-0.015	0.030	1.000
	Sig. (2-tailed)	0.256	0.861	0.600	0.804	0.013	0.006	0.499	0.873	0.156	0.942	0.000	0.015	0.977	0.783	0.716	0.186	0.253	0.965	0.931	.
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11

🟦 Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.5 Correlation analysis results for station P2 surface on Polley Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Alkalinity	Sulphate	Ammonia	Ortho Phosphorus	Phosphorus	TDS	Hardness	Arsenic	Calcium	Copper	Iron	Magnesium	Molybdenum	Potassium	Selenium	Silicon	Sodium	Strontium	Zinc
Conductivity	Correlation Coefficient	1.000	0.245	0.609	-0.685	0.326	-0.188	0.620	0.473	0.303	0.487	0.351	0.074	0.337	0.564	0.241	0.611	0.018	0.738	0.609	0.334
	Sig. (2-tailed)	.	0.467	0.047	0.020	0.327	0.603	0.056	0.142	0.365	0.128	0.290	0.829	0.311	0.071	0.474	0.046	0.958	0.010	0.047	0.316
	N	11	11	11	11	11	10	10	11	11	11	11	11	11	11	11	11	11	11	11	11
Alkalinity	Correlation Coefficient	0.245	1.000	0.566	-0.198	0.103	0.127	0.478	0.741	0.560	0.757	0.424	-0.083	0.753	0.413	0.757	0.671	0.455	0.662	0.629	0.370
	Sig. (2-tailed)	0.467	.	0.055	0.538	0.749	0.709	0.137	0.006	0.058	0.004	0.170	0.797	0.005	0.183	0.004	0.017	0.138	0.019	0.028	0.237
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Sulphate	Correlation Coefficient	0.609	0.566	1.000	-0.695	0.296	0.064	0.920	0.937	0.644	0.925	0.466	0.046	0.893	0.923	0.354	0.675	0.629	0.879	0.979	0.457
	Sig. (2-tailed)	0.047	0.055	.	0.012	0.350	0.853	0.000	0.000	0.024	0.000	0.127	0.888	0.000	0.000	0.259	0.016	0.028	0.000	0.000	0.135
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Ammonia	Correlation Coefficient	-0.685	-0.198	-0.695	1.000	-0.365	0.212	-0.620	-0.667	-0.293	-0.645	-0.306	-0.084	-0.601	-0.589	-0.442	-0.584	-0.363	-0.742	-0.631	-0.088
	Sig. (2-tailed)	0.020	0.538	0.012	.	0.243	0.532	0.042	0.018	0.355	0.024	0.334	0.795	0.039	0.044	0.151	0.046	0.246	0.006	0.028	0.786
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Ortho Phosphorus	Correlation Coefficient	0.326	0.103	0.296	-0.365	1.000	0.521	0.633	0.317	0.469	0.311	0.382	0.308	0.296	0.474	0.073	0.080	0.357	0.261	0.242	0.677
	Sig. (2-tailed)	0.327	0.749	0.350	0.243	.	0.100	0.036	0.315	0.124	0.326	0.220	0.331	0.349	0.119	0.821	0.805	0.255	0.413	0.448	0.016
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Phosphorus	Correlation Coefficient	-0.188	0.127	0.064	0.212	0.521	1.000	0.491	0.155	0.618	0.205	0.278	0.642	0.210	0.218	-0.228	0.111	0.673	-0.027	0.064	0.706
	Sig. (2-tailed)	0.603	0.709	0.853	0.532	0.100	.	0.150	0.650	0.043	0.545	0.408	0.033	0.536	0.519	0.501	0.744	0.023	0.937	0.853	0.015
	N	10	11	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11
TDS	Correlation Coefficient	0.620	0.478	0.920	-0.620	0.633	0.491	1.000	0.929	0.830	0.909	0.639	0.365	0.886	0.884	0.075	0.600	0.738	0.861	0.938	0.817
	Sig. (2-tailed)	0.056	0.137	0.000	0.042	0.036	0.150	.	0.000	0.002	0.000	0.034	0.270	0.000	0.000	0.826	0.051	0.010	0.001	0.000	0.002
	N	10	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Hardness	Correlation Coefficient	0.473	0.741	0.937	-0.667	0.317	0.155	0.929	1.000	0.739	0.991	0.567	0.042	0.960	0.832	0.494	0.739	0.727	0.918	0.951	0.500
	Sig. (2-tailed)	0.142	0.006	0.000	0.018	0.315	0.650	0.000	.	0.006	0.000	0.054	0.898	0.000	0.001	0.103	0.006	0.007	0.000	0.000	0.098
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Arsenic	Correlation Coefficient	0.303	0.560	0.644	-0.293	0.469	0.618	0.830	0.739	1.000	0.767	0.598	0.157	0.646	0.771	0.143	0.585	0.792	0.667	0.676	0.756
	Sig. (2-tailed)	0.365	0.058	0.024	0.355	0.124	0.043	0.002	0.006	.	0.004	0.040	0.626	0.023	0.003	0.658	0.046	0.002	0.018	0.016	0.004
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Calcium	Correlation Coefficient	0.487	0.757	0.925	-0.645	0.311	0.205	0.909	0.991	0.767	1.000	0.489	0.010	0.944	0.820	0.514	0.797	0.750	0.914	0.925	0.494
	Sig. (2-tailed)	0.128	0.004	0.000	0.024	0.326	0.545	0.000	0.000	0.004	.	0.106	0.974	0.000	0.001	0.087	0.002	0.005	0.000	0.000	0.103
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Copper	Correlation Coefficient	0.351	0.424	0.466	-0.306	0.382	0.278	0.639	0.567	0.598	0.489	1.000	0.433	0.553	0.553	0.128	0.139	0.466	0.505	0.599	0.639
	Sig. (2-tailed)	0.290	0.170	0.127	0.334	0.220	0.408	0.034	0.054	0.040	0.106	.	0.159	0.062	0.062	0.692	0.667	0.127	0.094	0.040	0.025
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Iron	Correlation Coefficient	0.074	-0.083	0.046	-0.084	0.308	0.642	0.365	0.042	0.157	0.010	0.433	1.000	0.167	0.129	-0.142	-0.049	0.412	-0.052	0.083	0.423
	Sig. (2-tailed)	0.829	0.797	0.888	0.795	0.331	0.033	0.270	0.898	0.626	0.974	0.159	.	0.605	0.690	0.660	0.881	0.183	0.872	0.797	0.171
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Magnesium	Correlation Coefficient	0.337	0.753	0.893	-0.601	0.296	0.210	0.886	0.960	0.646	0.944	0.553	0.167	1.000	0.767	0.509	0.648	0.722	0.800	0.907	0.501
	Sig. (2-tailed)	0.311	0.005	0.000	0.039	0.349	0.536	0.000	0.000	0.023	0.000	0.062	0.605	.	0.004	0.091	0.023	0.008	0.002	0.000	0.097
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Molybdenum	Correlation Coefficient	0.564	0.413	0.923	-0.589	0.474	0.218	0.884	0.832	0.771	0.820	0.553	0.129	0.767	1.000	0.130	0.526	0.629	0.767	0.902	0.624
	Sig. (2-tailed)	0.071	0.183	0.000	0.044	0.119	0.519	0.000	0.001	0.003	0.001	0.062	0.690	0.004	.	0.688	0.079	0.028	0.004	0.000	0.030
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Potassium	Correlation Coefficient	0.241	0.757	0.354	-0.442	0.073	-0.228	0.075	0.494	0.143	0.514	0.128	-0.142	0.509	0.130	1.000	0.644	0.130	0.523	0.347	-0.094
	Sig. (2-tailed)	0.474	0.004	0.259	0.151	0.821	0.501	0.826	0.103	0.658	0.087	0.692	0.660	0.091	0.688	.	0.024	0.688	0.081	0.269	0.770
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Selenium	Correlation Coefficient	0.611	0.671	0.675	-0.584	0.080	0.111	0.600	0.739	0.585	0.797	0.139	-0.049	0.648	0.526	0.644	1.000	0.515	0.840	0.647	0.203
	Sig. (2-tailed)	0.046	0.017	0.016	0.046	0.805	0.744	0.051	0.006	0.046	0.002	0.667	0.881	0.023	0.079	0.024	.	0.087	0.001	0.023	0.528
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Silicon	Correlation Coefficient	0.018	0.455	0.629	-0.363	0.357	0.673	0.738	0.727	0.792	0.750	0.466	0.412	0.722	0.629	0.130	0.515	1.000	0.539	0.636	0.580
	Sig. (2-tailed)	0.958	0.138	0.028	0.246	0.255	0.023	0.010	0.007	0.002	0.005	0.127	0.183	0.008	0.028	0.688	0.087	.	0.070	0.026	0.048
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Sodium	Correlation Coefficient	0.738	0.662	0.879	-0.742	0.261	-0.027	0.861	0.918	0.667	0.914	0.505	-0.052	0.800	0.767	0.523	0.840	0.539	1.000	0.893	0.396
	Sig. (2-tailed)	0.010	0.019	0.000	0.006	0.413	0.937	0.001	0.000	0.018	0.000	0.094	0.872	0.002	0.004	0.081	0.001	0.070	.	0.000	0.203
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Strontium	Correlation Coefficient	0.609	0.629	0.979	-0.631	0.242	0.064	0.938	0.951	0.676	0.925	0.599	0.083	0.907	0.902	0.347	0.647	0.636	0.893	1.000	0.500
	Sig. (2-tailed)	0.047	0.028	0.000	0.028	0.448	0.853	0.000	0.000	0.016	0.000	0.040	0.797	0.000	0.000	0.269	0.023	0.026	0.000	.	0.098
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12
Zinc	Correlation Coefficient	0.334	0.370	0.457	-0.088	0.677	0.706	0.817	0.500	0.756	0.494	0.639	0.423	0.501	0.624	-0.094	0.203	0.580	0.396	0.500	1.000
	Sig. (2-tailed)	0.316	0.237	0.135	0.786	0.016	0.015	0.002	0.098	0.004	0.103	0.025	0.171	0.097	0.030	0.770	0.528	0.048	0.203	0.098	.
	N	11	12	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12

▨ Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.6 Correlation analysis results for station P1 bottom on Polley Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Alkalinity	Sulphate	Ammonia	Ortho Phosphorus	Phosphorus	TDS	Hardness	Arsenic	Calcium	Copper	Iron	Magnesium	Molybdenum	Potassium	Selenium	Silicon	Sodium	Strontium	Zinc
Conductivity	Correlation Coefficient	1.000	0.333	0.243	-0.087	0.250	0.500	0.595	0.095	0.611	-0.024	-0.762	-0.609	-0.071	-0.048	0.539	-0.518	0.381	0.524	0.120	0.140
	Sig. (2-tailed)	.	0.381	0.529	0.824	0.516	0.207	0.120	0.823	0.108	0.955	0.028	0.109	0.867	0.911	0.168	0.188	0.352	0.183	0.778	0.740
	N	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Alkalinity	Correlation Coefficient	0.333	1.000	0.681	0.537	0.055	-0.167	0.617	0.800	0.494	0.733	0.133	0.296	0.750	0.417	0.326	-0.822	0.583	0.800	0.644	0.315
	Sig. (2-tailed)	0.381	.	0.030	0.110	0.881	0.668	0.077	0.010	0.177	0.025	0.732	0.439	0.020	0.265	0.391	0.007	0.099	0.010	0.061	0.409
	N	9	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Sulphate	Correlation Coefficient	0.243	0.681	1.000	0.532	0.061	0.109	0.720	0.778	0.261	0.603	-0.243	0.302	0.736	0.879	-0.134	-0.671	0.636	0.728	0.924	0.325
	Sig. (2-tailed)	0.529	0.030	.	0.114	0.868	0.781	0.029	0.014	0.498	0.086	0.529	0.430	0.024	0.002	0.730	0.048	0.066	0.026	0.000	0.394
	N	9	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Ammonia	Correlation Coefficient	-0.087	0.537	0.532	1.000	-0.472	-0.331	0.026	0.714	0.061	0.592	0.313	0.218	0.740	0.574	0.149	-0.088	-0.087	0.270	0.555	0.041
	Sig. (2-tailed)	0.824	0.110	0.114	.	0.168	0.385	0.947	0.031	0.876	0.093	0.412	0.573	0.023	0.106	0.703	0.822	0.824	0.483	0.121	0.916
	N	9	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Ortho Phosphorus	Correlation Coefficient	0.250	0.055	0.061	-0.472	1.000	0.617	0.617	0.150	0.636	0.233	-0.400	0.165	0.083	0.300	0.151	-0.564	0.767	0.500	0.285	-0.175
	Sig. (2-tailed)	0.516	0.881	0.868	0.168	.	0.077	0.077	0.700	0.066	0.546	0.286	0.671	0.831	0.433	0.699	0.113	0.016	0.170	0.458	0.653
	N	9	10	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Phosphorus	Correlation Coefficient	0.500	-0.167	0.109	-0.331	0.617	1.000	0.333	-0.238	0.671	-0.167	-0.690	-0.268	-0.405	-0.071	0.120	0.078	0.405	0.000	-0.323	-0.140
	Sig. (2-tailed)	0.207	0.668	0.781	0.385	0.077	.	0.420	0.570	0.069	0.693	0.058	0.520	0.320	0.867	0.778	0.854	0.320	1.000	0.435	0.742
	N	8	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8
TDS	Correlation Coefficient	0.595	0.617	0.720	0.026	0.617	0.333	1.000	0.633	0.619	0.583	-0.483	0.017	0.533	0.550	0.084	-0.782	0.833	0.883	0.653	0.568
	Sig. (2-tailed)	0.120	0.077	0.029	0.947	0.077	0.420	.	0.067	0.075	0.099	0.187	0.965	0.139	0.125	0.831	0.013	0.005	0.002	0.057	0.110
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Hardness	Correlation Coefficient	0.095	0.800	0.778	0.714	0.150	-0.238	0.633	1.000	0.510	0.900	-0.017	0.374	0.933	0.750	0.243	-0.574	0.517	0.800	0.795	0.420
	Sig. (2-tailed)	0.823	0.010	0.014	0.031	0.700	0.570	0.067	.	0.160	0.001	0.966	0.321	0.000	0.020	0.529	0.106	0.154	0.010	0.010	0.261
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Arsenic	Correlation Coefficient	0.611	0.494	0.261	0.061	0.636	0.671	0.619	0.510	1.000	0.427	-0.569	0.022	0.285	0.201	0.546	-0.512	0.644	0.594	0.189	0.127
	Sig. (2-tailed)	0.108	0.177	0.498	0.876	0.066	0.069	0.075	0.160	.	0.252	0.110	0.956	0.458	0.604	0.128	0.159	0.061	0.092	0.626	0.744
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Calcium	Correlation Coefficient	-0.024	0.733	0.603	0.592	0.233	-0.167	0.583	0.900	0.427	1.000	0.200	0.339	0.950	0.733	0.310	-0.426	0.400	0.800	0.753	0.402
	Sig. (2-tailed)	0.955	0.025	0.086	0.093	0.546	0.693	0.099	0.001	0.252	.	0.606	0.371	0.000	0.025	0.417	0.253	0.286	0.010	0.019	0.283
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Copper	Correlation Coefficient	-0.762	0.133	-0.243	0.313	-0.400	-0.690	-0.483	-0.017	-0.569	0.200	1.000	0.383	0.217	-0.033	-0.151	0.248	-0.417	-0.233	0.017	-0.219
	Sig. (2-tailed)	0.028	0.732	0.529	0.412	0.286	0.058	0.187	0.966	0.110	0.606	.	0.309	0.576	0.932	0.699	0.521	0.265	0.546	0.966	0.572
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Iron	Correlation Coefficient	-0.609	0.296	0.302	0.218	0.165	-0.268	0.017	0.374	0.022	0.339	0.383	1.000	0.313	0.331	-0.380	-0.228	0.418	0.061	0.267	-0.201
	Sig. (2-tailed)	0.109	0.439	0.430	0.573	0.671	0.520	0.965	0.321	0.956	0.371	0.309	.	0.412	0.385	0.313	0.556	0.263	0.876	0.488	0.604
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Magnesium	Correlation Coefficient	-0.071	0.750	0.736	0.740	0.083	-0.405	0.533	0.933	0.285	0.950	0.217	0.313	1.000	0.817	0.251	-0.465	0.333	0.783	0.870	0.376
	Sig. (2-tailed)	0.867	0.020	0.024	0.023	0.831	0.320	0.139	0.000	0.458	0.000	0.576	0.412	.	0.007	0.515	0.207	0.381	0.013	0.002	0.319
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Molybdenum	Correlation Coefficient	-0.048	0.417	0.879	0.574	0.300	-0.071	0.550	0.750	0.201	0.733	-0.033	0.331	0.817	1.000	-0.033	-0.396	0.433	0.650	0.929	0.131
	Sig. (2-tailed)	0.911	0.265	0.002	0.106	0.433	0.867	0.125	0.020	0.604	0.025	0.932	0.385	0.007	.	0.932	0.291	0.244	0.058	0.000	0.737
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Potassium	Correlation Coefficient	0.539	0.326	-0.134	0.149	0.151	0.120	0.084	0.243	0.546	0.310	-0.151	-0.380	0.251	-0.033	1.000	-0.114	-0.109	0.393	0.038	0.022
	Sig. (2-tailed)	0.168	0.391	0.730	0.703	0.699	0.778	0.831	0.529	0.128	0.417	0.699	0.313	0.515	0.932	.	0.770	0.781	0.295	0.923	0.955
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Selenium	Correlation Coefficient	-0.518	-0.822	-0.671	-0.088	-0.564	0.078	-0.782	-0.574	-0.512	-0.426	0.248	-0.228	-0.465	-0.396	-0.114	1.000	-0.842	-0.782	-0.631	-0.234
	Sig. (2-tailed)	0.188	0.007	0.048	0.822	0.113	0.854	0.013	0.106	0.159	0.253	0.521	0.556	0.207	0.291	0.770	.	0.004	0.013	0.068	0.545
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Silicon	Correlation Coefficient	0.381	0.583	0.636	-0.087	0.767	0.405	0.833	0.517	0.644	0.400	-0.417	0.418	0.333	0.433	-0.109	-0.842	1.000	0.667	0.502	0.192
	Sig. (2-tailed)	0.352	0.099	0.066	0.824	0.016	0.320	0.005	0.154	0.061	0.286	0.265	0.263	0.381	0.244	0.781	0.004	.	0.050	0.168	0.620
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Sodium	Correlation Coefficient	0.524	0.800	0.728	0.270	0.500	0.000	0.883	0.800	0.594	0.800	-0.233	0.061	0.783	0.650	0.393	-0.782	0.667	1.000	0.795	0.516
	Sig. (2-tailed)	0.183	0.010	0.026	0.483	0.170	1.000	0.002	0.010	0.092	0.010	0.546	0.876	0.013	0.058	0.295	0.013	0.050	.	0.010	0.155
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Strontium	Correlation Coefficient	0.120	0.644	0.924	0.555	0.285	-0.323	0.653	0.795	0.189	0.753	0.017	0.267	0.870	0.929	0.038	-0.631	0.502	0.795	1.000	0.255
	Sig. (2-tailed)	0.778	0.061	0.000	0.121	0.458	0.435	0.057	0.010	0.626	0.019	0.966	0.488	0.002	0.000	0.923	0.068	0.168	0.010	.	0.508
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Zinc	Correlation Coefficient	0.140	0.315	0.325	0.041	-0.175	-0.140	0.568	0.420	0.127	0.402	-0.219	-0.201	0.376	0.131	0.022	-0.234	0.192	0.516	0.255	1.000
	Sig. (2-tailed)	0.740	0.409	0.394	0.916	0.653	0.742	0.110	0.261	0.744	0.283	0.572	0.604	0.319	0.737	0.955	0.545	0.620	0.155	0.508	.
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9

🟦 Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.7 Correlation analysis results for station P2 bottom on Polley Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Alkalinity	Sulphate	Ammonia	Ortho Phosphorus	Phosphorus	TDS	Hardness	Arsenic	Calcium	Copper	Iron	Magnesium	Molybdenum	Potassium	Selenium	Silicon	Sodium	Strontium	Zinc
Conductivity	Correlation Coefficient	1.000	0.217	0.209	-0.026	0.283	0.405	0.429	0.167	0.580	0.333	-0.233	-0.017	0.209	-0.033	0.577	-0.439	0.650	0.502	0.343	-0.274
	Sig. (2-tailed)	.	0.576	0.589	0.948	0.460	0.320	0.289	0.668	0.102	0.381	0.546	0.965	0.589	0.932	0.104	0.237	0.058	0.168	0.366	0.476
	N	9	9	9	9	9	8	8	9	9	9	9	9	9	9	9	9	9	9	9	9
Alkalinity	Correlation Coefficient	0.217	1.000	0.316	0.389	-0.321	-0.217	0.183	0.588	0.214	0.709	-0.479	-0.582	0.468	0.079	0.723	0.541	0.042	0.298	0.426	-0.522
	Sig. (2-tailed)	0.576	.	0.374	0.267	0.365	0.576	0.637	0.074	0.553	0.022	0.162	0.078	0.172	0.829	0.018	0.106	0.907	0.403	0.220	0.122
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Sulphate	Correlation Coefficient	0.209	0.316	1.000	0.459	-0.176	-0.042	0.904	0.766	0.178	0.705	-0.766	-0.699	0.793	0.675	0.207	0.436	0.201	0.698	0.915	-0.524
	Sig. (2-tailed)	0.589	0.374	.	0.182	0.626	0.915	0.001	0.010	0.623	0.023	0.010	0.024	0.006	0.032	0.565	0.208	0.578	0.025	0.000	0.120
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Ammonia	Correlation Coefficient	-0.026	0.389	0.459	1.000	-0.734	-0.553	0.162	0.558	-0.294	0.351	-0.276	-0.576	0.516	0.358	0.327	0.091	-0.332	0.230	0.466	-0.360
	Sig. (2-tailed)	0.948	0.267	0.182	.	0.016	0.122	0.678	0.093	0.409	0.320	0.440	0.081	0.127	0.310	0.356	0.802	0.348	0.523	0.175	0.306
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Ortho Phosphorus	Correlation Coefficient	0.283	-0.321	-0.176	-0.734	1.000	0.900	0.350	-0.079	0.642	0.055	0.115	0.438	0.006	0.139	-0.128	-0.334	0.782	0.292	-0.067	0.406
	Sig. (2-tailed)	0.460	0.365	0.626	0.016	.	0.001	0.356	0.829	0.045	0.881	0.751	0.206	0.987	0.701	0.725	0.346	0.008	0.413	0.854	0.244
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Phosphorus	Correlation Coefficient	0.405	-0.217	-0.042	-0.553	0.900	1.000	0.405	0.233	0.740	0.333	-0.133	0.244	0.283	0.117	0.176	-0.236	0.883	0.452	0.075	0.137
	Sig. (2-tailed)	0.320	0.576	0.915	0.122	0.001	.	0.320	0.546	0.023	0.381	0.732	0.527	0.460	0.765	0.651	0.541	0.002	0.222	0.847	0.725
	N	8	9	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9
TDS	Correlation Coefficient	0.429	0.183	0.904	0.162	0.350	0.405	1.000	0.750	0.523	0.750	-0.617	-0.426	0.812	0.883	0.059	0.105	0.533	0.828	0.921	.
	Sig. (2-tailed)	0.289	0.637	0.001	0.678	0.356	0.320	.	0.020	0.148	0.020	0.077	0.252	0.008	0.002	0.881	0.787	0.139	0.006	0.000	.
	N	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Hardness	Correlation Coefficient	0.167	0.588	0.766	0.558	-0.079	0.233	0.750	1.000	0.367	0.952	-0.782	-0.738	0.979	0.636	0.523	0.378	0.382	0.760	0.863	-0.522
	Sig. (2-tailed)	0.668	0.074	0.010	0.093	0.829	0.546	0.020	.	0.297	0.000	0.008	0.015	0.000	0.048	0.121	0.282	0.276	0.011	0.001	0.122
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Arsenic	Correlation Coefficient	0.580	0.214	0.178	-0.294	0.642	0.740	0.523	0.367	1.000	0.526	-0.477	-0.183	0.328	0.416	0.411	-0.181	0.789	0.666	0.344	0.176
	Sig. (2-tailed)	0.102	0.553	0.623	0.409	0.045	0.023	0.148	0.297	.	0.118	0.163	0.613	0.354	0.232	0.238	0.617	0.007	0.036	0.331	0.627
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Calcium	Correlation Coefficient	0.333	0.709	0.705	0.351	0.055	0.333	0.750	0.952	0.526	1.000	-0.818	-0.694	0.912	0.552	0.602	0.447	0.491	0.772	0.827	-0.522
	Sig. (2-tailed)	0.381	0.022	0.023	0.320	0.881	0.381	0.020	0.000	0.118	.	0.004	0.026	0.000	0.098	0.066	0.195	0.150	0.009	0.003	0.122
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Copper	Correlation Coefficient	-0.233	-0.479	-0.766	-0.276	0.115	-0.133	-0.617	-0.782	-0.477	-0.818	1.000	0.769	-0.723	-0.515	-0.413	-0.478	-0.309	-0.693	-0.802	0.522
	Sig. (2-tailed)	0.546	0.162	0.010	0.440	0.751	0.732	0.077	0.008	0.163	0.004	.	0.009	0.018	0.128	0.235	0.162	0.385	0.026	0.005	0.122
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Iron	Correlation Coefficient	-0.017	-0.582	-0.699	-0.576	0.438	0.244	-0.426	-0.738	-0.183	-0.694	0.769	1.000	-0.630	-0.381	-0.574	-0.607	0.075	-0.401	-0.618	0.539
	Sig. (2-tailed)	0.965	0.078	0.024	0.081	0.206	0.527	0.252	0.015	0.613	0.026	0.009	.	0.051	0.277	0.083	0.063	0.837	0.250	0.057	0.108
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Magnesium	Correlation Coefficient	0.209	0.468	0.793	0.516	0.006	0.283	0.812	0.979	0.328	0.912	-0.723	-0.630	1.000	0.657	0.424	0.303	0.456	0.799	0.890	-0.524
	Sig. (2-tailed)	0.589	0.172	0.006	0.127	0.987	0.460	0.008	0.000	0.354	0.000	0.018	0.051	.	0.039	0.222	0.395	0.185	0.006	0.001	0.120
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Molybdenum	Correlation Coefficient	-0.033	0.079	0.675	0.358	0.139	0.117	0.883	0.636	0.416	0.552	-0.515	-0.381	0.657	1.000	-0.109	0.006	0.309	0.705	0.723	0.174
	Sig. (2-tailed)	0.932	0.829	0.032	0.310	0.701	0.765	0.002	0.048	0.232	0.098	0.128	0.277	0.039	.	0.763	0.986	0.385	0.023	0.018	0.631
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Potassium	Correlation Coefficient	0.577	0.723	0.207	0.327	-0.128	0.176	0.059	0.523	0.411	0.602	-0.413	-0.574	0.424	-0.109	1.000	0.170	0.280	0.345	0.287	-0.524
	Sig. (2-tailed)	0.104	0.018	0.565	0.356	0.725	0.651	0.881	0.121	0.238	0.066	0.235	0.083	0.222	0.763	.	0.638	0.434	0.330	0.422	0.120
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Selenium	Correlation Coefficient	-0.439	0.541	0.436	0.091	-0.334	-0.236	0.105	0.378	-0.181	0.447	-0.478	-0.607	0.303	0.006	0.170	1.000	-0.302	-0.069	0.278	-0.542
	Sig. (2-tailed)	0.237	0.106	0.208	0.802	0.346	0.541	0.787	0.282	0.617	0.195	0.162	0.063	0.395	0.986	0.638	.	0.396	0.849	0.437	0.105
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Silicon	Correlation Coefficient	0.650	0.042	0.201	-0.332	0.782	0.883	0.533	0.382	0.789	0.491	-0.309	0.075	0.456	0.309	0.280	-0.302	1.000	0.760	0.432	-0.058
	Sig. (2-tailed)	0.058	0.907	0.578	0.348	0.008	0.002	0.139	0.276	0.007	0.150	0.385	0.837	0.185	0.385	0.434	0.396	.	0.011	0.213	0.873
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Sodium	Correlation Coefficient	0.502	0.298	0.698	0.230	0.292	0.452	0.828	0.760	0.666	0.772	-0.693	-0.401	0.799	0.705	0.345	-0.069	0.760	1.000	0.887	-0.291
	Sig. (2-tailed)	0.168	0.403	0.025	0.523	0.413	0.222	0.006	0.011	0.036	0.009	0.026	0.250	0.006	0.023	0.330	0.849	0.011	.	0.001	0.415
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Strontium	Correlation Coefficient	0.343	0.426	0.915	0.466	-0.067	0.075	0.921	0.863	0.344	0.827	-0.802	-0.618	0.890	0.723	0.287	0.278	0.432	0.887	1.000	-0.524
	Sig. (2-tailed)	0.366	0.220	0.000	0.175	0.854	0.847	0.000	0.001	0.331	0.003	0.005	0.057	0.001	0.018	0.422	0.437	0.213	0.001	.	0.120
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Zinc	Correlation Coefficient	-0.274	-0.522	-0.524	-0.360	0.406	0.137	.	-0.522	0.176	-0.522	0.522	0.539	-0.524	0.174	-0.524	-0.542	-0.058	-0.291	-0.524	1.000
	Sig. (2-tailed)	0.476	0.122	0.120	0.306	0.244	0.725	.	0.122	0.627	0.122	0.122	0.108	0.120	0.631	0.120	0.105	0.873	0.415	0.120	.
	N	9	10	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10

🟦 Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.8: Water quality data for surface stations on Bootjack Lake (B1 and B2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	B1 Surface										Count	Mean[b]	Median	% > BCWQG	% > Baseline	Magnitude of increase[c]
				B1-Surface	B1-Surface	B1-Surface	B1-Surface	B1-Surface	B1-Surface	B1-Surface	B1-Surface	B1-Surface	B1-Surface						
				6/7/2001	5/23/2006	10/31/2006	3/6/2007	5/23/2007	10/23/2007	5/21/2008	10/27/2008	3/13/2009	8/26/2009						
Field pH	pH units			7.18	7.68	7.57	7.84	8.42	7.96	7.44	8.1	7.16	8.29	10	7.76	7.76			
Field Temperature	degrees C			13.2	14.1	5.06	0.71	10.7	6.74	6.78	5.64	0.38	18.2	10	8.15	6.76			
Field Conductivity	uS/cm	74.7		82	80	85	89	58	83	52		650	88	9	140.8	83.0		78%	8.7
Alkalinity Total	mg/l	38.6		36	35.2	41.5	36.1	37.3	39.8	37.8	43.7	57.4	43.4	10	40.8	38.8		50%	1.5
Sulfate	mg/l	3.36	50	2.3	3	2.93	2.93	3.15	3.24	3.1	3.04	4.71	3.13	10	3.2	3.1	0%	10%	1.4
N+N LL	mg/l			<0.005	<0.0050	<0.0050	0.0255	<0.0050	<0.0050	<0.0050	<0.0050	0.0168	0.0025	10	0.006	0.003		0%	
Ammonia Nitrogen (N)	mg/l	0.010		0.012	0.0067	<0.020	<0.0050	0.0052	<0.0050	0.0093	<0.0050	0.0412	0.0005	10	0.009	0.006		20%	4.0
N-Total	mg/l			<0.12	0.300	0.302	0.290	0.330	0.380	0.180	0.180	0.330	0.240	10	0.26	0.30		0%	
Ortho Phosporus	mg/l	0.015	1.85	0.005	<0.0010	<0.0010	<0.0010	<0.0010	0.0013	<0.0010	0.0011	<0.0010	0.0057	10	0.0016	0.0005	0%	0%	0.4
Phosphorus-T	mg/l	0.016		0.014	0.0041	0.0146	0.0186	0.0098	0.0166	0.0111	0.0146	0.0378	0.0047	10	0.0146	0.0143		30%	2.4
Phosphorus-D	mg/l	0.011		0.007	0.0021	0.0029	0.003	0.0032	0.0057	0.0036	0.0055	0.0056	0.001	10	0.0040	0.0034		0%	0.7
TSS	mg/l	6.3	31.3	<4	<3.0	<3.0	<3.0	<3.0	3.3	<3.0	5.3	<3.0	1.5	10	2.1	1.5	0%	0%	0.8
TDS	mg/l	60.00			55	51	53	50	61	50	158	83	54	9	68.3	54.0		33%	2.6
Turbidity	NTU	1.46	9.46	0.52	0.57	2.47	0.91	0.98	1.46	1	1.58	1.72	0.86	10	1.21	0.99	0%	30%	1.7
Dissolved Organic Carbon	mg/l	7.6		7.60	7.16	6.03	5.63	6.60	6.81	6.09	5.76	7.86	6.10	10	6.56	6.35		20%	1.0
Hardness	mg/l	34.4		35.4	39.9	44	37.6	39.7	38.9	36.5	39.9	56.3	40.1	10	40.8	39.8		100%	1.6
Aluminum Dissolved	mg/l	0.042	0.05	0.0038	0.0023	0.0019	0.001	0.0052	0.0012	0.013	0.0013	0.0045	0.0035	10	0.0038	0.0029	0%	0%	0.3
Aluminum Total	mg/l	0.075		0.0092	0.0085	0.0166	0.0044	0.0132	0.018	0.0312	0.0313	0.0344	0.0152	10	0.0182	0.0159		0%	0.5
Arsenic Dissolved	mg/l	0.0003		0.0003	0.00024	0.00034	0.00028	0.00027	0.00032	0.00025	0.00032	0.0004	0.00032	10	0.00030	0.00031		50%	1.3
Arsenic Total	mg/l	0.0003	0.005	0.0004	0.00024	0.00038	0.0003	0.00028	0.00039	0.00026	0.00035	0.00048	0.0003	10	0.00034	0.00033	0%	50%	1.6
Barium Dissolved	mg/l	0.013		0.0144	0.0152	0.0167	0.0148	0.0151	0.0157	0.0146	0.0156	0.0233	0.0157	10	0.01611	0.01540		100%	1.8
Barium Total	mg/l	0.015	1	0.016	0.0156	0.0175	0.0149	0.016	0.0172	0.0156	0.017	0.0265	0.0157	10	0.01720	0.01600	0%	100%	1.8
Calcium Dissolved	mg/l	10.5		10.8	12.2	13.5	11.6	12.1	12	11.2	12.3	17.4	12.3	10	12.5	12.2		100%	1.7
Calcium Total	mg/l	10.4		9.76	12.1	13.5	11.4	12.2	12	11.3	12.2	17.3	11	10	12.3	12.1		90%	1.7
Copper Dissolved	mg/l	0.004		0.0027	0.00209	0.00191	0.00175	0.00225	0.00181	0.00234	0.00186	0.0027	0.00235	10	0.00218	0.00217		0%	0.7
Copper Total	mg/l	0.004	0.002	0.0033	0.00274	0.00231	0.00193	0.00226	0.00227	0.00272	0.0031	**0.00757**	0.00281	10	0.00310	0.00273	90%	10%	1.9
Iron Dissolved	mg/l	0.040		<0.005	0.046	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	10	0.017	0.015		10%	1.2
Iron Total	mg/l	0.117	1	0.03	<0.030	0.068	0.04	0.051	0.082	0.062	0.08	0.104	<0.030	10	0.055	0.057	0%	0%	0.9
Lead Dissolved	mg/l	<0.001	0.35	0.000080	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	10	0.00003	0.00003	0%	0%	0.1
Lead Total	mg/l	<0.001	0.004	0.000120	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000060	0.000113	<0.000050	10	0.00005	0.00003	0%	0%	0.1
Magnesium Dissolved	mg/l	2.12		2.04	2.27	2.52	2.12	2.29	2.18	2.07	2.2	3.11	2.27	10	2.31	2.24		70%	1.5
Magnesium Total	mg/l	1.95		1.81	2.27	2.53	1.96	2.33	2.16	2.10	2.17	3.12	2.15	10	2.26	2.17		90%	1.6
Manganese Dissolved	mg/l	0.010		0.00097	0.00581	0.000873	0.000461	0.00338	0.00709	0.0024	0.00167	0.000364	0.00027	10	0.00233	0.00132		0%	0.7
Manganese Total	mg/l	0.045	0.756	0.00948	0.0114	0.0191	0.00148	0.0203	0.0396	0.0244	0.0202	0.0037	0.0124	10	0.01621	0.01575	0%	0%	0.9
Molybdenum Dissolved	mg/l	<0.001		0.00099	0.000842	0.00107	0.000905	0.000862	0.00103	0.00091	0.00101	0.00146	0.00105	10	0.00101	0.00100		50%	1.5
Molybdenum Total	mg/l	<0.001	1	0.00083	0.000924	0.00109	0.000896	0.000865	0.00102	0.000892	0.00101	0.00163	0.0011	10	0.00103	0.00097	0%	50%	1.6
Nickel Dissolved	mg/l	<0.001		<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	10	0.00025	0.00025		0%	0.0
Nickel Total	mg/l	<0.001	0.025	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00052	<0.00050	10	0.00028	0.00025	0%	0%	0.5
Potassium Dissolved	mg/l	0.65		0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.7	0.5	10	0.478	0.454		10%	1.0
Potassium Total	mg/l			0.58	0.459	<2.0	0.461	0.463	0.481	0.41	0.49	0.748	0.459	10	0.555	0.472		0%	
Selenium Dissolved	mg/l	<0.0005		<0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	10	0.0005	0.0005		0%	0.0
Selenium Total	mg/l	<0.0005	0.002	<0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	10	0.0005	0.0005	0%	0%	0.0
Silicon Dissolved	mg/l	2.12		0.74	1.15	1.54	1.2	1.79	1.7	1.93	1.51	1.91	1.52	10	1.50	1.53		0%	0.9
Silicon Total	mg/l	2.06		0.8	1.16	1.55	1.29	1.83	1.81	1.99	1.61	1.96	1.44	10	1.54	1.58		0%	1.0
Sodium Dissolved	mg/l	2.49		3.48	2.31	2.46	2.15	2.26	2.37	2.16	2.36	3.5	2.26	10	2.53	2.34		20%	1.4
Sodium Total	mg/l			2.6	2.28	2.45	2.14	2.31	2.55	2.17	2.52	3.77	2.27	10	2.51	2.38		0%	
Strontium Dissolved	mg/l	0.11		0.104	0.103	0.11	0.0953	0.0991	0.104	0.101	0.0965	0.139	0.115	10	0.107	0.104		30%	1.3
Strontium Total	mg/l	0.11		0.114	0.105	0.112	0.0964	0.103	0.114	0.101	0.0974	0.151	0.114	10	0.111	0.109		50%	1.4
Zinc Dissolved	mg/l	<0.005		0.0018	0.0017	<0.0010	0.0045	<0.0010	<0.0010	<0.0010	<0.0010	0.0056	<0.010	10	0.0021	0.0011		10%	1.1
Zinc Total	mg/l	<0.005	0.0075	0.0018	0.004	<0.0010	0.0046	<0.0010	<0.0010	<0.0010	0.0026	<0.010	0.0005	10	0.0021	0.0012	0%	0%	0.9

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

Table B.8: Water quality data for surface stations on Bootjack Lake (B1 and B2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	B2 Surface										Count	Mean[b]	Median	% > BCWQG	% > Baseline	Magnitude of increase[c]
				B2-Surface	B2-Surface	B2-Surface	B2-Surface	B2-Surface	B2-Surface	B2-Surface	B2-Surface	B2-Surface	B2-Surface						
				6/7/2001	5/23/2006	10/31/2006	3/6/2007	5/23/2007	10/23/2007	5/21/2008	10/27/2008	3/13/2009	8/26/2009						
Field pH	pH units			7.74	8.04	7.68	7.74	7.77	8.63	7.31	7.84	7.5	8.47	10	7.87	7.76			
Field Temperature	degrees C			13.1	11.76	5.38	0.29	10.78	7.18	6.94	6.67	0.39	18.4	10	8.09	7.06			
Field Conductivity	uS/cm	74.7		81	79	84	90	58	79	51		52	87	9	73.4	79.0		67%	1.2
Alkalinity Total	mg/l	38.6		36	36	40.6	52.8	37.8	39.8	37.6	41.2	48.6	42.1	10	41.3	40.2		60%	1.4
Sulfate	mg/l	3.36	50	2.4	2.96	2.83	4.41	3.07	3.27	2.82	2.98	3.93	3.13	10	3.2	3.0	0%	20%	1.3
N+N LL	mg/l			<0.005	<0.0050	<0.0050	0.0967	<0.0050	<0.0050	<0.0050	<0.0050	0.0139	<0.0050	10	0.013	0.003		0%	
Ammonia Nitrogen (N)	mg/l	0.010		0.006	<0.0050	<0.020	0.012	0.0206	<0.0050	0.0093	<0.0050	<0.0050	<0.0050	10	0.007	0.004		20%	2.0
N-Total	mg/l			<0.12	0.300	0.299	0.510	0.370	0.400	0.170	0.160	0.240	0.170	10	0.27	0.27		0%	
Ortho Phosporus	mg/l	0.015	1.85	0.005	<0.0010	<0.0010	<0.0010	<0.0010	0.0027	<0.0010	0.0012	<0.0010	<0.0010	10	0.0012	0.0005	0%	0%	0.3
Phosphorus-T	mg/l	0.016		0.026	0.0056	0.0186	0.0097	0.0091	0.0186	0.01	0.0052	0.0092	0.0036	10	0.0116	0.0095		30%	1.6
Phosphorus-D	mg/l	0.011		0.021	0.0024	0.0037	0.0054	0.0032	0.0066	0.0043	0.0046	0.0033	0.001	10	0.0056	0.0040		10%	2.0
TSS	mg/l	6.3	31.3	<4	<3.0	<3.0	<3.0	<3.0	3.8	<3.0	3.8	<3.0	4.5	10	2.3	1.5	0%	0%	0.7
TDS	mg/l	60.00			55	54	76	47	57	47	55	70	55	9	57.3	55.0		22%	1.3
Turbidity	NTU	1.46	9.46	0.71	0.49	2.62	0.53	0.84	2.24	0.75	1.34	0.99	0.55	10	1.11	0.80	0%	20%	1.8
Dissolved Organic Carbon	mg/l	7.6		9.70	7.01	6.41	8.59	6.84	6.32	6.33	5.94	6.63	6.12	10	6.99	6.52		20%	1.3
Hardness	mg/l	34.4			39.6	44.4	55.2	40.2	38.9	35.5	39.8	48.9	39.2	9	42.4	39.8		100%	1.6
Aluminum Dissolved	mg/l	0.042	0.05		0.0041	0.0013	0.0028	0.006	<0.0010	0.0174	<0.0010	0.005	0.003	9	0.0045	0.0030	0%	0%	0.4
Aluminum Total	mg/l	0.075			0.0079	0.0278	0.0053	0.0149	0.0172	0.0317	0.0211	0.0413	0.0078	9	0.0194	0.0172		0%	0.5
Arsenic Dissolved	mg/l	0.0003			0.00023	0.00035	0.00045	0.00026	0.00031	0.00027	0.00035	0.00035	0.0003	9	0.00032	0.00031		56%	1.5
Arsenic Total	mg/l	0.0003	0.005		0.00024	0.0004	0.00045	0.00028	0.00036	0.00026	0.00036	0.00038	0.00031	9	0.00034	0.00036	0%	67%	1.5
Barium Dissolved	mg/l	0.013			0.0153	0.0162	0.0221	0.0152	0.0162	0.0152	0.0161	0.0206	0.0155	9	0.01693	0.01610		100%	1.7
Barium Total	mg/l	0.015	1		0.0155	0.0178	0.0218	0.0157	0.0176	0.0156	0.0166	0.023	0.0153	9	0.01766	0.01660	0%	100%	1.5
Calcium Dissolved	mg/l	10.5			12.1	13.6	16.9	12.3	11.9	10.9	12.3	15.2	11.9	9	13.0	12.3		100%	1.6
Calcium Total	mg/l	10.4			12.2	13.1	17.3	12.3	11.9	11	11.9	14.7	12.5	9	13.0	12.3		100%	1.7
Copper Dissolved	mg/l	0.004			0.00315	0.00193	0.00294	0.00215	0.00177	0.00221	0.00198	0.00269	0.00226	9	0.00234	0.00221		0%	0.8
Copper Total	mg/l	0.004	0.002		0.0022	**0.00426**	0.00289	0.00224	0.00217	0.00239	0.00244	**0.0103**	0.00242	9	0.00348	0.00242	100%	22%	2.6
Iron Dissolved	mg/l	0.040			<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	9	0.015	0.015		0%	0.0
Iron Total	mg/l	0.117	1		<0.030	0.084	<0.030	0.054	0.102	0.048	0.089	0.085	<0.030	9	0.056	0.054	0%	0%	0.9
Lead Dissolved	mg/l	<0.001	0.35		0.000127	<0.000050	0.000061	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	9	0.00004	0.00003	0%	0%	0.1
Lead Total	mg/l	<0.001	0.004		<0.000050	0.000054	0.000102	<0.000050	<0.000050	<0.000050	<0.000050	0.000076	<0.000050	9	0.00004	0.00003	0%	0%	0.1
Magnesium Dissolved	mg/l	2.12			2.26	2.53	3.17	2.33	2.25	2	2.17	2.69	2.28	9	2.41	2.28		89%	1.5
Magnesium Total	mg/l	1.95			2.25	2.42	2.99	2.33	2.09	2.04	2.12	2.64	2.30	9	2.35	2.30		100%	1.5
Manganese Dissolved	mg/l	0.010			0.00138	0.000739	0.00202	0.00672	0.0186	0.00312	0.000206	0.000682	0.000273	9	0.00375	0.00138		11%	1.9
Manganese Total	mg/l	0.045	0.756		0.0108	0.0317	0.00238	0.0207	0.0682	0.0168	0.0314	0.00338	0.00898	9	0.02159	0.01680	0%	11%	1.5
Molybdenum Dissolved	mg/l	<0.001			0.000824	0.00108	0.00138	0.000854	0.00103	0.000852	0.00101	0.00123	0.000981	9	0.00103	0.00101		56%	1.4
Molybdenum Total	mg/l	<0.001	1		0.000834	0.00114	0.00134	0.000904	0.000978	0.000843	0.00104	0.00135	0.000955	9	0.00104	0.00098	0%	44%	1.4
Nickel Dissolved	mg/l	<0.001			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	9	0.00025	0.00025		0%	0.0
Nickel Total	mg/l	<0.001	0.025		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00103	<0.00050	9	0.00034	0.00025	0%	11%	1.0
Potassium Dissolved	mg/l	0.65			0.5	0.5	0.7	0.4	0.5	0.4	0.5	0.6	0.4	9	0.489	0.458		11%	1.0
Potassium Total	mg/l				0.504	<2.0	0.672	0.465	0.468	0.422	0.477	0.592	0.427	9	0.559	0.477		0%	
Selenium Dissolved	mg/l	<0.0005			<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	9	0.0005	0.0005		0%	0.0
Selenium Total	mg/l	<0.0005	0.002		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	9	0.0005	0.0005	0%	0%	0.0
Silicon Dissolved	mg/l	2.12			1.14	1.68	1.84	1.82	1.85	1.9	1.64	1.66	1.5	9	1.67	1.68		0%	0.9
Silicon Total	mg/l	2.06			1.19	1.65	1.92	1.86	1.96	1.96	1.68	1.68	1.57	9	1.72	1.68		0%	1.0
Sodium Dissolved	mg/l	2.49			2.28	2.37	3.19	2.26	2.22	2.18	2.38	2.9	2.23	9	2.45	2.28		22%	1.3
Sodium Total	mg/l				2.26	2.53	3.16	2.28	2.37	2.2	2.46	3.05	2.19	9	2.50	2.37		0%	
Strontium Dissolved	mg/l	0.11			0.103	0.11	0.146	0.1	0.109	0.104	0.0987	0.121	0.114	9	0.112	0.109		56%	1.3
Strontium Total	mg/l	0.11			0.103	0.113	0.142	0.101	0.103	0.105	0.0979	0.133	0.108	9	0.112	0.105		44%	1.3
Zinc Dissolved	mg/l	<0.005			0.0021	<0.0010	0.0075	<0.0010	<0.0010	<0.0010	<0.0010	0.0261	<0.0010	9	0.0043	0.0005		22%	5.2
Zinc Total	mg/l	<0.005	0.0075		0.0045	0.0023	0.0058	<0.0010	<0.0010	<0.0010	0.0011	**0.0374**	<0.0010	9	0.0059	0.0011	11%	22%	7.5

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

Table B.9: Water quality data for bottom stations on Bootjack Lake (B1 and B2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	B1 Bottom								Count	Mean[b]	Median	% > BCWQG	Count > Baseline	% > Baseline	Magnitude of increase[c]
				B1-9 metre	B1-9 metre	B1-9 metre	B1 at bottom	B1 at bottom	B1 at bottom	B1 at bottom	B1-9 metre							
				6/7/2001	5/23/2006	10/31/2006	5/23/2007	10/23/2007	5/21/2008	10/27/2008	8/26/2009							
Field pH	pH units			7.43	7.43	7.56	8.02	7.95	7.13	7.56	7.66	8	7.59	7.56				
Field Temperature	degrees C			9.3	6.51	5.3	5.86	6.71	4.27	5.62	9.4	8	6.62	6.19				
Field Conductivity	uS/cm	75.5		81	79	84	51	83	58		92	7	75.4	81.0		5	71%	1.2
Alkalinity Total	mg/l	38.3		36	36.5	41.4	37.9	39.7	42.6	42.2	43.8	8	40.0	40.6		5	63%	1.1
Sulfate	mg/l	3.36	50	2.3	3.01	2.9	3.14	3.24	3.59	3.05	2.64	8	3.0	3.0	0%	1	13%	1.1
N+N LL	mg/l			<0.005	<0.0050	<0.0050	<0.0050	<0.0050	0.0561	<0.0050	0.0087	8	0.010	0.003		0	0%	
Ammonia Nitrogen (N)	mg/l	0.010		0.011	0.0113	<0.020	0.0104	<0.0050	0.008	<0.0050	0.0092	8	0.008	0.010		3	38%	1.1
N-Total	mg/l			0.300	0.500	0.289	0.340	0.400	0.190	0.180	0.290	8	0.31	0.30		0	0%	
Ortho Phosporus	mg/l	0.086	1.85	0.01	<0.0010	<0.0010	0.0012	0.0014	0.0021	0.0012	0.0641	8	0.0101	0.0013	0%	0	0%	0.7
Phosphorus-T	mg/l	0.016		0.023	0.0064	0.0154	0.0152	0.0165	0.0152	0.0166	0.0304	8	0.0173	0.0160		4	50%	1.9
Phosphorus-D	mg/l	0.009		0.016	0.0031	0.0035	0.004	0.0082	0.0048	0.0158	0.0092	8	0.0081	0.0065		3	38%	1.8
TSS	mg/l	7.22	32.22	<4	<3.0	3.5	<3.0	3.3	3.7	3.3	1.5	8	2.5	2.7	0%	0	0%	0.5
TDS	mg/l	60.0			55	52	50	62	57	217	65	7	79.7	57.0		3	43%	3.6
Turbidity	NTU	1.90	9.90	0.9	0.86	2.46	1.28	1.78	1.75	1.6	3.76	8	1.80	1.68	0%	2	25%	2.0
Dissolved Organic Carbon	mg/l	8.4		9.10	7.33	6.04	6.52	6.90	5.89	5.63	6.09	8	6.69	6.31		1	13%	1.1
Hardness	mg/l	35.9		41.5	39.8	43.6	40.4	39	41.7	39.8	42.2	8	41.0	41.0		8	100%	1.2
Aluminum Dissolved	mg/l	0.060	0.05	0.0058	0.0022	0.0013	0.005	0.0011	0.0049	0.0014	0.0022	8	0.0030	0.0022	0%	0	0%	0.1
Aluminum Total	mg/l	0.069		0.0163	0.0096	0.0164	0.0152	0.0188	0.0224	0.0553	0.0149	8	0.0211	0.0164		0	0%	0.8
Arsenic Dissolved	mg/l	0.0003		0.0003	0.00025	0.00035	0.00026	0.00034	0.00026	0.00033	0.00042	8	0.00031	0.00032		4	50%	1.4
Arsenic Total	mg/l	0.0003	0.005	0.0003	0.00025	0.00037	0.00029	0.00034	0.00026	0.00035	0.00052	8	0.00034	0.00032	0%	4	50%	1.7
Barium Dissolved	mg/l	0.012		0.0186	0.0166	0.0167	0.0156	0.016	0.0158	0.0156	0.00967	8	0.01557	0.01590		7	88%	1.6
Barium Total	mg/l	0.014	1	0.0173	0.0171	0.0174	0.0165	0.0168	0.0172	0.0163	0.0134	8	0.01650	0.01695	0%	7	88%	1.2
Calcium Dissolved	mg/l	11.1		12.7	12.2	13.4	12.3	12.1	12.9	12.3	13.1	8	12.6	12.5		8	100%	1.2
Calcium Total	mg/l	10.5		9.89	12.2	13.4	12.3	11.9	12.5	12.2	12.6	8	12.1	12.3		7	88%	1.3
Copper Dissolved	mg/l	0.004		0.004	0.00218	0.00197	0.00202	0.00181	0.0022	0.00192	0.00174	8	0.00223	0.00200		0	0%	1.0
Copper Total	mg/l	0.010	0.002	0.0034	0.0023	0.00227	0.00224	0.00223	0.00271	0.00307	0.00226	8	0.00256	0.00229	100%	0	0%	0.3
Iron Dissolved	mg/l	0.051		0.019	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.054	8	0.020	0.015		1	13%	1.1
Iron Total	mg/l	0.117	1	0.083	0.043	0.082	0.087	0.089	0.14	0.071	0.22	8	0.102	0.085	0%	2	25%	1.9
Lead Dissolved	mg/l	<0.001	0.35	0.000160	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	8	0.00004	0.00003	0%	0	0%	0.2
Lead Total	mg/l	<0.001	0.004	0.000100	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000066	<0.000050	8	0.00004	0.00003	0%	0	0%	0.1
Magnesium Dissolved	mg/l	2.03		2.37	2.27	2.49	2.33	2.17	2.33	2.19	2.32	8	2.31	2.33		8	100%	1.2
Magnesium Total	mg/l	1.95		1.85	2.28	2.49	2.33	2.18	2.27	2.15	2.30	8	2.23	2.28		7	88%	1.3
Manganese Dissolved	mg/l	0.008		0.00289	0.00267	0.000836	0.00238	0.0116	0.00118	0.00144	0.00224	8	0.00315	0.00231		1	13%	1.4
Manganese Total	mg/l	0.048	0.763	0.0291	0.0128	0.0202	0.0274	0.0385	0.129	0.0202	0.206	8	0.06040	0.02825	0%	2	25%	4.3
Molybdenum Dissolved	mg/l	<0.001		0.00089	0.000804	0.0011	0.000885	0.000996	0.000987	0.00106	0.000937	8	0.00096	0.00096		2	25%	1.1
Molybdenum Total	mg/l	<0.001	1	0.00078	0.00087	0.00106	0.000841	0.000967	0.00101	0.00104	0.00109	8	0.00096	0.00099	0%	4	50%	1.1
Nickel Dissolved	mg/l	<0.001		<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	8	0.00025	0.00025		0	0%	0.0
Nickel Total	mg/l	0.0018	0.025	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	8	0.00025	0.00025	0%	0	0%	0.0
Potassium Dissolved	mg/l	0.65		0.6	0.4	0.5	0.5	0.5	0.5	0.5	0.5	8	0.479	0.453		0	0%	1.0
Potassium Total	mg/l			0.56	0.46	<2.0	0.46	0.461	0.402	0.485	0.518	8	0.543	0.473		0	0%	
Selenium Dissolved	mg/l	<0.0005		<0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	8	0.0005	0.0005		0	0%	0.0
Selenium Total	mg/l	<0.0005	0.002	<0.0005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	8	0.0005	0.0005	0%	0	0%	0.0
Silicon Dissolved	mg/l	2.10		1.32	1.17	1.53	2.05	1.71	2.63	1.52	3.53	8	1.93	1.62		2	25%	1.7
Silicon Total	mg/l	2.08		1.2	1.19	1.56	2.08	1.83	2.57	1.58	3.5	8	1.94	1.71		3	38%	1.7
Sodium Dissolved	mg/l	2.50		3.68	2.33	2.42	2.26	2.4	2.39	2.38	2.16	8	2.50	2.39		1	13%	1.5
Sodium Total	mg/l			2.5	2.27	2.37	2.26	2.38	2.34	2.46	2.33	8	2.36	2.36		0	0%	
Strontium Dissolved	mg/l	0.10		0.133	0.103	0.109	0.1	0.107	0.113	0.0967	0.119	8	0.110	0.108		5	63%	1.3
Strontium Total	mg/l	0.11		0.121	0.101	0.111	0.1	0.104	0.106	0.0974	0.128	8	0.109	0.105		3	38%	1.2
Zinc Dissolved	mg/l	<0.005		0.0027	0.0017	<0.0010	0.0016	<0.0010	0.0013	0.0011	<0.0010	8	0.0012	0.0012		0	0%	0.5
Zinc Total	mg/l	<0.005	0.0075	0.0062	0.0013	<0.0010	0.0017	<0.0010	<0.0030	0.0027	<0.0010	8	0.0019	0.0014	0%	1	13%	1.2

🟩 Indicates value above Baseline concentration.

🟦 Indicates value above BCWQG.

🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

Table B.9: Water quality data for bottom stations on Bootjack Lake (B1 and B2), 2001 - present.

Parameter	Units	Baseline 95th or MDL	BCWQG[a]	B2 Bottom								Count	Mean[b]	Median	% > BCWQG	% > Baseline	Magnitude of Increase[c]
				B2 -9 metre	B2 -9 metre	B2 -9 metre	B2 at bottom	B2 at bottom	B2 at bottom	B2 at bottom	B2 -9 metre						
				6/7/2001	5/23/2006	10/31/2006	5/23/2007	10/23/2007	5/21/2008	10/27/2008	8/26/2009						
Field pH	pH units			7.56	7.65	7.61	7.78	7.83	7.35	7.78	7.87	8	7.68	7.72			
Field Temperature	degrees C			11	6.52	4.96	9.83	7.17	6.46	6.36	10.4	8	7.84	6.85			
Field Conductivity	uS/cm	75.5		75	80	88	57	82	51		86	7	74.1	80.0		57%	1.2
Alkalinity Total	mg/l	38.3		35	35.7	42.2	37.8	39.8	37.6	42.1	41.2	8	38.9	38.8		50%	1.1
Sulfate	mg/l	3.36	50	2.2	3	2.83	3.03	3.18	2.83	2.99	2.98	8	2.9	3.0	0%	0%	0.9
N+N LL	mg/l			<0.005	<0.0050	<0.0050	<0.0050	<0.0050	0.0091	<0.0050	0.0150	8	0.005	0.003		0%	
Ammonia Nitrogen (N)	mg/l	0.010		0.008	<0.0050	<0.020	0.0109	<0.0050	0.0079	<0.0050	0.0029	8	0.006	0.005		13%	1.1
N-Total	mg/l			0.400	0.330	0.335	0.400	0.370	0.180	0.160	0.150	8	0.29	0.33		0%	
Ortho Phosporus	mg/l	0.086	1.85	0.008	<0.0010	<0.0010	<0.0010	0.0028	<0.0010	0.0013	0.0143	8	0.0036	0.0009	0%	0%	0.2
Phosphorus-T	mg/l	0.016		0.023	0.0147	0.017	0.0106	0.0232	0.0119	0.0189	0.0172	8	0.0171	0.0171		63%	1.4
Phosphorus-D	mg/l	0.009		0.027	0.0029	0.0041	0.0033	0.0067	0.0041	0.004	0.0035	8	0.0070	0.0041		13%	3.0
TSS	mg/l	7.22	32.22	<4	<3.0	3	<3.0	3.3	3.2	3.8	3	8	2.7	3.0	0%	0%	0.5
TDS	mg/l	60.0			57	56	52	58	55	57	58	7	56.1	57.0		0%	1.0
Turbidity	NTU	1.90	9.90	1.06	1.16	1.66	0.81	1.35	1.04	1.49	2.01	8	1.32	1.26	0%	13%	1.1
Dissolved Organic Carbon	mg/l	8.4		1.00	7.61	5.82	6.71	6.41	6.50	5.69	5.93	8	5.71	6.17		0%	0.9
Hardness	mg/l	35.9			38.8	43.7	39.7	38.9	36.3	39.7	39.5	7	39.5	39.5		100%	1.2
Aluminum Dissolved	mg/l	0.060	0.05		0.0029	0.0014	0.0053	0.0017	0.0156	0.0025	0.0027	7	0.0046	0.0027	0%	0%	0.3
Aluminum Total	mg/l	0.069			0.0101	0.0111	0.0143	0.0159	0.0424	0.0214	0.0179	7	0.0190	0.0159		0%	0.6
Arsenic Dissolved	mg/l	0.0003			0.00021	0.00035	0.00026	0.00035	0.00024	0.00033	0.00033	7	0.00030	0.00033		57%	1.2
Arsenic Total	mg/l	0.0003	0.005		0.00026	0.00038	0.00027	0.00036	0.00028	0.00036	0.00032	7	0.00032	0.00032	0%	57%	1.3
Barium Dissolved	mg/l	0.012			0.0163	0.0157	0.0152	0.0165	0.0154	0.0157	0.0159	7	0.01581	0.01570		100%	1.4
Barium Total	mg/l	0.014	1		0.017	0.017	0.0158	0.0171	0.0162	0.017	0.0166	7	0.01667	0.01700	0%	100%	1.2
Calcium Dissolved	mg/l	11.1			11.9	13.4	12.1	12	11.1	12.3	12.1	7	12.1	12.1		100%	1.2
Calcium Total	mg/l	10.5			12.2	13.1	12	12	11.1	12.3	10.8	7	11.9	12.0		100%	1.2
Copper Dissolved	mg/l	0.004			0.0023	0.00189	0.0021	0.00185	0.00214	0.0019	0.00211	7	0.00204	0.00210		0%	0.6
Copper Total	mg/l	0.010	0.002		0.00223	0.00222	0.00222	0.00211	0.00256	0.00248	0.0026	7	0.00235	0.00223	100%	0%	0.3
Iron Dissolved	mg/l	0.051			0.034	<0.030	<0.030	0.034	<0.030	<0.030	<0.030	7	0.020	0.015		0%	0.7
Iron Total	mg/l	0.117	1		0.099	0.073	0.053	0.109	0.073	0.083	0.097	7	0.084	0.083	0%	0%	0.9
Lead Dissolved	mg/l	<0.001	0.35		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	7	0.00003	0.00003	0%	0%	0.0
Lead Total	mg/l	<0.001	0.004		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	7	0.00003	0.00003	0%	0%	0.0
Magnesium Dissolved	mg/l	2.03			2.22	2.49	2.3	2.18	2.09	2.17	2.26	7	2.24	2.22		100%	1.2
Magnesium Total	mg/l	1.95			2.29	2.44	2.27	2.19	2.02	2.19	2.14	7	2.22	2.19		100%	1.3
Manganese Dissolved	mg/l	0.008			0.00132	0.000755	0.00445	0.0379	0.00725	0.00577	0.0443	7	0.01454	0.00577		29%	5.5
Manganese Total	mg/l	0.048	0.763		0.0225	0.0297	0.0231	0.0672	0.0262	0.0333	0.103	7	0.04357	0.02970	0%	29%	2.2
Molybdenum Dissolved	mg/l	<0.001			0.000807	0.00103	0.000887	0.00106	0.000796	0.00103	0.000962	7	0.00094	0.00096		43%	1.1
Molybdenum Total	mg/l	<0.001	1		0.000834	0.00104	0.000885	0.00101	0.000866	0.00105	0.00099	7	0.00095	0.00099	0%	43%	1.1
Nickel Dissolved	mg/l	<0.001			<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	7	0.00025	0.00025		0%	0.0
Nickel Total	mg/l	0.0018	0.025		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	7	0.00025	0.00025	0%	0%	0.0
Potassium Dissolved	mg/l	0.65			0.5	0.5	0.4	0.5	0.4	0.5	0.5	7	0.454	0.457		0%	0.7
Potassium Total	mg/l				0.472	<2.0	0.474	0.455	0.43	0.479	0.487	7	0.542	0.474		0%	
Selenium Dissolved	mg/l	<0.0005			<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	7	0.0005	0.0005		0%	0.0
Selenium Total	mg/l	<0.0005	0.002		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	7	0.0005	0.0005	0%	0%	0.0
Silicon Dissolved	mg/l	2.10			1.4	1.63	1.79	1.88	1.94	1.64	2.91	7	1.88	1.79		14%	1.4
Silicon Total	mg/l	2.08			1.46	1.64	1.8	2.01	2.01	1.73	2.74	7	1.91	1.80		14%	1.3
Sodium Dissolved	mg/l	2.50			2.3	2.32	2.27	2.46	2.2	2.33	2.23	7	2.30	2.30		0%	1.0
Sodium Total	mg/l				2.27	2.34	2.31	2.33	2.24	2.45	2.3	7	2.32	2.31		0%	
Strontium Dissolved	mg/l	0.10			0.102	0.109	0.0997	0.111	0.104	0.0963	0.115	7	0.105	0.104		43%	1.1
Strontium Total	mg/l	0.11			0.105	0.112	0.103	0.106	0.106	0.0981	0.118	7	0.107	0.106		29%	1.1
Zinc Dissolved	mg/l	<0.005			0.0028	<0.0010	0.0011	<0.0010	0.0015	0.0020	<0.0010	7	0.0013	0.0011		0%	0.6
Zinc Total	mg/l	<0.005	0.0075		0.0033	<0.0010	<0.0010	0.0013	0.0017	0.0022	<0.0010	7	0.0014	0.0013	0%	0%	0.7

🟩 Indicates value above Baseline concentration.
🟦 Indicates value above BCWQG.
🟧 Indicate parameter concentrations greater than baseline in more than 20% of samples or that maximum magnitude of increase is greater or eaqual to 1.5 times baseline.

Bold - above Baseline and BCWQG

[a] BCWQG - British Columbia Water Quality Guideline

[b] Mean calculated using half method detection limit if applicable.

[c] Magnitude of Increase - calculated as maximum observed concentration divided by baseline 95th

Table B.10: Correlation analysis results for station B1 surface on Bootjack Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Phosphorus	TDS	Turbidity	Hardness	Arsenic	Barium	Calcium	Copper	Iron	Magnesium	Manganese	Molybdenum	Silicon	Zinc
Conductivity	Correlation Coefficient	1.000	0.633	0.611	0.250	0.517	0.628	0.303	0.233	0.183	0.218	0.200	-0.617	0.700	-0.133	0.511
	Sig. (2-tailed)	.	0.067	0.108	0.516	0.154	0.070	0.429	0.546	0.637	0.574	0.606	0.077	0.036	0.732	0.160
	N	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9
Phosphorus	Correlation Coefficient	0.633	1.000	0.345	0.590	0.095	0.713	0.477	0.369	-0.006	0.750	0.109	-0.243	0.322	0.255	0.422
	Sig. (2-tailed)	0.067	.	0.364	0.073	0.795	0.021	0.163	0.294	0.987	0.012	0.763	0.498	0.364	0.476	0.225
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
TDS	Correlation Coefficient	0.611	0.345	1.000	0.209	0.420	0.538	0.408	0.290	0.628	0.437	0.209	-0.209	0.594	-0.151	0.532
	Sig. (2-tailed)	0.108	0.364	.	0.589	0.260	0.135	0.276	0.449	0.070	0.240	0.589	0.589	0.092	0.699	0.141
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Turbidity	Correlation Coefficient	0.250	0.590	0.209	1.000	0.541	0.377	0.713	0.766	-0.018	0.875	0.648	0.309	0.564	0.661	-0.071
	Sig. (2-tailed)	0.516	0.073	0.589	.	0.106	0.283	0.021	0.010	0.960	0.001	0.043	0.385	0.090	0.038	0.845
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Hardness	Correlation Coefficient	0.517	0.095	0.420	0.541	1.000	0.189	0.554	0.716	0.298	0.271	0.827	-0.158	0.851	0.176	0.156
	Sig. (2-tailed)	0.154	0.795	0.260	0.106	.	0.601	0.097	0.020	0.403	0.448	0.003	0.663	0.002	0.626	0.668
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Arsenic	Correlation Coefficient	0.628	0.713	0.538	0.377	0.189	1.000	0.765	0.195	0.444	0.570	0.116	-0.225	0.365	0.012	0.201
	Sig. (2-tailed)	0.070	0.021	0.135	0.283	0.601	.	0.010	0.589	0.199	0.085	0.751	0.532	0.300	0.973	0.578
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Barium	Correlation Coefficient	0.303	0.477	0.408	0.713	0.554	0.765	1.000	0.639	0.372	0.749	0.646	0.177	0.537	0.354	-0.059
	Sig. (2-tailed)	0.429	0.163	0.276	0.021	0.097	0.010	.	0.047	0.290	0.013	0.043	0.625	0.110	0.316	0.872
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Calcium	Correlation Coefficient	0.233	0.369	0.290	0.766	0.716	0.195	0.639	1.000	0.018	0.634	0.930	0.024	0.468	0.432	0.253
	Sig. (2-tailed)	0.546	0.294	0.449	0.010	0.020	0.589	0.047	.	0.960	0.049	0.000	0.947	0.172	0.213	0.481
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Copper	Correlation Coefficient	0.183	-0.006	0.628	-0.018	0.298	0.444	0.372	0.018	1.000	0.085	0.103	-0.297	0.285	-0.067	0.356
	Sig. (2-tailed)	0.637	0.987	0.070	0.960	0.403	0.199	0.290	0.960	.	0.815	0.777	0.405	0.425	0.855	0.313
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Iron	Correlation Coefficient	0.218	0.750	0.437	0.875	0.271	0.570	0.749	0.634	0.085	1.000	0.474	0.316	0.395	0.699	0.065
	Sig. (2-tailed)	0.574	0.012	0.240	0.001	0.448	0.085	0.013	0.049	0.815	.	0.166	0.374	0.258	0.024	0.859
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Magnesium	Correlation Coefficient	0.200	0.109	0.209	0.648	0.827	0.116	0.646	0.930	0.103	0.474	1.000	0.091	0.552	0.418	0.084
	Sig. (2-tailed)	0.606	0.763	0.589	0.043	0.003	0.751	0.043	0.000	0.777	0.166	.	0.803	0.098	0.229	0.817
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Manganese	Correlation Coefficient	-0.617	-0.243	-0.209	0.309	-0.158	-0.225	0.177	0.024	-0.297	0.316	0.091	1.000	-0.091	0.552	-0.782
	Sig. (2-tailed)	0.077	0.498	0.589	0.385	0.663	0.532	0.625	0.947	0.405	0.374	0.803	.	0.803	0.098	0.007
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Molybdenum	Correlation Coefficient	0.700	0.322	0.594	0.564	0.851	0.365	0.537	0.468	0.285	0.395	0.552	-0.091	1.000	0.212	0.110
	Sig. (2-tailed)	0.036	0.364	0.092	0.090	0.002	0.300	0.110	0.172	0.425	0.258	0.098	0.803	.	0.556	0.762
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Silicon	Correlation Coefficient	-0.133	0.255	-0.151	0.661	0.176	0.012	0.354	0.432	-0.067	0.699	0.418	0.552	0.212	1.000	-0.252
	Sig. (2-tailed)	0.732	0.476	0.699	0.038	0.626	0.973	0.316	0.213	0.855	0.024	0.229	0.098	0.556	.	0.482
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Zinc	Correlation Coefficient	0.511	0.422	0.532	-0.071	0.156	0.201	-0.059	0.253	0.356	0.065	0.084	-0.782	0.110	-0.252	1.000
	Sig. (2-tailed)	0.160	0.225	0.141	0.845	0.668	0.578	0.872	0.481	0.313	0.859	0.817	0.007	0.762	0.482	.
	N	9	10	9	10	10	10	10	10	10	10	10	10	10	10	10

▨ Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.11: Correlation analysis results for station B2 surface on Bootjack Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Phosphorus	TDS	Turbidity	Hardness	Arsenic	Barium	Calcium	Copper	Iron	Magnesium	Manganese	Molybdenum	Silicon	Zinc
Conductivity	Correlation Coefficient	1.000	0.004	0.455	-0.310	0.383	0.527	-0.012	0.539	0.132	-0.442	0.443	-0 240	0.287	-0.319	0.147
	Sig. (2-tailed)	.	0 991	0.258	0.417	0.349	0.180	0.978	0.168	0.756	0.273	0.272	0 568	0.490	0.441	0.729
	N	9	9	8	9	8	8	8	8	8	8	8	8	8	8	8
Phosphorus	Correlation Coefficient	0.004	1.000	0.009	0 328	0.025	0.382	0 544	-0.004	0.025	0.366	-0.008	0 393	0.251	0.587	0.022
	Sig. (2-tailed)	0 991	.	0.983	0 354	0.949	0.310	0.130	0.991	0.949	0.333	0.983	0 295	0.515	0.097	0.956
	N	9	10	9	10	9	9	9	9	9	9	9	9	9	9	9
TDS	Correlation Coefficient	0.455	0.009	1.000	-0.128	0.434	0.590	0.553	0.513	0.281	0.061	0.434	-0.451	0.638	0.030	0.613
	Sig. (2-tailed)	0 258	0 983	.	0.743	0.243	0.095	0.122	0.158	0.464	0.877	0.243	0 223	0.064	0.939	0.079
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Turbidity	Correlation Coefficient	-0 310	0.328	-0.128	1.000	0.033	0.427	0.467	-0.126	0.217	0.881	-0.100	0.750	0.433	0.227	-0.157
	Sig. (2-tailed)	0.417	0 354	0.743	.	0.932	0.252	0.205	0.748	0.576	0.002	0.798	0.020	0.244	0.557	0.687
	N	9	10	9	10	9	9	9	9	9	9	9	9	9	9	9
Hardness	Correlation Coefficient	0 383	0.025	0.434	0.033	1.000	0.711	0.717	0.862	0.717	-0.051	0.933	-0.417	0.733	-0.185	0.766
	Sig. (2-tailed)	0 349	0 949	0.243	0 932	.	0.032	0.030	0.003	0.030	0.897	0.000	0 265	0.025	0.634	0.016
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Arsenic	Correlation Coefficient	0 527	0.382	0.590	0.427	0.711	1.000	0.845	0.681	0.711	0.281	0.661	-0.100	0.946	0.152	0.503
	Sig. (2-tailed)	0.180	0 310	0.095	0 252	0.032	.	0.004	0.044	0.032	0.464	0.053	0.797	0.000	0.696	0.168
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Barium	Correlation Coefficient	-0.012	0.544	0.553	0.467	0.717	0.845	1.000	0.544	0.617	0.475	0.583	-0.067	0.883	0.328	0.627
	Sig. (2-tailed)	0 978	0.130	0.122	0 205	0.030	0.004	.	0.130	0.077	0.197	0.099	0 865	0.002	0.389	0.071
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Calcium	Correlation Coefficient	0 539	-0.004	0.513	-0.126	0.862	0.681	0 544	1.000	0.678	-0.298	0.979	-0 586	0.678	-0.304	0.660
	Sig. (2-tailed)	0.168	0 991	0.158	0.748	0.003	0.044	0.130	.	0.045	0.436	0.000	0.097	0.045	0.427	0.053
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Copper	Correlation Coefficient	0.132	0.025	0.281	0 217	0.717	0.711	0.617	0.678	1.000	0.034	0.683	-0.400	0.800	-0.202	0.635
	Sig. (2-tailed)	0.756	0 949	0.464	0 576	0.030	0.032	0.077	0.045	.	0.931	0.042	0 286	0.010	0.603	0.066
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Iron	Correlation Coefficient	-0.442	0.366	0.061	0 881	-0.051	0.281	0.475	-0.298	0.034	1.000	-0.254	0.678	0.373	0.359	-0.106
	Sig. (2-tailed)	0 273	0.333	0.877	0.002	0.897	0.464	0.197	0.436	0.931	.	0.509	0.045	0.323	0.343	0.786
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Magnesium	Correlation Coefficient	0.443	-0.008	0.434	-0.100	0.933	0.661	0 583	0.979	0.683	-0.254	1.000	-0 550	0.667	-0.269	0.679
	Sig. (2-tailed)	0 272	0.983	0.243	0.798	0.000	0.053	0.099	0.000	0.042	0.509	.	0.125	0.050	0.484	0.044
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Manganese	Correlation Coefficient	-0 240	0.393	-0.451	0.750	-0.417	-0.100	-0.067	-0.586	-0.400	0.678	-0.550	1.000	-0.200	0.193	-0.531
	Sig. (2-tailed)	0 568	0.295	0.223	0.020	0.265	0.797	0.865	0.097	0.286	0.045	0.125	.	0.606	0.618	0.141
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Molybdenum	Correlation Coefficient	0 287	0.251	0.638	0.433	0.733	0.946	0 883	0.678	0.800	0.373	0.667	-0 200	1.000	0.101	0.592
	Sig. (2-tailed)	0.490	0.515	0.064	0 244	0.025	0.000	0.002	0.045	0.010	0.323	0.050	0.606	.	0.796	0.093
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Silicon	Correlation Coefficient	-0 319	0.587	0.030	0 227	-0.185	0.152	0 328	-0.304	-0.202	0.359	-0.269	0.193	0.101	1.000	-0.325
	Sig. (2-tailed)	0.441	0.097	0.939	0 557	0.634	0.696	0.389	0.427	0.603	0.343	0.484	0.618	0.796	.	0.394
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Zinc	Correlation Coefficient	0.147	0.022	0.613	-0.157	0.766	0.503	0.627	0.660	0.635	-0.106	0.679	-0 531	0.592	-0.325	1.000
	Sig. (2-tailed)	0.729	0.956	0.079	0.687	0.016	0.168	0.071	0.053	0.066	0.786	0.044	0.141	0.093	0.394	.
	N	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9

🟦 Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.12: Correlation analysis results for station B1 bottom on Bootjack Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Phosphorus	TDS	Turbidity	Hardness	Arsenic	Barium	Calcium	Copper	Iron	Magnesium	Manganese	Molybdenum	Silicon	Zinc
Conductivity	Correlation Coefficient	1.000	0.739	0.600	0.714	0.429	0.857	0.000	0.321	-0.179	0.179	0.107	0.286	0.643	0.107	-0.741
	Sig. (2-tailed)	.	0.058	0.208	0.071	0.337	0.014	1.000	0.482	0.702	0.702	0.819	0.535	0.119	0.819	0.057
	N	7	7	6	7	7	7	7	7	7	7	7	7	7	7	7
Phosphorus	Correlation Coefficient	0.739	1.000	0.739	0.455	0.205	0.778	-0.323	-0.120	0.144	0.359	-0.371	0.494	0.323	0.252	0.037
	Sig. (2-tailed)	0.058	.	0.058	0.257	0.627	0.023	0.435	0.776	0.734	0.382	0.365	0.213	0.435	0.548	0.931
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
TDS	Correlation Coefficient	0.600	0.739	1.000	0.321	-0.288	0.393	-0.571	-0.288	0.321	0.214	-0.750	0.306	0.536	0.250	0.037
	Sig. (2-tailed)	0.208	0.058	.	0.482	0.531	0.383	0.180	0.531	0.482	0.645	0.052	0.504	0.215	0.589	0.937
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Turbidity	Correlation Coefficient	0.714	0.455	0.321	1.000	0.491	0.786	-0.190	0.635	-0.452	0.619	0.381	0.563	0.833	0.643	-0.708
	Sig. (2-tailed)	0.071	0.257	0.482	.	0.217	0.021	0.651	0.091	0.260	0.102	0.352	0.146	0.010	0.086	0.050
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Hardness	Correlation Coefficient	0.429	0.205	-0.288	0.491	1.000	0.395	0.323	0.759	0.144	0.323	0.515	0.283	0.467	0.275	-0.209
	Sig. (2-tailed)	0.337	0.627	0.531	0.217	.	0.333	0.435	0.029	0.734	0.435	0.192	0.497	0.243	0.509	0.620
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Arsenic	Correlation Coefficient	0.857	0.778	0.393	0.786	0.395	1.000	-0.286	0.371	-0.190	0.262	0.167	0.275	0.714	0.310	-0.390
	Sig. (2-tailed)	0.014	0.023	0.383	0.021	0.333	.	0.493	0.365	0.651	0.531	0.693	0.509	0.047	0.456	0.339
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Barium	Correlation Coefficient	0.000	-0.323	-0.571	-0.190	0.323	-0.286	1.000	-0.012	0.333	-0.286	0.024	-0.263	-0.286	-0.548	0.049
	Sig. (2-tailed)	1.000	0.435	0.180	0.651	0.435	0.493	.	0.978	0.420	0.493	0.955	0.528	0.493	0.160	0.909
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Calcium	Correlation Coefficient	0.321	-0.120	-0.288	0.635	0.759	0.371	-0.012	1.000	-0.263	0.275	0.826	0.127	0.731	0.467	-0.528
	Sig. (2-tailed)	0.482	0.776	0.531	0.091	0.029	0.365	0.978	.	0.528	0.509	0.011	0.765	0.040	0.243	0.179
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Copper	Correlation Coefficient	-0.179	0.144	0.321	-0.452	0.144	-0.190	0.333	-0.263	1.000	-0.405	-0.571	-0.228	-0.167	-0.429	0.708
	Sig. (2-tailed)	0.702	0.734	0.482	0.260	0.734	0.651	0.420	0.528	.	0.320	0.139	0.588	0.693	0.289	0.050
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Iron	Correlation Coefficient	0.179	0.359	0.214	0.619	0.323	0.262	-0.286	0.275	-0.405	1.000	0.095	0.970	0.262	0.881	-0.317
	Sig. (2-tailed)	0.702	0.382	0.645	0.102	0.435	0.531	0.493	0.509	0.320	.	0.823	0.000	0.531	0.004	0.444
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Magnesium	Correlation Coefficient	0.107	-0.371	-0.750	0.381	0.515	0.167	0.024	0.826	-0.571	0.095	1.000	-0.120	0.381	0.238	-0.586
	Sig. (2-tailed)	0.819	0.365	0.052	0.352	0.192	0.693	0.955	0.011	0.139	0.823	.	0.778	0.352	0.570	0.127
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Manganese	Correlation Coefficient	0.286	0.494	0.306	0.563	0.283	0.275	-0.263	0.127	-0.228	0.970	-0.120	1.000	0.228	0.802	-0.209
	Sig. (2-tailed)	0.535	0.213	0.504	0.146	0.497	0.509	0.528	0.765	0.588	0.000	0.778	.	0.588	0.017	0.620
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Molybdenum	Correlation Coefficient	0.643	0.323	0.536	0.833	0.467	0.714	-0.286	0.731	-0.167	0.262	0.381	0.228	1.000	0.452	-0.610
	Sig. (2-tailed)	0.119	0.435	0.215	0.010	0.243	0.047	0.493	0.040	0.693	0.531	0.352	0.588	.	0.260	0.108
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Silicon	Correlation Coefficient	0.107	0.252	0.250	0.643	0.275	0.310	-0.548	0.467	-0.429	0.881	0.238	0.802	0.452	1.000	-0.268
	Sig. (2-tailed)	0.819	0.548	0.589	0.086	0.509	0.456	0.160	0.243	0.289	0.004	0.570	0.017	0.260	.	0.520
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8
Zinc	Correlation Coefficient	-0.741	0.037	0.037	-0.708	-0.209	-0.390	0.049	-0.528	0.708	-0.317	-0.586	-0.209	-0.610	-0.268	1.000
	Sig. (2-tailed)	0.057	0.931	0.937	0.050	0.620	0.339	0.909	0.179	0.050	0.444	0.127	0.620	0.108	0.520	.
	N	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8

▨ Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.13: Correlation analysis results for station B2 bottom on Bootjack Lake water quality, Mount Polley Mine

Parameter	Statistic	Conductivity	Phosphorus	TDS	Turbidity	Hardness	Arsenic	Barium	Calcium	Copper	Iron	Magnesium	Manganese	Molybdenum	Silicon	Zinc
Conductivity	Correlation Coefficient	1.000	0.536	0.580	0 929	0.657	0.714	0 580	0.319	-0.145	0.290	0.486	0.600	0.771	0.000	-0.516
	Sig. (2-tailed)	.	0 215	0.228	0.003	0.156	0.111	0.228	0.538	0.784	0.577	0.329	0 208	0.072	1.000	0.295
	N	7	7	6	7	6	6	6	6	6	6	6	6	6	6	6
Phosphorus	Correlation Coefficient	0 536	1.000	0.855	0.476	0.126	0.667	0 815	0.144	-0.126	0.721	-0.126	0.786	0.679	0.198	0.111
	Sig. (2-tailed)	0 215	.	0.014	0 233	0.788	0.102	0.025	0.758	0.788	0.068	0.788	0.036	0.094	0.670	0.812
	N	7	8	7	8	7	7	7	7	7	7	7	7	7	7	7
TDS	Correlation Coefficient	0 580	0.855	1.000	0.673	-0.156	0.294	0.679	-0.174	0.092	0.899	-0.202	0.709	0.273	0.303	0.132
	Sig. (2-tailed)	0 228	0.014	.	0.098	0.738	0.523	0.093	0.709	0.845	0.006	0.664	0.074	0.554	0.509	0.778
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Turbidity	Correlation Coefficient	0 929	0.476	0.673	1.000	0.396	0.667	0.445	0.126	0.270	0.360	0.018	0.750	0.607	0.144	-0.259
	Sig. (2-tailed)	0.003	0 233	0.098	.	0.379	0.102	0.317	0.788	0.558	0.427	0.969	0.052	0.148	0.758	0.574
	N	7	8	7	8	7	7	7	7	7	7	7	7	7	7	7
Hardness	Correlation Coefficient	0.657	0.126	-0.156	0 396	1.000	0.573	0.037	0.573	-0.300	-0.418	0.555	0.198	0.721	-0.273	-0.561
	Sig. (2-tailed)	0.156	0.788	0.738	0 379	.	0.179	0.937	0.179	0.513	0.350	0.196	0.670	0.068	0.554	0.190
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Arsenic	Correlation Coefficient	0.714	0.667	0.294	0.667	0.573	1.000	0.524	0.409	-0.236	0.055	0.091	0.667	0.901	0.082	-0.337
	Sig. (2-tailed)	0.111	0.102	0.523	0.102	0.179	.	0.228	0.362	0.610	0.908	0.846	0.102	0.006	0.862	0.460
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Barium	Correlation Coefficient	0 580	0.815	0.679	0.445	0.037	0.524	1.000	0.486	-0.449	0.767	0.299	0 334	0.445	-0.280	0.346
	Sig. (2-tailed)	0 228	0.025	0.093	0 317	0.937	0.228	.	0.269	0.312	0.044	0.515	0.465	0.317	0.542	0.447
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Calcium	Correlation Coefficient	0 319	0.144	-0.174	0.126	0.573	0.409	0.486	1.000	-0.482	-0.091	0.791	-0 288	0.468	-0.864	0.224
	Sig. (2-tailed)	0 538	0.758	0.709	0.788	0.179	0.362	0.269	.	0.274	0.846	0.034	0 531	0.289	0.012	0.629
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Copper	Correlation Coefficient	-0.145	-0.126	0.092	0 270	-0.300	-0.236	-0.449	-0.482	1.000	-0.082	-0.618	0.180	-0.198	0.345	0.150
	Sig. (2-tailed)	0.784	0.788	0.845	0 558	0.513	0.610	0.312	0.274	.	0.862	0.139	0.699	0.670	0.448	0.749
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Iron	Correlation Coefficient	0 290	0.721	0.899	0 360	-0.418	0.055	0.767	-0.091	-0.082	1.000	-0.091	0 378	0.000	0.082	0.430
	Sig. (2-tailed)	0 577	0.068	0.006	0.427	0.350	0.908	0.044	0.846	0.862	.	0.846	0.403	1.000	0.862	0.335
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Magnesium	Correlation Coefficient	0.486	-0.126	-0.202	0.018	0.555	0.091	0 299	0.791	-0.618	-0.091	1.000	-0.450	0.108	-0.827	-0.075
	Sig. (2-tailed)	0 329	0.788	0.664	0 969	0.196	0.846	0.515	0.034	0.139	0.846	.	0 310	0.818	0.022	0.873
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Manganese	Correlation Coefficient	0.600	0.786	0.709	0.750	0.198	0.667	0 334	-0.288	0.180	0.378	-0.450	1.000	0.643	0.667	-0.371
	Sig. (2-tailed)	0 208	0.036	0.074	0.052	0.670	0.102	0.465	0.531	0.699	0.403	0.310	.	0.119	0.102	0.413
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Molybdenum	Correlation Coefficient	0.771	0.679	0.273	0.607	0.721	0.901	0.445	0.468	-0.198	0.000	0.108	0.643	1.000	0.018	-0.259
	Sig. (2-tailed)	0.072	0.094	0.554	0.148	0.068	0.006	0.317	0.289	0.670	1.000	0.818	0.119	.	0.969	0.574
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Silicon	Correlation Coefficient	0.000	0.198	0.303	0.144	-0.273	0.082	-0.280	-0.864	0.345	0.082	-0.827	0.667	0.018	1.000	-0.430
	Sig. (2-tailed)	1.000	0.670	0.509	0.758	0.554	0.862	0.542	0.012	0.448	0.862	0.022	0.102	0.969	.	0.335
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Zinc	Correlation Coefficient	-0 516	0.111	0.132	-0.259	-0.561	-0.337	0 346	0.224	0.150	0.430	-0.075	-0.371	-0.259	-0.430	1.000
	Sig. (2-tailed)	0 295	0.812	0.778	0 574	0.190	0.460	0.447	0.629	0.749	0.335	0.873	0.413	0.574	0.335	.
	N	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7

▨ Shading indicates significant correlation based on coefficient >0.6 or <-0.6 and p-value less than 0.05.

Table B.14: Water chemistry data omitted from baseline calculations and operational screening for Polley and Bootjack Lakes.

Parameter	Units	Polley Lake																		Bootjack Lake						
		P1-15 metre	P1-18 metre	P1-5 metre	P1-10metre	P1-15 metre	P1-20 metre	P1-25 metre	P1-34 metre	P1-10metre	P1-20 metre	P2-15 metre	P2-13 metre	P2-5 metre	P2-10 metre	P2-15 metre	P2-20 metre	P2-10 metre	P2-20 metre	B1-16 metre	B1-16 metre	B1-5 metre	B1-5 metre	B2-15 metre	B2-14 metre	B2 -5 metre
		5/15/1995	5/9/1996	6/13/2001	6/13/2001	6/13/2001	6/13/2001	6/13/2001	6/13/2001	8/26/2009	8/26/2009	5/15/1995	5/9/1996	6/14/2001	6/14/2001	6/14/2001	6/14/2001	8/26/2009	9/26/2009	5/15/1995	5/9/1996	6/7/2001	8/26/2009	5/15/1995	5/9/1996	6/7/2001
Field pH	pH units	7.51	7.38	7.95	7.82	7.69	7.69	7.32	7.53	8.14	8.05	7.5	7.51	8.15	8.14	7.85	7.64	8.19	8.06	6.87	7.21	7.54	8.32	6.98	7.15	7.87
Field Temperature	degrees C			13.1	11.8	9.2	8.3	9.6	11.5	10.0	6.5			11.4	11.2	8.2	6.8	10.0	6.3			11.9	17.6			12.3
Field Conductivity	uS/cm	126	126	141	144	141	139	144	144	205	205	125	124	143	137	139	139	204	206	77.4	72.7	80	88	73	70.9	80
Alkalinity Total	mg/l	62.9	60.8	67	67	67	67	67	67	75.9	75.7	61.3	59.7	67	67	67	67	76.8	75.4	36.4	34.1	23	41.1	34.9	33	35
Sulfate	mg/l	2.9	4.4	4.1	4.2	4	3.9	4	4.2	28.2	28.9	3.1	4.7	4	3.5	4	4.2	28.2	28.9	1.9	3.5	3.9	3.12	2.6	3.3	2.3
N+N LL	mg/l			0.006	0.0025	0.0025	0.0025	0.0025	0.0025	0.0088	0.165			0.0025	0.0025	0.0025	0.0025	0.0025	0.165			0.0025	0.0025			0.0025
Ortho Phosporus	mg/l	0.002	0.005	0.031	0.034	0.035	0.04	0.045	0.049	0.0012	0.0284	0.002	0.007	0.028	0.029	0.03	0.035	0.0018	0.0337	0.006	0.007	0.01	0.0005	0.006	0.006	0.006
N-Total	mg/l			0.13	0.06	0.06	0.06	0.06	0.06	0.160	0.280			0.06	0.13	0.06	0.06	0.130	0.250			0.14	0.230			0.45
Ammonia Nitrogen (N)	mg/l	<0.005	0.01	0.007	0.011	0.0025	0.0025	0.0025	0.009	0.0107	0.0025	<0.005	<0.005	0.015	0.009	0.008	0.0025	0.0081	0.0025	0.041	0.007	0.011	0.0025	0.009	0.007	0.007
Phosphorus-T	mg/l	0.015	0.019	0.023	0.037	0.023	0.026	0.034	0.045	0.0065	0.0298	0.011	0.013	0.028	0.025	0.023	0.027	0.0067	0.0321	0.033	0.017	0.025	0.0068	0.024	0.022	0.021
Phosphorus-D	mg/l	0.007	0.009	0.028	0.028	0.029	0.032	0.039	0.045	0.0021	0.0239	0.005	0.007	0.036	0.032	0.032	0.033	0.0027	0.0279	0.007	0.008	0.017	0.001	0.007	0.01	0.014
TDS	mg/l	80	80							130	134	80	79					128	129	47	46		57	48	46	
TSS	mg/l	3	3	2	2	2	2	2	2	3.5	4.0	3.0	3.0	2	2	2	2	4.0	4.0	7	1	2	1.5	3.0	<1	2
Turbidity	NTU	1.21	1.1	0.47	0.47	0.54	0.58	0.73	0.65	0.69	0.61	1.32	1.3	0.46	0.47	0.57	0.62	0.85	0.96	3.2	1.6	0.45	1.66	1.72	1.4	1.09
diss org carbon	mg/l			16.9	16.7	17.8	8.8	6.4	5.7	5.01	4.94			15.3	15.7	17.1	16.5	4.95	4.85			11.2	5.95			9.2
hardness total D	mg/l	60	59							101	102	61.6	55.9	67	65.6	67	65.8	101	103	35.6	33	35.8	40.1	35.7	33.3	
Aluminum Dissolved	mg/l	0.02	0.006							0.0005	0.0005	0.012	0.007	0.0042	0.0025	0.0018	0.0021	0.0005	0.0005	0.013	0.019	0.0047	0.0029	0.019	0.053	
Aluminum Total	mg/l	0.033	0.013							0.0103	0.0032	0.031	0.017	0.0096	0.0105	0.002	0.0092	0.0117	0.004	0.055	0.08	0.0081	0.0125	0.036	0.071	
Arsenic Dissolved	mg/l	0.0001	0.0003							0.00032	0.00035	<0.0001	0.0003	0.0004	0.0003	0.0003	0.0003	0.00035	0.00040	<0.0001	0.0003	0.0002	0.00030	0.0001	0.0003	
Arsenic Total	mg/l	0.0002	0.0004							0.00034	0.00040	0.0001	0.0003	0.0004	0.0003	0.0003	0.0003	0.00033	0.00043	0.0001	0.0003	0.0003	0.00031	0.0002	0.0003	
Barium Dissolved	mg/l	<0.010	<0.010							0.00701	0.00689	<0.010	<0.010	0.00426	0.00417	0.00424	0.00495	0.00732	0.00673	0.015	0.01	0.0138	0.0159	0.013	0.013	
Barium Total	mg/l	<0.010	<0.010							0.00747	0.00695	<0.010	<0.010	0.00428	0.00417	0.00426	0.00495	0.00732	0.00716	0.017	0.013	0.0161	0.0164	0.02	0.015	
Calcium Dissolved	mg/l	19.3	18.4							32.6	32.9	19.9	17.7	21.8	21.4	21.9	21.5	32.6	33.3	10.9	9.04	10.9	12.3	10.7	10	
Calcium Total	mg/l	19.3	19							32.5	34.9	19.9	17.9	21.2	21.3	21.7	21.4	29.9	30.8	10.9	10.1	9.89	11.2	10.7	10.2	
Copper Dissolved	mg/l	0.003	0.002							0.00147	0.00144	0.002	0.002	0.0025	0.0024	0.0023	0.0025	0.00154	0.00146	0.01	0.003	0.0033	0.00217	0.003	0.002	
Copper Total	mg/l	0.003	0.002							0.00196	0.00153	0.002	0.003	0.0032	0.0031	0.0023	0.0027	0.00187	0.00177	0.003	0.004	0.0033	0.00264	0.00300	0.00300	
Iron Dissolved	mg/l	<0.030	<0.030							0.015	0.015	<0.030	<0.030	0.0025	0.0025	0.0025	0.006	0.015	0.015	0.068	0.033	0.005	0.015	0.082	0.064	
Iron Total	mg/l	<0.030	0.032							0.015	0.015	<0.030	<0.030	0.079	0.078	0.009	0.091	0.015	0.015	0.194	0.141	0.031	0.048	0.228	0.228	
Lead Dissolved	mg/l	<0.001	<0.001							2.50E-05	2.50E-05	<0.001	<0.001	0.00008	0.00005	0.00005	0.00006	2.50E-05	2.50E-05	<0.001	<0.001	0.00004	2.50E-05	<0.001	<0.001	
Lead Total	mg/l	<0.001	<0.001							0.000087	2.50E-05	<0.001	<0.001	0.00016	0.0001	0.00005	0.00005	2.50E-05	2.50E-05	<0.001	<0.001	0.00008	2.50E-05	<0.001	<0.001	
Magnesium Dissolved	mg/l	2.83	2.77							4.74	4.76	2.92	2.73	3.04	2.95	2.99	2.95	4.73	4.83	2.03	1.78	2.08	2.26	2.15	1.9	
Magnesium Total	mg/l	2.83	2.81							4.75	4.87	2.92	2.72	2.99	3.01	3.06	2.98	4.44	4.71	2.03	1.88	1.85	2.14	2.01	1.89	
Manganese Dissolved	mg/l	<0.005	0.019							0.00161	0.000373	<0.005	<0.005	0.00069	0.00047	0.00044	0.00046	0.00198	0.000276	<0.005	<0.005	0.00028	0.000177	<0.005	<0.005	
Manganese Total	mg/l	0.006	0.048							0.0133	0.0192	0.015	0.018	0.00544	0.00526	0.00046	0.0221	0.0132	0.0365	0.081	0.05	0.00833	0.0165	0.087	0.129	
Molybdenum Dissolved	mg/l	<0.001	<0.001							0.00202	0.00203	<0.001	<0.001	0.00067	0.00065	0.00062	0.00065	0.00206	0.00203	<0.001	<0.001	0.00072	0.00105	<0.001	<0.001	
Molybdenum Total	mg/l	<0.001	<0.001							0.00211	0.00189	<0.001	<0.001	0.00092	0.00072	0.00052	0.00068	0.00199	0.00213	<0.001	<0.001	0.00085	0.00101	<0.001	<0.001	
Nickel Dissolved	mg/l	<0.001	<0.001							0.00025	0.00025	<0.001	<0.001	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	<0.001	<0.001	0.00025	0.00025	<0.001	<0.001	
Nickel Total	mg/l	<0.001	<0.001							0.00025	0.00025	<0.001	<0.001	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	<0.001	<0.001	0.00025	0.00025	0.004	<0.001	
Potassium Dissolved	mg/l	0.4	0.31							0.371	0.403	0.41	0.3	0.39	0.36	0.35	0.37	0.393	0.422	0.63	0.42	0.5	0.447	0.59	0.47	
Potassium Total	mg/l									0.421	0.390			0.35	0.33	0.34	0.32	0.408	0.444			0.55	0.476			
Selenium Dissolved	mg/l	<0.0005	<0.0005							0.0005	0.0005	<0.0005	<0.0005	0.00025	0.00025	0.00025	0.00025	0.0011	0.0005	<0.0005	<0.0005	0.00025	0.0005	<0.0001	<0.0005	
Selenium Total	mg/l	<0.0005	<0.0005							0.0005	0.0012	<0.0005	<0.0005	0.00025	0.00025	0.00025	0.00025	0.0005	0.0005	<0.0005	<0.0005	0.00025	0.0005	<0.0005	<0.0005	
Silicon Dissolved	mg/l	2.75	2.92							3.95	4.33	2.91	2.85	3.48	3.46	3.6	3.72	3.89	4.47	2.37	2.08	0.75	1.56	2.25	2.2	
Silicon Total	mg/l	2.75	2.98							3.95	4.49	2.91	2.78	3.4	3.4	3.6	3.7	3.64	4.28	2.38	2.07	0.7	1.49	2.25	2.2	
Sodium Dissolved	mg/l	3.8	3.49							3.95	4.13	3.99	3.82	3.71	3.6	3.64	3.59	4.22	4.10	2.37	2.2	3.65	2.29	2.44	2.38	
Sodium Total	mg/l									4.35	3.86			3.7	3.7	3.7	3.7	4.25	4.38			2.5	2.35			
Strontium Dissolved	mg/l	0.089	0.086							0.219	0.229	0.09	0.088	0.0954	0.0951	0.094	0.0959	0.231	0.234	0.106	0.097	0.105	0.115	0.108	0.109	
Strontium Total	mg/l	0.089	0.087							0.241	0.223	0.09	0.088	0.0939	0.0942	0.094	0.0942	0.227	0.245	0.106	0.105	0.119	0.119	0.108	0.111	
Zinc Dissolved	mg/l	<0.005	<0.005							0.0021	0.0005	<0.005	<0.005	0.0023	0.0016	0.0015	0.0016	0.0005	0.0005	<0.005	<0.005	0.0019	0.0005	<0.005	<0.005	
Zinc Total	mg/l	<0.005	<0.005							0.0029	0.0005	<0.005	<0.005	0.004	0.004	0.0015	0.0036	0.0011	0.0005	<0.005	<0.005	0.0019	0.0005	<0.005	<0.005	

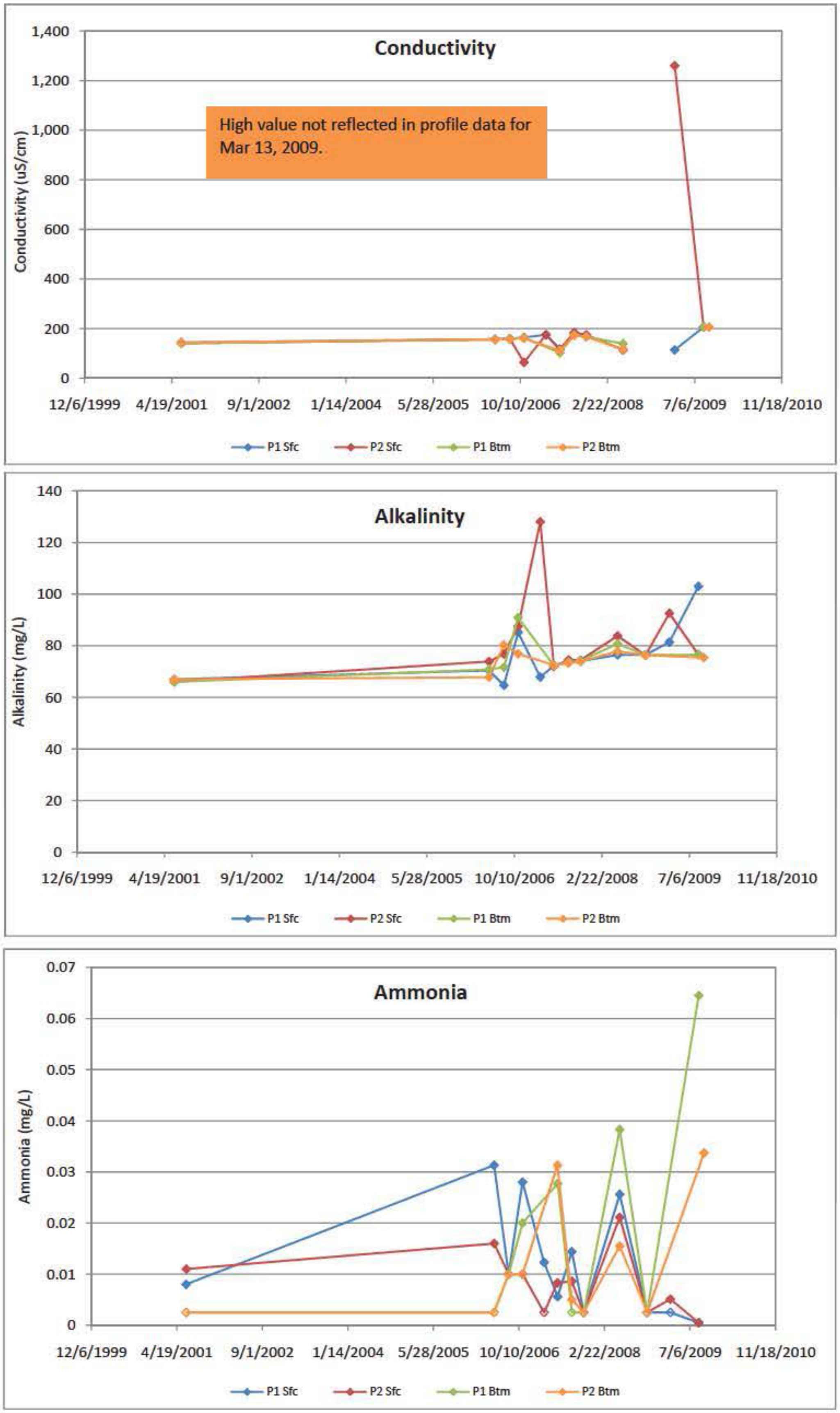


Figure B.1: Temporal comparison of select water chemistry parameters from Polley Lake

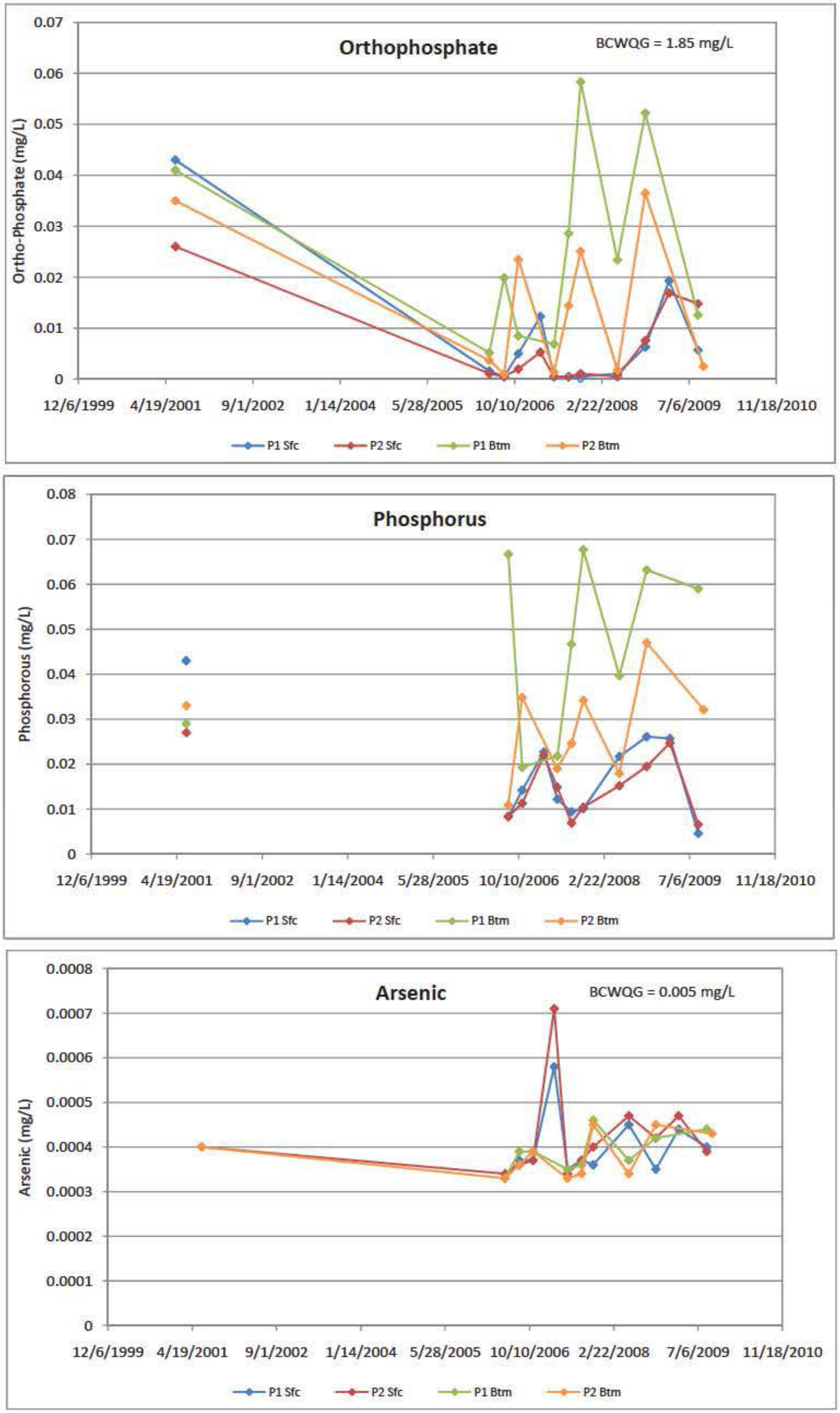


Figure B.1: Temporal comparison of select water chemistry parameters from Polley Lake

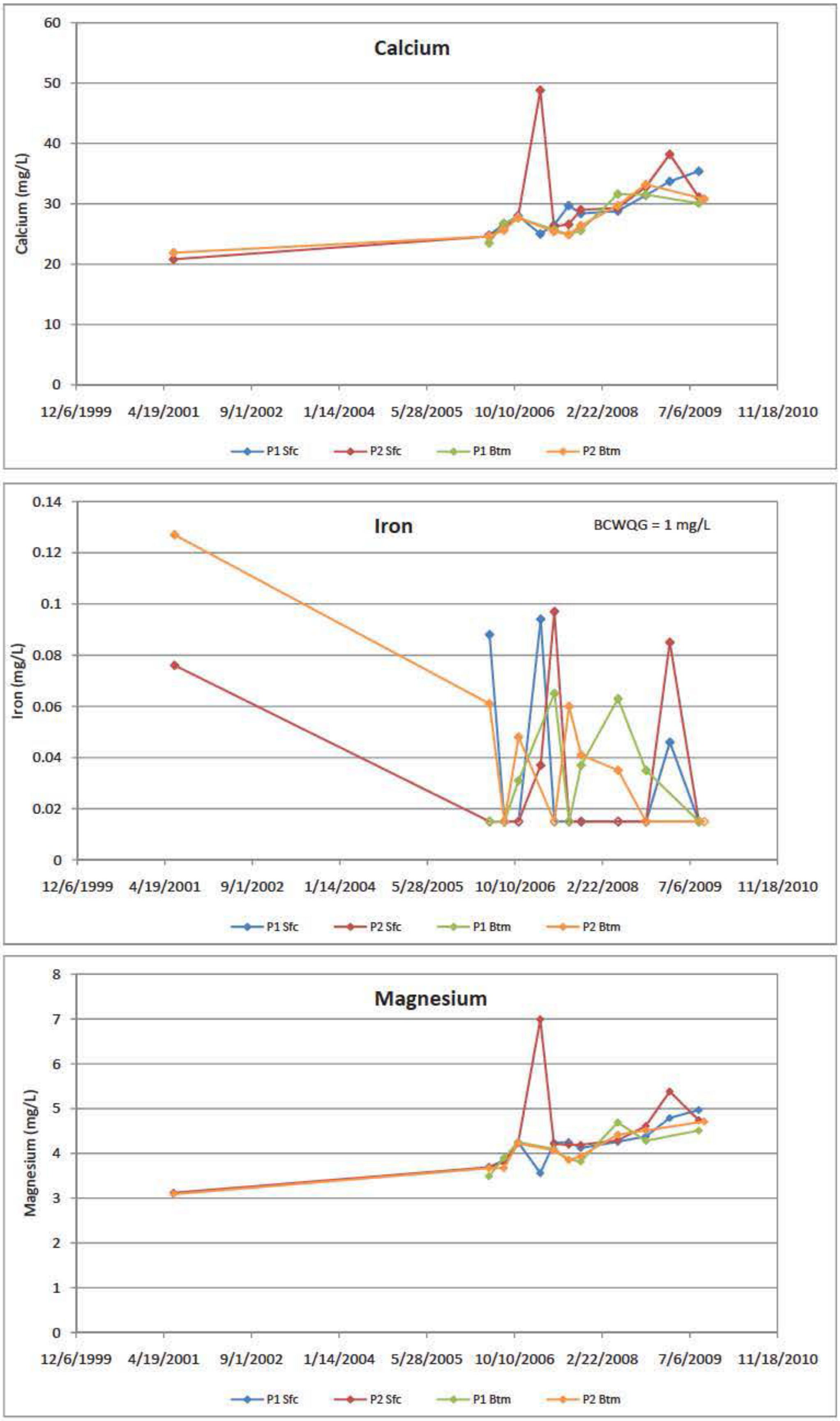


Figure B.1: Temporal comparison of select water chemistry parameters from Polley Lake

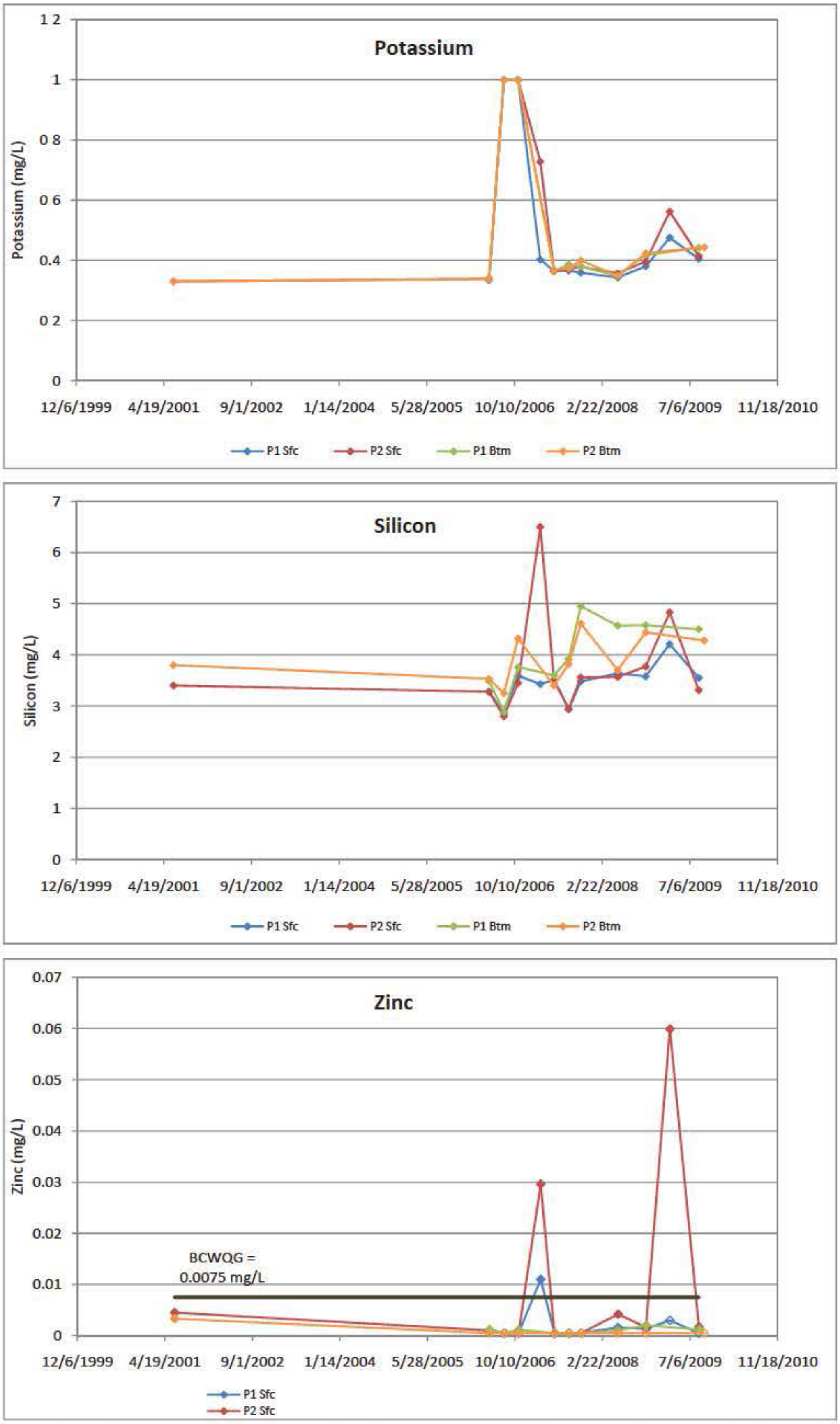


Figure B.1: Temporal comparison of select water chemistry parameters from Polley Lake

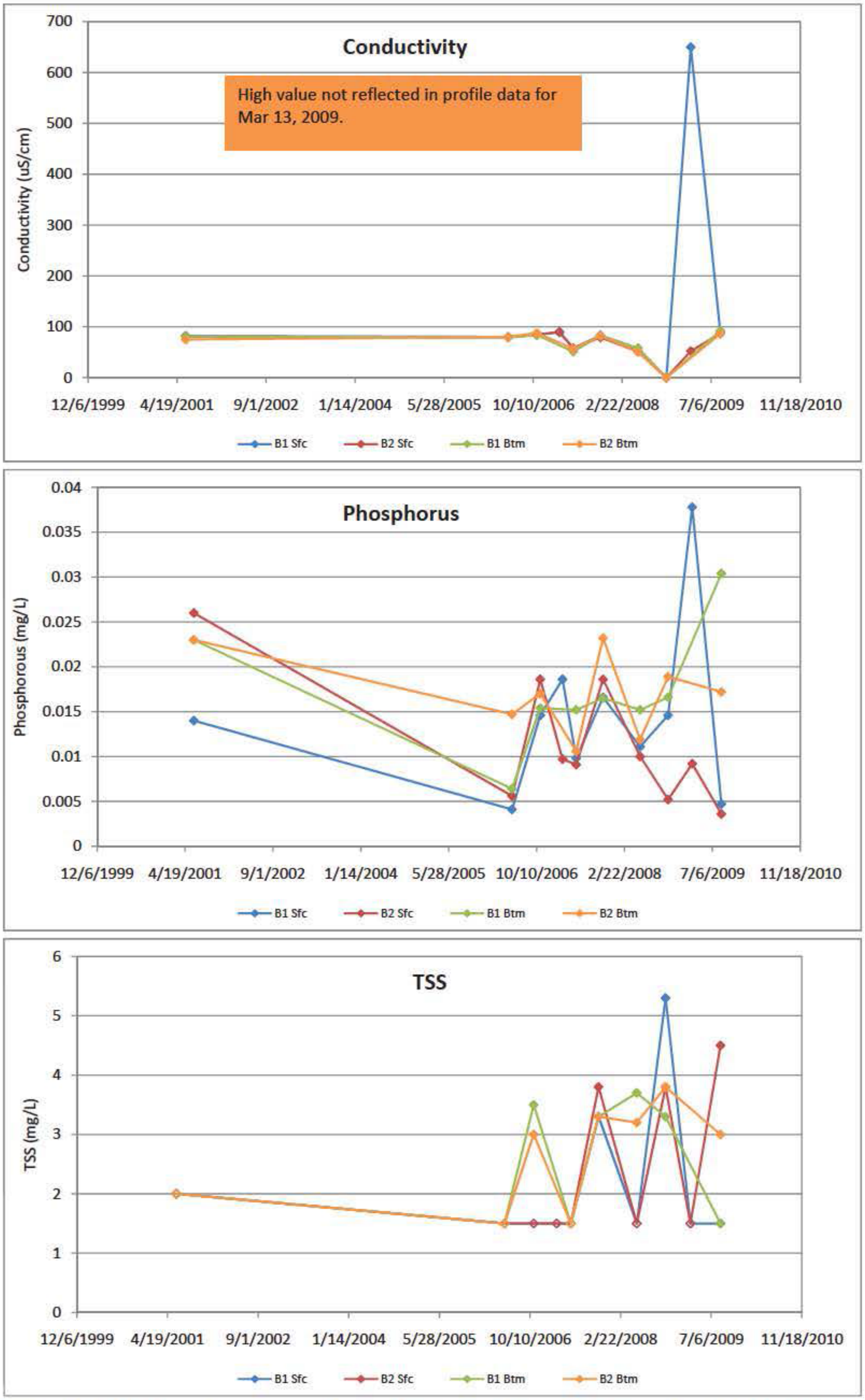


Figure B.2: Temporal comparison of select water chemistry parameters from Bootjack Lake

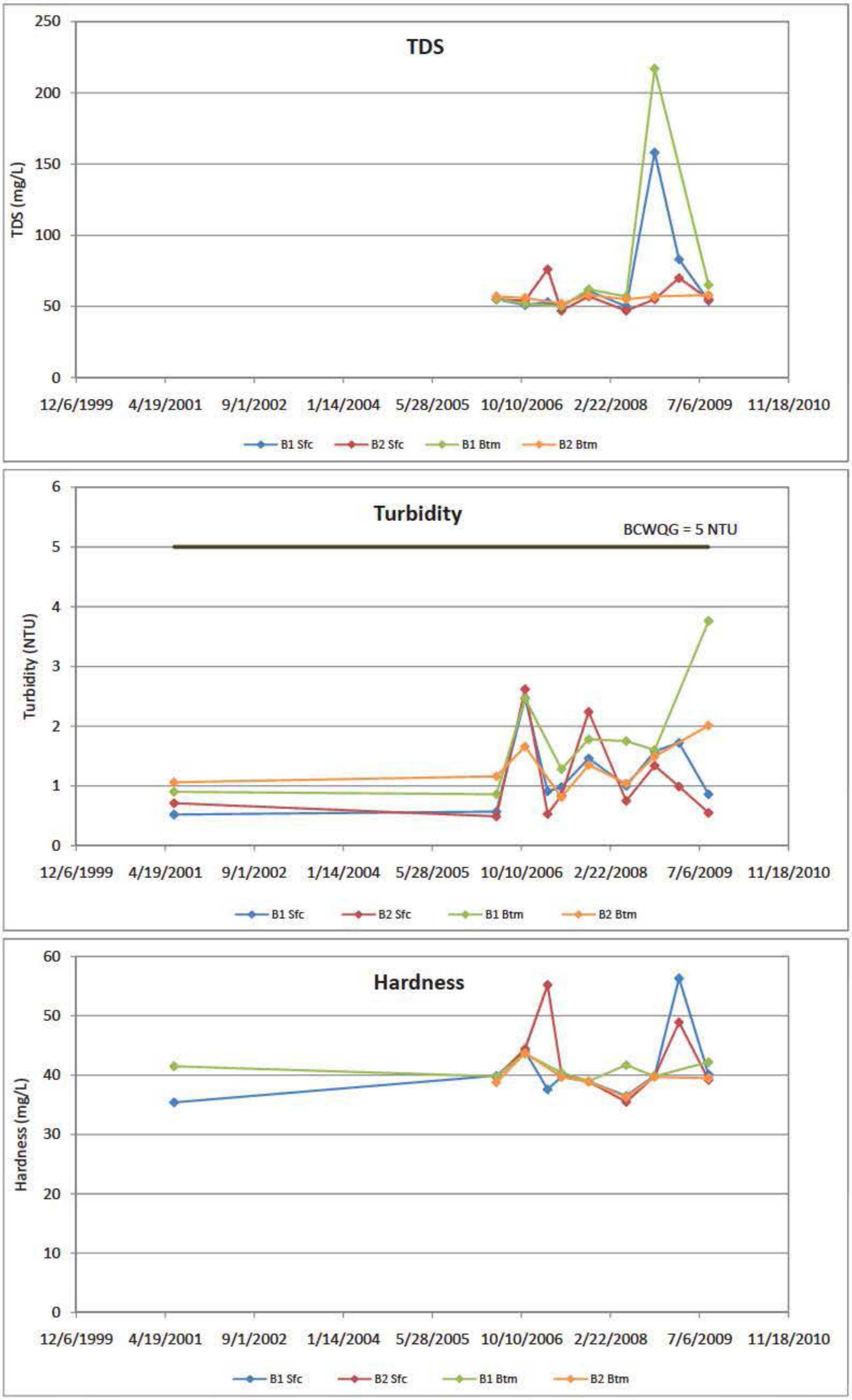
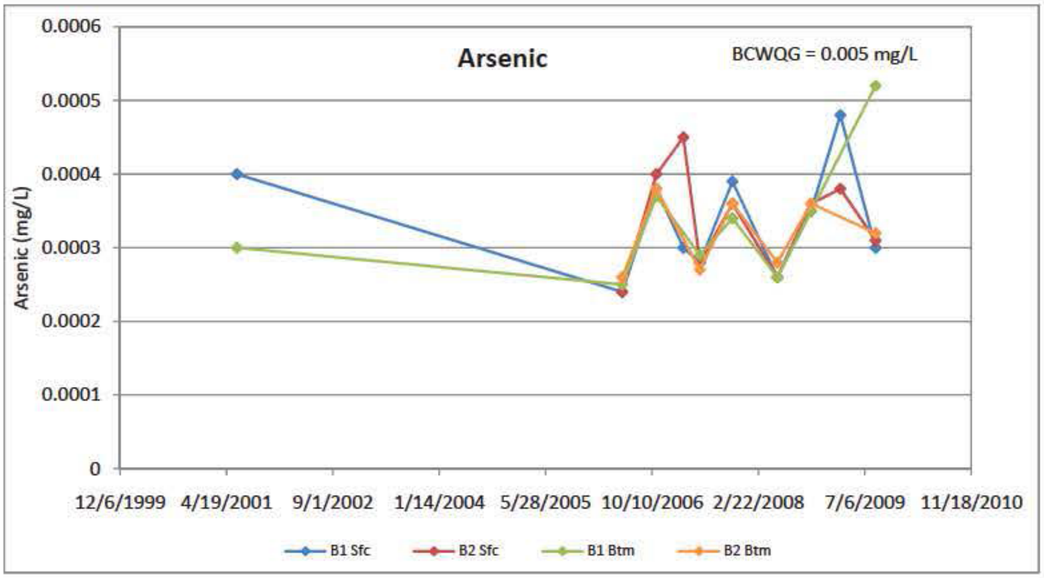
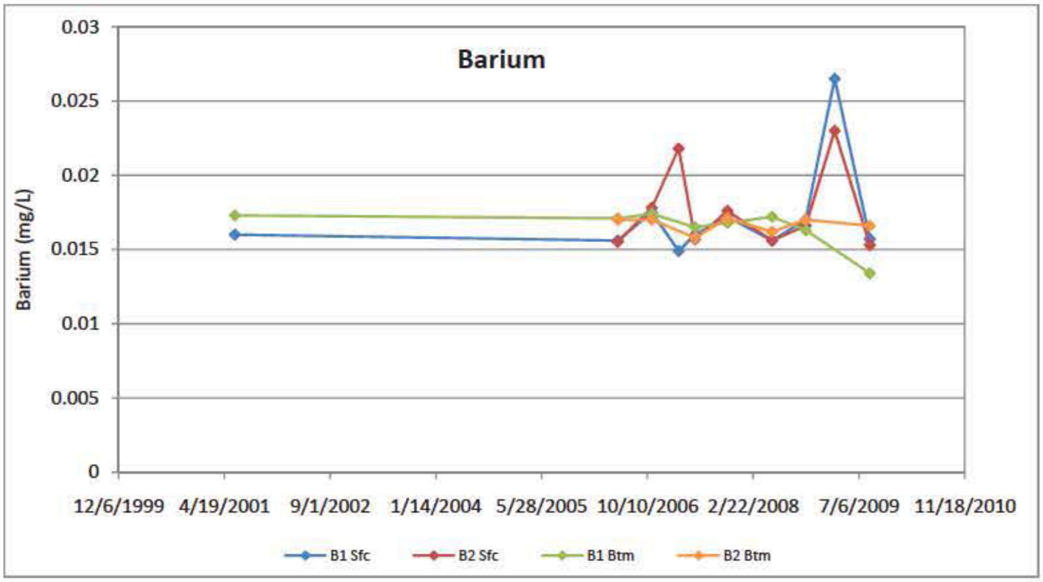


Figure B.2: Temporal comparison of select water chemistry parameters from Bootjack Lake





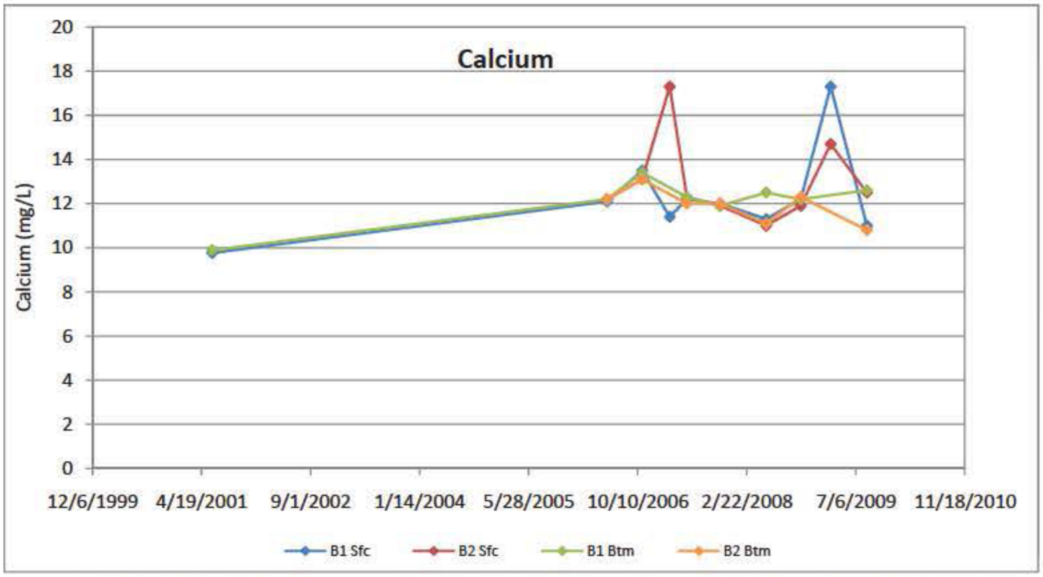
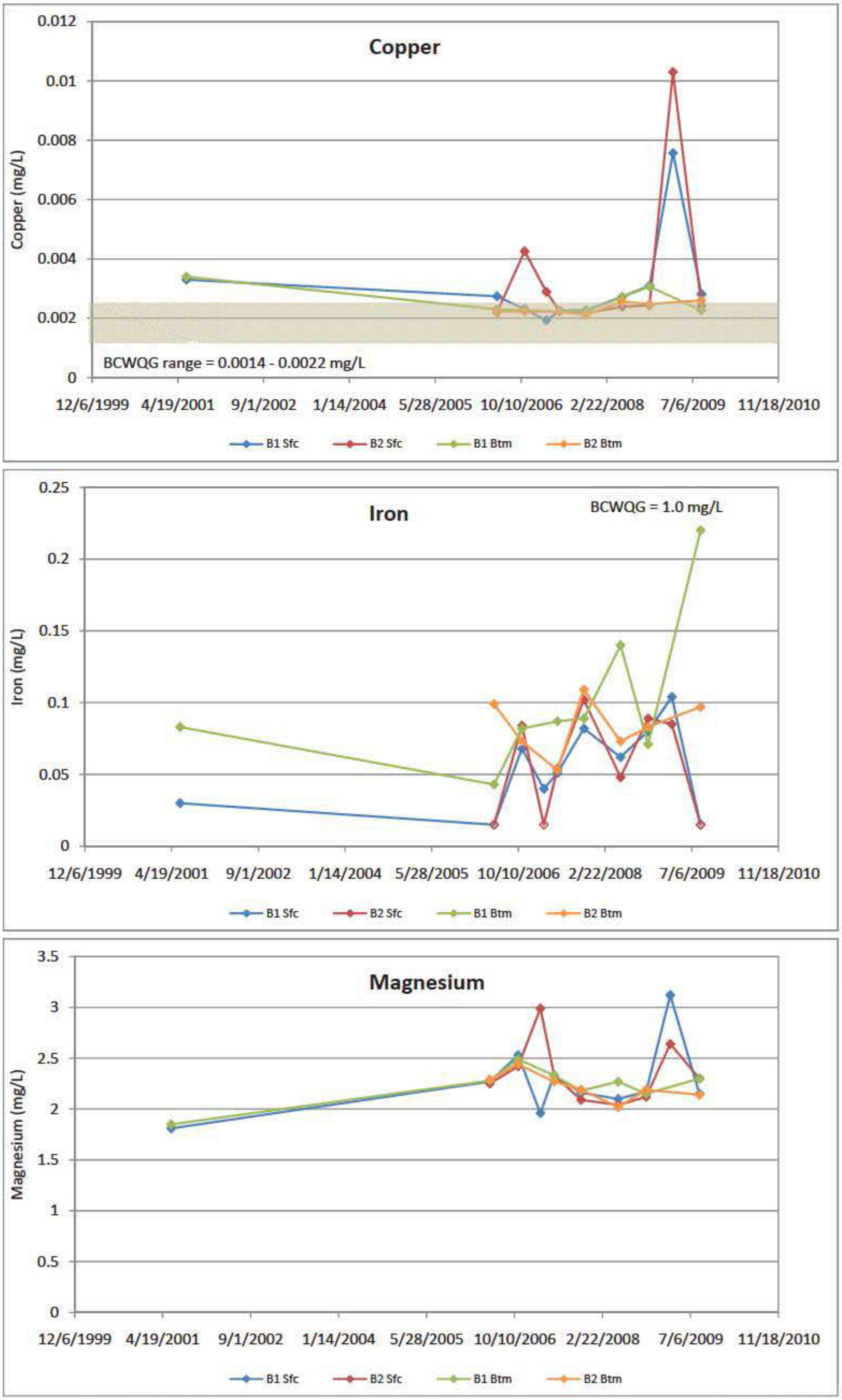


Figure B.2: Temporal comparison of select water chemistry parameters from Bootjack Lake



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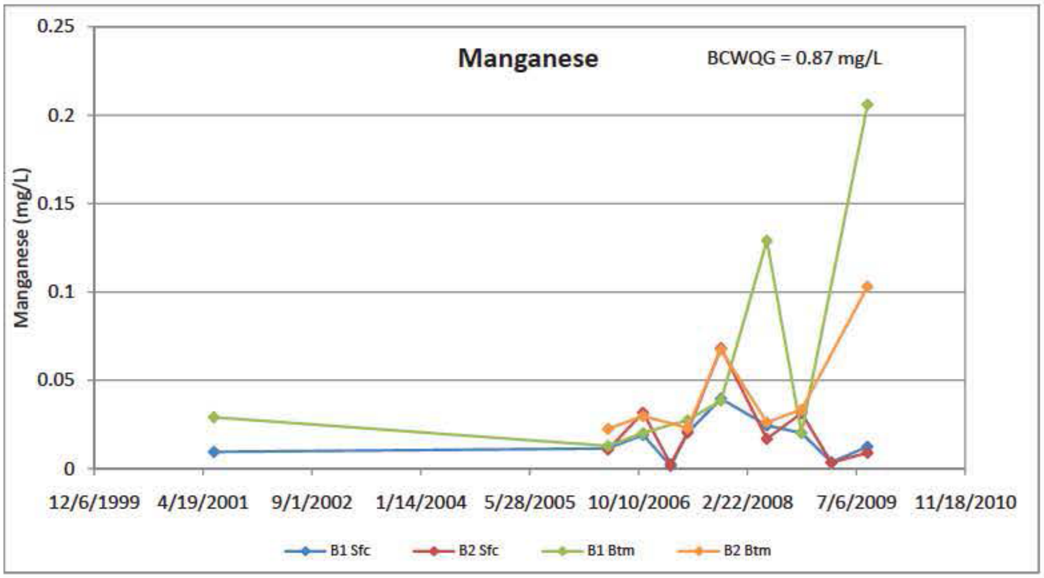

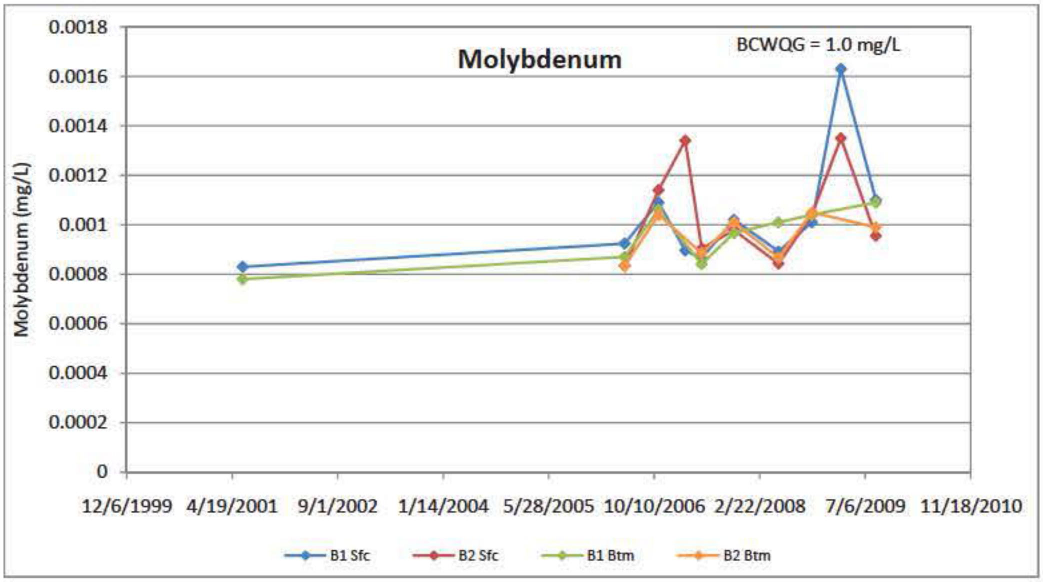

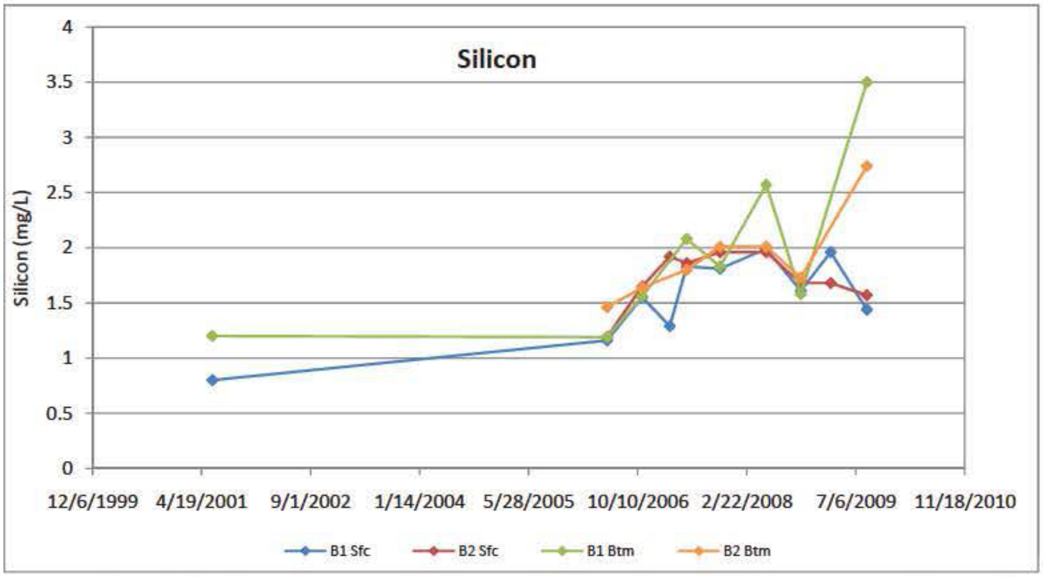

Figure B.2: Temporal comparison of select water chemistry parameters from Bootjack Lake

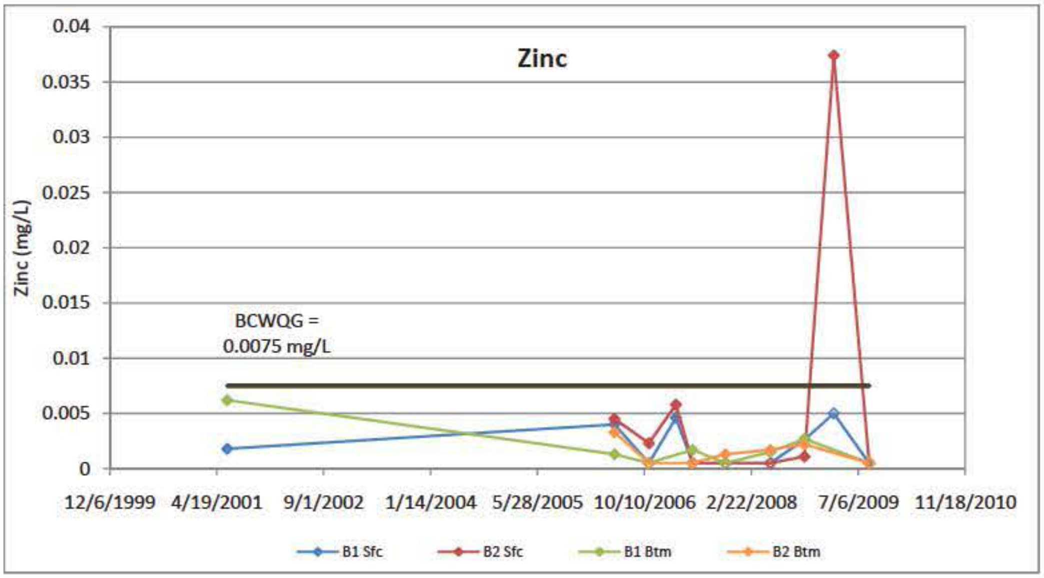

Figure B.2: Concentrations of select parameters from Bootjack Lake

MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS CORPORATION

Hazeltine Creek Toe Drain Discharge Strategy

DRAFT

October 2011

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Introduction

In consideration of Mount Polley Mining Corporation's (MPMC) application to discharge water into Hazeltine Creek, and the MPMC Technical Assessment Report for a Proposed Discharge of Mine Effluent (TAR), the idea has been put forward that discharging water from the toe drains only, and not the Long Ditch(LD) or other effluent sites, could lessen any adverse water quality impacts on Hazeltine Creek.

This report considers the potential water quality impact of effluent sites E1 (tailings supernatant), E4 (main effluent storage pond), and E7 (perimeter effluent storage pond) on Hazeltine Creek. Similarly, the effects of water from the LD, the South Toe Drain (STD), Main Toe Drain (MTD), and Perimeter Toe Drain (PTD) are considered. It is important to understand the connectivity of these sites. Water from the tailings pond (E1), over time, will flow through the toe drains. STD and MTD then discharge into E4, while PTD and LD discharge into E7. The water quality monitoring site in Hazeltine Creek is W7. Figure 1, in the "Discharge Strategy" section below may help provide a visual representation.

Water Quality Discussion

Table 1 provides a summary of the average water quality at: effluent sites E1, E4, and E7; the south, main, and perimeter toe drains; the long ditch; and Hazeltine Creek (W7). The average values are based on results of 2011 samples to date (i.e. January to September). The only exception is E1. Because the hold time for water in the tailings storage facility. averages based on 2010 and 2011 sample dates. The water quality sample results for each site are available in Appendix 1. However, no samples were taken at MTD and STD in 2009 or 2010, and no samples were taken at PTD in 2010. Note that for results with values below the detection limit, averages were calculated based on the detection limit value. Based on the results in Table 1, a discussion of key water quality parameters of the toe drains compared to LD, E1, and E4 is provided below.

Physical Tests

pH

The average pH of the toe drains and LD are approximately the same. STD (7.83) is lower than LD (8.01), while PTD (8.03) and MTD (8.08) are slightly higher. All of these sites have lower average pH than the effluent sites, especially E1 which has a pH of 8.61. This lower pH corresponds to decreased toxicity, because at lower pHs, more ammonia is in the less toxic ionized form (NH_4^+).

Temperature

While average temperatures can show general differences among the sites, for aquatic life it is more valuable to compare temperatures at different times of year and analyse the effects on various stages of organism lifecycles. Overall the toe drains and long ditch appear to have the coolest water average water temperature (and this temperature does not vary much throughout the year), while the ponds (E1, E4, and E7) are warmer. Using cooler water (from the toe drains, for example), may decrease the potential of discharge water causing detrimental warming in Hazeltine Creek. The effects of temperature will be considered more in depth below, when approximate discharge ratios (and the resulting temperatures) are discussed.

Table 1. Summary of Average Water Quality at Effluent Sites, Toe Drains and Hazeltine Creek (2009-2011)

Water Quality Parameters	E1	E4	E7	LD	PTD	MTD	STD	W7
Physicial Tests								
Conductivity (In Situ) µS/cm	1547	1245	1360	1253	1422	1110	1220.75	314
pH (In Situ)	8.46	8.09	8.45	8.01	7.85	8.09	7.815	7.90
Temperature (In Situ) °C	10.3	12.6	17.8	7.7	6.65	7.4	11.8	7.1
Hardness (Total)	666	534	740	714	585.25	376	531	103
Total Suspended Solids	8.3	14.8	19.4	44	3	3.0	3.0	3.9
Dissolved Anions								
Chloride (Total)	31.2	22.6	7.2	5	24.8	32.8	20.6	0.5
Sulphate (Dissolved)	747	563	649	603	670	433	562	28
Nutrients								
Ammonia (Total)	0.2883	0.0285	0.0095	0.0312	0.113	0.0804	0.066	0.0100
Nitrate (as N)	5.69	4.24	24.48	9.0	1.81	1.19	5.34	0.14
Nitrate+Nitrite (Dissolved)	5.86	4.28	24.50	9.0	1.87	1.27	5.44	0.14
Nitrite (as N)	0.17	0.04	0.06	0.0202	0.05725	0.08	0.098	0.00
Nitrogen (Total)	7.24	5.30	14.46	11.6	3.26	1.66	6.49	0.43
Phosphate (Total)	0.019	0.023		0.015				0.034
Phosphorus (Total)	0.0180	0.0286	0.0226	0.060	0.0135	0.035	0.0133	0.02838
Dissolved Metals								
Aluminum (Dissolved)	0.0163	0.0053	0.0443	0.0095	0.00375	0.0041	0.0133	0.0271
Iron (Dissolved)	0.030	0.030	0.134	0.03	0.03	0.030	0.03	0.044
Total Metals								
Cadmium (Total)	0.00015	0.00010	0.00028	0.0002	0.00013	0.00010	0.00020	0.00001
Copper (Total)	0.0160	0.0113	0.0166	0.0170	0.00463	0.0031	0.0163	0.0030
Iron (Total)	0.205	0.689	1.134	0.8	0.03	0.055	0.03	0.164
Molybdenum (Total)	0.217	0.162	0.204	0.160	0.187	0.182	0.15375	0.002
Selenium (Total)	0.0245	0.0141	0.0296	0.0374	0.00369	0.0019	0.0184	0.0007
Organics								
Carbon Organic (Dissolved)	7.2	4.9	7.1	4.49	3.55	4.5	3.46	7.3

Hardness

The water hardness at all sites being considered is greater than 181 mg/L, and is therefore considered "hard". Lower hardness is observed at the toe drains and E4, ranging from 365 mg/L (MTD) to 570 mg/L (PTD). E1 (667 mg/L), LD (721 mg/L) and E7 (755 mg/L) are all higher.

Total Suspended Solids (TSS)

The lowest TSS (3.0) is at MTD and STD. Low TSS is also observed at E4, which MTD and STD discharge into. All three toe drains have lower TSS than E7, and dramatically lower TSS than E1 and LD, which have TSS levels of 145 mg/L and 214 mg/L. At Mount Polley, majority of the metals in water are transported as suspended solids. The toe drains accommodate settling and filtration of TSS, which corresponds to a decreased presence of metals.

Dissolved Anions

Chloride

LD (5 mg/L) and E7 (7 mg/L) which LD discharges into are the lowest. PTD and STD, 20.1 mg/L and 20.5 mg/L respectively, and E4 (which they discharge into) are the next lowest. E1 (31.8 mg/L) is higher, with MTD being the highest at 35 mg/L.

Sulphate

Sulphate is lowest at E4 (404 mg/L) and MTD (420 mg/L). LD is higher (518 mg/L), followed by STD (553 mg/L), and PTD (559 mg/L). The highest sulphur levels are at E1 and E7, with 665 mg/L and 1004 mg/L respectively. These high sulphate concentrations indicate that sulphate is a major parameter of concern for discharging water. The toe drains (which includes water discharging into E4) and LD, however, are overall lower in sulphate and better potential options for discharge water.

Nutrients

Nitrite

PTD and LD have the lowest levels (0.03 mg/L). MTD has 0.06 mg/L and STD has 0.11 mg/L, but they are diluted to 0.04 mg/L when they flow into E4. E7 (0.05 mg/L) also falls in this range, while E1 contains the most nitrite (0.16 mg/L).

Nitrate

Similar to nitrite concentrations, PTD and MTD have the lowest levels of ~1 mg/L. STD is higher (5.73 mg/L), but is diluted to 1.96 mg/L after discharge into E4. LD (8.6 mg/L) and E1 (4.8 mg/L) contain more nitrate, while E7 exhibits much higher levels of 25 mg/L.

Phosphorus

PTD and STD, both with 0.014 mg/L of phosphorus contain the least phosphorus. LD is the highest (0.057 mg/L) and MTD the next highest at 0.0356 mg/L. The impact of this higher value at MTD is lessened to 0.026 mg/L when the water is discharged into E4. E1 had 0.019 mg/L of phosphorus and E7 has 0.028 mg/L.

Metals and Metalloids

Dissolved Metals (Aluminum, Iron)

The toe drains and E4 have the lowest dissolved aluminum levels of 0.003 mg/L. LD is higher (0.0167), while the E1(0.0345 mg/L) and E7 (0.0444 mg/L) have the highest concentrations. For dissolved iron, all sites are below the detection limit of 0.030 mg/L, except for E7, which has much higher concentrations of 0.134 mg/L.

Cadmium (Total)

The lowest cadmium level is at MTD (0.00009 mg/L) followed by E4, E1, and STD, which all contain 0.0002 mg/L. The highest cadmium concentrations are at E7 (0.00024 mg/L) and LD (0.00025 mg/L). These high concentrations at all sites (which well exceed provincial guidelines) indicate that Cadmium levels of discharge water will have to be carefully considered.

Copper (Total)

Copper levels are also high, and indicating it may be a "parameter of concern". Lowest levels are at PTD and MTD (0.0048 mg/L and 0.0030 mg/L). STD and E7 both have ~0.017 mg/L of Copper, but STD is diluted after discharge into E4 (0.0076 mg/L). E1 contains 0.0199 mg/L and LD has very high copper levels of 0.1000 mg/L. It important to note the effects of increased hardness and organic content, which decrease the bioavailability of carbon (will be further discussed below).

Iron (Total)

The toe drains have the lowest levels of iron (0.03 mg/L at STD, 0.06 mg/L at MTD, and 0.12 mg/L at PTD). E4 has 0.385 mg/L of iron, and E1 has 0.217 mg/L. E7 contains higher concentrations (1.14 mg/L), while LD has substantially more copper (5.22 mg/L).

Molybdenum (Total)

The toe drains, E4, and LD have comparable molybdenum concentrations (between 0.10 and 0.18 mg/L). E1 (0.217 mg/L) and E7 (0.215 mg/L) are the highest.

Selenium (Total)

The lowest levels are in MTD (0.0018 mg/L) and PTD (0.0028 mg/L), followed by E4 (0.0078 mg/L) and STD (0.0189 mg/L). This shows the toe drains to have the best selenium water quality. E1 and E7 both have greater than 0.02 mg/L, with E7 having the most selenium (0.0419 mg/L). High selenium at all sites (only MTD currently falls below the Provincial water quality guidelines), show that selenium levels of discharge water may be a concern.

Organics

Dissolved Organic Carbon (DOC)

DOC levels fluctuate throughout the year, and are generally higher in spring and fall. Overall trends can be observed from the averages, but it is important to consider that the toe drains have only been sampled in the summer. PTD (3.0 mg/L) and STD (3.4 mg/L) have the lowest DOC, followed by E4 (4.4 mg/L and MTD (4.6 mg/L). This indicates that the toe drains have the lowest DOC levels. LD and E1 have DOCs of approximately 6 mg/L, while E7 has the highest (7.5 mg/L).

Summary

In Summary, the toe drains (and E4, which is essentially a function of toe drain water quality) appear to demonstrate favourable water quality compared to water from the effluent sites E1, E7, and LD. E1 is high in TSS, and as a result high in total metals (of which Selenium, Copper, and Cadmium were identified as problem parameters). E7 TSS and metals levels are not as high, as E1, but concentrations are still higher than in the toe drains. Both of these sites also have comparatively higher pH levels and greater concentrations of sulphate, nitrate, and nitrite. The more adverse water quality conditions of E7 are largely due to the LD water discharging into it. In the LD the pH and sulphate levels are similar to those of the toe drains, and the TSS and total metals concentrations are high, which is not ideal for discharging into Hazeltine Creek. This Long Ditch water also has elevated phosphorus and nitrate levels compared to the toe drains.

For these reasons, in addition to the fact that the toe drain temperatures may cause less warming if discharged into Hazeltine Creek, it is recommended that a discharge strategy using water from the toe drains be developed. It is of note that the water at STD, while comparable for most parameters, generally has somewhat higher concentrations of total metals, nitrate and nitrite, and is warmer. This is likely due to the fact that it is the newest toe drain (constructed in 2009), meaning that it is at a higher elevation. There is less potential for the development of cooler and anoxic conditions than at the lower elevations of the other toe drains, and the water quality of STD will likely improve and stabilize over time. Ron- you may want to add a technical note describing why this is so

The water at E4 appears to accurately represent the mixing of MTD and STD water for most parameters. Exceptions are pH, TSS and Cadmium, where levels are slightly higher (but these small differences will likely have little effect on the receiving environment). Total iron levels, however are significantly higher, but still below the British Columbia water quality 30-day guideline. In contrast, the water at E4 has lower conductivity, and decreased sulphates, nitrates and nitrites than expected based on STD and MTD. These differences are likely due to the stagnant state and the foundation drains, which also discharge into E4. Overall the E4 water quality will likely prove appropriate for discharge, and it will be logistically and economically favourable to discharge this water instead of having to isolate water coming from the south and main toe drains. This discharge strategy for E4 and PTD is visually represented in Figure 1.

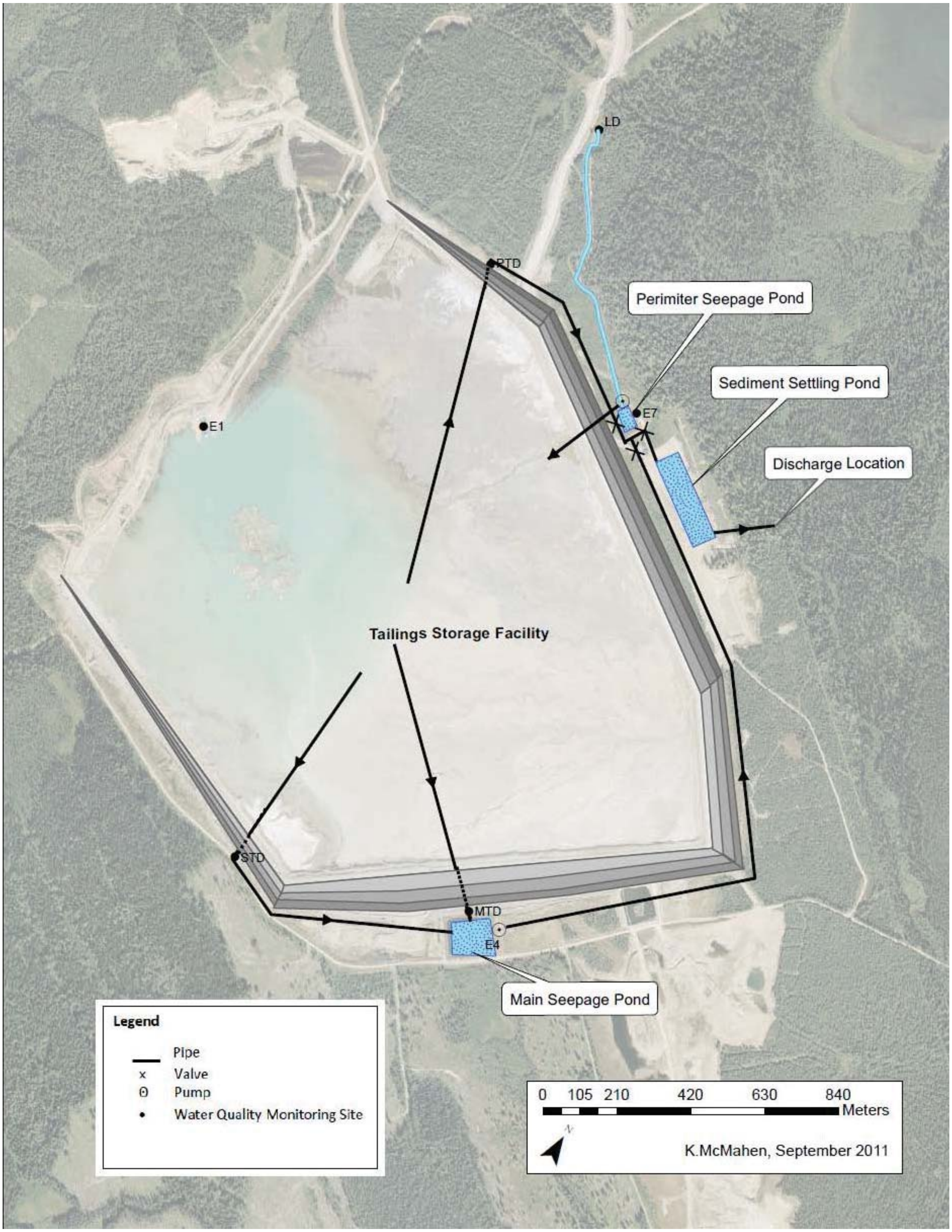


Figure 1. Toe Drain Discharge Strategy Map

Discharge Strategy

Table 2 shows the average discharge rates from the toe drains based on 2011 measurements. This shows that the combined discharge from the three toe drains is roughly 0.0552 m^3/s. Approximately 35% of the water is flowing from PTD, 25% from MTD, and 40% from STD. These discharge rates are relatively stable and do not fluctuate like the hydrograph of a stream. Table 3, extracted from data in the MPMC TAR, contains the average monthly flows for Hazeltine Creek.

Table 2. Toe Drain 2011 Average Discharge Rates (m^3/s)

Date	PTD		STD		MTD
	ADV Current Meter	Bucket Estimate	ADV Current Meter	Bucket Estimate	Estimate
07-Jun-11					
13-Jun-11					
23-Jun-11					
05-Jul-11	0.0200			0.02	
12-Jul-11					
20-Jul-11					
03-Aug-11	0.02				
11-Aug-11					
25-Aug-11		0.0185		0.02251	
30-Aug-11					
15-Sep-11	0.0166		0.0219		
29-Sep-11			0.0244		
Average	0.0197		0.0215		0.014
Total	0.0552				

Table 3. Hazeltine Creek Average Monthly Discharge

Month	Discharge (m^3/s)
January	0.05
February	0.05
March	0.07
April	0.74
May	0.69
June	0.24
July	0.10
August	0.08
September	0.07
October	0.07
November	0.08
December	0.05

Based on the discharge rates in Tables 2 and 3, between approximately April 1st and June 15th, the total flow from the toe drains is less than 25% of the flow in Hazeltine Creek. During this period, water would be discharged into Hazeltine Creek at the rate that it is flowing from the toe drains. Table 4 shows the resulting water quality. Highlighted cells indicate that the BC Guideline is exceeded. Note that Table 3 is based on the water quality from E4 instead of STD and MTD combined, because this is where the water would be pumped from. Discharge rates are, however, based on the flow rates of STD and MTD because this is essentially how fast water in E4 would be replenished.

Given this discharge strategy, the only guideline that is exceeded is sulphate by 26 mg/L in June. This however, is based on the average Hazeltine Creek flow rate for the whole month. If MPMC only discharged water for the first half of June when the flows are above the average, it is likely that the current sulphate limit of 100 mg/L would be met. Over this 76 day period, with a total toe drain discharge of 0.0552 m^3/s, approximately 362,000 m^3 would be discharged into Hazeltine Creek annually.

In the fall, when flow rates are lower, water cannot be discharged at the rate that water flows from the toe drains without adversely affecting the water quality in Hazeltine Creek. Instead, a percentage of Hazeltine Creek flow should be discharged that will not increase any parameters to potential harmful or toxic levels. Based on the proportions of 35% PTD and 65% E4 used above (proportional to the toe drain discharge rates), Table 5 shows the anticipated water quality in Hazeltine Creek before discharge, at 16% toe drain discharge, and 25% toe drain discharge. At 16% discharge, over the 61 days 61, 100 m^3 of water would be discharged annually and none of the current BC guidelines would be exceeded. At 25% discharge, 95, 500 m^3 of water would be discharged each year, however the sulphate level in Hazeltine Creek would exceed the recommended maximum of 100 mg/L by 35 mg/L.

In addition to sulphate, another parameter of note is chloride. The TAR refers to a study in which increased chloride concentrations in Hazeltine Creek (which would be observed in the discharge of mine waters) resulted in decreased the toxicity of sulphate to *Hyalella*. In addition, discharge would increase hardness, which decreases the bioavailability of copper and cadmium, which are both potential parameters of concern. The bioavailability of copper is also decreased when it binds with DOC. One of the benefits of a spring/fall discharge strategy is that DOC levels are higher at these times, and would decrease the impact of copper in Hazeltine Creek.

Temperature

Temperature should not change by more than one degree beyond the optimum temperature range for each life history phase of the most sensitive salmonoid species present and the hourly rate of change must not exceed 1 degree Celsius. Analysis based on annual averages, as used for the other parameters is not appropriate in this case. Table 6 shows the average monthly temperatures of discharge water based on the discharge ratio of PTD (35%) and E4 (65%) used above. Using the discharge strategy outline in this report (with the upper end 25% discharge in the fall), the resulting effect on the temperatures in Hazeltine Creek are shown. In no cases did the water change temperature by more than one degree, which means that the temperature will not change by more than one degree beyond the optimum temperature range of fish species in Hazeltine Creek. This shows the benefit of incorporating PTD water to prevent temperature increases in Hazeltine Creek when the main seepage pond (E4) is warmer during late spring, summer, and early fall.

Table 4. Monthly Hazeltine Creek Water Quality for April 1st – June 15th Compared to Pre-Existing Conditions, based on Discharge at Toe Drain Flow Rates

	BC Water Quality Criteria (mg/L)		April (7.5% Toe Drains)	May (8% Toe Drains)	June (23% Toe Drains)	Pre-Discharge
	30 Day Guideline	Maximum				
Physical Tests						
Conductivity (In Situ) µS/cm	...	...	284	288	426	215
pH (In Situ)	6.5 - 9.5	6.6 - 9.5	7.95	7.95	7.97	7.94
Temperature (In Situ) °C	< 1°C deviation from optimum range for each life stage		5.9	5.9	6.3	5.7
Hardness (Total)	...	...	147	149	209	117
Total Suspended Solids	maximum increase of 5 mg/L in clear waters		4.2	4.3	5.8	3.4
Dissolved Anions						
Chloride (Total)	150	600	2.5	2.6	6.0	0.7
Sulphate (Dissolved)	... (may become 60)	100 (may become 250)	60	62	126	27
Nutrients						
Ammonia (Total)	See Tables 3 and 4	See Tables 3 and 4	0.02	0.02	0.02	0.0123
Nitrate (as N)	3	32.8	0.73	0.73	0.88	0.66
Nitrate + Nitrite (Dissolved)	...	...	0.73	0.74	0.89	0.66
Nitrite (as N)	0.02	0.06	0.008	0.008	0.013	0.01
Nitrogen (Total)	...	...	1.26	1.27	1.40	1.20
Phosphate (Total)	...	...	0.0206	0.0205	0.0202	0.021
Phosphorus (Total)	none for streams, 0.005 - 0.015 for lakes		0.024	0.024	0.024	0.0247
Dissolved Metals						
Aluminum (Dissolved)	0.05	0.1	0.0226	0.0225	0.0194	0.0242
Iron (Dissolved)	...	0.35	0.04	0.04	0.04	0.046
Total Metals						
Cadmium (Total)	...	0.000046 / 0.000062*	0.000030	0.000031	0.000062	0.00001
Copper (Total)	...	0.0059 / 0.0084*	0.0030	0.0030	0.0036	0.0027
Iron (Total)	...	1	0.124	0.125	0.152	0.110
Molybdenum (Total)	1	2	0.013	0.013	0.035	0.002
Selenium (Total)	0.002	0.002	0.001	0.001	0.002	0.0009
Zinc (Total)			0.0	0.0	0.0	0.002
Organics						
Carbon Organic (Dissolved)	...	30-day median ± 20% of the median background concentration	6.2	6.2	5.8	6.4

*The maximum changes depending on water hardness. The first value is the maximum for April and May, the second value is for June.

Table 5. Hazeltine Creek Water Quality for September 15th to November 15th

	BC Water Quality Criteria (mg/L)		16% Toe Drain Discharge	25% Toe Drain Discharge	Pre-Discharge
	30 Day Guideline	Maximum			
Physical Tests					
Conductivity (In Situ) µS/cm	...	...	362	444	215
pH (In Situ)	6.5 - 9.5	6.6 - 9.5	7.96	7.97	7.94
Temperature (In Situ) °C	< 1°C deviation from optimum range for each life stage		6.1	6.4	5.7
Hardness (Total)	...	...	181	217	117
Total Suspended Solids	maximum increase of 5 mg/L in clear waters		5.1	6.0	3.4
Dissolved Anions					
Chloride (Total)	150	600	4.4	6.5	0.7
Sulphate (Dissolved)	... (may become 60)	100 (may become 250))	96	135	27
Nutrients					
Ammonia (Total)	See Tables 3 and 4	See Tables 3 and 4	0.02	0.02	0.0123
Nitrate (as N)	3	32.8	0.81	0.90	0.66
Nitrate+Nitrite (Dissolved)	...	...	0.82	0.91	0.66
Nitrite (as N)	0.02	0.06	0.010	0.013	0.01
Nitrogen (Total)	...	...	1.33	1.41	1.20
Phosphate (Total)	...	...	0.0204	0.0202	0.021
Phosphorus (Total)	none for streams, 0.005 - 0.015 for lakes		0.024	0.024	0.0247
Dissolved Metals					
Aluminum (Dissolved)	0.05	0.1	0.0208	0.0189	0.0242
Iron (Dissolved)	...	0.35	0.04	0.04	0.046
Total Metals					
Cadmium (Total)	...	0.000055	0.000047	0.000066	0.00001
Copper (Total)	...	0.0072	0.0033	0.0037	0.0027
Iron (Total)	...	1	0.139	0.156	0.110
Molybdenum (Total)	1	2	0.025	0.038	0.002
Selenium (Total)	0.002	0.002	0.002	0.002	0.0009
Zinc (Total)			0.0	0.0	0.002
Organics					
Carbon Organic (Dissolved)	...	30-day median ± 20% of the median background concentration	6.0	5.8	6.4

Table 6. Average Monthly Temperatures of Discharge Water and the Effects on Hazeltine Creek

Month	Average Temperature (°C)				
	PTD	E4	Discharge	W7 Post- Discharge	W7 Pre-Discharge
April	7.6	6.9	7.1	0.9	0.4
May	7.6	10.2	9.3	5.9	5.58
June	7.6	12.9	11.0	14.5	15.5
September	7.6	14.7	12.2	9.9	9.1
October	7.6	8.5	8.2	5.8	5.0
November	7.6	4.2	5.4	2.9	2.1

Conclusion

In summary, discharging water from the toe drains and E4 will result in more favourable discharge water quality than using water from E1, E7, and the Long Ditch. From April 1st to June 15th, water can likely be discharged at the full flow rates of the toe drains, without exceeding any of the provincial water quality guidelines. Furthermore, there is potential to discharge more water in April and May when Hazeltine Creek discharge is highest. In the fall, 16% of Hazeltine Creek's flow can be discharged and adhere to all current BC guidelines. If 25% is discharged, the sulphate guideline is exceeded by 35 mg/L. In total, if 25% of Hazeltine Creek's flow is discharged in the fall, 457,500 m^3 will be discharged each year. If only 16% is discharged in the fall, annual discharge will be 423, 100 m^3.

Appendix I: Sample Site Water Quality Results

Table 1.1 STD Water Quality May to August 2011 (results in mg/L unless otherwise stated)

Date/Time Sampled	18-May-11	14-Jul-11	03-Aug-11	31-Aug-11	Max	Mean
Physical Tests						
Conductivity (In Situ) µS/cm	1232	1166	1232	1253	1253	1220.75
pH (In Situ)	7.54	8.1	7.85	7.77	8.10	7.815
Temperature (In Situ) °C	6.3	12.8	13.5	14.5	14.5	11.8
Hardness (Total)	514	512	550	546	550	531
Total Suspended Solids	3	3	3	3	3.0	3.0
Dissolved Anions						
Chloride (Total)	20.7	18	21.7	21.9	21.9	20.6
Sulphate (Dissolved)	547	530	583	586	586	562
Nutrients						
Ammonia (Total)	0.0275	0.0259	0.079	0.132	0.132	0.066
Nitrate (as N)	6.27	5.25	5.66	4.19	6.27	5.34
Nitrate+Nitrite (Dissolved)	6.32	5.39	5.79	4.27	6.32	5.44
Nitrite (as N)	0.045	0.136	0.133	0.079	0.136	0.098
Nitrogen (Total)	6.29	7.69	6.76	5.22	7.69	6.49
Phosphorus (Total)	0.0184	0.0113	0.0121	0.0113	0.0184	0.0133
Dissolved Metals						
Aluminum (Dissolved)	0.003	0.003	0.0031	0.044	0.044	0.0133
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals						
Cadmium (Total)	0.000202	0.00018	0.0002	0.0002	0.000202	0.000196
Copper (Total)	0.0207	0.0156	0.0158	0.0131	0.0207	0.0163
Iron (Total)	0.03	0.03	0.03	0.03	0.03	0.03
Molybdenum (Total)	0.11	0.155	0.176	0.174	0.176	0.15375
Selenium (Total)	0.0184	0.0196	0.0186	0.0171	0.0196	0.0184
Organics						
Carbon Organic (Dissolved)	3.73	3.13	3.27	3.72	3.73	3.46

Table 1.2 MTD Water Quality May –August 2011 (results in mg/L unless otherwise stated)

Date/Time Sampled	18-May-11	13-Jul-11	03-Aug-11	31-Aug-11	Max	Mean
In Situ Parameters						
Conductivity (In Situ) µS/cm	1303	1217	791	1130	1303	1110
pH (In Situ)	7.68	8.32	8.25	8.1	8.32	8.09
Temperature (In Situ) °C	7.3	7.4	7.1	7.9	7.9	7.4
Hardness (Total)	459	430	207	408	459	376
Total Suspended Solids	3	3	3	3	3	3
Dissolved Anions						
Chloride (Total)	29.3	45.3	29.2	27.3	45.3	32.775
Sulphate (Dissolved)	549	508	202	471	549	433
Nutrients						
Ammonia (Total)	0.0743	0.077	0.102	0.0684	0.102	0.080
Nitrate (as N)	1.51	1.58	0.025	1.64	1.64	1.19
Nitrate+Nitrite (Dissolved)	1.6	1.66	0.025	1.78	1.78	1.27
Nitrite (as N)	0.093	0.08	0.005	0.14	0.14	0.080
Nitrogen (Total)	1.58	2.08	0.37	2.59	2.59	1.66
Phosphorus (Total)	0.0394	0.0347	0.0328	0.0328	0.0394	0.0349
Dissolved Metals						
Aluminum (Dissolved)	0.003	0.003	0.003	0.0075	0.0075	0.004125
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals						
Cadmium (Total)	0.00012	0.0001	0.00004	0.00015	0.00015	1.0E-04
Copper (Total)	0.00419	0.00409	0.00061	0.00363	0.00419	0.00313
Iron (Total)	0.03	0.031	0.129	0.03	0.129	0.055
Molybdenum (Total)	0.181	0.184	0.182	0.181	0.184	0.182
Selenium (Total)	0.00242	0.0024	0.0005	0.00246	0.00246	0.00195
Organics						
Carbon Organic (Dissolved)	4.14	4.41	5.21	4.14	5.21	4.48

Table 1.3 PTD Water Quality July 2009 to August 2011 (results in mg/L unless otherwise stated)

Date/Time Sampled	18-May-11	13-Jul-11	03-Aug-11	31-Aug-11	Max	Mean
In Situ Parameters						
Conductivity (In Situ) µS/cm	1533	1407	1388	1359	1533	1422
pH (In Situ)	7.5	8.06	7.92	7.93	8.06	7.85
Temperature (In Situ) °C	6.3	6.6	6.3	7.4	7.4	6.65
Hardness (Total)	612	595	572	562	612	585.25
Total Suspended Solids	3	3	3		3	3
Dissolved Anions						
Chloride (Total)	27.7	23.6	24.6	23.3	27.7	24.8
Sulphate (Dissolved)	724	668	652	635	724	670
Nutrients						
Ammonia (Total)	0.155	0.0584	0.163	0.0775	0.163	0.113
Nitrate (as N)	1.51	1.85	2.12	1.76	2.12	1.81
Nitrate+Nitrite (Dissolved)	1.54	1.88	2.21	1.84	2.21	1.87
Nitrite (as N)	0.025	0.033	0.095	0.076	0.095	0.05725
Nitrogen (Total)	1.51	2.24	2.68	6.61	6.61	3.26
Phosphate (Total)						
Phosphorus (Total)	0.0184	0.0142	0.0106	0.0108	0.0184	0.0135
Dissolved Metals						
Aluminum (Dissolved)	0.006	0.003	0.003	0.003	0.006	0.00375
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals						
Cadmium (Total)	0.00014	0.00011	0.00012	0.00015	0.00015	0.000130
Copper (Total)	0.0047	0.00478	0.00468	0.00436	0.00478	0.00463
Iron (Total)	0.03	0.03	0.03	<0.030	0.03	0.03
Molybdenum (Total)	0.186	0.192	0.181	0.187	0.192	0.187
Selenium (Total)	0.0029	0.00397	0.00419	0.00371	0.00419	0.003693
Organics						
Carbon Organic (Dissolved)	3.58	3.87	4.05	2.68	4.05	3.55

Table 1.4 Long Ditch Water Quality (at Outflow Pipe from Sump) April 2009 to August 2011 (results in mg/L unless otherwise stated)

Date/Time Sampled	02-Feb-11	04-May-11	11-May-11	18-May-11	09-Jun-11	04-Aug-11	08-Sep-11	Max	Mean
In Situ Parameters									
Conductivity (In Situ) µS/cm	1047	1173	1256	1125	1447	1380	1346	1447	1253
pH (In Situ)	7.95	7.66	7.87	7.65	8.18	8.48	8.29	8.48	8.01
Temperature (In Situ) °C	0.5		-1	5.4	15.4	15.3	10.8	15.4	7.7
Hardness (Total)	578	647	716	607	854	820	775	854	714
Total Suspended Solids	7.5	163	72.5	45.9	6	4.7	9.7	163	44
Dissolved Anions									
Chloride (Total)	2.5	5	5	5	5	5	5	5	5
Sulphate (Dissolved)	448	585	606	510	752	694	628	752	603
Nutrients									
Ammonia (Total)	0.0519	0.0155	0.0452	0.0451	0.005	0.0057	0.0497	0.0519	0.0312
Nitrate (as N)	5.04	6.38	9.52	8.12	12.8	11.7	9.4	12.8	9.0
Nitrate+Nitrite (Dissolved)	5.1	6.38	9.53	8.12	12.8	11.7	9.43	12.8	9.0
Nitrite (as N)	0.0573	0.01	0.013	0.01	0.01	0.01	0.031	0.0573	0.0202
Nitrogen (Total)	6.15	9.91	11.8	8.26	17.6	13.6	14.1	17.6	11.6
Phosphate (Total)	0.015							0.015	0.015
Phosphorus (Total)	0.015	0.223	0.0805	0.0583	0.0203	0.0108	0.0153	0.223	0.060
Dissolved Metals									
Aluminum (Dissolved)	0.0032	0.013	0.0116	0.0168	0.0087	0.0071	0.006	0.0168	0.0095
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals									
Cadmium (Total)	0.000163	0.0003	0.000206	0.0002	0.00014	0.00008	0.0004	0.0004	0.0002
Copper (Total)	0.011	0.0266	0.0227	0.019	0.0146	0.0134	0.0116	0.0266	0.0170
Iron (Total)	0.307	1.78	1.8	1.31	0.322	0.095	0.217	1.8	0.8
Molybdenum (Total)	0.121	0.138	0.162	0.143	0.224	0.156	0.179	0.224	0.160
Selenium (Total)	0.0174	0.04	0.0431	0.0399	0.0651	0.0424	0.014	0.0651	0.0374
Organics									
Carbon Organic (Dissolved)	3.32	6.32	4.34	5.08	4.75	4.74	2.87	6.32	4.49

Table 1.5 E1 (Tailings Supernatant) Water Quality January 2009 to August 2011 (results in mg/L unless otherwise stated)

Date Sampled	13-Jan-10	10-Feb-10	03-Mar-10	07-Apr-10	12-May-10	03-Jun-10	08-Jul-10	08-Jul-10	05-Aug-10	01-Sep-10	07-Oct-10
In Situ Parameters											
Conductivity (In Situ) µS/cm	1699	1636	1470	1273	1368	1460	1590	1642	1787	1848	2001
pH (In Situ)	9.43	9.94	9.71	9.35	8.24	7.3	7.83	7.87	7.94		7.78
Temperature (In Situ) °C	2.6	3.8	4.6	4.4	13.1	13.7		21.3	20.9	13.8	10.5
Hardness (Total)					517	552	740	740	781	773	908
Total Suspended Solids					22	8	3	3	3	5.5	14.2
Dissolved Anions											
Chloride (Total)					36	35.3	38	38	28.8	44	38
Sulphate (Dissolved)	809	790	689	566	613	674	835	835	616	915	1030
Nutrients											
Ammonia (Total)					0.207	0.073	0.143	0.143	0.083	0.172	0.286
Nitrate (as N)	4.05	4.02	4.1	3.88	4.46	4.91	5.67	5.67	4.36	6.99	6.93
Nitrate+Nitrite (Dissolved)	4.22	4.93	4.41	4.12	4.65	5.04	5.76	5.76	4.44	7.08	7.1
Nitrite (as N)	0.169	0.917	0.309	0.248	0.189	0.131	0.097	0.097	0.08	0.098	0.175
Nitrogen (Total)	6.42	4.52	5.97	4.82	6.62	7.36	6.26	6.26	7.62	10.1	7.42
Phosphate (Total)					0.0414	0.0163	0.0071	0.0071	0.0059	0.0108	0.0424
Phosphorus (Total)					0.0414	0.0163	0.0071		0.0059	0.0108	0.0424
Dissolved Metals											
Aluminum (Dissolved)	0.0105	0.0167	0.015	0.017	0.0123	0.0218	0.0197	0.0197	0.0095	0.0109	0.0166
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals											
Cadmium (Total)	0.001	0.000093	0.000085	0.00051	0.000046	0.0009	0.000028	0.000028	0.000093	0.00007	0.00007
Copper (Total)	0.00506	0.00548	0.00602	0.0265	0.04	0.0123	0.0101	0.0101	0.015	0.0125	0.0411
Iron (Total)	0.057	0.068	0.069	0.42	0.627	0.179	0.057	0.057	0.078	0.195	0.42
Molybdenum (Total)	0.23	0.24	0.203	0.191	0.22	0.233	0.25	0.25	0.273	0.287	0.228
Selenium (Total)	0.0227	0.0236	0.0232	0.024	0.0241	0.0269	0.0276	0.0276	0.0303	0.0334	0.0297
Organics											
Carbon Organic (Dissolved)	7.97	8.89	6.98	8	7.12	7.52	6.19	6.19	5.77	6.73	5.67

Table 1.5 E1 Water Quality Continued Cont'd

Date Sampled	04-Nov-10	01-Dec-10	10-Jan-11	03-Feb-11	07-Mar-11	06-Apr-11	12-May-11	09-Jun-11	14-Jul-11	04-Aug-11	08-Sep-11	Max
In Situ Parameters												
Conductivity (In Situ) µS/cm	1889	1992	1902	1740	1671	1439	1055	1076	1105	1174	1215	2001
pH (In Situ)	8.08	8.25	8.42	8.54	9.45	8.35	7.94	8.31	8.32	8.12	8.56	9.94
Temperature (In Situ) °C	5.2	1.8	2.8		3.7	3.3	11.6	17.2	17	18	17.3	21.3
Hardness (Total)	868	970	879	769	681	565	409	433	456	474	470	970
Total Suspended Solids	21.1	3.3	3	13.3	6.8	9.6	13.8	8.7	3.5	3	3.7	22
Dissolved Anions												
Chloride (Total)	33.2	38.8	37.6	35.5	33	28.2	19.7	17.7	17.7	20.3	21	44.0
Sulphate (Dissolved)	945	1100	994	899	829	657	474	525	508	547	573	1100
Nutrients												
Ammonia (Total)	0.353	0.408	0.46	0.654	0.612	0.719	0.407	0.196	0.0619	0.125	0.0869	0.719
Nitrate (as N)	7.29	8.15	7.9	7.7	7.33	5.94	4.59	4.95	5.21	5.68	5.38	8.15
Nitrate+Nitrite (Dissolved)	7.42	8.33	8.05	7.85	7.48	6.13	4.68	4.99	5.31	5.76	5.47	8.33
Nitrite (as N)	0.134	0.178	0.15	0.151	0.155	0.185	0.092	0.04	0.093	0.073	0.087	0.917
Nitrogen (Total)	7.38	9.15	8.5	10.1	7.97	6.51	6.33	7.12	7.52	7.14	8.16	10.10
Phosphate (Total)	0.0278	0.0139	0.0162	0.0185								0.0424
Phosphorus (Total)	0.0278	0.0139	0.0162	0.0185	0.0142	0.0288	0.0382	0.0094	0.0071	0.0035	0.0042	0.0424
Dissolved Metals												
Aluminum (Dissolved)	0.012	0.0083	0.0082	0.0093	0.0109	0.0132	0.015	0.0229	0.0203	0.0428	0.0255	0.0428
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals												
Cadmium (Total)	0.00007	0.000024	0.000021	0.00005	0.00006	0.00007	0.00002	0.00002	0.00002	0.00002	0.0000031	0.00100
Copper (Total)	0.0641	0.0067	0.00681	0.0158	0.0052	0.0139	0.0275	0.00627	0.0102	0.00572	0.00554	0.0641
Iron (Total)	0.547	0.033	0.043	0.318	0.08	0.504	0.462	0.075	0.119	0.066	0.041	0.627
Molybdenum (Total)	0.243	0.261	0.274	0.233	0.174	0.178	0.125	0.152	0.167	0.176	0.186	0.287
Selenium (Total)	0.0284	0.0273	0.025	0.0249	0.0221	0.0187	0.0158	0.0186	0.0221	0.0203	0.0219	0.0334
Organics												
Carbon Organic (Dissolved)	6.82	8.26	9.58	10.7	10.6	9.4	5.82	5.8	4.67	4.76	4.1	10.70

Table 1.6 E4 (Effluent from Main Effluent Storage Pond) Water Quality (results in mg/L unless otherwise stated)

Date/Time Sampled	10-Jan-11	03-Feb-11	08-Mar-11	05-Apr-11	12-May-11	09-Jun-11	13-Jul-11	04-Aug-11	08-Sep-11	Max	Mean
In Situ Parameters											
Conductivity (In Situ) µS/cm	1583	1510	1340	1138	1017	1117	1111	1188	1201	1583	1245
pH (In Situ)	7.49	7.84	8.01	7.57	7.78	8.42	8.32	9.2	8.17	9.2	8.1
Temperature (In Situ) °C	1.3			12.2	11.7	16.7	15.6	16.7	13.9	16.7	12.6
Hardness (Total)	711	668	558	508	423	473	466	506	496	711	534
Total Suspended Solids	3	5.3	10.1	64.2	37.2	4	3.5	3	3	64.2	14.8
Dissolved Anions											
Chloride (Total)	31.9	30.2	27	16	18.7	18	18.3	21.4	21.7	31.9	22.6
Sulphate (Dissolved)	756	715	597	475	427	513	503	544	535	756	563
Nutrients											
Ammonia (Total)	0.0612	0.0399	0.0616	0.0119	0.0075	0.0137	0.0128	0.0172	0.031	0.0616	0.0285
Nitrate (as N)	5.97	5.45	3.61	3.77	3.82	4.23	3.99	4.43	2.9	5.97	4.24
Nitrate+Nitrite (Dissolved)	6.02	5.47	3.64	3.77	3.84	4.26	4.06	4.5	2.99	6.02	4.28
Nitrite (as N)	0.049	0.022	0.027	0.01	0.016	0.028	0.07	0.069	0.095	0.095	0.043
Nitrogen (Total)	6.17	6.7	3.73	4.14	5.03	6.55	5.66	5.44	4.27	6.7	5.30
Phosphate (Total)	0.0231	0.0223								0.0231	0.0227
Phosphorus (Total)	0.0231	0.0223	0.0305	0.0993	0.0397	0.0077	0.0126	0.0101	0.0123	0.0993	0.0286
Dissolved Metals											
Aluminum (Dissolved)	0.003	0.003	0.003	0.0045	0.009	0.0152	0.0037	0.003	0.0032	0.0152	0.0053
Iron (Dissolved)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Metals											
Cadmium (Total)	0.00014	0.000178	0.000097	0.0002	0.000064	0.000036	0.000053	0.000047	0.000062	0.00020	0.00010
Copper (Total)	0.00726	0.00901	0.0135	0.0309	0.0119	0.0137	0.00562	0.00485	0.00457	0.0309	0.0113
Iron (Total)	0.102	0.162	0.347	3.34	1.75	0.15	0.195	0.089	0.062	3.34	0.69
Molybdenum (Total)	0.197	0.177	0.154	0.15	0.14	0.166	0.153	0.165	0.16	0.197	0.162
Selenium (Total)	0.0171	0.0152	0.01	0.0119	0.0106	0.0214	0.0147	0.0149	0.0115	0.0214	0.0141
Organics											
Carbon Organic (Dissolved)	6.74	7.06	5.22	4.73	4.64	4.66	3.34	3.5	3.98	7.06	4.87

Table 1.7 E7 (Perimeter Effluent Storage Pond) April 2009 to August 2011 (results in mg/L unless otherwise stated)

Date/Time Sampled	08-Jun-11	03-Aug-11	08-Sep-11	Max	Mean
In Situ Parameters					
Conductivity (In Situ) µS/cm	1339	1393	1348	1393	1360
pH (In Situ)	8.16	9.17	8.02	9.17	8.45
Temperature (In Situ) °C	15.6	23.5	14.4	23.5	17.8
Hardness (Total)	722	772	725	772	740
Total Suspended Solids	14	36	8.3	36	19.4
Dissolved Anions					
Chloride (Total)	7.7	7.7	6.1	7.7	7.2
Sulphate (Dissolved)	652	652	644	652	649
Nutrients					
Ammonia (Total)	0.005	0.0061	0.0173	0.0173	0.009
Nitrate (as N)	7.69	58	7.76	58	24.48
Nitrate+Nitrite (Dissolved)	7.69	58	7.8	58	24.50
Nitrite (as N)	0.01	0.134	0.043	0.134	0.062
Nitrogen (Total)	8.07	23.4	11.9	23.4	14.5
Phosphate (Total)					
Phosphorus (Total)	0.0145	0.0404	0.0129	0.0404	0.0226
Dissolved Metals					
Aluminum (Dissolved)	0.024	0.103	0.006	0.103	0.044
Iron (Dissolved)	0.03	0.341	0.03	0.341	0.134
Total Metals					
Cadmium (Total)	0.00008	0.00052	0.00025	0.00052	0.000283
Copper (Total)	0.011	0.0292	0.0095	0.0292	0.016567
Iron (Total)	0.299	2.91	0.193	2.91	1.13
Molybdenum (Total)	0.146	0.286	0.18	0.286	0.204
Selenium (Total)	0.0282	0.0487	0.0119	0.0487	0.0296
Organics					
Carbon Organic (Dissolved)	5.14	13.0	3.2	13	7.1

Table 1.8 W7 (Hazeltine Creek downstream of Polley Lake) Water Quality January 2009 to August 11(results in mg/L unless otherwise stated)

Date Sampled	10-Jan-11	02-Feb-11	07-Mar-11	05-Apr-11	########	08-Jun-11	14-Jul-11	########	08-Sep-11	Max	Mean
In Situ Parameters											
Conductivity (In Situ) µS/cm	135	152	230	216	144	199	202	203	1346	1346	314
pH (In Situ)	8.05	7.47	7.55	7.69	7.31	7.67	8.65	8.41	8.29	8.65	7.90
Temperature (In Situ) °C	0.1	0.1	1.4	0.6	4.3	15.5	14.7	16.6	10.8	16.6	7.1
Hardness (Total)	116	114	109	106	65.4	98.5	105	103	110	116	103
Total Suspended Solids	3	3	3	3	3	6.7	4.8	4.7	3.7	6.7	3.9
Dissolved Anions											
Chloride (Total)	0.57	0.54	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.57	0.52
Sulphate (Dissolved)	31.1	33	31.7	33.9	18.4	27.1	26.7	26.5	27.1	33.9	28.4
Nutrients											
Ammonia (Total)	0.005	0.005	0.0058	0.005	0.005	0.0217	0.0155	0.0174	0.0092	0.0217	0.0100
Nitrate (as N)	0.175	0.108	0.0904	0.799	0.0163	0.01	0.0179	0.0355	0.0437	0.799	0.1440
Nitrate+Nitrite (Dissolved)	0.175	0.108	0.0904	0.799	0.0163	0.01	0.0179	0.0355	0.0458	0.799	0.144
Nitrite (as N)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001
Nitrogen (Total)	0.363	0.34	0.323	1.14	0.48	0.37	0.44	0.37	0.0256	1.14	0.43
Phosphate (Total)	0.0352	0.0324								0.0352	0.0338
Phosphorus (Total)	0.0352	0.0324	0.0321	0.0346	0.0234	0.0262	0.0237	0.0222	0.0256	0.0352	0.0284
Dissolved Metals											
Aluminum (Dissolved)	0.0054	0.005	0.003	0.0788	0.0985	0.0128	0.0167	0.0193	0.0041	0.0985	0.0271
Iron (Dissolved)	0.03	0.03	0.03	0.091	0.078	0.03	0.036	0.042	0.03	0.091	0.044
Total Metals											
Cadmium (Total)	0.00001	0.00001	0.00001	0.00001	0.000012	0.00001	0.00001	0.00001	0.00001	0.000012	0.000010
Copper (Total)	0.00223	0.00528	0.00162	0.00391	0.00436	0.0027	0.00221	0.00222	0.00216	0.00528	0.00297
Iron (Total)	0.091	0.106	0.03	0.421	0.192	0.106	0.138	0.15	0.244	0.421	0.164
Molybdenum (Total)	0.00209	0.00204	0.00205	0.00173	0.00135	0.00214	0.00204	0.00222	0.00194	0.00222	0.0020
Selenium (Total)	0.0007	0.001	0.00073	0.00069	0.00055	0.00068	0.00071	0.00071	0.0006	0.001	0.001
Organics											
Carbon Organic (Dissolved)	6.2		5.38	9.37	11.1	6.52	6.77	7.1	5.99	11.1	7.3

Memo

To: Ron Martel, Environmental Superintendent, Mount Polley Mining Corporation

From: Fred Burgess, Minnow Environmental

EC: Pierre Stecko, Minnow Environmental; Violeta Martin & Gregory Smyth, Knight Piesold

Date: December 5th, 2011

Re: Hazeltine Creek November 2011 Results

In November 2011, Minnow Environmental Inc. implemented a field program to collect data to support efforts by the Mount Polley mine to select the most appropriate location for the discharge of excess water into Hazeltine Creek. The mine had previously flagged a location on the creek as a candidate for discharge. However, this location was found to be at a braid in the creek where the flow of water splits around a large island. This location was therefore not considered ideal due to the smaller channel width and consequent greater physical sensitivity and lower water volume for initial mixing of the effluent. Accordingly, Hazeltine Creek was assessed upstream and downstream of the previously flagged location to identify a more suitable location, if available. A distance of approximately 100 m downstream was assessed, and it was discovered that for this distance the creek continues to flow as multiple, smaller channels. However, a well defined single channel was observed over a distance of approximately 90 m upstream from the above mentioned island. This would allow 90 m of mixing of the effluent in a single channel before the start of braiding. The stream bed material at the upstream extent of this well defined channel was observed to be a combination of approximately 40% sand, and 60% gravel and pebbles, with a few larger cobbles and no observable areas of fines such as silt and clay. Further information was gathered at this site to better document the nature of the underlying material and the stream morphology, and to effectively describe the area.

Two aspects of the underlying material were examined: stream bed material composition and bank material composition. The stream bed material was sampled from an area within 2 m up and downstream (to stay within the 5 m width of the proposed final outfall riprap structure) of a wooden stake on shore set to mark the farthest upstream the mine could potentially discharge into the length of well-defined, single channel flow. This was done using the CABIN protocol “100 pebble count” (Environment Canada, 2010) which essentially involves sorting a sample of 100 randomly selected rocks in the stream by “intermediate diameter,” which is the measurement perpendicular to the longest axis of the rock (Table 1; Figure 1). To sample the bank material, a test pit was excavated approximately 5 m back from the creek edge, which would represent the middle of the 10 m rip-rap installation that is to make up the final approach of the discharge to the stream. Approximately 10 kg of generally sandy bank material was sampled from this pit at a depth of 30 cm – 60 cm. The sample was sent to Knight Piesold for analysis. Also, a standard penetration test based on Knight Piesold's "blows per foot" density relationship of sands and gravels was performed with a length of threaded rod in the bank material of the discharge site (Table 2).

Stream morphology at the alternate discharge location was characterized by means of cross sections measured at the proposed location, as well at one section 3 stream widths upstream and one section 3 stream widths downstream (Table 3; Figure 2). The slope of the creek along this section was measured with an inclinometer to be 2%.

The coordinates of the alternate discharge location were measured using a total station from control points set by mine survey staff. The rest of the discharge path—as it would be should this site be chosen for the final design—was then determined and marked with wooden stakes to link this point back to the end of the straight section of the existing trench at the polishing pond. All relevant coordinates from this total station work, including additional points along the proposed discharge path and new measurements of the upstream extent of the island (which marks the beginning of stream braiding), are presented in Table 4 and Figure 3. These measurements were not taken by a licensed surveyor and are only to support the selection of the most appropriate discharge location; they should not be used for engineering purposes.

Finally, photographic record of the area was made (Figure 4).

I look forward to discussing these results with you soon. Please do not hesitate to contact me at 250-595-1627 if you have any questions or comments.

REFERENCES

Environment Canada. 2010. Canadian Aquatic Biomonitoring Network Wadeable Streams Field Manual. Dartmouth, NS. March 2010.

Table 1: Diameter (intermediate) of pebbles, Hazeltine Creek proposed discharge site

Intermediate diameter	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**
	HAC-1																
Frequency	5	19	21	20	16	8	4	3	2	1	1	0	0	0	0	0	0
%Frequency	5%	19%	21%	20%	16%	8%	4%	3%	2%	1%	1%	0%	0%	0%	0%	0%	0%
Cumulative %	5%	24%	45%	65%	81%	89%	93%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%
	HAC-2																
Frequency	9	27	25	17	12	5	2	0	1	1	0	0	0	0	0	1	0
Relative Frequency	9%	27%	25%	17%	12%	5%	2%	0%	1%	1%	0%	0%	0%	0%	0%	1%	0%
Cumulative %	9%	36%	61%	78%	90%	95%	97%	97%	98%	99%	99%	99%	99%	99%	99%	100%	100%
	HAC-3																
Frequency	9	30	36	18	4	2	1	0	0	0	0	0	0	0	0	0	0
Relative Frequency	9%	30%	36%	18%	4%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cumulative %	9%	39%	75%	93%	97%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	HAC-4																
Frequency	16	40	16	15	9	2	0	0	1	0	1	0	0	0	0	0	0
Relative Frequency	16%	40%	16%	15%	9%	2%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%
Cumulative %	16%	56%	72%	87%	96%	98%	98%	98%	99%	99%	100%	100%	100%	100%	100%	100%	100%
	HAC-5																
Frequency	23	26	22	15	8	4	2	0	0	0	0	0	0	0	0	0	0
Relative Frequency	23%	26%	22%	15%	8%	4%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cumulative %	23%	49%	71%	86%	94%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Average																
Frequency	12.4	28.4	24	17	9.8	4.2	1.8	0.6	0.8	0.4	0.4	0	0	0	0	0.2	0
Relative Frequency	12%	28%	24%	17%	10%	4%	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Cumulative %	12%	41%	65%	82%	92%	96%	98%	98%	99%	99%	100%	100%	100%	100%	100%	100%	100%

Table 2: Standard penetration test of soil at proposed discharge site at Hazeltine Creek

Site*	Description	Blows to 30 cm	Descriptive term	Blows to 30 - 60 cm	Descriptive term	Blows to 60 - 90 cm	Descriptive term	Impenetrable at	Depth to noticeable increase in stiffness
1	Discharge site	6	Loose	22	Medium dense	33	Dense	-	39
2	2 m upstream of 1	11	Medium dense	19	Medium dense	>50	Very dense	63	63
3	2 m downstream of 1	8	Loose	22	Medium dense	>50	Very dense	54	54
4	5 m west of 1, away from creek along proposed discharge path	9	Loose	21	Medium dense	>50	Very dense	41	41
5	2 m upstream of 5	6	Loose	18	Medium dense	>50	Very dense	45	45
6	2 m downstream of 5	6	Loose	16	Medium dense	>50	Very dense	55	55
	Average	**8**	**Loose**	**20**	**Medium dense**	**>50**	**Very dense**	**52**	**50**

Table 3: Cross section measurements relative to bankfull height of Hazeltine Creek near proposed discharge

Distance NE from shore	Site 1	Site 2	Site 3
	12.45 m @ 328° Upstream	Discharge Location	11.7 m @ 127° Downstream*
0.25	53.7	43.5	35.5
0.5	53.3	45.2	39.7
0.75	56.2	47.3	35.7
1	60.2	50.9	36.8
1.25	58	50.1	37.7
1.5	57.3	48.2	39.9
1.75	52.8	45.7	45.8
2	55.1	40.6	48.2
2.25	55.4	41.4	48
2.5	55.3	40.3	46.7
2.75	57.2	41.3	43.5
3	48.6	46	45.2
3.25	50.1	50.1	45.6
3.5	47.9	51.2	48.8
3.75	48.9	44.6	46.6
4	48.4	39.3	43.8
4.25	49.1		38.3
4.5	50.2		36.7
4.75	43.7		37.4
5	44.4		38.8
5.25	40.2		40.2
5.5	43.3		42
5.75	40.8		40.2
6	36.3		41.9
6.25			38.3
6.5			42.9
6.75			42.7
7			39.7
7.25			37.3
7.5			30.3
Stream width	6.15	4.15	7.6

* A log obstructed the profile site at 12.45 m.

Table 4: Coordinates of points from November 2011 total station work at Mount Polley near Hazeltine Creek

Name	Easting	Northing	Elevation	Description	Notes
1	595438.580	5819860.627	931.694	CP	Initial backsight
2	595768.487	5819684.937	929.280	CP	Initial point occupied
8	595832.783	5819738.531	923.086	EL	Ditch invert
9	595856.343	5819769.364	924.445	TV	Traverse point
10	595762.044	5819688.370	926.650	EL	Ditch invert
11	595884.369	5819790.245	920.415	TV	Traverse point
12	595895.086	5819800.620	919.074	TV	Traverse point
13	595910.553	5819815.786	918.210	TV	Traverse point
14	595933.275	5819831.631	914.080	TV	Traverse point
15	595955.582	5819844.024	913.717	TV	Traverse point
16	595963.396	5819853.945	913.259	WE	Upstream extent of island
17	595966.085	5819858.503	913.365	WE	water's edge, opposite shore of discharge
18	595960.941	5819854.936	913.305	WE	water's edge same shore as discharge
19	595948.988	5819883.426	913.948	TV	Traverse point
20	595936.446	5819904.140	914.115	TV	Traverse point
21	595916.397	5819926.913	914.167	EL	Discharge point, stake on shore
22	595920.694	5819918.466	914.010	TV	Traverse point
G1	595865.111	5819840.119	918.995	TV	Midway between the ditch and the curve
G2	595877.688	5819898.260	918.656	TV	Start of curve
G3	595895.964	5819926.565	917.890	TV	End of curve

Figure 1: Diameter (intermediate) of pebbles, Hazeltine Creek proposed discharge site

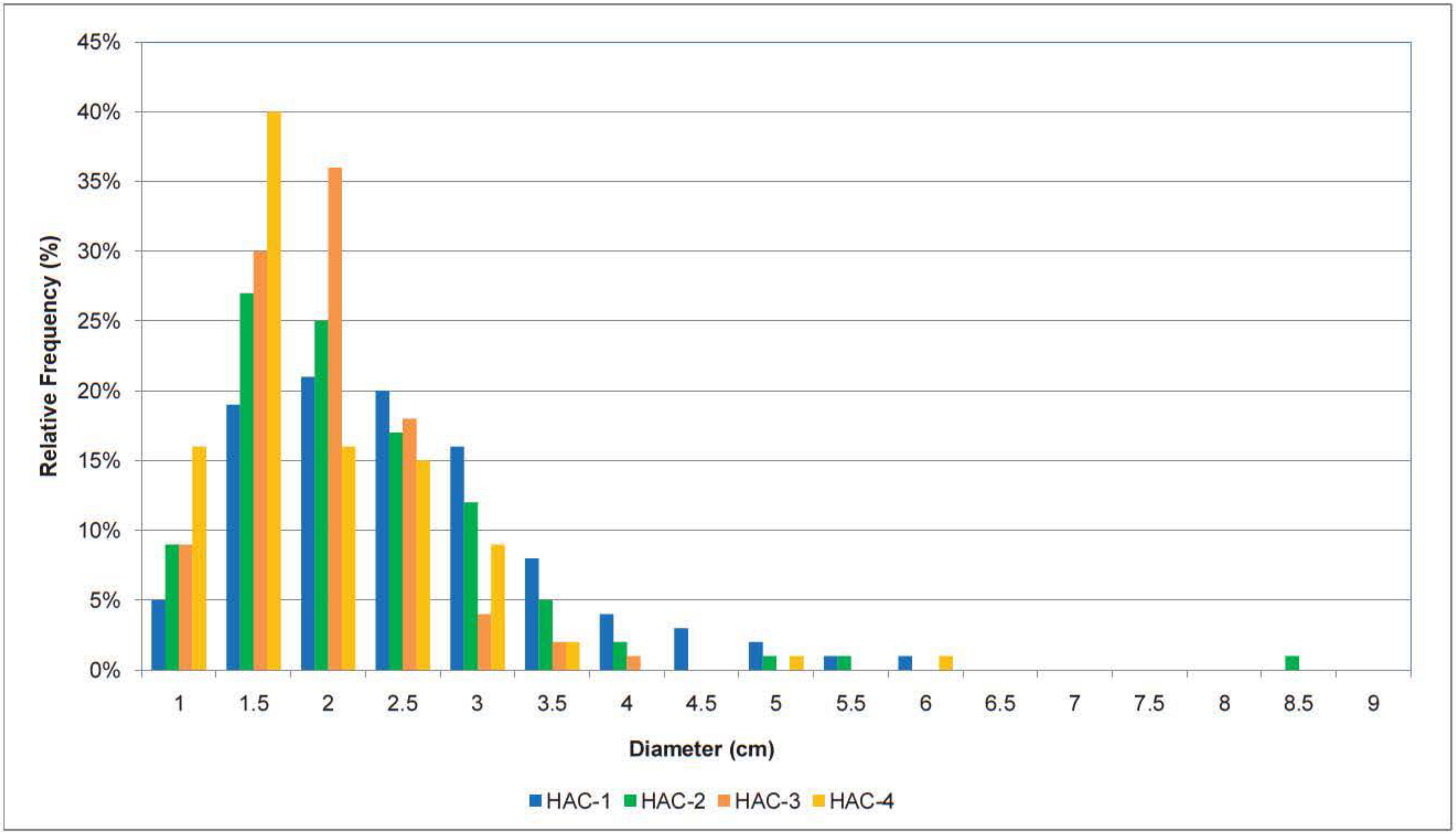
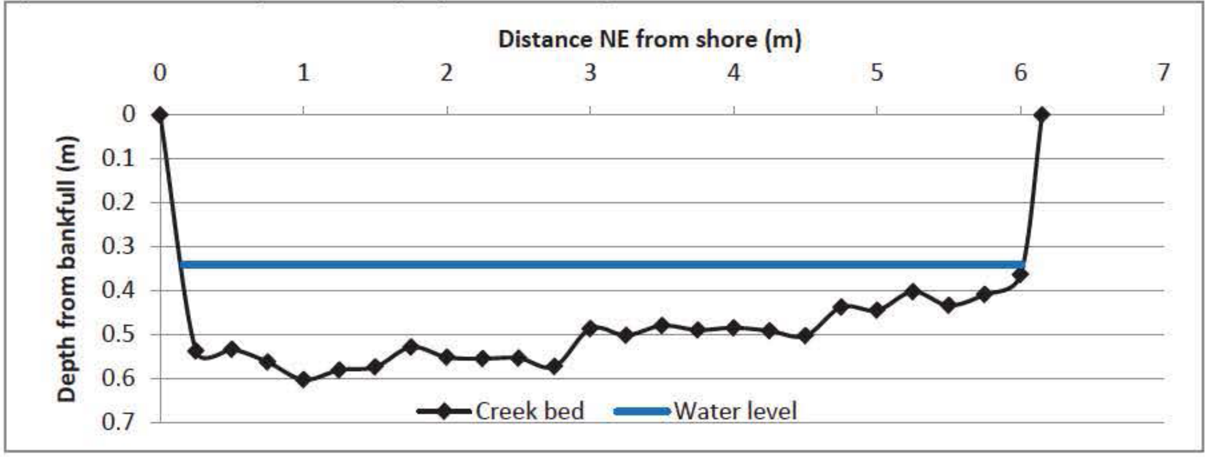
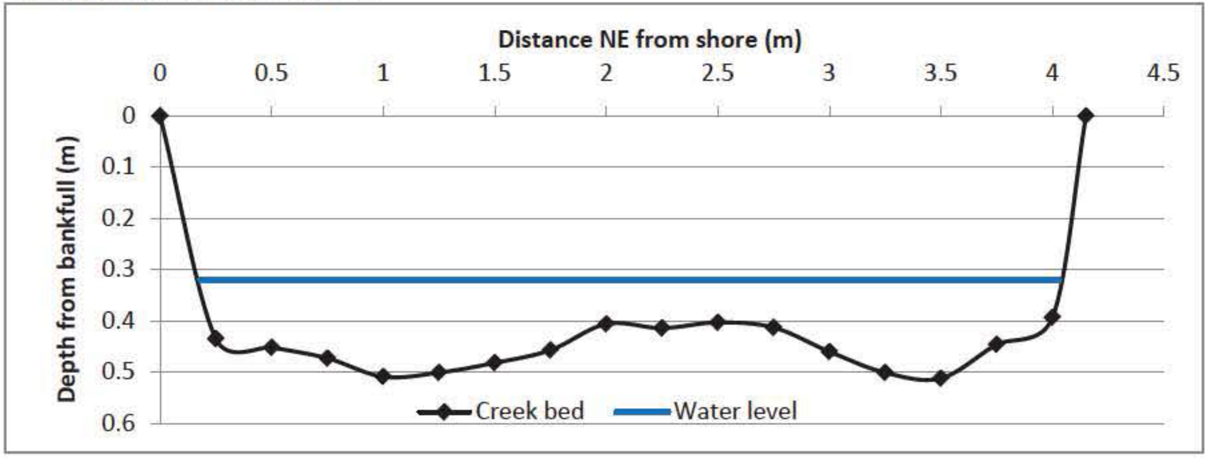


Figure 2: Cross section profiles near proposed discharge site at Hazeltine Creek

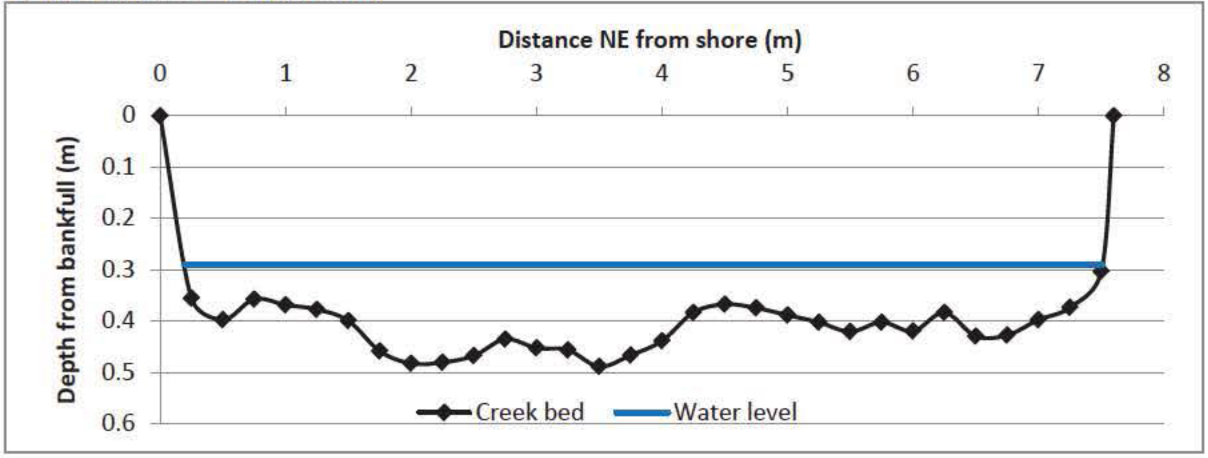
a) 12.45 m @ 328° upstream of proposed discharge



b) Proposed discharge location



c) 11.7 m @ 127° Downstream*



* A log obstructed the profile site at 12.45 m.

Figure 3: Plot of relevant total station measurements

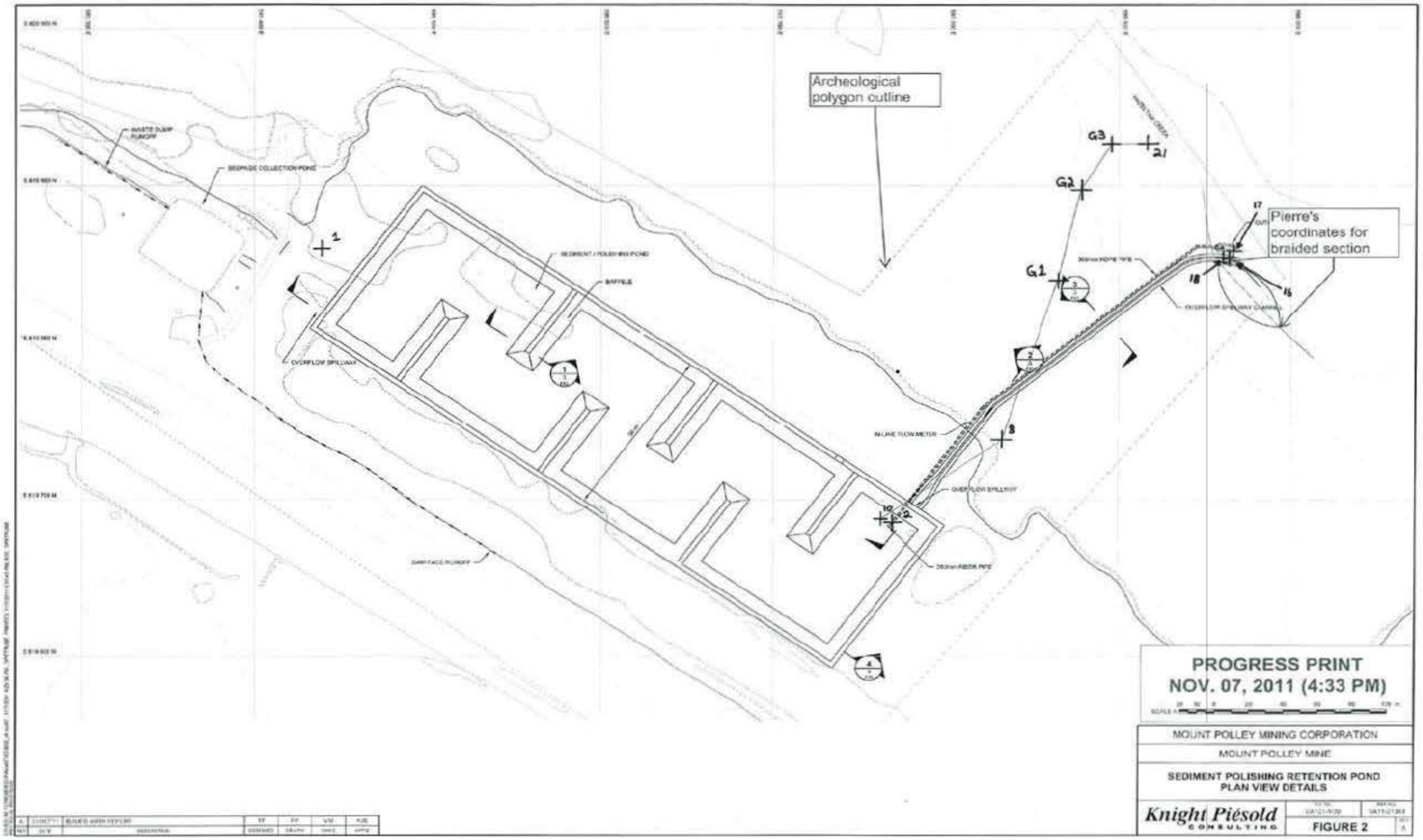


Figure 4: Photographs from November 2011 field work

a) Proposed discharge site from opposite shore

b) Looking downstream of discharge

c) Looking upstream of discharge

d) Looking up proposed discharge path from creek 1

e) Looking up proposed discharge path from creek 2

f) Looking up proposed discharge path from creek 3

Figure 4: Photographs from November 2011 field work


g) Looking up proposed discharge path from creek 4


h) Looking down proposed discharge path to creek 1


i) Looking down proposed discharge path to creek 2


j) Looking down proposed discharge path to creek 3


k) Looking down proposed discharge path to creek 4

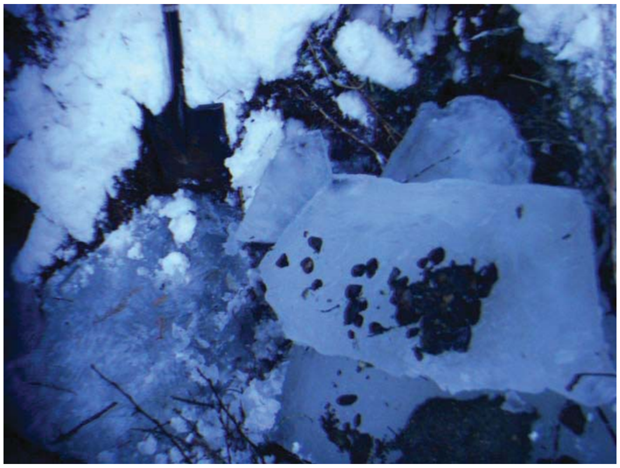

l) Looking down proposed discharge path 5

Figure 4: Photographs from November 2011 field work

m) Upstream cross section

n) Cross section at discharge

o) Cross section downstream



p) Substrate material adhered to ice cleared off creek

q) 0.5 m ruler in creek at proposed discharge site

minnow
environmental inc.

July 2, 2013

Ms. Colleen Hughes
Environmental Coordinator
Mount Polley Mining Corporation
Box 12, Likely, BC
V0L 1N0

Dear Ms. Hughes,

Re: Phosphorus in Polley Lake

The Mount Polley Mine, owned and operated by the Imperial Metals Corporation, is a copper/gold mine located northeast of Williams Lake, British Columbia on Mount Polley between Polley Lake and Bootjack Lake (Figure 1). Mine representatives have been monitoring the water quality of local lakes and creeks since prior to the initiation of mining operations in 1997. Through the examination of water quality monitoring data, Mount Polley has identified an apparent increase in concentrations of phosphorus in Polley Lake and has also recorded anecdotal observations of an increase in the occurrence of spring algal blooms. In response to this observation, Mount Polley retained Minnow Environmental Inc. (Minnow) to provide an analysis of current phosphorus concentrations, sources of phosphorus to Polley Lake, and potential implications of increased phosphorus concentrations in Polley Lake. Concentrations of nitrogen, measures of light penetration (turbidity and Secchi depth), and lake profiles of temperature, dissolved oxygen, pH and conductivity are also considered.

Review of Phosphorus in Lakes

Phosphorus is a ubiquitous element generally found in an inorganic state in sedimentary rock. Organic phosphorus, as phosphate ($^{-}$), is an essential nutrient, is the currency for cellular respiration and energy production, and forms the basis of metabolism and growth for all living organisms. In freshwaters, phosphate is required for growth of photosynthesizing aquatic organisms (i.e., plants, algae) and is often the nutrient limiting primary production (Wetzel 2001; CCME 2004). The trophic status, or level of productivity, of a lake is defined by, among other factors, the amount of phosphate available in the spring for the growth of phytoplankton, which form the base of the aquatic food chain. Therefore, an increase in phosphorus concentration above background levels has the potential to alter a lake's trophic status and dominant biota, decrease biodiversity, cause a decline in ecologically sensitive species/increase in tolerant species, cause an increase in biomass, turbidity and organic matter, and cause an increase in oxygen consumption, potentially decreasing aqueous dissolved oxygen concentrations.

Phosphorus in Polley Lake

British Columbia has a water quality guideline for phosphorus in lakes that is specified as an optimal range of total phosphorus (>5 to <15 ug/L) for the protection of salmonids (BCMOE 1985). The guideline also indicates that monitoring of chlorophyll a (the dominant photosynthetic pigment in phytoplankton) should be undertaken in response to elevated levels of total phosphorus (TP>15 mg/L). There is no BC water quality guideline for chlorophyll a in lakes. The Canadian Water Quality Guideline (CWQG) for phosphorus (protection of aquatic life) provides a somewhat different approach in the form of a guidance framework for the management of freshwater ecosystems that considers reference and baseline conditions (CCME 2004). This allows for a trigger range to be set for a particular receiving environment and also considers the effects of increased TP, such as increased levels of chlorophyll a and changes in dissolved oxygen (CCME 2004). A generalized trigger limit of 50% increase in TP from baseline is often used as a starting point for triggering an investigation into the cause of the increase and monitoring of secondary effects such as chlorophyll a and hypolimnetic dissolved oxygen (CCME 2004). In addition, TP-based trophic classification is used as a guideline to monitor lakes and rivers and to trigger management action to ensure that trophic status is not altered due to anthropogenic inputs (CCME 2004). If none of the associated effects are observed, then close monitoring of the system for chlorophyll a, dissolved oxygen, and further increases in TP is recommended.

Concentrations of TP in Polley Lake surface water (at monitoring stations P1 and P2) have increased significantly over the 2001 to 2012 period (Figure 2; Appendix Table 1; Spearman's Rank Order Correlation p<0.05; Appendix Table 2). A similar temporal increase did not occur in Bootjack Lake. The increase in concentrations of TP in Polley Lake is most evident starting in 2010, with surface concentrations prior to 2010 spanning a range of 5 to 43 ug/L (mean = 12 ug/L) and concentration in 2010-2012 spanning a range of 14 to 99 ug/L (mean = 50 ug/L; Appendix Table 1). Unlike TP, no consistent, significant trends were observed in concentrations of ortho-phosphate or total dissolved phosphorus (Appendix Tables 1 and 2). Baseline (1995/1996) concentrations of TP in Polley Lake and Bootjack Lake surface water were between 9 ug/L and 22 ug/L (Appendix Table 3; HKP 1996; HKP 1997). These baseline concentrations are somewhat greater than the BC criterion range (BCMOE 1985), precluding its application as an interpretive tool. However, based on conventional trophic classification systems using TP concentrations (Table 2), Polley Lake would have been classified as a mesotrophic lake during baseline (1995/1996). Based on current TP concentrations (2010-2012 mean of 50 ug/L), Polley Lake would now be classified as a eutrophic lake. In general, in the absence of other constraints on productivity (e.g., low nitrogen concentrations), this would be expected to result in increased phytoplankton growth and increased potential for conditions of low dissolved oxygen.

Nitrogen, Light Penetration and Profiles

The trophic status of an aquatic system depends on a number of factors in addition to phosphorus (e.g., total nitrogen, light, temperature; Carlson 1977; Wetzel 2001). Although phosphorus is normally the nutrient limiting phytoplankton growth in lakes, nitrogen (which is also essential for plant and algal growth) can also be a limiting nutrient. The Redfield Ratio (Redfield 1934) and the work of Dillon and colleagues (Dillon and Rigler 1975ab; Dillon et al. 1986) both provide nitrogen:phosphorus ratios (N:P ratios) that can be used to determine the limiting nutrient in a given system. Generally, an N:P ratio of 16:1 is optimal for algal growth and increasing or decreasing this ratio can affect the algal community and/or limit the system (Redfield 1934; Dillon and Rigler 1975a,b; Dillon et al. 1986). Phosphorus is typically a limiting nutrient at N:P ratios of 12:1 or more; whereas nitrogen is typically a limiting nutrient at N:P ratios of less than 10:1 (Dillon et al. 1986).

Concentrations of total nitrogen (TN) in Polley Lake surface water have also increased over the period from 2001 to 2012 (Figure 3; Appendix Table 1), significantly so at Station P1 (Spearman’s Rank Order Correlation $p<0.05$; Appendix Table 2). A significant temporal increase did not occur in Bootjack Lake; however, concentrations were much lower in 2001 than at all subsequent dates suggesting an increase between 2001 and 2006. The increase in concentrations of TN in Polley Lake appeared to occur from 2001 to 2007, followed by a decrease in 2008/2009 and a second, sustained increased from late 2009 to present (from <200 ug/L to roughly 400 ug/L). It is notable that the latter also appears to be the case in Bootjack Lake and that, unlike TP, concentrations of TN in Polley and Bootjack lakes are quite similar (Figure 3). Based on conventional trophic classification systems using TN concentrations alone (Table 2), Polley Lake would have been classified as oligotrophic in 2008/2009 and is more recently at the oligotrophic-mesotrophic boundary. Although nitrate and nitrite have been monitored in Polley and Bootjack Lakes, concentrations have frequently been below the method detection limit and detectable concentrations have been too few to conduct a meaningful analysis (Appendix Table 1). The ratio of total nitrogen to total phosphorus has generally decreased in Polley Lake since 2006 (which is consistent with the observed increase in TP concentration; Figure 4), but a significant trend was only evident at Station P1 (bottom; Appendix Table 2). Nonetheless, all temporal relationships were negative in both Polley and Bootjack Lakes, with the correlation coefficient greater in Polley Lake than in Bootjack Lake (Appendix Table 2). Unfortunately, no baseline concentrations of total nitrogen are available and a low TN/TP ratio in 2001 is not supported by additional data, but nonetheless suggests that the TN/TP ratio of both lakes may have increased substantially between 2001 and 2006 (Figure 4). In recent years (2010-2012), the average TN:TP ratio has been substantially lower in Polley Lake (8.3) than in Bootjack Lake (17.3). The low ratio in Polley Lake (less than 10) suggests that nitrogen may be the more limiting nutrient (than phosphorus) in Polley Lake (which is consistent with a classification of eutrophic based on TP and oligo-trophic/mesotrophic based on TN). This highlights the fact that loadings of both phosphorus and nitrogen must both be carefully considered in lake monitoring and in the management of nutrient loadings.

The turbidity of Polley Lake surface water has increased significantly over the 2001 to 2012 period (Figure 5; Appendix Table 1; Spearman's Rank Order Correlation $p<0.05$; Appendix Table 2), with no similar temporal increase observed in Bootjack Lake. As with phosphorus, the increase in turbidity in Polley Lake is most evident starting in 2010, with surface turbidity prior to 2010 spanning a range of 0.4 to 1.1 NTU (mean = 0.8 NTU) and surface turbidity in 2010-2012 spanning a range of 0.8 to 1.8 NTU (mean = 1.4 NT; Appendix Table 1). The increase in turbidity is supported by observations of Secchi depth (a measure of light penetration; Figure 6). Although temporal change in Secchi depth is difficult to assess statistically due to seasonal differences (i.e., only same season data can be compared over time; Appendix Table 3), it is evident that Secchi depth was lowest in 2011 and 2012 in Polley Lake (Figure 6). However, it must be noted that lowest Secchi depths in Bootjack Lake were also observed in 2011 and 2012, confounding the interpretation of cause of low Secchi depth in Polley Lake.

Examination of lake profile data for temperature, dissolved oxygen, conductance and pH (Appendix Figures 1 to 12) indicate that conductivity in Polley Lake (but not Bootjack Lake) has increased in recent years. This observation is consistent with previous observations of lake water quality (Minnow 2010). Although incidents of low dissolved oxygen were observed in both Polley and Bootjack lakes in the fall of 2012 (Appendix Figures 1 to 12); results appear to have been due to improper function of a field meter and there is no clear evidence of a productivity-related temporal decrease in dissolved oxygen concentrations in Polley Lake.

Overall, the observed increase in TP and TN concentrations in Polley Lake would be expected to result in some increase in productivity. Greater productivity is supported by a concurrent temporal increase in turbidity and observations of lower light penetration in recent years (lower Secchi depth). This provides a weight-of-evidence indicating that some level of eutrophication of Polley Lake has occurred. It is notable that recent ratios of total nitrogen to total phosphorus are sufficiently low that any temporal increase in nitrogen concentration would also be expected to increase production.

Trophic Classification

To provide additional perspective on the implications of the temporal increase in phosphorus concentrations in Polley Lake, the Carlson Trophic State Index (Carlson 1977) was applied using available data for total phosphorus and Secchi depth. The Carlson Trophic State Index (TSI) was developed to communicate the trophic status of a lake, with a scale that represents an approximate doubling of algal biomass with each 10 TSI unit change. Using the Carlson Index, the increase in phosphorus concentration in Polley Lake from the period prior to 2010 to the 2010-2102 period results in an increase in TSI from 40 to 61 (Table 2). This change of approximately 20 TSI units represents an expected four-fold increase in algal biomass. The decrease in Secchi depth over the same period results in an increase in TSI from 34 to 41 (Table 2). This change of approximately 10 TSI units represents an increase in algal biomass of roughly two-fold. The calculated increases in TSI suggest a temporal change in the trophic condition of Polley Lake from the oligotrophic/mesotrophic boundary to the mesotrophic/eutrophic boundary (Table 2). Physicochemical and biological changes expected with this increase in trophic status include increased algal growth (particularly of blue-green algae), reduced water transparency, greater macrophyte growth, lower hypolimnetic dissolved oxygen, and possible changes in fish community composition (Table 2).

Source of Phosphorus and Nitrogen to Polley Lake

Since 2001, increases in TP at Mount Polley water quality monitoring Station W4 (North Dump Creek, which flows into Polley Lake; Figure 7 [see Figure 1 for the location of Station W4]) have been followed closely by increases in TP in Polley Lake (Figure 2). This is a strong indication that North Dump Creek may be (or may have been) the main source of above-background phosphorus in Polley Lake. Furthermore, TP concentrations at both W4 and Polley Lake responded to the construction of a coffer dam and an interception/conveyance ditch (Long Ditch) in September 2009, which collects seepage water from the North Bell Dump (which previously flowed into the headwaters of North Dump Creek). Following construction of the Long Ditch, TP levels decreased at W4 and at P1 and P2 (Figures 7 and 2), suggesting that seepage into W4 was a major source of phosphorus. For example, in October 2008, TP at W4 was 131 ug/L and the highest since 2001 and by November 2009 TP dropped to 28 ug/L (near baseline; Figure 7). Polley Lake followed a similar course - in October 2008 TP was 26 ug/L (also the highest since 2001) and decreased to 4.4 ug/L in September 2009 (Figure 2). Following construction of the Long Ditch, seepage water intercepted and sampled at Joe's Creek Pipe had relatively high concentrations of TP (i.e., up to 150 ug/L). The corresponding high concentrations of TP at Joe's Creek Pipe and the decrease at W4 suggests that this seepage was a major cause of the pre-2009 increase of TP observed at W4, Polley Lake and in Hazeltine Creek downstream of Polley Lake (Station W7). The relationship between total nitrogen (TN) at Station W4 and Polley Lake is less clear than for phosphorus (Figures 7 and 3). Nonetheless, it is clear that North Dump Creek represented a significant source of nitrogen to Polley Lake, particularly over the period from 2007-2009 (Figure 7) and concentrations up to 91 mg/L at Joe's Creek Pipe attest to the importance of interception. Nonetheless, recent increases in both phosphorus and nitrogen in Polley Lake (2010-2012) suggest that Polley Lake is slow to respond to the construction of the Long Ditch, that seepage had not been fully contained (addressed in the summer of 2012), and/or that there may be another seepage or groundwater source flowing into North Dump Creek, another drainage to Polley Lake, or directly into Polley Lake.

Recommendations and Closure

As previously indicated, baseline concentrations of total phosphorus in both Polley Lake and Bootjack Lake were greater than the BCWQG optimal range of 5-15 ug/L and application of the CCME framework for phosphorus indicates that an increase in trophic level from the oligotrophic-mesotrophic boundary to the mesotrophic-eutrophic boundary has occurred in Polley Lake. It is therefore recommended that an integrated ecosystem approach such as that outlined in the CCME framework is used to address the present concerns over increased TP in Polley Lake. While a weight-of-evidence indicates that eutrophication of Polley Lake has occurred, monitoring of the secondary effects of increased nutrient concentrations is required to fully assess the implications of the increase. Accordingly, the following recommendations are provided:

1) Ensure that monitoring of phosphorus and nitrogen at lake stations (P1, P2, B1 and B2) is completed as specified in the Mount Polley Lake Sampling Program;
2) Monitor Secchi depth, chlorophyll a and phytoplankton communities at P1, P2, B1 and B2 monthly between the spring and fall overturn;
3) Continue to monitor chlorophyll a on substrates in Hazeltine Creek downstream of Polley Lake (Station W7); and
4) Identify the source of phosphorus and nitrogen loadings to Polley Lake by conducting a focused site assessment. The current data suggests that North Dump Creek (monitored at Station W4) is a source, but there may be another source (or sources) that should also be determined.

I trust that this brief letter serves to communicate temporal trends in nutrient concentrations in Polley and Bootjack lakes and the corresponding physical, chemical and biological implications. If you have any questions or would like to discuss any aspect of this letter report, please do not hesitate to let me know.

Sincerely,
Minnow Environmental Inc.

Pierre Stecko, M.Sc., EP, RPBio
Senior Aquatic Scientist/Principal

References

BCMOE (British Columbia Ministry of Environment). 1985. Water Quality Criteria for Nutrients and Algae. Prepared by R.N. Nordin, Water Management Branch. October 1985.

Burns, N.M., J.C. Rutherford and J.S. Clayton. 1999. A Monitoring and Classification System for New Zealand Lakes and Reservoirs. Lake Reservoir Manag. 15: 255-271.

Carlson, R.E.. 1977. A Trophic Index State for Lakes. Limnol. Oceanogr. 22(2): 361-369.

Carlson, R.E. and J. Simpson. 1996. A Coordinators Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. Madison, WI.

CCME (Canadian Council of Ministers of the Environment). 2004. Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. CCME Canadian Environmental Quality Guidelines.

Dillon, P.J. and F.H. Rigler. 1975a. A Simple Method for Predicting the Capacity of a Lake for Development based on Lake Trophic Status. J. Fish. Res. Board Can. 31: 1771-1778.

Dillon, P.J. and F.H. Rigler. 1975b. The Phosphorus-Chlorophyll Relationship in Lakes. Limnol. Oceanogr. 19: 767:773.

Dillon, P.J., K.H. Nicholls, W.A. Schneider, N.D. Yan and D.S. Jeffries. 1986. Lakeshore Capacity Study – Trophic Status. Ontario Ministry of Municipal Affairs, Research and Special Projects Branch. May 1986.

HKP (Hallam Knight Piésold Ltd.). 1996. Mount Polley Project - Environmental Baseline and Monitoring Report: 1995. March 1996.

HKP (Hallam Knight Piésold Ltd.). 1997. Mount Polley Mining Corporation - Mount Polley Project - Environmental Baseline and Monitoring Report: 1996. June 1997.

Imperial Metals. 1990. Stage 1 Environmental and Socioeconomic Impact Assessment Report for the Mount Polley Project.

Minnow (Minnow Environmental Inc.). 2010. Mount Polley Mine: Evaluation of the Water Quality of Polley and Bootjack Lakes. Report Prepared for Mount Polley Mining Corporation, July 2010.

Nürnberg, G.. 2001. Eutrophication and Trophic State. Lakeline pp. 29-33.

QMDDEP (Quebec Ministere du Developpement Durable et de l'Environnement et des Parcs). 2011. Critères de qualité de l'eau surface au Québec. Accessed at : http://www.mddep.gouv.qc.ca/eau/criteres_eau/index.htm. August 2011.

Redfield, A.C. 1934. On the Proportions of Organic Derivations in Sea Water and Their Relation to the Composition of Plankton. In: James Johnstone Memorial Volume. (ed. R.J. Daniel). University Press of Liverpool, pp. 177–192.

Ryding, S.O. and W. Rast. 1994. The Control of Eutrophication of Lakes and Reservoirs. Volume 1. United Nations Educational, Scientific and Cultural Organization (UNESCO). 281 p.

University of Florida. 1983. Trophic State: A Waterbody's Ability to Support Plants and Fish.

Vollenweider, R.A. and J.J. Kerekes. 1980. Background and Summary Results of the OECD Cooperative Program on Eutrophication. In: Proceedings of an International Symposium on Inland Waters and Lake Restoration. United States Environmental Protection Agency. EPA 440/5-81-010. pp. 26-36.

Wetzel, R.G. 2001. Limnology. Academic Press, New York. 1006 pp.

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MAP INFORMATION
Map Projection: NAD 1983
Data Source: Department of Natural Resources Canada. All rights reserved.
Created By: J.Wilson
Creation Date: June 2013
Project No.: 2475

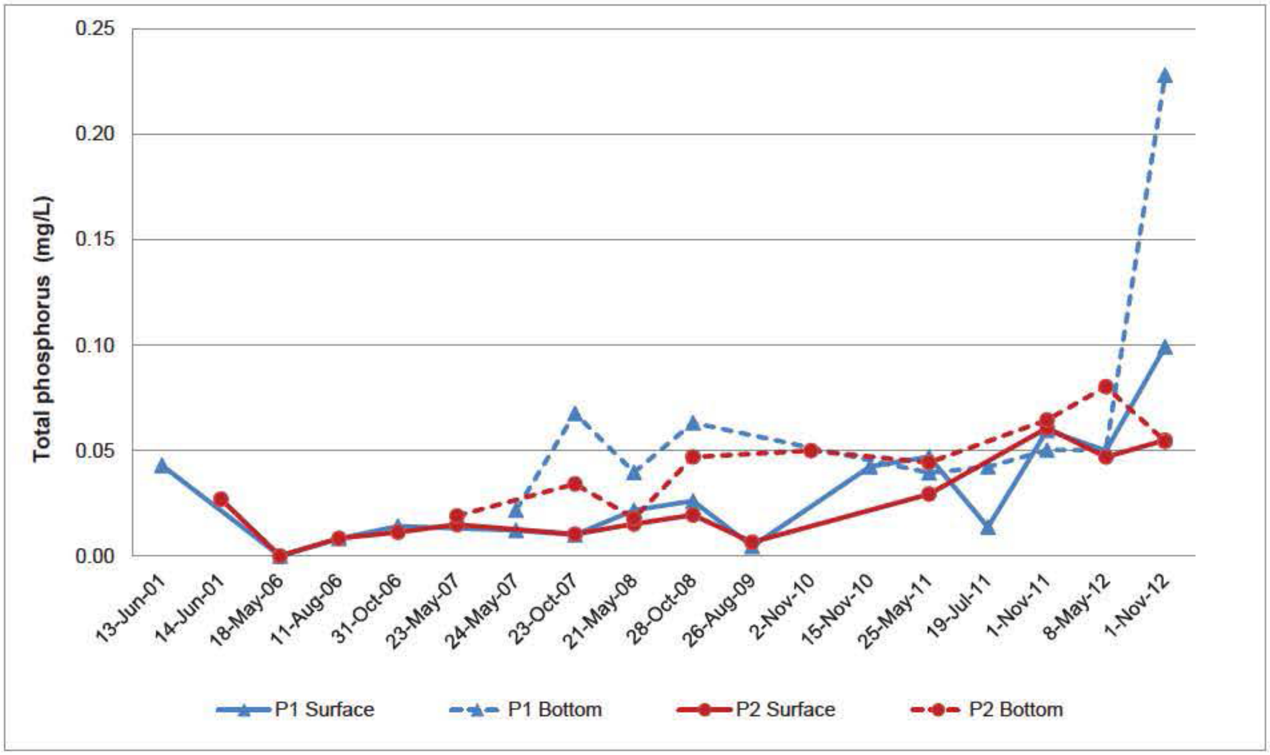
Features

- ● Sample Station
- ▨ Lake
- — River
- abc Mine Infrastructure
- abc Mine Zone

Figure 1: Overview of the Mount Polley Mine Site

Created by:

minnow
environmental inc.



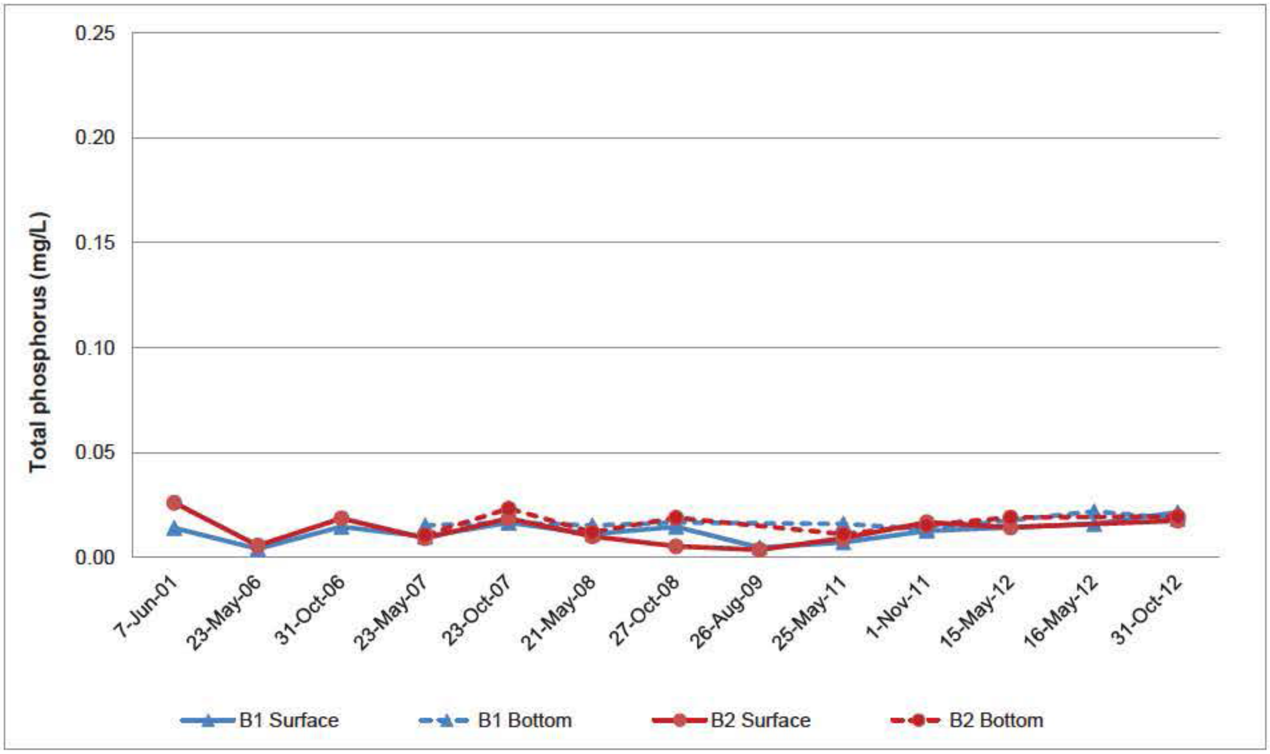
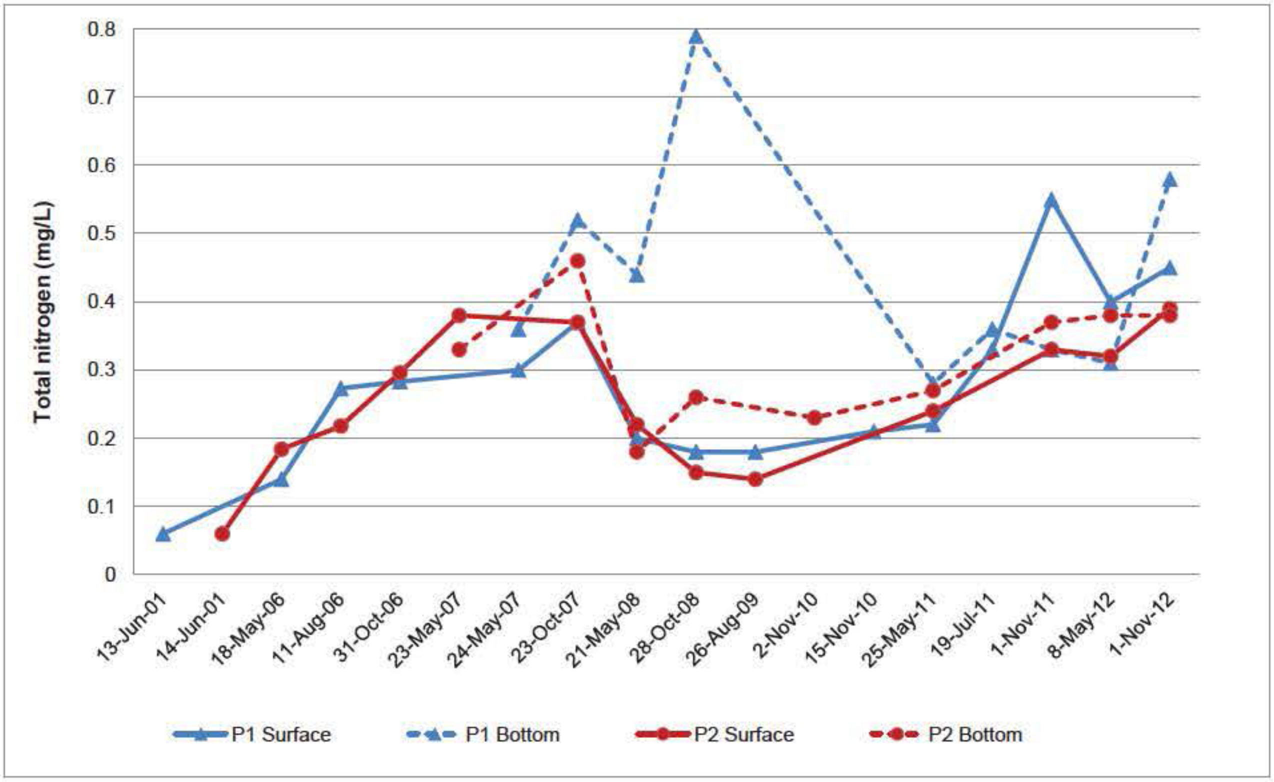


Figure 2: Total phosphorus concentrations (mg/L) in surface and bottom water collected from Polley Lake (top) and Bootjack Lake (bottom), 2001-2012



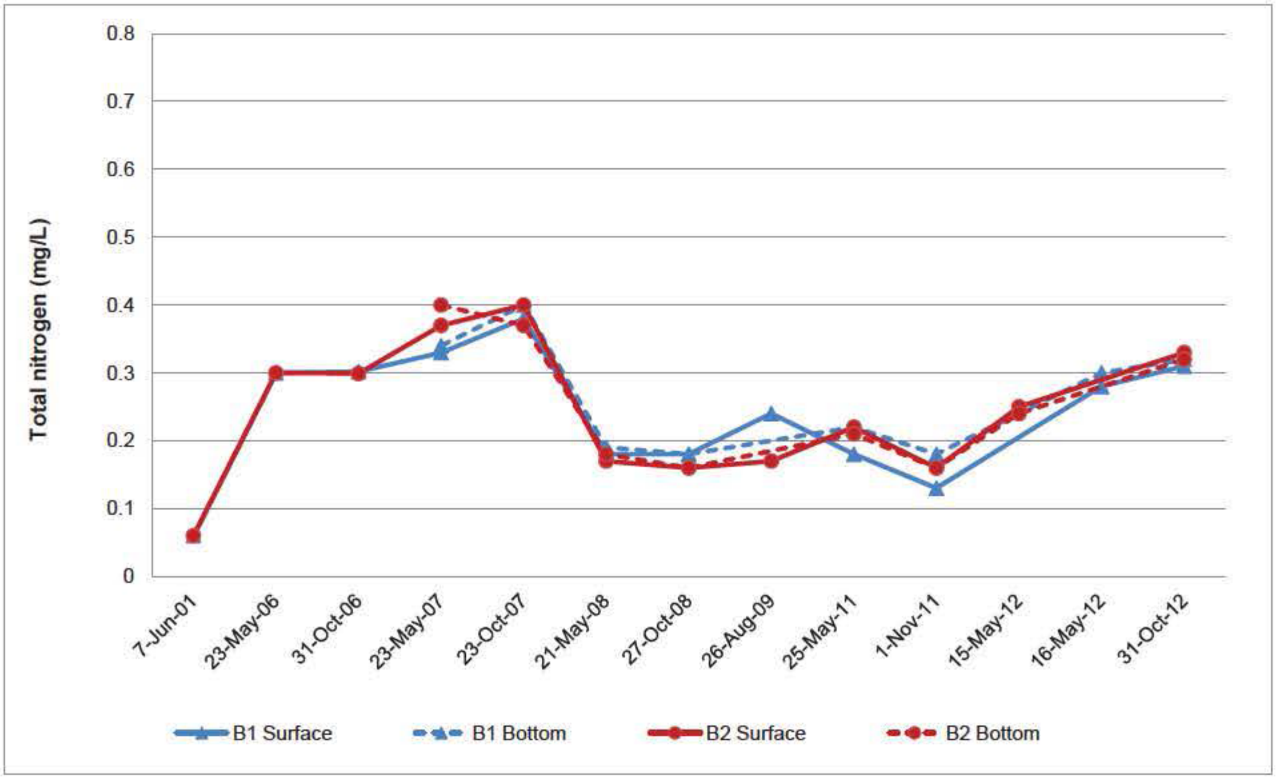


Figure 3: Total nitrogen concentrations (mg/L) in surface and bottom water collected from Polley Lake (top) and Bootjack Lake (bottom), 2001-2012

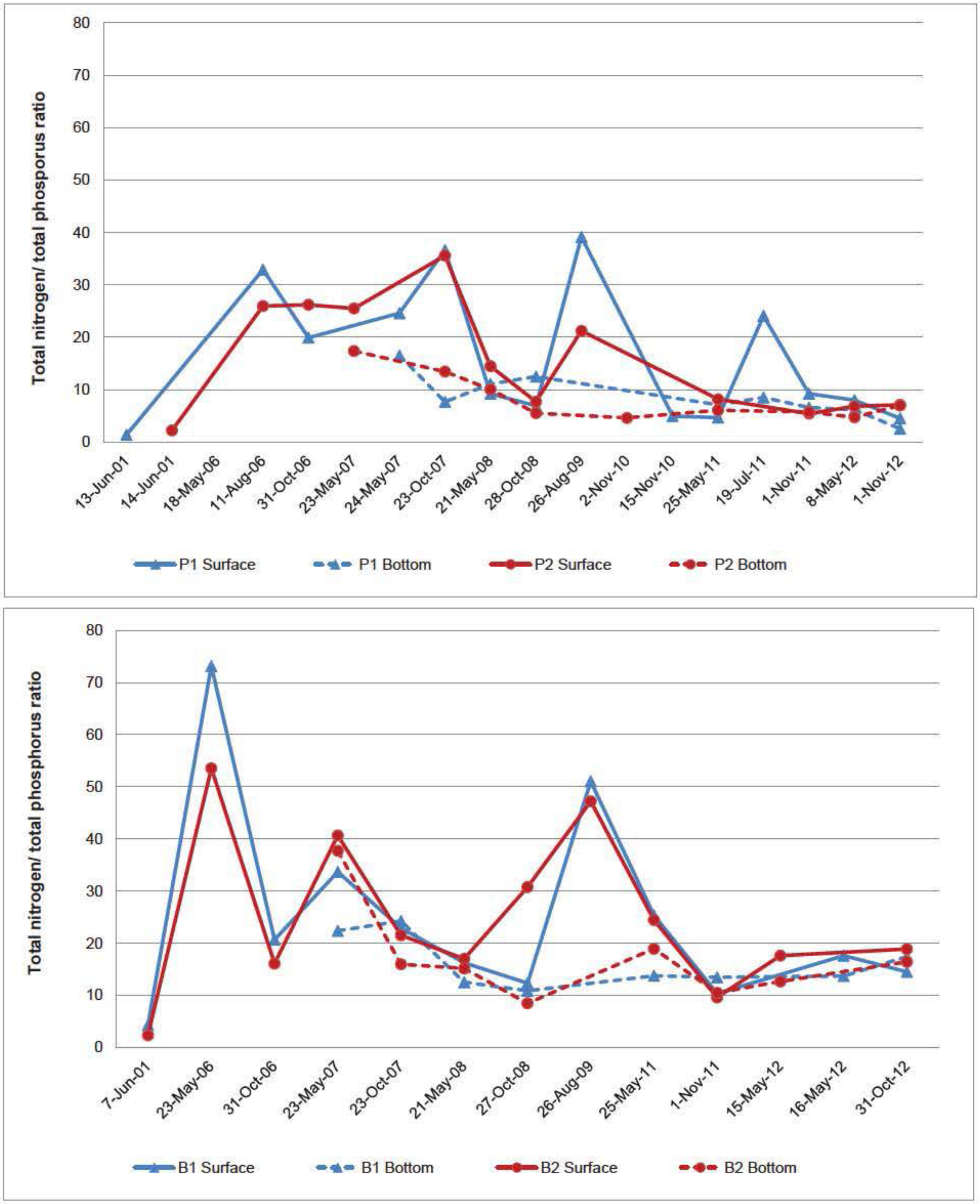
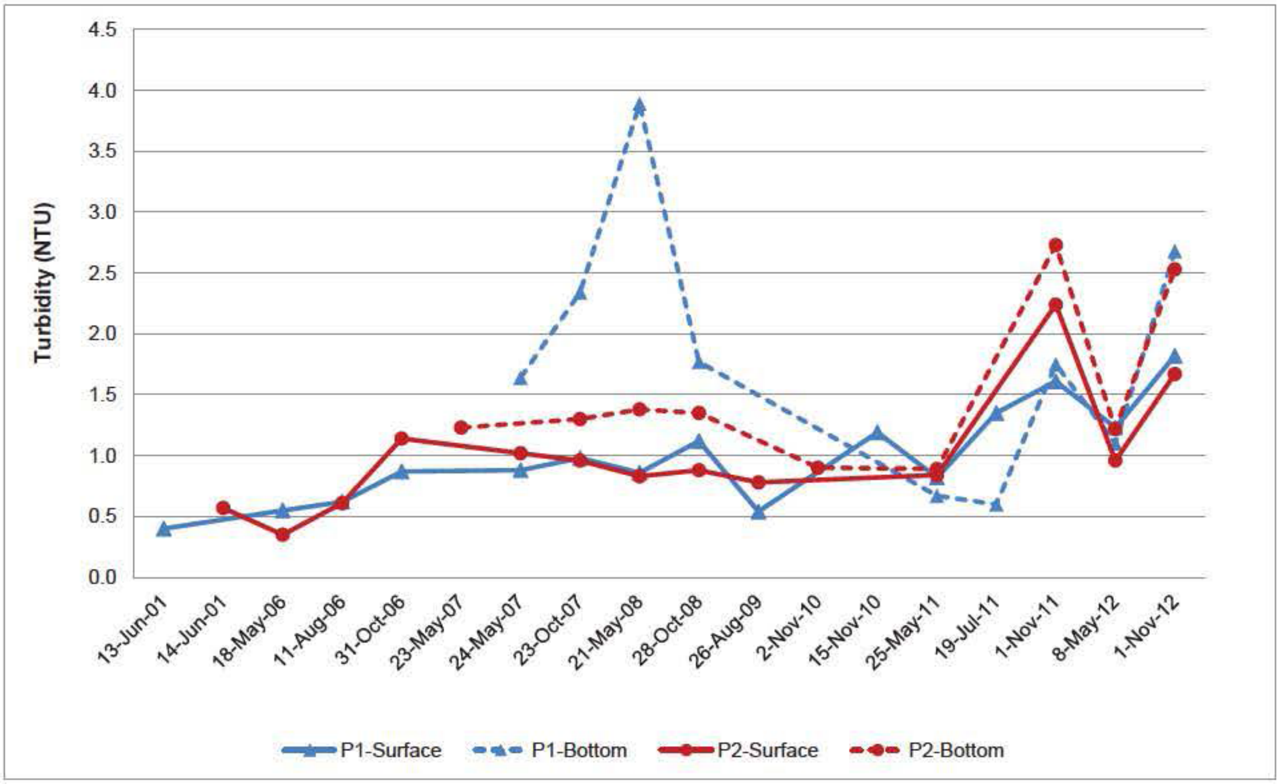


Figure 4: Ratios of total nitrogen to total phosphorus in surface and bottom water collected from Polley Lake (top) and Bootjack Lake (bottom), 2001-2012



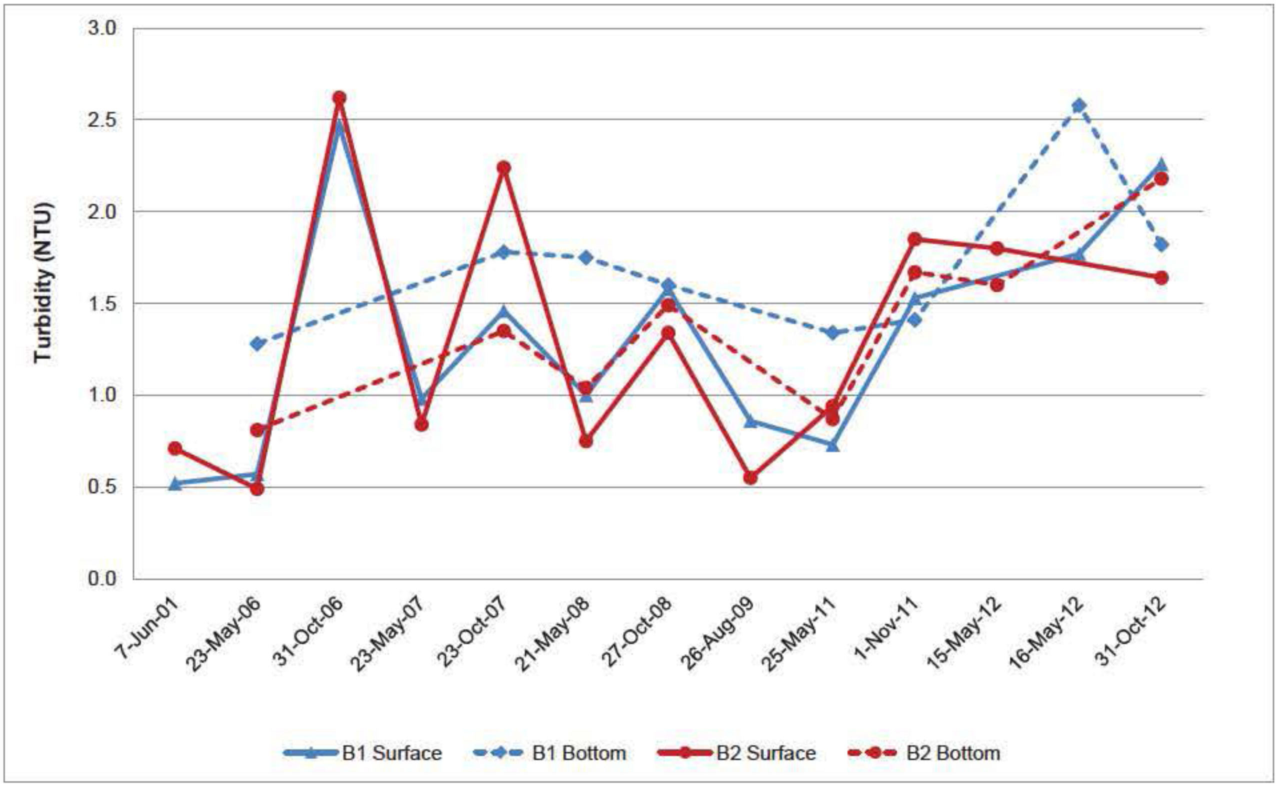
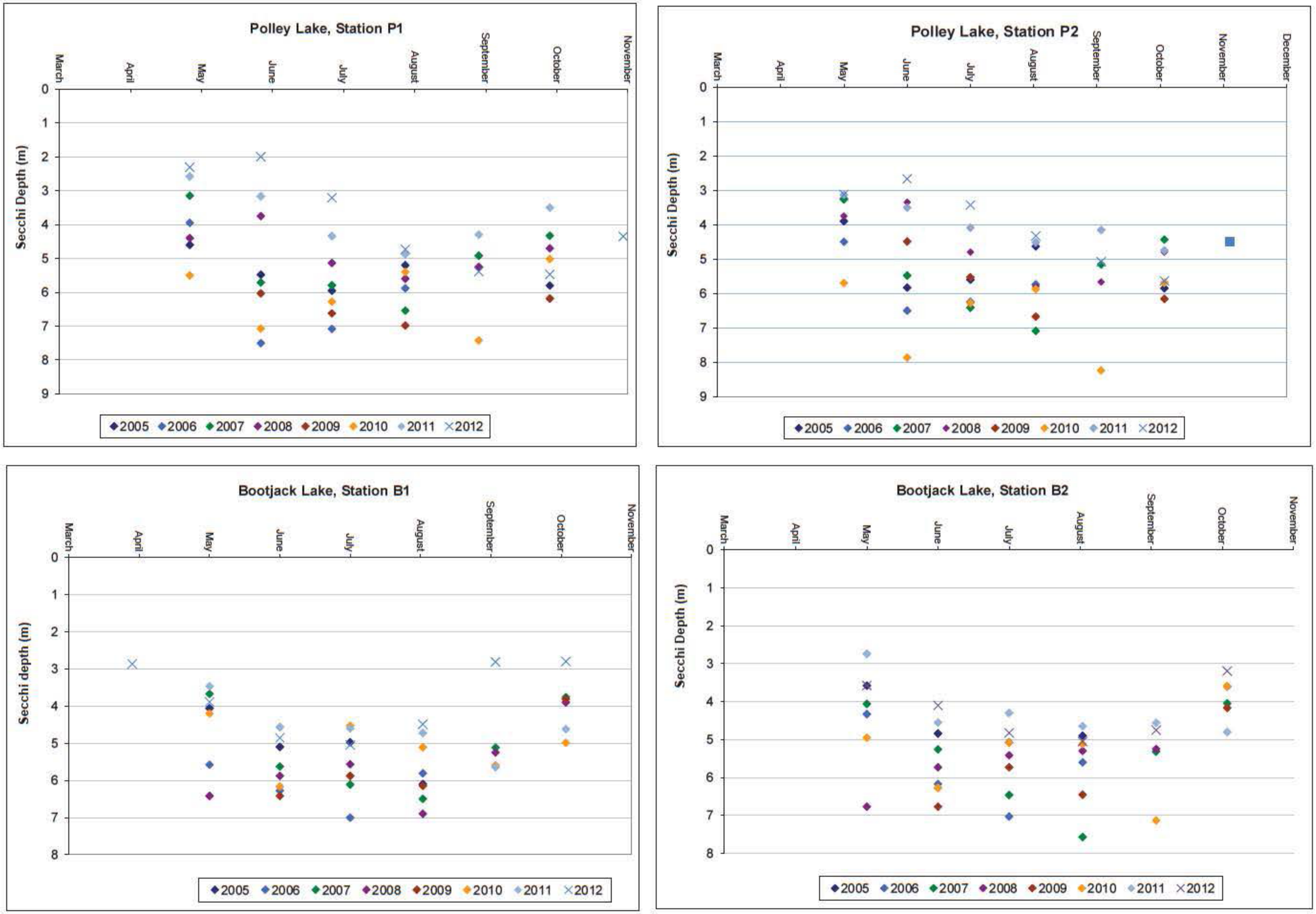


Figure 5: Turbidity in surface and bottom water collected from Polley Lake (top) and Bootjack Lake (bottom), 2001-2012

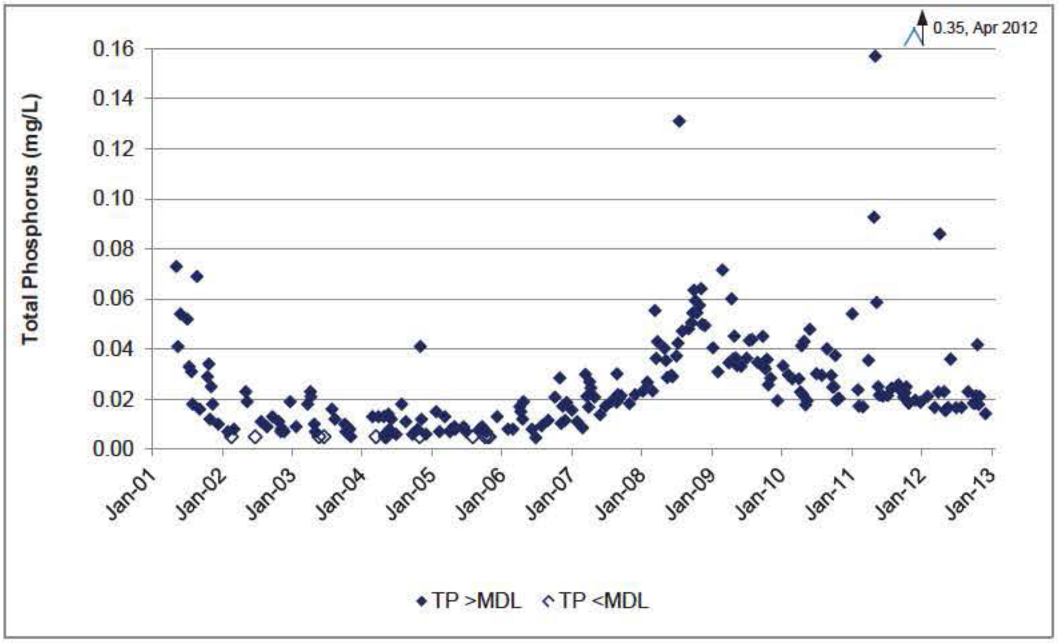

Polley Lake, Station P1

Polley Lake, Station P2

Bootjack Lake, Station B1

Bootjack Lake, Station B2

Figure 6: Secchi depth (m) in Polley Lake and Bootjack Lake, 2005-2012



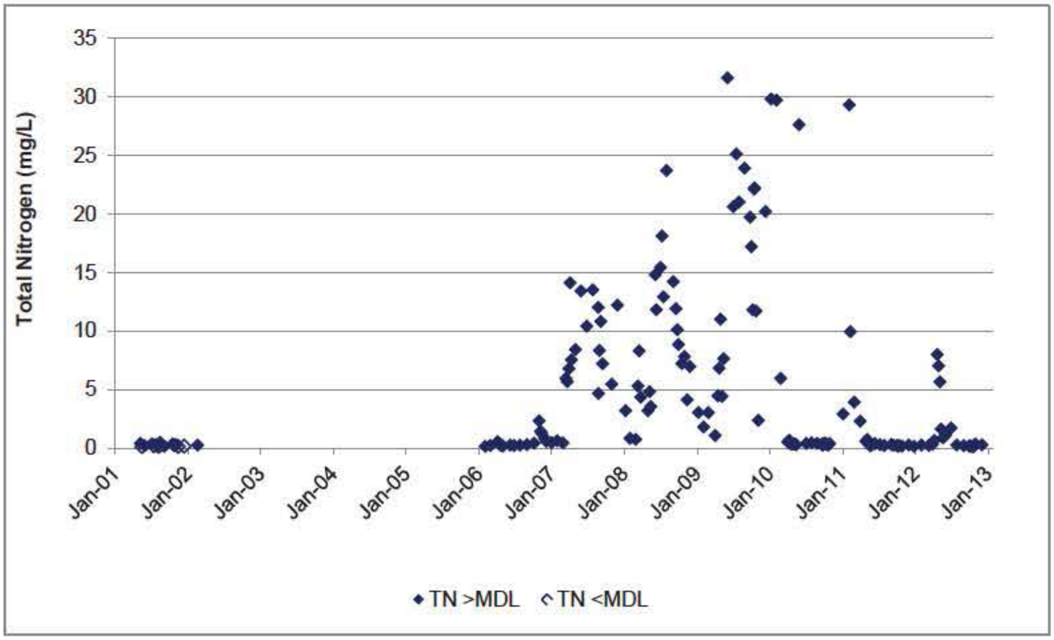
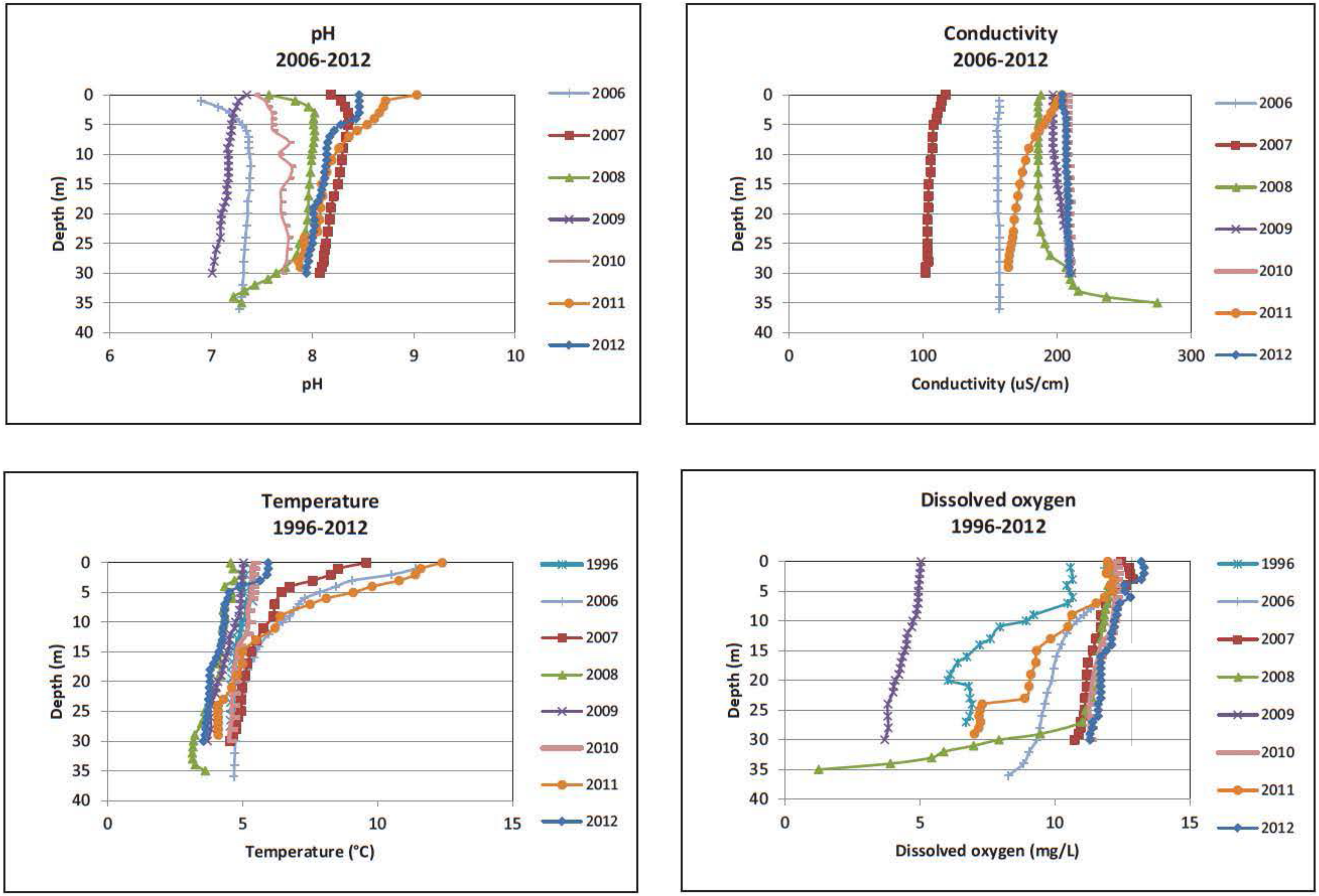
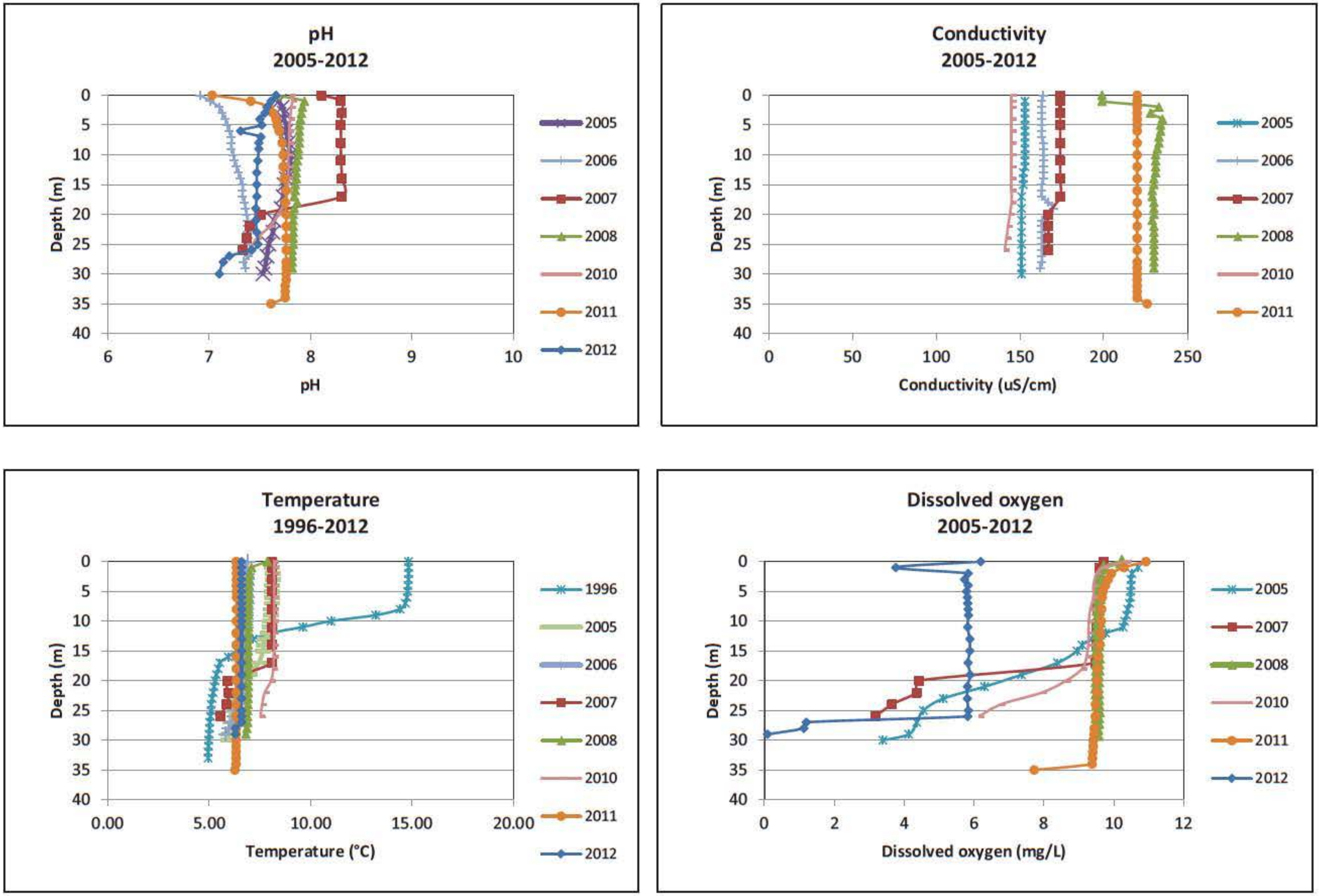


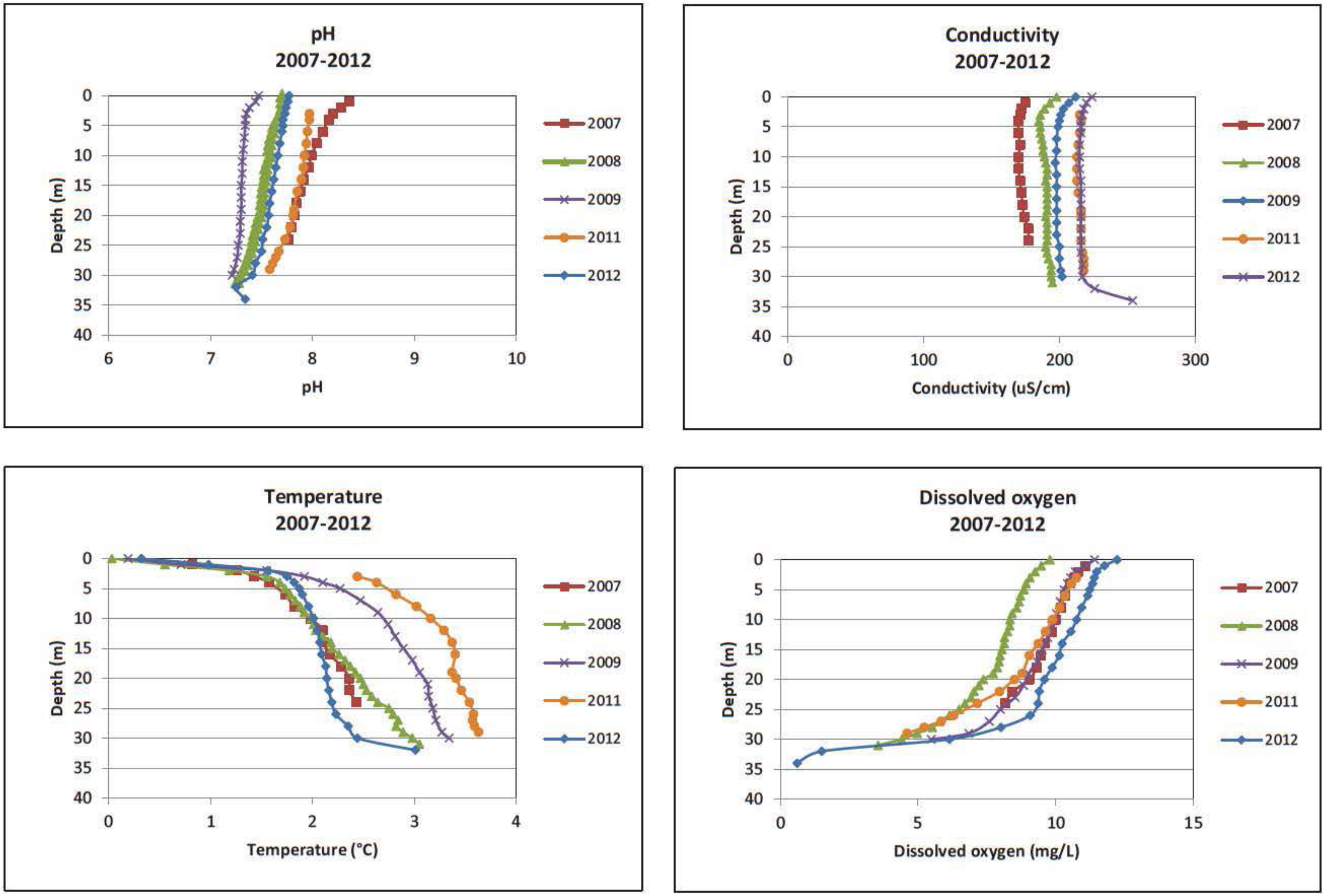
Figure 7: Total phosphorus (top) and total nitrogen (bottom) in North Dump Creek, 2001-2012



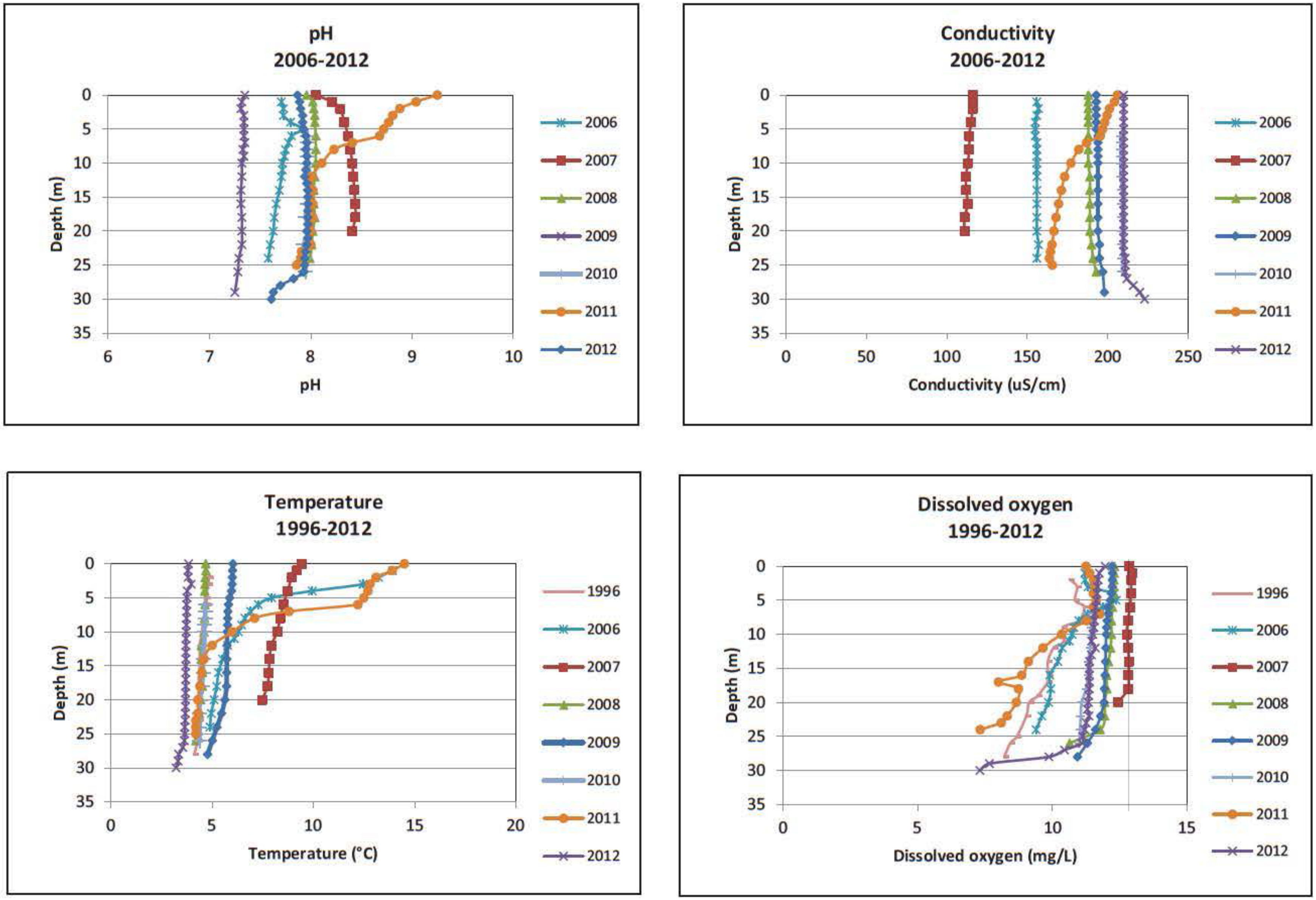
Appendix Figure 1: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Polley Lake - P1, Spring



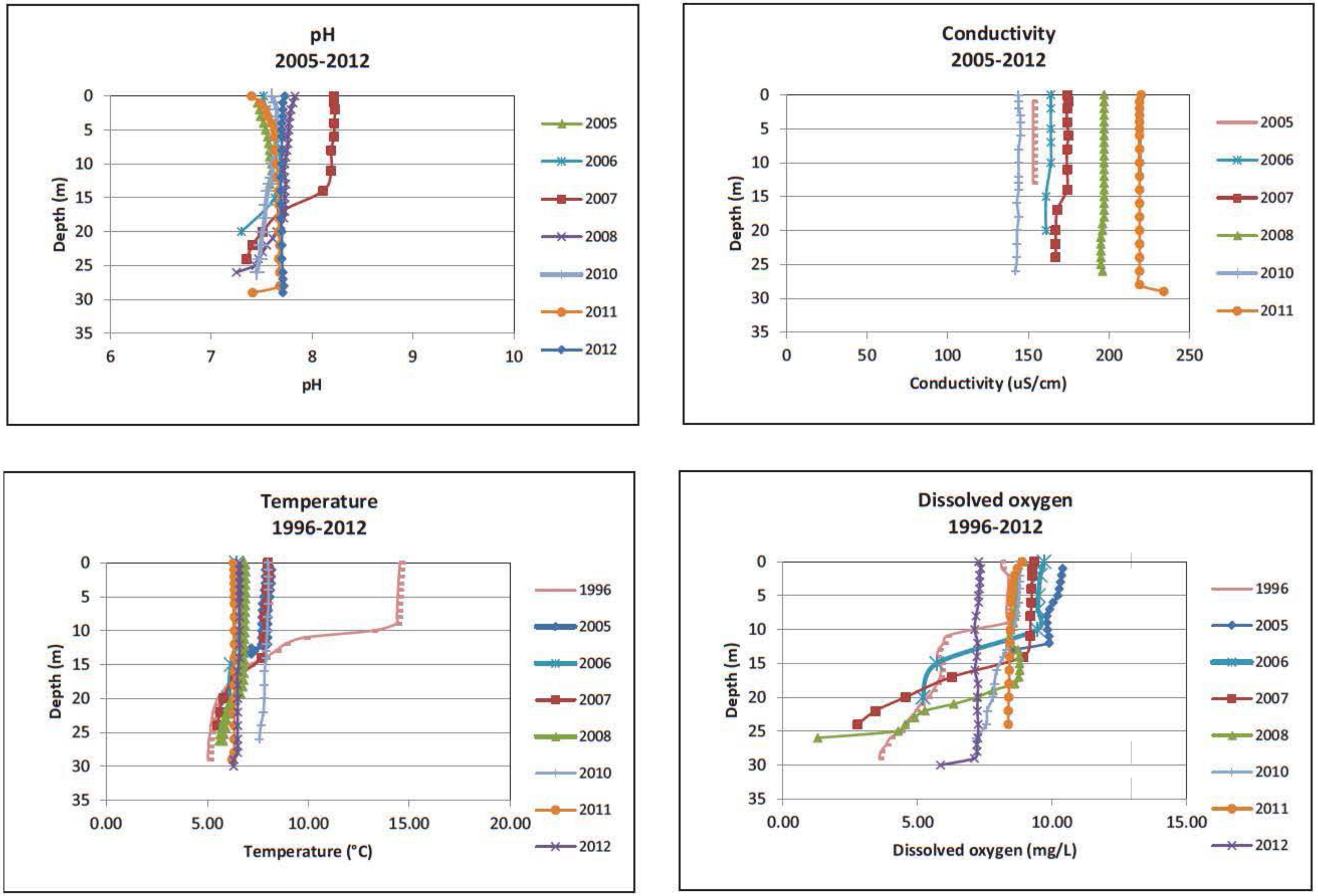
Appendix Figure 2: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Polley Lake - P1, Fall



Appendix Figure 3: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Polley Lake - P1, Winter



Appendix Figure 4: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Polley Lake - P2, Spring



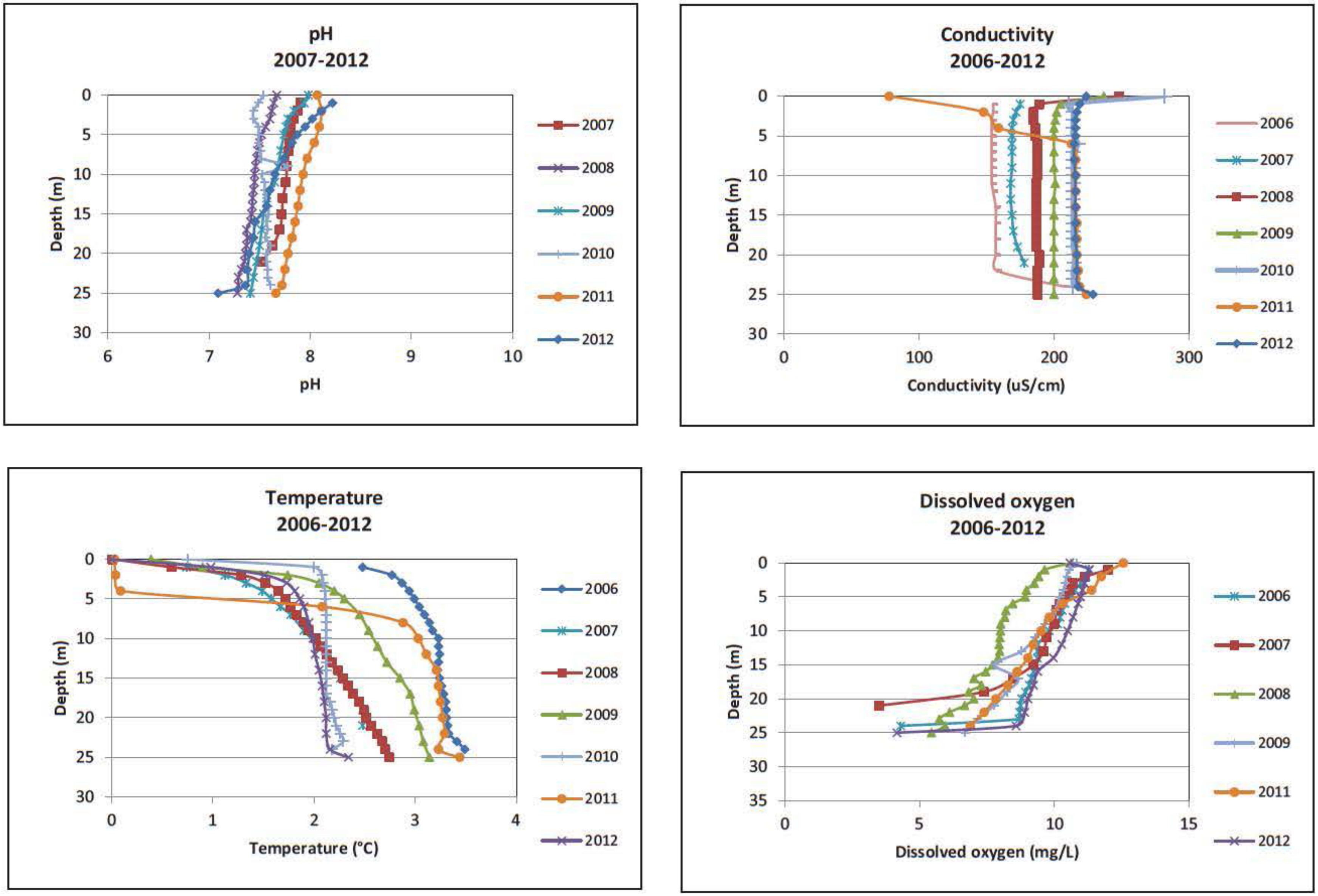
pH 2005-2012

Conductivity 2005-2012

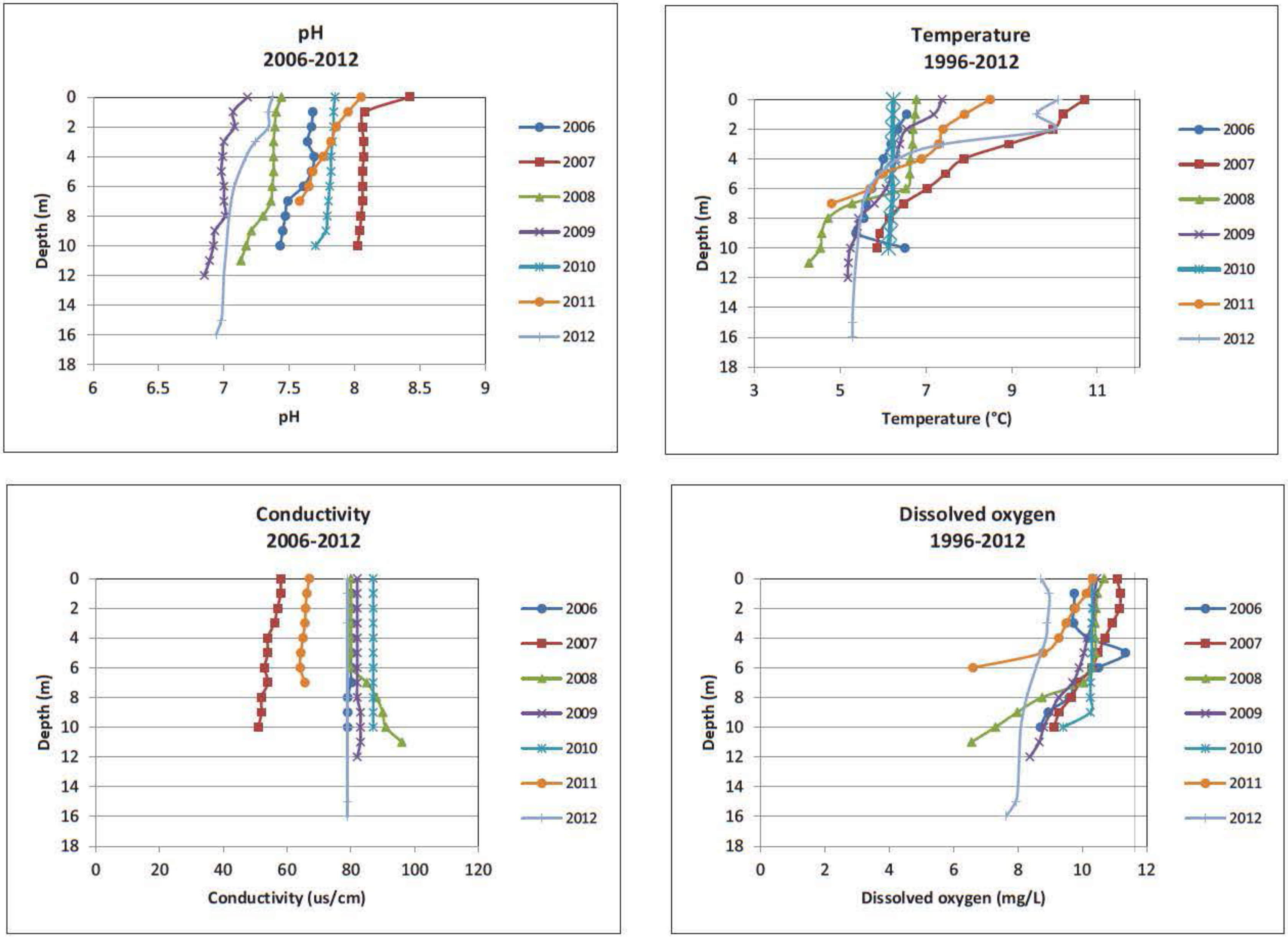
Temperature 1996-2012

Dissolved oxygen 1996-2012

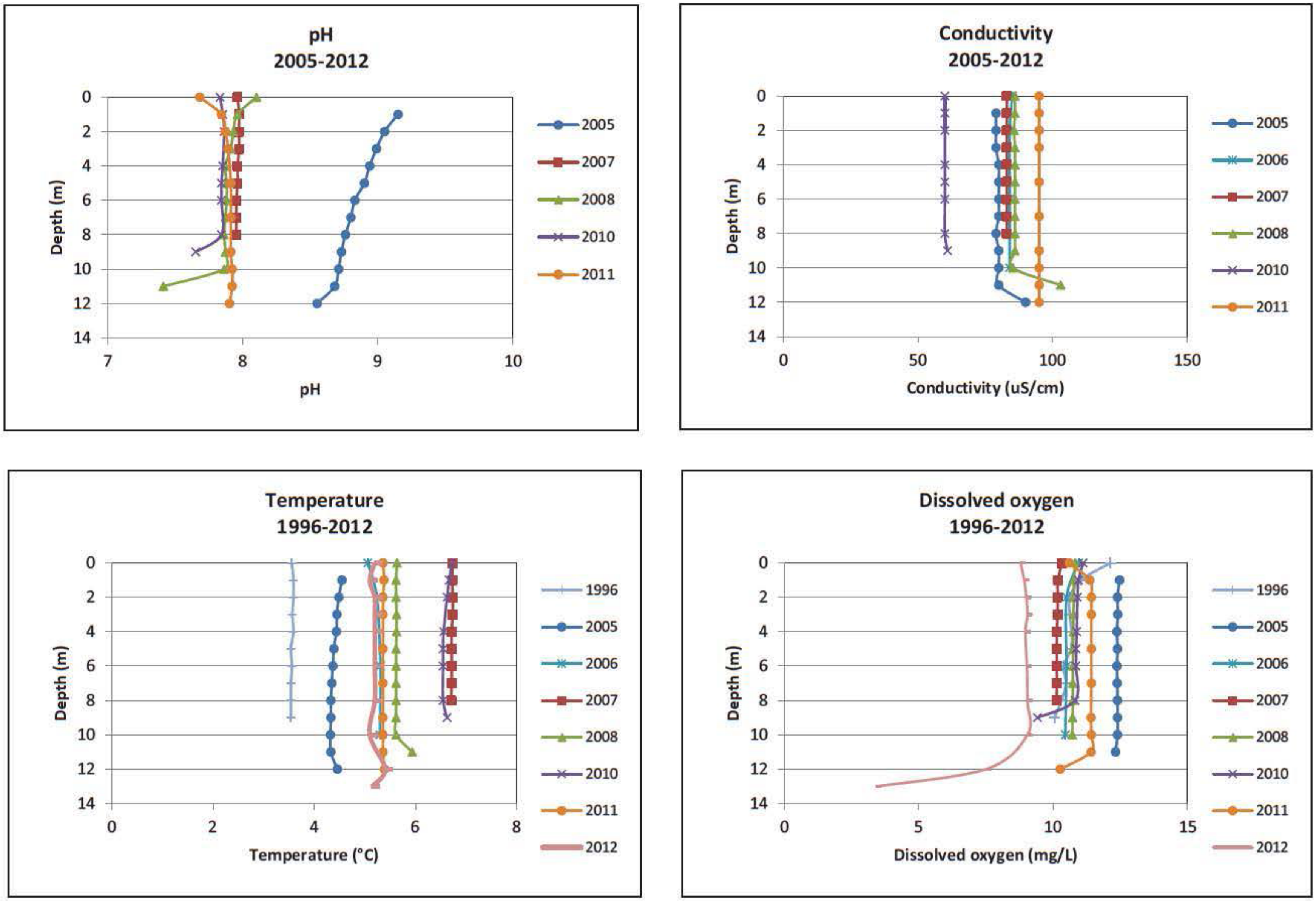
Appendix Figure 5: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Polley Lake - P2, Fall



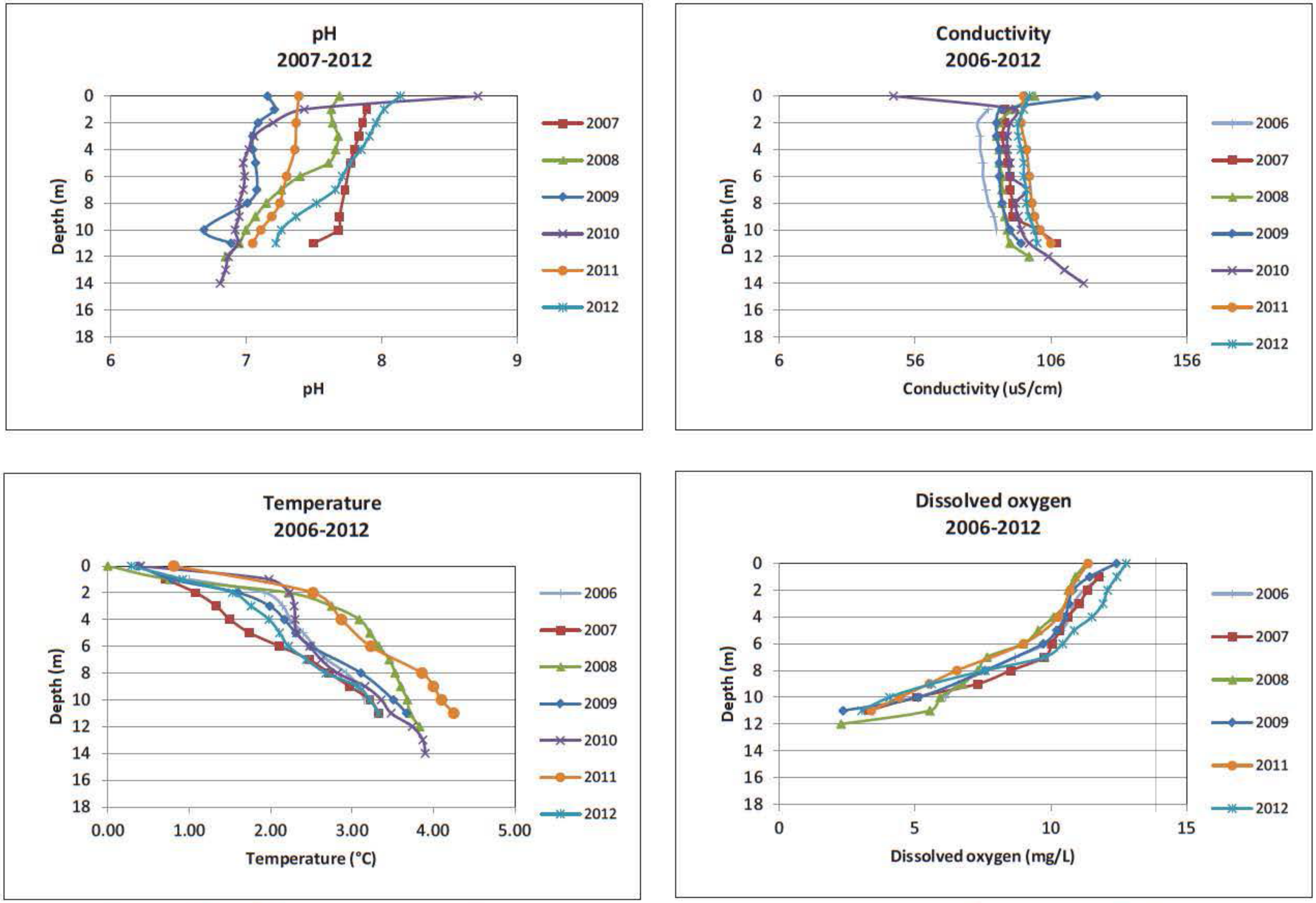
Appendix Figure 6: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Polley Lake - P2, Winter



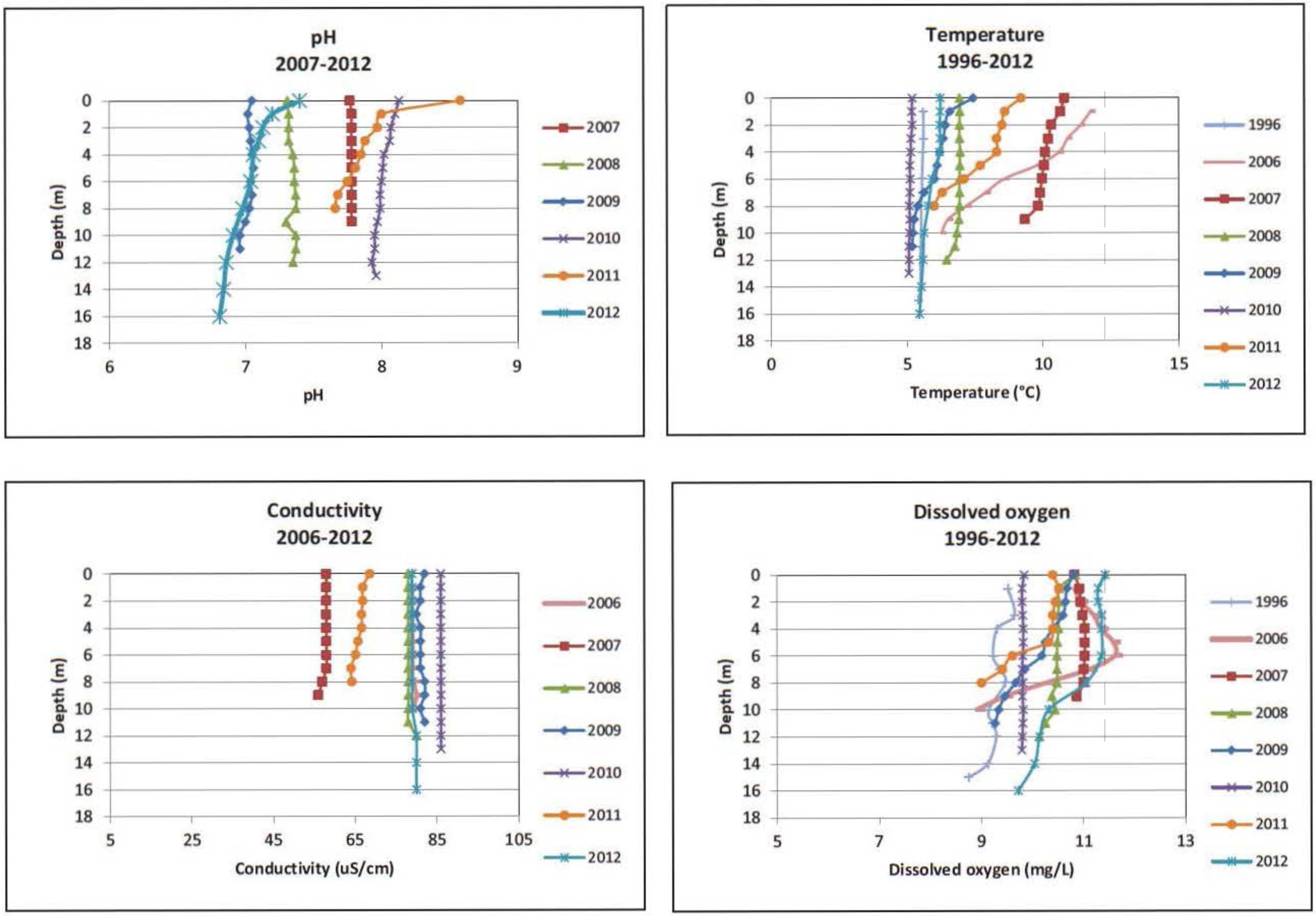
Appendix Figure 7: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Bootjack Lake - B1, Spring



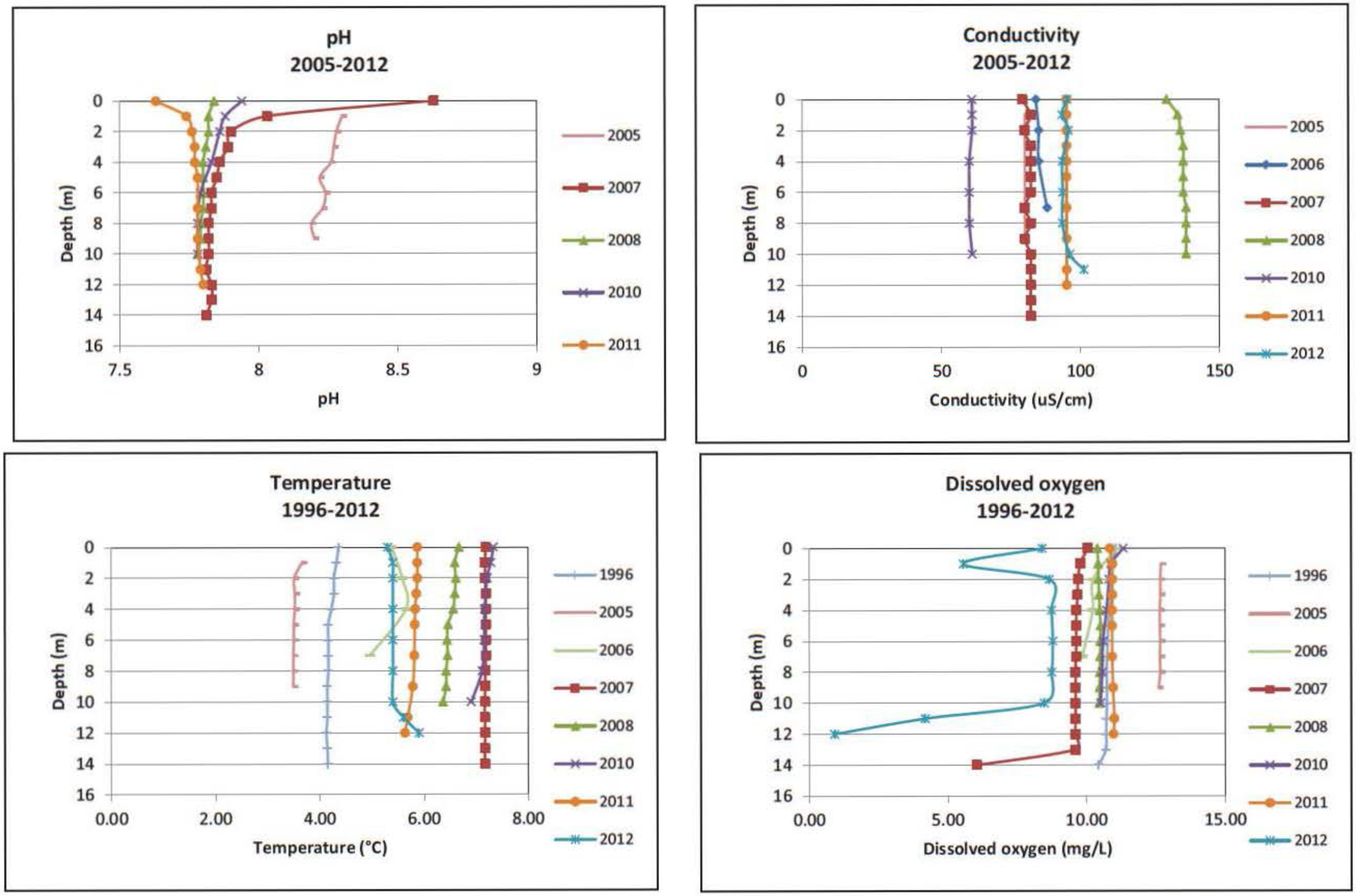
Appendix Figure 8: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Bootjack Lake - B1, Fall



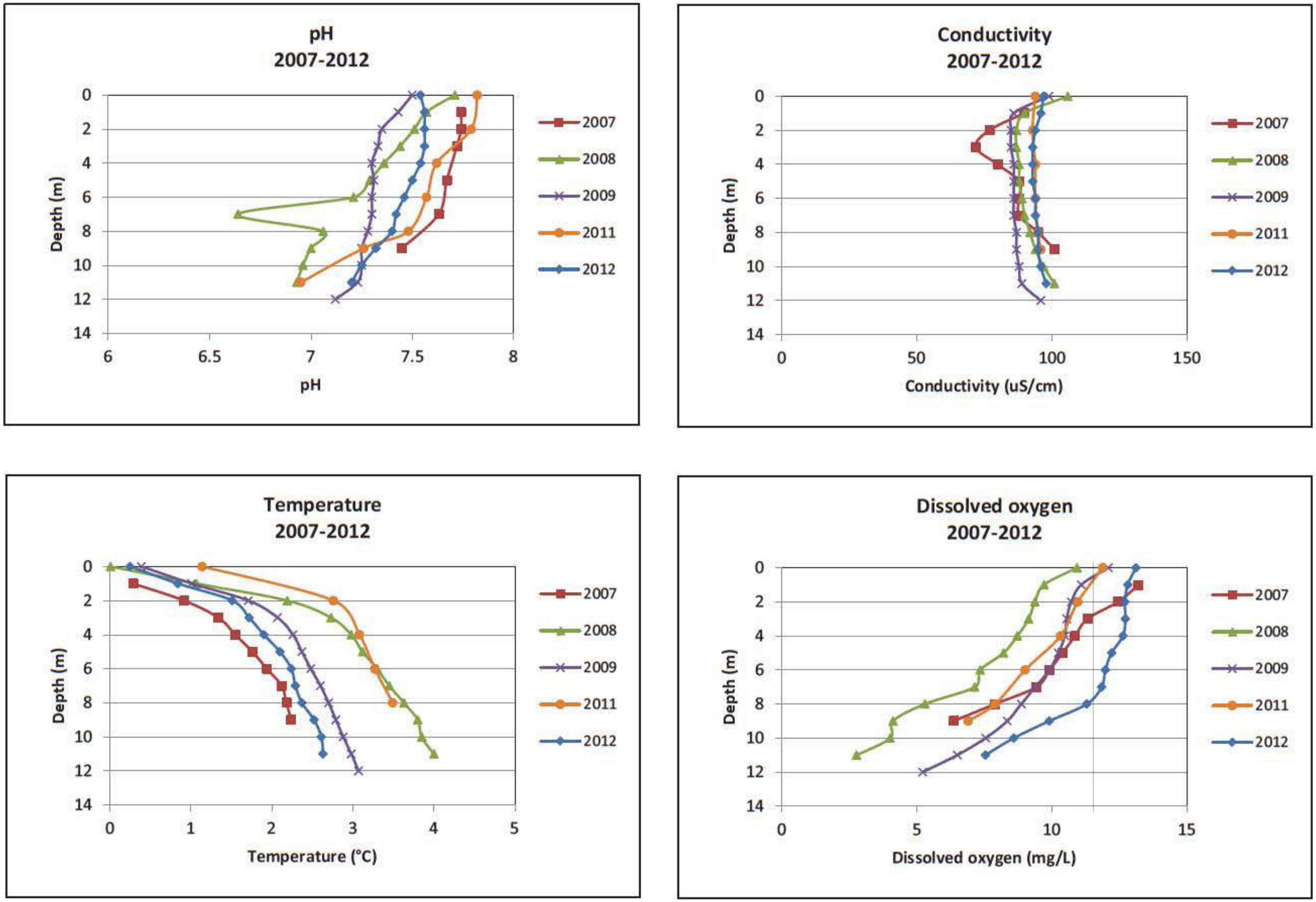
Appendix Figure 9: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Bootjack Lake - B1, Winter



Appendix Figure 10: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Bootjack Lake - B2, Spring



Appendix Figure 11: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Bootjack Lake - B2, Fall


pH 2007-2012

Conductivity 2007-2012

Temperature 2007-2012

Dissolved oxygen 2007-2012

Appendix Figure 12: Vertical profiles of pH, conductivity, temperature and dissolved oxygen in Bootjack Lake - B2, Winter

Table 1: Trophic classification systems for lakes

Measure	Reference	Ultra-Oligotrophic	Oligotrophic	Mesotrophic	Meso-Eutrophic	Eutrophic	Hyper-Eutrophic
Total Phosphorus (ug/L)	Vollenweider and Kerekes (1980)	-	8	27	-	84	-
	University of Florida (1983)	-	< 15	15 - 25	-	25 - 100	> 100
	Ryding and Rast (1994)	< 4	< 10	10 - 35	-	35 - 100	> 100
	Carlson and Simpson (1996)	-	0 - 12	12 - 24	-	24 - 96	> 96
	Nurnberg (2001)	-	< 10	10 - 30	-	31 - 100	> 100
	CCME (2004)	< 4	4 - 10	10 - 20	20 - 35	35 - 100	> 100
	MDDEP (2011)	< 4	4 - 10	10 - 30	-	30 - 100	-
Total Nitrogen (ug/L)	Vollenweider and Kerekes (1980)	-	660	750	-	1,900	-
	University of Florida (1983)	-	< 400	400 - 600	-	600 - 1,500	> 1,500
	Ryding and Rast (1994)	-	-	-	-	-	-
	Carlson and Simpson (1996)	-	-	-	-	-	-
	Nurnberg (2001)	-	< 350	350 - 650	-	651 - 1,200	> 1,200
	CCME (2004)	-	-	-	-	-	-
	MDDEP (2011)	-	-	-	-	-	-
Chlorophyll a (ug/L)	Vollenweider and Kerekes (1980)	-	1.7	4.7	-	14	-
	University of Florida (1983)	-	< 3	3 - 7	-	7 - 40	> 40
	Ryding and Rast (1994)	< 1	< 2.5	2.5 - 8	-	8 - 25	> 25
	Carlson and Simpson (1996)	-	0 - 2.6	2.6 - 20	-	20 - 56	> 56
	Nurnberg (2001)	-	< 3.5	3.5 - 9	-	9.1 - 25	> 25
	CCME (2004)	< 1	< 2.5	2.5 - 8	-	8 - 25	> 25
	MDDEP (2011)	< 1	1 - 3	3 - 8	-	8 - 25	> 25
Secchi Depth (m)	Vollenweider and Kerekes (1980)	-	9.9	4.2	-	2.4	-
	University of Florida (1983)	-	> 3.96	3.96 - 2.43	-	2.43 - 0.91	< 0.91
	Ryding and Rast (1994)	> 12	> 6	6 - 3	-	3 - 1.5	< 1.5
	Carlson and Simpson (1996)	-	> 8 - 4	4 - 2	-	2 - 0.5	< 0.5
	Nurnberg (2001)	-	-	-	-	-	-
	CCME (2004)	> 12	> 6	6 - 3	-	3 - 1.5	< 1.5
	MDDEP (2011)	> 12	12 - 5	5 - 2.5	-	2.5 - 1	< 1

Table 2: Trophic State Index calculations for Polley Lake (after Carlson 1977)

A) Trophic State Index calculated from total phosphorus

Carlson (1977) Equation: $TSI = 10*(6-(\ln(48/TP)/\ln2))$

Time Frame	Total Phosphorus (mg/L)	Trophic State Index
2001 - 2009	12	40
2010 - 2012	50	61
Change in TSI		**+ 21**

B) Trophic state index calculated from Secchi depth

Carlson (1977) Equation: $TSI = 10(6 - \log_2 SD)$

Time Frame	Secchi Depth (m)	Trophic State Index
2001 - 2009	5.9	34
2010 - 2012	3.7	41
Change in TSI		**+ 7**

C) Carlson Lake Classification based on Trophic State Index

TSI	**Classification**	**Description**
< 30	Oligotrophic	Clear water, dissolved oxygen throughout the year in the hypolimnion
30 - 40	Oligotrophic	Deep lakes still exhibit classical oligotrophy, but some shallow lakes will become anoxic in hypolimnion during the summer
40 - 50	Mesotrophic	Water moderately clear, but increasing probability of anoxia in the hypolimnion during the summer
50 - 60	Eutrophic	Lower boundary of classical eutrophy; decreased transparency, anoxic hypolimnion during summer, macrophyte problems evident, and warm-water fisheries only
60 - 70	Eutrophic	Dominance of blue-green algae, algal scum probable, extensive macrophyte problems
70 - 80	Hypereutrophic	Heavy algal blooms possible throughout summer, dense macrophyte beds, but extent limited by light penetration
> 80	Hypereutrophic	Algal scum, summer fish kills, few macrophytes, dominance of rough fish

Appendix Table 1: Mount Polley lake water quality monitoring program data, Nutrients, 2001-present

A) Polley Lake Station P1 (north) - Surface

Component	Units	Date																									
		13-Jun-01	18-May-06	11-Aug-06	31-Oct-06	24-May-07	23-Oct-07	21-May-08	28-Oct-08	26-Aug-09	15-Nov-10	25-May-11	6-Jun-11	21-Jun-11	6-Jul-11	19-Jul-11	9-Aug-11	1-Nov-11	8-May-12	13-Jun-12	16-Jun-12	24-Jul-12	31-Jul-12	8-Aug-12	15-Aug-12	28-Aug-12	1-Nov-12
pH (in situ)	pH	7.89	6.90	7.52	6 91	8.18	8.28	7.57	7.60	9.00	7.39	8.75	9.03	8.16	9.40	9 55	9.40	7 03	8.46	8 87	9.16	9.04	9.12	9.13	8 92	8.94	8.00
Conductivity (in situ)	µs/cm	144	157	159	164	117	174	114		206	212	151	203.7	202	198	197	198	220	204	205	205	205	206	207	209	211	216
Temperature (in situ)	°C	12.4	11.42	18.07	6 97	9.6	8.11	4 56	7.87	17 8	6.7	9.4	12.4	14.1	16.2	18.4	19.7	6 33	5.95	12.3	21.5	20	20.7	21.9	19.6	19 2	6 5
Total Dissolved Solids	mg/L		100	98	103	103	108	113	1.5	132	130	114				129		135	132								126
Total Suspended Solids	mg/L	2	46 9	1.5	1.5	1.5	1.5	1.5	139	5.5	<3	<3				<3		<3.0	<3 0								<3 0
Turbidity	ntu	0.4	0.55	0.62	0 87	0.88	0.98	0.86	1.12	0.54	1.19	0 82				1 35		1 61	1.23								1.82
Ammonia (as N)	mg/L	0.008	0.0313	0.01	0 028	0.0056	0 0025	0.0256	0.0025	0.0057	0 0051	<0 005				<0.005		0.0113	0 0054								<0.0050
Nitrate (as N)	mg/L										0 0425	<0 005				<0.005		0.153	0 0236								0.144
Nitrate and Nitrite (as N)	mg/L	0.0025	0.0025	0.0025	0.0237	0.0025	0 0025	0.0402	0.0486	0.0025	0 0436	<0.0051				<0.0051		0.155	0 0236								0.145
Nitrite (as N)	mg/L										0 0011	<0 001				<0.001		0.0019	<0 0010								0 0011
Total Nitrogen	mg/L	0.06	0.14	0 273	0.283	0.3	0.37	0.2	0.18	0.18	0.21	0 22				0 33		0 55	0.40								0.45
Orthophosphate-Dissolved (as P)	mg/L	0.043	0.0016	0.0005	0 005	0 0005	0.0005	0.0011	0.0063	0.0005	0 0371	0.0143				<0.001		0.0394	0 0131								0 0848
Phosphorus (P) Total Dissolved	mg/L	0.043	0 0051	0.004	0.0075	0 0038	0 0038	0 005	0.01	0 001	0 0369	0.0166				0.0038		0.0436	0.02								0 0895
Phosphorus (P) Total	mg/L	0.043		0 0083	0.0142	0 0122	0 0101	0.0217	0.0261	0.0046	0 0424	0.0471				0.0137		0.0596	0.05								0 0992
Total Nitrogen / Total Phosphorus		1.4		32 9	19.9	24 6	36 6	9.2	6.9	39.1	5 0	4.7				24.1		9.2	8.0								4 5

B) Polley Lake Station P1 (north - Bottom)

Component	Units	Date								
		24-May-07	23-Oct-07	21-May-08	28-Oct-08	25-May-11	19-Jul-11	1-Nov-11	8-May-12	1-Nov-12
pH (in situ)	pH	8.09	7.33	7.22	7 81	8.07	7.99	7.61	7.92	7.78
Conductivity (in situ)	µs/cm	102	167	139				226	210	221
Temperature (in situ)	°C	4.66	5.55	3.25	6.71	4.3	11 2	6.27	3.55	5.9
Total Dissolved Solids	mg/L	98	117	129	1.5	141	133	135	133	136
Total Suspended Solids	mg/L	3	1.5	3.2	136	<3	<3	<3.0	<3 0	<3.0
Turbidity	ntu	1.64	2.34	3.89	1.77	0.67	0.6	1.75	1.1	2.68
Ammonia (as N)	mg/L	0 0277	0.0025	0.0383	0.0025	0.0068	<0.005	0.0119	0 011	0.0132
Nitrate (as N)	mg/L					0.0534	0.0838	0.155	0.0544	0 311
Nitrate and Nitrite (as N)	mg/L	0.0434	0.18	0 266	0 213	0.0534	0 0838	0.157	0 0544	0 313
Nitrite (as N)	mg/L					<0.001	<0.001	0.0025	<0 0010	0.0019
Total Nitrogen	mg/L	0.36	0.52	0.44	0.79	0.28	0.36	0.33	0.31	0.58
Orthophosphate-Dissolved (as P)	mg/L	0 0069	0.0583	0.0234	0.0522	0.0316	0.0313	0.0399	0.0179	0 216
Phosphorus (P) Total Dissolved	mg/L	0.0101	0.0569	0.0253	0.0564	0.0347	0 0357	0.0431	0.0252	0 213
Phosphorus (P) Total	mg/L	0.0218	0.0677	0.0397	0.0632	0.0395	0 0423	0.0502	0.0503	0 228
Total Nitrogen / Total Phosphorus		16.5	7.7	11.1	12.5	7.1	8.5	6.6	6.2	2.5

Appendix Table 1: Mount Polley lake water quality monitoring program data, Nutrients, 2001-present

C) Polley Lake Station P2 (south) - Surface

Component	Units	Date																							
		14-Jun-01	18-May-06	11-Aug-06	31-Oct-06	23-May-07	23-Oct-07	21-May-08	28-Oct-08	26-Aug-09	25-May-11	6-Jun-11	21-Jun-11	6-Jul-11	9-Aug-11	1-Nov-11	8-May-12	13-Jun-12	16-Jun-12	24-Jul-12	31-Jul-12	8-Aug-12	15-Aug-12	28-Aug-12	1-Nov-12
pH (in situ)	pH	8.19	7.71	8.22	7.52	8.05	8.22	7.96	7.83	8 94	8 83	9.25	8.18	9.43	9.42	7.40	7.87	8.87	9.18	9.06	9.14	9.12	9.02	8.97	7.95
Conductivity (in situ)	µs/cm	141	156	159	64	116	174	115		207	203	206.2	200	198	197	220	210	206	205	205	206	207	207	211	217
Temperature (in situ)	°C	12.4	13.91	19	6.43	9.43	8	4.69	6.79	18	9.7	14.5	14.8	16.9	18.9	6.29	3 84	12.4	20.5	20	21.3	20.9	19 8	18.7	6 5
Total Dissolved Solids	mg/L		101	98	101	105	111	117	1 5	135	125					133	137								132
Total Suspended Solids	mg/L	2	1.5	1.5	1.5	1.5	1 5	1 5	132	4 5	<3					<3.0	<3.0								<3.0
Turbidity	ntu	0.57	0.35	0.61	1.14	1.02	0.96	0 83	0.88	0.78	0 84					2.24	0.96								1.67
Ammonia (as N)	mg/L	0.011	0.016	0.01	0.01	0.0083	0.0025	0.0211	0.0025	0.0148	0.0051					0 0112	0.0114								<0.0050
Nitrate (as N)	mg/L										<0.005					0.177	0.0959								0.0827
Nitrate and Nitrite (as N)	mg/L	0.0025	0 0025	0.0025	0.0133	0.0025	0.0089	0.0408	0.0543	0.0125	<0.0051					0.179	0.0959								0.0827
Nitrite (as N)	mg/L										<0.001					0 0013	<0.0010								<0.0010
Total Nitrogen	mg/L	0.06	0.184	0.218	0.296	0.38	0.37	0 22	0.15	0.14	0 24					0.33	0 32								0.39
Orthophosphate-Dissolved (as P)	mg/L	0.026	0 0011	0.0005	0.002	0.0005	0.0011	0.0005	0.0076	0.0005	0 014					0.0487	0.0311								0.041
Phosphorus (P) Total Dissolved	mg/L	0.032	0.0048	0.0043	0.0053	0.0042	0.0036	0.0048	0.0117	0 001	0.0159					0.0525	0.0316								0.0467
Phosphorus (P) Total	mg/L	0.027		0.0084	0.0113	0.0149	0.0104	0.0152	0.0195	0.0066	0.0294					0.0607	0.047								0.0549
Total Nitrogen / Total Phosphorus		2 2		26.0	26.2	25 5	35.6	14.5	7.7	21.2	8.2					5.4	6.8								7.1

D) Polley Lake Station P2 (south) - Bottom

Component	Units	Date								
		23-May-07	23-Oct-07	21-May-08	28-Oct-08	2-Nov-10	25-May-11	1-Nov-11	8-May-12	1-Nov-12
pH (in situ)	pH	8.41	7.51	7.92	7.44	7.45	7.91	7.41	7.61	8 08
Conductivity (in situ)	µs/cm	111	167	116		142		234	223	216
Temperature (in situ)	°C	7.47	5.77	4.2	5.73	7.57	4	6 22	3.22	5 8
Total Dissolved Solids	mg/L	102	109	116	1.5	131	138	135	134	132
Total Suspended Solids	mg/L	1 5	1.5	4.2	130	<3	3.4	<3 0	<3.0	<3.0
Turbidity	ntu	1.23	1.3	1.38	1.35	0.9	0.89	2.73	1 22	2 53
Ammonia (as N)	mg/L	0.0313	0 0025	0.0155	0.0025	<0.005	0.0125	0.0144	0.0508	<0.0050
Nitrate (as N)	mg/L					0.0454	0.0704	0.18	0.114	0.086
Nitrate and Nitrite (as N)	mg/L	0.0025	0.128	0.0732	0.166	0.0454	0.0704	0.186	0.114	0.086
Nitrite (as N)	mg/L					<0.001	<0.001	0.0061	<0.0010	<0.0010
Total Nitrogen	mg/L	0.33	0.46	0.18	0.26	0.23	0.27	0 37	0 38	0 38
Orthophosphate-Dissolved (as P)	mg/L	0.0014	0.0251	0.0018	0.0365	0.0424	0.0359	0.0488	0.0568	0.0423
Phosphorus (P) Total Dissolved	mg/L	0.0048	0.0261	0.0053	0.0405	0.0424	0.0388	0.0562	0.0633	0.0469
Phosphorus (P) Total	mg/L	0.019	0 0342	0.0179	0.047	0.05	0.0444	0.0645	0.0803	0.0544
Total Nitrogen / Total Phosphorus		17.4	13.5	10.1	5.5	4.6	6.1	5.7	4.7	7 0

Appendix Table 1: Mount Polley lake water quality monitoring program data, Nutrients, 2001-present

E) Bootjack Lake Station B1 (north) - Surface

Component	Units	Date																				
		7-Jun-01	23-May-06	31-Oct-06	23-May-07	23-Oct-07	21-May-08	27-Oct-08	26-Aug-09	25-May-11	20-Jun-11	6-Jul-11	9-Aug-11	1-Nov-11	16-May-12	13-Jun-12	16-Jun-12	24-Jul-12	31-Jul-12	8-Aug-12	15-Aug-12	28-Aug-12	31-Oct-12
pH (in situ)	pH	7.18	7.68	7.57	8.42	7.96	7.44	8.10	8.29	8.05	6.93	8.35	8.14	7.87	7.37	7.89	8.19	8.07	8.19	8.35	8.27	8.16	7.74
Conductivity (in situ)	µs/cm	82	80	85	58	83	52		88	67	88	88	90	93	79	90	92	92	93	94	94.8	94.8	95
Temperature (in situ)	°C	13.2	14.1	5.06	10.7	6.74	6.78	5.64	18 2	8.5	15.9	16.1	19.8	5.4	10.08	13.7	20	20.1	20.8	21.6	20.7	19	5.2
Total Dissolved Solids	mg/L		55	51	50	61	50	5.3	54	59				59	49								60
Total Suspended Solids	mg/L	2	1.5	1.5	1.5	3.3	1.5	158	1 5	<3				<3.0	4.7								6.7
Turbidity	ntu	0.52	0.57	2.47	0.98	1.46	1	1.58	0 86	0.73				1.53	1.77								2.26
Ammonia (as N)	mg/L	0.012	0.0067	0.01	0 0052	0.0025	0.0093	0.0025	0.0057	<0 005				<0 0050	0.0167								<0.0050
Nitrate (as N)	mg/L									<0 005				<0.0050	<0.0050								<0.0050
Nitrate and Nitrite (as N)	mg/L	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	<0.0051				<0 0051	<0.0051								<0.0051
Nitrite (as N)	mg/L									<0 001				<0.0010	<0.0010								<0.0010
Total Nitrogen	mg/L	0.06	0.3	0.302	0.33	0.38	0.18	0.18	0.24	0.18				0.13	0.28								0.31
Orthophosphate-Dissolved (as P)	mg/L	0.005	0.0005	0.0005	0 0005	0.0013	0.0005	0.0011	0.0005	<0 001				<0 0010	<0.0010								<0.0010
Phosphorus (P) Total Dissolved	mg/L	0.007	0.0021	0.0029	0 0032	0.0057	0.0036	0.0055	0.001	0 0029				0 0033	0.0046								0.0037
Phosphorus (P) Total	mg/L	0.014	0.0041	0.0146	0.0098	0.0166	0.0111	0.0146	0.0047	0 0071				0 0126	0.0159								0.0214
Total Nitrogen / Total Phosphorus		4.3	73.2	20.7	33.7	22.9	16.2	12.3	51.1	25.4				10.3	17.6								14.5

F) Bootjack Lake Station B1 (north) - Bottom

Component	Units	Date							
		23-May-07	23-Oct-07	21-May-08	27-Oct-08	25-May-11	1-Nov-11	16-May-12	31-Oct-12
pH (in situ)	pH	8.02	7.95	7.13	7.56	7.58	7.90	7.74	
Conductivity (in situ)	µs/cm	51	83	58		65.6	95	95	94 8
Temperature (in situ)	°C	5.86	6.71	4.27	5.62	4.8	5.39	5.2	5 5
Total Dissolved Solids	mg/L	50	62	57	3.3	48	63	49	59
Total Suspended Solids	mg/L	1.5	3.3	3.7	217	<3	4.3	<3.0	<3.0
Turbidity	ntu	1.28	1.78	1.75	1.6	1.34	1.41	2.58	1.82
Ammonia (as N)	mg/L	0.0104	0.0025	0.008	0 0025	0.0131	<0.0050	0.0223	<0.0050
Nitrate (as N)	mg/L					0.0242	<0.0050	0.0164	<0.0050
Nitrate and Nitrite (as N)	mg/L	0.0025	0.0025	0.0561	0.0025	0.0242	<0.0051	0.0164	<0.0051
Nitrite (as N)	mg/L					<0.001	<0.0010	<0.0010	<0.0010
Total Nitrogen	mg/L	0.34	0.4	0.19	0.18	0.22	0.18	0.3	0.32
Orthophosphate-Dissolved (as P)	mg/L	0.0012	0.0014	0.0021	0 0012	0.002	<0.0010	<0.0010	<0.0010
Phosphorus (P) Total Dissolved	mg/L	0.004	0.0082	0.0048	0 0158	0.0035	0.0039	0.0052	0.0042
Phosphorus (P) Total	mg/L	0.0152	0.0165	0.0152	0.0166	0.016	0.0134	0.0219	0.0184
Total Nitrogen / Total Phosphorus		22.4	24.2	12.5	10.8	13.8	13.4	13.7	17.4

Appendix Table 1: Mount Polley lake water quality monitoring program data, Nutrients, 2001-present

G) Bootjack Lake Station B2 (south) - Surface

Component	Units	Date											
		7-Jun-01	23-May-06	31-Oct-06	23-May-07	23-Oct-07	21-May-08	27-Oct-08	26-Aug-09	25-May-11	1-Nov-11	15-May-12	31-Oct-12
pH (in situ)	pH	7.74	8.04	7.68	7.77	8.63	7.31	7.84	8.47	7.07	7 81	7.40	
Conductivity (in situ)	µs/cm	81	79	84	58	79	51		87	68.6	93	79	95.2
Temperature (in situ)	°C	13.1	11.76	5.38	10.78	7.18	6.94	6.67	18.4	9.5	5 9	6.24	5.3
Total Dissolved Solids	mg/L		55	54	47	57	47	3.8	55	53	54	43	61
Total Suspended Solids	mg/L	2	1.5	1.5	1.5	3.8	1.5	55	4.5	<3	3.7	<3.0	6.7
Turbidity	ntu	0.71	0.49	2.62	0 84	2.24	0.75	1.34	0 55	0.94	1 85	1.8	1.64
Ammonia (as N)	mg/L	0.006	0.0025	0.01	0.0206	0.0025	0.0093	0.0025	0.0025	0.0084	<0 0050	<0.0050	0.0091
Nitrate (as N)	mg/L									<0.005	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (as N)	mg/L	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	<0.0051	<0 0051	<0.0051	<0.0051
Nitrite (as N)	mg/L									<0 001	<0.0010	<0.0010	0.0011
Total Nitrogen	mg/L	0.06	0.3	0.299	0.37	0.4	0.17	0.16	0.17	0.22	0.16	0.25	0.33
Orthophosphate-Dissolved (as P)	mg/L	0.005	0.0005	0.0005	0.0005	0.0027	0.0005	0.0012	0.0005	<0.001	<0 0010	<0.0010	0.0012
Phosphorus (P) Total Dissolved	mg/L	0.021	0.0024	0.0037	0.0032	0.0066	0.0043	0.0046	0.001	0.0027	0 0032	0.0043	0.0041
Phosphorus (P) Total	mg/L	0.026	0.0056	0.0186	0.0091	0.0186	0.01	0.0052	0 0036	0.009	0 0167	0.0142	0.0175
Total Nitrogen / Total Phosphorus		2.3	53.6	16.1	40.7	21.5	17.0	30.8	47 2	24.4	9.6	17.6	18.9

H) Bootjack Lake Station B2 (south) - Bottom

Component	Units	Date							
		23-May-07	23-Oct-07	21-May-08	27-Oct-08	25-May-11	1-Nov-11	15-May-12	31-Oct-12
pH (in situ)	pH	7.78	7.83	7.35	7.78	7.66	7.80	6.81	
Conductivity (in situ)	µs/cm	57	82	51		64.2	95	80	101.2
Temperature (in situ)	°C	9.83	7.17	6.46	6 36	6	5.63	5.46	5.9
Total Dissolved Solids	mg/L	52	58	55	3.8	59	63	59	64
Total Suspended Solids	mg/L	1.5	3.3	3.2	57	<3	4.3	3.3	<3.0
Turbidity	ntu	0.81	1.35	1.04	1.49	0.87	1.67	1.6	2.18
Ammonia (as N)	mg/L	0.0109	0.0025	0.0079	0 0025	<0.005	<0.0050	0.0127	0 0095
Nitrate (as N)	mg/L					<0.005	<0.0050	0.0105	<0.0050
Nitrate and Nitrite (as N)	mg/L	0.0025	0.0025	0.0091	0.0025	<0.0051	<0.0051	0.0105	<0.0051
Nitrite (as N)	mg/L					<0.001	<0.0010	<0.0010	<0.0010
Total Nitrogen	mg/L	0.4	0.37	0.18	0.16	0.21	0.16	0.24	0.32
Orthophosphate-Dissolved (as P)	mg/L	0.0005	0.0028	0.0005	0.0013	0.0011	<0.0010	0.0012	<0.0010
Phosphorus (P) Total Dissolved	mg/L	0.0033	0.0067	0.0041	0.004	0.0035	0.0031	0.0051	0.0041
Phosphorus (P) Total	mg/L	0.0106	0.0232	0.0119	0.0189	0.0111	0.0153	0.019	0.0195
Total Nitrogen / Total Phosphorus		37.7	15.9	15.1	8.5	18.9	10.5	12.6	16.4

Appendix Table 2: Results of Spearman's Rank Order Correlation (Trends over Time)

Analyte	Lake	Station	N	Significant? [1]	p [2]	r [3]
Total Phosphorus	Polley	P1S	14	Yes	0.0235	0.596
		P2S	12	Yes	0.0308	0.615
		P1B	9	No	0.204	0.450
		P2B	9	Yes	0.0004	0.850
	Bootjack	B1S	12	No	0.306	0.315
		B2S	12	No	0.557	-0.182
		B1B	8	No	0.207	0.479
		B2B	8	No	0.321	0.381
Total Dissolved Phosphorus	Polley	P1S	15	No	0.199	0.348
		P2S	13	No	0.166	0.399
		P1B	9	No	0.407	0.300
		P2B	9	Yes	<0.0001	0.883
	Bootjack	B1S	12	No	0.974	0.007
		B2S	12	No	0.619	-0.151
		B1B	8	No	0.662	-0.167
		B2B	8	No	0.839	0.060
ortho-Phosphorus	Polley	P1S	15	No	0.154	0.384
		P2S	13	No	0.078	0.502
		P1B	9	No	0.434	0.283
		P2B	9	Yes	0.004	0.817
	Bootjack	B1S	12	No	0.733	0.103
		B1B	8	No	0.072	-0.651
		B2S	12	No	0.651	0.143
		B2B	8	No	0.794	0.096
Total Nitrogen	Polley	P1S	15	Yes	0.01	0.634
		P2S	13	No	0.098	0.473
		P1B	9	No	0.58	-0.192
		P2B	9	No	0.434	0.276
	Bootjack	B1S	12	No	0.886	-0.042
		B2S	12	No	0.921	-0.025
		B1B	8	No	0.46	-0.287
		B2B	8	No	0.423	-0.311

Appendix Table 2: Results of Spearman's Rank Order Correlation (Trends over Time)

Analyte	Lake	Station	N	Significant?[1]	p[2]	r[3]
Ammonia	Polley	P1S	15	No	0.071	-0.474
		P2S	13	No	0.629	-0.140
		P1B	9	No	0.913	0.034
		P2B	9	No	0.775	0.101
	Bootjack	B1S	12	No	0.34	-0.294
		B2S	12	No	0.834	-0.061
		B1B	8	No	0.619	0.193
		B2B	8	No	0.46	0.277
TN:TP Ratio	Polley	P1S	14	No	0.356	-0.262
		P2S	13	No	0.157	-0.427
		P1B	9	Yes	0.0004	-0.856
		P2B	9	No	0.010	-0.567
	Bootjack	B1S	12	No	0.542	-0.189
		B2S	12	No	0.921	-0.028
		B1B	8	No	0.537	-0.238
		B2B	8	No	0.460	-0.286
Turbidity	Polley	P1S	15	Yes	0.0002	0.775
		P2S	13	Yes	0.029	0.600
		P1B	9	No	0.676	-0.150
		P2B	9	No	0.676	0.150
	Bootjack	B1S	12	No	0.105	0.483
		B2S	12	No	0.284	0.329
		B1B	8	No	0.16	0.524
		B2B	8	Yes	0.01	0.810

Appendix Table 2: Results of Spearman's Rank Order Correlation (Trends over Time)

Lake	Station	Month	N	Significant? [1]	p [2]	r [3]
Polley	P1	May	7	No	0.181	-0.536
		June	8	No	0.182	-0.500
		July	8	No	0.120	-0.571
		August	8	No	0.207	-0.476
		September	5	No	0.783	0.200
		October	7	No	0.720	-0.143
	P2	May	7	No	0.150	-0.571
		June	8	No	0.207	-0.476
		July	8	No	0.102	-0.595
		August	8	No	0.387	-0.333
		September	5	No	0.450	-0.500
		October	7	No	0.843	-0.071
Bootjack	P1	May	7	No	0.181	-0.536
		June	8	No	0.353	-0.357
		July	8	No	0.072	-0.643
		August	8	No	0.102	-0.595
		September	5	No	1.000	0.000
		October	6	No	1.000	0.029
	P2	May	7	No	0.438	-0.321
		June	8	No	0.498	-0.262
		July	8	No	0.102	-0.595
		August	8	No	0.387	-0.333
		September	5	No	0.350	-0.600
		October	6	No	0.658	-0.257

[1] statistically significant correlation at $p<0.05$; Yes or No

[2] p-value of the Spearman Rank Order Correlation

[3] correlation coefficient of the Spearman Rank Order Correlation