DE BEERS CANADA INC.

SNAP LAKE MINE

TOTAL DISSOLVED SOLIDS RESPONSE PLAN

REPORT

December 2013

PLAIN LANGUAGE SUMMARY

Introduction

De Beers Canada Inc. (De Beers) owns and operates the Snap Lake Mine (the Mine), a diamond mine located approximately 220 kilometres northeast of Yellowknife, Northwest Territories. This document, the Total Dissolved Solids (TDS) Response Plan, fulfills the requirements of Part F, Item 16 and Schedule 5, Item 3 of Water Licence MV2011L2-0004 for the Mine.

Total dissolved solids is the sum of the dissolved salts in water. The water trapped between rocks underground at the Mine contains elevated concentrations of TDS, which is released through mining activities. Concentrations of TDS in Snap Lake are increasing at a faster rate than predicted in the Environmental Assessment Report and are predicted to reach concentrations above the Water Licence Limit. There are many dissolved salts that are part of TDS. Two of the dissolved salts, chloride and fluoride, are specifically discussed in this Plan. Like TDS, concentrations of chloride and fluoride are increasing and have been above generic water quality guidelines on at least one occasion in Snap Lake. The TDS Response Plan describes the tasks that De Beers has completed and is in the process of completing in response to increasing TDS, chloride, and fluoride concentrations in Snap Lake:

- determine sources of TDS, chloride, and fluoride loadings to Snap Lake;
- provide current and ongoing management practices to reduce TDS, chloride, and fluoride loadings to Snap Lake;
- recommend TDS, chloride, and fluoride site-specific water quality objectives (SSWQO) in Snap Lake that are protective of aquatic life and consider factors that reduce exposure to and toxicity of the salts;
- propose concentrations of TDS, chloride, and fluoride that are not to be exceeded in the discharge to Snap Lake (i.e., effluent quality criteria applied at the last point of discharge);
- update modelling predictions; and,
- provide a water management strategy for the life of the Mine.

Sources of TDS, Chloride, and Fluoride Loadings to Snap Lake

The largest source of TDS, chloride, and fluoride loadings to Snap Lake is the minewater pumped from the underground mine. Mining operations release deep groundwater that contains naturally high concentrations of TDS, including chloride and fluoride, compared to surface waters.

Current and Ongoing Management Practices to Reduce TDS, Chloride, and Fluoride Loadings to Snap Lake

Current management practices to assess and reduce TDS, chloride, and fluoride loadings to Snap Lake include:

- an underground sampling program started by De Beers in 2013 to collect inflow and water quality data to better describe the deep groundwater (i.e., groundwater from the footwall) flowing into the Mine; and,

- standard operating procedures to reduce groundwater inflows to the Mine including grouting, which have been only partially effective.

Ongoing management efforts to reduce TDS, chloride, and fluoride loadings to Snap Lake are focused on a phased study initiated by De Beers in 2012 on water treatment technologies. The first phase of the study assessed the feasibility of treating the entire volume of effluent discharged to Snap Lake to remove salts. However, due to the large volume of water, treatment of the total volume was determined to be uneconomical. Furthermore, treatment of TDS on this scale would produce too large a volume of concentrated brine solution for safe disposal. The second phase of the study focused on treatment of only a separate (targeted) stream of deep groundwater. Treatment of a portion of the deep groundwater was identified as the most economical method for reducing TDS loadings to Snap Lake because that portion contains the highest concentrations of TDS and makes up only a small amount of the water pumped from the Mine. De Beers initiated a reverse osmosis and desalination (two potential methods for removing salts from the minewater) pilot scale treatment study that is scheduled to be completed in 2014.

TDS, Chloride, and Fluoride Site-Specific Water Quality Objectives in Snap Lake

De Beers developed SSWQOs for TDS, chloride, and fluoride that are protective of aquatic life in Snap Lake. The proposed SSWQOs for TDS, chloride, and fluoride are 684, 388, and 2.46 milligrams per litre (mg/L), respectively (Table 1).

For TDS, De Beers completed laboratory tests on fish and small animals and plants that live in Snap Lake. The laboratory tests used water that was similar to Snap Lake treated water. Salts were added to the water to determine what concentrations of salt would be toxic to the fish and the small animals and plants that form their food chain.

For chloride, De Beers used the SSWQO that was developed and approved for the EKATI Diamond Mine, which is based on laboratory tests similar to the tests conducted by De Beers for TDS. In the laboratory tests, chloride was added to the water to determine what chloride concentration would be toxic to the fish and the small animals and plants that form their food chain.

For fluoride, De Beers collected data from laboratory tests similar to the tests conducted for TDS. In the laboratory tests, fluoride was added to the water to determine what fluoride concentration would be toxic to the fish and the small animals and plants that form their food chain.

Table 1 Proposed Site-specific Water Quality Objectives (SSWQOs) for Snap Lake

Parameter	SSWQO (mg/L)
Total Dissolved Solids	684
Chloride	388
Fluoride	2.46

mg/L = milligrams per litre; SSWQO = site-specific water quality objective.

Discharge Concentrations of TDS, Chloride, and Fluoride

De Beers calculated what the average monthly and maximum daily concentrations of TDS, chloride, and fluoride must be in the discharge to Snap Lake to maintain concentrations below the values presented in Table 1 at all locations in Snap Lake throughout the life of the Mine. It is proposed that the Water Licence

be revised to include the limits in Table 2, which would be applicable at the final point of discharge (Surveillance Network Program [SNP] 02-17B).

Table 2 Proposed Effluent Quality Criteria to be Applied at the Last Point of Discharge

Parameter	Average Monthly Limit (mg/L)	Maximum Daily Limit (mg/L)
Total Dissolved Solids	684	1,003
Chloride (from January 1, 2015)	378	607
Fluoride (from January 1, 2015)	2.43	3.73

mg/L = milligrams per litre.

Modelling Predictions

De Beers updated their water quality models to predict whether concentrations in Snap Lake will remain below the SSWQOs (Table 1) and whether the discharge to Snap Lake will remain below the effluent quality criteria (Table 2).

Model predictions were made for four different scenarios. The model scenarios used two different effluent discharge rates and two different effluent TDS concentrations. The modelling results showed that TDS concentrations in Snap Lake are predicted to exceed the SSWQO of 684 mg/L between 2015 and 2019 depending on the modelling scenario. Chloride concentrations in Snap Lake are predicted to exceed the SSWQO of 388 mg/L between 2016 and 2019, similarly depending on the model scenario. The average monthly concentrations of TDS and chloride in the discharge are predicted to exceed the proposed average monthly limits (Table 2) in 2015 and 2017, respectively. Fluoride concentrations are not predicted to exceed their SSWQO over the life of mine.

Water Management Plan

As noted above, De Beers has started a pilot scale treatment study to reduce concentrations of TDS, chloride, and fluoride in the discharge to Snap Lake. This study is part of a larger water management strategy.

Groundwater modelling completed in 2013 indicated that the volume of water pumped from the Mine each day was predicted to increase from 42,000 to 54,000 cubic metres per day (m^3/day) by the beginning of 2015. To predict the volume of water that will need to be pumped from the Mine each day past 2015 with more confidence, De Beers has installed a network of instruments underground to collect information about the groundwater above the Mine and from planned future mining areas. The data collected will be used to update the groundwater model and subsequently the water quality model for Snap Lake.

To successfully manage the predicted increase in the volume of water that will need to be pumped from the Mine in future, De Beers has initiated a phased approach that will allow for increased pumping of water from the Mine and expansion of the water treatment plant.

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ACRONYMS

Term	Definition
AEMP	Aquatic Effects Monitoring Program
AML	average monthly limit
APHA	American Public Health Association
BC	British Columbia
BCMOE	British Columbia Ministry of the Environment
$CaCO_3$	calcium carbonate
CCME	Canadian Council of Ministers of the Environment
CEB	chronic effects benchmark
De Beers	De Beers Canada Inc.
EAR	Environmental Assessment Report
EDR	electrodialysis reversal
EQC	effluent quality criteria
F^-	fluoride
FW	footwall
Golder	Golder Associates Ltd.
IX	ion-exchange
LOM	life of Mine
MDL	maximum daily limit
Mine	Snap Lake Mine
MWTP	modular water treatment plant
MVLWB	Mackenzie Valley Land and Water Board
MVEIRB	Mackenzie Valley Environmental Impact Review Board
N/A	not applicable
NO_3	nitrate
NWT	Northwest Territories
O&M	operating and maintenance
Policy	Mackenzie Valley Land and Water Board's Effluent Quality Management Policy
RO	reverse osmosis
SNP	Surveillance Network Program
SO_4	sulphate
SSD	species sensitivity distribution
SSWQO	site-specific water quality objective
TDS	total dissolved solids
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
Water Licence	Water Licence MV2011L2-0004
WMP	water management pond
WQG	water quality guideline
WTP	water treatment plant

UNITS OF MEASURE

Unit	Definition
%	percent
<	less than
>	greater than
d	day
h	hour
hp	horsepower
m	metre
m^3/d	cubic metres per day
mg/L	milligrams per litre
NTU	nephlometric turbidity unit
kg/d	kilograms per day
km	kilometres

1 INTRODUCTION

De Beers Canada Inc. (De Beers) owns and operates the Snap Lake Mine (Mine) in the Northwest Territories (NWT). The Mine is located approximately 220 kilometres (km) northeast of Yellowknife, 30 km south of MacKay Lake, and 100 km south of Lac de Gras where the Diavik Diamond Mine and the Ekati Diamond Mine are located. Final regulatory approvals for construction and operation of the Mine were granted in May 2004, and construction began in April 2005. The Mine officially opened on July 25, 2008. A renewal to the land use permit was granted in February 2010. A water licence amendment application was received from the Mackenzie Valley Land and Water Board (MVLWB) in June 2012.

The Environmental Assessment Report (EAR; De Beers 2002) predicted that concentrations of total dissolved solids (TDS) and its component ions (i.e., chloride and fluoride), nutrients, and some metals would increase in Snap Lake over the operational life of the Mine. Water quality in Snap Lake is changing over time predominantly due to influences from treated effluent discharge (De Beers 2012a). Specifically, TDS concentrations have increased as a result of mining operations liberating deep groundwater characterized by high salinity.

The observed whole-lake average TDS concentration in Snap Lake has increased at a faster rate than predicted in the EAR due to greater than predicted TDS loading to Snap Lake from the treated effluent. As a result of increasing trends in TDS concentrations in Snap Lake, De Beers is evaluating current on-site practices, and has quantified TDS, chloride, and fluoride loadings to the receiving environment. Recent modelling scenarios (De Beers 2013a) predict that the whole-lake average TDS concentration in Snap Lake will exceed the current management compliance limit of 350 milligrams per litre (mg/L) specified in Water Licence MV2011L2-0004 (Water Licence; MVLWB 2013) between January 2014 and January 2015. In their Reasons for Decision (MVEIRB 2003), the Mackenzie Valley Environmental Impact Review Board (MVEIRB) acknowledged (p. 67) “De Beers predicted that TDS concentrations would increase 22-fold: from baseline concentrations of 15 mg/L in Snap Lake to a maximum average whole lake concentration of 330 mg/L” and that “No guidelines or site specific benchmarks exist for TDS”. As a result (p 79), “The Production Water Licence for the Snap Lake project shall specify that the whole lake average TDS concentration in Snap Lake not exceed 350 mg/L at any point in the mine life.”

Because there are no national water quality guidelines (WQGs) for TDS based on toxicity data, De Beers initiated the process of developing site-specific water quality objectives (SSWQOs) for TDS, chloride, and fluoride consistent with the principles of adaptive management and the Response Framework. This process was subsequently required by the Mine’s water licence. Specifically, Water Licence MV2011L2-0004 (Part F, Item 16 and Schedule 5, Item 3) requires a TDS Response Plan that includes the development of SSWQOs for TDS, chloride, and fluoride, and which must involve the following tasks:

1. *A description of current TDS sources and management including:*

    a) *an assessment and quantification of sources of TDS loading to minewater* (Section 2.2)*;*

    b) *a description of current practices for minimizing groundwater seepage into the underground* (Section 2.3)*;*

    c) *a summary of ongoing investigations into improvements to minewater management that would reduce TDS loadings* (Section 2.4)*; and,*

d) any other information necessary to describe issues related to minimizing the TDS loadings to the receiving environment (Section 2.5)*.*

2. *A description of the ecological implications of TDS, chloride, and fluoride loadings to the receiving environment including:*

    a) recommendations and supporting rationale for an appropriate water quality objective for TDS, chloride, and fluoride in Snap Lake derived from toxicity testing and /or published toxicology studies (Section 3.1)*; and,*

    b) recommendations and rationale for EQC for TDS, chloride, and fluoride, to be applied at SNP station 02-17B, that would ensure protection of aquatic life in Snap Lake (Section 3.2)*.*

3. *A discussion of options for reducing the amount of TDS in the final effluent discharged to Snap Lake by, for example, grouting or otherwise reducing significant flows of connate groundwater or treating some portion of the minewater. This discussion should include:*

    a) options that would allow for the maintenance of the whole-lake average of TDS at below 350 mg/L (Section 4.1)*;*

    b) options that would achieve the lowest practical effluent quality criteria at the site (Section 4.1) *and,*

    c) for each option, a discussion of technical feasibility, cost/benefit analyses, and any other information necessary to support recommendations made below (Section 4.2)*.*

4. *Recommendations for improvements to minewater management and monitoring to be implemented through the Water Management Plan and a schedule for implementation* (Section 5)*.*

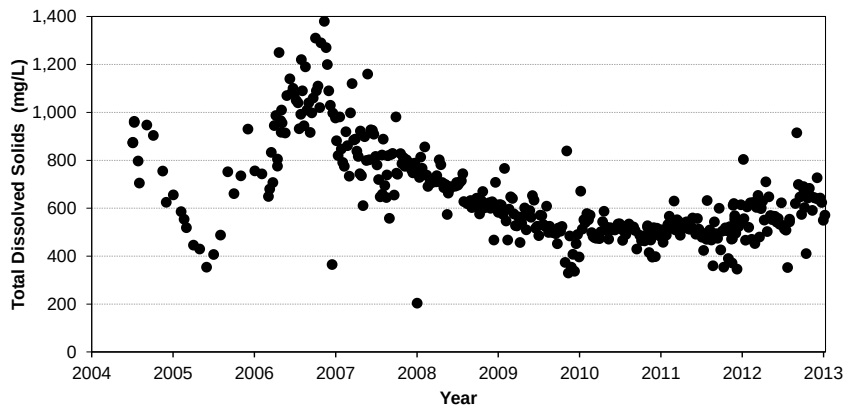
2 TOTAL DISSOLVED SOLIDS, CHLORIDE, AND FLUORIDE SOURCES AND MANAGEMENT

2.1 Historical TDS, Chloride, and Fluoride Data

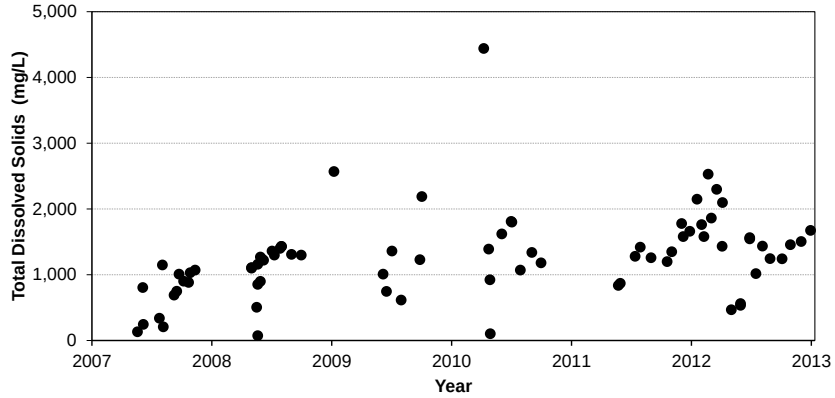
Plots of monitored TDS, chloride, and fluoride concentrations are presented in Figures 2-1 to 2-3. The plots show data from 2004 to 2012 for the final minewater collection sump (i.e., Surveillance Network Program [SNP 02-01]), the North Pile collection ditch (i.e., SNP 02-02), the water management pond (WMP) (i.e., SNP 02-14), and the treated effluent discharge from the temporary water treatment plant (WTP) (i.e., SNP 02-17) and the permanent WTP (i.e., SNP 02-17B) (Figure 2-4). A rapid increase in concentrations of TDS and chloride was observed at the final minewater collection sump when mining operations commenced in 2005 and 2006. As mining progressed, concentrations in the minewater were diluted by seepage of water from Snap Lake and a decrease in concentration was observed from 2006 to 2010.

Plots of monitored TDS, chloride, and fluoride concentrations for the North Pile collection ditch and the WMP show that concentrations vary considerably since the North Pile collection ditch and the WMP are influenced by surface runoff water, discrete mining activities, and performance of the WTP. Plots of monitored TDS, chloride, and fluoride concentrations at the treated effluent discharge point show a similar pattern to concentrations in the final minewater collection sump because the minewater is pumped directly to the WTP.

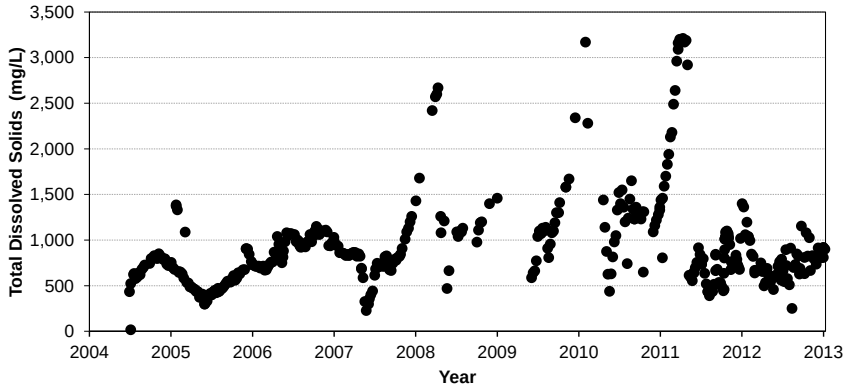
Figure 2-1 Monitored Total Dissolved Solids Concentrations for the Snap Lake Mine



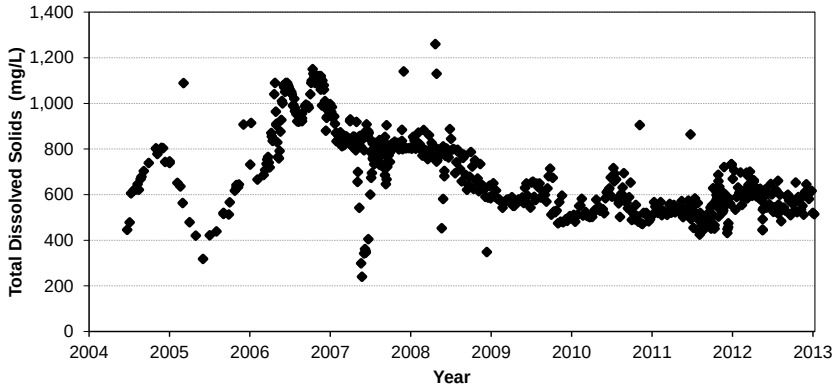
(a) Final minewater collection sump, SNP 02-01



(b) North Pile drainage collection ditch, SNP 02-02



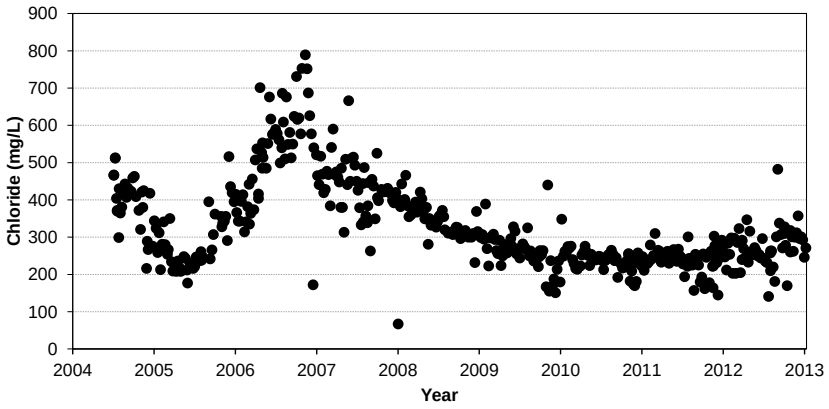
(c) WMP, SNP 02-14



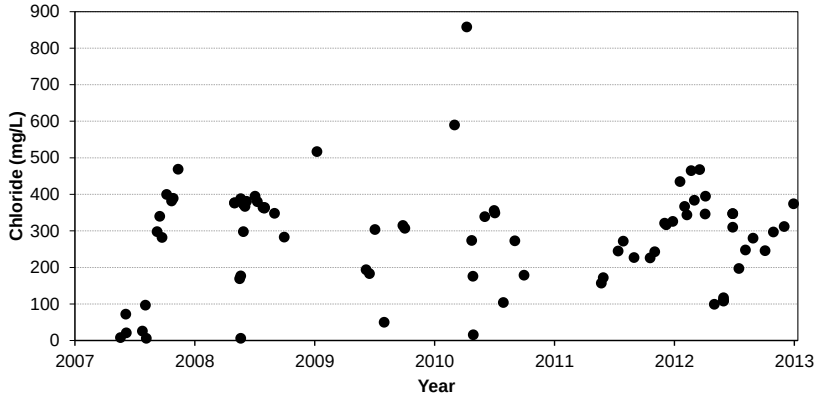
(d) Treated effluent discharge, SNP 02-17B

mg/L = milligrams per litre; SNP = Surveillance Network Program; WMP = water management pond.

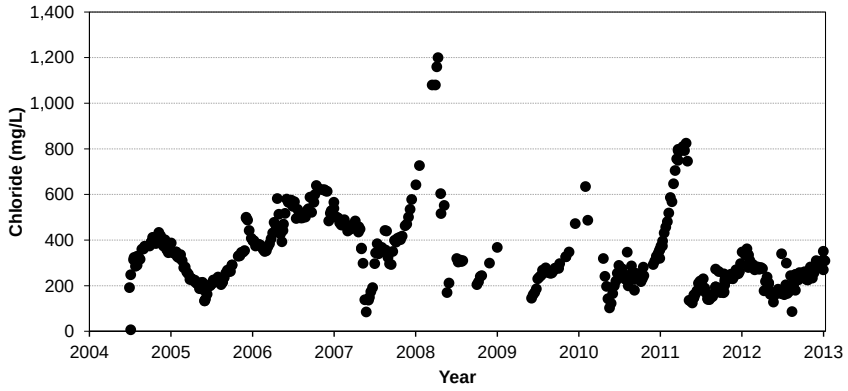
Figure 2-2 Monitored Chloride Concentrations for the Snap Lake Mine



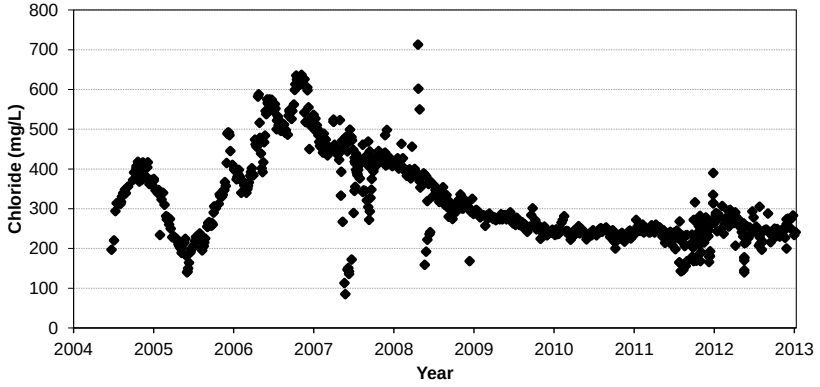
(a) Final minewater collection sump, SNP 02-01



(b) North Pile drainage collection ditch, SNP 02-02



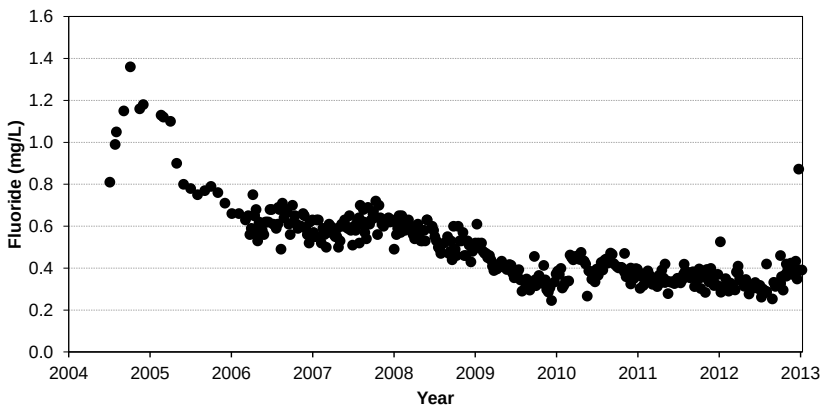
(c) WMP, SNP 02-14



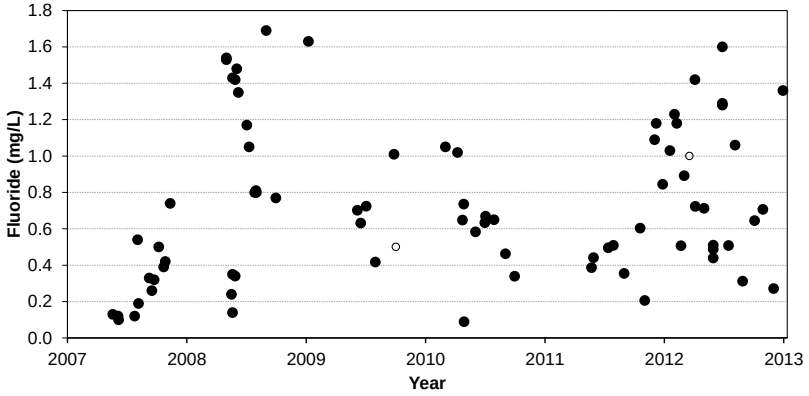
(d) Treated effluent discharge, SNP 02-17 and SNP 02-17B

mg/L = milligrams per litre; SNP = Surveillance Network Program; WMP = water management pond.

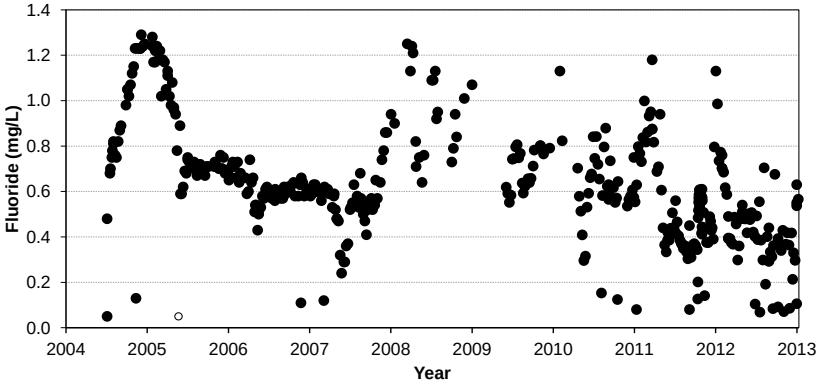
Figure 2-3 Monitored Fluoride Concentrations for the Snap Lake Mine



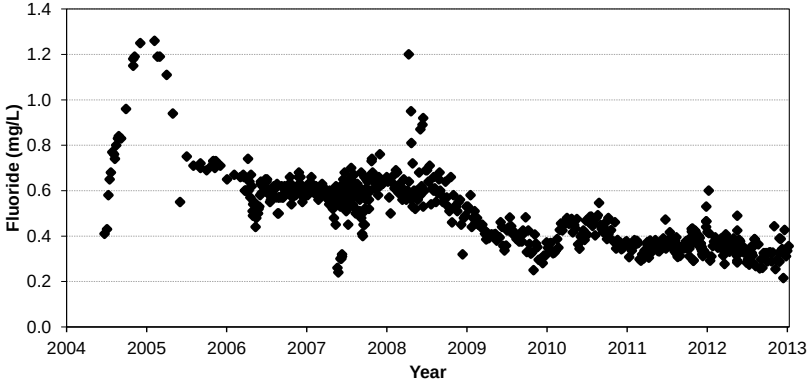
(a) Final minewater collection sump, SNP 02-01



(b) North Pile drainage collection ditch, SNP 02-02



(c) WMP, SNP 02-14



(d) Treated effluent discharge, SNP 02-17 and SNP 02-17B

mg/L = milligrams per litre; SNP = Surveillance Network Program; WMP = water management pond.

2.2 Assessment and Quantification of Sources of Total Dissolved Solids, Chloride, and Fluoride Loadings

Mass loadings of TDS, chloride, and fluoride from 2012 to 2028 at the final minewater collection sump (i.e., Surveillance Network Program [SNP 02-01]), the North Pile drainage collection ditch (i.e., SNP 02-02), the WMP (i.e., SNP 02-14), and the treated effluent discharge from the permanent WTP (i.e., SNP 02-17B) (Figure 2-4) were predicted using the Snap Lake site model (De Beers 2013b) for the following four modelling scenarios (Itasca 2013):

- Upper Bound Scenario A;
- Upper Bound Scenario B;
- Lower Bound Scenario A; and,
- Lower Bound Scenario B.

Upper Bound Scenarios were based on minewater inflows from Scenario 4 of the groundwater model, and Lower Bound Scenarios were based on minewater inflows from Base Case of the groundwater model (Figure 2-5) (Itasca 2013). Scenarios A and B were developed based on TDS concentration differences from the deep groundwater (Itasca 2013).

Figure 2-4 Aerial View of the Mine Site

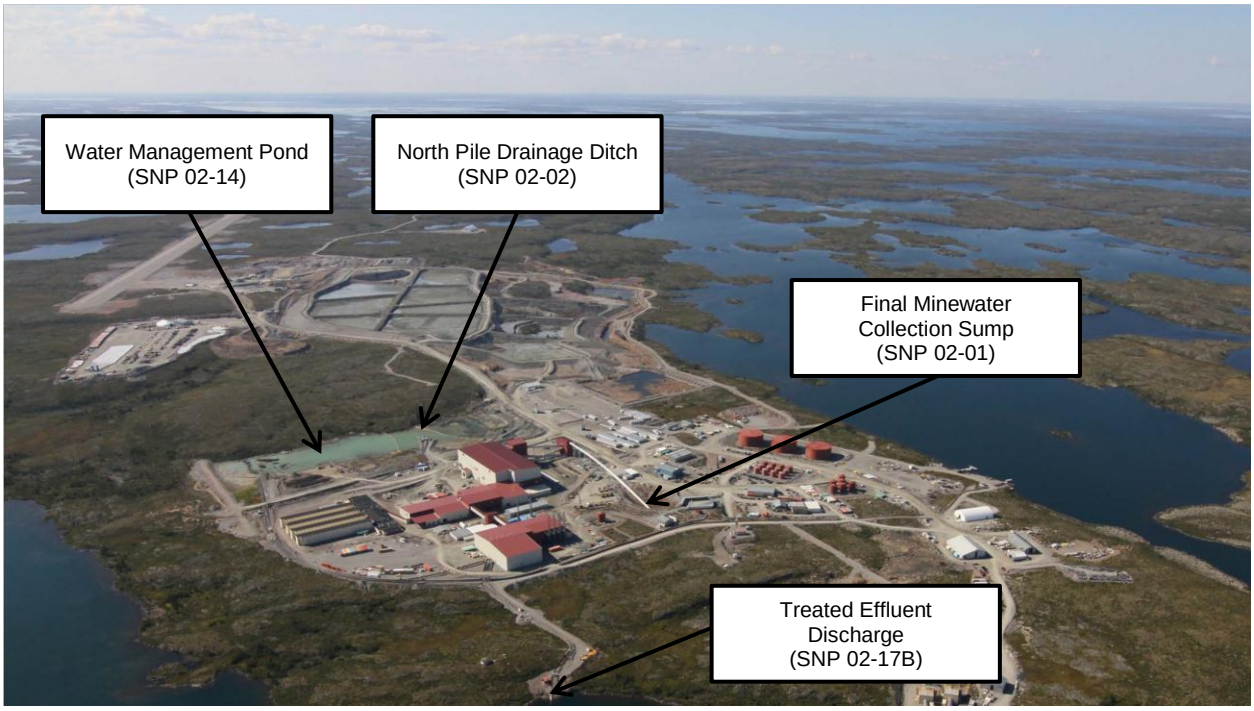
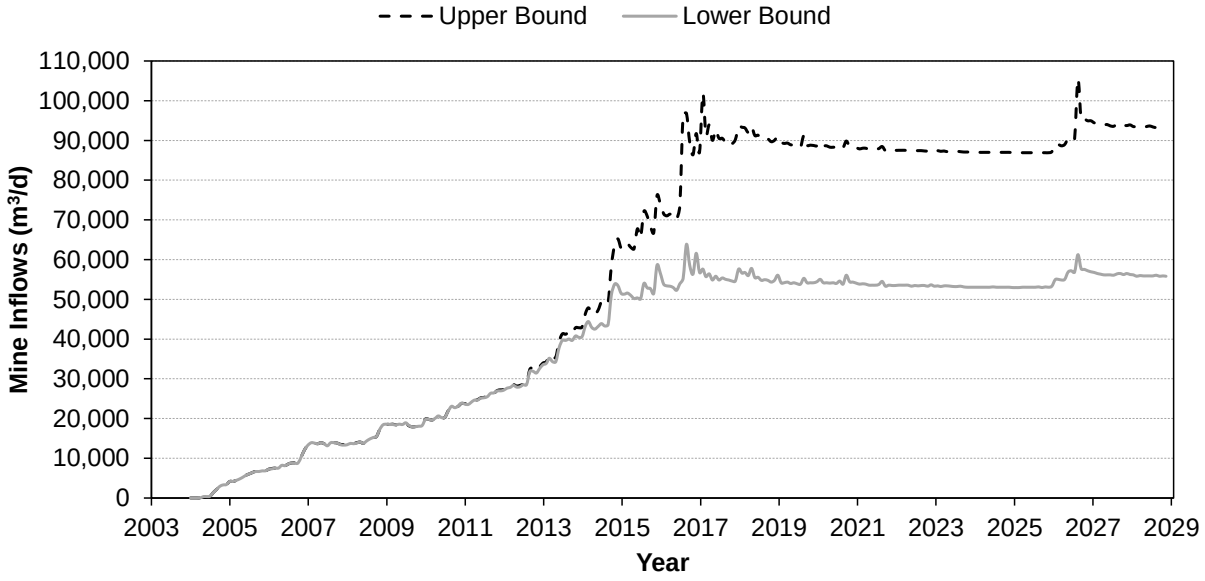


Figure 2-5 Minewater Inflows from Upper Bound and Lower Bound Scenarios



m^3/d = cubic metres per day.

Average loadings of TDS (Table 2-1 and Figure 2-6) and chloride (Table 2-2 and Figure 2-7) at SNP 02-01, SNP 02-02, SNP 02-14, and SNP 02-17B were predicted to increase from 2014 to 2028. Average loadings of fluoride (Table 2-3 and Figure 2-8) were predicted to increase from 2014 to 2028 with the exception of fluoride loadings at SNP 02-02 and SNP 02-14. On average, 91 percent (%) and 90% of the TDS loadings in the treated effluent discharge from the WTP to Snap Lake were predicted to originate from minewater for the Upper Bound and Lower Bound scenarios, respectively; 92% and 91% of the chloride loadings in the treated effluent discharge from the WTP to Snap Lake were predicted to originate from minewater for the Upper Bound and Lower Bound scenarios, respectively; and, 89% and 88% of the fluoride loadings in the treated effluent discharge from the WTP to Snap Lake were predicted to originate from minewater for the Upper Bound and Lower Bound scenarios, respectively.

An understanding of future concentrations of TDS, including chloride and fluoride, aids in planning so that feasibility studies and the implementation thereof are coordinated appropriately to address loading profiles. The models are useful tools, but their accuracy is directly dependent on the quality and quantity of information incorporated. Current predictions will be refined by input of field data into the hydrogeological model and, in turn, incorporation of the model results into the site and lake models.

Table 2-1 Average Total Dissolved Solids Loadings for the Snap Lake Mine

Location	Description	Average Total Dissolved Solids Load (kg/d)							
		Upper Bound Scenario A		Upper Bound Scenario B		Lower Bound Scenario A		Lower Bound Scenario B	
		2014	2028	2014	2028	2014	2028	2014	2028
SNP 02-01	Final minewater collection sump	44,166	142,189	30,165	89,443	37,066	69,168	25,546	43,846
SNP 02-02	North Pile drainage collection ditch	1,809	2,786	1,519	2,110	1,767	2,476	1,494	1,925
SNP 02-14	Water management pond	3,785	6,222	2,881	4,284	3,615	5,326	2,781	3,749
SNP 02-17B	Treated effluent discharge	49,413	149,851	34,017	94,614	41,111	74,577	28,602	47,620

kg/d = kilograms per day; SNP = Surveillance Network Program.

Table 2-2 Average Chloride Loadings for the Snap Lake Mine

Location	Description	Average Chloride Load (kg/d)							
		Upper Bound Scenario A		Upper Bound Scenario B		Lower Bound Scenario A		Lower Bound Scenario B	
		2014	2028	2014	2028	2014	2028	2014	2028
SNP 02-01	Final minewater collection sump	20,269	65,104	13,683	40,335	16,976	31,497	11,556	19,602
SNP 02-02	North Pile drainage collection ditch	495	930	358	606	474	779	346	515
SNP 02-14	Water management pond	1,403	2,461	972	1,555	1,320	2,032	923	1,295
SNP 02-17B	Treated effluent discharge	22,349	68,266	15,106	42,322	18,501	33,615	12,616	20,949

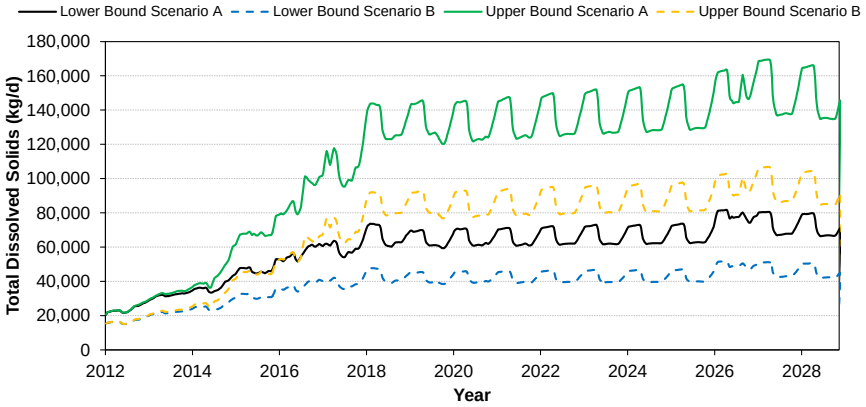
kg/d = kilograms per day; SNP = Surveillance Network Program.

Table 2-3 Average Fluoride Loadings for the Snap Lake Mine

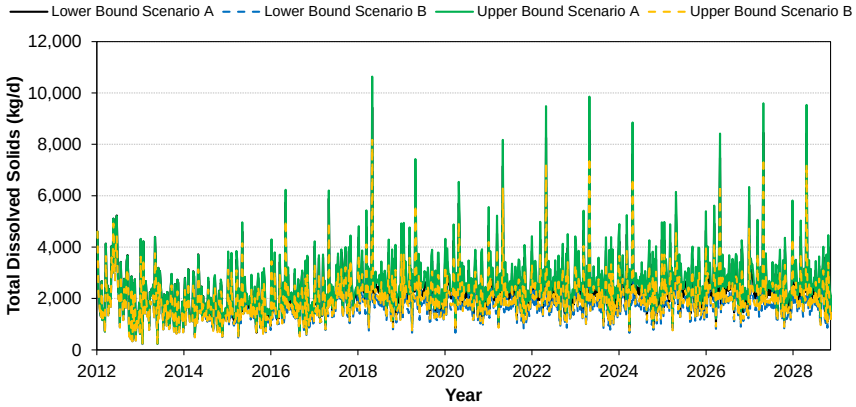
Location	Description	Average Fluoride Load (kg/d)							
		Upper Bound Scenario A		Upper Bound Scenario B		Lower Bound Scenario A		Lower Bound Scenario B	
		2014	2028	2014	2028	2014	2028	2014	2028
SNP 02-01	Final minewater collection sump	15	40	15	40	16	25	16	25
SNP 02-02	North Pile drainage collection ditch	1	1	1	1	1	1	1	1
SNP 02-14	Water management pond	2	2	2	2	2	3	2	3
SNP 02-17B	Treated effluent discharge	17	43	17	43	19	27	19	27

kg/d = kilograms per day; SNP = Surveillance Network Program.

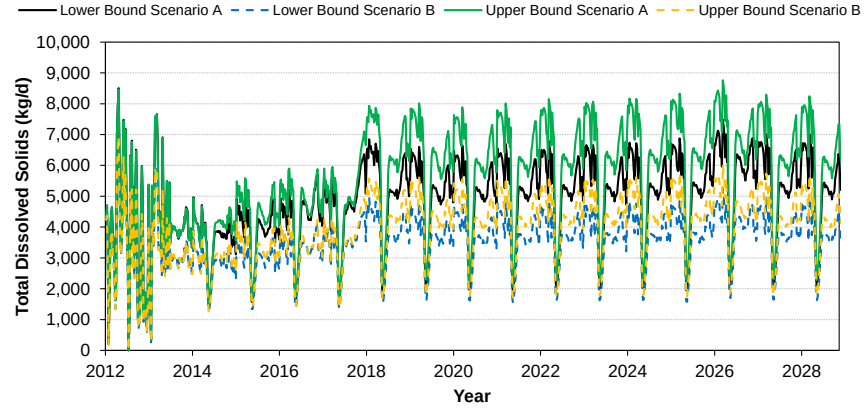
Figure 2-6 Total Dissolved Solids Loading Estimates for the Snap Lake Mine



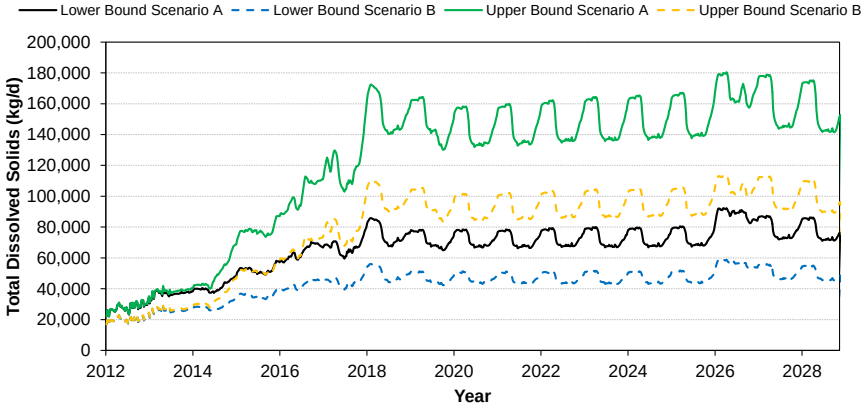
(a) Final minewater collection sump, SNP 02-01



(b) North Pile drainage collection ditch, SNP 02-02



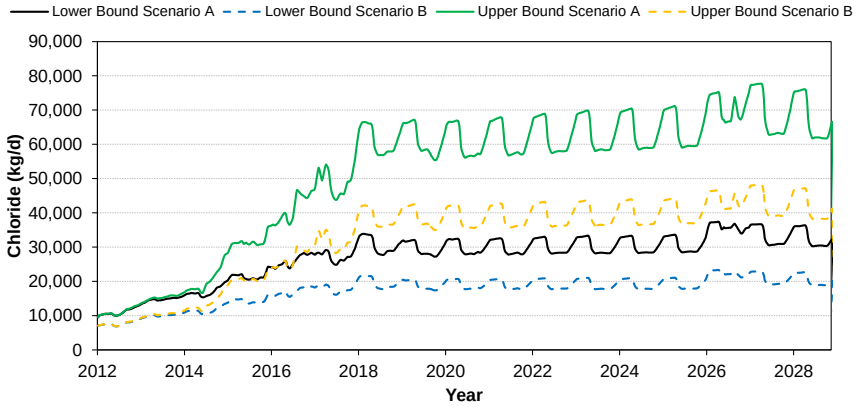
(c) WMP, SNP 02-14



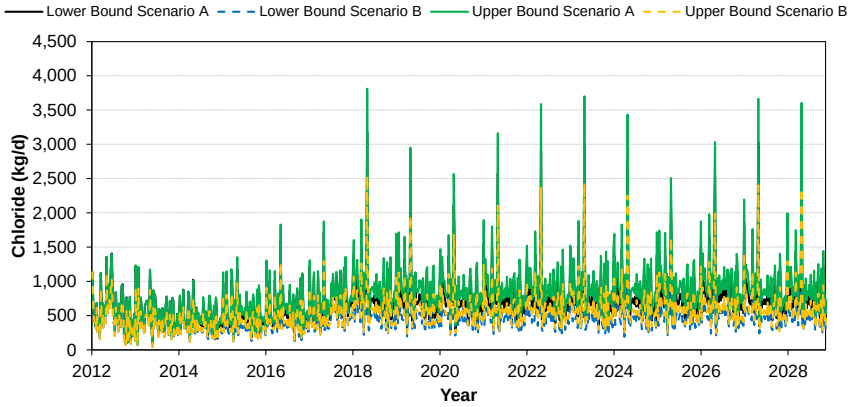
(d) Treated effluent discharge, SNP 02-17B

kg/d = kilograms per day; SNP = Surveillance Network Program; WMP = water management pond.

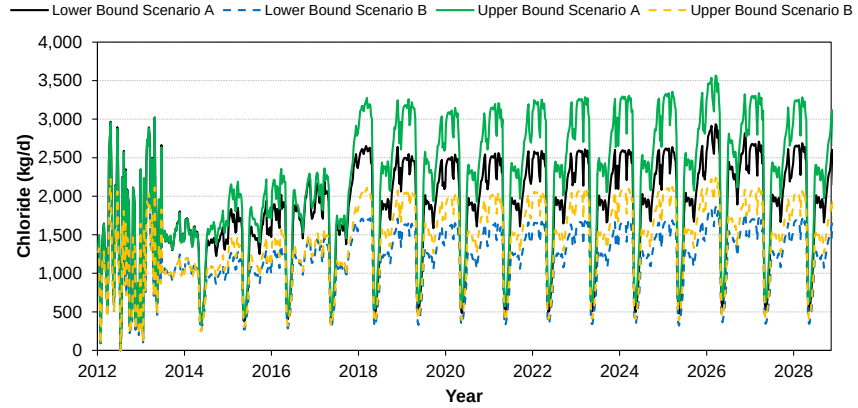
Figure 2-7 Chloride Loading Estimates for the Snap Lake Mine



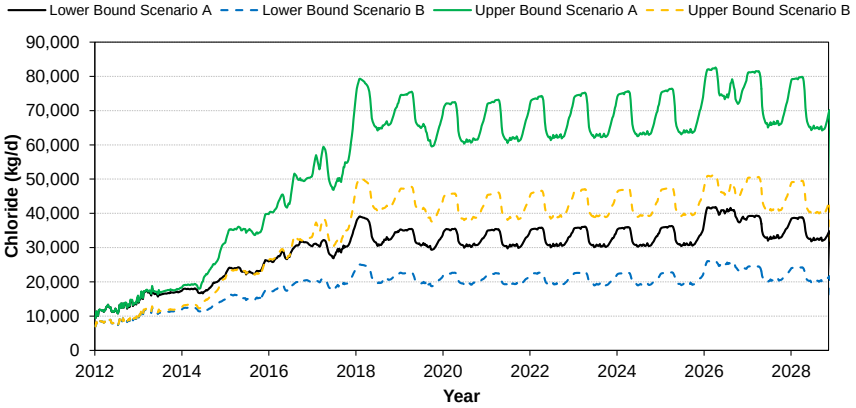
(a) Final minewater collection sump, SNP 02-01



(b) North Pile drainage collection ditch, SNP 02-02



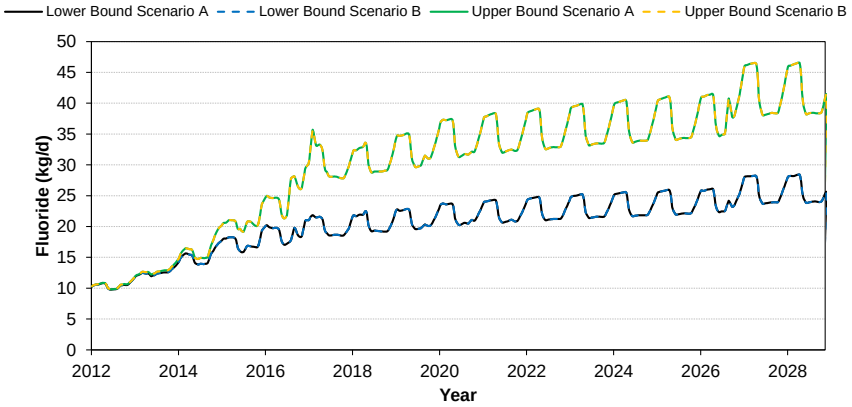
(c) WMP, SNP 02-14



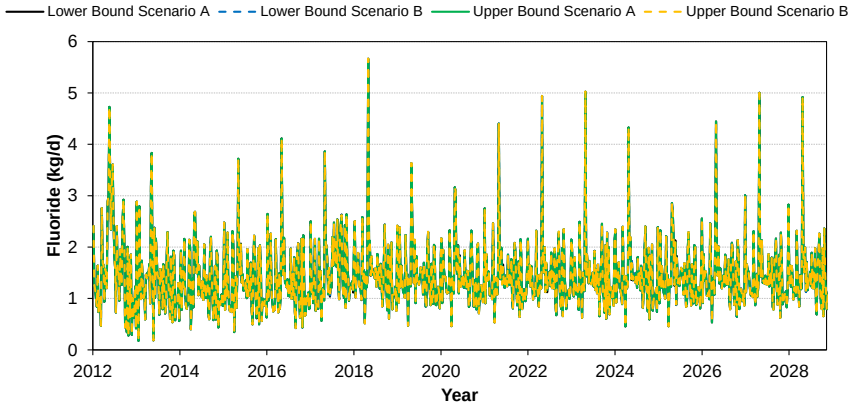
(d) Treated effluent discharge, SNP 02-17B

kg/d = kilograms per day; SNP = Surveillance Network Program; WMP = water management pond.

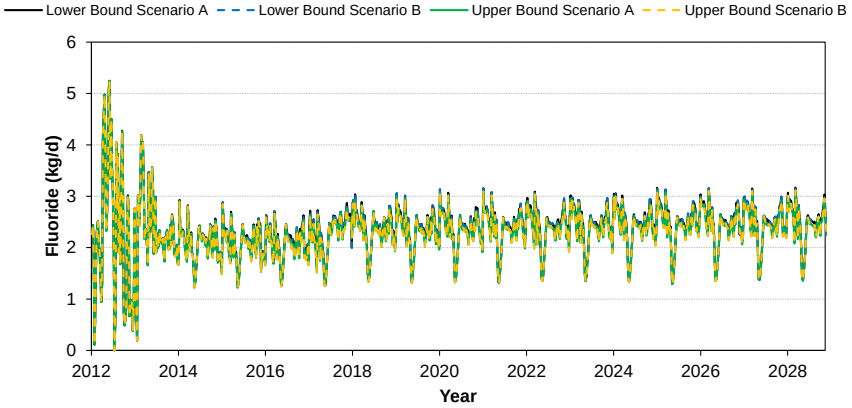
Figure 2-8 Fluoride Loading Estimates for the Snap Lake Mine



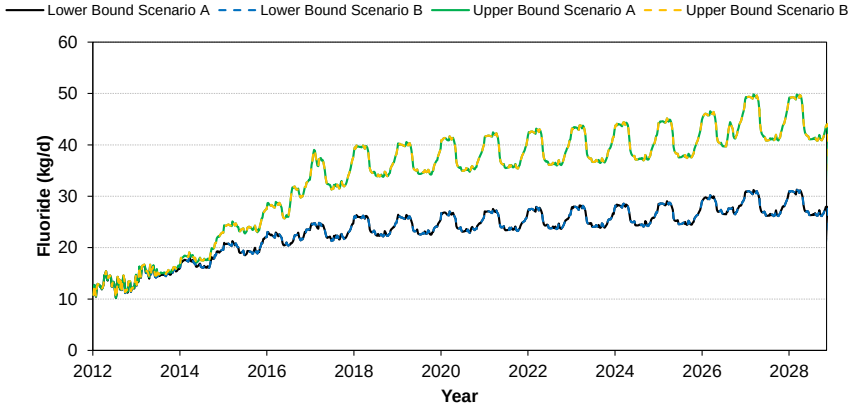
(a) Final minewater collection sump, SNP 02-01



(b) North Pile drainage collection ditch, SNP 02-02



(c) WMP, SNP 02-14



(d) Treated effluent discharge, SNP 02-17B

kg/d = kilograms per day; SNP = Surveillance Network Program; WMP = water management pond.

2.3 Current Practices for Minimizing Groundwater Seepage into the Underground Mine

2.3.1 Groundwater Sources

Two geochemical groundwater sources can be described at the Mine: one from the hanging wall, which tends to be similar to freshwater, and a second one from the footwall (FW), which tends to relate to connate water (i.e., deep groundwater with elevated TDS concentrations). Footwall samples show higher TDS concentrations by approximately a multiple of 10, ranging from 3,000 to 18,000 mg/L. The water from the FW represents approximately 10% of the groundwater inflow. A sampling program was initiated to establish a baseline of FW water quality. Currently, endeavours are being made to correlate TDS readings with flow from specific water inflows and explain the reason behind large variances found in the FW results. Investigation commenced in July 2013 and is currently on-going with 12 sampling stations. New stations will be added as needed.

The main contribution of the high TDS appears to be from an upwelling of historically encapsulated water below the dyke from the FW. Footwall development comes first in the mining sequences, which allows a preferential pathway for water inflow below the dyke. During FW development, TDS concentrations increase exponentially, directly affecting (i.e., increasing) the TDS mass discharged into Snap Lake.

2.3.2 Ongoing Efforts to Reduce Groundwater Inflows

To mitigate the risk of intersecting a high inflow during mining, cover holes are drilled ahead of the Mine face advance. A Technical Services Department standard operating procedure document discusses the requirements for cover drilling. Cover holes are mandatory for all FW, ore access, and ore development headings. There is also a standard operating procedure for mining through pillars around grouted diamond drill holes from the surface. The technical services standard operating procedure details the necessary steps, and sign offs required before mining of a pillar is allowed. This helps to mitigate the possible risk of intersecting a high water inflow associated with drill holes from surface; the salinity of inflow water is assessed using a portable conductivity analyser.

If the cover holes intersect water, they are then converted to grout holes, and cement grouting is performed. The objective of the grouting is to seal off potential inflow areas ahead of the mine face to minimize inflow when development occurs. However, current experience at the Mine indicates that grouting only provides a temporary abatement to the inflows. The inflows may be stopped or reduced, but will find the next easiest flow path in the same area and recommence.

Liquid grouting has also been used to stop or slow down Mine face advances that have intersected high flows (≥1,000 litres per minute [lpm]). However, liquid grouting has had mixed success, has proven to be costly, and inflows will continue to flow in alternate locations.

Relatively high inflows are associated with kimberlite breccia, which are situated typically 3 metres (m) or greater above the FW. The breccia is a weak rock material that needs to be reinforced to create a safe mining environment. Reinforcing the breccia helps reduce inflows of high TDS water but, like grouting, is not a permanent solution.

2.4 On-going Investigations to Reduce Total Dissolved Solids Loadings

This section provides a summary of on-going investigations into improvements to minewater management, including best available technology (i.e., most effective and economically achievable) to reduce TDS loadings to minewater. The current total minewater inflow is 42,000 cubic metres per day (m^3/d) and could go up to between 64,000 and 80,000 m^3/d (based on the base case/lower bound scenario and the upper bound scenarios, respectively) for Life of Mine (LOM). The existing WTP was designed to remove particulates through flocculation, sedimentation, and filtration, and does not remove TDS. A cost-benefit analysis of best available technologies to reduce TDS loadings to minewater is provided in Section 4 of this Plan.

2.4.1 Assessment of Full Effluent Treatment

Full effluent treatment was assessed in 2012 for the expansion of the Mine WTP (CH2M Hill 2012). Alternative treatment technologies were identified, reviewed, and compared for the removal of total suspended solids (TSS), nitrate, metals, chloride, and fluoride from the Mine and WMP. Additionally, the scale-of-treatment required to comply with the 2015 licence limits for each contaminant, which would come into force if SSWQOs were not developed and approved, was assessed.

High rate clarification processes were compared for the reduction of TSS and metals in the secondary treatment train. The Densadeg® Integrated Reactor/Clarifier/Thickener was found to be more economical in terms of equipment costs compared to the Actiflo® Package Plant Clarifier.

In terms of nitrate removal technologies, nitrate specific ion-exchange (IX) and reverse osmosis (RO) were identified as potentially viable options. Similarly for chloride removal, IX and RO were identified as viable treatment options. Electrodialysis reversal (EDR) was eliminated from consideration as it is typically more costly than RO, more complex, and can be difficult to operate and maintain. While distillation can achieve high removals of all three contaminants, it was deemed to be not economically viable, as it would require a large input of thermal energy, and has a very low recovery ratio (approximately 50%). For fluoride removal, RO, IX, and activated alumina were all identified as potentially viable options; however, the efficiency to which activated alumina or IX processes can remove fluoride from the minewater is uncertain (CH2M Hill 2012). A summary of the different treatment technologies is shown in Table 2-4.

The RO process would require pre-treatment with conventional or high-rate clarification and microfiltration/ultrafiltration to remove potential membrane foulants. Additionally, concentrate from the RO system containing high levels of dissolved ions and nutrients would require a proper treatment or disposal strategy. Further, full effluent treatment may not be necessary if the high TDS groundwater can be treated at source (Section 2.4.2).

Table 2-4 Comparison of Treatment Technology

Treatment Technology	Removal Efficiency		Brine Waste Bi-Product	Optimal Conditions	Advantages	Disadvantages
	Fluoride	Chloride				
Ion Exchange	Low	65>90%	1-2%	<50 mg/L SO_4 <5 mg/L NO_3 Low turbidity (<0.3 NTU) <500 mg/L TDS	• Can also remove some nitrate • Smaller waste stream that RO or EDR	• Moderate capital cost • Moderate to high operating and maintenance (O & M) costs • Low capacity for fluoride • Can impart chloride into the water • Demineralization IX may be required to remove chloride • Capacity affected by competing ions, turbidity, and TDS
Reverse Osmosis	85 to 95%	>95%	20 to 40%	<30 mg/L of silica; no particulates Slightly acidic pH (5.5 to 6.0)	• Treats for both chloride and fluoride • Can also remove nitrate	• High capital and O & M costs • High energy consumption • High water loss • Inference by turbidity and silica • Requires pretreatment and may require post-treatment (pH alkalinity adjustment) • Brine stream must be disposed of
EDR	85 to 95%	70 to >90%	10 to 30%	Treats most waters without preference; most economical for TDS of 3000 to 5000 mg/L; maximum turbidity = 0.5 NTU	• Treats for both chloride and fluoride • Can also remove nitrate • Not affected by silica concentrations in the feed water	• High capital and O & M costs • High energy consumption • High water loss • Brine stream must be disposed of
Distillation	>99%	>99%	50%	-	• Can be more economic if waste heat is available • Removes chloride fluoride, and nitrate • High quality water produced • Less monitoring than for membrane processes • No membrane replacement	• Higher capital costs and energy requirements compared with membrane processes • Large footprint • Lower recovery ratios than membrane processes • Pretreatment required to prevent scaling and corrosion of plant components
Activated Alumina	<50 to 100% (most removals have been reported for influent concentration >1 mg/L)	-	1 to 2%	pH of 5.5 to 6.5 <30 mg/L Silica low turbidity	• Smaller waste stream • Low energy consumption • Low water loss (3 to 5%) • Sludge typically non-hazardous	• Requires pH adjustment before and after treatment • Periodic regeneration • Chemical and sludge handling required • Will not remove chloride and nitrate
Lime Precipitation	Up to 80% removal at high fluoride conc.; not very effective at lower fluoride conc.	-	1 to 2%	Precipitation occurs at an alkaline pH (10 to 11)	• Easy to operate • Provisions for lime softening already at the Snap Lake WTP	• Not very effective at low fluoride concentrations (<1 mg/L) • Will not remove chloride or nitrate • Requires sludge handling and disposal • Requires post-pH adjustment

EDR = electrodialysis reversal; RO = reverse osmosis; TDS = total dissolved solids; WTP = water treatment plant; IX = ion-exchange; O&M = operating and maintenance; SO_4 = sulphate; NO_3 = nitrate; NTU = nephelometric turbidity unit; mg/L = milligrams per litre;% = percent; <= less than; >= greater than.

2.4.2 Modular Unit Treatment for Connate Groundwater Entering the Footwall

Current experience underground (Section 2.3.2) indicates that efforts to reduce inflows of water with high TDS concentrations are best directed to treatment at source. Conceptual level technology screening studies have been completed to understand TDS loadings in the mine dewatering flow and have presented options to reduce the amount of TDS discharged in treated effluent.

The studies (Golder 2013) resulted in the development of a preferred treatment approach, premised on minimisation of secondary waste:

- ultrafiltration;
- reverse osmosis;
- evaporation/crystallization of the RO reject stream; and,
- pressure filtration of crystallized salts to further reduce the volume of secondary waste.

Additional TDS removal technologies that were previously evaluated (Golder 2008) were IX, EDR, evaporation, and chemical precipitation, with the treatment sequence described above being identified as the preferred approach. The primary factors supporting the recommendation were minimization of secondary waste volume and energy cost. Golder (2008) considered treatment of the full mine dewatering (haulage drift) flow up to a projected maximum rate of 30,000 m^3/d and utilized maximum historical concentrations of contaminants. Golder (2013) focused on FW water quality and projected flows of 4,000 to 9,000 m^3/d through operating year 2028. The water quality characterisations of haulage drift and FW waters were sufficiently similar to conclude that technology screening and alternatives evaluation would result in the same preferred approach.

A capital cost estimate of $83,700,000 was developed on the basis of treating the maximum FW flow. This cost was based on a supplier's quote for all required process, storage, and ancillary components. The quote was obtained in support of Golder's (2008) work, and was updated to current conditions with input from the supplier.

The summary of estimated costs for TDS control through treatment of FW water is shown in Table 2-5. The capital cost estimate is for construction of the above-described treatment facilities at the maximum design flow rate of 9,000 m^3/d. Relatively high flows are projected to occur during the first several years of the remaining mine life as the mine is expanded, justifying the installation of the full-capacity system. A range of annual operation cost estimates is shown, corresponding to the range of projected flows for operating years 2014 through 2028. At the conceptual stage of analysis, the cost estimates have a potential range of -10% to +50%.

Table 2-5 Summary of Total Dissolved Solids Treatment Costs

	Total Estimated Cost ($million)	Flow Basis (m^3/d)
Capital Cost	$84	9,000
Operational Cost	$5.4/year to $12.1/year	4,000 to 9,000

m^3/d = cubic metres per day.

Capital costs for TDS removal from the FW water flow are optimized for minimization of secondary waste volume and energy costs. Treatment of the higher TDS concentration flow from the FW source, at a greatly reduced flow rate in comparison to treatment of the full mine dewatering flow, provides improved cost-effectiveness for TDS removal. The blended TDS concentration (untreated mine dewatering flow with treated footwall flow) has not been determined as part of this study.

Membrane treatment processes and brine processing technologies are very energy intensive, and the unit cost of power generation at the Mine is high. In addition, chemical costs for scale control and membrane cleaning are large. Power and chemical costs constitute about 90% of total operational costs and generally increase directly with increasing flow rate.

The Mine has requested a proposal from a third party vendor for a portable modular water treatment system that is centered on a RO, and a desalination system that can achieve up to 90% recovery of TDS ions of 1,000 m^3/d per unit; generating only 10% of brine water. These numbers are unconfirmed at this stage, and further investigations are required to prove their efficiency.

Some of the key requirements of such a treatment system are:

- Buffer storage or collection – Acts as a wet well to provide the source water to the WTP;
- Pressurization – Raw water is pumped via duplex pumps with automatic control and failure alarms;
- Pre-treatment – Water is pumped to four high-flow multimedia pressurized vessels to reduce sediments and turbidity;
- A pair of 5 micron filters is used to achieve finer sediment removal and additional system protection;
- Due to high hardness and mineral concentrations in raw water, an anti-scalant dosing system is provided upstream of the RO system; and,
- Clean water is pumped out of the system and return to the main system.

A full scope feasibility study will be carried out by Q4 2014 for a pilot scale treatment RO facility. Treatment is part of a three-phase water management strategy for the LOM, as described in Section 5 of this Plan.

2.4.3 Enhanced Monitoring of Treated Effluent

To provide early warning, and help to inform management actions, in-house sampling test kits for chlorides have been ordered. These tests will be used similarly to the HACH nitrate kits that were successfully used onsite in response to concerns during freshet 2011. Quality Assurance/Quality Control

will be applied to the in house tests, which will include collecting laboratory samples at the same time as samples processed in house to assess accuracy and range of variability.

Chloride inline meters will be installed in the WTP to better understand flows and trends. These meters will be located on the underground line as well as the final compliance point at 02-17B within the WTP to prevent discharge of water above EQC. The chloride inline meters were ordered the week of October 21st, 2013 and there is a 6 to 8 week delivery. Once the inline analyzers arrive on-site, the designer will come to site to calibrate the equipment as per installation and provide maintenance instructions. Calibration will occur in the form of recording the values at the point of metering and sending out samples to a certified laboratory to assess accuracy and range of variability.

3 ECOLOGICAL IMPLICATIONS OF TOTAL DISSOLVED SOLIDS, CHLORIDE, AND FLUORIDE LOADINGS TO THE RECEIVING ENVIRONMENT

3.1 Site-Specific Water Quality Objectives

3.1.1 Total Dissolved Solids

Total dissolved solids is an expression of salinity; it is the sum of the concentrations of all common dissolved ions in freshwaters (e.g., sodium, calcium, magnesium, potassium, chloride, sulphate, bicarbonate, nitrate, reactive silicate). TDS is naturally present in water; however, elevated concentrations can cause adverse effects to fish and other aquatic organisms, as a result of osmotic stress and specific ion toxicity. The ionic composition of TDS varies depending on site conditions and the proportions of constituent ions present. Total dissolved solids benchmarks, as opposed to benchmarks for individual ions, can only be developed for sites where the TDS composition does not vary, which is the case for Snap Lake.

The EAR (De Beers 2002) predicted that TDS concentrations would increase in Snap Lake over the operational life of the Mine, as a result of mining operations that would liberate deep connate water – ancient groundwater entrapped in sediments, and rock characterized by high salinity. As a result of the increases in TDS concentrations predicted in the EAR, requirements for TDS monitoring were established for Snap Lake as well as a TDS compliance limit of 350 mg/L, calculated as a whole-lake average but excluding the northwest arm stations.[1] This TDS compliance limit was not effects-based but, rather, was solely based on modelling predictions in the EAR (De Beers 2002).

The TDS concentration in Snap Lake has increased at a faster rate than predicted in the EAR due to greater than predicted TDS loading to Snap Lake from treated Minewater. De Beers initiated a tiered study in 2010 to investigate the potential effects of elevated TDS concentrations on aquatic life for the purpose of developing a chronic effects benchmark (CEB) for TDS that could be adopted as a SSWQO for Snap Lake.

Water Quality Benchmarks for Total Dissolved Solids

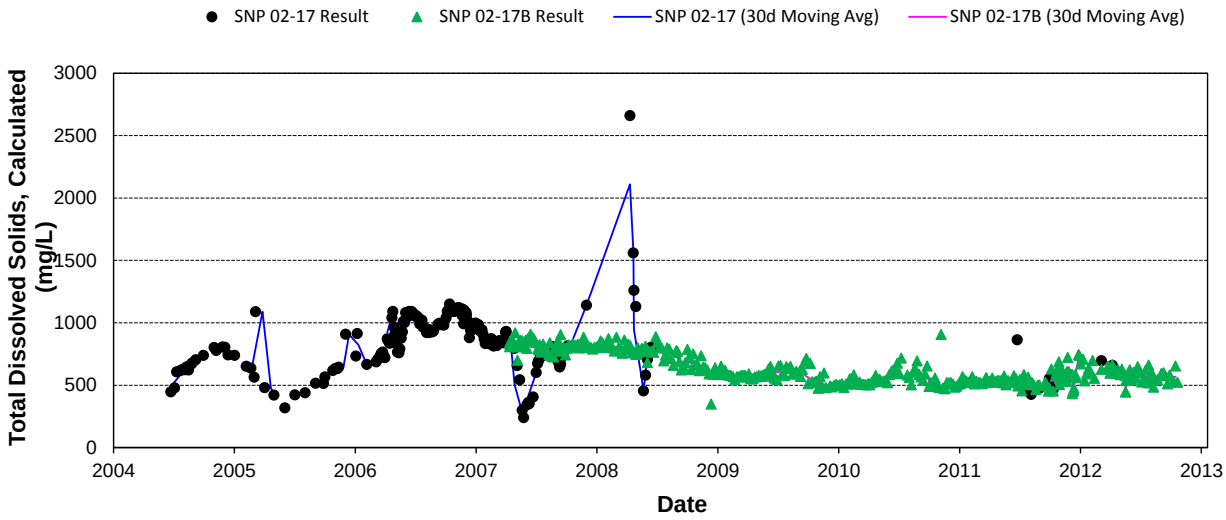
There are no national WQGs for TDS for protection of aquatic life in Canada or the United States. In Alaska, TDS may not exceed 1,000 mg/L and permits are required for discharges to receiving water that result in increased TDS concentrations in a waterbody to between 500 and 1,000 mg/L (ADEC 2012). A TDS benchmark of 500 mg/L was approved for the Diavik Diamond Mine in August 2013 (WLWB 2013a), in the absence of a SSWQO.

[1] The northwest arm of Snap Lake is connected to the main basin by a narrow channel and the volume of flow between the two is small relative to the main body of Snap Lake. The northwest arm of Snap Lake is therefore not included in the whole-lake TDS calculation.

Total Dissolved Solids Concentrations in Snap Lake

The TDS concentrations measured in treated effluent from the temporary WTP (Station SNP 02-17) and the permanent WTP (Station SNP 02-17B) between 2004 and 2012 are shown in Figure 3-1. Individual measurements and 30-day (d) moving averages are shown for each discharge point.

Figure 3-1 Total Dissolved Solids Concentrations in Treated Effluent, 2004 to October 2012



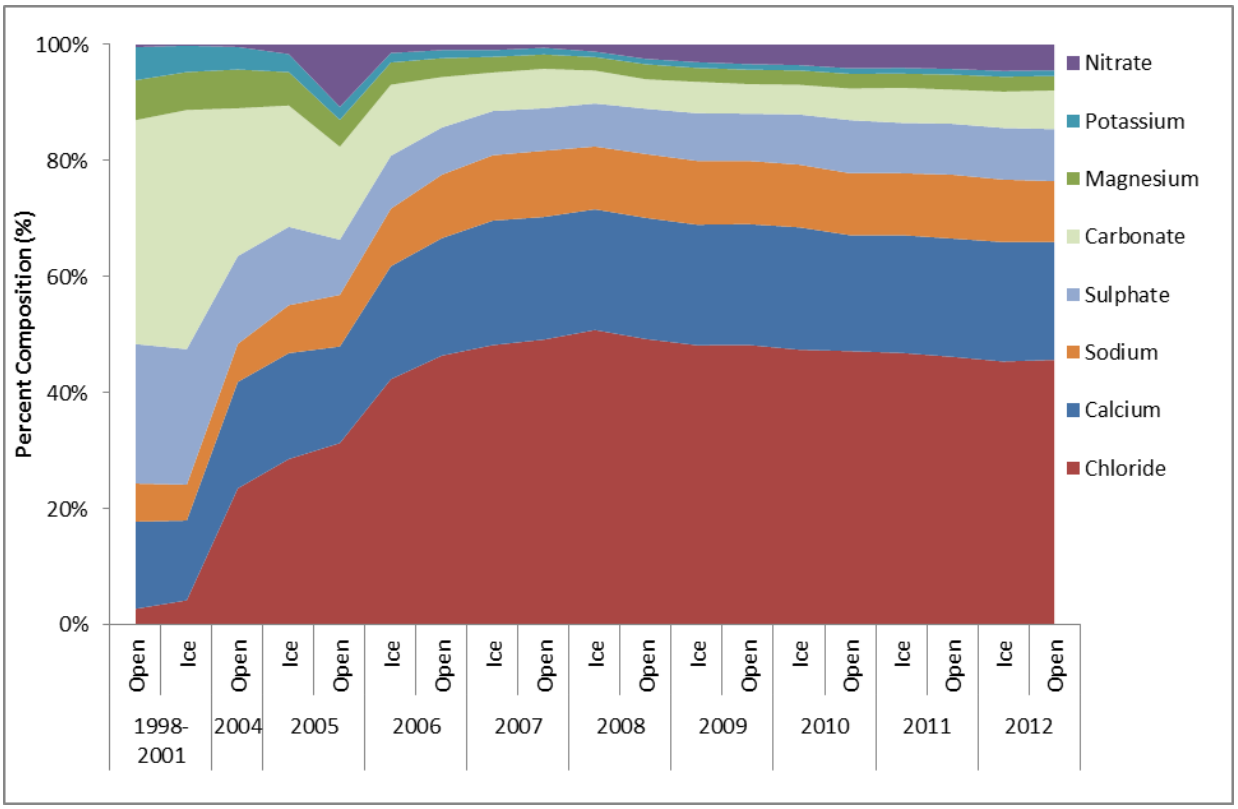
Total dissolved solids calculation formula was updated in January 2012. The 2012 TDS concentrations were calculated based on the formula described in Part 1030 E of American Public Health Association (APHA; 2005). 30d Moving Avg = 30-day moving average; SNP 02-17 = treated effluent from the temporary water treatment plant; SNP 02-17B = treated effluent from the permanent water treatment plant; mg/L = milligrams per litre.

Under baseline conditions (1998 to 2001), prior to Mine construction and the discharge of treated effluent, the average TDS concentration in Snap Lake was less than 12 mg/L and the ionic composition was dominated by carbonate and sulphate ions (approximately 50% to 60% of the TDS), with calcium and chloride contributing less than 20% of the TDS. A shift in the TDS ionic composition occurred from 2004 to 2006, with an increasing dominance of calcium and chloride ions as a result of treated effluent discharges. The ionic composition of TDS in Snap Lake has remained relatively stable since 2007 (Figure 3-2). In 2010, when this SSWQO development work was initiated, the mean composition was: chloride, 47%; calcium, 21%; sodium, 11%; sulphate, 9%; and, carbonate, nitrate, fluoride, potassium, and magnesium each contributing 1% to 5%. The 2010 ionic composition was used to prepare the synthetic lake water used for the site-specific TDS toxicity testing program. The ionic composition of TDS in Snap Lake continues to remain stable, with small variations in mean composition in 2012 as compared to 2010: chloride, 45%; calcium, 20%; sodium, 10%; sulphate, 9%; and, carbonate, nitrate, fluoride, potassium, and magnesium each contributing 1% to 7%. In 2012, TDS concentrations in Snap Lake (excluding northwest arm stations) ranged from 167 to 279 mg/L, all below the Water Licence limit of 350 mg/L (Figure 3-3). The overall whole-lake average for TDS in 2012 was 212 mg/L.

Predicted Total Dissolved Solids Concentrations in Snap Lake

The EAR (De Beers 2002) predicted that the maximum TDS concentration in Snap Lake would be 444 mg/L within 1% of the lake. Additional modelling performed in 2013 (De Beers 2013a) indicated that the TDS concentrations in Snap Lake were predicted to range from an average of 800 to 1,200 mg/L under Lower Bound Scenarios and from an average of 1,100 to 1,700 mg/L under Upper Bound Scenarios (Figure 3-4).

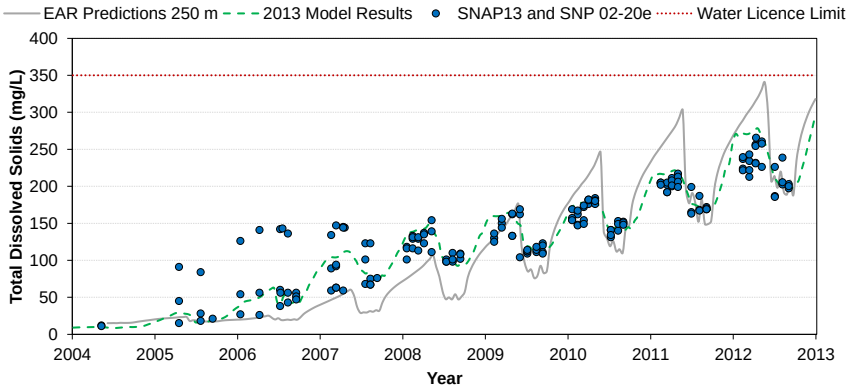
Figure 3-2 Ionic Composition of Total Dissolved Solids in Snap Lake, 1998 to 2012



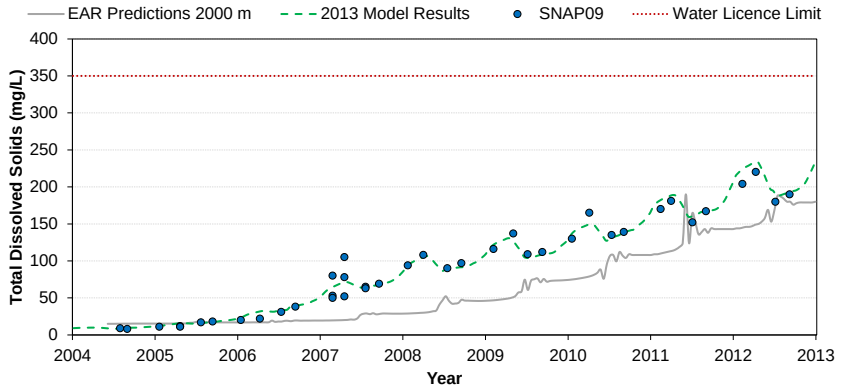
% = percent.

Figure 3-3 Total Dissolved Solids Concentrations in Snap Lake Compared to the Water Licence Limit, 2004 to 2012

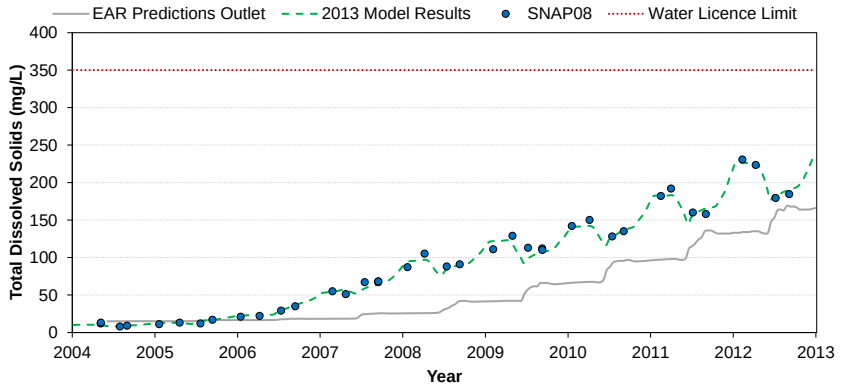
a. Diffuser Area



b. Main Basin



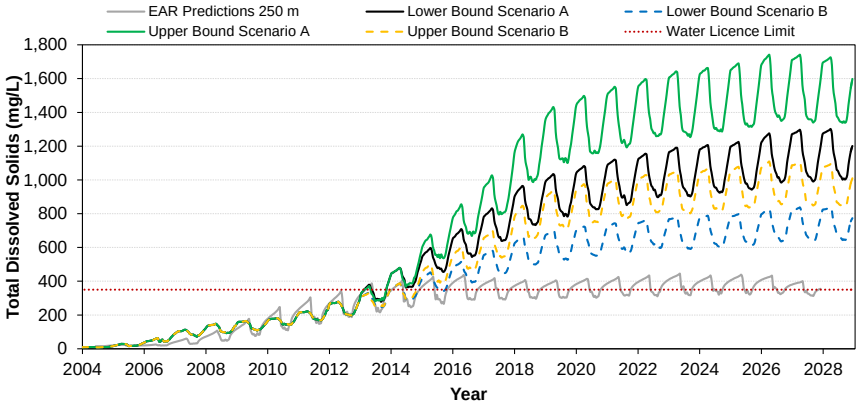
c. Outlet



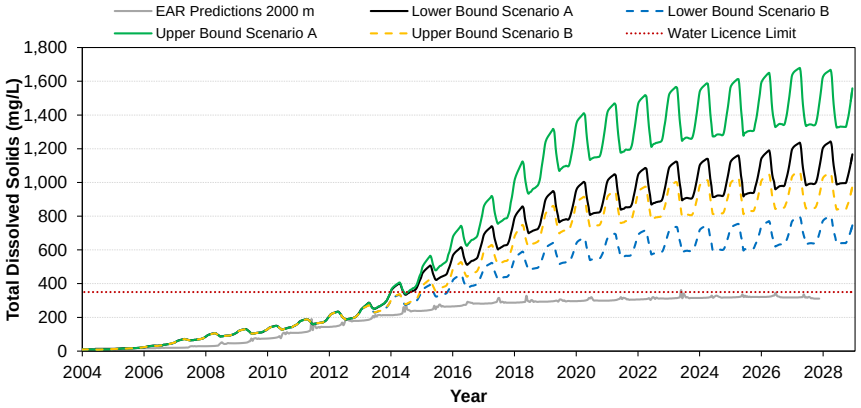
Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08; mg/L = milligrams per litre.

Figure 3-4 Predicted Total Dissolved Solids Concentrations in Snap Lake Compared to the Water Licence Limit, 2004 to 2029

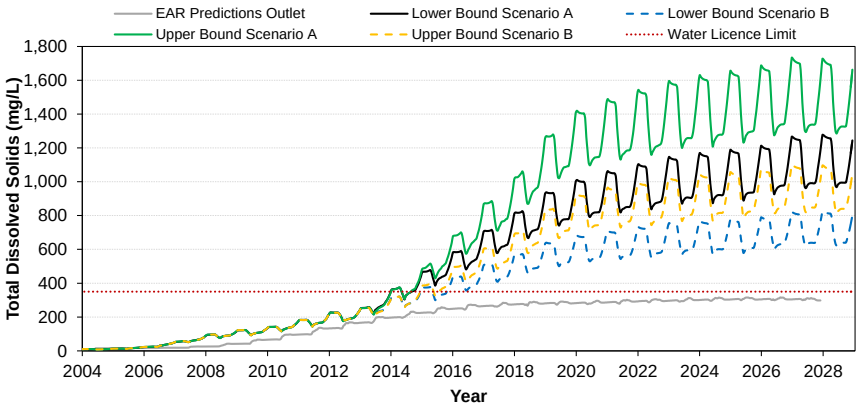
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08; mg/L = milligrams per litre.

Derivation of the Site-Specific Water Quality Objective for Total Dissolved Solids

In their Reasons for Decision (MVEIRB 2003), the Mackenzie Valley Environmental Impact Review Board acknowledged (p. 67) "De Beers predicted that TDS concentrations would increase 22-fold: from baseline concentrations of 15 mg/L in Snap Lake to a maximum average whole lake concentration of 330 mg/L" and that "No guidelines or site specific benchmarks exist for TDS". As a result (p 79), "The Production Water Licence for the Snap Lake project shall specify that the whole lake average TDS concentration in Snap Lake not exceed 350 mg/L at any point in the mine life." Because there are no national WQGs for TDS based on toxicity data, De Beers initiated the process of developing site-specific water quality objectives (SSWQOs) for TDS, chloride and fluoride.

A literature review was conducted to identify studies on the toxicity of TDS, calcium, and/or chloride (the major constituents of TDS in Snap Lake) using temperate or northern cold-water species. Most of the existing literature on TDS toxicity was for studies with TDS that was composed primarily of sulphate, calcium sulphate, or sulphate and bicarbonate. In contrast, as noted above, TDS in Snap Lake is composed primarily of chloride (45% to 47%) and calcium (20% to 21%). Therefore, site-specific toxicity testing was conducted to assess the toxicity of TDS using synthetic lake water prepared to match the ionic composition of Snap Lake.

The site-specific toxicity data set generated to support the Snap Lake TDS benchmark consisted of two studies with fish (both salmonid species present in Snap Lake), four studies with invertebrates (two planktonic crustaceans, one rotifer, and one chironomid - the latter two represent dominant taxa in the zooplankton and benthic invertebrate communities in Snap Lake), and two studies with phytoplankton (one taxon present in Snap Lake).

Application of the species sensitivity distribution (SSD) approach to derive the benchmark for TDS was considered. The majority of endpoints were unbounded (i.e., toxicity occurred above the highest TDS concentration measured); therefore, an SSD could not be developed. Given that the majority of site-specific testing showed no adverse effects at TDS concentrations greater than 1,400 mg/L, a benchmark on the order of 1,400 mg/L TDS may be realistic for Snap Lake, but was not considered to be sufficiently conservative given that lower effects endpoints were obtained for two daphnid (water flea) species. A benchmark based on these daphnid toxicity results would be arguably highly conservative for three reasons: consistently a low population of daphnids in the Snap Lake zooplankton (average 2%); the more abundant rotifer zooplankton showed no adverse effects at TDS concentrations greater than 1,400 mg/L; and, literature indicating that the other major taxon in the zooplankton, copepods, are relatively insensitive to TDS compared to daphnids (Galat and Robinson 1983). Repeating testing at higher TDS concentrations was not considered necessary because the upper limit used was already higher than the maximum TDS concentration predicted to occur in Snap Lake.

The most sensitive point estimate derived from the site-specific toxicity testing was a 10% effect at 560 mg/L on *Ceriodaphnia dubia* reproduction, which was a conservative low-effect endpoint and the lowest test endpoint recorded in the site-specific test program. The 20% effect for reproduction from the same test was 778 mg/L. The second-most sensitive point estimate was a 20% effect of 684 mg/L for *Daphnia magna* reproduction. The genus *Daphnia* is found in Snap Lake but not the species *D. magna*; the genus *Ceriodaphnia* is not found in Snap Lake. The zooplankton community in Snap Lake and Northeast Lake is comprised primarily of copepods and rotifers. Site-specific testing with the rotifer *Brachionus calyciflorus*, a genus that occurs in Snap Lake, showed that reproduction was not adversely

affected at TDS concentrations greater than 1,474 mg/L. Between 2004 and 2012 daphnids accounted for an average of less than 2% of zooplankton biomass in both lakes.

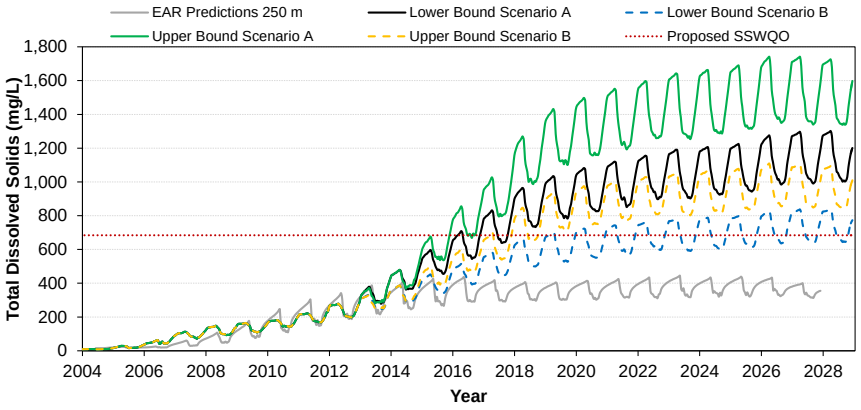
Applying either of the other two Canadian Council of Ministers of the Environment (CCME; 2007) WQG derivation approaches (i.e., not the SSD approach which is preferred but which could not be applied to this particular data set) involves applying a safety factor. Given that *C. dubia* are not present in Snap Lake, but *Daphnia* species are, it was considered appropriate to use the lowest effect level for *D. magna* reproduction for the benchmark derivation and to apply a safety factor of 1.0 to yield a CEB of 684 mg/L TDS for Snap Lake, recommending that this CEB be adopted as the SSWQO for TDS in Snap Lake.

A SSWQO of 684 mg/L TDS is not substantially greater than the current TDS benchmark of 500 mg/L for the Diavik Diamond Mine (WLWB 2013a), which was established in absence of a site-specific objective. It is also in the lower range of the State of Alaska permitted increases in TDS concentrations in natural Northern waterbodies: 500 to 1,000 mg/L (ADEC 2012). Finally, this SSWQO, if used to develop a benchmark for chloride based on the average percent composition of chloride (i.e., 684 mg/L x 46%) would result in a lower chloride benchmark (315 mg/L) than that proposed in Section 3.1.2, below, based on the EKATI Diamond Mine SSWQO (372 mg/L) – indicating that the proposed SSWQO for TDS is likely overprotective.

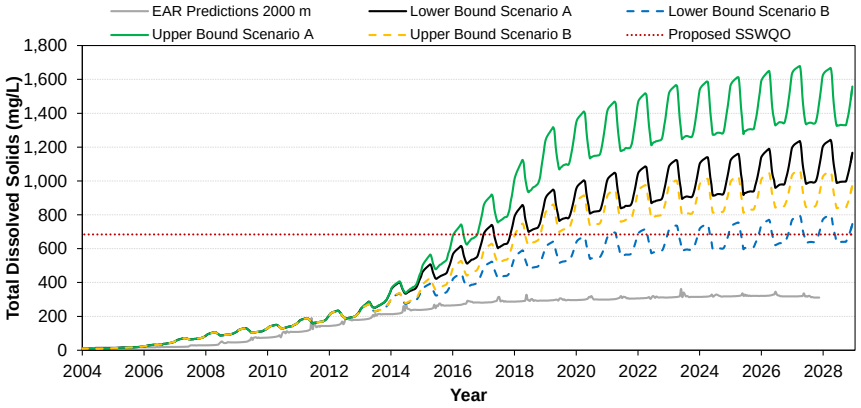
Modelling completed in 2013 (De Beers 2013a) indicated that the TDS concentrations in Snap Lake were predicted to exceed the proposed SSWQO in 2015 and 2017 under Upper Bound Scenarios A and B, and were predicted to exceed the proposed SSWQO in 2016 and 2019 under Lower Bound Scenarios A and B (Figure 3-5).

Figure 3-5 Predicted Total Dissolved Solids Concentrations in Snap Lake Compared to the Proposed Site-Specific Water Quality Objective, 2004 to 2029

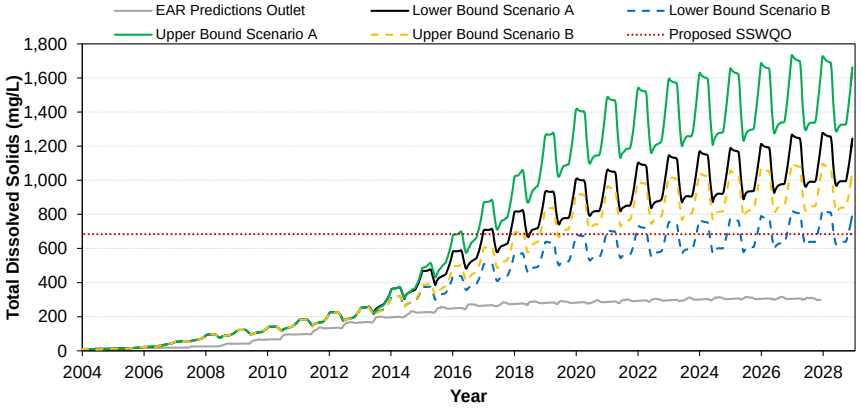
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08; mg/L = milligrams per litre; SSWQO = site-specific water quality objective.

3.1.2 Chloride

Chloride is the primary ionic constituent of TDS in Snap Lake, comprising 45% to 47% of TDS since 2010. The TDS benchmark study initiated by De Beers in 2010 was not intended to develop a benchmark for chloride, and therefore site-specific toxicity tests on chloride were not performed. However, the current Water Licence requires that a benchmark be recommended for chloride, either from site-specific testing or published toxicology studies.

Water Quality Benchmarks for Chloride

For the State of Kentucky, Birge et al. (1985) recommended that, for protection of aquatic life, chloride concentrations should not exceed 600 mg/L for any consecutive 3-d period and that the maximum chloride concentration should not exceed 1,200 mg/L.

Environment Canada and Health Canada (2001) prepared a Priority Substance List assessment report for road salts, specifically inorganic chloride salts. Although not a WQG, it was estimated that 5% of aquatic species would be affected (median lethal concentration) at a chloride concentration of about 210 mg/L, and 10% of aquatic species would be affected at a chloride concentration of 240 mg/L.

British Columbia (BC) has an approved WQG for chloride for protection of freshwater aquatic life (Nagpal et al. 2003). The maximum chloride concentration should not exceed 600 mg/L at any time, and the 30-d average chloride concentration should not exceed 150 mg/L.

The United States has a national water quality criterion for protection of freshwater aquatic life for chloride, when associated with sodium (USEPA 1988), that has been adopted by Quebec (MDDEP 2009). The 4-d average concentration of chloride (chronic effects concentration) should not exceed 230 mg/L more than once every three years on average, and the 1-hour (h) average concentration of chloride (acute effects concentration) should not exceed 860 mg/L more than once every three years on average.

The CCME (2011) long-term chloride WQG for protection of freshwater aquatic life is 120 mg/L. CCME (2011, p4) noted that chloride toxicity decreased with increasing water hardness for a number of aquatic species and that, although there were insufficient data available to derive a national hardness-dependent WQG for chloride, “jurisdictions may choose to derive site-specific hardness-adjusted water quality criteria (or objectives) where appropriate.”

Elphick et al. (2011) conducted toxicity tests with chloride to develop a SSWQO for chloride for the EKATI Diamond Mine. That testing program used nine species of zooplankton, benthic invertebrates, and fish, including a number of the same species used in De Beers’ site-specific TDS testing program, and included investigation of the effects of water hardness on toxicity of chloride to the water flea, *Ceriodaphnia dubia*. Based on those results, a hardness-dependent SSWQO was developed that was applicable for water hardness concentrations ranging from 10 to 160 mg/L as calcium carbonate ($CaCO_3$). This hardness-dependent SSWQO was adopted as the maximum average chloride effluent quality criteria (EQC) for the EKATI Diamond Mine in their renewed Water Licence W2012L2-0001 (WLWB 2013b) according to the following formulae:

EQC for maximum average concentration = 116.6(ln[Hardness])-204.1; and,

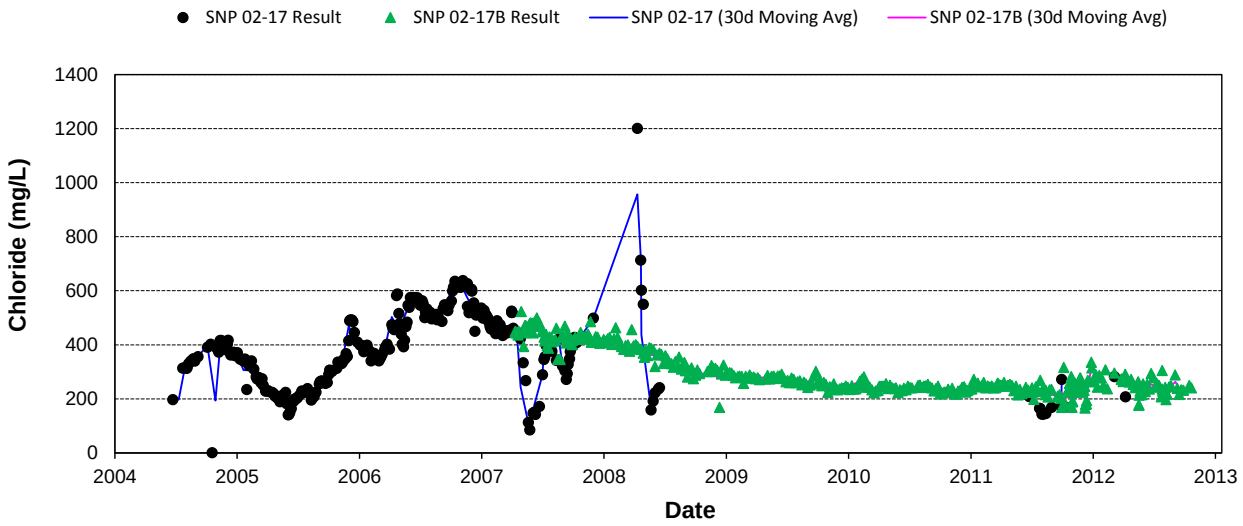
EQC for maximum concentration of any grab sample = 2(116.6(ln[Hardness])-204.1).

Chloride Concentrations in Snap Lake

Chloride concentrations measured in treated effluent from the temporary WTP (Station SNP 02-17) and the permanent WTP (Station SNP 02-17B) between 2004 and 2012 are shown in Figure 3-6. Individual measurements and 30-d moving averages are shown for each discharge point.

Chloride concentrations are increasing in Snap Lake (Figure 3-7). In 2012, concentrations of chloride in Snap Lake were typically below the CCME WQG of 120 mg/L, with the exception of one chloride result of 121 mg/L collected from the diffuser area. The EAR (De Beers 2002) predicted that chloride concentrations could reach 177 mg/L in 1% of Snap Lake. More recent modelling predictions performed in 2013 (De Beers 2013a) indicated that average chloride concentrations were predicted to range between 500 mg/L and 800 mg/L at the diffuser area and at the outlet of Snap Lake under Upper Bound Scenarios, and between 350 mg/L and 600 mg/L at the diffuser area and at the outlet of Snap Lake under Lower Bound Scenarios (Figure 3-8). Chloride concentrations in Snap Lake were predicted to exceed the CCME WQG in 2012 at the diffuser area under Upper Bound and Lower Bound Scenarios.

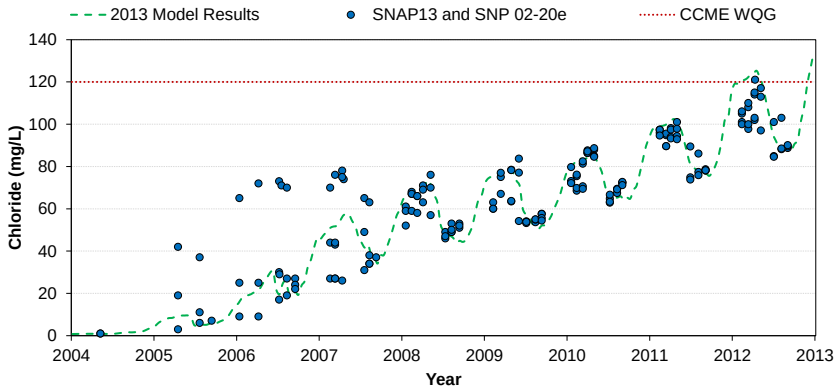
Figure 3-6 Chloride in the Treated Effluent, 2004 to 2012



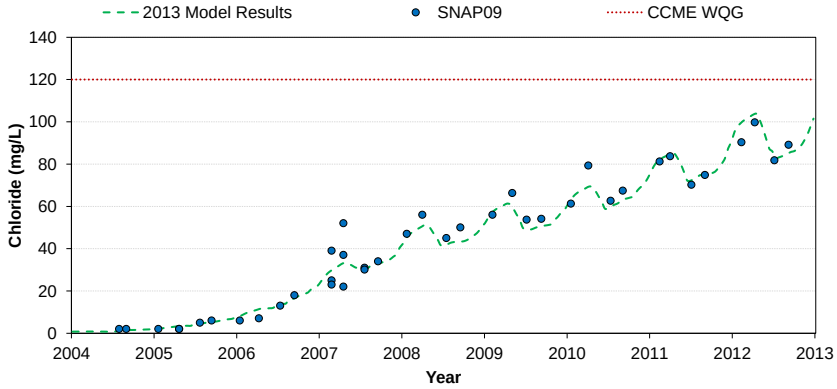
30d Moving Avg = 30-day moving average; SNP 02-17 = treated effluent from the temporary water treatment plant; SNP 02-17B = treated effluent from the permanent water treatment plant; SNP = Surveillance Network Program; mg/L = milligrams per litre.

Figure 3-7 Chloride Concentrations in Snap Lake, 2004 to 2012

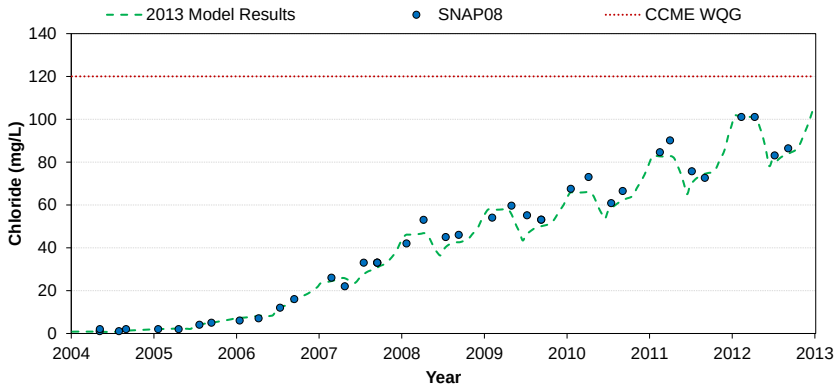
a. Diffuser Area



b. Main Basin



c. Outlet

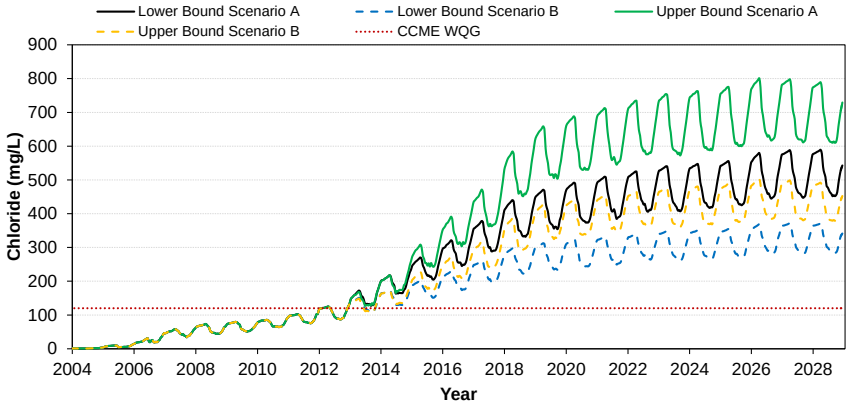


Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08.

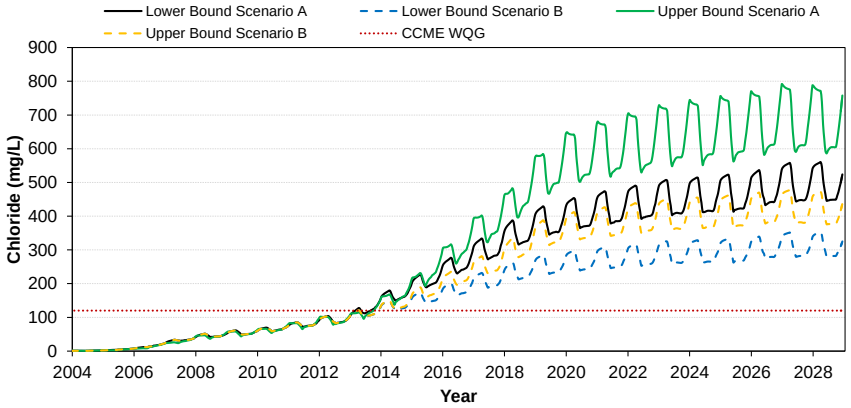
mg/L = milligrams per litre; CCME = Canadian Council of Ministers of the Environment; WQG = water quality guideline.

Figure 3-8 Predicted Chloride Concentrations in Snap Lake Compared to the Existing AEMP Benchmark, 2004 to 2029

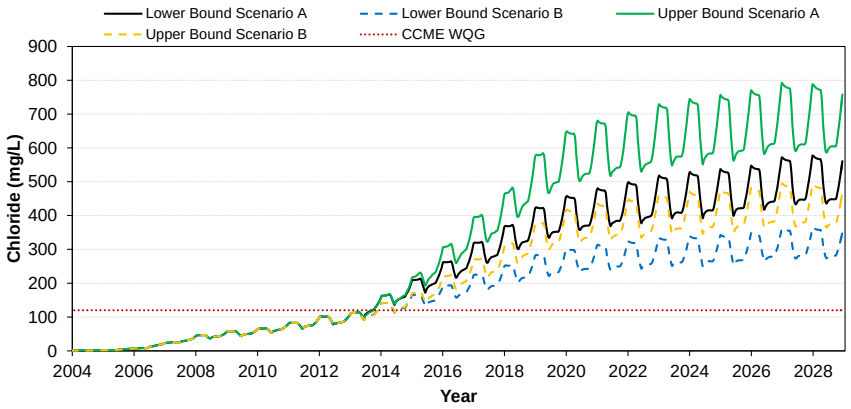
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08.

mg/L = milligrams per litre; CCME = Canadian Council of Ministers of the Environment; WQG = water quality guideline.

Derivation of the Site-Specific Water Quality Objective for Chloride

The chloride SSWQO developed and approved for the EKATI Diamond Mine (Elphick et al. 2011) was considered to be suitable for application to Snap Lake, based on current and predicted maximum chloride and water hardness concentrations. The equation is:

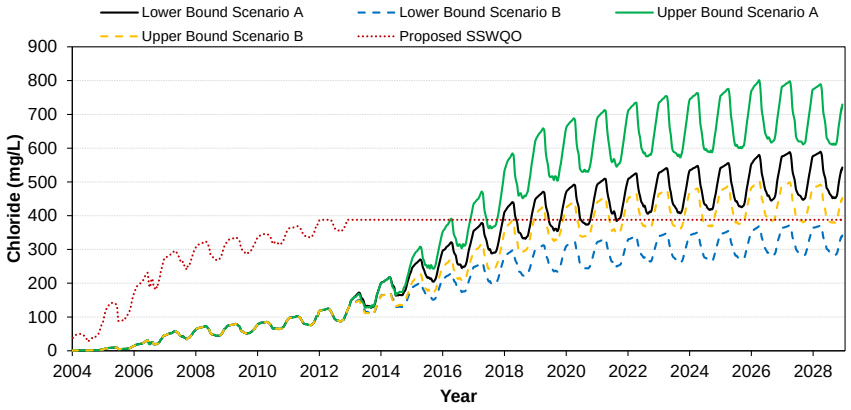
$$\text{Chloride SSWQO} = 116.6\ (\ln[\text{hardness}])-204.1.$$

At the current water hardness of Snap Lake (140 mg/L as $CaCO_3$), the chloride CEB would be 372 mg/L. It is recommended that this hardness-dependent SSWQO equation be adopted for Snap Lake up to a hardness of 160 mg/L.

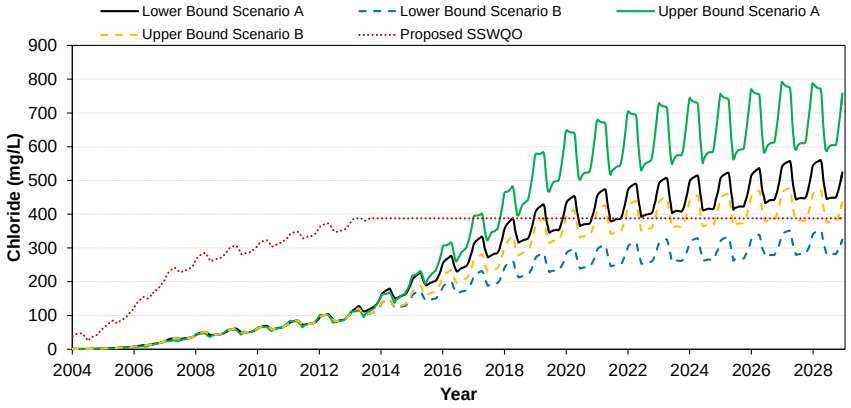
Modelling completed in 2013 (De Beers 2013a) indicated that chloride concentrations in Snap Lake were predicted to exceed the proposed SSWQO in 2016 and 2019 under Upper Bound Scenarios A and B, and were predicted to exceed the proposed SSWQO in 2017 under Lower Bound Scenario A (Figure 3-9).

Figure 3-9 Predicted Chloride Concentrations in Snap Lake Compared to the Site-Specific Water Quality Objective, 2004 to 2029

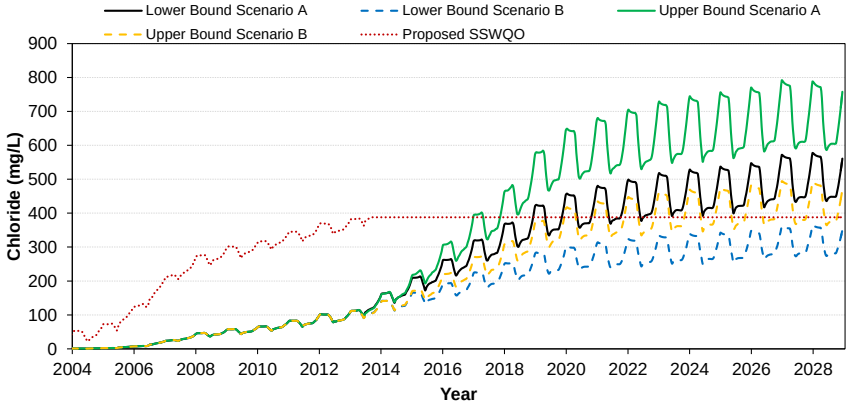
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08; the proposed SSWQO for chloride is hardness dependent.

mg/L = milligrams per litre; SSWQO = site-specific water quality objective.

3.1.3 Fluoride

Fluoride is present in Snap Lake primarily as a result of seepage of shallow groundwater into the underground Mine (Drysdale 2011). The EAR (De Beers 2002) did not make predictions about changes to fluoride concentrations in Snap Lake over the operational life of the Mine. No benchmark for fluoride was proposed in the EAR, although an interim Canadian WQG for protection of freshwater aquatic life was subsequently developed for fluoride and adopted as the Aquatic Effects Monitoring Program (AEMP) benchmark for Snap Lake. Fluoride concentrations in Snap Lake were measured at concentrations above the AEMP benchmark in 2012; therefore, a site-specific fluoride benchmark was developed for Snap Lake to determine whether there is a risk of adverse effects above the current AEMP benchmark.

Water Quality Benchmarks for Fluoride

British Columbia has an interim provincial WQG for total fluoride that is hardness dependent (BCMOE 1995). At a water hardness of 10 mg/L as $CaCO_3$ the provincial fluoride WQG is 0.4 mg/L; otherwise it is calculated using the following hardness-dependent equation:

$$\mathrm{WQG}(hardness) = -51.73 + 92.57\ \mathrm{Log}_{10}(hardness), multiplied\ by\ 0.01$$

This hardness-dependent equation was developed by Pimentel and Bulkley (1983) using 96-h LC50s from acute toxicity tests performed with juvenile Rainbow Trout (*Oncorhynchus mykiss*) at a range of water hardness concentrations. Because the hardness-dependent equation is intended to estimate 96-h LC50s for fluoride relative to water hardness, a 0.01 LC50-to-chronic uncertainty factor was applied to derive the WQG. At the current water hardness in Snap Lake (approximately 140 mg/L as $CaCO_3$), applying this hardness-dependent equation would result in a SSWQO of 1.47 mg/L.

The CCME (2002) national interim WQG for total inorganic fluoride for protection of freshwater aquatic life is 0.12 mg/L. There were insufficient data from acceptable chronic toxicity tests (Environment Canada 2001), so this interim WQG was derived by multiplying the most sensitive LC50 or EC50 from an acceptable acute study, the 144-h acute LC50 of 11.5 mg/L fluoride (F^-) for the caddisfly *Hydropsyche bronta* (Camargo et al. 1992), by an application factor of 0.01.

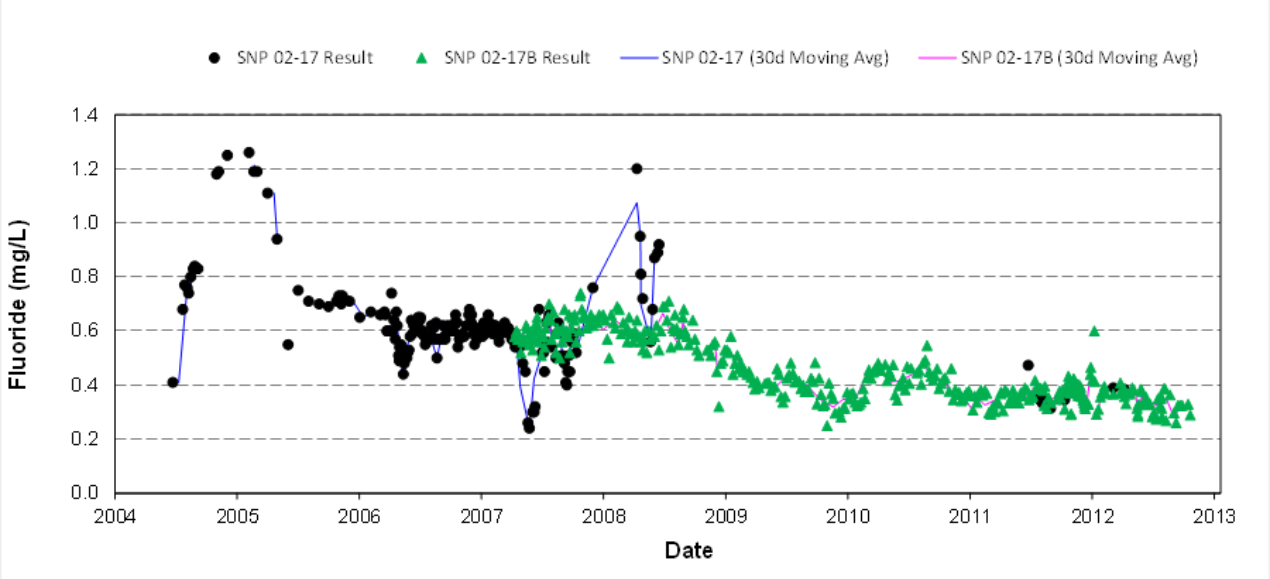
Manitoba has a surface WQG for inorganic fluorides of 0.12 micrograms per litre for protection of freshwater aquatic life (Manitoba Water Stewardship 2011); this is intended to be the CCME (2002) WQG but appears to use incorrect concentration units.

The United States does not have a national benchmark for protection of freshwater aquatic life for fluoride. North Carolina has a surface water quality standard of 1.8 mg/L for protection of freshwater aquatic life (NCDENR 2003).

Fluoride Concentrations in Snap Lake

Concentrations of total fluoride measured in treated effluent from the temporary WTP (Station SNP 02-17) and the permanent WTP (Station SNP 02-17B) between 2004 and 2012 are shown in Figure 3-10. Individual measurements as well as 30-d moving averages for each discharge point are shown. Fluoride concentrations in treated effluent have been consistently decreasing since 2004, ranging from greater than 1.2 mg/L in 2005 to approximately 0.3 mg/L in 2012. There are currently no EQC set for fluoride in the Water Licence; however, as of January 1, 2015 in the absence of a SSWQO the Water Licence specifies EQC of 0.15 mg/L as the maximum average monthly concentration and 0.3 mg/L as the maximum concentration in any grab sample.

Figure 3-10 Fluoride Concentrations in the Treated Effluent, 2004 to 2012

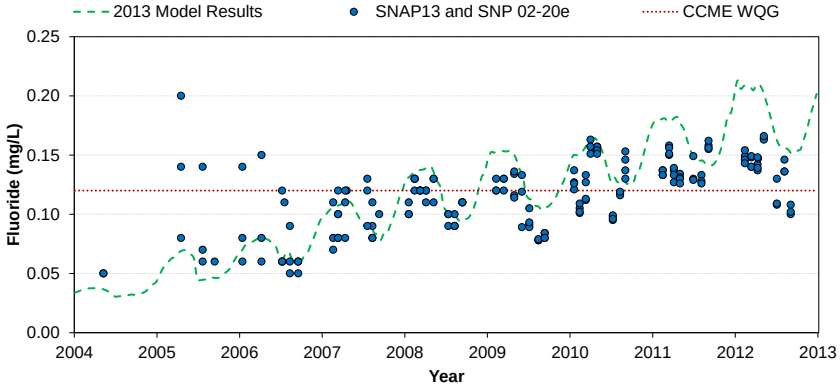


30d Moving Avg = 30-day moving average; SNP 02-17 = treated effluent from the temporary water treatment plant; SNP 02-17B = treated effluent from the permanent water treatment plant; mg/L = milligrams per litre.

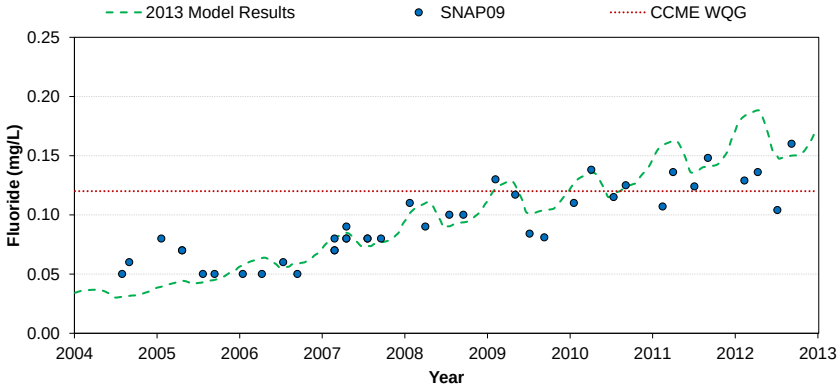
Baseline concentrations of total fluoride measured in Snap Lake in 1999 and 2001 ranged from 0.04 to 0.06 mg/L (De Beers 2002). Fluoride concentrations have increased in Snap Lake since Mine operations began, and have been above the CCME WQG since 2008 (Figure 3-11). In 2012, the maximum fluoride concentration measured in Snap Lake was 0.18 mg/L. Preliminary review of 2013 water quality data for Snap Lake indicates that fluoride concentrations remain elevated, with a maximum concentration of 0.23 mg/L reported at a diffuser station. Updated modelling in 2013 (De Beers 2013a) indicated that average fluoride concentrations at the diffuser area and at the outlet of Snap Lake were predicted to increase to 0.45 mg/L under Upper Bound and Lower Bound Scenarios (Figure 3-12).

Figure 3-11 Fluoride Concentrations in Snap Lake, 2004 to 2012

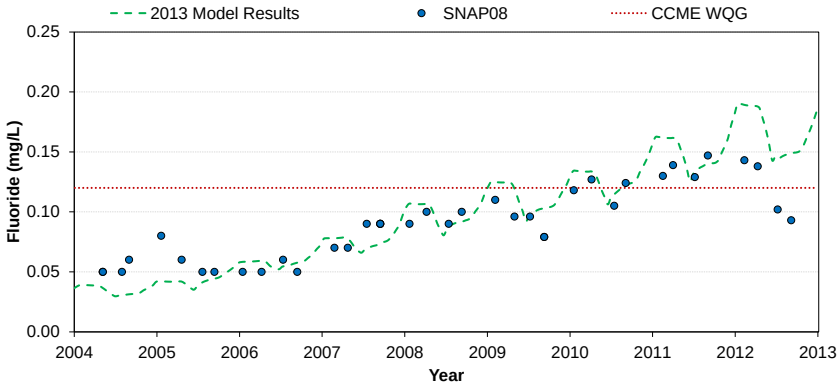
a. Diffuser Area



b. Main Basin



c. Outlet

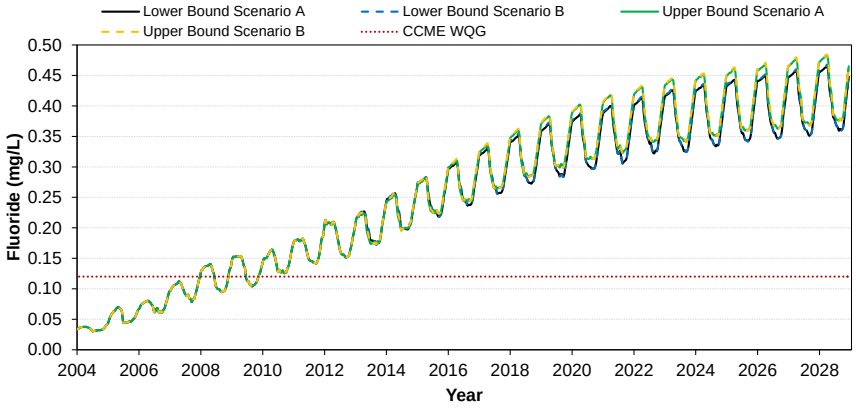


Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08.

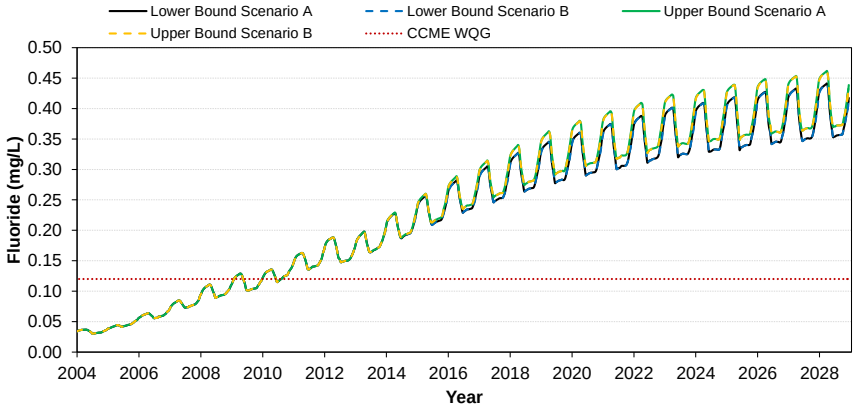
mg/L = milligrams per litre; CCME = Canadian Council of Ministers of the Environment; WQG = water quality guideline.

Figure 3-12 Predicted Fluoride Concentrations in Snap Lake Compared to the Existing AEMP Benchmark, 2004 to 2029

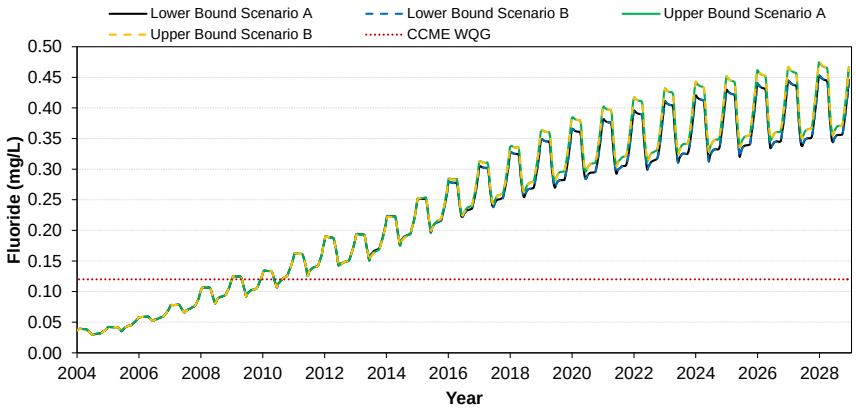
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08.

mg/L = milligrams per litre; CCME = Canadian Council of Ministers of the Environment; WQG = water quality guideline.

Derivation of the Site-Specific Water Quality Objective for Fluoride

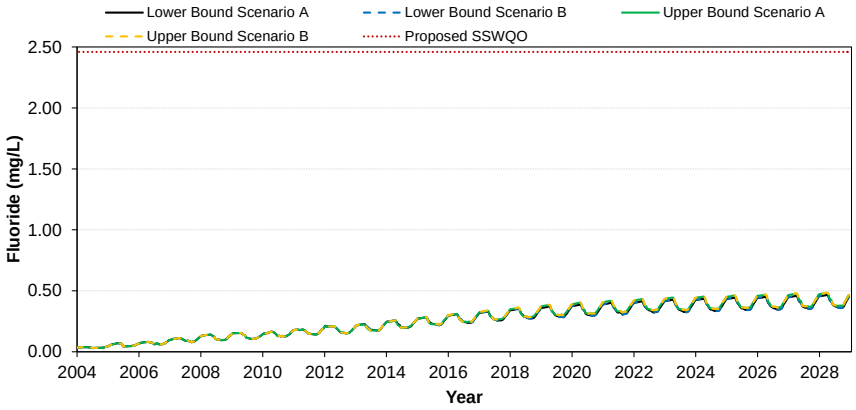
Available data on the acute and chronic toxicity of fluoride to freshwater aquatic life were compiled and reviewed. Acute toxicity occurs at fluoride concentrations ranging from 12 to greater than 800 mg/L. The majority of chronic effects occur at concentrations between 2.25 and 229 mg/L. Only chronic studies were considered for development of the CEB. A total of 11 chronic studies representing 15 species (3 fish, 8 invertebrates, and 4 algae/aquatic plants) were used to derive a CEB of 2.46 mg/L F^-, applying the SSD approach recommended by CCME (2007).

The above CEB is approximately 20-fold higher than the CCME (2002) WQG2: 0.12 mg/L. However, the CCME criteria did not use the SSD approach, nor did it consider the effect of increasing hardness in reducing fluoride toxicity. British Columbia's interim WQG for fluoride is hardness-dependent; that benchmark would be 1.47 mg/L at the current Snap Lake water hardness of 140 mg/L as $CaCO_3$, which is within a factor of two of the CEB derived above and about 10-fold higher than the CCME (2002) fluoride WQG. However, the BC WQG was derived from a single study that used acute data for Rainbow Trout at different hardness concentrations rather than the SSD approach; thus, the BC WQG is not as robust as the CEB calculated herein using multiple chronic studies and applying the CCME SSD approach. Accordingly, the CEB of 2.46 mg/L F^- is recommended as a SSWQO for fluoride in Snap Lake.

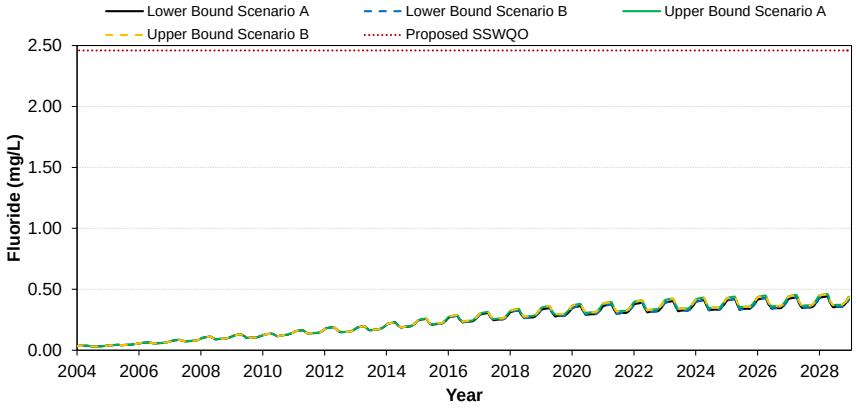
Modelling completed in 2013 (De Beers 2013a) indicated that fluoride concentrations in Snap Lake were predicted to remain below the proposed SSWQO under Upper Bound and Lower Bound Scenarios (Figure 3-13).

Figure 3-13 Predicted Fluoride Concentrations in Snap Lake Compared to the Proposed Site-Specific Water Quality Objective, 2004 to 2029

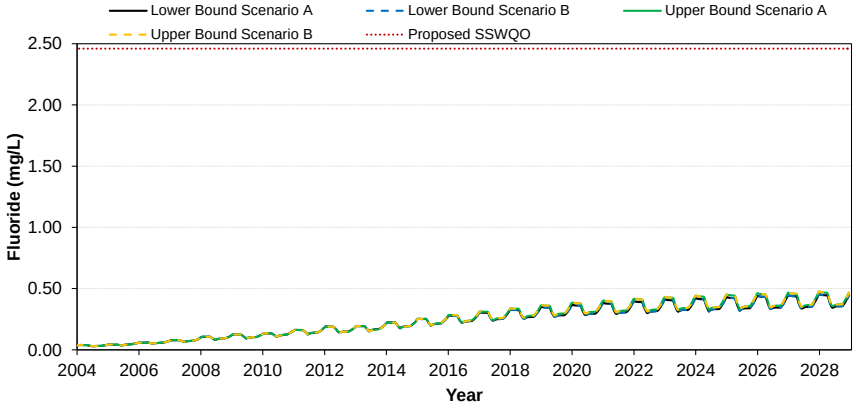
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08.

mg/L = milligrams per litre; SSWQO = site-specific water quality objective.

3.2 Effluent Quality Criteria

Effluent quality criteria (EQC) are to be applied at the last point of discharge (i.e., they assess treated minewater quality from the permanent WTP). The EQC represent values that, when maintained at the point of discharge, will be protective for aquatic life in the receiving environment (i.e., Snap Lake and downstream waterbodies). This is consistent with guidance provided by the MVLWB's Effluent Quality Management Policy (Policy) (MVLWB 2011), which also states (p 11) "the Boards will ensure that EQC are set at levels that the proponent can reasonably and consistently achieve."

Variability in the treated effluent is accounted for in the Water Licence through the requirement for two EQC:

1) Maximum daily limit (MDL), which represents the maximum concentration of a parameter measured in a single grab sample of the treated effluent; and,

2) Average monthly limit (AML), which represents the average concentration of a parameter that the Mine may release into Snap Lake, determined by averaging consecutive samples collected over six-day intervals over a thirty-day period.

Under Schedule 5: Part F, 3b (ii) of the Water Licence, recommendations and rationale for revised EQC are specifically required for TDS, chloride, and fluoride. This Section includes a summary of the method(s) used to calculate EQC and presents the EQC results for TDS, chloride, and fluoride based on the SSWQOs from Section 3.1.

3.2.1 Methods

The MVLWB's Policy (MVLWB 2011) does not outline specific methods for establishing EQC; therefore, the existing Snap Lake EQC were reviewed with reference, as appropriate, to the methods used previously for the Mine (Golder 2003) and those recommended by other jurisdictions (USEPA 1991; AEP 1995). Derivation of EQC for the Mine for all parameters, not just TDS, chloride, and fluoride, involved the following steps:

- identify parameters for which EQC should be evaluated;
- select an appropriate benchmark for each parameter;
- select a location in Snap Lake where benchmarks should be met (i.e., the mixing zone boundary);
- calculate an EQC that results in peak concentrations in Snap Lake being equal to or lower than SSWQOs or existing AEMP benchmarks; and,
- compare proposed EQC to existing EQC in the Water Licence and predicted treated effluent discharge concentrations.

The present *TDS Response Plan* only presents EQC for TDS, chloride, and fluoride. A detailed description of the methods used to calculate EQC for these parameters and others is presented in De Beers (2013c).

It is proposed that the approach for managing TDS be consistent with other parameters in the Water Licence: the in-lake compliance limit be removed from the Water Licence and replaced with an end-of-pipe limit (i.e., an EQC) that would maintain TDS concentrations in Snap Lake below the SSWQO (De Beers 2013c). The legal justification for this change is provided in Osler (2013). An EQC for TDS would provide the Mine with more operational control than is presently the case, as it would be clear what the TDS concentration in the minewater must be to maintain Snap Lake TDS concentrations below the SSWQO. A TDS EQC rather than a whole-lake-average is also better aligned with the AEMP Response Framework and proposed Action Levels (De Beers 2012b).

The second task in the EQC setting process involved selecting appropriate benchmarks. The proposed SSWQOs described in Sections 3.1.1, 3.1.2, and 3.1.1 were used to calculate EQC for TDS, chloride, and fluoride, respectively (Table 3-1). Detailed methods for calculating EQC based on the benchmarks presented in Table 3-1 are in De Beers (2013c).

The third task in the EQC setting process involved re-visiting mixing zone considerations. The Policy allows for the consideration of allocated mixing zones. A mixing zone is the region in which initial dilution of treated minewater occurs. For Snap Lake, the mixing zone boundary also represents the location at which AEMP benchmarks should be met. For the present study, the mixing zone was assumed to be the same as that established in the EAR (De Beers 2002). This assumption and corresponding uncertainties are discussed further in De Beers (2013c).

The fourth task (i.e., the EQC setting process) is also outlined in De Beers (2013c); the results from that assessment are summarized below, in Section 3.2.2.

Table 3-1 AEMP Benchmarks Used for Calculating Effluent Quality Criteria

Parameter	AEMP Benchmark (mg/L)	Description	Source
Total Dissolved Solids	684	Site-specific water quality objective (SSWQO)	De Beers (2013d); Section 3.1.1
Chloride	388	Hardness dependent SSWQO developed for the EKATI Diamond Mine, at a hardness of 160 mg/L[(a)] as $CaCO_3$	Elphick et al. (2011); De Beers (2013d); Section 3.1.2
Fluoride	2.46	SSWQO calculated from chronic toxicity data	De Beers (2013e); Section 3.1.3

Notes: mg/L = milligrams per litre; % = percent; AEMP = Aquatic Effects Monitoring Program; Golder = Golder Associates, Ltd.; $CaCO_3$ = calcium carbonate.

(a) The SSWQO is based on a maximum hardness of 160 mg/L (Elphick et al. 2011). Toxicity-hardness relationships were not defined for hardness concentrations beyond 160 mg/L.

3.2.2 Results

A comparison of the proposed EQC for TDS, chloride, and fluoride to existing EQC are presented in Section 3.2.2.1. Section 3.2.2.2 including a comparison of the proposed EQC to measured and predicted treated effluent concentrations. Finally, Section 3.2.2.3 presents a summary of recommended EQC for inclusion in the Water Licence Amendment.

3.2.2.1 Comparison of Proposed Effluent Quality Criteria to Existing Effluent Quality Criteria

A comparison of the proposed EQC for TDS, chloride, and fluoride to existing EQC are presented in Table 3-2. Key findings for TDS, chloride, and fluoride are:

- A new EQC was calculated for TDS based on the SSWQO (Section 3.1). Developing an EQC for TDS at the Mine affords De Beers more operational control, as it would be clear what the TDS concentration in the treated effluent must be to maintain Snap Lake TDS concentrations below the SSWQO.
- The AMLs and MDLs proposed for chloride and fluoride are greater than the existing AMLs and MDLs and those that could come into effect on January 1, 2015. The increase was a result of moving to more realistic, site-specific, protective benchmarks from conservative, generic benchmarks when deriving EQC. As described in Table 3.1, the site-specific benchmark for chloride was based on hardness-dependent equations developed for the EKATI diamond mine and approved by the Wek'èezhìi Land and Water Board (WLWB 2013b).
- Proposed AMLs were essentially equivalent to the AEMP benchmarks (Table 3-1 and 3-2). Therefore, the Mine must meet proposed AMLs approximately equal to the AEMP benchmarks at the end-of-pipe.

Table 3-2 Comparison of Existing and Proposed[(a)] Effluent Quality Criteria for Snap Lake Mine

Parameter	EQC (mg/L)					
	AML		Existing >Proposed (Y/N)	MDL		Existing >Proposed (Y/N)
	Existing	Proposed		Existing	Proposed	
Total Dissolved Solids	N/A	684	N/A	N/A	1,003	N/A
Chloride (to December 31, 2014)	310	N/A	N/A	620	N/A	N/A
Chloride (from January 1, 2015)	160	378	N	320	607	N
Fluoride (from January 1, 2015)	0.15	2.43	N	0.30	3.73	N

(a) The final list of recommended EQC for inclusion in the Water Licence is presented in Section 3.2.2.3; the final list was developed based on the comparisons of existing and proposed EQC presented in Tables 3-2 and 3-3.

mg/L = milligrams per litre; EQC = effluent quality criteria; AML = average monthly limit; MDL = maximum daily limit; Y = yes; N = no; N/A = not applicable; >= greater than.

3.2.2.2 Comparison of Proposed Effluent Quality Criteria to Treated Effluent Discharge Quality

Comparisons of proposed EQC to treated effluent discharge quality in 2012, and to predicted treated effluent discharge quality are presented in Table 3-3. Key findings for TDS, chloride, and fluoride are:

- Based on the treated effluent discharge quality in 2012, the Mine can currently meet the proposed EQC.
- Based on the predicted treated effluent discharge quality, De Beers will not be able to meet proposed EQC for TDS. Based on calculations of the predicted average monthly concentrations of TDS in the

treated effluent discharge, mitigation will be required prior to 2015 to meet the proposed AML for TDS. The average monthly concentrations of TDS in the treated effluent discharge are predicted to exceed the proposed AML during ice-covered conditions in 2015 and exceed the proposed AML every month from 2016 to 2028. The maximum average monthly concentration of TDS in the treated effluent discharge is predicted to be 1,066 mg/L.

- Based on the predicted treated effluent discharge quality, the Mine will be able to meet the proposed MDL for chloride. Based on calculations of the predicted average monthly concentrations of chloride in the treated effluent discharge, mitigation will be required prior to 2017 to meet the proposed AML for chloride. The average monthly concentrations of chloride in the treated effluent discharge are predicted to exceed the proposed AML during ice-covered conditions between 2017 and 2028. The maximum average monthly concentration of chloride in the treated effluent discharge is predicted to be 473 mg/L.

Table 3-3 Comparison of Proposed[(a)] Effluent Quality Criteria to Treated Effluent Discharge Quality in 2012 and to Predicted Treated Effluent Discharge Quality for Snap Lake Mine

Parameter	Proposed EQC (mg/L)		Treated Effluent Discharge Quality in 2012[(b)]			Predicted Treated Effluent Discharge Quality[(c)]	
	AML	MDL	Flow-weighted Average (mg/L)	Maximum (mg/L)	n	Maximum (mg/L)	Year
Total Dissolved Solids	684	1,003	570	744	94	1,081	2026
Chloride (from January 1, 2015)	378	607	246	335	96	475	2026
Fluoride (from January 1, 2015)	2.43	3.73	0.35	0.60	95	0.57	2028

Notes: Shaded cells represent parameters for which, based on calculations of the predicted average monthly concentrations in the treated effluent discharge, the Mine will not be able to meet the proposed AML.

a) The final list of recommended EQC for inclusion in the Water Licence is presented in Section 3.2.2.3; the final list was developed based on the comparisons of existing and proposed EQC presented in Tables 3-2 and 3-3.

b) De Beers (2013f).

c) De Beers (2013b).

mg/L = milligrams per litre; EQC = effluent quality criteria; AML = average monthly limit; MDL = maximum daily limit; n = sample number.

3.2.2.3 Recommended Effluent Quality Criteria

The EQC for TDS, chloride, and fluoride presented in Table 3-4 represent the recommended values for inclusion in the Water Licence Amendment. For TDS, chloride, and fluoride the following changes are recommended:

- remove the whole-lake average TDS Water Licence limit of 350 mg/L; replace with an AML of 684 mg/L and an MDL of 1,003 mg/L for TDS;
- increase the AML to come into effect on January 1, 2015 from 160 to 378 mg/L for chloride and from 0.15 to 2.43 mg/L for fluoride; and,
- increase the MDL to come into effect on January 1, 2015 from 320 to 607 mg/L for chloride, and from 0.30 to 3.73 mg/L for fluoride.

Table 3-4 Recommended Effluent Quality Criteria for Snap Lake Mine

Parameter	Proposed EQC (mg/L)	
	AML	MDL
Total Dissolved Solids	684	1,003
Chloride (from January 1, 2015)	378	607
Fluoride (from January 1, 2015)	2.43	3.73

mg/L = milligrams per litre; EQC = effluent quality criteria; AML = average monthly limit; MDL = maximum daily limit.

3.3 Summary and Recommendations

In summary:

- the CEB of 684 mg/L TDS is recommended as a SSWQO for TDS in Snap Lake;
- the chloride SSWQO developed and approved for the EKATI Diamond Mine (Elphick et al. 2011) was considered to be suitable for application to Snap Lake up to a hardness concentration of 160 mg/L;
- the CEB of 2.46 mg/L F- is recommended as a SSWQO for fluoride in Snap Lake;
- TDS concentrations in Snap Lake are predicted to exceed the proposed SSWQO in years 2015 and 2017 under Upper Bound Scenarios A and B, and were predicted to exceed the proposed SSWQO in years 2016 and 2019 under Lower Bound Scenarios A and B;
- Chloride concentrations in Snap Lake are predicted to exceed the proposed SSWQO in years 2016 and 2019 under Upper Bound Scenarios A and B, and are predicted to exceed the proposed SSWQO in year 2017 under Lower Bound Scenario A; and,
- Fluoride concentrations in Snap Lake are predicted to remain below the SSWQO throughout the life of the Mine.

In future monitoring, it is recommended that TDS, chloride, and fluoride concentrations in Snap Lake be compared to the SSWQOs presented in Section 3.1.

The calculated EQC were compared to existing EQC in the Water Licence, treated effluent discharge quality in 2012, and predicted treated effluent discharge quality. Based on those comparisons, it is recommended that the:

- Water Licence be updated to include the EQC summarized in Table 3-4.
- Monitoring requirements at SNP 02-17B remain the same for TDS, chloride, and fluoride.
- Wording used to describe the EQC Table in Part F, 9a of the Water Licence be changed from “maximum average” to “average monthly limit” to improve clarity.

4 COST-BENEFIT ANALYSIS OF TREATMENT TECHNOLOGIES

4.1 Options to Achieve the Lowest Practical Effluent Quality Criteria

Treatment technology screening assessment and on-going investigations to reduce TDS loadings are described in Section 2.4 of this document. A key conclusion is that treatment targeted at reducing TDS in the connate groundwater entering the FW of the Mine is the most potentially viable approach. A cost-benefit analysis of the options considered is provided in this section. Section 5 of this Plan describes a three phase water management strategy for the LOM.

4.2 Cost-Benefit Analysis of Treatment Technologies

The estimated capital and operating costs for FW water treatment are significantly lower than the costs for treating the full mine dewatering flow. Mine dewatering flow is currently 45,000 m^3/d and could increase to 80,000 m^3/d over the LOM. Footwall flow is projected in a range of 4,000 to 9,000 m^3/d. Capital and operating cost advantages are described below.

4.2.1 Capital Cost Comparison

The capital cost for treatment of FW water has been estimated at $84 million, for capacity to treat the maximum projected flow of 9,000 m^3/d. In comparison, the capital cost for the nitrogen treatment plant, which would also accomplish TDS removal, is $174 million for a plant sized at 75,000 m^3/day (De Beers 2013g). Capital cost savings for treatment of FW water as opposed to nitrogen treatment (including TDS) of the entire mine water flow, is $90 million. If additional treatment for nitrogen removal were necessary for WMP water to meet nitrogen benchmarks, those capital costs would add to the FW water treatment cost and reduce the capital cost savings. Treatment of WMP water for nitrate removal is currently under study.

5 LIFE OF MINE WATER MANAGEMENT STRATEGY

This section describes the strategy and recommendations for improving minewater management and monitoring for the LOM.

5.1 Operational Review

A review of the hydrology and dewatering system at the Mine was carried out by a third party review during the week of June 3rd 2013 including hydrogeological model assumptions and structural data. Key outcomes from that review were:

- There is a need to refine current hydrogeological model assumptions and address gaps in structural data within the future mining footprint. This work is ongoing.
- There is an immediate need to install piezometers to collect water pressure data from above and from ahead of the workings. At present, it is not possible to verify hydrogeological conditions, or to predict long term future inflow rates with confidence. Installation of a monitoring network commenced in July 2013.
- Given the available dataset, at present the best method of estimating future Mine inflow rates is by means of the trend analysis. This predicts that the groundwater inflow will rise from the current rate of 42,000 m^3/d to a rate of about 43,000 m^3/d by the start of 2014. There is good confidence in this prediction provided no discrete large water-bearing structural zones are encountered.
- Continuation of the trend analysis indicates that the inflow rate will further rise to approximately 54,000 m^3/d by the start of 2015. There is reasonable confidence in this prediction; however, this prediction assumes that no discrete high groundwater inflow zones will be encountered.
- There is an immediate need to re-engineer and expand the underground water management and pumping system. However, because of the current uncertainties in the future inflow predictions, this needs to move forward in phases, commensurate with the expansion of the monitoring program.

Based on the operational review the following improvement objectives were identified that support the overall water management strategy:

- water treatment plant capacity;
- pumping capacity to meet the inflow predictions;
- reliability and functionality of pumping systems;
- reticulation and redundancy of piping and pumping;
- submersible pump stage pumping;
- temporary sump design; and,
- mine settling sump cleaning.

5.2 Water Management Strategy

The Underground Water Management Strategy will be achieved in a three phase process:

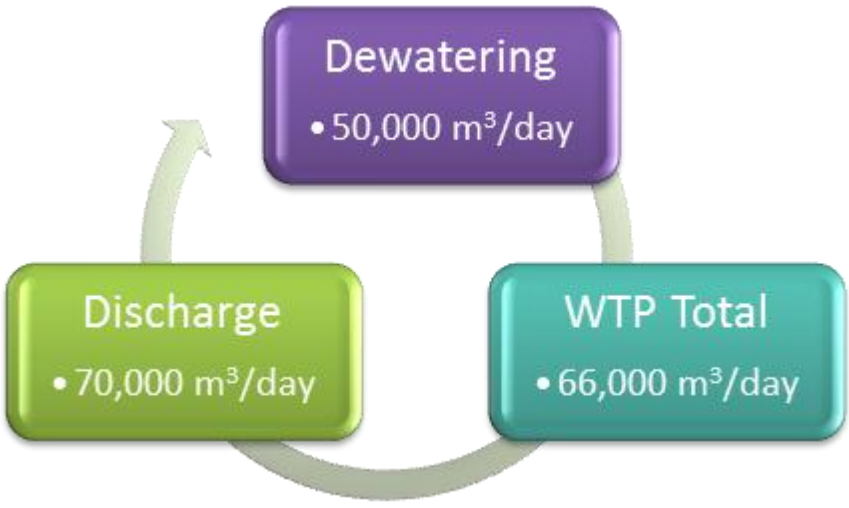
- **Phase I – 2013 to mid-2014**: Phase I is required (Table 5-1, Figure 5-1) to reach an acceptable buffer for pumping and treatment capacity of the current and short term dewatering needs generated by major fluctuations in Mine inflows and equipment maintenance requirements. This short term action plan will increase the clean water pumping capacity into the main system.

Table 5-1 Phase I Task Descriptions

Task	Description
Task 1: CWS Portable Pump Station at 5250N "5250 CWS"	One tank; two 200 hp flowserves; two by 250 m 6'' pipeline to pipefit into existing 8'' pipeline to surface
Task 2: Surface Clean Water Header Pipeline Installation	350 m 20'' heat traced piping, three major tie in points to portal, WTP, and WMP
Task 3: Clean Water Collection	6'' pipe installation for collection of water at 5250N; drainholes for collection at 5250N; 6'' pipe installation collection of water to the TDA CWS
Task 4: Creation of Drainhole Drive at 5230 TDA Level "TDA CWS"	Piped drainholes to 5180 CWS Tank; four by 35 m 6'' drainholes; 15 m of excavation for drift
Task 5: 5180 Pump Room Upgrade	Installation of clean water tank in the 5180 Pump Room; installation of 7th Mather-Platt pump in the pump room; installation of 35 m suction line (to be designed)
Task 6: Interim Pumping Plan for B12 WR	Installation of 1900 m 10 in piping to the 5050SHD; installation of the first stage of the Portable UG Pumping Stations at the top of B12

hp = horsepower; m = metre; '' = inch.

Figure 5-1 Phase I Summary



- **Phase II – End of 2015**: Phase II is required in order to achieve design capacities, prior to the completion of the LOM Dewatering Plan. This is essentially a staged solution to the LOM Dewatering Plan, before it is completed. Phase II is designed such that options for Phase III (below) can still be

evaluated. Phase II is designed to meet the Mine inflows for the end of 2015. Phase II is meant to implement projects which will be necessary regardless of the final Phase III design. Phase II will also focus on improving the reliability of the main pumping system. The different tasks planned for this phase are:

- hydrogeological probing or dewatering drilling program;
- installation of two additional 600 horsepower pumps increasing the clean water pumping system by 7,000 m^3/d;
- installation of two additional lines from the main pump room to surface up the conveyor ramp;
- installation of pipeline from the bottom of the Mine, targeting dirty and clean water; and,
- installation of two portable pumping stations.

- **Phase III – LOM:** Phases I and II are intended to provide enough pumping capacity in 2013 and 2014 to allow the required time to finalize the LOM Dewatering Design.

5.3 Water Treatment Capacity

Water Treatment Plant Expansion

The phased approach to water management in Section 5.1 addresses infrastructure capacity to allow increased pumping from underground, and segregation of dirty and clear water. A key strategy is to maximize the pumped volume of clear (lake) water to reduce TSS treatment requirements. Current pumping of the lower bench, more turbid water is in excess of 30,000 m^3/d. The excess overflows to the WMP and is allowed to settle. Water from the WMP passes through the three filters of the Auxiliary Treatment Plant (formerly referred to as the Temporary WTP) which treats the excess, and discharges the treated effluent into the pH adjustment tank. The WTP operation is currently at full capacity, causing a long term water management and treatment risk. The following section describes the planned WTP expansion strategy.

Modular Water Treatment Plant

The WTP expansion strategy is to pilot a modular water treatment plant (MWTP) in lieu of a second stand-alone plant. The benefit of this is that turbid water treatment capacity can be increased based on operational needs as the modular option is flexible to allow incremental increases if required, as opposed to a single capital investment and construction plan. A capital of $2,293,250 has been approved in 2013 for setup and rental of a modular WTP; $2,917,500 has been allocated in 2014 for the purchase of the modular units. The modular units will be housed in an insulated sprung structure adjacent to the existing WTP to aid in shortest pipe tie-ins.

Ballasted flocculation will be used in Phase I of the treatment process, followed by Phase II being disc filtration. The treatment objectives are a reduction to five or less nephelometric turbidity unit (NTU) after Phase I to two or less NTU after Phase II. This will be in line with current treatment quality of the main WTP. Current treatment safe guards are maintained as the treated water is discharged into the pH tank, as per the main WTP. The treated water passes through an analytics monitoring instrumentation before being discharged to the lake, so all interlock valves are applicable, in the event that treated water does not meet the required discharge criteria.

Modular Water Treatment Plant Volume Treatment Capacity

In the MWTP, the water treatment expansion is planned to increase capacity by approximately 10,000 m^3/d, by means of two Aquamove units, where each have the potential to treat up to 6,000 m^3/d, dependant on the water quality. The treated water is then gravity fed to a disc filter, capable of treating up to 30,000 m^3/d. The 20,000 m^3/d excess treatment capacity will be used for the treatment of the planned underground clear water expansions before being discharged to the pH tank.

Transportation and Installation of Units to Site

One Aquamove unit as well as the disc filter will be transported to site during summer 2014. The second Aquamove unit will be shipped to site on the 2014 winter road. The MWTP will be placed onto concrete pads with the Aquamove units being 300 mm above the disc filter to ensure the required hydraulic profile is attained.

5.4 Water Discharge Capacity

Water Treatment Plant and Modular Water Treatment Plant Diffuser Installation

The MWTP is only one facet of the overall water management of the Mine. Phases I, II, and, III of the water treatment strategy address infrastructure upgrades for both underground and surface. The MWTP increases the current water treatment capacity by 10,000 m^3/d and provides an additional 20,000 m^3/d of water treatment for future expansions. All treated water will be discharged to Snap Lake by means of the diffusers. The existing permanent diffuser is capable of treating 35,000 m^3/d with the aid of a booster pump, and 30,000 m^3/d without the booster pump. During freshet 2013, the use of a temporary floating diffuser was required to deal with increased water. A second permanent diffuser has since been installed to replace the temporary diffuser. Combined, the two diffusers will be able to discharge 60,000 m^3/d by means of gravity flow. The permanent tie-in of the second diffuser will form part of the overall tie-in of the MWTP to the main WTP.

Snap Lake Mine has a defined strategy and phased approach for water management to meet the anticipated increased water volumes as mining progresses. Water will be managed successfully and in an environmentally responsible manner.

6 SUMMARY AND CONCLUSIONS

Since TDS concentrations in Snap Lake are increasing at a faster rate than predicted in the EAR (2002) and are predicted to exceed the whole-lake average Water Licence limit of 350 mg/L between January 2014 and January 2015 (De Beers 2013a), De Beers initiated studies to investigate the potential effects of elevated TDS concentrations on aquatic life in Snap Lake for the purpose of developing SSWQOs. As a result of these studies the proposed SSWQOs for TDS, chloride, and fluoride are 684 mg/L, 388 mg/L, and 2.46 mg/L, respectively.

The proposed SSWQOs for TDS, chloride, and fluoride were used to develop new EQC intended to allow the Mine to discharge treated effluent into Snap Lake while maintaining TDS, chloride, and fluoride concentrations in the lake below the SSWQOs. As a result, the proposed AMLs for TDS, chloride, and fluoride are 684 mg/L, 378 mg/L, and 2.43 mg/L, respectively, and the proposed MDLs for TDS, chloride, and fluoride are 1,003 mg/L, 607 mg/L, and 3.73 mg/L, respectively.

Modelling completed by De Beers (2013a,b) indicated:

- TDS concentrations in Snap Lake are predicted to exceed the proposed SSWQO in years 2015 and 2017 under Upper Bound Scenarios A and B, and are predicted to exceed the proposed SSWQO in years 2016 and 2019 under Lower Bound Scenarios A and B;
- Chloride concentrations in Snap Lake are predicted to exceed the proposed SSWQO in years 2016 and 2019 under Upper Bound Scenarios A and B, and are predicted to exceed the proposed SSWQO in year 2017 under Lower Bound Scenario A; and,
- Fluoride concentrations in Snap Lake are predicted to remain below the SSWQO throughout the life of the Mine.

To reduce loadings to the receiving environment and meet the proposed EQC, De Beers initiated a phased study focused on water treatment technologies for TDS. The first phase of the study was an assessment of alternative treatment technologies for the total minewater inflow. Because of the large volume, treatment of the total minewater inflow was determined to be uneconomical. A conceptual capital cost estimate of $174 million was determined to allow treatment of the range of total mine flows over the LOM. Further, treatment of TDS on this scale would produce too large a volume of concentrated brine solution for safe disposal. The second phase of the study focused on treatment of a target stream of FW groundwater, the major source of TDS. Treatment of a portion of the FW groundwater was identified as the most economical method for achieving the lowest possible EQC because the FW groundwater contains the highest concentrations of TDS and the FW groundwater represents 10% of the total minewater inflow. A full scope feasibility study will be carried out by Q4 2014 for a pilot scale treatment RO facility.

Hydrogeological modelling completed by Itasca (2013) indicated that total minewater inflow was predicted to increase to approximately 54,000 m^3/d by the beginning of 2015. To predict long term future total minewater inflow rates with confidence, in July 2013 De Beers installed a network of piezometers to collect water pressure data from above and from ahead of the Mine workings. The data collected will be used to update the hydrogeological model.

To successfully manage the predicted increase in total minewater inflow, De Beers has initiated a phased approach that addresses infrastructure capacity.

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DE BEERS CANADA INC.

SNAP LAKE MINE

DEVELOPMENT OF FLUORIDE CHRONIC EFFECTS BENCHMARK FOR AQUATIC LIFE IN SNAP LAKE

December 2013

EXECUTIVE SUMMARY

Concentrations of fluoride measured in treated Snap Lake minewater have been consistently decreasing since 2004, ranging from greater than 1.2 milligrams per litre (mg/L) in 2005 to approximately 0.3 mg/L in 2012. However, fluoride concentrations remain elevated in Snap Lake with a maximum concentration of 0.18 mg/L reported in 2012. A fluoride chronic effects benchmark (CEB) is required as part of the *TDS Response Plan* that the Snap Lake Mine is required to submit to the Mackenzie Valley Land and Water Board by December 31, 2013. Fluoride is a constituent of total dissolved solids (TDS), although its contribution to the ionic composition of Snap Lake TDS is greater than 0.1 percent (%).

Available data on the acute and chronic toxicity of fluoride to freshwater aquatic life were compiled and reviewed. Acute toxicity occurs at fluoride concentrations ranging from 12 to greater than 800 mg/L. The majority of chronic effects occur at concentrations between 2.25 and 229 mg/L. A total of 11 chronic studies representing 15 species (3 fish, 8 invertebrates, and 4 algae/aquatic plants) were used to derive a CEB of 2.46 mg/L F^-, applying the species sensitivity distribution (SSD) approach recommended by the Canadian Council of Ministers of the Environment (CCME).

The above CEB is about 20-fold higher than the CCME fluoride fresh water quality guideline (WQG) set in 2002: 0.12 mg/L. However, that WQG did not use the SSD approach, nor did it consider the effect of increasing hardness in reducing fluoride toxicity. British Columbia (BC) has a provincial WQG for fluoride that is hardness-dependent; the BC WQG would be 1.47 mg/L at the current Snap Lake water hardness of 140 mg/L as calcium carbonate ($CaCO_3$), which is within a factor of two of the CEB derived above and about 10-fold higher than the 2002 CCME fluoride WQG. However, the BC WQG was derived from a single study that used acute data for Rainbow Trout at different hardness concentrations rather than the SSD approach; thus, the BC WQG is not as robust as the CEB calculated herein using multiple chronic studies and applying the CCME SSD approach. Accordingly, the CEB derived herein (2.46 mg/L F^-) is recommended as a site-specific water quality objective (SSWQO) for fluoride in Snap Lake.

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Appendix A Fluoride Toxicity Data

LIST OF ACRONYMS

AEMP	Aquatic Effects Monitoring Program
BC	British Columbia
BCMOE	British Columbia Ministry of Environment
$CaCO_3$	calcium carbonate
CCME	Canadian Council of Ministers of the Environment
CEB	chronic effects benchmark
Cl^-	chloride ion
De Beers	De Beers Canada Inc.
EAR	Environmental Assessment Report
ECx	concentrations of sample estimated to cause a specified effect to x% of the test organisms
EQC	effluent quality criterion
F^-	fluoride ion
HC5	hazardous concentration to 5% of species
ICx	the inhibiting concentration for an x% effect; the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms
LCx	concentrations of sample estimated to be lethal to x% of the test organisms
LOEC	lowest observed effect concentration
MATC	maximum acceptable toxicant concentration; the geometric mean of the NOEC and LOEC
Mine	Snap Lake Mine
MVLWB	Mackenzie Valley Land and Water Board
NaF	sodium fluoride
NOEC	no observed effect concentration
NWT	Northwest Territories
SMCV	species mean chronic value
SNP	Surveillance Network Program
SSD	species sensitivity distribution
SSWQO	site-specific water quality objective
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency
WQG	water quality guideline

UNITS OF MEASURE

%	percent
<	lower than
>	greater than
±	plus or minus
°C	degrees Celsius
µg/L	micrograms per litre
d	days
h	hours
km	kilometre
mg/L	milligrams per litre
mg/L F^-	milligrams per litre fluoride

1 INTRODUCTION

De Beers Canada Inc. (De Beers) owns and operates the Snap Lake Mine (Mine) in the Northwest Territories (NWT). The Mine is located approximately 220 kilometres (km) northeast of Yellowknife, 30 km south of MacKay Lake, and 100 km south of Lac de Gras where the Diavik Diamond Mine and EKATI Diamond Mine are located. Final regulatory approvals for construction and operation of the Mine were granted in May 2004, and construction began in April 2005. The Mine officially opened on July 25, 2008.

To comply with the Mine's Water Licence (Water Licence MV2001L2-0002, renewed as MV2011L2-0004 in 2012; MVLWB 2012), De Beers is required to undertake water quality monitoring as part of a larger Aquatic Effects Monitoring Program (AEMP) that also includes monitoring of sediment quality, plankton, benthic invertebrates, and fish in Snap Lake. The AEMP water quality component includes monitoring of fluoride concentrations in Snap Lake; these data are submitted in annual AEMP reports to the Mackenzie Valley Land and Water Board (MVLWB) (e.g., De Beers 2013a). In addition, De Beers is required to monitor the quality of its treated effluent discharge as part of its Surveillance Network Program (SNP), results of which are also submitted to the MVLWB.

Fluoride is present in Snap Lake primarily as a result of seepage of shallow groundwater into the underground Mine (Drysdale 2011). The 2002 Environmental Assessment Report (EAR; De Beers 2002) did not make predictions about changes to fluoride concentrations in Snap Lake over the operational life of the mine. No benchmark for fluoride was proposed in the EAR, although an interim Canadian water quality guideline (WQG) for protection of freshwater aquatic life was subsequently developed for fluoride and adopted as the AEMP benchmark for Snap Lake. Fluoride concentrations in Snap Lake were measured at concentrations above the AEMP benchmark in 2012; therefore, a site-specific fluoride benchmark needs to be developed for Snap Lake to determine whether there is a risk of adverse effects above the current AEMP benchmark.

The Mine's Water Licence requires that a *TDS Response Plan* be submitted to the MVLWB by December 31, 2013. One component of that *TDS Response Plan* is to provide recommendations and supporting rationale for site-specific water quality objectives (SSWQOs) for total dissolved solids (TDS), chloride, and fluoride in Snap Lake, derived from toxicity tests conducted by De Beers and/or published toxicology studies. A second component is to provide recommendations and supporting rationale for effluent quality criteria (EQC) for those parameters. Development of SSWQOs for TDS and chloride is reported separately (Golder 2013).

The purpose of this report is to address the requirement of the *TDS Response Plan* that a SSWQO be developed for fluoride. This report reviews existing fluoride benchmarks, provides an overview of environmental concentrations of fluoride associated with Snap Lake, summarizes available information on the toxicity of fluoride to freshwater aquatic life, and proposes a chronic effects benchmark (CEB) for fluoride in Snap Lake.

2 WATER QUALITY BENCHMARKS FOR FLUORIDE

The Canadian Council of Ministers of the Environment (CCME 2002) established a national WQG for total inorganic fluoride for protection of freshwater aquatic life of 0.12 milligrams per litre (mg/L). This was an interim WQG because there were insufficient toxicity data available at that time to derive a full WQG. The interim WQG was derived following CCME (1991) methodology, which provided three approaches depending on data availability: multiplying the most sensitive Lowest Observed Effect Concentration (LOEC) from an acceptable chronic study by a safety factor of 0.1; dividing the most sensitive LC50 or EC50 from an acceptable acute study by an appropriate acute-to-chronic ratio; or, multiplying the most sensitive LC50 or EC50 from an acceptable acute study by an application factor (0.05 for nonpersistent substances; 0.01 for persistent substances). Available data on fluoride toxicity were compiled and reviewed as part of the WQG derivation process (Environment Canada 2001). There were insufficient data from acceptable chronic toxicity studies; therefore, the interim WQG was derived by multiplying the 144-hour (h) acute LC50 of 11.5 mg/L fluoride (F^-) for the caddisfly *Hydropsyche bronta* (Camargo et al. 1992a) by an application factor of 0.01.

British Columbia (BC) has an interim provincial WQG for total fluoride that is hardness dependent (BCMOE 1995); this WQG is considered interim until additional studies on the influence of temperature and water hardness on fluoride toxicity can be conducted. At a water hardness of 10 mg/L as calcium carbonate ($CaCO_3$) the provincial fluoride WQG is 0.4 mg/L; otherwise it is calculated using the following hardness-dependent equation:

$$\mathrm{WQG}(hardness) = -51.73 + 92.57\ \mathrm{Log}_{10}(hardness), \text{multiplied by } 0.01$$

This hardness-dependent equation was developed by Pimentel and Bulkley (1983) using 96-h LC50s from acute toxicity tests performed with juvenile Rainbow Trout (*Oncorhynchus mykiss*) at a range of water hardness concentrations. Because the hardness-dependent equation is intended to estimate 96-h LC50s for fluoride relative to water hardness, a 0.01 LC50-to-chronic uncertainty factor is applied to derive the WQG. The current water hardness in Snap Lake is approximately 140 mg/L as $CaCO_3$; applying the BC hardness-dependent equation would result in a SSWQO of 1.47 mg/L.

Manitoba has a surface WQG for inorganic fluorides of 0.12 micrograms per litre (µg/L) for protection of freshwater aquatic life (Manitoba Water Stewardship 2011); this is intended to be the CCME (2002) WQG but appears to use incorrect concentration units.

The United States does not have a national benchmark for protection of freshwater aquatic life for fluoride. North Carolina has a surface water quality standard of 1.8 mg/L for protection of freshwater aquatic life (NCDENR 2003).

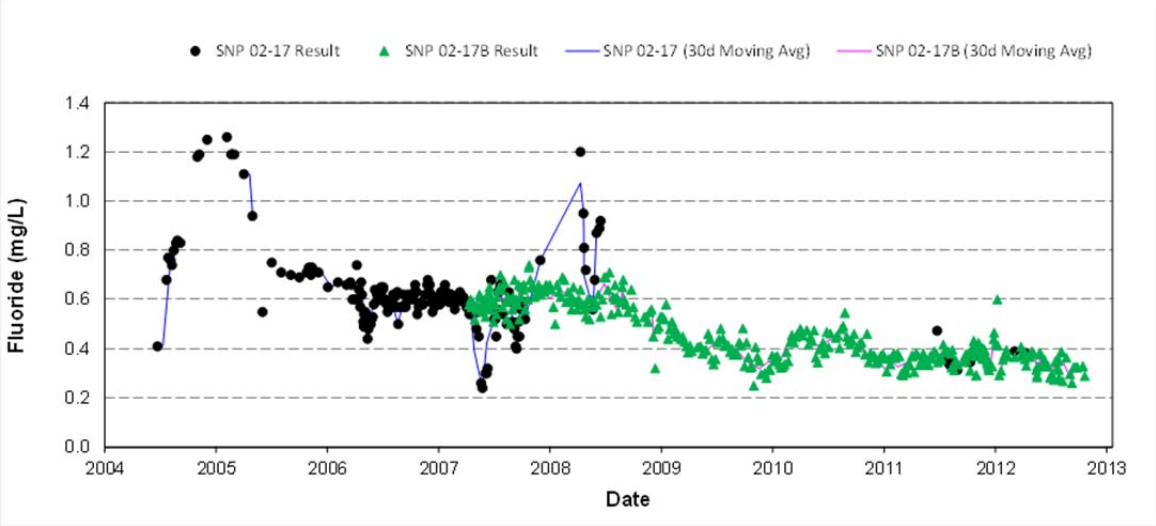
3 ENVIRONMENTAL CONCENTRATIONS OF FLUORIDE IN SNAP LAKE

Information on total fluoride concentrations measured in treated effluent and in water samples collected from Snap Lake and associated reference lakes is briefly summarized below. These data have previously been provided to the MVLWB as part of the EAR, and/or in AEMP and SNP monitoring reports. Data from October 2012 were the most recent data available[1] for inclusion herein. Fluoride concentrations are not monitored in sediments or fish tissues in Snap Lake or the reference lakes.

3.1 Treated Effluent

Concentrations of total fluoride measured in treated effluent from the temporary water treatment plant (Station SNP02-17) and the permanent water treatment plant (Station SNP02-17B) between 2004 and 2012 are shown in Figure 1. Individual measurements as well as 30-day (d) moving averages for each discharge point are shown. Fluoride concentrations in treated effluent have been consistently decreasing since 2004, ranging from more than 1.2 mg/L in 2005 to approximately 0.3 mg/L in 2012. There are currently no EQC set for fluoride in the Water Licence; however, as of January 1, 2015, in the absence of a SSWQO the Water Licence specifies EQC of 0.15 mg/L as the maximum average monthly concentration and 0.3 mg/L as the maximum concentration in any grab sample.

Figure 1: Fluoride Concentrations in Treated Effluent, 2004 to 2012



30d Moving Avg = 30-day moving average; SNP 02-17 = treated effluent from the temporary water treatment plant; SNP 02-17B = treated effluent from the permanent water treatment plant; mg/L = milligrams per litre.

[1] Data collected in 2013 are undergoing screening and compilation as part of preparation for the 2013 AEMP report and were therefore not available for inclusion.

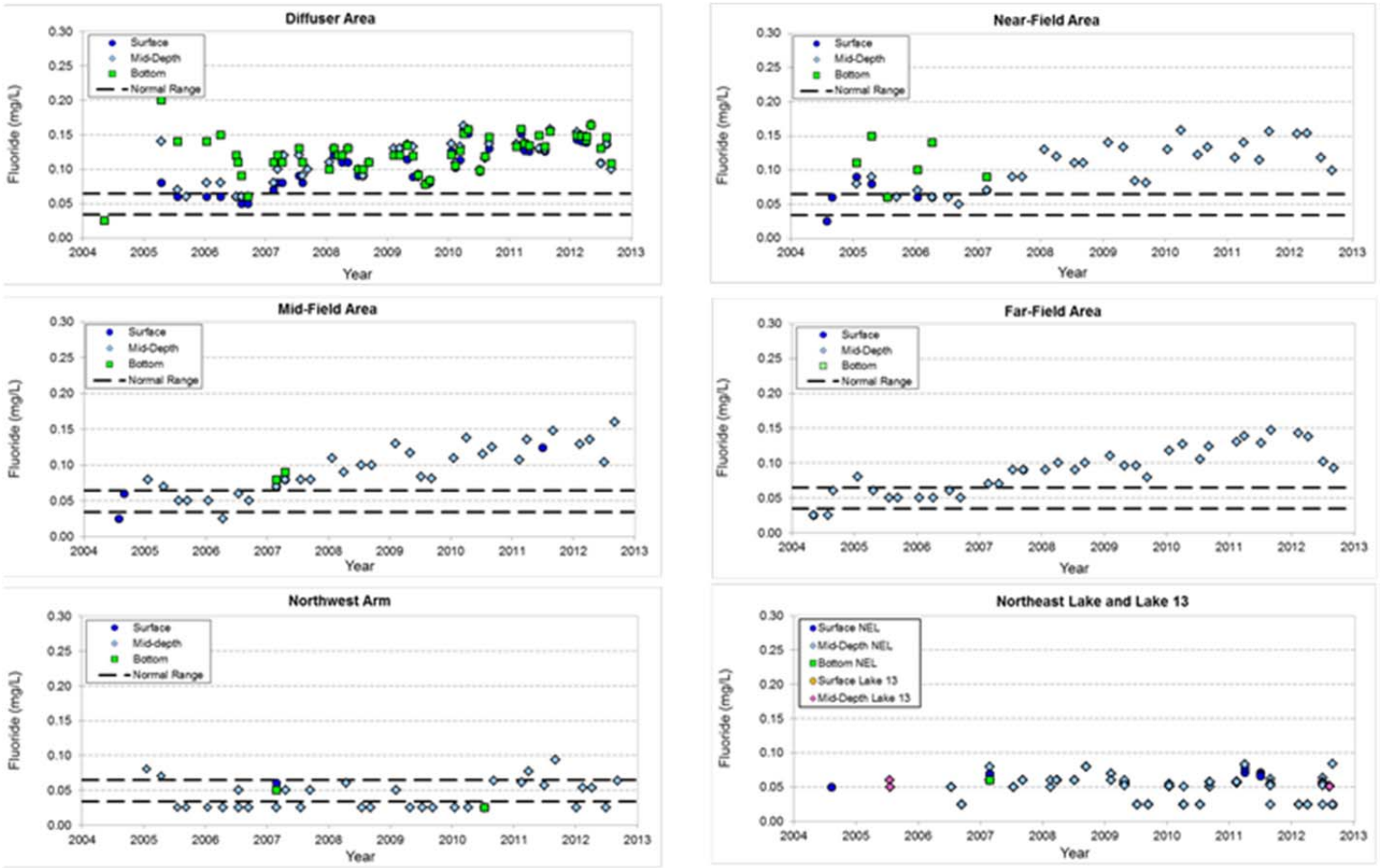
3.2 Snap Lake Water

Concentrations of total fluoride measured in Snap Lake water between 2005 and 2012 are shown in Figure 2 for the five different areas of the lake: diffuser; near-field; mid-field; far-field; and, northwest arm. Concentrations measured in the Northeast Lake and Lake 13 reference lakes are also provided.

Baseline water quality of Snap Lake was characterized through analyses of water samples collected in 1999 and 2001; results from those analyses were reported in the EAR (De Beers 2002). Baseline concentrations of total fluoride in Snap Lake ranged from 0.04 to 0.06 mg/L. Fluoride concentrations have increased in Snap Lake since Mine operations began, and have been above the CCME WQG since 2008. In 2012, the maximum fluoride concentration measured in Snap Lake was 0.18 mg/L; the average concentrations for the five lake areas ranged from 0.05 to 0.13 mg/L. In 2012, fluoride concentrations were 0.08 mg/L in Northeast Lake and 0.05 mg/L in Lake 13. Preliminary review of 2013 water chemistry data for Snap Lake indicates that fluoride concentrations remain elevated, with a maximum concentration of 0.23 mg/L reported at a diffuser station.

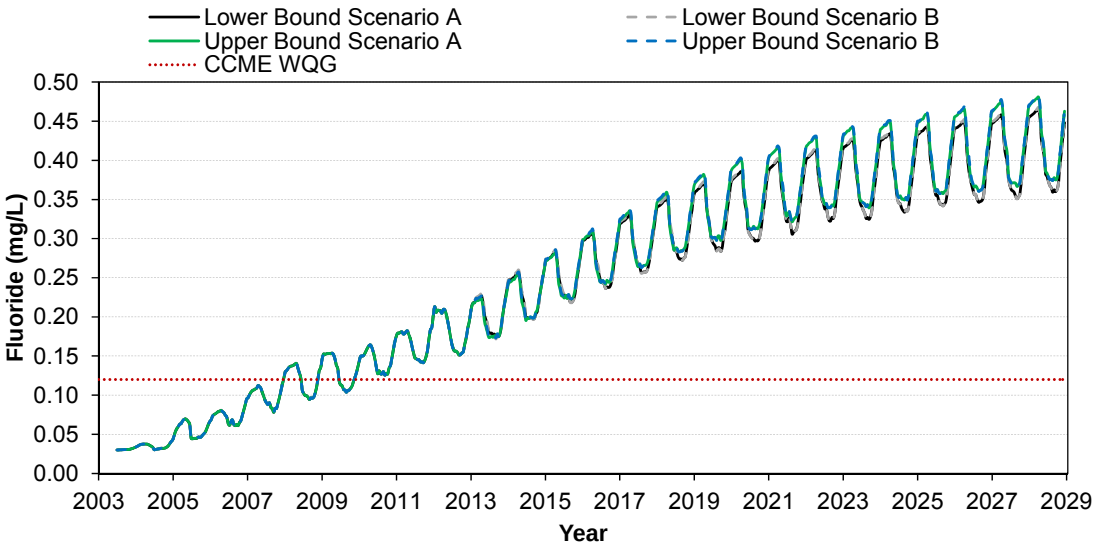
The 2013 model results (De Beers 2013b) indicated that fluoride concentrations were predicted to increase from approximately 0.20 mg/L in 2012 to 0.50 mg/L in 2028 at the diffuser stations and at the outlet of Snap Lake (Figure 3-3).

Figure 2: Concentrations of Fluoride in Water in Five Areas of Snap Lake, and in the Northeast Lake and Lake 13 Reference Lakes, 2004 to 2012

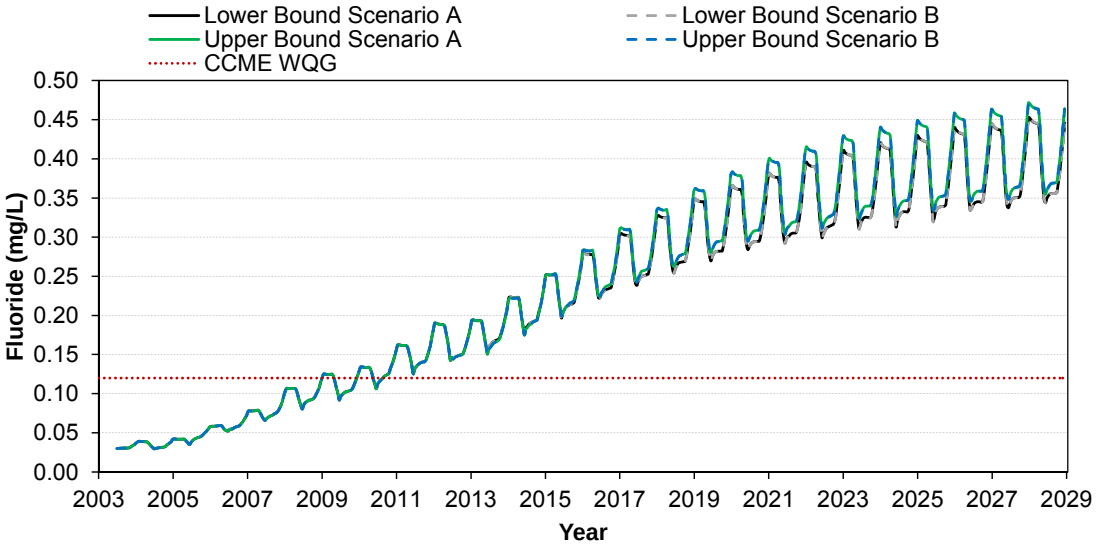


Note: mg/L = milligrams per litre; normal range is based on data collected prior to 2004, with the upper and lower range calculated as the mean ± 2 standard deviations.

Figure 3: Predicted Fluoride Concentrations in Snap Lake



(a) Near diffuser, SNP 02-20e



(b) Outlet, SNAP07

mg/L = milligrams per litre; CCME = Canadian Council of Ministers of the Environment; SNP = surveillance network program; WQG = water quality guideline.

4 TOXICITY OF FLUORIDE TO FRESHWATER AQUATIC LIFE

Available acute and chronic toxicity data for freshwater fish, invertebrates, algae, and aquatic plants are tabulated in Appendix A. This included information compiled by Fleiss (2011). Because the objective of this review was to develop a CEB for fluoride, only the chronic and sub-chronic toxicity studies are summarized below. Test endpoints are expressed in terms of the concentration of fluoride, not the inorganic salt (i.e., mg/L F^-, not mg/L sodium fluoride [NaF]).

Definitions for test endpoints are provided. The LC*x* is the concentration of test material estimated to be lethal to "*x*" percent of the test organisms, (e.g., LC50); the ECx is the concentration of test material estimated to cause a specified non-lethal effect to "*x*" percent of the test organisms (e.g., EC50). The IC*x* is the concentration of test material estimate to cause "*x*" percent inhibition in a sublethal endpoint such as growth or reproduction. The no observed effect concentration (NOEC) is the highest concentration tested where there was no statistically significant response compared to the negative control. The LOEC is the lowest concentration tested where there was a statistically significant response relative to the negative control. The MATC is the geometric mean of the NOEC and LOEC.

The criteria provided by CCME (2007) were used to determine whether a test was considered chronic (i.e., sufficient test duration or life stage sensitivity) and could therefore be included in the species sensitivity distribution (SSD) for derivation of the fluoride CEB. For example, exposure periods ≥21 days (or ≥7 days for eggs and larvae) were considered chronic for fish toxicity endpoints. For invertebrates, sublethal endpoints from exposure periods ≥4 days were considered chronic for short-lived invertebrates (e.g., *Ceriodaphnia dubia*) or from ≥7-day exposures for invertebrates with longer life-cycles (e.g., crayfish). For invertebrates, lethal endpoints were only considered chronic if the exposure period was ≥21 days. Sub-chronic data represented endpoints from tests where the exposure duration was longer than for acute tests but not as long as specified for chronic tests (e.g., invertebrate mortality tests between 4 and 21 days); these were considered on a case-by-case basis. If sufficient chronic data were not available for a species, sub-chronic data were considered: CCME (2007) allows inclusion of a sub-chronic endpoint in an SSD if the test is for a sensitive lifestage such as larval development and no additional chronic data are available for that particular species. Data from acute toxicity tests were excluded from the SSD derivation.

4.1 Fish

Angelovic et al. (1961) conducted 10-d tests with juvenile Rainbow Trout, using sodium fluoride. The fish were exposed to fluoride concentrations of 0 to 25 mg/L F^- at four temperatures: 7.5, 13, 18, and 24 degrees Celsius (°C). Tests were conducted at a low hardness; the dilution water was passed through a commercial softener to remove excess calcium and magnesium prior to adding the fluoride. Survival was the only endpoint measured. Point estimates could not be determined at 24°C, due to high mortality in multiple treatments. Probit equations were reported for each test temperature and used here to calculate the following point estimates: LC10s of 4.1, 2.2, and 1.8 mg/L; and, LC50s of 6.6, 3.9, and 4.8 mg/L at 7.5°C, 13°C, and 18°C, respectively. This study showed that Rainbow Trout sensitivity to fluoride increased with increasing temperature. This test

duration was sub-chronic as defined in Section 4.0; this study was not used for CEB derivation because sufficient chronic data were available from other studies as detailed below.

Herbert and Shurben (1964) conducted 21-d static-renewal tests with Rainbow Trout yearlings (~10 cm). Tests were conducted at 14.5°C, at three water hardness concentrations: 12, 45, and 320 mg/L as $CaCO_3$. Mortality was the only endpoint measured. For the test conducted at 12 mg/L as $CaCO_3$, the LC5, LC10, LC20, and LC50 values were 4, 5, 6, and 8.5 mg/L, respectively. The test conducted at 45 mg/L as $CaCO_3$ had 100% survival at 75 mg/L and zero survival at 113 mg/L. The test conducted at 320 mg/L as $CaCO_3$ had 100 percent (%) survival at 100 mg/L and zero survival at 200 mg/L. In the toxicity tests conducted at the two higher hardness concentrations, precipitation was observed after fluoride (as sodium fluoride) was introduced into the exposure system, resulting in daily variation in dissolved fluoride concentrations. For this reason, Rainbow Trout survival could not be accurately related to the fluoride concentration in those two tests. Thus, only the 21-d LC10 for the test conducted at 12 mg/L as $CaCO_3$ was included for the CEB determination.

Banack et al. (2012) conducted 7-d survival and growth tests with Rainbow Trout fry to assess the potential effects of chloride as a modifying factor on fluoride toxicity. The tests were conducted at a water hardness of 6 mg/L as $CaCO_3$ and chloride concentrations of 2, 6, and 18 mg/L Cl^-. The IC25 values for growth at each chloride concentration were 10.3, 12.3, and 31.5 mg/L F^-, respectively, which showed that in soft water the toxicity of fluoride to Rainbow Trout decreased as the chloride concentration increased. This test duration was sub-chronic; it was not used for CEB determination again because sufficient chronic data were available for this species.

Neuhold and Sigler (1960) conducted fluoride toxicity tests with different life stages of Rainbow Trout in soft water (7.5 mg/L as $CaCO_3$) at a range of temperatures. The authors reported LC50s as a range of fluoride concentrations representing 95% confidence levels rather than discrete point estimates; where possible, point estimates were determined using equations or plots provided in the original publication. A 20-d test was conducted at 12.8°C using fish that were 10 to 20 cm long; the 20-d LC10, LC20, and LC50 were estimated to be 1.5, 2.0, and 3.6 mg/L F^-, respectively. Tests with 20-d old fertilized eggs conducted at three temperatures had similar LC50s but test durations were shorter as temperature increased. At 7.7°C the 18-d LC50 was between 222 and 273 mg/L F^-; at 12.8°C the 9-d LC50 was between 242 and 261 mg/L F^-; and, at 15.5°C the 7-d LC50 was between 237 and 281 mg/L F^-. A 34-d test conducted with 20-d old fertilized eggs at 15.5°C had an estimated LC50 for fry survival of 76 mg/L F^-. Results from these tests indicated that Rainbow Trout eggs and fry were less sensitive to fluoride than older fish, presumably because the younger life stages do not begin feeding until after hatching and yolk sac absorption. The 34-d LC50 of 76 mg/L F^- was included for CEB determination as this was the lowest chronic test result, whereas the other exposure durations were sub-chronic.

Banack et al. (2012) conducted 7-d survival and growth with larval Fathead Minnow (*Pimephales promelas*), to assess the potential effects of chloride as a modifying factor for fluoride toxicity. The tests were conducted at a hardness of 86 to 90 mg/L as $CaCO_3$ and chloride concentrations of 2, 6, and 18 mg/L Cl^-. The IC25 values for growth at each chloride concentration were 82.2, 63.1, and 93.2 mg/L F^-, respectively. Unlike similar testing with juvenile Rainbow Trout, increasing

chloride concentrations did not modify fluoride toxicity for Fathead Minnow. The IC25 of 63.1 mg/L F^- was included for CEB determination because it was the lowest chronic endpoint.

Metcalfe-Smith et al. (2003) conducted 7-d survival and growth tests with larval Fathead Minnow at two water hardness concentrations. At 160 mg/L as $CaCO_3$ the LC25 for survival was 132 mg/L F^- and the IC25 for growth was 72 mg/L F^-. At 280 mg/L as $CaCO_3$ the LC25 for survival was 145 mg/L F^- and the IC25 for growth was 94 mg/L F^-. These results showed that the toxicity of fluoride to larval Fathead Minnow decreased as hardness increased. The IC25 of 72 mg/L F^- was included for CEB determination because the water hardness was similar to that of Snap Lake and it was the lowest chronic endpoint.

Neuhold and Sigler (1960) conducted a 20-d fluoride toxicity test with Common Carp, *Cyprinus carpio*, that were 10 to 36 cm long. The test was conducted in soft water (7.5 mg/L as $CaCO_3$) at 18°C to 24°C. The 20-d LC20 and LC50 were estimated as 25 and 81 mg/L F^-, respectively. This test duration was sub-chronic; thus, it was not used for CEB determination.

Cao et al. (2013) exposed juvenile Common Carp to fluoride concentrations ranging from 35 to 124 mg/L F^- for 90 days. The test was conducted at 22°C at a water hardness of 20 mg/L as $CaCO_3$; the fluoride concentration in the control was 1.8 mg/L F^-. Following exposure to fluoride, enzyme activity assays were performed on gill tissues to measure superoxide dismutase, Na^+-K^+-ATPase, and Ca^{2+}-ATPase levels. For superoxide dismutase and Ca^{2+}-ATPase activities, the NOEC and LOEC were 63.3 and 77.7 mg/L F^-, respectively, and the MATC was 70.1 mg/L F^-. For Na^+-K^+-ATPase activities, the NOEC and LOEC were 77.7 and 124.4 mg/L F^-, respectively, and the MATC was 98.3 mg/L F^-. These endpoints were based on biomarker responses, whose relationship to whole body effects is uncertain; thus, they were not included in the SSD.

Shi et al. (2009) conducted a 90-d fluoride growth study using juvenile Siberian Sturgeon *(Acipenser baerii*). The test was performed at 23°C and a hardness of 22 mg/L as $CaCO_3$. The fluoride concentration in the control was 0.26 mg/L F^-; no mortalities occurred. No mortalities occurred during testing so the LC10 and LC20 for survival were greater than 51.8 mg/L F^- (the highest tested concentration). The NOEC and LOEC for growth were 3.1 and 7.8 mg/L F^-, respectively. The MATC, calculated as the geometric mean of the NOEC and LOEC, was 4.9 mg/L F^-. Point estimates for the growth endpoint were calculated from mean body weights reported for each fluoride concentration; the IC10 was estimated as 7.7 mg/L F^- and the IC20 was more than 51.8 mg/L F^-. The IC10 of 7.7 mg/L F^- was included for CEB determination as this was the lowest chronic endpoint.

Wright (1977) conducted a 10-d fluoride toxicity test with Brown Trout fry (*Salmo trutta*) that were less than eight weeks old and had just absorbed their yolk sac. The test was performed at 12°C and a water hardness of 73 mg/L as $CaCO_3$. The fluoride concentration in the control was 0.9 mg/L F^-; no mortalities occurred. An acute (100-h) LC50 of 15 mg/L F^- was estimated. A 10-d LC10 for survival could not be estimated from the available data, but a 10-d LC20 for survival of 5 mg/L F^- was estimated. This 10-d test duration was sub-chronic; thus, it was not used for the CEB determination.

4.2 Invertebrates

Dave (1984) conducted a 21-d survival and reproduction toxicity test with less than 24-h old neonates of the water flea, *Daphnia magna*. The test was conducted at 20.5°C at a hardness of 250 mg/L as $CaCO_3$. Survival, body length, and reproduction were the endpoints measured. For all three endpoints, the NOEC and LOEC were 3.7 and 7.4 mg/L F^-, respectively. For each endpoint, the MATC was calculated to be 5.2 mg/L F^-. Mean control survival was 83% after 14 days, but only 55% after 21 days; this low level of control survival was not considered acceptable, and therefore results from this test were not used in the CEB determination.

Fieser et al. (1986) conducted a 21-d survival and reproduction toxicity test with less than 24-h old neonates of *D. magna*. The test was conducted at 20°C and a target water hardness of 181 mg/L as $CaCO_3$; the actual hardness decreased with increasing fluoride concentration and ranged from 102 to 181 mg/L as $CaCO_3$. Mortality was low among treatments and the LC10 and LC20 for survival were greater than 142 mg/L F^-. The IC10 and IC20 for reproduction were estimated to be 27.7 and 29.4 mg/L F^-, respectively. The IC10 of 27.7 mg/L F^- was included for the CEB determination as this was the lowest chronic endpoint.

Banack et al. (2012) conducted 7-d survival and reproduction toxicity tests with less than 24-h old neonates of the water flea, *Ceriodaphnia dubia*, to assess the effects of chloride on fluoride toxicity. The tests were conducted at 25°C and a water hardness of 82 to 88 mg/L as $CaCO_3$; the chloride concentrations were 2, 6, and 18 mg/L Cl^-. At the three chloride concentrations tested, the IC25s for reproduction were 17.2, 12.7, and 11.2 mg/L F^-, respectively. For *C. dubia*, fluoride toxicity increased as the chloride concentration increased. The IC25 of 11.2 mg/L F^- was included for the CEB determination as this was the lowest chronic endpoint.

Banack et al. (2012) conducted 14-d survival and growth toxicity tests with juvenile amphipods, *Hyalella azteca*, to assess the effects chloride on fluoride toxicity. The tests were conducted at 23°C and a water hardness of 88 to 90 mg/L as $CaCO_3$; the chloride concentrations were 2, 6, and 18 mg/L Cl^-. At the three chloride concentrations tested, the IC25s for growth were 2.8, 5.1, and 7.1 mg/L F^-, respectively. Unlike *C. dubia*, fluoride toxicity to *H. azteca* decreased as the chloride concentration increased. The IC25 of 2.8 mg/L F^- was included for the CEB determination as this was the lowest chronic endpoint.

Banack et al. (2012) conducted a 10-d survival and growth toxicity test with the juvenile midge, *Chironomus dilutus* (formerly *C. tentans*). The test was conducted at 23°C, a water hardness of 90 mg/L as $CaCO_3$, and a chloride concentration of 2 mg/L Cl^-. The IC25 for growth was 11.5 mg/L F^-; this chronic endpoint was included in the CEB determination.

Casellato et al. (2013) conducted 18-d toxicity tests with the oligochaete worm, *Branchiura sowerbyi*, at two temperatures; the water hardness was not reported. Tests were performed with a sediment substrate. At 17°C, mortality in all three fluoride treatments was estimated to be 5% and therefore the LC10 and LC20 for survival were greater than 160 mg/L F^-. In the test performed at 22°C, mortality increased by 1.2% for every 10 mg/L F^-, and the LC10 and LC20 for survival were estimated to be 40 and 60 mg/L F^-, respectively. Casellato et al. (2013) also conducted a 5-month study to assess the effects of fluoride on gametogenesis of *B. sowerbyi*; the test was conducted at 23°C and the water hardness was not reported. Gametogenesis was impaired at 6.8 and 13.6 mg/L F^- but the magnitude of the effects relative to the control was not

reported for both treatments. In the higher fluoride concentration, *B. sowerbyi* did not complete spermatozoan maturation, the number of mature eggs produced was largely reduced, and the male line stopped maturation at the spermatid stage. Overall, the worms in the fluoride treatments were thinner and shorter and cocoon deposition did not occur. The 18-d test duration was sub-chronic; it was not used for the CEB determination. The 5-month study did not provide a clear endpoint for use in the SSD.

Alonso and Camargo (2011) conducted a 28-d survival and reproduction test with the New Zealand mud snail, *Potamopyrgus antipodarum*. The test was conducted at 12°C and a water hardness of 97 mg/L as $CaCO_3$. For survival, no statistically significant adverse effects were observed in the fluoride treatments; therefore, the NOEC for survival was 16.2 mg/L F^-. Reproduction endpoints were newborn production during the 28-d exposure, and numbers of embryos present on the six longest specimens (the novel second sublethal endpoint used by these authors) at the end of the 28-d exposure. For newborn production, the NOEC and LOEC were 4.6 and 9.5 mg/L F^-, respectively, and the MATC was 6.6 mg/L F^-. For numbers of embryos, the NOEC and LOEC were 9.5 and 16.2 mg/L F^-, respectively, and the MATC was 12.4 mg/L F^-. The lower MATC of 6.6 mg/L F^- for newborn production (a standard sublethal endpoint) was included for the CEB determination.

Keller and Augspurger (2005) conducted 9-d survival and growth toxicity tests with juveniles of two species of unionid mussels: Appalachian elktoe (*Alasmidonta raveneliana)* and Wavy-rayed Lampmussel (*Lampsilis fasciola)*. The tests were conducted at 25°C and a water hardness of 28 to 32 mg/L as $CaCO_3$. The 9-d LC50s for survival were 223 mg/L F^- for *A. raveneliana* and 177 mg/L F^- for *L. fasciola.* Growth (shell length) was measured for *A. raveneliana* but not *L. fasciola*. Growth was significantly reduced in all three fluoride concentrations relative to the control; the LOEC for shell length was 31 mg/L F^- and an IC10 of 91 mg/L F^- was calculated from the shell length data. This IC10 (a preferential endpoint compared to the LOEC) of 91 mg/L F^- for *A. raveneliana* growth was included for the CEB determination.

Sparks and Sandusky (1983) conducted an 8-week survival and growth toxicity test with juvenile fingernail clams, *Musculium transversum*. The test was conducted at 21°C and a water hardness of 232 mg/L as $CaCO_3$. The fluoride concentration in the control was 0.12 mg/L F^-. After 8 weeks, mortality in the control treatment was 25%. The NOEC and LOEC for survival were 1.80 and 2.82 mg/L F^-, respectively; the MATC was 2.25 mg/L F^-. There was at least 50% survival in all test treatments, so the LC50 for survival was greater than 4.56 mg/L F^- (the highest tested fluoride concentration). There were no adverse effects on growth (shell length) at the fluoride concentrations tested, so the NOEC for growth was 4.56 mg/L F^- and the IC10 and IC20 were greater than 4.56 mg/L F^-. The MATC of 2.25 mg/L F^- was included for the CEB determination as this was the lowest chronic endpoint.

Del Piero et al. (2012) conducted 17-week tests with adult zebra mussels, *Dreissena polymorpha.* Water hardness was 106 mg/L as $CaCO_3$, and tests were performed at two temperatures. In the test conducted at 17°C, a 17-week LC20 for survival could not be determined but the LC50 was estimated to be 10 mg/L F^-. In the test conducted at 22°C, the mussels were dead in all treatments by 11 weeks; an 8-week LC50 of 10 mg/L F^- was estimated. The 17-week chronic LC50 of 10 mg/L F^- was included for the CEB determination.

Aguirre-Sierra et al. (2013) conducted an 8-day toxicity test with white-clawed crayfish, *Austropotamobius pallipes*. The test was conducted at 19.5°C, at a water hardness of 190 mg/L as $CaCO_3$. The 8-d LC50 for survival was 28.9 mg/L F^-; the NOEC and LOEC were 19.4 and 45.1 mg/L F^-, respectively, and the MATC was 29.6 mg/L F^-. Behaviour was also assessed, in terms of an escape response (i.e., a tail flip when the organism was tapped on the abdomen three times); the EC50 for the escape response was 5.9 mg/L F^-. The 8-d test duration was sub-chronic; it was not used for the CEB determination.

4.3 Algae and Aquatic Plants

Banack et al. (2012) conducted a 72-h algal growth toxicity test with the green phytoplankton, *Pseudokirchneriella subcapitata*. The test was conducted at 25°C; the water hardness was 14 mg/L as $CaCO_3$ and the chloride concentration was 4 mg/L Cl^-. Inhibition of algal growth was the endpoint measured. The IC25 for growth inhibition was 217 mg/L F^-; this chronic endpoint was included for the CEB determination.

Joy and Balakrishnan (1990) conducted a 96-h algal growth test with the diatom, *Nitzchia palea*. Algal growth was stimulated at all fluoride concentrations from 10 to 110 mg/L F^-. Because the endpoint for this test method is inhibition of algal growth, there were no adverse effects in any treatment and the NOEC for growth inhibition was greater than 110 mg/L F^-. This test was not included for the CEB determination.

Hekman and Budd (1984) conducted algal growth toxicity tests with six species of phytoplankton: *Ankistrodesmus braunii*, *Cyclotella meneghiniana*, *Oscillatoria limnetica*, *Scenedesmus quadricauda*, *Stephanodiscus minutus*, and *Synechococcus leopoliensis*. The test temperature was 23°C, except *S. minutus* that was tested at 15°C; water hardness was not reported. Growth inhibition was not observed at the highest fluoride concentration tested for *A. braunii*, *C. meneghiniana*, *O. limnetica*, *S. quadricauda*, and *S. minutus*; therefore, an unbounded NOEC of greater than 50 mg/L F^- was determined for those five test species. For *S. leopoliensis*, the NOEC, LOEC, and MATC for growth inhibition were 25, 50, and 36 mg/L F^-, respectively; there was a 13% reduction in algal growth at 50 mg/L F^- so that concentration was used as an EC13 estimate (per CCME 2007 a preferential endpoint to the NOEC, LOEC, or MATC) and included in the CEB determination.

Rai et al. (1998) conducted 15-d chronic toxicity tests with the green phytoplankton, *Chlorella vulgaris,* investigating the pH-induced toxicity of $AlCl_3$, AlF_3, NaF, and $AlCl_3$ + NaF. Tests were conducted at 26°C, at pH values of 4.5, 6, and 6.8. Survival and growth were the biological endpoints measured. For organisms tested at pH 6.8 and 6, the LC50s were 840 and 588 mg/L F-, respectively, in 15-day exposures. A 3-d LC50 of 294 mg/L F^- was reported for organisms tested at pH 4.5. The concentration at which algal growth inhibition was observed for 11% of the test population (IC11) was 95 mg/L F- in the 15-day exposures; this IC11 was included in the CEB determination.

Banack et al. (2012) conducted a 7-d toxicity test with duckweed, *Lemna minor*. The test was conducted at 25°C; the water hardness was 206 mg/L as $CaCO_3$ and the chloride concentration was 73 mg/L Cl^-. Reproduction/growth was the biological endpoint measured; the IC25 of 229 mg/L F^- was included in the CEB determination.

Oota (1971) conducted toxicity tests with duckweed (*Lemna gibba*). Tests were conducted at 26°C for 3 days; the water hardness was not reported. Growth and flower germination were the biological endpoints measured. From plots provided in the paper, an EC10 of 4.2 mg/L F^- for growth as well as an EC18 and EC50 of 0.42 and 4.2 mg/L F^-, respectively, for flower germination were estimated. Due to the short test duration and lack of experimental details of the study, results from this study were not included in the CEB determination.

4.4 Toxicity Modifying Factors

Fluoride toxicity can be affected by a number of modifying factors, particularly temperature and water hardness, but also chloride concentration. The influence of these modifying factors is not necessarily consistent among different species. Information on these modifying factors and their relationship to fluoride toxicity is summarized below.

Angelovic et al. (1961) conducted 10-d fluoride tests with Rainbow Trout at temperatures ranging from 7.5 to 24°C, and found that fluoride toxicity increased with increasing temperature.

Fieser et al. (1986) conducted acute tests with *D. magna* at 15, 20, and 25°C and a water hardness of 170 mg/L as $CaCO_3$ and reported 48-h LC50s of 304, 251, and 200 mg/L F-, respectively. The relationship between increasing temperature and increased fluoride concentration was described by the equation: LC50 = (6.93 – 0.065T), where "T" represents temperature.

Metcalfe-Smith et al. (2003) conducted 7-d survival and growth tests with larval Fathead Minnow at two water hardness concentrations. At 160 mg/L as $CaCO_3$ the LC25 for survival was 132 mg/L F^- and the LC25 for growth was 72 mg/L F^-. At 280 mg/L as $CaCO_3$ the LC25 for survival was 145 mg/L F^- and the IC25 for growth was 94 mg/L F^-. The toxicity of fluoride to larval Fathead Minnow decreased as hardness increased.

Pimentel and Bulkley (1983) conducted static 96-h toxicity tests to determine the effects of water hardness on fluoride toxicity to Rainbow Trout. The 96-h LC50 for Rainbow Trout increased from 51 mg/L F^- at a hardness of 17 mg/L as $CaCO_3$ to an LC50 of 140 mg/L F- at a water hardness of 182 mg/L as $CaCO_3$. The authors developed an equation for this fluoride-hardness relationship that is the basis of the BCMOE (1995) WQG.

Smith et al. (1985) conducted static acute toxicity tests with Threespine Stickleback (*Gasterosteus aculeatus)* and Fathead Minnow at different water hardness concentrations. For Threespine Stickleback, the 96-h LC50s increased from 340 mg/L F^- at a hardness of 78 mg/L as $CaCO_3$ to 460 mg/L F- at a hardness of 300 mg/L as $CaCO_3$. Conversely, the 96-h LC50s for Fathead Minnow decreased from 315 mg/L F^- at hardness concentrations of 20 to 48 mg/L as $CaCO_3$ to 205 mg/L F^- at a hardness of 256 mg/L as $CaCO_3$.

Keller and Augspurger (2005) conducted 96-h toxicity tests with juveniles of the unionid Pheasantshell mussel, *Actinonaias pectorosa*. Tests were conducted at 25°C, at four water hardness concentrations ranging from 28 to 84 mg/L as $CaCO_3$. The 96-h LC50s ranged from 178 to 347 mg/L F^-; they generally increased (i.e., toxicity decreased) with increasing water hardness.

Banack et al. (2012) conducted toxicity tests with Rainbow Trout fry, Fathead Minnow, *C. dubia*, and *H. azteca*, to determine whether chloride concentrations of 2, 6, or 18 mg/L Cl^- affected fluoride toxicity. The toxicity of fluoride to Rainbow Trout fry and *H. azteca* decreased as the chloride concentration increased, but chloride did not affect the toxicity of fluoride to Fathead Minnow. Increasing the chloride concentration resulted in an increase in fluoride toxicity to *C. dubia*.

In summary, the above tests indicate that fluoride toxicity increases with increasing temperature. Thus, many of the benchmarks used for the CEB are likely conservative as they were derived at higher temperatures than would occur in Snap Lake. Fluoride toxicity also increases with water hardness. Again, benchmarks used in the CEB at lower hardness concentrations than Snap Lake are likely conservative. In contrast, increasing chloride concentrations did not reduce fluoride toxicity for all tested biota; thus, inclusion of benchmarks derived at variable chloride concentrations in the CEB is appropriate.

5 PROPOSED CHRONIC EFFECTS BENCHMARK FOR FLUORIDE

5.1 Overview of Benchmark Calculation Methodology

Toxicity test endpoints calculated from chronic studies were compiled using an SSD approach; no-effect and low-effect endpoints were given preference. When more than one endpoint was available from a particular study, only the most suitable, lowest endpoint was used in accordance with the CCME (2007) ranking system. For example, if both an EC10 and EC20 were reported for an endpoint then the EC10 was selected, and if both lethal and sublethal effects were assessed then only the more sensitive sublethal endpoint was selected. If endpoints from multiple studies were available for a particular species (see Sections 4.1 to 4.3), then with one exception[2] a Species Mean Chronic Value (SMCV) was calculated as the geometric mean of the most suitable endpoint from each study. The geometric mean, as opposed to the arithmetic mean, was used to minimize bias toward high test results. The resulting SMCV was used in the SSD so that there was only one data entry for each available species. SMCVs were then ranked from lowest to highest, and the percent of species affected was calculated using the following equation:

$$\text{Percent Affected} = (X - 0.5) / N$$

where X is the species rank, with 1 being the most sensitive species, and N is the total number of species in the database. The correction factor of 0.5 was used (Hazen plotting position [Aldenberg et al. 2002]) to create symmetry in cumulative probability (i.e., median ranked species will be associated with 50% affected) and to acknowledge that the concentration affecting the highest ranked species is not necessarily associated with adverse effects to the entire aquatic community.

SigmaPlot software was used to fit the SMCV data to a curve for the SSD, using a Weibull four-parameter model and log-transformed concentration data. The CCME (2007) approach for WQG derivation is to use the intercept of the fifth (5th) percentile of the SSD as the WQG, with the intent that this hazardous concentration to 5% of species (HC5) will provide protection to 95% of the aquatic species. This approach was adopted to calculate the fluoride CEB for Snap Lake.

5.2 Calculation of Fluoride CEB

Table 1 summarizes the toxicity test endpoints that were used to generate the SSD for fluoride. Data from 11 chronic studies with 15 species (representing 3 fish, 8 invertebrates, and 4 algae/plant species) were used for this calculation.

[2] Two Rainbow Trout chronic studies were identified for inclusion in the SSD: a 21-d LC10 for survival of 4.8 mg/L F^- conducted with yearling fish (Herbert and Shurben 1964); and, a 34-d LC50 of 76 mg/L F^- conducted with embryos (Neuhold and Sigler 1960). Other testing with different life stages by Neuhold and Sigler (1960) showed that Rainbow Trout eggs and embryos were considerably less sensitive to fluoride than were older fish, presumably because they were not actively feeding until yolk sac absorption. Given the difference in sensitivities between the different life stages used in these two studies, only the Herbert and Shurben (1964) result was used in the SSD rather than calculating a SMCV.

Table 1: Chronic Toxicity Data Used to Generate Species Sensitivity Distribution (SSD) for Fluoride

Citation	Test Species	Common Name	Endpoint	Concentration [mg/L F]	Species Mean Chronic Value (SMCV)	Rank	Percent Affected
Sparks and Sandusky 1983	*Musculium transversum*	Fingernail clam	MATC	2.25	2.25	1	3%
Banack et al. 2012	*Hyalella azteca*	Amphipod	IC25	2.8	2.8	2	10%
Herbert and Shurben 1964	*Oncorhynchus mykiss*	Rainbow Trout	LC10	4.8	4.8	3	17%
Alonso and Camargo 2011	*Potamopyrgus antipodarum*	New Zealand mud snail	MATC	6.6	6.6	4	23%
Shi et al. 2009	*Acipenser baerii*	Siberian Sturgeon	IC10	7.7	7.7	5	30%
Del Piero et al. 2012	*Dreissena polymorpha*	Zebra Mussel	LC50	10.0	10	6	37%
Banack et al. 2012	*Ceriodaphnia dubia*	Water Flea	IC25	11.2	11.2	7	43%
Banack et al. 2012	*Chironomus dilutus*	Midge	IC25	11.5	11.5	8	50%
Fieser et al. 1986	*Daphnia magna*	Water Flea	IC10	27.7	27.7	9	57%
Hekman and Budd 1984	*Synechococcus leopoliensis*	Algae	EC13	50	50	10	63%
Metcalfe-Smith et al. 2003	*Pimephales promelas*	Fathead Minnow	IC25	72	67.4	11	70%
Banack et al. 2012	*Pimephales promelas*	Fathead Minnow	IC25	63.1			
Keller and Augspurger 2005	*Alasmidonta raveneliana*	Appalachian Elktoe	IC10	91	91	12	77%
Rai et al. 1998	*Chlorella vulgaris*	Algae	IC11	95	95	13	83%
Banack et al. 2012	*Pseudokirchneriella subcapitata*	Algae	IC25	217	217	14	90%
Banack et al. 2012	*Lemna minor*	Duckweed	IC25	229	229	15	97%

ECx = concentration of sample estimated to cause a specified effect to x% of the test organisms.

LCx = concentration of sample estimated to be lethal to x% of the test organisms.

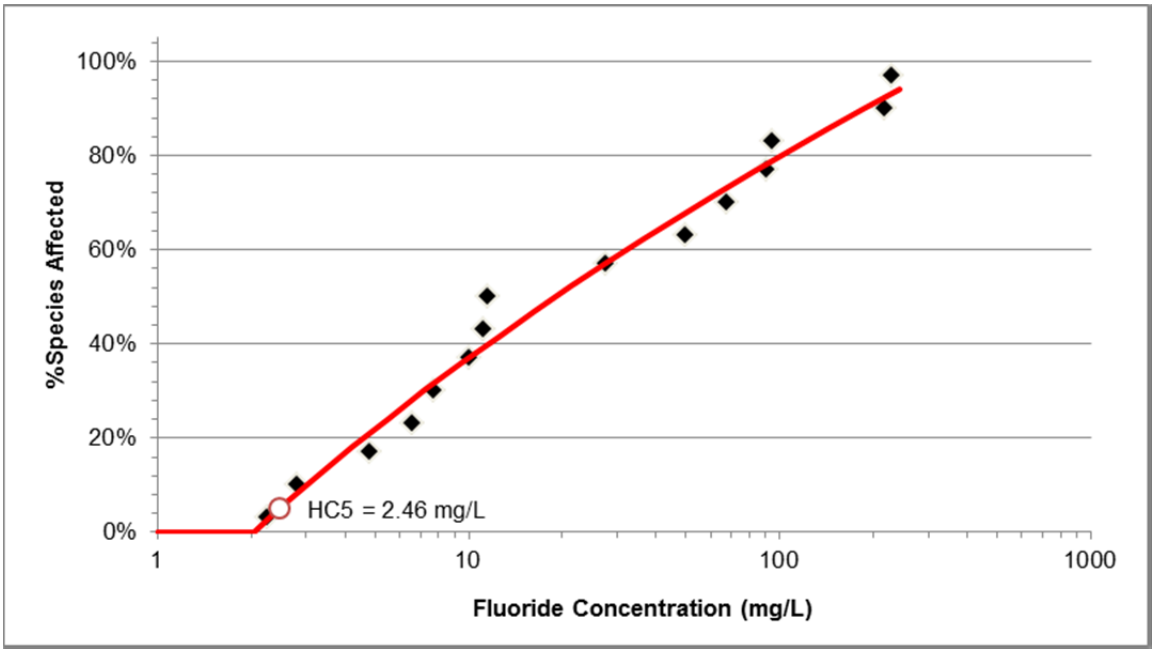
ICx = the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms.

MATC = maximum acceptable toxicant concentration; the geometric mean of the NOEC and LOEC.

TDS = total dissolved solids; mg/L F = milligrams per litre fluoride;% = percent.

Figure 4 shows the SSD curve for the fluoride CEB dataset, and the associated HC5 of 2.46 mg/L F^-. That HC5 is within a factor of two of a benchmark of 1.47 mg/L F^- obtained by applying the BCMOE (1995) hardness-dependent WQG equation using the current Snap Lake water hardness of 140 mg/L as $CaCO_3$. However, the BCMOE (1995) WQG was derived from a single study that used acute data for Rainbow Trout at different hardness concentrations rather than the SSD approach; thus, the BC WQG is not as robust as the CEB calculated herein using multiple chronic studies and applying the CCME SSD approach. Accordingly, the CEB derived herein (2.46 mg/L F^-) is recommended as a site-specific water quality objective (SSWQO) for fluoride in Snap Lake.

Figure 4: Species Sensitivity Distribution for Fluoride



mg/L = milligrams per litre;% = percent.

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Note: This list includes references for the main body of the report and Appendix A.

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APPENDIX A

FLUORIDE TOXICITY DATA

Trophic Group	Common Name	Test Species	Life Stage	Temperature [°C]	Hardness [mg/L $CaCO_3$]	Exposure System	Test Duration	Biological Measurement	Endpoint	Concentration [mg/L F]	Citation
Acute Toxicity Tests											
Fish	Brown Trout	*Salmo trutta*	<8-week old fry; 2 cm	12	73	SR, M	100 h	Survival	LC50	15	Wright 1977
Fish	Brown Trout	*Salmo trutta fario*	fingerlings; 2 mo old	16.1	21.2	S, M	5 d	Survival	LC50	135.6	Camargo and Tarazona 1991
Fish	Brown Trout	*Salmo trutta fario*	fingerlings; 2 mo old	16.1	21.2	S, M	6 d	Survival	LC50	118.5	Camargo and Tarazona 1991
Fish	Brown Trout	*Salmo trutta fario*	fingerlings; 2 mo old	16.1	21.2	S, M	7 d	Survival	LC50	105.1	Camargo and Tarazona 1991
Fish	Brown Trout	*Salmo trutta fario*	fingerlings; 2 mo old	16.1	21.2	S, M	8 d	Survival	LC50	97.5	Camargo and Tarazona 1991
Fish	Chinese Sturgeon	*Acipenser sinensis*	larval; <1-d post-hatch	18 ± 0.2	22 ± 4	SR, N	6 d	Survival	LC50	131.7	Zhuang et al. 2011
Fish	Chinook Salmon	*Oncorhynchus tshawytscha*	adult	11 - 12	NR	FT, NR	0.5 h	Avoidance	LOEC	0.2	Damkaer and Dey 1989
Fish	Chinook Salmon	*Oncorhynchus tshawytscha*	adult	11 - 12	NR	FT, NR	0.5 h	Avoidance	LOEC	0.5	Damkaer and Dey 1989
Fish	Chum Salmon	*Oncorhynchus keta*	adult	11 - 12	NR	FT, NR	0.5 h	Avoidance	LOEC	0.5	Damkaer and Dey 1989
Fish	Coho Salmon	*Oncorhynchus kisutch*	adult	11 - 12	NR	FT, NR	0.5 h	Avoidance	LOEC	0.2	Damkaer and Dey 1989
Fish	Coho Salmon	*Oncorhynchus kisutch*	adult	11 - 12	NR	FT, NR	0.5 h	Avoidance	LOEC	0.5	Damkaer and Dey 1989
Fish	Fathead Minnow	*Pimephales promelas*	juvenile (10 d old)	20	140-150	SR, NR	4 d	Survival	LC50	262	Metcalfe-Smith et al. 2003
Fish	Fathead Minnow	*Pimephales promelas*	<1 g	20	92	S, M	4 d	Survival	LC50	180	Smith et al. 1985
Fish	Fathead Minnow	*Pimephales promelas*	<1 g	20	256	S, M	4 d	Survival	LC50	205	Smith et al. 1985
Fish	Fathead Minnow	*Pimephales promelas*	<1 g	15-19	10-44	S, M	4 d	Survival	LC50	315	Smith et al. 1985
Fish	Fathead Minnow	*Pimephales promelas*	<1 g	16-20	20-48	S, M	4 d	Survival	LC50	315	Smith et al. 1985
Fish	Indian Carp	*Catla catla*	eggs	37	NR	S, M	8 h	Hatching time	NOEC	1.86	Pillai and Mane 1984
Fish	Indian Carp	*Catla catla*	eggs	37	NR	S, M	8 h	Hatching time	LOEC	3.56	Pillai and Mane 1984
Fish	Indian Carp	*Catla catla*	eggs	37	NR	S, M	8 h	Egg weight	NOEC	3.56	Pillai and Mane 1984
Fish	Indian Carp	*Catla catla*	eggs	37	NR	S, M	8 h	Egg weight	LOEC	7.34	Pillai and Mane 1984
Fish	Mosquitofish	*Gambusia affinis*	Adult	21-24	NR	NR	4 d	Survival	LC50	418	Wallen et al. 1957 (cited from Environment Canada 2001)
Fish	Pool Barb	*Puntius sophore*	juveniles	17.9-18.6	284-302	SR, NR	96 h	Mortality	LC50	56.7	Narwaria and Saksena 2012
Fish	Rainbow Trout	*Oncorhynchus mykiss*	59 mm, 1.8 g	12	17	S, M	4 d	Survival	LC50	51	Pimentel and Bulkley 1983
Fish	Rainbow Trout	*Oncorhynchus mykiss*	59 mm, 1.8 g	12	49	S, M	4 d	Survival	LC50	128	Pimentel and Bulkley 1983
Fish	Rainbow Trout	*Oncorhynchus mykiss*	59 mm, 1.8 g	12	182	S, M	4 d	Survival	LC50	140	Pimentel and Bulkley 1983
Fish	Rainbow Trout	*Oncorhynchus mykiss*	59 mm, 1.8 g	12	385	S, M	4 d	Survival	LC50	193	Pimentel and Bulkley 1983
Fish	Rainbow Trout	*Oncorhynchus mykiss*	<3 g	15	23-62	S, M	4 d	Survival	LC50	200	Smith et al. 1985
Fish	Rainbow Trout	*Oncorhynchus mykiss*	fingerlings; 2 mo old	15.3	22.4	S, M	8 d	Survival	LC50	64.1	Camargo and Tarazona 1991
Fish	Rainbow Trout	*Oncorhynchus mykiss*	fingerlings; 2 mo old	15.3	22.4	S, M	7 d	Survival	LC50	73.4	Camargo and Tarazona 1991
Fish	Rainbow Trout	*Oncorhynchus mykiss*	fingerlings; 2 mo old	15.3	22.4	S, M	6 d	Survival	LC50	85.1	Camargo and Tarazona 1991
Fish	Rainbow Trout	*Oncorhynchus mykiss*	fingerlings; 2 mo old	15.3	22.4	S, M	5 d	Survival	LC50	92.4	Camargo and Tarazona 1991
Fish	Rainbow Trout	*Oncorhynchus mykiss*	NR	NR	SOFT	NR	NR	NR	NR	358	Klein 1958 (cited from BCMOE 1995)
Fish	Threespine Stickleback	*Gasterosteus aculeatus*	<1 g	20	78	S, M	4 d	Survival	LC50	340	Smith et al. 1985
Fish	Threespine Stickleback	*Gasterosteus aculeatus*	<1 g	20	146	S, M	4 d	Survival	LC50	380	Smith et al. 1985
Fish	Threespine Stickleback	*Gasterosteus aculeatus*	<1 g	20	300	S, M	4 d	Survival	LC50	460	Smith et al. 1985
Invertebrate	Amphipod	*Hyalella azteca*	1 - 7 d old	20	140-150	S, NR	2 d	Survival	LC50	32.3	Metcalfe-Smith et al. 2003
Invertebrate	Amphipod	*Hyalella azteca*	14 days	22	68-100	S, M	2 d	Survival	LC50	16.0	USEPA 2010
Invertebrate	Amphipod	*Hyalella azteca*	14 days	22	68-100	S, M	4 d	Survival	LC50	13.4	USEPA 2010
Invertebrate	Appalachian Elktoe	*Alasmidonta raveneliana*	glochidia	25	30	S, M	1 d	Survival	LC50	288	Keller and Augspurger 2005

Trophic Group	Common Name	Test Species	Life Stage	Temperature [°C]	Hardness [mg/L $CaCO_3$]	Exposure System	Test Duration	Biological Measurement	Endpoint	Concentration [mg/L F]	Citation
Invertebrate	Appalachian Elktoe	*Alasmidonta raveneliana*	juvenile	25	28	S, M	4 d	Survival	NOEC	250	Keller and Augspurger 2005
Invertebrate	Appalachian Elktoe	*Alasmidonta raveneliana*	juvenile	25	28	S, M	4 d	Survival	LC50	303	Keller and Augspurger 2005
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6		3 d	Survival	LC50	44.9	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6		2 d	Survival	LC50	79.2	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.2	15.6		3 d	Survival	LC50	43.7	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.2	15.6		2 d	Survival	LC50	86.6	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6		3 d	Survival	LC50	78.2	Camargo 1991
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		3 d	Survival	LC50	79.7	Camargo 1991
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		2 d	Survival	LC50	120.0	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche pellucidula*	Last instar larvae	15.2	15.6		2.5 d	Survival	LC50	72.0	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche pellucidula*	Last instar larvae	15.2	15.6		2 d	Survival	LC50	112.0	Camargo 1991
Invertebrate	Caddisfly	*Hydropsyche tibialis*	middle instar larvae	17.8	19.5	S, N	5 d	Survival	LC50	71.8	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	middle instar larvae	17.8	19.5	S, N	5 d	Survival	NOEC	15	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	middle instar larvae	17.8	19.5	S, N	5 d	Survival	LC50	28	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	middle instar larvae	17.8	19.5	S, N	5 d	Survival	NOEC	5	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	Last instar larvae	17.8	19.5	S, N	5 d	Survival	LC50	76	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	Last instar larvae	17.8	19.5	S, N	5 d	Survival	NOEC	15	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	Last instar larvae	17.8	19.5	S, N	5 d	Survival	LC50	37	Camargo 2004
Invertebrate	Caddisfly	*Hydropsyche tibialis*	Last instar larvae	17.8	19.5	S, N	5 d	Survival	NOEC	10	Camargo 2004
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		4 d	Migration	NOEC	12.4	Camargo and La Point 1995
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		4 d	Migration	LOEC	19.4	Camargo and La Point 1995
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		4 d	Migration	NOEC	12.4	Camargo and La Point 1995
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		4 d	Migration	LOEC	19.4	Camargo and La Point 1995
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		4 d	Migration	MATC	15.5	Camargo and La Point 1995
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6		4 d	Migration	EC50	38.3	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6		4 d	Migration	NOEC	2.5	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6		4 d	Migration	MATC	7.6	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6		4 d	Migration	MATC	4.4	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6		4 d	Migration	EC50	23.0	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.2	15.6		4 d	Migration	EC50	24.97	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.2	15.6		1 d	Migration	NOEC	30.08	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6		4 d	Migration	NOEC	12.2	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6		4 d	Migration	LOEC	19.1	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6		4 d	Migration	MATC	15.3	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6		4 d	Migration	EC50	29.0	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6		4 d	Migration	NOEC	2.5	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6		4 d	Migration	LOEC	7.6	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6		4 d	Migration	MATC	4.4	Camargo and La Point 1995
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6		4 d	Migration	EC50	29.0	Camargo and La Point 1995
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	17.3	12.04	S, M	4 d	Survival	LC50	44.9	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	17.3	12.04	S, M	4 d	Survival	LC10	19.4	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.95	13.18	S, M	4 d	Survival	LC20	20.5	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.15	17.6	S, M	4 d	Survival	LC50	26.3	Camargo and Tarazona 1990

Trophic Group	Common Name	Test Species	Life Stage	Temperature [°C]	Hardness [mg/L $CaCO_3$]	Exposure System	Test Duration	Biological Measurement	Endpoint	Concentration [mg/L F]	Citation
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.15	17.6	S, M	4 d	Survival	LC10	7.4	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	13.25	16.28	S, M	4 d	Survival	LC10	11.8	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	17.3	12.04	S, M	4 d	Survival	LC50	26.5	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	17.3	12.04	S, M	4 d	Survival	LC10	19.4	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.95	13.18	S, M	4 d	Survival	LC20	20.5	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	14.1	18.77	S, M	4 d	Survival	LC50	48.2	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	14.1	18.77	S, M	4 d	Survival	LC10	19.1	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	13.25	16.28	S, M	4 d	Survival	LC10	18.9	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche pellucidula*	Last instar larvae	15.15	17.6		4 d	Survival	LC50	38.5	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche pellucidula*	Last instar larvae	15.15	17.6		4 d	Survival	LC17	21.3	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Hydropsyche pellucidula*	Last instar larvae	14.1	18.77		4 d	Survival	LC20	19.1	Camargo and Tarazona 1990
Invertebrate	Caddisfly	*Cheumatopsyche pettiti*	Last instar larvae	18	40.2	S, M	2 d	Survival	LC50	128	Camargo et al. 1992a
Invertebrate	Caddisfly	*Cheumatopsyche pettiti*	Last instar larvae	18	40.2	S, M	3 d	Survival	LC50	73	Camargo et al. 1992a
Invertebrate	Caddisfly	*Cheumatopsyche pettiti*	Last instar larvae	18	40.2	S, M	4 d	Survival	LC50	43	Camargo et al. 1992a
Invertebrate	Caddisfly	*Cheumatopsyche pettiti*	Last instar larvae	18	40.2	S, M	5 d	Survival	LC50	32	Camargo et al. 1992a
Invertebrate	Caddisfly	*Cheumatopsyche pettiti*	Last instar larvae	18	40.2	S, M	6 d	Survival	LC50	24	Camargo et al. 1992a
Invertebrate	Caddisfly	*Cheumatopsyche pettiti*	Last instar larvae	18	40.2	S, M	6 d	Survival	LC10	12	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche bronta*	Last instar larvae	18	40.2	S, M	2 d	Survival	LC50	53	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche bronta*	Last instar larvae	18	40.2	S, M	3 d	Survival	LC50	26	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche bronta*	Last instar larvae	18	40.2	S, M	4 d	Survival	LC50	17	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche bronta*	Last instar larvae	18	40.2	S, M	5 d	Survival	LC50	13	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche bronta*	Last instar larvae	18	40.2	S, M	6 d	Survival	LC50	12	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche bronta*	Last instar larvae	18	40.2	S, M	6 d	Survival	LC20	6.0	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche occidentalis*	Last instar larvae	18	40.2	S, M	2 d	Survival	LC50	102	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche occidentalis*	Last instar larvae	18	40.2	S, M	3 d	Survival	LC50	54	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche occidentalis*	Last instar larvae	18	40.2	S, M	4 d	Survival	LC50	35	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche occidentalis*	Last instar larvae	18	40.2	S, M	5 d	Survival	LC50	27	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche occidentalis*	Last instar larvae	18	40.2	S, M	6 d	Survival	LC50	21	Camargo et al. 1992a
Invertebrate	Caddisfly	*Hydropsyche occidentalis*	Last instar larvae	18	40.2	S, M	6 d	Survival	LC20	10	Camargo et al. 1992a
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6	S, M	4 d	Migration	EC50	33.5	Camargo et al. 1992b
Invertebrate	Caddisfly	*Chimarra marginata*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	EC50	109	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	NOEC	2.51	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	EC50	18.9	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche bulbifera*	Last instar larvae	15.2	15.6	S, M	4 d	Migration	EC50	19.2	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.2	15.6	S, M	4 d	Migration	EC50	21.3	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche exocellata*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	EC50	20.5	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6	S, M	4 d	Migration	EC50	34.8	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche lobata*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	EC50	33.9	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	NOEC	2.51	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6	S, M	4 d	Abdomen	EC50	23.5	Camargo et al. 1992b
Invertebrate	Caddisfly	*Hydropsyche pellucidulla*	Last instar larvae	15.2	15.6	S, M	4 d	Migration	EC50	24.6	Camargo et al. 1992b

Trophic Group	Common Name	Test Species	Life Stage	Temperature [°C]	Hardness [mg/L $CaCO_3$]	Exposure System	Test Duration	Biological Measurement	Endpoint	Concentration [mg/L F]	Citation
Invertebrate	Grooved fingernail clam	*Sphaerium simile*	juvenile	22	2 to 160	S, M	2 d	Survival	LC50	>800	USEPA 2010
Invertebrate	Grooved fingernail clam	*Sphaerium simile*	juvenile	22	2 to 160	S, M	4 d	Survival	LC50	62	USEPA 2010
Invertebrate	Mayfly	*Hexagenia limbata*	larvae (3-4 months)	20	140-150	S, NR	4 d	Survival	LC50	283	Metcalfe-Smith et al. 2003
Invertebrate	Midge	*Chironomus tentans*	larvae (10 d old)	20	140-150	S, NR	4 d	Survival	LC50	14.6	Metcalfe-Smith et al. 2003
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	Juvenile (1.2 mm)	15.6 ± 0.5	92.5 ± 5.4	SR, M	4 d	Survival	LC50	52.2	Aguirre-Sierra et al. 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	Juvenile (1.2 mm)	15.6 ± 0.6	92.5 ± 5.5	SR, M	4 d	Immobilization	EC50	39.2	Aguirre-Sierra et al. 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	Adult (3.8 mm)	15.6 ± 0.7	92.5 ± 5.6	SR, M	4 d	Survival	LC50	69.9	Aguirre-Sierra et al. 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	Adult (3.8 mm)	15.6 ± 0.8	92.5 ± 5.7	SR, M	4 d	Immobilization	EC50	58.2	Aguirre-Sierra et al. 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	NR	12.6 ± 0.65	91.3 ± 6.6	S, M	4 d	Survival	LC50	58.5	Alonso and Camargo 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	NR	12.6 ± 0.65	91.3 ± 6.6	S, M	4 d	Immobilization	EC50	47.0	Alonso and Camargo 2011
Invertebrate	Paper Pondshell	*Utterbackia imbecillis*	juvenile	25	34	S, M	4 d	Survival	LC50	234	Keller and Augspurger 2005
Invertebrate	Paper Pondshell	*Utterbackia imbecillis*	glochidia	25	30	S, M	1 d	Survival	LC50	351	Keller and Augspurger 2005
Invertebrate	Pheasantshell, Mussel	*Actinonaias pectorosa*	juvenile	25	30	S, M	4 d	Survival	LC50	178	Keller and Augspurger 2005
Invertebrate	Pheasantshell, Mussel	*Actinonaias pectorosa*	juvenile	25	28	S, M	4 d	Survival	LC50	259	Keller and Augspurger 2005
Invertebrate	Pheasantshell, Mussel	*Actinonaias pectorosa*	juvenile	25	84	S, M	4 d	Survival	LC50	298	Keller and Augspurger 2005
Invertebrate	Pheasantshell, Mussel	*Actinonaias pectorosa*	juvenile	25	68	S, M	4 d	Survival	LC50	347	Keller and Augspurger 2005
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	17 ± 0.5	NR	S, N	4 d	Survival	LC50	267.6	Casellato et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	22± 0.5	NR	S, N	4 d	Survival	LC50	91.3	Casellato et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	17 ± 0.5	NR	S, N	4 d	Survival	LC50	80.1	Casellato et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	22 ± 0.5	NR	S, N	4 d	Survival	LC50	61.7	Casellato et al. 2013
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	20	250	S, N	2 d	Immobilization	EC50	98	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	25	169.3	S, M	2 d	Survival	LC50	180	Fieser et al. 1986
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	20	169.3	S, M	2 d	Survival	LC50	247	Fieser et al. 1986
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	15	169.3	S, M	2 d	Survival	LC50	350	Fieser et al. 1986
Invertebrate	Water Flea	*Daphnia magna*	<24h of age	22	173	S, N	2 d	Survival	LC50	154	LeBlanc 1980
Invertebrate	Water Flea	*Daphnia magna*	NR (Env Can protocol)	20	140-150	S, NR	2 d	Survival	LC50	124.1	Metcalfe-Smith et al. 2003
Invertebrate	Wavy-Rayed Lampmussel	*Lampsilis fasciola*	juvenile	25	32	S, M	4 d	Survival	LC50	172	Keller and Augspurger 2005
Invertebrate	Zebra Mussel	*Dreissena polymorpha*	Adult (1.5 - 2 cm)	17 ± 0.5	106 ± 14	S, NR	4 d	Survival	LC50	361	Del Piero et al. 2012
Invertebrate	Zebra Mussel	*Dreissena polymorpha*	Adult (1.5 - 2 cm)	22 ± 0.5	106 ± 14	S, NR	4 d	Survival	LC50	62	Del Piero et al. 2012
Chronic and Sub-chronic Toxicity Tests											
Fish	Common Carp	*Cyprinus carpio*	Juvenile	22-24	20	SR, M	90 d	reduced enzyme activity in gill tissue	NOEC	63.3	Cao et al. 2013
Fish	Common Carp	*Cyprinus carpio*	Juvenile	22-24	20	SR, M	90 d	reduced enzyme activity in gill tissue	LOEC	77.7	Cao et al. 2013
Fish	Common Carp	*Cyprinus carpio*	Juvenile	22-24	20	SR, M	90 d	reduced enzyme activity in gill tissue	MATC	70.1	Cao et al. 2013
Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	90	SR, NR	7 d	Growth	IC25	82.2	Banack et al. 2012
Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	86	SR, NR	7 d	Growth	IC25	63.1	Banack et al. 2012

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Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	86	SR, NR	7 d	Growth	IC25	93.2	Banack et al. 2012
Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	280	SR, NR	7 d	Growth	IC25	94	Metcalfe-Smith et al. 2003
Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	280	SR, NR	7 d	Survival	LC25	145	Metcalfe-Smith et al. 2003
Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	160	SR, NR	7 d	Growth	IC25	72	Metcalfe-Smith et al. 2003
Fish	Fathead Minnow	*Pimephales promelas*	<24h post-hatch	25	160	SR, NR	7 d	Survival	LC25	132	Metcalfe-Smith et al. 2003
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	12	SR, N	21 d	Survival	LC5	4	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	12	SR, N	21 d	Survival	LC10	5	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	12	SR, N	21 d	Survival	LC20	6	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	12	SR, N	21 d	Survival	LC50	8.5	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	45	SR, M	21 d	Survival	LC0	75	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	45	SR, M	21 d	Survival	LC100	113	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	320	SR, M	21 d	Survival	LC0	100	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	yearlings; 10 cm	14.5	320	SR, M	21 d	Survival	LC100	200	Herbert and Shurben 1964
Fish	Rainbow Trout	*Oncorhynchus mykiss*	20-d old embryos	7.7	7.5	S, M	18 d	Survival	LC50	222 - 273	Neuhold and Sigler 1960
Fish	Rainbow Trout	*Oncorhynchus mykiss*	20-d old embryos	12.8	7.5	S, M	9 d	Survival	LC50	242 - 261	Neuhold and Sigler 1960
Fish	Rainbow Trout	*Oncorhynchus mykiss*	20-d old embryos	15.5	7.5	S, M	7 d	Survival	LC50	237 - 281	Neuhold and Sigler 1960
Fish	Rainbow Trout	*Oncorhynchus mykiss*	20-d old embryos	15.5	7.5	S, M	34 d	Survival	LC50	76	Neuhold and Sigler 1960
Fish	Siberian Sturgeon	*Acipenser baerii*	juvenile; 10.8 cm, 8.55 g	23	22	SR, M	90 d	Survival	LC0	>51.8	Shi et al. 2009
Fish	Siberian Sturgeon	*Acipenser baerii*	juvenile; 10.8 cm, 8.55 g	23	22	SR, M	90 d	Growth	NOEC	3.1	Shi et al. 2009
Fish	Siberian Sturgeon	*Acipenser baerii*	juvenile; 10.8 cm, 8.55 g	23	22	SR, M	90 d	Growth	LOEC	7.8	Shi et al. 2009
Fish	Siberian Sturgeon	*Acipenser baerii*	juvenile; 10.8 cm, 8.55 g	23	22	SR, M	90 d	Growth	MATC	4.9	Shi et al. 2009
Fish	Siberian Sturgeon	*Acipenser baerii*	juvenile; 10.8 cm, 8.55 g	23	22	SR, M	90 d	Growth	IC10	7.7	Shi et al. 2009
Fish	Siberian Sturgeon	*Acipenser baerii*	juvenile; 10.8 cm, 8.55 g	23	22	SR, M	90 d	Growth	IC20	>51.8	Shi et al. 2009
Invertebrate	Amphipod	*Hyalella azteca*	juvenile	23	90	NR	14 d	Growth	IC25	2.8	Banack et al. 2012
Invertebrate	Amphipod	*Hyalella azteca*	juvenile	23	88	NR	14 d	Growth	IC25	5.1	Banack et al. 2012
Invertebrate	Amphipod	*Hyalella azteca*	juvenile	23	88	NR	14 d	Growth	IC25	7.1	Banack et al. 2012
Invertebrate	Appalachian Elktoe	*Alasmidonta raveneliana*	juvenile	25	28	SR, M	9 d	Survival	LC50	223	Keller and Augspurger 2005
Invertebrate	Appalachian Elktoe	*Alasmidonta raveneliana*	juvenile	25	28	SR, M	9 d	Growth (shell length)	LOEC	31	Keller and Augspurger 2005
Invertebrate	Appalachian Elktoe	*Alasmidonta raveneliana*	juvenile	25	28	SR, M	9 d	Growth (shell length)	IC10	91	Keller and Augspurger 2005
Invertebrate	Fingernail clam	*Musculium transversum*	adult	20.9	232.4	FT, M	56 d	Survival	NOEC	1.80	Sparks and Sandusky 1983
Invertebrate	Fingernail clam	*Musculium transversum*	adult	20.9	232.4	FT, M	56 d	Survival	LOEC	2.82	Sparks and Sandusky 1983
Invertebrate	Fingernail clam	*Musculium transversum*	adult	20.9	232.4	FT, M	56 d	Survival	MATC	2.25	Sparks and Sandusky 1983
Invertebrate	Fingernail clam	*Musculium transversum*	adult	20.9	232.4	FT, M	56 d	Survival	LC50	>4.56	Sparks and Sandusky 1983
Invertebrate	Fingernail clam	*Musculium transversum*	adult	20.9	232.4	FT, M	56 d	Growth (shell length)	NOEC	4.56	Sparks and Sandusky 1983
Invertebrate	Midge	*Chironomus dilutus*	juvenile	23	90	NR	10 d	Growth	IC25	11.5	Banack et al. 2012
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	3.6 mm shell length	12.2	96.8	SR, M	28 d	Reproduction - newborn production	NOEC	4.6	Alonso and Camargo 2011

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Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	3.6 mm shell length	12.2	96.8	SR, M	28 d	Reproduction - newborn production	LOEC	9.5	Alonso and Camargo 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	3.6 mm shell length	12.2	96.8	SR, M	28 d	Reproduction - newborn production	MATC	6.6	Alonso and Camargo 2011
Invertebrate	New Zealand mud snail	*Potamopyrgus antipodarum*	3.6 mm shell length	12.2	96.8	SR, M	28 d	Survival	NOEC	16.2	Alonso and Camargo 2011
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	9 - 12 cm	23 ± 1	NR	SR, N	5 months	Gametogenesis	LOEC	6.8	Casellato et al. 2013
Invertebrate	Water Flea	*Ceriodaphnia dubia*	Neonates (<24 h)	25	82	SR, NR	7 d	Reproduction	IC25	17.2	Banack et al. 2012
Invertebrate	Water Flea	*Ceriodaphnia dubia*	Neonates (<24 h)	25	82	SR, NR	7 d	Reproduction	IC25	12.7	Banack et al. 2012
Invertebrate	Water Flea	*Ceriodaphnia dubia*	Neonates (<24 h)	25	88	SR, NR	7 d	Reproduction	IC25	11.2	Banack et al. 2012
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Survival	NOEC	3.7	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Survival	LOEC	7.4	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Survival	MATC	5.2	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Body length	NOEC	3.7	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Body length	LOEC	7.4	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Body length	MATC	5.2	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Reproduction	NOEC	3.7	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Reproduction	LOEC	7.4	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	19.5-21.5	250	SR, N	21 d	Reproduction	MATC	5.2	Dave 1984
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	20	101.6-181.3	SR, M	21 d	Survival	LC10	>142	Fieser et al. 1986
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	20	101.6-181.3	SR, M	21 d	Survival	LC20	>142	Fieser et al. 1986
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	20	101.6-181.3	SR, M	21 d	Reproduction	IC10	27.7	Fieser et al. 1986
Invertebrate	Water Flea	*Daphnia magna*	Neonates (<24 h)	20	101.6-181.3	SR, M	21 d	Reproduction	IC20	29.4	Fieser et al. 1986
Invertebrate	Wavy-Rayed Lampmussel	*Lampsilis fasciola*	juvenile	25	32	SR, M	9 d	Survival	LC50	177	Keller and Augspurger 2005
Invertebrate	Zebra Mussel	*Dreissena polymorpha*	Adult (1.5 - 2 cm)	17 ± 0.5	106 ± 14	SR, NR	17 weeks	Survival	LC50	10.0	Del Piero et al. 2012
Invertebrate	Zebra Mussel	*Dreissena polymorpha*	Adult (1.5 - 2 cm)	22 ± 0.5	106 ± 14	SR, NR	8 weeks	Survival	LC50	10.0	Del Piero et al. 2012
Algae	Algae	*Pseudokirchneriella subcapitata*	growth stage	25	14	S, NR	72 h	Growth inhibition	IC25	217	Banack et al. 2012
Algae	Algae	*Ankistrodesmus braunii*	growth stage	23	NR	S, M	7.3 d	Growth	NOEC	50	Hekman et al. 1984
Algae	Algae	*Cyclotella meneghiniana*	growth stage	23	NR	S, M	7.3 d	Growth	NOEC	50	Hekman et al. 1984
Algae	Algae	*Oscillatoria limnetica*	growth stage	23	NR	S, M	7.3 d	Growth	NOEC	50	Hekman et al. 1984
Algae	Algae	*Scenedesmus quadricauda*	growth stage	23	NR	S, M	7.3 d	Growth	NOEC	50	Hekman et al. 1984
Algae	Algae	*Stephanodiscus minutus*	growth stage	15	NR	S, M	7.3 d	Growth	NOEC	50	Hekman et al. 1984
Algae	Algae	*Synechococcus leopoliensis*	growth stage	23	NR	S, M	7.3 d	Growth	NOEC	25	Hekman et al. 1984
Algae	Algae	*Synechococcus leopoliensis*	growth stage	23	NR	S, M	7.3 d	Growth	LOEC	50	Hekman et al. 1984
Algae	Algae	*Synechococcus leopoliensis*	growth stage	23	NR	S, M	7.3 d	Growth	EC13	50	Hekman et al. 1984
Algae	Algae	*Synechococcus leopoliensis*	growth stage	23	NR	S, M	7.3 d	Growth	MATC	35	Hekman et al. 1984
Algae	Algae	*Chlorella vulgaris*	growth stage	26	double distilled water	S, N	15 d	Survival	LC50	840	Rai et al. 1998
Algae	Algae	*Chlorella vulgaris*	growth stage	26	double distilled water	S, N	15 d	Survival	LC50	588	Rai et al. 1998
Algae	Algae	*Chlorella vulgaris*	growth stage	26	double distilled water	S, N	3 d	Survival	LC50	294	Rai et al. 1998

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Algae	Algae	*Chlorella vulgaris*	growth stage	26	double distilled water	S, N	15 d	Growth	IC11	95	Rai et al. 1998
Algae	Diatom	*Nitzschia palea*	growth stage	NR	NR	S, M	4 d	Growth inhibition	NOEC	110	Joy and Balakrishnan 1990
Plant	Duckweed	*Lemna minor*	cultures in logarithmic growth stage	?	206	S, NR	7 d	Growth inhibition	IC25	229	Banack et al. 2012
Fish	Brown Trout	*Salmo trutta*	<8-week old fry; 2 cm	12	73	SR, M	10 d	Survival	LC20	5	Wright 1977
Fish	Common Carp	*Cyprinus carpio*	10–36 cm	18 - 24	7.5	S, M	20 d	Survival	LC20	25	Neuhold and Sigler 1960
Fish	Common Carp	*Cyprinus carpio*	10–36 cm	18 - 24	7.5	S, M	20 d	Survival	LC50	81	Neuhold and Sigler 1960
Fish	Rainbow Trout	*Oncorhynchus mykiss*	7 - 13 cm; 15 - 25 g	18	Soft	NR	10 d	Survival	LC50	4.8	Angelovic et al. 1961
Fish	Rainbow Trout	*Oncorhynchus mykiss*	7 - 13 cm; 15 - 25 g	18	Soft	NR	10 d	Survival	LC10	1.8	Angelovic et al. 1961
Fish	Rainbow Trout	*Oncorhynchus mykiss*	7 - 13 cm; 15 - 25 g	13	Soft	NR	10 d	Survival	LC50	3.9	Angelovic et al. 1961
Fish	Rainbow Trout	*Oncorhynchus mykiss*	7 - 13 cm; 15 - 25 g	13	Soft	NR	10 d	Survival	LC10	2.2	Angelovic et al. 1961
Fish	Rainbow Trout	*Oncorhynchus mykiss*	7 - 13 cm; 15 - 25 g	7.5	Soft	NR	10 d	Survival	LC50	6.6	Angelovic et al. 1961
Fish	Rainbow Trout	*Oncorhynchus mykiss*	7 - 13 cm; 15 - 25 g	7.5	Soft	NR	10 d	Survival	LC10	4.1	Angelovic et al. 1961
Fish	Rainbow Trout	*Oncorhynchus mykiss*	Fry	15	6	SR, NR	7 d	Growth	IC25	10.3	Banack et al. 2012
Fish	Rainbow Trout	*Oncorhynchus mykiss*	Fry	15	6	SR, NR	7 d	Growth	IC25	12.3	Banack et al. 2012
Fish	Rainbow Trout	*Oncorhynchus mykiss*	Fry	15	6	SR, NR	7 d	Growth	IC25	31.5	Banack et al. 2012
Fish	Rainbow Trout	*Oncorhynchus mykiss*	10–20 cm	12.8	7.5	S, M	20 d	Survival	LC10	1.5	Neuhold and Sigler 1960
Fish	Rainbow Trout	*Oncorhynchus mykiss*	10–20 cm	12.8	7.5	S, M	20 d	Survival	LC20	2.0	Neuhold and Sigler 1960
Fish	Rainbow Trout	*Oncorhynchus mykiss*	10–20 cm	12.8	7.5	S, M	20 d	Survival	LC50	3.6	Neuhold and Sigler 1960
Fish	White-Clawed Crayfish	*Austropotamobius pallipes*	6-mo old; 57 mm length	19.5	190	SR, M	8 d	Survival	LC50	28.9	Aguirre-Sierra et al. 2013
Fish	White-Clawed Crayfish	*Austropotamobius pallipes*	6-mo old; 57 mm length	19.5	190	SR, M	8 d	Survival	NOEC	19.4	Aguirre-Sierra et al. 2013
Fish	White-Clawed Crayfish	*Austropotamobius pallipes*	6-mo old; 57 mm length	19.5	190	SR, M	8 d	Survival	LOEC	45.1	Aguirre-Sierra et al. 2013
Fish	White-Clawed Crayfish	*Austropotamobius pallipes*	6-mo old; 57 mm length	19.5	190	SR, M	8 d	Survival	MATC	29.6	Aguirre-Sierra et al. 2013
Fish	White-Clawed Crayfish	*Austropotamobius pallipes*	6-mo old; 57 mm length	19.5	190	SR, M	8 d	Escape Response	EC50	5.9	Aguirre-Sierra et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	17 ± 0.5	NR	SR, N	18 d	Survival	LC10	>160	Casellato et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	17 ± 0.5	NR	SR, N	18 d	Survival	LC20	>160	Casellato et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	22 ± 0.5	NR	SR, N	18 d	Survival	LC10	40	Casellato et al. 2013
Invertebrate	Tubificid worm	*Branchiura sowerbyi*	NR	22 ± 0.5	NR	SR, N	18 d	Survival	LC20	60	Casellato et al. 2013
Plant	Inflated Duckweed	*Lemna gibba*	culture	26	NR	NR	3 d	Growth	EC10	4.2	Oota 1971
Plant	Inflated Duckweed	*Lemna gibba*	culture	26	NR	NR	3 d	Reduction in flowers	EC18	0.42	Oota 1971
Plant	Inflated Duckweed	*Lemna gibba*	culture	26	NR	NR	3 d	Reduction in flowers	EC50	4.2	Oota 1971

LCx = concentration of sample estimated to be lethal to x% of the test organisms.

ECx = concentration of sample estimated to cause a specified effect to x% of the test organisms.

ICx = the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms.

MATC = maximum acceptable toxicant concentration; the geometric mean of the NOEC and LOEC.

NR = No data reported; S = Static; SR = Static-Renewal; FT = Flow-through; N = Nominal; M = Measured; NOEC = no observed effect concentration; LOEC = lowest observed effect concentration;
h = hours; d = days; mo = months; g = gram; mm = millimetre; cm = centimetre; mg/L F= milligrams per litre fluoride; mg/L CaCO3 = milligrams per litre calcium carbonate ;% = percent; >= greater than; <= less than; + = plus or minus; °C = degrees Celsius.

DE BEERS CANADA INC.

SNAP LAKE MINE

DEVELOPMENT OF TOTAL DISSOLVED SOLIDS CHRONIC EFFECTS BENCHMARK FOR AQUATIC LIFE IN SNAP LAKE

December 2013

EXECUTIVE SUMMARY

Total dissolved solids (TDS) is an expression of salinity; it is the sum of the concentrations of all common dissolved ions in freshwaters (e.g., sodium, calcium, magnesium, potassium, chloride, sulfate, bicarbonate, nitrate, reactive silicate). The ionic composition of TDS varies depending on site conditions and the proportions of constituent ions present. Adverse effects to aquatic life can occur as a result of osmotic stress and specific ion toxicity.

There are no national water quality guidelines (WQGs) for TDS for protection of aquatic life in Canada or the United States; however, Alaska has TDS limits that range from 500 to 1,500 milligram per litre (mg/L) depending on whether salmonid fish are spawning. In August 2013, a TDS benchmark of 500 mg/L was approved for the Diavik Diamond Mine, 300 kilometres (km) northeast of Yellowknife, Northwest Territories (NWT). The Water Licence for the Snap Lake Mine has a management compliance limit for TDS of 350 mg/L, expressed as a whole-lake average concentration, excluding stations in the northwest arm of the lake.

Both Canada and the United States have generic WQGs for chloride, which is the major constituent of TDS in Snap Lake, as do British Columbia and Quebec; the long-term chloride WQGs from these jurisdictions range from 120 to 230 mg/L. A hardness-dependent site-specific water quality objective (SSWQO) for chloride was proposed for the EKATI Diamond Mine, 300 km northeast of Yellowknife, NWT. The SSWQO was adopted in May 2013 as an effluent quality criterion (EQC) in the Water Licence renewal for that mine. At the current Snap Lake water hardness of 140 mg/L as calcium carbonate ($CaCO_3$), the hardness-dependent SSWQO for chloride would be 372 mg/L.

As part of the *TDS Response Plan* that De Beers Canada Inc. (De Beers) is required to submit to the Mackenzie Valley Land and Water Board (MVLWB) in December 2013, benchmarks for TDS, chloride, and fluoride are to be recommended. To address this requirement for TDS and chloride, a tiered study was initiated to: compile data on TDS concentrations in Snap Lake to characterize ionic composition; conduct a literature review on toxicity of TDS and its constituent ions; conduct site-specific aquatic toxicity tests using a TDS mixture representative of Snap Lake conditions; and, propose a chronic effects benchmark (CEB) for TDS and its major constituent ions in Snap Lake. Development of a fluoride benchmark is reported separately.

Concentrations of TDS in Snap Lake have increased since Mine operations began in 2005, as a result of mining operations that liberate deep connate water – ancient groundwater trapped in sediments and rocks that is characterized by high salinity, in this case primarily calcium and chloride. The ionic composition of TDS in Snap Lake has remained relatively consistent since 2007. For example, since the present study was initiated in 2010, the ionic composition has been: chloride, 45 to 47 percent (%); calcium, 20 to 21%; sodium, 10 to 11%; sulfate, 9%; carbonate, 5 to 7%; nitrate, 4%; magnesium, 2 to 3%, and minor contributions from potassium and fluoride.

Available data on the acute and chronic toxicity of TDS and its constituent ions to freshwater aquatic life were compiled and reviewed. A wide range of effect concentrations have been reported, depending on the ionic composition, test species, and life stage tested. The presence of more than one cation may ameliorate TDS toxicity, TDS toxicity is hardness-dependent, and the ratios of ionic constituents can be important factors affecting TDS toxicity.

A site-specific toxicity testing program was undertaken to assess the potential adverse effects of Snap Lake TDS on eight phytoplankton, zooplankton, benthic invertebrate, and fish species representative of the aquatic community in Snap Lake. Synthetic lake water was prepared in the laboratory, using the same ionic composition of TDS found in Snap Lake, and tested at a range of concentrations up to a nominal TDS concentration of 1,500 mg/L. Only the two planktonic water flea species (*Ceriodaphnia dubia* and *Daphnia magna*), sensitive surrogates for Snap Lake zooplankton, demonstrated adverse effects to elevated TDS concentrations. The most sensitive test result obtained from this site-specific testing program was a 10% inhibitory concentration (IC10) of 560 mg/L TDS for *C. dubia* reproduction. The next most sensitive test result was an IC20 of 684 mg/L TDS for *D. magna* reproduction. Daphnids (Cladocera) are not abundant in Snap Lake, accounting for less than two percent of zooplankton biomass; however, these two species are sensitive, standardized test organisms that the literature indicates provided conservative effects endpoints. *Ceriodaphnia* are not present in Snap Lake, whereas *Daphnia* species other than *D. magna* are. All other test results (for green algae, diatoms, rotifers, chironomids, and fish) showed a lack of toxicity even at the highest TDS concentration tested, except for minor effects on Lake Trout survival in one of the two early life stage (ELS) tests performed with that species.

Based on the results of the site-specific toxicity testing program, a CEB of 684 mg/L TDS is recommended for Snap Lake. A species sensitivity distribution (SSD) using data from the site-specific TDS toxicity tests was unsuitable for benchmark derivation because the majority of test results were unbounded (i.e., no adverse effects at the highest TDS concentration tested). The CEB was therefore derived using the *D. magna* IC20 of 684 mg/L and an uncertainty factor of 1.0.

The hardness-dependent chloride SSWQO developed for the EKATI Diamond Mine is considered suitable for Snap Lake. The equation is: chloride SSWQO = 116.6 (ln[hardness])-204.1. At the current water hardness in Snap Lake, the chloride SSWQO would be 372 mg/L.

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LIST OF ACRONYMS

ADEC	Alaska Department of Environmental Conservation
AEMP	Aquatic Effects Monitoring Program
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
BC	British Columbia
Ca	Calcium
Ca^{2+}	calcium ion
$CaCl_2$	calcium chloride
$CaCl_2 \cdot 2H_2O$	calciuchloride dehydrate
CaCo3	calcium carbonate
CCME	Canadian Council of Ministers of the Environment
CEB	chronic effects benchmark
CL	Confidence Limit
Cl	Chlorine
Cl^-	chloride ion
COPC	contaminant of potential concern
CSM	conceptual site model
De Beers	De Beers Canada Inc.
EAR	Environmental Assessment Report
EC	effective concentration
ECx	concentration of sample estimated to cause a specified effect to x% of the test organisms
ELS	early life stage (test)
EQC	effluent quality criterion
GLEC	Great Lakes Environmental Center
HC5	hazardous concentration to 5% of species
HCO_3^-	bicarbonate ion
IC	inhibition concentration
ICx	the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms
IDNR	Iowa Department of Natural Resources
INHS	Illinois Natural History Survey
K	Potassium
K^+	potassium ion
KCl	potassium chloride
LC	lethal concentration
LCx	concentration of sample estimated to be lethal to x% of the test organisms
LOEC	lowest observed effect concentration
MB	Manitoba
Mg	Magnesium
Mg^{2+}	magnesium ion
$MgCl_2$	magnesium chloride
$MgCl_2 \cdot 6H_2O$	magnesium chloride hexahydrate
$MgSO_4$	magnesium sulfate
Mine	Snap Lake Mine
MVLWB	Mackenzie Valley Land and Water Board

Na	Sodium
Na^+	sodium ion
Na_2SO_4	sodium sulfate
NaCl	sodium chloride
$NaHCO_3$	sodium carbonate
NOEC	no observed effect concentration
NWT	Northwest Territories
ON	Ontario
PF	problem formulation
r	intrinsic rate of reproduction
RO	reverse osmosis
ROPC	receptor of potential concern
SD	standard deviation
SO_4^{2-}	sulfate ion
SSD	species sensitivity distribution
SSWQO	site-specific water quality objective
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency
WQG	water quality guideline
YCT	yeast, cerophyl, trout chow

UNITS OF MEASURE

%	percent
<	lesser than
>	greater than
±	plus or minus
°C	degrees Celsius
µeq/L	microequivalents per litre
µL	microlitre
cells/mL	cells per millilitre
d	days
h	hours
km	kilometre
L	litre
mg/L	milligrams per litre
mL	millilitre

1 INTRODUCTION

1.1 Background

De Beers Canada Inc. (De Beers) owns and operates the Snap Lake Mine (Mine) in the Northwest Territories (NWT). The Mine is located approximately 220 kilometres (km) northeast of Yellowknife, 30 km south of MacKay Lake, and 100 km south of Lac de Gras where the Diavik Diamond Mine and the Ekati Diamond Mine are located. Final regulatory approvals for construction and operation of the Mine were granted in May 2004, and construction began in April 2005. The Mine officially opened on July 25, 2008.

The Environmental Assessment Report (EAR; De Beers 2002) predicted that concentrations of total dissolved solids (TDS) would increase in Snap Lake over the operational life of the Mine as a result of mining operations that would liberate deep connate water – ancient groundwater entrapped in sediments and rock that is characterized by high salinity, in this case calcium and chloride. As a result of the increases in TDS concentrations predicted in the EAR, requirements for TDS monitoring were established for Snap Lake, as originally set out in Section 5.6 of the Fisheries Authorization. These requirements included a TDS compliance limit of 350 milligrams per litre (mg/L) in Snap Lake, calculated as a whole-lake average but excluding the northwest arm stations. The northwest arm of Snap Lake is connected to the main basin by a narrow channel and the volume of flow between the two is small relative to the main body of Snap Lake. The northwest arm of Snap Lake is therefore not included in the whole-lake TDS calculation.

The observed whole-lake average TDS concentration in Snap Lake has increased at a faster rate than predicted in the EAR due to greater than predicted TDS loading to Snap Lake from treated minewater. Minewater inflow rates have been higher than predicted during the early stages of Mine development (De Beers 2010a). In 2010, De Beers initiated a tiered study to investigate the potential effects of elevated TDS concentrations on aquatic life for the purpose of developing a site-specific benchmark for TDS in Snap Lake. The objectives of this TDS study are described in Section 1.2.

1.2 Study Objectives

The current Water Licence requires that a *TDS Response Plan* be submitted to the Mackenzie Valley Land and Water Board (MVLWB) by December 31, 2013. One component of that *TDS Response Plan* is to provide recommendations and supporting rationale for site-specific water quality objectives (SSWQOs) for TDS, chloride, and fluoride in Snap Lake, derived from toxicity tests conducted by De Beers and/or published toxicology studies. A second component is to provide recommendations and supporting rationale for effluent quality criteria (EQC) for these parameters.

The objective of the TDS benchmark study that was initiated in 2010 was to undertake three tasks to support development of a chronic effects benchmark (CEB) for TDS in Snap Lake:

- **Task 1** – Conduct a literature review and problem formulation (PF) to: compile and review available information on the toxicity of TDS and its constituent ions to freshwater aquatic life; compile available data on TDS concentrations in Snap Lake; characterize the ionic composition of TDS in Snap Lake; identify aquatic receptors that may be exposed to elevated TDS concentrations in Snap Lake; and, recommend species for the laboratory toxicity testing program to be undertaken as Task 2.
- **Task 2 –** Conduct site-specific aquatic toxicity tests to determine the effects of elevated TDS concentrations on phytoplankton, zooplankton, benthic invertebrates, and fish species representative of aquatic receptors in Snap Lake.
- **Task 3** – Use the information generated from Tasks 1 and 2 to develop benchmarks for TDS and its constituent ions (e.g., chloride) for application to Snap Lake.

Task 1 was undertaken in late 2010 and the results from the literature review and problem formulation were reported based on information available at that time (Golder 2011a, b). The site-specific TDS toxicity testing program (Task 2) was initiated in 2011; testing of phytoplankton and invertebrate species was completed in 2012, and early life stage (ELS) testing with fish was completed in 2013. Development of a fluoride benchmark for Snap Lake was undertaken separately (Golder 2013).

This report incorporates relevant information from Task 1 previously reported in Golder (2011a,b) and updated where applicable, reviews existing TDS and chloride benchmarks, presents the results of the site-specific TDS toxicity tests, and proposes CEBs for TDS and chloride in Snap Lake.

2 CHARACTERISTICS OF TOTAL DISSOLVED SOLIDS

The total dissolved solids (TDS) of a waterbody, which is essentially an expression of salinity, is the sum of the concentrations of all common dissolved ions (e.g., sodium, calcium, magnesium, potassium, chloride, sulfate, bicarbonate, nitrate, reactive silicate) in freshwaters (APHA 2005). TDS concentrations can be measured gravimetrically by evaporating a known volume of filtered water and measuring the mass of the residue left after evaporation, or they can be calculated from measured concentrations of constituent ions in the water sample.

Snap Lake aquatic monitoring programs use calculated TDS concentrations determined from measured concentrations of constituent ions, rather than gravimetrically measured TDS concentrations. De Beers (2013) provides information on the rationale for this decision, which has been in practice since the EAR (De Beers 2002).

Dissolved solids are naturally present in water, and the concentration and relative composition of individual components are determined by natural factors, such as the geology and soil in the watershed, atmospheric precipitation, and the water balance (evaporation-precipitation) (Weber-Scannell and Duffy 2007). Elevated concentrations of TDS can be harmful to fish and other aquatic organisms. Changes in TDS concentrations can result from anthropogenic activities; treated effluents from mining or industrial water treatment are common sources of TDS (Soucek 2007; Weber-Scannell and Duffy 2007).

There are two main mechanisms of TDS toxicity, which are not necessarily mutually exclusive: toxicity from osmotic stress; and, specific ion toxicity (Davies and Hall 2007; Weber-Scannell and Duffy 2007). Osmotic stress can occur with an increase in TDS, which causes cellular desiccation owing to an increased osmotic potential between the organism and the aquatic medium, in which water flows from an area of relatively low solute concentration (the cell) to an area of relatively high solute concentration (the surrounding environment) (Davies and Hall 2007). Specific ion toxicity refers to the uptake of a particular ion by an organism to concentrations that have adverse effects on normal cellular function. Thus, TDS toxicity is dependent on a number of factors, such as overall TDS concentration, the specific ion composition, and the organisms that may be affected.

Measurement of TDS does not differentiate among ions; therefore, a breakdown of individual components is necessary to determine the contribution of specific ions. Goodfellow et al. (2000) and Weber-Scannell and Duffy (2007) recommended that generic limits be established for individual ions rather than TDS for protection of freshwater aquatic species, because the ionic composition of TDS is generally variable. TDS limits as opposed to limits for individual constituent ions can only be developed in cases where the TDS ionic composition does not vary, which is the case for Snap Lake (Section 4.1).

3 WATER QUALITY BENCHMARKS FOR TOTAL DISSOLVED SOLIDS AND CHLORIDE

Available water quality guidelines (WQGs) and benchmarks for protection of freshwater aquatic life were compiled for TDS and chloride, which is the primary constituent ion of TDS in Snap Lake waters. No WQGs or benchmarks were identified for calcium, the secondary constituent ion of TDS in Snap Lake.

3.1 Benchmarks for Total Dissolved Solids

The Canadian Council of Ministers of the Environment (CCME) has not established a WQG for TDS for the protection of aquatic life (CCME 1999 with updates).

In Alaska, TDS may not exceed 1,000 mg/L (ADEC 2012). Moreover, a concentration of TDS may not be present in water that causes an adverse effect to aquatic life. Permits are required for discharges to receiving water that result in increased TDS concentrations in a waterbody to between 500 and 1,000 mg/L. Studies conducted for Coeur Alaska's Kensington Mine site resulted in the first site-specific TDS permit in Alaska (Chapman et al. 2000). That permit states that TDS may not exceed 1,000 mg/L in Sherman Creek, the receiving waterbody for Kensington Mine effluent (ADEC 2012). Alaska also granted a site-specific permit for Red Dog Creek, the receiving waterbody for Red Dog Mine effluent (Brix et al. 2010; ADEC 2012). Concentrations of TDS up to 1,500 mg/L are permitted during periods when salmonids are not spawning, provided calcium is greater than 50 percent (%) by weight of the total cations (Brix et al. 2010; ADEC 2012). During spawning periods, the limit is set at 500 mg/L (Brix et al. 2010).

In 2004, the Iowa Department of Natural Resources (IDNR) adopted an interim TDS standard that required toxicity testing in situations where discharges resulted in receiving stream TDS concentrations greater than 1,000 mg/L (IDNR 2009). However, IDNR subsequently recommended replacing the existing site-specific TDS approach with numerical sulfate and chloride criteria (IDNR 2009).

A TDS benchmark of 500 mg/L was approved for the Diavik Diamond Mine in August 2013 (WLWB 2013a). Adoption of Alaska's TDS benchmark of 1,000 mg/L (ADEC 2012) was proposed but, because of concerns about Action Levels associated with that mine's Response Framework, and because Alaska requires permits for discharges that result in TDS concentrations above 500 mg/L, WLWB (2013b) set the TDS benchmark at 500 mg/L.

3.2 Benchmarks for Chloride

For chloride, CCME (2011) has established a long-term WQG of 120 mg/L that is intended to protect all forms of aquatic life for an indefinite exposure period, and a short-term WQG of 640 mg/L that is the concentration at which severe effects are likely to be observed. Although CCME (2011) noted that chloride toxicity decreased with increasing water hardness for a number of aquatic species, there were insufficient data available to derive a national hardness-dependent WQG for chloride.

British Columbia has an approved WQG for chloride for protection of freshwater aquatic life (Nagpal et al. 2003). The maximum chloride concentration should not exceed 600 mg/L at any time, and the 30-day (d) average chloride concentration should not exceed 150 mg/L.

The United States has a national water quality criterion for protection of freshwater aquatic life for chloride, when associated with sodium (USEPA 1988). The 4-d average concentration of chloride (chronic effects concentration) should not exceed 230 mg/L more than once every three years on average, and the 1-h average concentration of chloride (acute effects concentration) should not exceed 860 mg/L more than once every three years on average.

Quebec adopted the United States Environmental Protection Agency (USEPA; 1988) acute and chronic benchmarks for chloride (MDDEP 2009): 860 and 230 mg/L, respectively.

Environment Canada and Health Canada (2001) prepared a Priority Substance List assessment report for road salts, specifically inorganic chloride salts. Although not a WQG, it was estimated that 5% of aquatic species would be affected (median lethal concentration) at a chloride concentration of about 210 mg/L, and 10% of aquatic species would be affected at a chloride concentration of 240 mg/L.

For the State of Kentucky, Birge et al. (1985) recommended that, for protection of aquatic life, chloride concentrations should not exceed 600 mg/L for any consecutive 3-d period and that the maximum chloride concentration should not exceed 1,200 mg/L.

EVS (2004) conducted a Tier I ecological risk assessment for chloride for the EKATI Diamond Mine, located approximately 300 km northeast of Yellowknife, NWT, and used a site-specific species sensitivity distribution (SSD) to calculate a chronic hazardous concentration to 5% of species (HC5) (concentration intended to protect 95% of the species assemblages) of 180 mg/L for chloride in surface waters. BHP Billiton (2008) subsequently proposed a SSWQO for chloride for the EKATI Diamond Mine. This SSWQO was hardness-dependent; at a water hardness of 80 mg/L as $CaCO_3$, the proposed SSWQO for chloride was 325 mg/L, and the equation for the hardness-adjusted SSWQO over a range of hardness from 10 to 160 mg/L as $CaCO_3$ was:

$$SSWQO = 124(\ln[Hardness])-218.$$

The above SSWQO equation was subsequently modified by Elphick (2011a). The Water Licence for the EKATI Diamond Mine (W2012L2-0001 [Renewal of W2009L2-0001]; WLWB 2013c) provides for hardness-adjusted chloride EQC in mg/L according to the following formulae:

$$\text{EQC for maximum average concentration} = 116.6(\ln[Hardness])-204.1; \text{ and}$$

$$\text{EQC for maximum concentration of any grab sample} = 2(116.6(\ln[Hardness])-204.1).$$

4 PROBLEM FORMULATION FOR TOTAL DISSOLVED SOLIDS IN SNAP LAKE

Problem Formulation (PF) is the first stage of an ecological risk assessment, and is used to develop and communicate a clear understanding of the site under investigation. It involves review of available information about a particular site to identify contaminants of potential concern (COPCs), receptors of potential concern (ROPCs), exposure pathways, and assessment and measurement endpoints, and integration of this information into a conceptual site model (CSM). The PF detailed herein briefly summarizes and, where appropriate, updates Golder (2011b), focusing on TDS as a specifically targeted COPC in Snap Lake.

The objectives of the PF were to:

- review and compile available data on TDS concentrations in Snap Lake including ionic composition and proportion (Section 4.1);
- choose appropriate test organisms to characterize ROPCs (representing different trophic levels from algae to invertebrates to fish) exposed to increased TDS concentrations in Snap Lake (Section 4.2); and
- develop a CSM to visually examine the potential interactions of COPCs, exposure pathways, and ROPCs (Section 4.3).

4.1 Review of Total Dissolved Solids Data for Snap Lake

The TDS data were obtained from the following sources: the EAR (De Beers 2002), Golder (2005), annual TDS reports for 2006 to 2011 (De Beers 2006, 2007, 2008, 2009, 2010b, 2011), and annual Aquatic Effects Monitoring Program (AEMP) reports for 2011 and 2012 (De Beers 2012, 2013). The TDS and major ion concentrations at Snap Lake by year are summarized in Table 1. Average concentrations are presented separately for the ice-covered versus open-water periods. The percent contribution of each major ion to the mean TDS concentrations (ice-cover and open-water seasons) from 1998 to 2012 is illustrated in Figure 1.

Under baseline conditions (1998 to 2001) prior to Mine construction and the discharge of treated effluent, TDS composition was dominated by carbonate and sulfate ions (approximately 50% to 60% of TDS), with calcium and chloride contributing less than 20% of TDS. A shift in the TDS ionic composition occurred from 2004 to 2006, with an increasing dominance of calcium and chloride ions as a result of treated minewater discharges. The ionic composition of TDS has remained relatively stable since 2007. In 2010 the mean composition was: chloride, 47%; calcium, 21%; sodium, 11%; sulfate, 9%; and, carbonate, nitrate, fluoride, potassium and magnesium each contributing 1% to 5%. The 2010 ionic composition was used to prepare the synthetic lake water used for the site-specific TDS toxicity testing program that was initiated in 2011 and completed in 2013 (Section 6.0). The ionic composition of TDS in Snap Lake continues to remain stable, with only small variations in mean composition in 2012 as compared to 2010: chloride, 45%; calcium, 20%; sodium, 10%; sulfate, 9%; and, carbonate, nitrate, fluoride, potassium and magnesium each contributing 1% to 7%.

Annual summary statistics (mean, standard deviation, minimum, and maximum) are presented for TDS, calcium, chloride, sodium, and sulfate concentrations in Table 2. Maximum concentrations of these five parameters were measured during the most recently reported sampling event (2012 ice-covered period).

The conclusions of the Snap Lake TDS data review are:

- calcium and chloride have been the dominant ionic constituents of TDS in Snap Lake from 2004 to 2012, followed by sodium and sulfate;
- TDS and its constituent ions, particularly chloride, are considered COPCs for the purpose of this assessment; and
- TDS concentrations were generally higher during ice-covered periods as compared to open-water periods.

4.2 Receptors of Potential Concern for Snap Lake

Since it is not possible to directly assess the risk for each individual species, the overall aquatic ecosystem of Snap Lake was divided into different components (e.g., phytoplankton, zooplankton). At least one representative species (i.e., the receptor) was then selected for each ecosystem component. The risks calculated for each ROPC are interpreted as applying to all members of each ecosystem component. Four key factors were considered in the selection of appropriate ROPCs (USEPA 1998):

- Site relevance: The selected ROPCs should reflect the dominant species/groups of organisms present at the site.
- Ecological relevance: The selected ROPCs should play a measurable role in the functioning of the ecosystem (e.g., primary food items for other organisms, provide valuable habitat, or act as top-level predators).
- Availability of toxicological data: Toxicological data are available for a limited number of species, although extrapolation of potential adverse biological effects is often possible for similar species.
- Representative of different exposure pathways: Organisms are exposed through a number of pathways; the selected receptors should represent the major site-relevant pathways.

Biological data collected within Snap Lake were reviewed to select representative ROPCs relative to the above four key factors. Biotic sampling has been carried out in Snap Lake since 2004 to assess changes in aquatic species composition over time, and to allow comparison to the EAR (De Beers 2002). Results of annual sampling programs are provided in the AEMP reports, which document community composition on a yearly basis for plankton, benthic invertebrates, and fish.

Table 1 Average Concentrations of Total Dissolved Solids and Constituent Ions in Snap Lake, 1998 to 2012

Year	Season	Sampling period	N	Mean Concentration (mg/L)								
				TDS	Calcium	Chloride	Magnesium	Nitrate (as N)	Potassium	Sodium	Sulfate	Alkalinity (as $CaCO_3$)
1998 to 2001	Ice covered	1998-2001 (July to Oct)	12	11.0	1.7	0.30	0.76	0.01	0.6	0.72	2.6	7.1
	Open water	1998-2002 (Feb to Mar)	14	8.3	1.1	0.35	0.55	0.004	0.4	0.52	1.9	5.7
2004	Open water	May to August 2004	50	12.0	2.2	2.8	0.8	0.01	0.5	0.79	1.8	5.1
2005	Ice covered	Jan to April 2005	70	21.7	4.0	6.3	1.3	0.08	0.7	1.8	3.0	7.7
	Open water	May to Oct 2005	118	23.5	3.9	7.3	1.1	0.57	0.5	2.1	2.2	6.2
2006	Ice covered	Jan to April 2006	142	44.1	8.5	18.4	1.7	0.14	0.7	4.3	4.0	8.9
	Open water	July to Sep 2006	65	47.4	9.6	22.1	1.6	0.11	0.7	5.2	3.9	6.9
2007	Ice covered	Feb to April 2007	87	82.8	17.7	39.8	2.2	0.18	1.0	9.3	6.3	9.1
	Open water	July to Sep 2007	51	73.5	15.5	36.1	1.8	0.10	0.9	8.4	5.4	8.3
2008	Ice covered	Jan to May 2008	64	119	24.8	60.6	2.8	0.33	1.1	12.9	8.9	11.3
	Open water	July to Sep 2008	58	99.0	20.6	48.7	2.6	0.56	0.9	10.9	7.7	8.4
2009	Ice covered	Feb to June 2009	69	138	28.7	66.5	3.3	0.95	1.4	15.2	11.3	12.4
	Open water	July to Sep 2009	56	112	23.3	54.0	2.8	0.86	1.1	12.2	9.1	9.5
2010	Ice covered	Jan to May 2010	74	163	34.3	77.0	4.0	1.3	1.5	17.6	14.0	13.8
	Open water	July to Sep 2010	59	138	27.5	64.9	3.5	1.28	1.3	14.7	12.6	12.5
2011	Ice covered	Feb to May 2011	67	193	39.0	90.0	4.7	1.76	1.9	20.5	16.7	19.3
	Open water	July to Sep 2011	49	165	33.7	76.3	4.3	1.58	1.6	18.2	14.5	16.2
2012	Ice covered	Jan to Apr 2012	55	233	47.2	104	5.9	2.37	2.3	24.7	20.4	23.9
	Open water	July to Sep 2012	63	193	39.0	87.6	4.8	1.93	1.9	20.1	17.2	21.3

N = Sample size; TDS = Total Dissolved Solids; $CaCO_3$ = calcium carbonate; Sep = September; Oct = October; Jan = January; Feb = February; Mar = March; mg/L = milligrams per litre.

Figure 1 Ionic Composition of Total Dissolved Solids in Snap Lake, 1998 to 2012

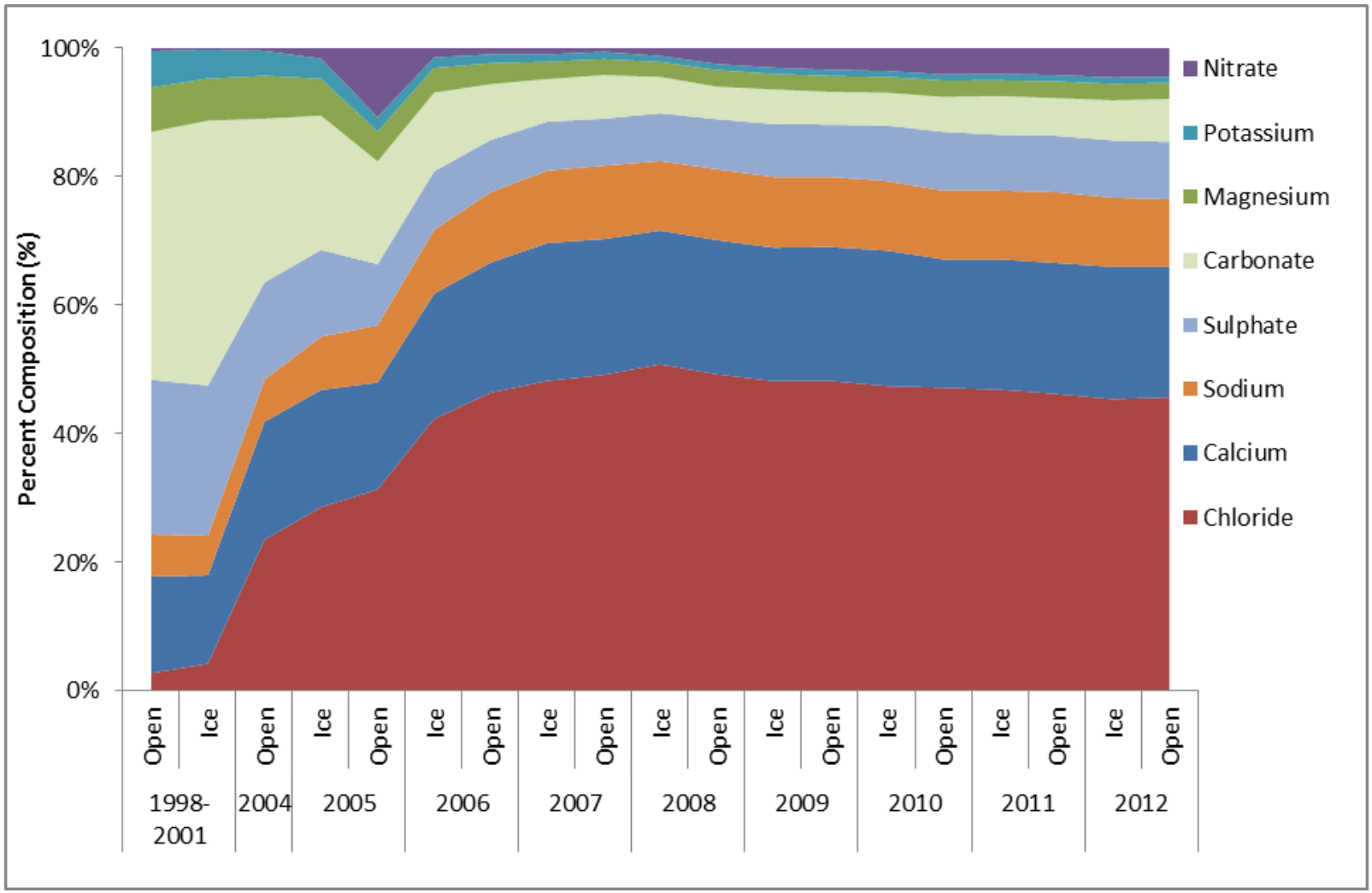


Table 2 Summary Statistics by Year for Total Dissolved Solids, Calcium, Chloride, Sodium, and Sulfate Concentrations in Snap Lake

	TDS [mg/L]					Calcium [mg/L]					Chloride [mg/L]					Sodium [mg/L]					Sulfate [mg/L]				
Year	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
1998 to 2001	26	10	2	6.6	14	26	1.4	0.3	0.9	2.1	23	0.3	0.2	0.1	1	26	0.6	0.2	0.4	1	26	2.3	1.4	1.3	6
2004	50	12	3	8.2	20	50	2.2	0.6	1.5	3.4	50	2.8	1.8	1.0	7	50	0.8	0.6	0.5	2	50	1.8	0.3	1.4	2.3
2005	187	23	15	11	93	183	3.9	2.6	2.1	17	189	6.9	6.7	2.0	42	187	2.0	1.6	0.2	10	188	2.5	1.8	0.02	20
2006	207	45	32	19	155	207	8.8	6.7	4	33	207	20	17	6	78	207	4.6	3.4	2	19	207	3.9	1.9	2.3	10.4
2007	138	79	26	49	147	138	17	5.9	10	33	138	38	15	22	78	138	8.9	3.0	5	17	138	6.0	1.7	0.02	9.8
2008	122	110	16	76	155	122	23	3.5	16	33	122	55	9	38	77	122	12	1.8	8	18	122	8.3	1.3	5.9	12.2
2009	125	126	20	56	172	125	26	4.5	10	36	125	61	10	31	84	125	14	2.3	5	19	125	10.3	1.6	6.0	14.2
2010	132	153	19	67	187	132	31	5	13	39	132	72	9	31	92	132	16.4	2.2	7.3	20.7	132	13.5	1.6	6.7	16.9
2011	116	181	21	97	217	116	37	4	19	45	116	84	10	45	101	116	20	2.1	11	24	116	16	1.7	9.1	19
2012	118	212	25	167	279	118	43	5	34	62	118	95	10	77	121	118	22	3.2	17	31	118	19	2.1	14.8	25

TDS = total dissolved solids; N = sample size; SD = standard deviation; Min = minimum; Max = maximum; mg/L = milligrams per litre.

The EAR and the AEMP reports divided the species present in Snap Lake into four main trophic groups for which the following ROPCs were selected as representative toxicity test species for each ecosystem component following a two-step process as detailed in Golder (2011b):

Phytoplankton: green algae (using a standardized test species; green algae are found in Snap Lake) and diatoms (again using standardized testing; diatoms comprised up to 79% of total abundance and 82% of phytoplankton biomass in 2012 and were also a dominant component of the phytoplankton during baseline studies);

Zooplankton: rotifers (less standardized for testing, but an ecologically relevant group of organisms) and daphnid (cladoceran) waterfleas, which are highly standardized test organisms (rotifers and copepods have been dominant components of the zooplankton since baseline studies in terms of abundance; waterfleas are less abundant in Snap Lake but are more sensitive than copepods to TDS [see Section 5.2]);

Benthic Invertebrates: chironomids (using a standardized test species; this group of organisms have been dominant components of the benthic invertebrate community since baseline studies – in terms of abundance); and

Fish: Lake Trout and Arctic Grayling (not standardized tests, but two of the seven fish species found in Snap Lake from baseline through to 2012 and of high economic and cultural value).

4.3 Conceptual Site Model for Snap Lake

Conceptual site models (CSMs) are developed during the PF to examine the potential interactions of COPCs, exposure pathways, and ROPCs. CSMs also provide a visual depiction of these relationships. A CSM of the aquatic receiving environment at Snap Lake is presented in Figure 2.

Key features of this CSM are:

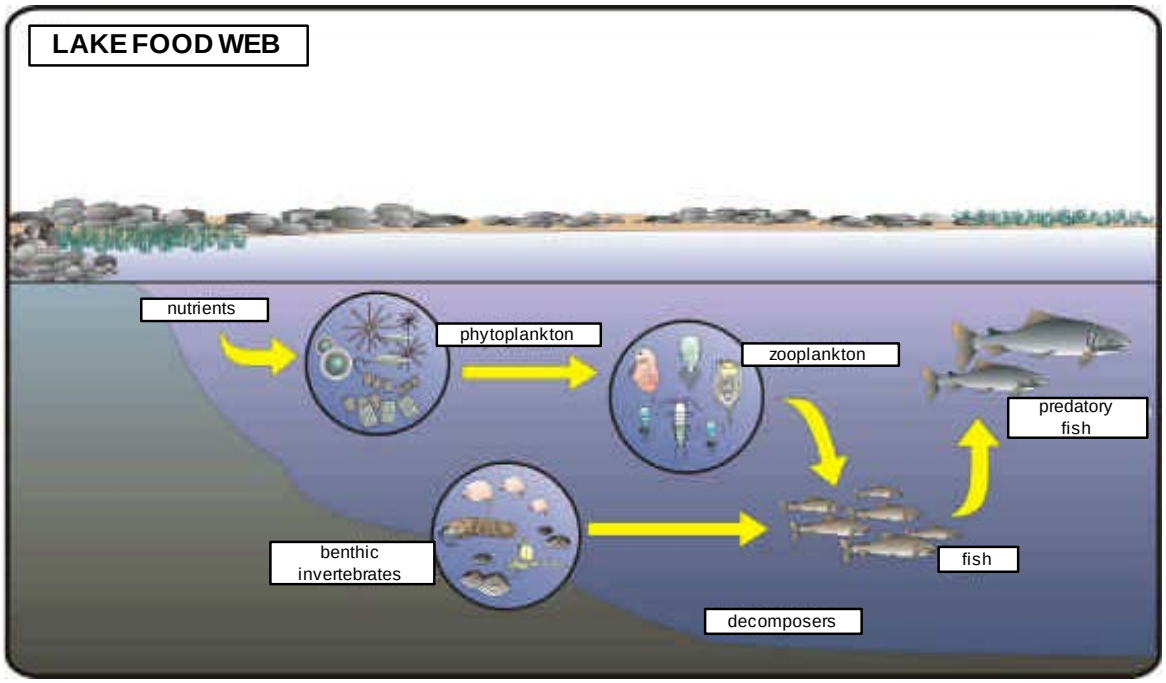
Source of TDS to Snap Lake: The source of elevated TDS to Snap Lake is groundwater that enters the Mine workings, is collected and directed to the treatment plant, and is discharged to Snap Lake following treatment.

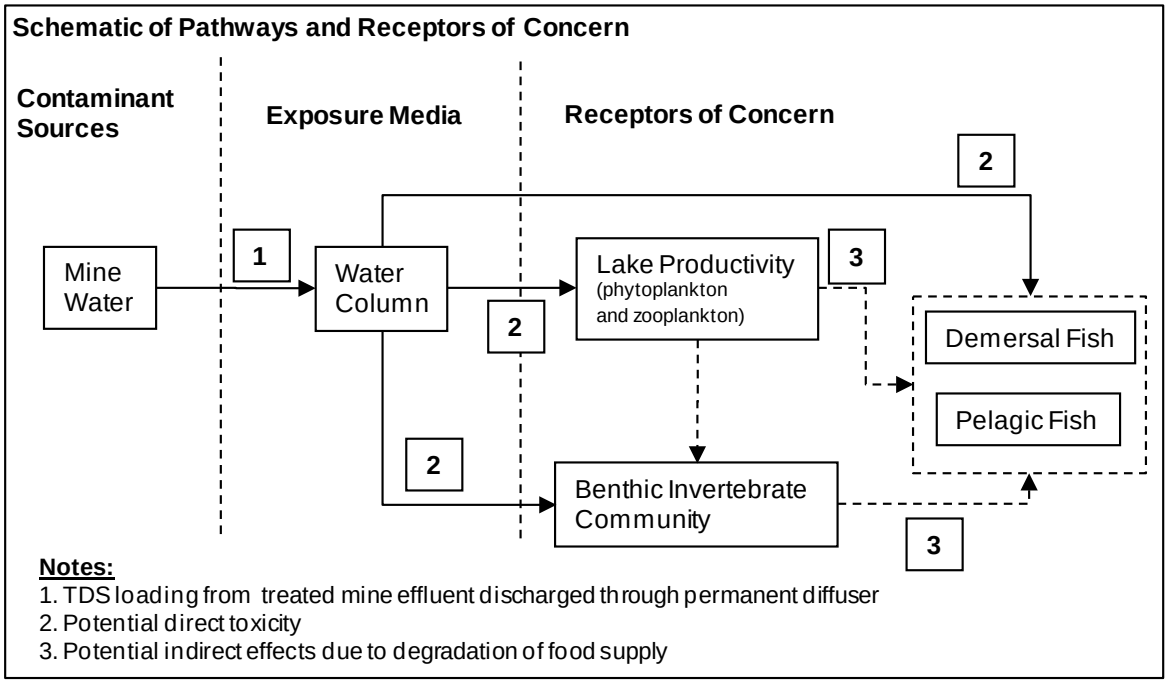
Contaminants of Potential Concern (COPCs): The only COPC being assessed is TDS, and its constituent ions.

Receptors of Potential Concern (ROPCs): The ROPCs for potential TDS impacts in Snap Lake are detailed in Section 4.2.

Pathways: The exposure pathway is primarily direct contact of aquatic organisms with TDS and its constituent ions in the waters of Snap Lake. Phytoplankton and zooplankton are directly exposed to the water column and may be affected by direct toxicity. The benthic invertebrate community may be directly exposed via water above or in the sediments and may be similarly affected by direct toxicity. Fish are directly exposed to the water column and may be affected by direct toxicity or indirectly by adverse effects to the food chain upon which they depend (i.e., phytoplankton, zooplankton, and benthic invertebrates).

Figure 2 **Conceptual Site Model – Schematic Food-Web for Snap Lake (top panel) and Relevant Exposure Pathways (bottom panel)**





5 LITERATURE REVIEW: TOXICITY OF TOTAL DISSOLVED SOLIDS TO FRESHWATER AQUATIC LIFE

Literature reviews or compilations of toxicity data pertaining to TDS, calcium, and/or chloride are provided in: USEPA (1988); Environment Canada and Health Canada (2001); Evans and Frick (2001); Weber-Scannell and Jacobs (2001); Golder (2003); Weber-Scannell and Duffy (2007); BHP Billiton (2008); and, CCME (2011). Relevant literature from these reviews was sourced where possible, for independent review, and a literature search was conducted to identify additional publications not included in these reviews. The present literature review focussed on studies that investigated the toxicity of TDS, calcium, and/or chloride using temperate or northern cold-water species, including additional information from studies using other salts or aquatic species as appropriate.

Available toxicity data for freshwater phytoplankton, zooplankton, benthic invertebrates, and fish are tabulated in Appendix A (Tables A-1 to A-4), and summarized in the following subsections. Effects concentrations were reported either as concentrations of TDS, the individual salts used for testing (e.g., calcium chloride, sodium chloride), or as the constituent ion of interest (e.g., chloride), consistent with the format used for reporting results in the original studies.

5.1 Phytoplankton Community

Data on the toxicity of TDS or its constituent ions to freshwater phytoplankton species are tabulated in Table A-1 (Appendix A) and summarized below.

Chapman et al. (2000) and LeBlond and Duffy (2001) reported TDS toxicity endpoints for the green alga, *Selenastrum capricornutum* related to effluents from two Alaskan mines. Chapman et al. (2000) reported a 96-hour (h) no observed effect concentration (NOEC) of greater than 2,000 mg/L TDS for testing of a synthetic effluent based on the TDS characteristics of Coeur Alaska's Kensington Mine effluent, which consisted of approximately 50% sulfate and 20% calcium. LeBlond and Duffy (2001) reported a 72-h 20% effects concentration (EC20) of 551.3 mg/L TDS for a synthetic effluent that was approximately 70% sulfate. In contrast, in 2012 sulfate accounted for only about 9% of the TDS in Snap Lake.

Wilson et al. (1994, 1996) collected surface sediment samples for diatom analyses and limnological data from 219 lakes in British Columbia and the northern Great Plains, from which they were able to estimate salinity optima, as well as upper and lower salinity limits for many of the diatom taxa present in these lakes. Table 3 presents results from Wilson et al. (1996) for three species found in Snap Lake. *Tabellaria flocculosa* and *Fragilaria tenera* were reported to tolerate TDS concentrations above 8,000 mg/L; *Cyclotella bodanica* tolerated TDS concentrations slightly above 1,800 mg/L TDS.

Table 3 Salinity (as total dissolved solids) Optima for Selected Diatom Phytoplankton Species Found in Snap Lake

Taxon	Salinity Optimum [mg/L]	Lower Limit [mg/L]	Upper Limit [mg/L]
Tabellaria flocculosa	180	0	10,090
Cyclotella bodanica	240	30	1,820
Fragilaria tenera	320	10	8,070

Source: Wilson et al. (1996).
mg/L = milligrams per litre.

Effects concentrations for toxicity of sodium chloride to various species of green algae ranged from approximately 5,000 to greater than 11,000 mg/L (Reynoso and de Gamboa 1982; Setter et al. 1982; Mohammed and Shafea 1992).

Patrick et al. (1968) conducted toxicity tests with the diatom *Nitzschia linearis* and reported 120-h concentrations causing an effect to 50% of the test organisms (EC50s) for four salts: calcium sulfate (3,200 mg/L); calcium chloride (3,130 mg/L); sodium chloride (2,430 mg/L); and, potassium chloride (1,337 mg/L). These results indicated that diatoms were more sensitive to potassium and sodium toxicity than to calcium toxicity. Calcium is the dominant cation in Snap Lake, whereas potassium and sodium are present in relatively smaller concentrations in Snap Lake.

Vyverman et al. (1996) examined relationships between the physico-chemical environment and diatom species composition in 76 highland lakes in Tasmania, Australia. Among the measured lake water characteristics, they found that pH, calcium, and sodium accounted for most of the explained species variation, although none of the variables appeared to have an overriding effect on species composition. Calcium concentrations ranged from 8 to 203 microequivalents per litre (µeq/L) (approximately 0.2 to 4.1 mg/L). The range of calcium concentrations in Snap Lake was approximately 0.9 to 2.4 mg/L during the 1998 to 2001 baseline study, as compared to the current 2012 range of 34 to 62 mg/L (Table 2). The mean optimum calcium concentration for *Tabellaria flocculosa*, which was a dominant diatom species in Snap Lake during baseline conditions, was 44.26 µeq/L (0.9 mg/L) although higher concentrations can be tolerated. Twelve taxa were particularly sensitive to calcium concentrations and all but one taxon (*Cymbella gracilis*) was associated with low calcium concentrations. Pientiz et al. (1995) also found that calcium was an important variable explaining diatom distribution in 59 lakes located between Whitehorse in the Yukon and Tuktoyaktuk in the Northwest Territories. However, ranges or optimum concentrations were not reported. The findings of Vyverman et al. (1996) and Pienitz et al. (1995) indicate that calcium concentrations affect (i.e., cause changes in) diatom assemblages. This illustrates the need for site-specific studies to assess the effects of an increasing concentration of TDS, and more specifically calcium and chloride, to phytoplankton in Snap Lake (cf Section 6.0).

5.2 Zooplankton Community

Data on the toxicity of TDS or its constituent ions to freshwater zooplankton species are tabulated in Table A-2 (Appendix A) and summarized below.

Galat and Robinson (1983) conducted acute toxicity tests with three cladoceran species (*Ceriodaphnia quadrangula*, *Diaphanosoma leuchtenbergianum*, and *Moina hutchinsoni*), one calanoid copepod (*Diaptomus sicilis*)[1], and one cyclopoid copepod (*Cyclops vernalis*) to assess effects of increasing TDS concentrations (reported as salinity by the authors) in Pyramid Lake, NV, USA. The lake water TDS concentration was 5,350 mg/L; its ionic composition was 39% chloride, 32% sodium, 5% sulphate, and less than 1% calcium. Test organisms were isolated from the lake (and therefore adapted to elevated TDS concentrations) and maintained in laboratory cultures prior to testing. Test solutions were prepared by concentrating lake water using reverse osmosis to increase the salinity. Two cladocerans, *D. leuchtenbergianum* and *C. quadrangula*, had 96-h LC50s of 6,500 and 7,100 mg/L TDS, respectively. In contrast, the third cladoceran, *M. hutchinsoni*, exhibited a higher tolerance with a 96-h LC50 of 17,800 mg/L TDS. This result for *M. hutchinsoni* was also higher than the copepod 96-h LC50s of 13,300 mg/L TDS for *D. sicilis* and 14,800 mg/L TDS for *C. vernalis*. The results of this study illustrated that variation in sensitivity to increasing TDS among cladoceran species, and also that copepods (including a dominant species present in Snap Lake) were less sensitive to TDS than two cladoceran species (including the genus *Ceriodaphnia*).

Dowden and Bennett (1965) investigated the acute toxicity of four chloride salts to the water flea, *Daphnia magna*, using 96-h exposures and three different types of dilution water. The type of dilution water used affected the test results. Filtered lake water generally provided the most sensitive results, but characteristics of these dilutions waters such as hardness were not reported. Both 48-h and 96-h lethal concentrations that killed 50% of the test organisms (LC50s) were calculated and are provided in Table A-2. The standard duration for acute *D. magna* tests is 48 h and relative sensitivities were similar for both 48 h and 96 h testing. Potassium chloride was the most toxic salt in filtered lake water, with a 48-h LC50 of 337 mg/L, as compared to a 48-h LC50 of 759 mg/L for calcium chloride. Magnesium chloride and sodium chloride were the least toxic in filtered lake water, with 48-h LC50s of 3,699 and 3,310 mg/L, respectively.

Mount et al. (1997) reported a higher 48-h LC50 of 2,770 mg/L for calcium chloride toxicity to *D. magna* than that reported by Dowden and Bennett (1965). *Ceriodaphnia dubia* was more sensitive than *D. magna* to calcium chloride toxicity, with a 48-h LC50 of 1,834 mg/L; this relationship was generally consistent for all the ion solutions tested with these two species.

Baudouin and Scoppa (1974) conducted acute toxicity tests with calcium chloride, but reported their results in terms of the calcium ion (Ca^{2+}). They reported a 48-h LC50 of 3,000 mg/L Ca^{2+} for the daphnid, *Daphnia hyalina*, and 48-h LC50s of 4,000 mg/L Ca^{2+} for the calanoid copepod, *Eudiaptomus padanus*, and 7,000 mg/L Ca^{2+} for the cyclopoid copepod, *Cyclops abyssorum* (Cyclopoida). These results indicated that cladocerans were more sensitive than copepods to calcium, and that calanoid copepods were more sensitive than cyclopoid copepods.

Similar to the findings of Dowden and Bennett (1965), Mount et al. (1997) reported that potassium chloride was the most toxic of the chloride salts and sodium chloride the least toxic, to both *D. magna* and *C. dubia*. The high LC50s reported by Mount et al. (1997) for sodium chloride were in general agreement with other studies testing sodium chloride toxicity to various zooplankton

1 *Diaptomus sicilis* has since been re-named *Leptodiaptomus sicilis*, and is the dominant calanoid copepod species in Snap Lake.

species (Calleja et al. 1994; Lilius et al. 1995; Schuytema et al. 1997; Harmon et al. 2003). Magnesium chloride was more toxic than calcium chloride to both daphnid (cladoceran) species, in contrast to Dowden and Bennett (1965) who found the reverse. Mount et al. (1997) reported that the relative ion toxicity to freshwater species was generally $K^+ > HCO_3^- \approx Mg^{2+} > Cl^- > SO_4^{2-}$, whereas Ca^{2+} and Na^+ did not appear to cause significant toxicity. Rather, the toxicity of Ca^{2+} and Na^+ was primarily attributable to the corresponding anion. Mount et al. (1997) also observed a reduction in chloride toxicity for *C. dubia* and *D. magna* when test solutions contained more than one cation. Other studies have similarly reported a decrease in toxicity with an increase in hardness (i.e., an increase in Mg^{2+} and Ca^{2+}) for various freshwater zooplankton species as well as other invertebrates and fish (Dwyer et al. 1992; Kennedy et al. 2005; Davies and Hall 2007; Soucek 2007; Lasier and Hardin 2010).

Similar to observations by Mount et al. (1997), Cowgill and Milazzo (1990) reported that *C. dubia* were more sensitive than *D. magna* to TDS constituents. The 48-h LC50s for sodium chloride toxicity to *C. dubia* were similar in both studies with concentrations of 1,956 and 2,019 mg/L, respectively. *Daphnia magna* were less sensitive to sodium chloride, with 48-h LC50s of 4,766 and 6034 mg/L, respectively. Cowgill and Milazzo (1990) reported 48-h LC50s for calcium carbonate of 1,031 mg/L for *C. dubia* and 1,516 mg/L for *D. magna*. Hoke et al. (1992) also observed a higher sensitivity to sodium chloride for *C. dubia* relative to *D. magna*. Based on mean 48-h LC50 values, *C. dubia* were approximately six times more sensitive than *D. magna* to sodium chloride (790 and 5,010 mg/L, respectively), which was attributed to sodium toxicity rather than chloride toxicity. Arambasic et al. (1995) reported a 48-h LC50 of 4,746 mg/L for sodium chloride toxicity to *D. magna*, which was similar to the value reported by Hoke et al. (1992), and which was also attributed to sodium.

Cooney et al. (1992) and DeGraeve et al. (1992) conducted 7-d *C. dubia* survival and reproduction tests with sodium chloride. Cooney et al. (1992) reported that the reproduction endpoint was more sensitive, with lowest observed effect concentrations (LOECs) of 750 to 1,000 mg/L sodium chloride (NaCl) as compared to an LOEC for survival of 2,400 mg/L NaCl. DeGraeve et al. (1992) reported 7-d LC50s of 1,330 and 1,770 mg/L NaCl for survival, and 7-d concentrations causing 50% inhibition to a sublethal endpoint (IC50s) of 960 and 1,340 mg/L NaCl for reproduction. In a similar experiment, Aragao and Pereira (2003) reported a 7-d IC50 of 885 mg/L NaCl for *C. dubia* reproduction.

Lasier and Hardin (2010) evaluated the chronic toxicity (reproduction; 6 to 7 days exposure) of chloride (Cl^-) to *C. dubia* in waters of low and moderate hardness. In low-hardness water (44 mg/L as $CaCO_3$), the IC25 and IC50 for reproduction were 147 and 342 mg/L Cl^-, respectively. In moderate-hardness water (93 mg/L as $CaCO_3$), the IC25 and IC50 for reproduction were 456 and 653 mg/L Cl^-, respectively. The IC50s based on TDS concentrations were 1,139 and 1,569 mg/L for low and moderate hardness water, respectively. Increased water hardness reduced chloride toxicity. The authors also reported a decrease in chloride toxicity with an increase in sodium concentration, as was observed by Goodfellow et al. (2000).

Elphick et al. (2011a) conducted acute and chronic toxicity tests with three zooplankton species: *D. magna*, *C. dubia*, and the rotifer, *Brachionus calyciflorus*. Tests were conducted using sodium chloride, but all results were reported in terms of measured chloride concentrations. The acute LC50s for these three species were each greater than 1,000 mg/L Cl^-. In the chronic toxicity tests,

the 7-d IC25 for reproduction was 454 mg/L Cl^- for *C. dubia* and the 21-d IC25 for reproduction was 421 mg/L Cl^- for *D. magna*. *Ceriodaphnia dubia* was also used to test the effect of hardness on chloride toxicity. At low hardness (10 to 40 mg/L as $CaCO_3$), the 7-d IC25s for reproduction ranged from 117 to 146 mg/L, similar to the 147 mg/L IC25 reported by Lasier and Hardin (2010). In general, the effect of chloride on cladoceran survival and reproduction decreased with increasing water hardness, as also observed by Lasier and Hardin (2010).

In addition to the zooplankton toxicity tests reported by Elphick et al. (2011a), BHP Billiton (2008) had previously reported a 42-d chronic toxicity test conducted using a cladoceran species, *Daphnia middendorfiana*, resident in the vicinity of the EKATI Diamond Mine. This species was tested to determine whether resident cladocerans were more sensitive than *C. dubia* or *D. magna* to chloride. A laboratory culture was isolated from field-collected zooplankton samples. Survival of *D. middendorfiana* was reduced at a chloride concentration of 455 mg/L Cl^-; although control performance was poor in this test, the authors considered it to be consistent with the IC25s for reproduction reported for *C. dubia* and *D. magna*, and thus providing confirmation of the suitability of the latter two surrogate test species.

Great Lakes Environmental Center (GLEC) and Illinois Natural History Survey (INHS; 2008) and Soucek et al. (2011) reported a general decrease in chloride toxicity to *C. dubia* with increasing water hardness. In addition, a general trend of increasing chloride toxicity with an increase in sulfate concentration was observed. However, the sulfate concentrations tested (25 to 800 mg/L) were all above 19 mg/L, the mean sulfate concentration in Snap Lake in 2012 (Table 2).

Soucek (2007) investigated the effect of hardness and chloride concentrations on sodium sulfate (Na_2SO_4) toxicity to *C. dubia*. Tests with *C. dubia* were conducted for 48 h. The study found that hardness had a strong influence on sulfate toxicity. LC50 values increased from less than 1,900 mg/L SO_4^{2-} at a hardness of 100 mg/L as $CaCO_3$ to greater than 4,000 mg/L SO_4^{2-} at a hardness of 500 mg/L. Increasing the chloride concentration from 5 to 25 mg/L did not result in a significant change in sulfate toxicity to *C. dubia*. At the maximum chloride test concentration of 500 mg/L, the 48-h LC50 for sulfate was 1,500 mg/L.

Derry et al. (2003) found that differences in zooplankton communities among chloride- and sulfate-dominated saline lake waters were largely a result of contrasting ion dominance rather than overall salinity. In chloride-dominated hyposaline (3,000 to 20,000 mg/L) and mesosaline (20,000 to 50,000 mg/L) study lakes, the rotifer *Brachionus plicatilis* and the harpactacoid copepod *Cletocamptus* sp. were the dominant species, with the former demonstrating a broad salinity tolerance at intermediate to high concentrations of sodium chloride (840 to 26,318 mg/L TDS). Almost all rotifer and crustacean species were most abundant in the more dilute subsaline lakes, with many rotifer species showing tolerance to low to intermediate concentrations of chloride (133 to 5,672 mg/L Cl^-). Hammer et al. (1975) determined that the rotifer *Keratella quadrata*, which is present in Snap Lake, thrives in saline environments of 2,000 to 3,000 mg/L TDS. Peredo-Alvarez et al. (2003) assessed the effect of sodium chloride on two freshwater rotifers, *Brachionus calyciflorus* and *Brachionus patulus*, and reported 24-h LC50s of 3,750 and 2,140 mg/L NaCl, respectively. Elphick et al. (2011a) reported a 24-h LC50 of 1,645 mg/L for chloride toxicity to *B. calyciflorus*, equivalent to 2,712 mg/L as NaCl, consistent with the LC50s reported by Peredo-Alvarez et al. (2003).

Biesinger and Christensen (1972) investigated the acute toxicity of calcium to *D. magna*, and reported 48-h LC50s of 52 and 464 mg/L Ca^{2+} for tests conducted without and with food, respectively. Acute toxicity tests are normally conducted without food provided because feeding and the organic matter provided by food in the test containers can reduce toxicity. In this case, the addition of food resulted in a nine-fold increase in the 48-h LC50. The authors also conducted a 21-d chronic toxicity test with *D. magna*, for which feeding was necessary to sustain the test organisms. The 21-d LC50 was 330 mg/L Ca^{2+}; IC50 and IC16 values for reproductive impairment were 220 and 116 mg/L Ca^{2+}, respectively. When considered in conjunction with the chronic test results, the 48-h LC50 of 52 mg/L Ca^{2+} appeared to be an outlier, as it was lower than the results from the 21-d chronic test and also lower than other acute test results reported for calcium.

The mean concentration of calcium in Snap Lake in 2012 was 43 mg/L (Table 2), which is an order of magnitude below the effects concentration reported by Goodfellow et al. (2000). Therefore, calcium in the TDS should be having no adverse effect on the zooplankton community. Lower sodium concentrations compared to calcium concentrations can result in increased toxicity (Goodfellow et al. 2000). However, this is not a factor in Snap Lake, as the Ca:Na ratio has remained relatively level at approximately 2:1 since 2007 (Table 2).

Mount et al. (1997) concluded that the toxicity of calcium was largely due to the corresponding anion. In the case of Snap Lake, chloride is the dominant anion. Using water hardnesses of 80 and 160 mg/L as $CaCO_3$ to bracket current Snap Lake conditions (2012 whole-lake average water hardness of 129 mg/L as $CaCO_3$), the most sensitive results for chloride from chronic toxicity tests were 7-d IC25s for *C. dubia* reproduction of 454 and 580 mg/L Cl^-, respectively (Elphick et al. 2011a). The mean concentration of chloride in Snap Lake in 2012 was 95 mg/L (Table 2). Calcium can have an ameliorative effect on chloride toxicity, as increasing hardness has been found to reduce toxicity for a number of species as noted above and as recognized in the EKATI Diamond Mine Water Licence (WLWB 2013c). The toxic effects of calcium chloride were generally only observed at concentrations above 1,800 mg/L, with the exception of the studies by Dowden and Bennett (1965), who reported a 96-h LC50 of 649 mg/L $CaCl_2$. The mean concentrations of calcium and chloride reported for Snap Lake in 2012 (Table 2) were well below that LC50 value.

Golder (2003) predicted a positive effect of initial increases in TDS to cladoceran species such as *D. magna*, with the potential for causing a shift in community structure towards larger-sized zooplankton. Calcium limitation can negatively affect *D. magna* as it is a required element (Alstad et al. 1999; Hessen et al. 2000), and such limitation can in turn affect zooplankton species distributions (Alstad et al. 1999; Waevagen et al. 2002). Hessen et al. (2000) found that calcium concentrations less than 10 mg/L strongly reduced age-specific egg production in *D. magna*, owing to reduced growth rates. The low calcium concentrations of approximately 1 mg/L in Snap Lake during the baseline study were potentially sub-optimal for the growth and egg production of daphnids (Golder 2003); with Mine inputs, calcium concentrations should now be in the optimal range.

Much of the existing literature on the effects of elevated TDS concentrations to the zooplankton community has focused on cladocerans (i.e., daphnids), as they are commonly used in laboratory toxicity tests. Although the zooplankton community in Snap Lake is dominated by copepods and

not by cladocerans, which contribute less than 2% to total biomass (De Beers 2013), *D. magna* and *C. dubia* are more sensitive than copepods to high calcium concentrations (Baudouin and Scoppa 1974). Therefore, data on cladoceran sensitivity to TDS are conservative compared to copepod sensitivity. In other words, higher TDS concentrations are required to affect copepods than to affect cladocerans (i.e., daphnids); thus the latter were used in site-specific toxicity tests (Section 6.0).

5.3 Benthic Invertebrate Community

Data on the toxicity of TDS or its constituent ions to freshwater benthic invertebrate species are tabulated in Table A-3 (Appendix A) and summarized below.

Chapman et al. (2000) conducted short-term chronic toxicity tests (10-d exposure) on larval chironomids (*Chironomus tentans*, now renamed *C. dilutus*) to assess their TDS tolerance to simulated effluents from two Alaskan mines (Coeur Alaska's Kensington Mine and Teck Cominco's Red Dog Mine). The TDS content of the simulated Kensington Mine effluent consisted of 50% sulfate and 20% calcium, whereas the simulated Red Dog Mine effluent was 70% sulfate and 24% calcium. In 2012 Snap Lake TDS was 9% sulfate and 20% calcium. Alkalinity was higher in the Kensington Mine effluent than in the Red Dog Mine effluent, by approximately one order of magnitude (i.e., a factor of 10 higher). There was no effect on survival of chironomids exposed to 2,089 mg/L TDS in the simulated Red Dog effluent, but larval growth (dry weight) was reduced by approximately 45% at that TDS concentration. There was a significant effect on chironomid survival (30% decrease) at 1,750 mg/L TDS in the simulated Kensington effluent, but not at 1,220 mg/L TDS; there were no effects on larval growth at any of the TDS test concentrations.

Moore (1978) found that the distribution of chironomids showed little relation to salinity in an examination of 22 saline lakes in Saskatchewan. In contrast, Leland and Fend (1998) found that the distributions of many benthic invertebrate taxa were indicative of salinity optima in the San Joaquin River in California, which had TDS concentrations ranging from 55 to 1,700 mg/L. TDS optima for chironomid species reported by Leland and Fend (1998) that belong to the same genera found in Snap Lake is presented in Table 4. The optimum TDS concentration for Chironomidae, the benthic invertebrate taxon most prevalent in Snap Lake, ranged up to 1,300 mg/L.

Hynes (1990) assessed the benthic invertebrate community of a lake in northern Saskatchewan receiving treated uranium effluent with elevated TDS. The increase in TDS from baseline conditions was from 76 to 2,700 mg/L TDS, and the major constituents were calcium, sodium, chloride, and sulfate. There were no statistically significant decreases in abundance or species diversity; however, species richness declined, with fewer oligochaetes, leeches, and amphipods, but considerably more chironomids.

Table 4 Dissolved Solids Optima and Tolerance for Chironomidae Species in the San Joaquin River and Major Tributaries

Taxon	Dissolved Solids Optima [mg/L]	Dissolved Solids Tolerance [mg/L]
Tanytarsus sp. 1	160	139 to 181
Polypedilum cf. *halterale*	170	140 to 200
Ablabesmyia mallochi	240	209 to 271
Cladotanytarsus vanderwulpi gr.	280	230 to 330
Paratanytarsus sp.	560	465 to 655
Parachironomus arcuatas gr.	630	547 to 713
Parachironomus frequens gr.	670	600 to 740
Tanytarsus sp. 2	890	865 to 915
Cladotanytarsus mancus gr.	1,300	1,247 to 1,353

Source: Leland and Fend (1998).

mg/L = milligrams per litre.

Crowther and Hynes (1977) tested pulses of sodium chloride to determine the effect of road salt runoff on the drift of benthic invertebrates in urban streams. The three species tested had similar LOECs of approximately 1,000 mg/L (as chloride) as measured in a field experiment. During laboratory experiments, the NOEC of 800 mg/L for the amphipod, *Gammarus pseudolimnaeus*, was lower than the NOEC reported for the trichopterans, *Cheumatopsyche analis* and *Hydropsyche betteni* (1,650 mg/L for both).

Hamilton et al. (1975) reported 48-h LC50s for sodium chloride of 2,569 mg/L for an oligochaete worm (*Nais variabilis*), 6,221 mg/L for chironomid larvae (*Cricotopus trifascia*), and 6,621 mg/L for caddisfly larvae (*Hydroptila angusta*). They also reported that, at concentrations greater than 8,800 mg/L, mortality of the chironomid and caddisfly larvae was 100%. Sutcliffe (1961) reported that larvae of the caddisflies *Limnephilus stigma* and *Anabolia nervosa* began to die at sodium chloride concentrations of approximately 3,500 mg/L.

Two studies investigated sodium chloride toxicity to mayfly larvae. Diamond et al. (1992) reported an NOEC and LOEC of 2,700 and 3,500 mg/L NaCl, respectively, after exposing *Stenonema modestum* larvae for 14 days. Hassell et al. (2006) reported 21-d LC50s of 600 and 1,400 mg/L NaCl for *Centroptilum* sp. and *Cloeon* sp., respectively. Hassell et al. (2006) hypothesized that their low survival was caused in part by the laboratory dilution water and noted that the LC50 for *Centroptilium* sp. increased to approximately 1,800 mg/L NaCl when river water was used instead of laboratory water.

Dowden and Bennett (1965) tested the toxicity of a number of chloride salts to the eggs of a freshwater snail (*Lymnaea* sp.). They found that potassium chloride was the most toxic salt, with a 96-h LC50 of 1,100 mg/L, which was comparable to the 96-h LC50 of 940 mg/L reported by Patrick et al. (1968) for the freshwater snail, *Physa heterostropha*. The toxicities of sodium chloride and calcium chloride were similar, with 96-h LC50s above 2,500 mg/L. Jones (1940) carried out toxicity tests for various chloride salts on the planarian worm *Polycelis nigra*. Similar to the findings of Dowden and Bennett (1965), Jones (1940) reported that the relative toxicity of

chloride salts was KCl >$MgCl_2$ >$CaCl_2$ >NaCl. Khangarot (1991) tested the same three chloride salts on the oligochaete worm, *Tubifex tubifex*: potassium chloride and sodium chloride had similar toxicities, with 96-h EC50s of 813 and 781 mg/L, respectively, whereas calcium chloride was more toxic with a 96-h EC50 of 281 mg/L.

Soucek (2007) assessed the effect of hardness and chloride concentrations on Na_2SO_4 toxicity to the amphipod *Hyalella azteca*, in 96-h acute tests. This study found that hardness had a strong influence on sulfate toxicity. Elphick et al. (2011b) also found that increasing hardness decreased sulfate toxicity. In the Water Licence for the EKATI Diamond Mine, the EQC for sulfate varies dependent on hardness (WLWB 2013c). Soucek (2007) found that LC50 values increased from less than 1,900 mg/L SO_4^{2-} at a hardness of 100 mg/L as $CaCO_3$ to greater than greater than 4,000 mg/L SO_4^{2-} at a hardness of 500 mg/L. Chloride had a strong but variable influence on sulfate toxicity. Increasing the chloride concentration from 5 to 25 mg/L resulted in an increase in the LC50 for sulfate from 512 to greater than 1,500 mg/L. At the maximum chloride test concentration of 500 mg/L, the LC50 for sulfate was approximately 1,500 mg/L.

Elphick et al. (2011a) carried out acute and chronic chloride toxicity tests on two species of oligochaete worm (*Lumbriculus variegatus* and *T. tubifex*), a chironomid (*C. dilutus*, formerly *C. tentans*), and an amphipod (*H. azteca*). The 96-h LC50s for the chironomid and oligochaetes were each greater than 3,000 mg/L Cl^-, whereas *H. azteca* was more sensitive with a 96-h LC50 of 1,382 mg/L Cl^-. *Tubifex tubifex* was the most sensitive in terms of chronic effects, with a 28-d IC25 for reproduction of 606 mg/L Cl^-. *Chironomus dilutus* was the least sensitive of these four benthic invertebrates to both acute and chronic toxicity, with a 20-d IC25 for growth of 2,590 mg/L Cl^-. GLEC and INHS (2008) investigated the toxicity of chloride to three benthic invertebrate species and found that the 96 h LC50s for *T. tubifex* and a snail (*Gyraulus parvus*) were greater than 3,000 mg/L, but that the fingernail clam (*Sphaerium simile*) had a 96-h LC50 of 740 mg/L. The researchers also tested the effect of hardness on chloride toxicity, which generally had an ameliorative effect. For example, the LC50 for the fingernail clam increased from 740 to 1,100 mg/L with an increase of hardness from 50 to 200 mg/L as $CaCO_3$. Palladini (1980) and Birge et al. (1985) have also reported LC50s above 1,000 mg/L for benthic invertebrates.

Sodium chloride was used as a reference toxicant by Bringolf et al. (2007) for toxicity tests with glochidia and juveniles of five species of freshwater mussel. The 48-h EC50s for sodium chloride toxicity to glochidia ranged from 560 mg/L for *Lampsilis siliquoidea* to 3,630 mg/L for *Villosa delumbis*. Juvenile mussels were less sensitive to sodium chloride toxicity with 96-h EC50s ranging from 3,980 to 5,230 mg/L for *Lampsilis fasciola* and *Villosa delumbis*, respectively.

5.4 Fish Community

A wide range of effect concentrations for TDS to fish have been reported in the literature (Appendix A, Table A-4), generally dependent on the major components of TDS and the life stage tested. This literature is summarized below.

Atton (1986) investigated the distributions of selected fish species in saline lakes in Saskatchewan, and reported that Rainbow Trout (*Oncorhynchus mykiss*) reproduction occurred at a salinity of approximately 4,500 mg/L TDS, but that populations did not survive at 20,000 mg/L TDS.

Shuter et al. (1998) observed mostly positive effects on life history characteristics of 54 Ontario Lake Trout (*Salvelinus namaycush*) populations with increases in TDS concentrations from 15 to 180 mg/L. Populations from the higher TDS lakes exhibited higher growth rates in early life, lower age at first maturity, but higher natural mortality rates.

Stekoll et al. (2003) compared the responses of six species of salmonids in 24-h fertilization trials to synthetic effluent from the Red Dog Mine in Alaska. The TDS composition of the synthetic effluent was primarily calcium sulfate. The 24-h NOECs ranged from less than 250 mg/L TDS for Chinook, Pink, and Coho Salmon to 1,250 mg/L TDS for Arctic Char; 24-h LOECs ranged from 250 to 1,875 mg/L TDS.

Chapman et al. (2000) conducted short-term chronic toxicity tests on Rainbow Trout embryos and fry, using synthetic effluents from two Alaskan mines as described for chironomids in Section 5.3. There were no adverse effects on early life stages of Rainbow Trout following 7-d exposures to either synthetic effluent, at TDS concentrations of up to 2,000 mg/L.

The effects of elevated TDS on fertilization success in Arctic Grayling (*Thymallus arcticus*) and Dolly Varden (*Salvelinus malma*) were tested to assess the site-specific water quality standard for TDS in Red Dog Creek, the receiving environment for Red Dog Mine effluent (Brix and Grosell 2005; Brix et al. 2010). The site-specific TDS standard for Red Dog Creek is 1,500 mg/L during periods when salmonids are not spawning and 500 mg/L during spawning season. A synthetic effluent was developed for the TDS in the Mine discharge, which was comprised primarily of calcium sulfate. There were no significant adverse effects on fertilization success: a 72-h EC20 of greater than 2,782 mg/L was determined for Arctic Grayling, and a 24-h EC20 of greater than 1,817 mg/L for Dolly Varden. However, elevated TDS did affect embryo water absorption in 14-h exposures: the LOEC and NOEC were 964 and 585 mg/L, respectively, for Dolly Varden, and the LOEC for Arctic Grayling was 1,402 mg/L. Brix et al. (2010) concluded that the current water quality standard for TDS at Red Dog Mine was adequate for the protection of salmonid reproduction, but recommended that the 500 mg/L TDS standard during salmonid spawning periods not be increased. The results and recommendations from this study were specific to the Red Dog Mine site, where TDS was comprised primarily of $CaSO_4$, and again illustrate the importance of site-specific studies when attempting to set benchmarks for TDS.

The relatively high TDS toxicity values obtained by Chapman et al. (2000), Brix and Grosell (2005), and Brix et al. (2010) were consistent with the results reported by Elphick et al. (2011a) for acute and chronic toxicity tests of chloride with Fathead Minnow and Rainbow Trout. The 96-h LC50s for chloride were 4,079 mg/L for Fathead Minnow and 6,030 mg/L for Rainbow Trout. The 32-d IC25 for Fathead Minnow growth was 704 mg/L, and the 56-d IC25 for Rainbow Trout growth was 1,174 mg/L.

Goodfellow et al. (2000) reported a 96-h acute LC50 for Fathead Minnow (*Pimephales promelas*), a warm-water fish species, of 266 mg/L for the calcium ion (Ca^{2+}), but did not report the calcium salt used. Ketola et al. (1988) reported that exposure to elevated calcium sulfate concentrations (520 mg/L Ca^{2+}) during water hardening resulted in adverse effects on egg survival for three salmonid species: Rainbow Trout, Atlantic Salmon (*Salmo salar*), and Brook Trout (*Salvelinus fontinalis*). Other studies on the acute toxicity of calcium chloride have reported acute LC50s

ranging from 4,000 to greater than 10,000 mg/L for various fish species (Dowden and Bennett 1965; Patrick et al. 1968; Stoss et al. 1977; Grizzle and Mauldin 1995; Waller et al. 1996).

Birge et al. (1985) reported a 33-d LC80 of 1,650 mg/L for Fathead Minnow eggs exposed to sodium chloride, as compared to a 96-h LC50 of 10,830 mg/L for juvenile fish. High tolerance of Fathead Minnow to increased sodium chloride concentrations was also observed by Adelman et al. (1975) who reported a 96-h LC50 of 7,650 mg/L, and a 96-h LC50 of 7,341 mg/L for Goldfish (*Carassius carassius*).

Phillips et al. (1944) assessed the physiological effect of sodium chloride on Brook Trout and reported that exposure to 25,000 mg/L for one hour did not result in distress or an increase in blood salt, but exposure to 50,000 mg/L for 15 minutes resulted in approximately 50% mortality. Vosyliene et al. (2006) reported 96-h LC50s of 18,250 and 20,380 mg/L for the respective toxicities of road salt and common salt to Rainbow Trout. The authors hypothesized that the relatively small difference between the LC50s was due to the presence of additional constituents in road salt, which increased its toxicity. Camargo and Tarazona (1991) exposed juvenile Rainbow Trout and Brook Trout to concentrations of 800 and 1,000 mg/L sodium chloride, respectively, for eight days and reported no significant adverse effects.

Similar to their experiments with zooplankton (Section 5.2), Dowden and Bennett (1965) found that potassium chloride was the most toxic of the chloride salts to fish with a 24-h LC50 of 5,500 mg/L for Bluegill Sunfish (*Lepomis macrocheirus*), a warm-water fish species, and a 24-h LC50 of 8,350 mg/L for calcium chloride. Dowden and Bennett (1965) reported 24-h LC50s for sodium chloride that were greater than 13,700 mg/L for Goldfish and Bluegill Sunfish. Patrick et al. (1968) also used Bluegill Sunfish to test four salts and reported 96-h LC50s ranging from 2,010 mg/L for potassium chloride to 12,946 mg/L for sodium chloride. Pickering et al. (1996) similarly found that potassium chloride was more toxic than sodium chloride to larval Fathead Minnow, reporting 7-d NOECs for both survival and growth of 500 mg/L potassium chloride and 4,000 mg/L sodium chloride.

Mount et al. (1997) examined the acute toxicity of over 2,900 ion solutions using Fathead Minnows in 96-h exposures. Similar to the results obtained for zooplankton, there were a wide range of LC50s depending on the ionic composition. However, Fathead Minnow were generally less sensitive than zooplankton species. Of the chloride salts, potassium chloride alone and in combination with other compounds was the most toxic with an individual 96-h LC50 of 884 mg/L, which was in agreement with the general findings of Dowden and Bennett (1965), Patrick et al. (1968), and Waller et al. (1996). Mount et al. (1997) reported a mean 96-h LC50 for calcium chloride of 4,632 mg/L.

The lethal effects of sodium chloride to Striped Bass (*Morone saxatilis*) were ameliorated by addition of calcium chloride (Grizzle et al. 1990), although this was not found by Goodfellow et al. (2000). The highest mean survival rate (91%) of the various treatments tested was obtained when both salts were added (278 mg/L $CaCl_2$ and 5 g/L NaCl), evidence for a multiple-cation ameliorative effect theorized by Mount et al. (1997). In a similar study, Grizzle and Mauldin (1995) found that addition of calcium chloride resulted in an increase in the 24-h LC50 for sodium chloride toxicity to Striped Bass from 1,400 to 18,200 mg/L, as the calcium concentration increased from 3 to 100 mg/L, and concluded that toxicity was dependent on the Na:Ca ratio.

Research is being conducted at the University of Guelph (Guelph, Ontario [ON]) to compare the relative sensitivities of juveniles of northern fish species with juvenile Rainbow Trout in acute toxicity tests with a number of salts, nutrients, metals, and metalloids (Moore et al. 2010; Moore 2011). Tests were conducted under a range of temperature, pH, and hardness conditions. The study findings have not yet been published, but preliminary results for TDS constituents tested at 15 degrees Celsius (°C) are summarized here. For calcium chloride the 96-h LC50 for Rainbow Trout was 12,000 mg/L, whereas the 96-h LC50s for Lake Whitefish (*Coregonus clupeaformis*), Lake Trout, Arctic Grayling, and Arctic Charr (*Salvelinus arcticus*) ranged from approximately 2,000 to 10,000 mg/L. For sodium chloride the 96-h LC50 for Rainbow Trout was 32,000 mg/L, whereas the 96-h LC50s for Lake Whitefish, Lake Trout, Arctic Grayling, and Arctic Charr ranged from approximately 7,000 to 35,000 mg/L. For sulfate the 96-h LC50 for Rainbow Trout was 9,000 mg/L, whereas the 96-h LC50s for Lake Whitefish, Lake Trout, Arctic Grayling, and Arctic Charr ranged from approximately 7,000 to 31,000 mg/L. For magnesium chloride the 96-h LC50 for Rainbow Trout was 13,000 mg/L, whereas the 96-h LC50s for Lake Trout and Arctic Charr were approximately 5,000 and 9,500 mg/L, respectively. For potassium chloride the 96-h LC50 for Rainbow Trout was 4,000 mg/L, whereas the 96-h LC50s for Lake Whitefish, Lake Trout, Arctic Grayling, and Arctic Charr ranged from approximately 500 to 4,300 mg/L. For each salt, toxicity generally decreased at lower test temperatures of 5°C or 10°C. The northern fish species were generally more sensitive than Rainbow Trout to the chloride salts, but less sensitive to sulfate. These preliminary results indicate that acute adverse effects would only be expected to occur at concentrations well about those predicted for Snap Lake.

5.5 Summary

TDS toxicity depends on its ionic composition, species tested, and the life stage(s) of the species tested:

- Phytoplankton generally have a high tolerance to TDS (greater than 1,000 mg/L).
- For zooplankton, daphnids (cladocerans) are generally the most sensitive to TDS, with *C. dubia* generally more sensitive than *D. magna*. Calcium chloride, which comprises the majority of the Snap Lake TDS, generally exhibited intermediate toxicity to zooplankton when compared to other chloride salts, with effect concentrations generally ranging from 650 to 7,000 mg/L.
- For benthic invertebrates, toxicity of TDS and chloride salts other than calcium chloride was generally observed to occur above 1,000 mg/L.
- In general, fish were less sensitive to TDS than zooplankton, dependent on the life stage tested; fertilization and egg-hardening stages are the life stages most sensitive to TDS toxicity. Calcium chloride was relatively non-toxic to fish, with LC50s ranging from 4,600 mg/L to greater than 15,000 mg/L.

The following conclusions were common to many of the papers reviewed:

- the presence of more than one cation can ameliorate the toxicity of TDS;
- TDS, chloride, and sulfate toxicity are hardness dependent, with increases in hardness generally resulting in a decrease in toxicity; and
- the ratios of particular TDS constituents may be an important factor (e.g., Ca:Na, Ca:Mg, Na:K) affecting TDS toxicity.

6 SITE-SPECIFIC TOXICITY TESTS FOR TOTAL DISSOLVED SOLIDS IN SNAP LAKE

6.1 Background

The literature review (Section 5) clearly indicated that TDS toxicity depends on its ionic composition. The ionic composition of Snap Lake water has remained relatively constant since 2007. Site-specific aquatic toxicity testing was conducted using formulated water samples with the ionic composition of Snap Lake waters. Toxicity testing balanced the need to test species representative of the aquatic community in Snap Lake with the availability of standardized methods that use well-established test species, and a focus on sensitive species (Section 4.2):

- Phytoplankton: Chronic 72-h growth inhibition tests with green algae (*P. subcapitata*) according to Environment Canada (2007a) and 120-h growth inhibition tests with the diatom *Navicula pelliculosa* according to ASTM (2004a).
- Zooplankton: Chronic 3-brood toxicity tests with *C. dubia* according to Environment Canada (2007b) and 21-d toxicity tests with *D. magna* according to ASTM (2004b); the test endpoints for both of these tests are effects of survival and reproduction. Acute 48-h toxicity tests with the rotifer, *B. calyciflorus* according to Snell and Moffat (1992) and WDOE (1998). Acute tests were not performed with *C. dubia* and *D. magna* because the focus of this testing program was on identifying chronic effects.
- Benthic Invertebrates: Chronic 10-d tests with chironomid larvae (*C. dilutus*) according to Environment Canada (1997), to assess effects on survival and growth.
- Fish: Chronic ELS tests with Lake Trout (a fall spawner) and Arctic Grayling (a spring spawner) according to procedures based on Environment Canada (1998) to assess potential effects on embryo, alevin, and fry development of each species.

6.2 Test Methods

The study design for the TDS toxicity testing program consisted of two phases for all tested biota (Section 6.1) other than fish (Phase 1 and Phase 2) in addition to supplemental tolerance testing with *C. dubia*. Phase 1 testing was performed on all test species and was intended to determine thresholds for TDS effects for each test species based on the ionic composition of TDS in Snap Lake. Phase 2 testing was only performed on those non-fish species that demonstrated adverse effects to TDS in Phase 1. Phase 2 testing was intended to determine which of the four major ions that comprise TDS in Snap Lake were responsible for observed adverse effects, by testing those ions in different ratios. The supplemental tolerance testing with *C. dubia* was performed to determine whether tolerance could be acquired through multiple generations of exposure to elevated TDS concentrations and would reduce sensitivity to TDS. All toxicity tests were performed by Nautilus Environmental (Burnaby, British Columbia [BC]); associated chemical analyses to confirm TDS concentrations were performed by ALS Environmental (Burnaby, BC).

The toxicity tests with phytoplankton, zooplankton, and benthic invertebrates were performed in 2011 and 2012. Fish ELS tests with Arctic Grayling were attempted in spring 2012 but initiating the tests was unsuccessful due to problems transporting gametes from the remote collection site to the laboratory; repeat fish collection and testing was therefore initiated in May 2013 and completed in July 2013. Fish ELS tests with Lake Trout were initiated in November 2012 and were completed in April 2013.

6.2.1 Phase 1 Toxicity Tests

Phase 1 toxicity testing was performed with all test species. A synthetic lake water sample was prepared in the laboratory, with the same ratio of major ions in Snap Lake but at a nominal TDS concentration of 1,500 mg/L, which was several times higher than the current maximum average concentration in Snap Lake and intended to greatly exceed worst-case predictions for future maximum TDS concentrations in Snap Lake.

The synthetic lake water was prepared by dissolving reagent-grade sodium, potassium, calcium, and magnesium salts (i.e., NaCl, KCl, $MgCl_2 \cdot 6H_2O$, $MgSO_4$ $CaCl_2$, $CaSO_4 \cdot 2H_2O$, and $NaHCO_3$) in reverse osmosis-(RO) treated water; concentrations of salts added to prepare the water are summarized in Table 5. Five batches of synthetic lake water were prepared for use in the Phase 1 tests, with one being used for tests with *C. dilutus*, one for tests with *P. subcapitata, C. dubia, D. magna,* and *B. calyciflorus*, one for tests with *N. peliculosa*, and one each for the Lake Trout and Arctic Grayling tests. Each batch of synthetic lake water was analyzed for its ionic composition to assess concentrations of the major ions and to calculate TDS concentrations. Results of those analyses confirmed that the calculated TDS concentrations for the synthetic lake water batches ranged from 1,379 to 1,490 mg/L, which was within 10% of the target nominal concentration of 1,500 mg/L.

Table 5 Concentrations of Salts Used to Prepare Synthetic Total Dissolved Solids Mixtures for Phase 1 and 2 Toxicity Testing

Constituent Salt	Quantity of Salt Added [mg/L] to Prepare 1,500 mg/L TDS Solution for Phase 1 Testing	Quantity of Salt Added [mg/L] to Prepare 450 mg/L TDS Solution for Phase 2 Testing
NaCl	291.8	87.5
KCl	26.3	7.9
$MgCl_2 \cdot 6H_2O$	16.5	5.0
$MgSO_4$	161.3	48.4
$CaCl_2 \cdot 2H_2O$	1,105.9	331.8
$NaHCO_3$	185.3	55.6
Total (excluding hydration water)	**1,516.2**	**454.9**

TDS = total dissolved solids; NaCl = sodium chloride; KCl = potassium chloride; $MgCl_2 \cdot 6H_2O$ = magnesium chloride hexahydrate; $MgSO_4$ = magnesium sulfate; $CaCl_2 \cdot 2H_2O$ = calciuchloride dehydrate; $NaHCO_3$ = sodium carbonate; mg/L = milligrams per litre.

Dilutions of the synthetic lake water were prepared using a 0.67 times dilution factor to achieve a nominal TDS concentration series of: 1,500; 1,000; 667; 444; 296; 198; and, 132 mg/L, plus a negative (clean) control for the plankton and benthic invertebrate tests. The fish ELS tests were

performed using only the five highest TDS concentrations from this dilution series. The TDS concentrations in each test solution were measured gravimetrically; those data are provided in the laboratory report appendices for information purposes but were not used in statistical analyses of the data. The test solutions were analyzed for ionic composition to verify the concentrations of the major ions at test initiation, which were then used to calculate TDS concentrations of each test solution for use in estimating test endpoints[2] Due to the length of the fish ELS tests, test solutions were also analyzed at interim points during the test and at test termination.

Phase 1 toxicity tests were conducted with the eight phytoplankton, zooplankton, benthic invertebrate, and fish test species selected for this study; the exposure systems and testing conditions for each method are summarized in Tables 6 to 12. Two fish ELS tests were conducted for each fish species, one using dry fertilization and one using wet fertilization[3]. Dry fertilization involved fertilizing the eggs under dry conditions and then adding them to the test solutions, where water hardening took place, and was the procedure specified in Environment Canada (1998). The wet fertilization technique involved placing eggs and milt on opposite sides of a container, then adding test solution, mixing, and allowing fertilization to occur during exposure to the TDS solutions. Additional testing details for all species are provided in the laboratory reports (Appendices B to D).

Statistical analyses using either non-linear regression or linear interpolation were performed to calculate point estimates for each test endpoint. For tests with a survival endpoint (i.e., zooplankton, benthic invertebrate, and fish tests), the LC10, LC20, and LC50 point estimates were calculated as estimates of the TDS concentration that was expected to be lethal to 10%, 20%, and 50% of test organisms, respectively. For the growth or reproduction endpoints, the IC10, IC20, and IC50 point estimates were calculated as estimates of the TDS concentrations that were expected to cause 10%, 20%, or 50% inhibition, respectively, relative to the laboratory control.

2 During the first set of Phase 1 tests (performed with *C. dilutus*), there was a misunderstanding by the testing laboratory regarding the type of TDS chemistry analyses that were required, and consequently a miscommunication with the analytical laboratory. The calculated TDS concentration and ionic composition were determined for the synthetic lake water used for this set of tests; the calculated TDS concentration was 1,379 mg/L. TDS concentrations in the test solutions from this set of tests were only measured gravimetrically whereas calculated TDS concentrations should also have been determined. Therefore, the test endpoints presented in the laboratory report were higher (i.e., endpoints greater than 2,115 mg/L) than if calculated TDS concentrations were used. Because no adverse effects were observed at the highest concentration tested, the calculated TDS concentration for the synthetic lake water was used to replace the gravimetric TDS concentrations. This omission was corrected for all subsequent testing.

3 Lake Trout ELS tests were initiated on November 16, 2012 using gametes that were collected in the field and shipped to the laboratory. Due to concerns about gamete quality at test initiation, a second collection of adult fish was performed on November 19, 2012; initiation of a second pair of tests by dry and wet fertilization was performed in the field and then fertilized eggs in test solutions were returned to the laboratory to continue the test exposure. As the tests progressed, it was determined that the November 15 wet fertilization and November 19 dry fertilization tests had failed to achieve adequate fertilization and these tests were terminated. The November 15 dry fertilization and November 19 wet fertilization tests with Lake Trout were continued to completion, but these tests used gametes from different batches of fish and therefore the results are not directly comparable. The Arctic Grayling tests using dry and wet fertilization were initiated with gametes from the same batch of adult fish.

Table 6 Test Conditions for the 72-hour *Pseudokirchneriella subcapitata* Growth Inhibition Test

Test Condition	Description
Test organism	Green alga (*Pseudokirchneriella subcapitata*)
Test organism source	In-house culture
Test organism age	3 to 7-d old culture in logarithmic growth phase
Test type	Static
Test duration	72 h
Test chamber	96-well microplate
Test solution volume	220 µL
Test concentrations	7 concentrations, plus laboratory control
Number of replicates	4 for treatments, 8 for control
Control/Dilution water	RO water supplemented with nutrients
Test solution renewal	None
Test temperature	24 ± 2°C
Number of organisms/chamber	10,000 cells/mL
Light intensity	3600 to 4600 lux
Photoperiod	Continuous light
Aeration	None
Test protocol	Environment Canada (2007a)
Test endpoint	Algal cell growth inhibition
Test acceptability criteria for controls	~16-fold increase in number of algal cells; control must not exhibit a positive or negative trend with Mann-Kendall test; and the coefficient of variation of the control replicates must not exceed 20%.
Reference toxicant	Zinc

RO = reverse osmosis; h= hour; °C = degrees Celsius; µL = microlitre; d = days; cells/mL = cells per millilitre;% = percent; ~ = approximately; ± = plus or minus.

Table 7 Test Conditions for the 120-hour *Navicula pelliculosa* Growth Inhibition Test

Test Condition	Description
Test organism	Diatom alga (*Navicula pelliculosa*)
Test organism source	In-house culture of strain #UTEXB674
Test organism age	Culture in logarithmic growth phase
Test type	Static
Test duration	120 h
Test chamber	250-mL Erlenmeyer flask
Test solution volume	100 mL
Test concentrations	7 concentrations, plus laboratory control
Number of replicates	3 for treatments, 6 for control
Control water	ASTM Type 1 water nutrient addition
Test solution renewal	None
Test temperature	24 ± 2°C
Number of organisms/chamber	10,000 cells/mL
Light intensity	3,600 to 4,600 lux
Photoperiod	16 h light/8 h dark
Aeration	None
Test protocol	ASTM (2004a)
Test endpoint	Algal cell growth inhibition
Test acceptability criteria for controls	16-fold increase in cell numbers
Reference toxicant	Not tested (no previous data for comparison)

ASTM = American Society for Testing and Materials; h = hours; °C = degrees Celsius; mL = millilitre; cells/mL = cells per millilitre; ± = plus or minus.

Table 8 Test Conditions for the 48-hour *Brachionus calyciflorus* Reproduction Test

Test Condition	Description
Test organism	Rotifer (*Brachionus calyciflorus*)
Test organism source	Brine Shrimp Direct
Test organism age	<2 h-post hatch
Test type	Static
Test duration	48 h
Test chamber	Microplate
Test solution volume	0.5 mL
Test concentrations	7 concentrations, plus laboratory control
Number of replicates	8
Control water	Moderately-hard reconstituted water (hardness 80 to100 mg/L)
Test solution renewal	None
Test temperature	25 ± 1°C
Number of organisms/chamber	1
Feeding	*P. subcapitata* at test initiation
Light intensity	None
Photoperiod	0 h light/24 h dark
Aeration	None
Test protocol	Snell and Moffat (1992); WDOE (2008)
Test endpoint	Growth Rate (intrinsic rate of population increase [r])
Test acceptability criteria for controls	r ≥ 0.7
Reference toxicant	Not tested (no previous data for comparison)

WDOE = Washington Department of Ecology; h = hours; °C = degrees Celsius; mL = millilitre; mg/L = milligrams per litre; <= less than; ≥ = greater than or equal to; ± = plus or minus.

Table 9 Test Conditions for the 3-brood *Ceriodaphnia dubia* Survival and Reproduction Test

Test Condition	Description
Test organism	Water flea (*Ceriodaphnia dubia*)
Test organism source	In-house culture
Test organism age	<24-h old neonates produced within 12 h of each other
Test type	Static-renewal
Test duration	7 ± 1 d
Test chamber	20-mL test tube
Test solution volume	15 mL
Test concentrations	Phase 1: 7 concentrations, plus laboratory control Phase 2: 5 concentrations, plus laboratory control
Number of replicates	10
Control water	20% Perrier water (hardness 80-100 mg/L $CaCO_3$)
Test solution renewal	Daily
Test temperature	25 ± 1°C
Number of organisms/chamber	1
Feeding	Daily, with *P. subcapitata* and YCT
Light intensity	100 to 600 lux
Photoperiod	16 h light/8 h dark
Aeration	None
Test protocol	Environment Canada (2007b)
Test endpoints	Survival and reproduction
Test acceptability criterion for controls	≥80% survival; ≥15 young per surviving control female; ≥60% of controls producing three or more broods
Reference toxicant	Sodium chloride (NaCl)

$CaCO_3$ = calcium carbonate; YCT = yeast, cerophyl, and trout chow; h = hours; d = days; °C = degrees Celsius; % = percent; mL = millilitre; mg/L = milligrams per litre; <= less than; ≥ = greater than or equal to; ± = plus or minus.

Table 10 Test Conditions for the 21-day *Daphnia magna* Survival and Reproduction Test

Test Condition	Description
Test organism	Water flea (*Daphnia magna*)
Test organism source	In-house culture
Test organism age	<24 h
Test type	Static-renewal
Test duration	21 d
Test chamber	250-mL glass beakers
Test solution volume	100 mL
Test concentrations	Phase 1: 7 concentrations, plus laboratory control Phase 2: 5 concentrations, plus laboratory control
Number of replicates	10
Control water	Moderately-hard reconstituted water (hardness 80-100 mg/L as $CaCO_3$)
Test solution renewal	Three times per week
Test temperature	20 ± 2°C
Number of organisms/chamber	1
Feeding	Daily with *P. subcapitata* and YCT
Light intensity	400 to 800 lux
Photoperiod	16 h light/8 h dark
Aeration	None
Test protocol	ASTM (2004b)
Test endpoint	Survival and reproduction
Test acceptability criteria for controls	Survival ~70%; ≥60 young per surviving control female
Reference toxicant	NaCl

$CaCO_3$ = calcium carbonate; NaCl = sodium chloride; ASTM = American Society for Testing and Materials; YCT = yeast, cerophyl, and trout chow; h = hours; d = days; °C = degrees Celsius; % = percent; mL = millilitre; <= less than; ≥ = greater than or equal to; ~ = around; ± = plus or minus; mg/L = milligrams per litre.

Table 11 Test Conditions for the 10-day *Chironomus dilutus* Survival and Growth Test

Test Condition	Description
Test organism	Chironomid (*Chironomus dilutus*)
Test organism source	Aquatic BioSystems, Fort Collins, CO, USA
Test organism age	Third instar
Test type	Static-renewal
Test duration	10 d
Test vessel	375-mL glass jars
Test treatment	100 mL sediment, 175 mL overlying water
Test concentrations	7 concentrations, plus a negative control
Test replicates	4 replicates per concentration
No. of organisms	10 per replicate
Control/dilution water	Moderately hard synthetic water/dechlorinated city water
Test solution renewal	3 times per week
Test temperature	23 ± 1°C
Feeding	6.0 mg Tetramin™ fish flakes in 1.5 mL suspension per replicate daily
Light intensity	500 to 1000 lux at water surface
Photoperiod	16 h light/8 h dark
Aeration	Gentle aeration throughout test
Test protocol	Modified from Environment Canada (1997)
Test endpoint	Survival and dry weight
Test acceptability criteria for controls	Mean control survival of 70%; 0.6 mg/worm dry weight
Reference toxicant	Potassium chloride (KCl)

KCl = potassium chloride; h = hours; d = days; °C = degrees Celsius; % = percent; mL = millilitre; mg = milligram; mg/worm = milligram per worm; ± = plus or minus.

Table 12 Test Conditions for the Lake Trout and Arctic Grayling Embryo-Alevin-Fry Survival and Growth Tests

Test Condition	Description
Test organisms	Lake Trout (*Salvelinus namaycush*) Arctic Grayling (*Thymallus arcticus*)
Test organism sources	Wild collected Lake Trout (Shuswap Lake) and Arctic Grayling (Sukunka River tributary)
Test organism age	Eggs and milt; initiated using both wet and dry fertilization
Test type	Static-renewal
Test duration	Fertilization to 30 days post-swim-up
Test vessel	4-L plastic containers
Test volume	2 L
Test concentrations	5 concentrations, plus a negative control
Test replicates	4 replicates per concentration for Lake Trout; 3 replicates per concentration for Arctic Grayling
No. of organisms	30 per replicate
Control/dilution water	Dechlorinated city water
Test solution renewal	3 times per week, except daily during the 30-d feeding period
Test temperature	7 ± 1°C
Feeding	*Artemia* fed daily for 30 days following swim-up
Photoperiod	24 hours dark until hatch; 16:8 h light: dark thereafter
Aeration	Gentle aeration throughout test
Test protocol	Environment Canada (1998)
Test endpoint	Survival, length, and dry weight of fry
Test acceptability criteria for controls	Mean control survival of at least 65%
Reference toxicant	Sodium dodecyl sulfate (SDS)

h = hours; d = days; °C = degrees Celsius; % = percent; L = Litre; mL = millilitre; ± = plus or minus.

6.2.2 Phase 2 Toxicity Tests

Phase 2 testing was only conducted with those species that demonstrated adverse effects to TDS exposure during Phase 1 testing (defined as IC20 or IC50 values for lower than the highest test concentration), specifically the daphnids, *C. dubia* and *D. magna*. The objective of the Phase 2 testing was to determine whether changes to the ionic composition of the synthetic lake water would affect TDS toxicity, by varying the concentrations of the major individual ionic constituents (chloride, calcium, sodium, and sulfate). The nominal baseline TDS concentration used for Phase 2 was 450 mg/L, which was approximately half the Phase 1 IC25 for these species and considered unlikely to cause toxicity. This baseline TDS solution was prepared by adding individual salts to RO water (Table 1) in the same manner as for Phase 1, maintaining the same ratios of major anions and cations but at a lower overall TDS concentration than the synthetic lake water used in Phase 1 (i.e., 450 mg/L vs 1,500 mg/L).

In addition to the 450 mg/L baseline TDS concentration, a range of four additional nominal test concentrations (607, 817, 1,132, and 1,500 mg/L TDS) was then prepared using this 450 mg/L TDS solution separately for each of the following four salts: NaCl, Na_2SO_4, $CaCl_2$, and $CaSO_4$.

For example, for the NaCl treatments, 1,050 mg/L NaCl was added to the baseline 450 mg/L TDS solution to prepare the highest nominal TDS concentration of 1,500 mg/L and then the dilution series was prepared by diluting the highest concentration with appropriate amounts of the 450 mg/L baseline TDS solution. This process was repeated for the other three salts. Thus, the final concentration series was 450, 607, 817, 1,132, and 1,500 mg/L TDS for each of the four salts. A single batch of each salt-spiked TDS solution was prepared for use throughout the exposure period. Test solutions were analyzed for ionic composition to confirm concentrations of major ions for calculation of TDS concentrations, as well as gravimetric measurement of TDS. For *C. dubia*, measured concentrations were the mean of values measured at test initiation and termination (measurements at test termination were not required but were mistakenly taken by the laboratory), and for *D. magna* concentrations measured at test initiation.

Tests using the four salts were set up simultaneously in a single test design so that the results from the four salts could be directly compared and so that uncertainty associated with batch-to-batch variability in test organism sensitivity would be minimized. The tests using the four salts shared the same laboratory control and baseline 450 mg/L TDS treatment, and were initiated simultaneously using a single batch of test organisms for each species. This approach reflected a planned deviation from typical practice, which would use separate controls for each test, but was considered appropriate to minimize variability associated with the study.

Testing was conducted under the same test conditions summarized in Tables 9 and 10, except that there were five TDS test concentrations instead of seven for Phase 2 testing. Additional testing details are provided in the laboratory report (Appendix B).

6.2.3 *Ceriodaphnia dubia* Tolerance Testing

Additional chronic toxicity tests were performed with *C. dubia* to determine whether tolerance to elevated TDS concentrations would be acquired and would result in decreased sensitivity to the ionic composition of TDS in Snap Lake. For example, the Environment Canada (2007b) test protocol for this species recommends acclimation of test organisms for at least two generations to the hardness conditions used for testing. Lasier and Hardin (2010) reported that *C. dubia* are known to acclimate to differing ionic strengths under certain conditions, and Soucek and Kennedy (2005) reported that acclimation of *C. dubia* reduced sulfate toxicity.

The *C. dubia* tolerance tests were conducted using synthetic lake water that was prepared in the same manner used for Phase 1 testing (Table 5) and having a nominal TDS concentration of 1,500 mg/L. A series of five nominal TDS concentrations was tested (1,500, 1,000, 667, 444, and 296 mg/L) plus a negative (clean) control. The tolerance testing was conducted as a series of four consecutive 3-brood survival and reproduction tests, each having a duration of approximately one week and encompassing four generations. At the end of each test, young produced in each TDS test concentration were used to initiate the corresponding treatment in the next test (i.e., young produced in the 1,500 mg/L treatment on the last day of the first test were used to initiate the 1,500 mg/L treatment in the second test, and so on). Point estimates were calculated for each of the four sequential tests, to determine whether there were changes in sensitivity to TDS over time.

6.3 Results

6.3.1 Phase 1 Toxicity Tests

Results of the Phase 1 toxicity tests performed on eight phytoplankton, zooplankton, and benthic invertebrate species are summarized in Tables 13 to 22. All point estimates are presented as calculated TDS concentrations. Additional details, including bench sheets and statistical calculations, are provided in the laboratory reports (Appendices B to D). Control performance met test acceptability criteria for all test methods, and test results were corrected for mean control responses. Results for reference toxicant tests were also within acceptable limits, based on comparison to historical laboratory performance.

Table 13 Phase 1 Results for the 72-hour *Pseudokirchneriella subcapitata* Growth Inhibition Test

TDS Concentration [mg/L]		Cell Yield [x 10^4 cells/mL] (Mean ± SD)
Nominal	Calculated (Sum of Ions)	
Control	NA	75.5 ± 5.3
132	131	214.3 ± 8.1
198	196	197.8 ± 11.3
296	287	186.5 ± 22.5
444	428	193.3 ± 8.8
667	650	167.3 ± 14.8
1,000	974	181.5 ± 11.5
1,500	1,474	159.3 ± 17.5
Test Endpoint [mg/L TDS]		
IC10 (95% CL)		>1,474 (NC)
IC20 (95% CL)		>1,474 NC)
IC50 (95% CL)		>1,474 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; NC = Not Calculated; SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; cells/mL = cells per millilitre; % = percent; >= greater than; ± = plus or minus; NA = not applicable.

Table 14 Phase 1 Results for the 120-hour *Navicula pelliculosa* Growth Inhibition Test

TDS Concentration [mg/L]		Cell Yield [x 104 cells/mL] (Mean ± SD)
Nominal	Calculated (Sum of Ions)	
Control	NA	19.0 ± 2.4
132	196	28.7 ± 4.2
198	248	38.0 ± 12.5
296	453	35.3 ± 6.7
444	455	29.0 ± 5.6
667	629	34.3 ± 3.5
1,000	968	24.7 ± 4.2
1,500	1,487	23.0 ± 7.9
Test Endpoint [mg/L TDS]		
IC10 (95% CL)		>1,487 (NC)
IC20 (95% CL)		>1,487 (NC)
IC50 (95% CL)		>1,487 (NC)

CL = Confidence Limit: IC = Inhibition Concentration; NC = Not Calculated; SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; cells/mL = cells per millilitre; % = percent; >= greater than; ± = plus or minus; NA = not applicable.

Table 15 Phase 1 Results for the 48-hour *Brachionus calyciflorus* Reproduction Test

TDS Concentration [mg/L]		Intrinsic Rate of Reproduction (r)
Nominal	Calculated (Sum of Ions)	
Control	NA	0.82 ± 0.14
132	131	0.67 ± 0.16
198	196	0.72 ± 0.10
296	287	0.44 ± 0.31
444	428	0.67 ± 0.18
667	650	0.56 ± 0.19
1,000	974	0.52 ± 0.25
1,500	1,474	0.66 ± 0.14
Test Endpoint [mg/L TDS]		
IC10 (95% CL)		241 (185 - >1,474)
IC20 (95% CL)		>1,474 (NC)
IC50 (95% CL)		>1,474 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; NC = Not Calculated: SD = Standard Deviation; mg/L = milligrams per litre; TDS = Total Dissolved Solids; % = percent; >= greater than; ± = plus or minus; NA = not applicable.

Table 16 Phase 1 Results for the 3-brood *Ceriodaphnia dubia* Survival and Reproduction Test

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	100	18.3 ± 8.9
132	131	90	15.1 ± 5.2
198	196	100	16.5 ± 3.3
296	287	100	19.5 ± 6.5
444	428	100	13.9 ± 5.6
667	650	100	15.5 ± 2.5
1,000	974	100	11.9 ± 6.3
1,500	1,474	100	7.7 ± 3.9
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		>1,474 (NC)	NA
LC20 (95% CL)		>1,474 (NC)	NA
LC50 (95% CL)		>1,474 (NC)	NA
IC10 (95% CL)		NA	560 (<131 – 827)
IC20 (95% CL)		NA	778 (420 – 1,060)
IC50 (95% CL)		NA	1,368 (1,016 – 1,842)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; % = percent; >= greater than; <= less than; ± = plus or minus.

Table 17 Phase 1 Results for the 21-day *Daphnia magna* Survival and Reproduction Test

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	100	110.4 ± 27.8
132	131	100	122.4 ± 20.5
198	196	90	99.4 ± 30.7
296	287	90	110.2 ± 12.2
444	428	70	94.1 ± 34.0
667	650	60	94.5 ± 10.4
1,000	974	90	78.7 ± 9.1
1,500	1,474	80	76.1 ± 42.5
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		183 (19 – 339)	NA
LC20 (95% CL)		663 (377 – 1,771)	NA
LC50 (95% CL)		>1,474 (NC)	NA
IC10 (95% CL)		NA	312 (90 – 560)
IC20 (95% CL)		NA	684 (415 – 984)
IC50 (95% CL)		NA	>1,474 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre;% = percent; >= greater than; ± = plus or minus.

Table 18 Phase 1 Results for the 10-day *Chironomus dilutus* Survival and Reproduction Test

TDS Concentration [mg/L]		Survival (%) (Mean ± SD)	Average Dry Weight (mg/ind) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	80.0 ± 8.2	2.34 ± 0.39
132	125	85.0 ± 17.3	2.30 ± 0.47
198	186	87.5 ± 9.6	2.17 ± 0.25
296	278	82.5 ± 5.0	2.36 ± 0.17
444	415	80.0 ± 14.1	2.28 ± 0.18
667	619	82.5 ± 12.6	2.24 ± 0.37
1,000	924	82.5 ± 9.6	2.03 ± 0.29
1,500	1,379	80.0 ± 8.2	2.31 ± 0.38
Test Endpoint (mg/L TDS)			
LC10 (95% CL)		>1,379 (NC)	NA
LC20 (95% CL)		>1,379 (NC)	NA
LC50 (95% CL)		>1,379 (NC)	NA
IC10 (95% CL)		NA	>1,379 (NC)
IC20 (95% CL)		NA	>1,379 (NC)
IC50 (95% CL)		NA	>1,379 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; mg/ind = milligrams per individual; % = percent; >= greater than; ± = plus or minus.

Table 19 Phase 1 Results for the Lake Trout Embryo-Alevin-Fry Test – Dry Fertilization

TDS Concentration [mg/L]		Survival (%) (Mean ± SD)	Dry Weight [mg/ind] (Mean ± SD)	Total Length [mm] (Mean ± SD)
Nominal	Calculated (sum of ions)			
Control	21	80.8 ± 12.6	35.9 ± 1.9	33.8 ± 0.8
296	314	75.0 ± 20.8	36.1 ± 2.7	33.6 ± 0.6
444	452	68.3 ± 27.6	39.1 ± 6.2	34.2 ± 0.3
667	674	76.7 ± 15.6	36.4 ± 1.8	34.1 ± 0.3
1,000	995	64.2 ± 17.9	39.1 ± 1.9	33.9 ± 0.5
1,500	1,490	65.0 ± 37.2	39.8 ± 5.3	33.6 ± 0.3
Test Endpoints [mg/L TDS]				
LC50 (95% CL)		>1,490	NA	NA
LC20 (95% CL)		991 (NC)	NA	NA
IC50 (95% CL)		NA	>1,490 (NC)	>1,490 (NC)
IC20 (95% CL)		NA	>1,490 (NC)	>1,490 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; mg/ind = milligrams per individual; % = percent; >= greater than; ± = plus or minus; mm = millimetre.

Table 20 Phase 1 Results for the Lake Trout Embryo-Alevin-Fry Test – Wet Fertilization

TDS Concentration [mg/L]		Survival (%) (Mean ± SD)	Dry Weight [mg/ind] (Mean ± SD)	Total Length [mm] (Mean ± SD)
Nominal	Calculated (sum of ions)			
Control	22	89.2 ± 5.0	33.3 ± 1.2	32.4 ± 0.5
296	312	87.5 ± 8.3	32.6 ± 1.8	32.4 ± 0.3
444	451	86.7 ± 8.2	34.5 ± 3.4	32.5 ± 0.7
667[(a)]	671	73.3 ± 0.0	36.4 ± 3.2	32.9 ± 0.7
1,000[(a)]	994	83.3 ± 9.4	33.6 ± 5.4	32.7 ± 1.2
1,500	1,484	80.0 ± 23.7	35.3 ± 4.5	32.7 ± 0.8
Test Endpoints [mg/L TDS]				
LC50 (95% CL)		>1,484 (NC)	NA	NA
LC20 (95% CL)		>1,484 (NC)	NA	NA
IC50 (95% CL)		NA	>1,484 (NC)	>1,484 (NC)
IC20 (95% CL)		NA	>1,484 (NC)	>1,484 (NC)

[(a)] One replicate of the 671 mg/L treatment and two replicates of the 994 mg/L treatment were excluded as a result of mortalities associated with over-feeding of the fry during a 3-d period of the exposure.

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; mg/ind = milligrams per individual; % = percent; >= greater than; ± = plus or minus; mm = millimetre.

Table 21 Phase 1 Results for the Arctic Grayling Embryo-Alevin-Fry Test – Dry Fertilization

TDS Concentration [mg/L]		Survival (%) (Mean ± SD)	Dry Weight [mg/ind] Mean ± SD	Total Length [mm] Mean ± SD
Nominal	Calculated (sum of ions)			
Control	22	82.2 ± 3.8	7.2 ± 0.5	21.0 ± 0.3
296	325	91.1 ± 6.9	7.2 ± 1.0	21.0 ± 0.4
444	454	84.4 ± 6.9	7.5 ± 0.3	21.4 ± 0.2
667	646	93.3 ± 5.8	7.1 ± 0.6	21.0 ± 0.5
1,000	957	75.0 ± 23.7	8.1 ± 0.9	21.5 ± 0.1
1,500	1,419	88.9 ± 11.7	7.3 ± 1.4	21.0 ± 0.1
Test Endpoints [mg/L TDS]				
LC50 (95% CL)		>1,419 (NC)	NA	NA
LC20 (95% CL)		>1,419 (NC)	NA	NA
IC50 (95% CL)		NA	>1,419 (NC)	>1,419 (NC)
IC20 (95% CL)		NA	>1,419 (NC)	>1,419 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; mg/ind = milligrams per individual; % = percent; >= greater than; ± = plus or minus; mm = millimetre.

Table 22 Phase 1 Results for the Arctic Grayling Embryo-Alevin-Fry Test – Dry Fertilization

TDS Concentration [mg/L]		Survival (%) (Mean ± SD)	Dry Weight [mg/ind] Mean ± SD	Total Length [mm] Mean ± SD
Nominal	Calculated (sum of ions)			
Control	23	77.0 ± 11.3	7.3 ± 0.5	21.4 ± 0.5
296	326	68.7 ± 18.4	7.9 ± 0.6	21.3 ± 0.4
444	453	78.1 ± 16.2	7.4 ± 0.8	21.0 ± 0.6
667	650	76.8 ± 9.1	7.6 ± 0.7	21.3 ± 0.3
1,000	954	83.7 ± 4.3	7.6 ± 0.5	21.4 ± 0.1
1,500	1,414	73.0 ± 9.3	7.8 ± 0.6	21.1 ± 0.4
Test Endpoints [mg/L TDS]				
LC50 (95% CL)		>1,414 NC)	NA	NA
LC20 (95% CL)		>1,414 (NC)	NA	NA
IC50 (95% CL)		NA	>1,414 (NC)	>1,414 (NC)
IC20 (95% CL)		NA	>1,414 (NC)	>1,414 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = Total Dissolved Solids; mg/L = milligrams per litre; mg/ind = milligrams per individual; % = percent; >= greater than; ± = plus or minus; mm = millimetre.

There were no adverse effects, defined as inhibition of algal growth, for either of the phytoplankton species that were tested at the highest measured TDS concentration tested (1,474 mg/L). Cell growth of the green alga (*P. subcapitata*) was stimulated at all TDS concentrations relative to the control, although the degree of stimulation was less at the higher TDS concentrations than at lower concentrations (Table 13). Cell growth of the diatom (*N. pelliculosa*) was also stimulated at all TDS concentrations relative to the control; as with *P. subcapitata*, the amount of growth stimulation decreased at higher TDS concentrations (Table 14). There were no adverse effects to *N. pelliculosa* at the highest TDS concentration tested (1,487 mg/L).

Results for the rotifer (*B. calyciflorus*) reproduction test are summarized in Table 15. All of the TDS treatments showed a lower intrinsic rate of reproduction (r) than the control response, but there was also a lack of concentration-response across the range of TDS concentrations that were tested. Nautilus (2012) considered this to be a test artifact, rather than reflecting an adverse response to TDS. The laboratory control water used for this test had a higher TDS concentration (around 200 mg/L, with differing ionic composition to the synthetic lake water) than the lowest TDS test concentration of 131 mg/L, so TDS could not explain the lower reproductive rate in the 131 mg/L TDS solution relative to the control. To account for this apparent artifact, the control treatment was excluded and replaced with the 131 mg/L TDS treatment for calculation of point estimates. For rotifer reproduction, the IC10 was 241 mg/L, and the IC20 and IC50 were both greater than 1,474 mg/L. The IC10 was not considered a reliable or technically defensible endpoint because it was driven in part by the 287 mg/L treatment having higher replicate variability and a lower mean response (r = 0.44) than in higher TDS treatments (r = 0.67 at 428 mg/L and r = 0.66 at 1,474 mg/L). There was no difference in mean responses between the lowest and highest TDS treatments (r = 0.67 and 0.66, respectively). Therefore, the IC20 of greater than 1,474 mg/L was the lowest reliable, technically defensible endpoint for this test.

Results for the water flea (*C. dubia*) survival and reproduction test are summarized in Table 16. There were no adverse effects on survival, with 90 or 100% survival in all treatments, and the LC10, LC20, and LC50 for survival were greater than 1,474 mg/L. Mean reproduction decreased with increasing TDS concentration, and was approximately 60% lower in the highest TDS treatment as compared to the control. For reproduction, the IC10 was 560 mg/L, the IC20 was 778 mg/L, and the IC50 was 1,368 mg/L.

Results for *D. magna* survival and reproduction test are summarized in Table 17. Survival in the various TDS treatments ranged from 60 to 100%, but did not follow a typical concentration-response pattern. Two intermediate TDS treatments (650 and 428 mg/L) had 60% and 70% survival, respectively, whereas the two highest TDS treatments had 80% and 90% survival. For survival, the LC10 was 183 mg/L, the LC20 was 663 mg/L, and the LC50 was greater than 1,474 mg/L. Mean reproduction decreased with increasing TDS concentration although to a lesser extent than was observed for *C. dubia*; mean reproduction was approximately 30% lower in the highest TDS treatment as compared to the control. For reproduction, the IC10 was 312 mg/L, the IC20 was 684 mg/L, and the IC50 was greater than 1,474 mg/L. Both the LC10 and IC10 from this test were considered to be overly conservative because of the influence of the mortalities that occurred at intermediate TDS concentrations, and therefore not reliable or technically defensible endpoints. The IC20 of 684 mg/L for reproduction was the lowest reliable, technically defensible endpoint.

Results for the chironomid (*C. dilutus*) survival and growth test are summarized in Table 18. Mean survival ranged from 80 to 87.5% across all TDS treatments and mean dry weight ranged from 2.03 to 2.36 mg/individual. There were no adverse effects on survival or growth for this test. For survival, the LC10, LC20, and LC50 were greater than 1,379 mg/L. For growth, the IC10, IC20, and IC50 were greater than 1,379 mg/L.

Results for the Lake Trout (*S. namaycush*) ELS tests are summarized in Table 19 (dry fertilization) and Table 20 (wet fertilization). Results for these two tests were similar, despite being performed using gametes from different batches of adult fish. Mean fry survival in the dry fertilization test fluctuated among treatments, ranging from 64.2 to 80.8%, but generally decreasing with increasing TDS concentration. There were minor effects on Lake Trout fry survival in the dry fertilization test, although no more than a 21% decrease relative to the control, with an LC20 of 991 mg/L and LC50 of greater than 1,490 mg/L. There were no adverse effects on fry length or dry weight in the dry fertilization test, with IC20s of greater than 1,490 mg/L for both endpoints. In the wet fertilization test, there were no adverse effects on Lake Trout fry survival (LC20 greater than 1,484 mg/L) or growth (IC20 greater than 1,484 mg/L for dry weight and length). Observations for presence of deformities and abnormal behaviour in both Lake Trout tests determined that the overall deformity rate was less than 1%; no abnormal behaviour was observed.

Results for the Arctic Grayling (*T. arcticus*) ELS tests are summarized in Table 21 (dry fertilization) and Table 22 (wet fertilization). There were no adverse effects on fry survival or growth (dry weight or length) in either test, and no relationship between increasing TDS concentration and increasing response. For the dry fertilization test, the LC20 for fry survival and the IC20s for fry growth were all greater than 1,419 mg/L. For the wet fertilization test, the LC20 for fry survival and the IC20s for fry growth were all greater than 1,414 mg/L. Observations for presence of deformities and abnormal behaviour in both Arctic Grayling tests determined that the overall deformity rate was less than 1%; no abnormal behaviour was observed.

6.3.2 Phase 2 Toxicity Tests

Phase 2 toxicity tests were only performed with *C. dubia* and *D. magna*, the two species that demonstrated adverse effects to TDS during Phase 1 testing. Additional details, including bench sheets and statistical calculations, are provided in the laboratory report (Appendix B). Control performance met test acceptability criteria for both test methods, and test results were corrected for mean control responses.

Results of the Phase 2 *C. dubia* tests are summarized in Tables 23 to 26, with results for each of the four salts (sodium chloride, sodium sulfate, calcium sulfate, and calcium chloride) provided in a separate table. For each test, a baseline TDS concentration of 450 mg/L with the ionic composition of Snap Lake water was supplemented with one of these four salts to prepare a range of TDS concentrations up to a nominal concentration of 1,500 mg/L. For three of the four salts, varying the TDS ionic composition had little or no effect on survival, which ranged from 80% to 100% among all TDS treatments; the LC20s for these three tests were greater than 1,516 to greater than 1,561 mg/L. The test with calcium sulfate demonstrated adverse effects on survival, with only 10% survival at the highest TDS concentration; the LC20 for this test was 1,240 mg/L (Table 25). All four tests showed adverse effects on reproduction, with reproduction in the highest

TDS treatments reduced by 32% to 95% relative to the control, depending on the salt being tested. The IC20s for reproduction ranged from 428 to 1,170 mg/L, with the four salts being ranked in the following order from highest to lowest toxicity:

Calcium sulfate >calcium chloride >sodium sulfate >sodium chloride.

These results indicate that changing the ionic composition of the synthetic Snap Lake water to have a higher proportion of calcium results in increased toxicity to *C. dubia*. Calcium currently makes up 20% of the ionic composition of TDS in Snap Lake, and the average calcium concentration in Snap Lake was 43 mg/L in 2012.

Results of the Phase 2 *D. magna* tests are summarized in Tables 27 to 30, with results for each of the four salts provided in a separate table. There were effects on survival in all four tests, with survival ranging from 60 to 100% among all TDS treatments, and the LC20s ranging from 804 mg/L for the sodium sulfate test to greater than 1,556 mg/L for the sodium chloride test. The survival results for three of the four salts (sodium chloride, sodium sulfate, and calcium sulfate) were confounded by the fact that mortalities were greater in one or more intermediate TDS treatments than in the higher TDS treatments. This had a corresponding influence on the reproduction data for those tests, with lower mean reproduction in those intermediate treatments than in the highest TDS treatments. In general, mean reproduction decreased with increasing TDS concentration in all four tests, with mean reproduction in the highest TDS treatments reduced by 20% to 45% relative to the control; however, mean reproduction was reduced by up to 60% in one or more intermediate TDS treatments. The IC20s for reproduction ranged from 493 to 1,235 mg/L with the four samples ranked in the following order from highest to lowest toxicity:

Sodium chloride >sodium sulfate = calcium chloride >calcium sulfate.

Although the range of IC20s for *D. magna* reproduction was similar to the range reported for *C. dubia*, the ranking of the four salts was different, most notably for sodium chloride and calcium sulfate. While the calcium salts drove toxicity for *C. dubia*, the sodium salts drove toxicity for *D. magna*.

Table 23 Phase 2 Results for the 3-brood *Ceriodaphnia dubia* Survival and Reproduction Test with Varying Sodium Chloride Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	100	25.9 ± 2.1
450	460	100	21.2 ± 6.4
607	636	100	23.8 ± 3.7
817	852	100	19.3 ± 6.8
1,132	1,160	90	20.2 ± 5.8
1,500	1,561	100	9.2 ± 6.1
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		>1,561 (NC)	NA
LC20 (95% CL)		>1,561 (NC)	NA
LC50 (95% CL)		>1,561 (NC)	NA
IC10 (95% CL)		NA	1,000 (NA – 1,356)
IC20 (95% CL)		NA	1,170 (NA – 1,513)
IC50 (95% CL)		NA	1,482 (1,144 – 1,790)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; >= greater than; ± = plus or minus.

Table 24 Phase 2 Results for the 3-brood *Ceriodaphnia dubia* Survival and Reproduction Test with Varying Sodium Sulfate Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	100	25.9 ± 2.1
450	460	100	21.2 ± 6.4
607	623	100	21.9 ± 2.2
817	833	100	20.4 ± 4.7
1,132	1,200	100	19.7 ± 3.2
1,500	1,554	90	17.7 ± 7.1
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		1,554 (1,308 – NA)	NA
LC20 (95% CL)		>1,554 (NC)	NA
LC50 (95% CL)		>1,554 (NC)	NA
IC10 (95% CL)		NA	232 (27 – 590)
IC20 (95% CL)		NA	758 (490 – 1,086)
IC50 (95% CL)		NA	>1,554 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre;% = percent; >= greater than; ± = plus or minus.

Table 25 Phase 2 Results for the 3-brood *Ceriodaphnia dubia* Survival and Reproduction Test with Varying Calcium Sulfate Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	100	25.9 ± 2.1
450	460	100	21.2 ± 6.4
607	628	90	14.8 ± 6.0
817	846	100	12.2 ± 6.0
1,132	1,173	90	15.2 ± 5.3
1,500	1,517	10	1.3 ± 4.1
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		1,189 (1,091 – 1,252)	NA
LC20 (95% CL)		1,240 (1,157 – 1,298)	NA
LC50 (95% CL)		1,344 (1,282 – 1,401)	NA
IC10 (95% CL)		NA	262 (NA – 429)
IC20 (95% CL)		NA	428 (265 – 578)
IC50 (95% CL)		NA	896 (768 – 1,035)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; >= greater than; ± = plus or minus.

Table 26 Phase 2 Results for the 3-brood *Ceriodaphnia dubia* Survival and Reproduction Test with Varying Calcium Chloride Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	100	25.9 ± 2.1
450	460	100	21.2 ± 6.4
607	628	100	18.0 ± 3.7
817	845	90	15.7 ± 6.2
1,132	1,163	80	9.3 ± 7.9
1,500	1,516	100	4.8 ± 2.5
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		1,516 (724 – NA)	NA
LC20 (95% CL)		>1,516 (NC)	NA
LC50 (95% CL)		>1,516 (NC)	NA
IC10 (95% CL)		NA	337 (141 - 476)
IC20 (95% CL)		NA	509 (379 – 627)
IC50 (95% CL)		NA	950 (846 – 1,059)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; >= greater than; ± = plus or minus.

Table 27 Phase 2 Results for the 21-day *Daphnia magna* Survival and Reproduction Test with Varying Sodium Chloride Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	579	70	25.8 ± 29.8
817	817	60	25.4 ± 31.3
1,132	1,166	90	39.8 ± 26.7
1,500	1,556	100	47.7 ± 18.9
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		522 (481 – NA)	NA
LC20 (95% CL)		>1,556 (NC)	NA
LC50 (95% CL)		>1,556 (NC)	NA
IC10 (95% CL)		NA	464 (27 – 485)
IC20 (95% CL)		NA	493 (443 – 539)
IC50 (95% CL)		NA	>1,556 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; >= greater than; ± = plus or minus.

Table 28 Phase 2 Results for the 21-day *Daphnia magna* Survival and Reproduction Test with Varying Sodium Sulfate Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	625	90	59.0 ± 21.3
817	843	60	39.7 ± 35.5
1,132	1,193	80	43.0 ± 24.1
1,500	1,566	80	45.3 ± 22.6
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		678 (501 – 1,483)	NA
LC20 (95% CL)		804 (576 – NA)	NA
LC50 (95% CL)		>1,566 (NC)	NA
IC10 (95% CL)		NA	388 (NA – 958)
IC20 (95% CL)		NA	766 (282 – 1296)
IC50 (95% CL)		NA	>1,566 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre;% = percent; >= greater than; ± = plus or minus.

Table 29 Phase 2 Results for the 21-day *Daphnia magna* Survival and Reproduction Test with Varying Calcium Sulfate Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	614	70	42.3 ± 32.4
817	828	100	59.6 ± 7.7
1,132	1,162	90	49.4 ± 22.2
1,500	1,531	80	51.0 ± 30.2
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		573 (517 – NA)	NA
LC20 (95% CL)		>1,531 (NC)	NA
LC50 (95% CL)		>1,531 (NC)	NA
IC10 (95% CL)		NA	406 (NA – 1,987)
IC20 (95% CL)		NA	1,235 (195 – 3,067)
IC50 (95% CL)		NA	>1,531 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; >= greater than; ± = plus or minus.

Table 30 Phase 2 Results for the 21-day *Daphnia magna* Survival and Reproduction Test with Varying Calcium Chloride Concentrations

TDS Concentration [mg/L]		Survival (%)	Reproduction (Young/ Female) (Mean ± SD)
Nominal	Calculated (Sum of Ions)		
Control	NA	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	607	100	57.8 ± 20.4
817	826	80	43.7 ± 32.9
1,132	1,160	80	43.2 ± 27.1
1,500	1,523	70	35.0 ± 30.2
Test Endpoint [mg/L TDS]			
LC10 (95% CL)		726 (663 – NA)	NA
LC20 (95% CL)		1,247 (724 – NA)	NA
LC50 (95% CL)		>1,523 (NC)	NA
IC10 (95% CL)		NA	470 (NA – 856)
IC20 (95% CL)		NA	756 (332 – 1,123)
IC50 (95% CL)		NA	>1,523 (NC)

CL = Confidence Limit; IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; NC = Not Calculated: SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; >= greater than; ± = plus or minus.

6.3.3 *Ceriodaphnia dubia* Tolerance Testing

Results of the four-generation *C. dubia* tolerance tests are summarized in Table 31. Additional details, including bench sheets and statistical calculations, are provided in the Nautilus laboratory report (Appendix E). Control performance met test acceptability criteria, and test results were corrected for mean control responses.

During the first week of the test, 100% mortality occurred in the lowest TDS concentration (302 mg/L) after one day of exposure. The reason for this mortality was unknown but did not appear to be related to TDS because all the higher TDS treatments had 100% survival. For the second generation test, the 302 mg/L concentration was re-started using young from the control.

There were some effects on survival at higher TDS concentrations across the four weeks of testing, with survival in the various TDS treatments ranging from 60 to 100%. The LC20s for survival for each of the four tests ranged from 1,074 to greater than 1,538 mg/L but overall there was no evidence of tolerance as the LC20s for the first and fourth weeks were almost identical.

There were adverse effects on reproduction in each of the four weeks of testing, with mean reproduction decreasing as TDS concentrations increased. However, the magnitude and pattern of those decreases varied from week to week. The IC20 for reproduction for Week 1 was 1,323 mg/L, which was higher than the result obtained during Phase 1 testing (IC20 of 778 mg/L) that was performed under similar testing conditions. The IC20s for Weeks 2 to 4 were lower and varied from week to week. Reproduction in the highest TDS treatment (1,538 mg/L) declined over the four weeks of testing, with average reproduction of 10.1, 6.1, 5.3, and 2.0 offspring per adult produced during the four generations. The overall mean reproduction patterns were such that the IC20 for Week 3 (320 mg/L) was considerably lower than for the other weeks of testing, largely

due to lower reproduction in intermediate TDS treatments relative to the control. Nautilus (2013b) considered this to be an artifact, rather than a true estimate of TDS effects, because both earlier and later generations had higher IC20s.

The geometric mean of the four IC20s reported from the four generations of *C. dubia* testing was 796 mg/L, which was similar to the IC20 of 778 mg/L reported from Phase 1 testing and showed that TDS effects did not decrease with increased exposed generations. These results indicate that for the specific ionic composition associated with TDS in Snap Lake at present, *C. dubia* were not able to acquire tolerance over multi-generational exposures. This finding is surprising given that acquired tolerance with prolonged exposure typically occurs for invertebrates with short life-spans such as these daphnids (Chapman 2008). However, although Soucek et al. (2011) reported that exposing *C. dubia* through two to three generations to hardness ranging from 25 to 800 mg/L as $CaCO_3$ decreased acute toxicity to chloride by a factor of two, similar exposure to sulfate concentrations ranging from 25 to 600 mg/L did not reduce chloride toxicity. Thus, acquired tolerance appears to be substance-specific.

Table 31 Results for the 3-brood *Ceriodaphnia dubia* Total Dissolved Solids Tolerance Tests

Calculated TDS Concentration [mg/L] (Sum of Ions)	Survival (%)				Reproduction (Young/ Female) (Mean ± SD)			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Control (167 mg/L)	**100**	**100**	**100**	**100**	**14.3 ± 2.3**	**15.2 ± 2.0**	**19.9 ± 2.5**	**15.7 ± 2.1**
302	No Data	100	100	100	No Data	25.8 ± 4.6	16.4 ± 5.4	25.4 ± 3.9
464	100	90	100	90	13.9 ± 2.6	20.2 ± 5.7	11.7 ± 2.3	22.8 ± 6.9
705	100	90	80	100	14.2 ± 2.6	27.7 ± 4.6	14.1 ± 8.1	21.4 ± 3.7
1,031	100	90	100	100	17.1 ± 2.2	18.9 ± 8.3	8.9 ± 8.3	14.3 ± 4.5
1,538	100	60	70	80	10.1 ± 2.8	6.1 ± 5.1	5.3 ± 4.9	2.0 ± 2.7
Test Endpoint [mg/L TDS]								
LC20	>1,538	1,074	1,267	1,538	NA	NA	NA	NA
LC50	>1,538	>1,538	>1,538	>1,538	NA	NA	NA	NA
IC20	NA	NA	NA	NA	1,323	1,068	320	888
IC50	NA	NA	NA	NA	>1,538	>1,538	933	1,160

IC = Inhibition Concentration; LC = Lethal Concentration; NA = Not Applicable; SD = Standard Deviation; TDS = total dissolved solids; mg/L = milligrams per litre;% = percent; >= greater than; ± = plus or minus.

7 DEVELOPMENT OF SITE-SPECIFIC CHRONIC EFFECTS BENCHMARK FOR SNAP LAKE

7.1 Proposed Benchmark for Total Dissolved Solids

The existing literature on TDS toxicity (Section 5.0) primarily deals with TDS solutions comprised primarily of either sulfate (Chapman et al. 2000; LeBlond and Duffy 2001), calcium sulfate (Stekoll et al. 2003), or sulfate and bicarbonate (Lasier and Hardin 2010). The major ionic constituents of TDS in Snap Lake are chloride (45 to 47% of TDS) and calcium (20 to 21% of TDS), hence the importance of site-specific testing.

Chapman et al. (2000) reported an NOEC for *P. subcapitata* of greater than 2,000 mg/L TDS, and LeBlond and Duffy (2001) reported an EC20 of 551 mg/L TDS for the same species. Those results bracketed the results obtained from the Phase 1 testing reported here for the same phytoplankton species but with different TDS composition. Lasier and Hardin (2010) reported IC50s for *C. dubia* reproduction of 1,139 and 1,569 mg/L TDS for tests conducted at two hardnesses that were lower than the current Snap Lake water hardness; those IC50s were similar to the IC50s obtained from the Phase 1 testing reported here for the same species. Chapman et al. (2000) reported NOECs for *C. dilutus* survival and growth that ranged from 1,134 to 2,240 mg/L TDS, and which were similar to the Phase 1 results reported here for that species. Chapman et al. (2000) reported NOECs for Rainbow Trout survival and growth of 1,999 and 2,080 mg/L TDS, which were similar to the Phase 1 results reported here for Lake Trout and Arctic Grayling although for a different TDS composition.

A summary of the point estimates from the Phase 1 and Phase 2 Snap Lake toxicity testing that reflect 10% and/or 20% effect concentrations is provided in Table 32. As also noted by Elphick (2011a), daphnids were the most sensitive tested species and were in fact the only ones with point estimates that were clearly lower than the highest tested TDS concentration. Only those point estimates that were considered reliable and technically defensible were included. Calculated 10% effect concentrations were used where possible; however, a 10% effect can be difficult to determine accurately due to the level of variability that occurs at this low effect level and the test design (for additional discussion on this point, see BHP Billiton 2012). Although the Phase 1 test results were similar to results obtained in studies with other TDS compositions, only the site-specific Snap Lake data were used for derivation of the CEB for TDS and its major ions.

CCME (2007) describes three approaches for development of generic short-term and long-term WQGs. The most rigorous method involves compiling no-effect and low-effect endpoints using a SSD approach, ranking the results from lowest to highest, and fitting a curve to the SSD; the intercept of the fifth percentile of the SSD is selected as the WQG, with the intent that this HC5 will provide protection to 95% of the aquatic species. The other two approaches are less rigorous and involve compiling and ranking available toxicity data, and then applying a safety factor to the most sensitive test endpoint; that safety factor may vary depending on the type of data that are available.

Table 32 Summary of Phase 1 and Phase 2 Test Results Expressed as 10% and 20% Effect Concentrations

Test Species	Phase 1 Results	Phase 2 Results	Comments
Pseudokirchneriella subcapitata (green alga)	IC10 >1,474 mg/L	Not tested	Growth in all concentrations exceeded control; no growth reductions
Navicula pelliculosa (diatom)	IC10 >1,487 mg/L	Not tested	Growth in all concentrations exceeded control; no growth reductions
Brachionus calyciflorus (rotifer)	IC20 >1,474 mg/L	Not tested	No concentration-response for TDS
Ceriodaphnia dubia (water flea)	IC10 = 560 mg/L IC20 = 778 mg/L	NaCl: IC20 = 1,170 mg/L	Calcium salts had generally higher toxicity than sodium salts; sodium salts had generally similar toxicity to synthetic lake water tested in Phase 1
	LC10 >1,474 mg/L	NaCl: LC20 >1,561 mg/L	
		Na_2SO_4: IC20 = 758 mg/L	
		Na_2SO_4: LC20 >1,554 mg/L	
		$CaSO_4$: IC20 = 428 mg/L	
		$CaSO_4$: LC20 = 1,240 mg/L	
		$CaCl_2$: IC20 = 509 mg/L	
		$CaCl_2$: LC20 >1,516 mg/L	
Daphnia magna (water flea)	IC20 = 684 mg/L	NaCl: IC20 = 493 mg/L	Each of the four salts had similar toxicity to each other and to synthetic lake water tested in Phase 1; the test with NaCl had high variability, which complicated statistical analyses for that test
	LC20 = 662 mg/L	NaCl: LC20 >1,556 mg/L	
		Na_2SO_4: IC20 = 766 mg/L	
		Na_2SO_4: LC20 = 804 mg/L	
		$CaSO_4$: IC20 = 1,235 mg/L	
		$CaSO_4$: LC20 >1,531 mg/L	
		$CaCl_2$: IC20 = 756 mg/L	
		$CaCl_2$: LC20 = 1,247 mg/L	
Chironomus dilutus (chironomid)	IC10 >1,379 mg/L	Not tested	No concentration-response for TDS
	LC10 >1,379 mg/L		
Salvelinus namaycush (Lake Trout)	IC20 >1,490 mg/L	Not tested	Dry fertilization; minor effect on survival but no concentration-response for TDS
	LC20 = 991 mg/L		
	IC20 >1,484 mg/L	Not tested	Wet fertilization; no concentration-response for TDS
	LC20 >1,484 mg/L		
Thymallus arcticus (Arctic Grayling)	IC20 >1,419 mg/L	Not tested	Dry fertilization; no concentration-response for TDS
	LC20 >1,419 mg/L		
	IC20 >1,414 mg/L	Not tested	Wet fertilization; no concentration-response for TDS
	LC20 >1,414 mg/L		

IC = Inhibition Concentration; LC = Lethal Concentration; TDS = total dissolved solids; mg/L = milligrams per litre; >= greater than; NaCl = sodium chloride; Na_2SO_4 = sodium sulfate; $CaSO_4$ = calcium sulfate; $CaCl_2$ = calcium chloride.

The minimum data set requirements for the CCME (2007) SSD approach for a long-term WQG are three studies with fish (including at least one salmonid and one non-salmonid), three studies with invertebrates (one of which must be a planktonic crustracean), and at least one study with a vascular plant or algal species. The site-specific toxicity data set generated to support the Snap Lake TDS benchmark consisted of two studies with fish (both salmonid species present in Snap Lake), four studies with invertebrates (two planktonic crustaceans, one rotifer, and one chironomid - the latter two represent dominant taxa in the zooplankton and benthic invertebrate communities in Snap Lake), and two studies with phytoplankton (one taxa present in Snap Lake).

Application of the SSD approach to derive the CEB for TDS was considered, despite the fact that only two site-specific studies had been performed with fish. However, typically SSDs are developed using bounded endpoints (i.e., test endpoints clearly indicating the onset of toxicity). In this case the majority of the endpoints were unbounded (i.e., endpoints indicating that toxicity occurred at a higher concentration than the highest TDS concentration measured). This did not allow for development of an appropriate SSD as the toxicity threshold had not been determined for six of the eight species tested. Given that the majority of site-specific testing showed no adverse effects at TDS concentrations greater than 1,400 mg/L, a CEB on the order of 1,400 mg/L TDS may be realistic for Snap Lake but was not considered to be sufficiently conservative given the lower results obtained for two daphnid species, despite the consistent very low abundance of daphnids in the Snap Lake zooplankton and the fact that the more abundant rotifer zooplankton showed no adverse effects at TDS concentrations greater than 1,400 mg/L. Repeating testing at higher TDS concentrations to obtain bounded results was not considered necessary because the upper limit used was already higher than the maximum TDS concentration predicted to occur in Snap Lake.

The most sensitive point estimate derived from the Phase 1 testing was the IC10 of 560 mg/L for *C. dubia* reproduction, which was a conservative low-effect endpoint and the lowest test endpoint recorded in the site-specific test program. The IC20 for reproduction from the same test was 778 mg/L. The second sensitive point estimate was the IC20 of 684 mg/L for *D. magna* reproduction.

The zooplankton community in Snap Lake and Northeast Lake is comprised primarily of calanoid copepods, cyclopoid copepods, and rotifers. Between 2004 and 2012, cladocerans have accounted for an average of less than 2% of biomass in both lakes. From 2004 to 2012, relative zooplankton biomass in the main basin of Snap Lake has been consistently dominated by calanoid copepods, with cyclopoid copepods or rotifers as the sub-dominant group. In 2004 (baseline), relative zooplankton biomass was 74% calanoid copepods, 18% cyclopoid copepods, 5% rotifers, and 3% cladocerans. Between 2005 and 2012, relative zooplankton biomass was 43% to 72% calanoid copepods, 15% to 39% cyclopoid copepods, 4% to 29% rotifers, and less than 1 to 7% cladocerans.

In 2012, the dominant calanoid copepod taxon in Snap Lake, in terms of both abundance and biomass, was *Leptodiaptomus silicis*. The dominant cyclopoid taxa were *Cyclops scutifer* and cyclopoid nauplii, and the dominant rotifer taxon was *Kellicotia longispina* (frequently the only rotifer species enumerated). The four cladoceran taxa present in 2012 were *Daphnia pulex*, *D. longiremis*, *Holopedium gibberum*, and *Bosmina longirostris*; *Ceriodaphnia* is not present in Snap Lake, nor is *D. magna*.

Site-specific testing with the rotifer *B. calyciflorus*, a genus that occurs in Snap Lake, showed that reproduction was not adversely affected at TDS concentrations greater than 1,474 mg/L. Acute toxicity testing by Galat and Robinson (1983) included testing with the calanoid copepod (*Diaptomus sicilis*)[4] and found that not all cladocerans were sensitive to increasing TDS, and that copepods (including a dominant species present in Snap Lake) were less sensitive to TDS than two cladoceran species, one of which was from the genus *Ceriodaphnia* (*C. dubia* has been shown to be relatively sensitive to Snap Lake TDS). Copepods and rotifers, as noted above, dominate the zooplankton in Snap Lake in terms of both abundance and biomass. Applying one of the other CCME (2007) WQG derivation approaches would involve applying a safety factor to the most sensitive test endpoint. A safety factor of 10 applied to that value would yield a benchmark of 56 mg/L TDS if the IC10 for *C. dubia* reproduction were used. That would be an overly conservative and technically indefensible benchmark given that the 2012 whole-lake average TDS concentration was 212 mg/L (range 167 to 279 mg/L) and there were no sublethal effects to *C. dubia* reproduction reported in toxicity tests performed on Snap Lake water samples collected at the diffuser stations in 2012 (De Beers 2013). Given that *C. dubia* are not present in Snap Lake, but *Daphnia* species are, it was considered more appropriate to use the IC20 for *D. magna* reproduction for the benchmark derivation and to apply a safety factor of 1.0 to yield a CEB of 684 mg/L TDS for Snap Lake.

A CEB of 684 mg/L TDS is not substantially greater than the current TDS benchmark of 500 mg/L for the Diavik Diamond Mine (WLWB 2013a,b). It is also in the lower range of the State of Alaska permitted increases in TDS concentrations in natural Northern waterbodies: 500 to 1,000 mg/L (ADEC 2012). Finally, this CEB, if used to develop a benchmark for chloride based on the average percent composition of chloride (i.e., 648 mg/L x 46%) would result in a lower chloride benchmark (315 mg/L) than that proposed in Section 7.2, below, based on the EKATI Diamond Mine SSWQO (372 mg/L) – indicating that the proposed TDS CEB is likely overprotective.

7.2 Proposed Benchmark for Chloride

The TDS benchmark study that De Beers began in 2010 was not initially intended to develop a benchmark for chloride, and therefore site-specific toxicity tests on chloride were not performed. However, the current Water Licence requires that a benchmark be recommended for chloride, either from site-specific testing or published toxicology studies.

The CCME (2011) long-term WQG for chloride of 120 mg/L is intended to protect all forms of aquatic life for an indefinite exposure period. Although CCME (2011) noted that chloride toxicity decreased with increasing water hardness for a number of aquatic species, there were insufficient data available to derive a national hardness-dependent WQG for chloride.

Elphick et al. (2011a) conducted toxicity tests with chloride to develop an SSWQO for chloride for the EKATI Diamond Mine. That testing program used nine species of zooplankton, benthic invertebrates, and fish, including a number of the same species used in De Beers' site-specific TDS testing program, and included investigation on the effects of water hardness on toxicity of

4 *Diaptomus sicilis* has since been re-named *Leptodiaptomus sicilis*, and is the dominant calanoid copepod species in Snap Lake.

chloride to *C. dubia*. Based on those results, a hardness-dependent SSWQO was developed that was applicable for water hardnesses ranging from 10 to 160 mg/L as $CaCO_3$. This hardness-dependent SSWQO has now been adopted as the maximum average chloride EQC for the EKATI Diamond Mine in their renewed Water Licence W2012L2-0001 (WLWB 2013c).

The chloride SSWQO developed and approved for the EKATI Diamond Mine was considered to be suitable for application to Snap Lake, based on current and predicted maximum chloride and water hardness concentrations. The equation is: chloride SSWQO = 116.6 (ln[hardness])-204.1. At the current water hardness of Snap Lake (140 mg/L $CaCO_3$), the chloride CEB would be 372 mg/L.

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APPENDIX A

SUMMARY TABLES - TOXICITY OF TOTAL DISSOLVED SOLIDS (TDS) AND ITS CONSTITUENT IONS TO FRESHWATER AQUATIC LIFE

Table A-1 Toxicity of Total Dissolved Solids and Constituent Ions to Phytoplankton

Common Name	Scientific Name	TDS Component	Test Duration [h]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Reference
Diatom	*Nitzschia linearis*	$CaCl_2$	120	growth (cell production)	EC50	3,130	Patrick et al. (1968)
Diatom	*Nitzschia linearis*	$CaSO_4$	120	growth (cell production)	EC50	3,200	Patrick et al. (1968)
Diatom	*Nitzschia linearis*	KCl	120	growth (cell production)	EC50	1,337	Patrick et al. (1968)
Diatom	*Nitzschia linearis*	NaCl	120	growth (cell production)	EC50	2,430	Patrick et al. (1968)
Diatom	*Navicula pelliculosa*	TDS (47% chloride)	120	growth (cell production)	IC10	>1,487	Nautilus (2012)
Green algae	*Pseudokirchneriella subcapitata*	TDS (47% chloride)	72	growth (cell production)	IC10	>1,474	Nautilus (2012)
Green algae	*Selenastrum capricornutum*	TDS (50% sulfate)	96	growth (cell production)	NOEC	>2,000	Chapman et al. (2000)
Green algae	*Selenastrum capricornutum*	TDS (70% sulfate)	72	growth (cell production)	EC20	551.3	LeBlond and Duffy (2001)
Green algae	*Scenedesmus obliquus*	NaCl	168	growth (cell production)	43% inhibition	11,690	Mohammed and Shafea (1992)
Green algae	*Chlamydomonas reinhardtii*	NaCl	144	growth	EC50	4,965	Reynoso et al. (1982)
Green algae	*Chlorella emersonii*	NaCl	192 to 336	growth (cell production)	growth inhibition	11,700	Setter et al. (1982)

Notes: ECx = concentration of sample estimated to cause a specified effect to x% of the test organisms.
ICx = the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms.
NOEC = no observed effect concentration; $CaCl_2$ = calcium chloride; $CaSO_4$ = calcium sulfate; KCl = potassium chloride; NaCl = sodium chloride; TDS = total dissolved solids; h = hour; mg/L = milligrams per litre; % = percent; >= greater than.

Table A-2 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Zooplankton

Common Name	Scientific Name	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Acute								
Cladoceran	*Ceriodaphnia dubia*	$CaCl_2$	48 h	survival	LC50	1,834	-	Mount et al. (1997)
Cladoceran	*Ceriodaphnia dubia*	$CaCO_3$	48 h	survival	LC50	1,031	-	Cowgill and Milazzo (1990)
Cladoceran	*Ceriodaphnia dubia*	$CaSO_4$	48 h	survival	LC50	>1,913	-	Mount et al. (1997)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	861	Hardness = 50 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	977	Hardness = 25 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,068	-	Elphick et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,154	[sulfate] = 400 mg/L	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,192	[sulfate] = 600 mg/L	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,250	Hardness = 100 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,317	[sulfate] = 100 mg/L	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,356	[sulfate] = 25 mg/L	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,357	[sulfate] = 200 mg/L	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,402	Hardness = 200 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,489	[sulfate] = 50 mg/L	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,589	Hardness = 400 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,779	Hardness = 600 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	48 h	survival	LC50	1,836	Hardness = 800 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Cladoceran	*Ceriodaphnia dubia*	KCl	48 h	survival	LC50	627	-	Mount et al. (1997)

Table A-2 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Zooplankton (continued)

Common Name	Scientific Name	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Cladoceran	*Ceriodaphnia dubia*	$MgCl_2$	48 h	survival	LC50	884	-	Mount et al. (1997)
Cladoceran	*Ceriodaphnia dubia*	NaCl	48 h	survival	LC50	790	-	Hoke et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	48 h	survival	LC50	1,590	-	Harmon et al. (2003)
Cladoceran	*Ceriodaphnia dubia*	NaCl	48 h	survival	LC50	1,956	-	Mount et al. (1997)
Cladoceran	*Ceriodaphnia dubia*	NaCl	48 h	survival	LC50	2,019	-	Cowgill and Milazzo (1990)
Cladoceran	*Ceriodaphnia dubia*	Na_2SO_4	48 h	survival	LC50	>2,000	5 to 25 mg/L chloride	Soucek (2007)
Cladoceran	*Ceriodaphnia dubia*	Na_2SO_4	48 h	survival	LC50	≈1,500	500 mg/L chloride	Soucek (2007)
Cladoceran	*Ceriodaphnia quadrangula*	TDS	96 h	survival	LC50	7,100	TDS is 39% chloride, 32% sodium-	Galat and Robinson (1983)
Cladoceran	*Daphnia ambigua*	NaCl	48 h	survival	LC50	2,000	-	Harmon et al. (2003)
Cladoceran	*Daphnia hyalina*	Ca^{2+}	48 h	immobilization/ survival	LC50	3,000	-	Baudouin and Scoppa (1974)
Cladoceran	*Daphnia magna*	Ca^{2+}	48 h	survival	LC50	52	-	Biesinger and Christensen (1972)
Cladoceran	*Daphnia magna*	$CaCl_2$	96 h	survival	LC50	649	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	$CaCl_2$	48 h	survival	LC50	759	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	$CaCl_2$	48 h	survival	LC50	2,770	-	Mount et al. (1997)
Cladoceran	*Daphnia magna*	$CaCO_3$	48 h	survival	LC50	1,516	-	Cowgill and Milazzo (1990)
Cladoceran	*Daphnia magna*	$CaSO_4$	48 h	survival	LC50	>1,968	-	Mount et al. (1997)
Cladoceran	*Daphnia magna*	Cl^-	48 h	survival	LC50	3,630	-	Elphick et al. (2011a)
Cladoceran	*Daphnia magna*	KCl	96 h	survival	LC50	29	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	KCl	48 h	survival	LC50	337	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	KCl	48 h	survival	LC50	665	-	Mount et al. (1997)
Cladoceran	*Daphnia magna*	KCl	24 h	immobilization	LC50	1,120	-	Lilius et al. (1995)
Cladoceran	*Daphnia magna*	$MgCl_2$	48 h	survival	LC50	1,326	-	Mount et al. (1997)

Table A-2 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Zooplankton (continued)

Common Name	Scientific Name	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Cladoceran	*Daphnia magna*	$MgCl_2$	96 h	survival	LC50	3,484	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	$MgCl_2$	48 h	survival	LC50	3,699	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	NaCl	48 h	survival	LC50	3,310	-	Dowden and Bennett (1965)
Cladoceran	*Daphnia magna*	NaCl	24 h	survival	LC50	3,606	-	Calleja et al. (1994)
Cladoceran	*Daphnia magna*	NaCl	48 h	survival	LC50	4,746	-	Arambasic et al. (1995)
Cladoceran	*Daphnia magna*	NaCl	48 h	survival	LC50	4,766	-	Mount et al. (1997)
Cladoceran	*Daphnia magna*	NaCl	48 h	survival	LC50	5,010	-	Hoke et al. (1992)
Cladoceran	*Daphnia magna*	NaCl	48 h	survival	LC50	6,034	-	Cowgill and Milazzo (1990)
Cladoceran	*Daphnia magna*	NaCl	48 h	survival	LC50	6,840	-	Schuytema (1997)
Cladoceran	*Daphnia magna*	NaCl	24 h	immobilization	LC50	2,190	-	Lilius et al. (1995)
Cladoceran	*Daphnia pulex*	NaCl	24 h	immobilization	LC50	3,300	-	Lilius et al. (1995)
Cladoceran	*Daphnia pulex*	Ca^{2+}	48 h	survival	EC50	499	dependent on Ca:Na ratio	Goodfellow et al. (2000)
Cladoceran	*Daphnia pulex*	Cl^-	48 h	survival	LC50	1,470	-	Birge et al. (1985; cited by Evans and Frick 2001)
Cladoceran	*Diaphanosoma leuchtenbergianum*	TDS	96 h	survival	LC50	6,500	TDS is 39% chloride, 32% sodium	Galat and Robinson (1983)
Cladoceran	*Moina hutchinsoni*	TDS	96 h	survival	LC50	17,800	TDS is 39% chloride, 32% sodium-	Galat and Robinson (1983)
Copepod, calanoid	*Diaptomus sicilis*	TDS	96 h	survival	LC50	13,300	TDS is 39% chloride, 32% sodium-	Galat and Robinson (1983)
Copepod, calanoid	*Eudiaptomus padanus*	Ca^{2+}	48 h	immobilization/ survival	LC50	4,000	-	Baudouin and Scoppa (1974)
Copepod, cyclopoid	*Cyclops abyssorum*	Ca^{2+}	48 h	immobilization/ survival	LC50	7,000	-	Baudouin and Scoppa (1974)
Copepod, cyclopoid	*Cyclops vernalis*	TDS	96 h	survival	LC50	14,800	TDS is 39% chloride, 32% sodium-	Galat and Robinson (1983)
Rotifer	*Brachionus calyciflorus*	TDS	48 h	reproduction	IC20	>1,474	TDS is 47% chloride	Nautilus (2012)

Table A-2 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Zooplankton (continued)

Common Name	Scientific Name	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Rotifer	*Brachionus calyciflorus*	Cl^-	24 h	survival	LC50	1,645	-	Elphick et al. (2011a)
Rotifer	*Brachionus calyciflorus*	Cl^-	48 h	reproduction	IC25	1,505	-	Elphick et al. (2011a)
Rotifer	*Brachionus calyciflorus*	NaCl	24 h	survival	LC50	6,897	-	Calleja et al. (1994)
Rotifer	*Brachionus calyciflorus*	NaCl	24 h	survival	LC50	3,750	-	Peredo-Alvarez et al. (2003)
Rotifer	*Brachionus patulus*	NaCl	24 h	survival	LC50	2,140	-	Peredo-Alvarez et al. (2003)
Chronic								
Cladoceran	*Ceriodaphnia dubia*	TDS	6 to 7 d	survival	LC10	>1,474	TDS is 47% chloride	Nautilus (2012)
Cladoceran	*Ceriodaphnia dubia*	TDS	6 to 7 d	reproduction	IC10	560	TDS is 47% chloride	Nautilus (2012)
Cladoceran	*Ceriodaphnia dubia*	TDS	6 to 7 d	reproduction	IC20	778	TDS is 47% chloride	Nautilus (2012)
Cladoceran	*Ceriodaphnia dubia*	TDS	6 to 7 d	reproduction	IC50	1,139	hardness 44 mg/L as $CaCO_3$	Lasier and Hardin (2010)
Cladoceran	*Ceriodaphnia dubia*	TDS	6 to 7 d	reproduction	IC50	1,569	hardness 93 mg/L as $CaCO_3$	Lasier and Hardin (2010)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	6 to 7 d	reproduction	IC50	342	hardness 44 mg/L as $CaCO_3$	Lasier and Hardin (2010)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	6 to 7 d	reproduction	IC50	653	hardness 93 mg/L as $CaCO_3$	Lasier and Hardin (2010)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	6 to 7 d	reproduction	IC25	147	hardness 44 mg/L as $CaCO_3$	Lasier and Hardin (2010)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	6 to 7 d	reproduction	IC25	456	hardness 93 mg/L as $CaCO_3$	Lasier and Hardin (2010)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	454	-	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC50	697	-	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	survival	LC50	132	Hardness = 10 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	survival	LC50	316	Hardness = 20 mg/L as $CaCO_3$	Elphick et al. (2011a)

Table A-2 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Zooplankton (continued)

Common Name	Scientific Name	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	survival	LC50	540	Hardness = 40 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	survival	LC50	1,134	Hardness = 80 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	survival	LC50	1,240	Hardness = 160 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	survival	LC50	1,303	Hardness = 320 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	117	Hardness = 10 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	264	Hardness = 20 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	146	Hardness = 40 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	454	Hardness = 80 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	580	Hardness = 160 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	Cl^-	7 d	reproduction	IC25	521	Hardness = 320 mg/L as $CaCO_3$	Elphick et al. (2011a)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	IC50	885	mean of 6 tests	Aragao and Pereira (2003)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	survival	NOEC	1,800	value equal for all age groups tested	Cooney et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	survival	LOEC	2,400	value equal for all age groups tested	Cooney et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	NOEC	750	0-24 h old organisms	Cooney et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	NOEC	<750	0-24 h old organisms	Cooney et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	LOEC	1,000	0-24 h old organisms	Cooney et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	LOEC	750	0-24 h old organisms	Cooney et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	survival	LC50	1,770	Test 1 (mean of 5 interlaboratory results)	DeGraeve et al. (1992)

Table A-2 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Zooplankton (continued)

Common Name	Scientific Name	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	survival	LC50	1,330	Test 2 (mean of 5 interlaboratory results)	DeGraeve et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	IC50	1,340	Test 1 (mean of 5 interlaboratory results)	DeGraeve et al. (1992)
Cladoceran	*Ceriodaphnia dubia*	NaCl	7 d	reproduction	IC50	960	Test 2 (mean of 5 interlaboratory results)	DeGraeve et al. (1992)
Cladoceran	*Daphnia magna*	TDS	21 d	survival	LC20	662	TDS is 47% chloride	Nautilus (2012)
Cladoceran	*Daphnia magna*	TDS	21 d	reproduction	IC20	684	TDS is 47% chloride	Nautilus (2012)
Cladoceran	*Daphnia magna*	Cl^-	21 d	reproduction	IC25	421	-	Elphick et al. (2011a)
Cladoceran	*Daphnia magna*	Ca^{2+}	21 d	survival	LC50	330	-	Biesinger and Christensen (1972)
Cladoceran	*Daphnia magna*	Ca^{2+}	21 d	reproduction	IC50	220	-	Biesinger and Christensen (1972)
Cladoceran	*Daphnia magna*	Ca^{2+}	21 d	reproduction	IC16	116	-	Biesinger and Christensen (1972)

Notes: LCx = concentration of sample estimated to be lethal to x% of the test organisms.
ECx = concentration of sample estimated to cause a specified effect to x% of the test organisms.
ICx = the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms.
NOEC = no observed effect concentration; LOEC = lowest observed effect concentration. $CaCO_3$ = calcium carbonate; $CaCl_2$ = calcium chloride; $CaSO_4$ = calcium sulfate; KCl = potassium chloride; $MgCl_2$ = magnesium chloride; Na_2SO_4 = sodium sulfate; NaCl = sodium chloride; Cl^- = chloride ion; Ca^{2+} = calcium ion; TDS = total dissolved solids; h = hours; d = days; mg/L = milligrams per litre; % = percent; >= greater than; - = no information available.

Table A-3 Toxicity of Total Dissolved Solids and Constituent Ions to Benthic Invertebrates

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Acute									
Amphipod	*Gammarus pseudolimnaeus*	larvae	NaCl	24 h	survival (drift)	LC20	2,500	static water test	Crowther and Hynes (1977)
Amphipod	*Gammarus pseudolimnaeus*	larvae	NaCl	24 h	survival (drift)	NOEC	800	lab experiment	Crowther and Hynes (1977)
Amphipod	*Gammarus pseudolimnaeus*	larvae	NaCl	20 h	survival(drift)	LOEC	≈1,000	field experiment	Crowther and Hynes (1977)
Amphipod	*Hyalella azteca*	third instar larvae	Na_2SO_4	96 h	survival	LC50	512	5 mg/L chloride	Soucek (2007)
Amphipod	*Hyalella azteca*	third instar larvae	Na_2SO_4	96 h	survival	LC50	>1,500	25 mg/L chloride	Soucek (2007)
Amphipod	*Hyalella azteca*	third instar larvae	Na_2SO_4	96 h	survival	LC50	≈1,500	500 mg/L chloride	Soucek (2007)
Amphipod	*Hyalella azteca*	third instar larvae	Na_2SO_4	96 h	survival	LC50	<1,900	hardness = 100 mg/L	Soucek (2007)
Amphipod	*Hyalella azteca*	third instar larvae	Na_2SO_4	96 h	survival	LC50	>4,000	hardness = 500 mg/L	Soucek (2007)
Amphipod	*Hyalella azteca*	third instar larvae	Cl^-	96 h	survival	LC50	1,382	-	Elphick et al. (2011a)
Chironomid	*Chironomus dilutus*	larvae	Cl^-	96 h	survival	LC50	5,867	-	Elphick et al. (2011a)
Chironomid	*Cricotopus trifascia*	larvae	NaCl	48 h	survival	LC50	6,221	-	Hamilton et al. (1975)
Fingernail clam	*Sphaerium simile*	-	Cl^-	96 h	survival	LC50	740	Hardness = 50 mg/L as $CaCO_3$	GLEC and INHS (2008); Soucek et al. (2011)
Fingernail clam	*Sphaerium simile*	-	Cl^-	96 h	survival	LC50	1,100	Hardness = 200 mg/L as $CaCO_3$	GLEC and INHS (2008)
Flatworm	*Dugesia gonocephala*	NR	Cl^-	192 h	survival	100% survival	1,230	-	Palladini (1980)
Isopod	*Lirceus fontinalis*	-	Cl^-	96 h	survival	LC50	2,950	-	Birge et al. (1985; cited by Evans and Frick 2001)
Mosquito larvae	*Culex sp.*	larvae	NaCl	48 h	survival	LC50	10,200	-	Dowden and Bennett (1965)
Mussel	*Villosa delumbis*	glochidia	NaCl	24 h	viability	EC50	3,310	-	Bringolf et al. (2007)
Mussel	*Villosa delumbis*	glochidia	NaCl	48 h	viability	EC50	3,630	-	Bringolf et al. (2007)
Mussel	*Villosa delumbis*	2-month-old	NaCl	96 h	survival	EC50	5,230	-	Bringolf et al. (2007)

Table A-3 Toxicity of Total Dissolved Solids and Constituent Ions to Benthic Invertebrates (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
		juvenile							
Mussel	*Villosa constricta*	glochidia	NaCl	24 h	viability	EC50	2,760	-	Bringolf et al. (2007)
Mussel	*Villosa constricta*	glochidia	NaCl	48 h	viability	EC50	2,590	-	Bringolf et al. (2007)
Mussel	*Elliptio complanata*	glochidia	NaCl	24 h	viability	EC50	2,670	-	Bringolf et al. (2007)
Mussel	*Elliptio complanata*	glochidia	NaCl	48 h	viability	EC50	2,230	-	Bringolf et al. (2007)
Mussel	*Lampsilis fasciola*	glochidia	NaCl	24 h	viability	EC50	1,840	-	Bringolf et al. (2007)
Mussel	*Lampsilis fasciola*	glochidia	NaCl	48 h	viability	EC50	1,740	-	Bringolf et al. (2007)
Mussel	*Lampsilis fasciola*	2-month-old juvenile	NaCl	96 h	survival	EC50	3,980	-	Bringolf et al. (2007)
Mussel	*Lampsilis siliquoidea*	glochidia	NaCl	24 h	viability	EC50	550	-	Bringolf et al. (2007)
Mussel	*Lampsilis siliquoidea*	glochidia	NaCl	48 h	viability	EC50	560	-	Bringolf et al. (2007)
Mussel	*Lampsilis siliquoidea*	2-month-old juvenile	NaCl	96 h	survival	EC50	4,560	-	Bringolf et al. (2007)
Oligochaete worm	*Lumbriculus variegatus*	-	Cl^-	96 h	survival	LC50	3,100	-	Elphick et al. (2011a)
Oligochaete worm	*Nais variabilis*	-	NaCl	48 h	survival	LC25	2,569	-	Hamilton et al. (1975)
Oligochaete worm	*Tubifex tubifex*	-	$CaCl_2$	48 h	immobilization	EC50	389	-	Khangarot (1991)
Oligochaete worm	*Tubifex tubifex*	-	$CaCl_2$	96 h	immobilization	EC50	281	-	Khangarot (1991)
Oligochaete worm	*Tubifex tubifex*	-	KCl	48 h	immobilization	EC50	1,320	-	Khangarot (1991)
Oligochaete worm	*Tubifex tubifex*	-	KCl	96 h	immobilization	EC50	813	-	Khangarot (1991)
Oligochaete worm	*Tubifex tubifex*	-	NaCl	48 h	immobilization	EC50	1,016	-	Khangarot (1991)
Oligochaete worm	*Tubifex tubifex*	-	NaCl	96 h	immobilization	EC50	781	-	Khangarot (1991)
Oligochaete worm	*Tubifex tubifex*	-	Cl^-	96 h	survival	LC50	5,648	-	Elphick et al. (2011a)
Oligochaete worm	*Tubifex tubifex*	-	Cl^-	96 h	survival	LC50	4,278	Hardness = 50 mg/L as $CaCO_3$	GLEC and INHS (2008)

Table A-3 Toxicity of Total Dissolved Solids and Constituent Ions to Benthic Invertebrates (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Oligochaete worm	*Tubifex tubifex*	-	Cl^-	96 h	survival	LC50	6,008	Hardness = 200 mg/L as $CaCO_3$	GLEC and INHS (2008)
Planarian worm	*Polycelis nigra*	-	NaCl	48 h	survival	NOEC	11,109	-	Jones (1940)
Planarian worm	*Polycelis nigra*	-	$CaCl_2$	48 h	survival	NOEC	7,199	-	Jones (1940)
Planarian worm	*Polycelis nigra*	-	$MgCl_2$	48 h	survival	NOEC	3,798	-	Jones (1940)
Planarian worm	*Polycelis nigra*	-	KCl	48 h	survival	NOEC	1,259	-	Jones (1940)
Planorbid snail	*Gyraulus parvus*	-	Cl^-	96 h	survival	LC50	3,078	Hardness = 50 mg/L as $CaCO_3$	GLEC and INHS (2008)
Planorbid snail	*Gyraulus parvus*	-	Cl^-	96 h	survival	LC50	3,009	Hardness = 200 mg/L as $CaCO_3$	GLEC and INHS (2008)
Snail	*Lymnaea sp.*	eggs	$CaCl_2$	48 h	survival	LC50	3,094	-	Dowden and Bennett (1965)
Snail	*Lymnaea sp.*	eggs	$CaCl_2$	96 h	survival	LC50	2,573	-	Dowden and Bennett (1965)
Snail	*Lymnaea sp.*	eggs	KCl	48 h	survival	LC50	1,492	-	Dowden and Bennett (1965)
Snail	*Lymnaea sp.*	eggs	KCl	96 h	survival	LC50	1,100	-	Dowden and Bennett (1965)
Snail	*Lymnaea sp.*	eggs	NaCl	48 h	survival	LC50	3,388	-	Dowden and Bennett (1965)
Snail	*Physa gyrina*	-	Cl^-	96 h	survival	LC50	2,540	-	Birge et al. (1985; cited by Evans and Frick 2001)
Snail	*Physa heterostropha*	-	KCl	96 h	survival	LC50	940	-	Patrick et al. (1968)
Trichoptera larvae	*Cheumatopsyche analis*	larvae	Cl^-	24 h	survival (drift)	NOEC	1,650	lab experiment	Crowther and Hynes (1977)
Trichoptera larvae	*Cheumatopsyche analis*	larvae	Cl^-	20 h	survival (drift)	LOEC	≈1,000	field experiment	Crowther and Hynes (1977)
Trichoptera larvae	*Hydropsyche betteni*	larvae	NaCl	24 h	survival (drift)	NOEC	1,650	lab experiment	Crowther and Hynes (1977)
Trichoptera larvae	*Hydropsyche betteni*	larvae	NaCl	20 h	survival (drift)	LOEC	≈1,000	field experiment	Crowther and Hynes (1977)
Trichoptera larvae	*Hydroptila angusta*	larvae	NaCl	48 h	survival	LC50	6,621	-	Hamilton et al. (1975)

Table A-3 Toxicity of Total Dissolved Solids and Constituent Ions to Benthic Invertebrates (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Chronic									
Amphipod	*Hyalella azteca*	larvae	Cl^-	28 d	growth (dry weight)	IC25	1,705	-	Elphick et al. (2011a)
Diptera larvae	*Chironomus dilutus*	larvae	TDS	10 d	survival	LC10	>1,379	TDS is 47% chloride	Nautilus (2011)
Diptera larvae	*Chironomus dilutus*	larvae	TDS	10 d	growth (dry weight)	IC10	>1,379	TDS is 47% chloride	Nautilus (2011)
Diptera larvae	*Chironomus dilutus*	larvae	Cl^-	20 d	biomass	IC25	2,590	-	Elphick et al. (2011a)
Diptera larvae	*Chironomus tentans*	larvae	TDS (50% sulfate)	10 d	survival	LOEC	1,750	Kensington mine	Chapman et al. (2000)
Diptera larvae	*Chironomus tentans*	larvae	TDS (50% sulfate)	10 d	survival	NOEC	1,220	Kensington mine	Chapman et al. (2000)
Diptera larvae	*Chironomus tentans*	larvae	TDS (50% sulfate)	10 d	growth (dry weight)	NOEC	2,240	Kensington mine	Chapman et al. (2000)
Diptera larvae	*Chironomus tentans*	larvae	TDS (70% sulfate)	10 d	survival	NOEC	2,089	Red Dog mine	Chapman et al. (2000)
Diptera larvae	*Chironomus tentans*	larvae	TDS (70% sulfate)	10 d	growth	LOEC	2,089	Red Dog mine	Chapman et al. (2000)
Diptera larvae	*Chironomus tentans*	larvae	TDS (70% sulfate)	10 d	growth	NOEC	1,134	Red Dog mine	Chapman et al. (2000)
Ephemeroptera larvae	*Stenonema modestum*	larvae	NaCl	14 d	survival	NOEC	2,700	-	Diamond et al. (1992)
Ephemeroptera larvae	*Stenonema modestum*	larvae	NaCl	14 d	survival	LOEC	3,500	-	Diamond et al. (1992)
Ephemeroptera larvae	*Cloeon* sp.	larvae	NaCl	21 d	survival	LC50	≈ 1,400	Wet Lab Water; confounding factors	Hassell et al. (2006)
Ephemeroptera larvae	*Centroptilum* sp.	larvae	NaCl	21 d	survival	LC50	≈ 600	Wet Lab Water; confounding factors	Hassell et al. (2006)
Ephemeroptera larvae	*Centroptilum* sp.	larvae	NaCl	21 d	survival	LC50	≈ 1,800	River Water	Hassell et al. (2006)
Oligochaete worm	*Tubifex tubifex*	adults	Cl^-	28 d	reproduction	IC25	606	-	Elphick et al. (2011a)
Oligochaete worm	*Lumbriculus variegatus*	adults	Cl^-	28 d	reproduction	IC25	825	-	Elphick et al. (2011a)

Table A-3 Toxicity of Total Dissolved Solids and Constituent Ions to Benthic Invertebrates (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Trichoptera larvae	*Hydropsyche betteni*	larvae	NaCl	10 d	survival and pupate	-	1,319	-	Kersey (1981; cited by Evans and Frick 2001)
Trichoptera larvae	*Hydropsyche betteni*	larvae	NaCl	6 d	survival	LC80	9,890	-	Kersey (1981; cited by Evans and Frick 2001)

Notes: LCx = concentration of sample estimated to be lethal to x% of the test organisms.
ECx = concentration of sample estimated to cause a specified effect to x% of the test organisms.
ICx = the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms.
NR = not reported; NOEC = no observed effect concentration; LOEC = lowest observed effect concentration; $CaCO_3$ = calcium carbonate; $CaCl_2$ = calcium chloride; KCl = potassium chloride; $MgCl_2$ = magnesium chloride; NaCl = sodium chloride; Na_2SO_4 = sodium sulfate; Cl^- = chloride ion; TDS = total dissolved solids; h = hours; d = days; mg/L = milligrams per litre; % = percent; >= greater than; <= less than; - = no information available.

Table A-4 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Fish

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Acute									
Arctic Char	*Salvelinus alpinus*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	NOEC	1,250	-	Stekoll et al. (2003)
Arctic Char	*Salvelinus alpinus*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	LOEC	1,875	-	Stekoll et al. (2003)
Arctic Grayling	*Thymallus arcticus*	-	$CaSO_4$	72 h	fertilization	EC20	>2,782	-	Brix et al. (2010)
Arctic Grayling	*Thymallus arcticus*	-	$CaSO_4$	14 h	embryo water absorption	LOEC	1,402	-	Brix et al. (2010)
Arctic Grayling	*Thymallus arcticus*	-	$CaSO_4$	14 h	embryo water absorption	NOEC	784	-	Brix et al. (2010)
Atlantic Salmon	*Salmo salar*	eggs (water hardening)	Ca^{2+} ($CaSO_4$)	fertilization to eye-up	survival	34% survival	520	-	Ketola et al. (1988)
Bluegill Sunfish	*Lepomis macrochirus*	-	$CaCl_2$	24 h	survival	LC50	8,350	-	Dowden and Bennett (1965)
Bluegill Sunfish	*Lepomis macrochirus*	-	$CaCl_2$	96 h	survival	LC50	10,650	-	Patrick et al. (1968)
Bluegill Sunfish	*Lepomis macrochirus*	-	$CaSO_4$	96 h	survival	LC50	2,980	-	Patrick et al. (1968)
Bluegill Sunfish	*Lepomis macrochirus*	-	KCl	24 h	survival	LC50	5,500	-	Dowden and Bennett (1965)
Bluegill Sunfish	*Lepomis macrochirus*	-	KCl	96 h	survival	LC50	2,010	-	Patrick et al. (1968)
Bluegill Sunfish	*Lepomis macrochirus*	-	NaCl	24 h	survival	LC50	14,125	-	Dowden and Bennett (1965)
Bluegill Sunfish	*Lepomis macrochirus*	-	NaCl	96 h	survival	LC50	12,946	-	Patrick et al. (1968)
Bluegill Sunfish	*Lepomis macrochirus*	-	NaCl	96 h	survival	LC50	9,628	-	Birge et al. (1985; cited by Evans and Frick 2001)

Table A-4 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Fish (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Brook Trout	*Salvelinus fontinalis*	eggs (water hardening)	Ca^{2+} ($CaSO_4$)	fertilization to eye-up	survival	38% survival	554	-	Ketola et al. (1988)
Brook Trout	*Salvelinus fontinalis*	-	NaCl	1 h	survival	NOEC	25,000	-	Phillips et al. (1947)
Brook Trout	*Salvelinus fontinalis*	-	NaCl	0.25 h	survival	LC50	50,000	-	Phillips et al. (1947)
Brown Trout	*Salmo trutta*	-	$CaCl_2$	24 h	survival	LC20	10,000	-	Waller et al. (1996)
Chinook Salmon	*Oncorhynchus tschawytscha*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	LOEC	250	-	Stekoll et al. (2003)
Chinook Salmon	*Oncorhynchus tschawytscha*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	NOEC	<250	-	Stekoll et al. (2003)
Chum Salmon	*Oncorhynchus keta*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	LOEC	750	-	Stekoll et al. (2003)
Chum Salmon	*Oncorhynchus keta*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	NOEC	500	-	Stekoll et al. (2003)
Coho Salmon	*Oncorhynchus kisutch*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	LOEC	250	-	Stekoll et al. (2003)
Coho Salmon	*Oncorhynchus kisutch*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	NOEC	<250	-	Stekoll et al. (2003)
Dolly Varden	*Salvelinus malma*	-	$CaSO_4$	24 h	fertilization	EC20	>1,817	-	Brix et al. (2010)
Dolly Varden	*Salvelinus malma*	-	$CaSO_4$	14 h	embryo water absorption	LOEC	964	-	Brix et al. (2010)
Dolly Varden	*Salvelinus malma*	-	$CaSO_4$	14 h	embryo water absorption	NOEC	585	-	Brix et al. (2010)
Fathead Minnow	*Pimephales promelas*	-	Ca^{2+}	96 h	survival	LC50	266	dependent on Ca:Na ratio	Goodfellow et al. (2000)

Table A-4 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Fish (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Fathead Minnow	*Pimephales promelas*	1 to 7 d old	$CaCl_2$	96 h	survival	LC50	4,632	-	Mount et al. (1997)
Fathead Minnow	*Pimephales promelas*	1 to 7 d old	$CaSO_4$	96 h	survival	LC50	>1,968	-	Mount et al. (1997)
Fathead Minnow	*Pimephales promelas*	1to 7 d old	KCl	96 h	survival	LC50	884	-	Mount et al. (1997)
Fathead Minnow	*Pimephales promelas*	1 to 7 d old	$MgCl_2$	96 h	survival	LC50	2,117	-	Mount et al. (1997)
Fathead Minnow	*Pimephales promelas*	1 to 7 d old	NaCl	96 h	survival	LC50	6,392	-	Mount et al. (1997)
Fathead Minnow	*Pimephales promelas*	-	NaCl	96 h	survival	LC50	10,830	-	Birge et al. (1985; cited by Evans and Frick 2001)
Fathead Minnow	*Pimephales promelas*	-	NaCl	96 h	survival	LC50	7,650	-	Adelman et al. (1975)
Fathead Minnow	*Pimephales promelas*	-	Cl^-	96 h	survival	LC50	4,079	-	Elphick et al. (2011a)
Goldfish	*Carassius carassius*	-	NaCl	24 h	survival	LC50	13,750	-	Dowden and Bennett (1965)
Goldfish	*Carassius carassius*	-	NaCl	96 h	survival	LC50	7,341	-	Adelman et al. (1975)
Lake Trout	*Salvelinus namaycush*	-	$CaCl_2$	24 h	survival	NOEC	10,000	-	Waller et al. (1996)
Mollie Fish	*Mollienesia latipinna*	-	NaCl	48 h	survival	LC50	16,595	-	Dowden and Bennett (1965)
Pink Salmon	*Oncorhynchus gorbuscha*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	LOEC	250	-	Stekoll et al. (2003)
Pink Salmon	*Oncorhynchus gorbuscha*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	NOEC	<250	-	Stekoll et al. (2003)

Table A-4 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Fish (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Rainbow Trout	*Oncorhynchus mykiss*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	LOEC	750	-	Stekoll et al. (2003)
Rainbow Trout	*Oncorhynchus mykiss*	-	TDS (primarily $CaSO_4$)	24 h	fertilization	NOEC	500	-	Stekoll et al. (2003)
Rainbow Trout	*Oncorhynchus mykiss*	eggs (water hardening)	Ca^{2+} ($CaSO_4$)	fertilization to eye-up	survival	23% survival	520	-	Ketola et al. (1988)
Rainbow Trout	*Oncorhynchus mykiss*	-	$CaCl_2$	24 h	survival	LC16	10,000	-	Waller et al. (1996)
Rainbow Trout	*Oncorhynchus mykiss*	-	$CaCl_2$	-	spermatozoa activity	-	15,229	-	Stoss et al. (1977)
Rainbow Trout	*Oncorhynchus mykiss*	-	Cl^-	96 h	survival	LC50	6,030	-	Elphick et al. (2011a)
Rainbow Trout	*Oncorhynchus mykiss*	-	$MgCl_2$	-	spermatozoa activity	-	11,749	-	Stoss et al. (1977)
Rainbow Trout	*Oncorhynchus mykiss*	juveniles	NaCl	96 h	survvial	LC50	18,250	Road Maintenance Salt	Vosyliene et al. (2006)
Rainbow Trout	*Oncorhynchus mykiss*	juveniles	NaCl	96 h	survival	LC50	20,380	Common Salt	Vosyliene et al. (2006)
Rainbow Trout	*Oncorhynchus mykiss*	-	NaCl	-	spermatozoa activity	-	16,010	-	Stoss et al. (1977)
Striped Bass	*Morone saxatilis*	-	NaCl	24 h	survival	LC50	1,400	3 mg/L calcium (dependent on Na:Ca ratio)	Grizzle and Mauldin (1995)

Table A-4 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Fish (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Striped Bass	*Morone saxatilis*	-	NaCl	24 h	survival	LC50	18,200	100 mg/L calcium (dependent on Na:Ca ratio)	Grizzle and Mauldin (1995)
Chronic									
Arctic Grayling	*Thymallus arcticus*	eggs	TDS (47% chloride)	64 d	survival	LC20	>1,414	-	Nautilus (2013a)
Arctic Grayling	*Thymallus arcticus*	eggs	TDS (47% chloride)	64 d	growth	IC20	>1,414	-	Nautilus (2013a)
Brown Trout	*Salmo trutta fario*	2 month old fingerlings	NaCl	8 d	survival	NOEC	1,000	-	Camargo and Tarazona (1991)
Fathead Minnow	*Pimephales promelas*	larvae	KCl	7 d	survival	NOEC	500	-	Pickering et al. (1996)
Fathead Minnow	*Pimephales promelas*	larvae	KCl	7 d	survival	LOEC	1,000	-	Pickering et al. (1996)
Fathead Minnow	*Pimephales promelas*	larvae	NaCl	7 d	survival	NOEC	4,000	-	Pickering et al. (1996)
Fathead Minnow	*Pimephales promelas*	larvae	NaCl	7 d	survival	LOEC	8,000	-	Pickering et al. (1996)
Fathead Minnow	*Pimephales promelas*	eggs	NaCl	33 d	survival	LC80	1,650	-	Birge et al. (1985; cited by Evans and Frick 2001)
Fathead Minnow	*Pimephales promelas*		Cl^-	32 d	biomass	IC25	704	-	Elphick et al. (2011a)
Lake Trout	*Salvelinus namaycush*	eggs	TDS (47% chloride)	140 d	survival	LC20	991	-	Nautilus (2013a)
Lake Trout	*Salvelinus namaycush*	eggs	TDS (47% chloride)	140 d	growth	IC20	>1,490	-	Nautilus (2013a)
Rainbow Trout	*Oncorhynchus mykiss*	embryos	TDS (70% sulfate)	7 d	viability	NOEC	1,999	Red Dog Mine	Chapman et al. (2000)

Table A-4 Toxicity of Total Dissolved Solids and Constituent Ions to Freshwater Fish (continued)

Common Name	Scientific Name	Life Stage Tested	TDS Component	Test Duration [h or d]	Biological Measurement	Endpoint	Effects Concentration [mg/L]	Comments	Reference
Rainbow Trout	*Oncorhynchus mykiss*	fry	TDS (70% sulfate)	7 d	survival and growth	NOEC	1,999	Red Dog Mine	Chapman et al. (2000)
Rainbow Trout	*Oncorhynchus mykiss*	fry	TDS (50% sulfate)	7 d	survival and growth	NOEC	2,080	Kensington Mine	Chapman et al. (2000)
Rainbow Trout	*Oncorhynchus mykiss*	-	Cl^-	56 d	biomass	IC25	1,174	-	Elphick et al. (2011a)
Rainbow Trout	*Oncorhynchus mykiss*	2 month old fingerlings	NaCl	8 d	survival	NOEC	800	-	Camargo and Tarazona (1991)

Notes: LCx = concentration of sample estimated to be lethal to x% of the test organisms.
ECx = concentration of sample estimated to cause a specified effect to x% of the test organisms.
ICx = the inhibiting concentration for an x% effect; it is the concentration of sample estimated to cause x% reduction in growth or fecundity of the test organisms.
NOEC = no observed effect concentration; LOEC = lowest observed effect concentration; $CaCl_2$ = calcium chloride; $CaSO_4$ = calcium sulfate; KCl = potassium chloride; $MgCl_2$ = magnesium chloride; NaCl = sodium chloride; Cl^- = chloride ion; Ca^{2+} = calcium ion; TDS = total dissolved solids; h = hours; d = days; mg/L = milligrams per litre;% = percent; >= greater than; <= less than; - = no information available.

APPENDIX B

NAUTILUS (2012) LABORATORY REPORT: EVALUATION OF THE EFFECTS OF TOTAL DISSOLVED SOLIDS (TDS) ON AQUATIC ORGANISMS

Nautilus Environmental

Evaluation of the Effects of Total Dissolved Solids (TDS) on Aquatic Organisms

Final Report

Report date: April 27, 2012

Submitted to:

GOLDER ASSOCIATES
Burnaby, BC

8664 Commerce Court
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1.0 INTRODUCTION

Nautilus Environmental conducted toxicity tests for Golder Associates to evaluate the effects of a site-specific mixture of Total Dissolved Solids (TDS) on selected aquatic organisms. The study was conducted in two phases. Phase 1 involved testing to identify effect concentrations of TDS for five test species using the ratio of major ions currently present at the site of interest. Phase 2 focused on the most sensitive species identified in Phase 1, and examined the role of selected major TDS constituent ions on toxicity. Toxicity was evaluated with a suite of invertebrate algal and chronic toxicity tests, including the 3-brood *Ceriodaphnia dubia* (water flea) survival and reproduction test, the 21-d *Daphnia magna* (water flea) survival and reproduction test, the 48-h *Brachionus calyciflorus* (rotifer) reproduction test, the 120-h *Navicula pelliculosa* (diatom) growth inhibition test and the 72-h *Pseudokirchneriella subcapitata* (green alga) growth inhibition test. Results from similar testing for the effect of TDS on *Chironomus dilutus* have been provided previously in a separate report (Nautilus Environmental 2011).

This report describes the results of the toxicity tests and the relationships of elevated TDS and specific ions to toxicity. The results presented herein only relate to the composition of the samples tested.

2.0 METHODS

2.1 Synthetic Lake Water and Test Solution Preparation

2.1.1 Phase 1

The composition of the synthetic lake water used for the Phase 1 study was based on concentrations of major ions present at the site of interest. The synthetic lake water was prepared by dissolving reagent-grade sodium, potassium, calcium and magnesium salts (i.e., NaCl, KCl, $MgCl_2.6H_2O$, $MgSO_4$ $CaCl_2$, $CaSO_4.2H_2O$ and $NaHCO_3$) in reverse osmosis-treated (RO) water; concentrations of salts added to prepare the water are summarized in Table 1. The nominal TDS concentration of the synthetic lake water was approximately 1500 mg/L, with individual ions present in ratios representative of the current site-specific receiving environment conditions. Two batches of synthetic lake water were prepared, with the first being used for tests with *C. dubia, D. magna, B. calyciflorus* and *P. subcapitata*, and the second for *N. peliculosa*, since this test was conducted well after the tests with the other species.

Dilutions of the synthetic lake water were then prepared using a 0.67 times dilution factor to achieve a nominal concentration series of 1500, 1000, 667, 444, 296, 198 and 132 mg TDS/L. The test solutions were analyzed for ionic composition by ALS Laboratory Group (Burnaby, BC) to verify the concentrations of the major ions, which were then used to calculate total dissolved solids. The TDS concentrations were also measured gravimetrically and are provided in the report appendices for information purposes, but were not used in the statistical analyses of the data. Actual measured TDS concentrations presented in this report were calculated from measured concentrations of ionic constituents (spreadsheets showing these TDS calculations, as well as the ALS analytical reports, are provided in the report appendices).

Table 1. Concentrations (mg/L) of salts used to prepare synthetic TDS mixtures.

Constituent Added	1500 mg/L solution	450 mg/L solution
NaCl	291.8	87.5
KCl	26.3	7.9
$MgCl_2.6H_2O$	16.5	5.0
$MgSO_4$	161.3	48.4
$CaCl_2.2H_2O$	1105.9	331.8
$NaHCO_3$	185.3	55.6
Total (excluding hydration water)	**1516.2**	**454.9**

2.1.2 Phase 2

The objective of the Phase 2 testing was to determine whether changes to the ionic composition of the synthetic lake water would affect TDS toxicity, by varying the concentrations of the major individual ionic constituents (chloride, calcium, sodium, and sulphate). The most sensitive species identified in Phase 1 were the cladocerans *C. dubia* and *D. magna* and, therefore, Phase 2 testing was only performed with these two species. The nominal baseline TDS concentration used in Phase 2 targeted a TDS concentration that was identified in Phase 1 as being unlikely to cause toxicity to these species. The target TDS nominal concentration of the baseline solution was 450 mg/L TDS, which was approximately half the concentration associated with the IC25 in the Phase 1 tests with these species. This solution was prepared similarly to Phase 1 by adding individual salts to RO water (Table 1); thus, the Phase 2 baseline TDS solution maintained the same ratios of anions and cations, but at a lower overall nominal TDS concentration than the synthetic lake water used in Phase 1 (i.e., 450 mg/L vs 1500 mg/L).

A range of nominal test concentrations (607, 817, 1132 and 1500 mg/L TDS) was then prepared using this 450 mg/L TDS solution separately for each of the following four salts: NaCl, Na_2SO_4, $CaCl_2$ and $CaSO_4$. For example, 1050 mg/L NaCl was added to the baseline 450 mg/L TDS solution to increase the TDS to the highest nominal concentration of 1,500 mg/L; intermediate concentrations were then prepared by diluting the highest concentration with appropriate amounts of the 450 mg/L baseline TDS solution. Thus, the final concentration series was 450, 607, 817, 1,132 and 1,500 mg/L TDS for each of the four salts. A single batch of each of the salt-spiked TDS treatments was prepared for use throughout the exposure period for each species. The test solutions were analyzed for ionic composition by ALS Laboratory Group (Burnaby, BC) to verify the concentrations of the major ions as well as gravimetric measurement of total dissolved solids. For *C. dubia*, the measured concentrations are presented as the mean of values measured at test initiation and termination and for *D. magna*, as concentrations measured at test initiation.

Tests using the four salts were set up simultaneously in a single test design so that the results from the four salts could be directly compared and so that uncertainty associated with batch-to-batch variability in test organism sensitivity was minimized. Thus, the tests using the four salts shared the same control and 450 mg/L TDS exposures, and all of the exposures were established simultaneously using a single batch of test organisms. This approach reflects a planned deviation from typical practice, which would utilize separate controls for each test, but was considered appropriate to minimize variability associated with the study.

2.2 Toxicity Test Procedures

General methods for the toxicity tests are summarized in Tables 2 to 6. Testing with *Ceriodaphnia dubia* and *Pseudokirchneriella subcapitata* followed Environment Canada protocols (2007a and 2007b, respectively). The *Brachionus calyciflorus* test was conducted following procedures specified by the Washington Department of Ecology (WDOE 2008), which are based on procedures from Snell and Moffat (1992). The *Daphnia magna* and *Navicula pelliculosa* tests were performed according to American Society for Testing and Materials methods (ASTM 2004a and 2004b, respectively).

Table 2. Summary of test conditions for the *Ceriodaphnia dubia* survival and reproduction test.

Test organism	*Ceriodaphnia dubia*
Test organism source	In-house culture
Test organism age	< 24-h old neonates produced within 12 hr
Test type	Static-renewal
Test duration	7 ± 1 day
Test chamber	20-mL test tube
Test solution volume	15 mL
Test concentrations (% sample)	Seven concentrations, plus laboratory control (Phase 1) Five concentrations, plus laboratory control (Phase 2)
Number of replicates	10
Control water	20% Perrier water (hardness 80-100 mg/L $CaCO_3$)
Test solution renewal	Daily
Test temperature	25 ± 1°C
Number of organisms/chamber	1
Feeding	Daily, with *P. subcapitata* and YCT
Light intensity	100 to 600 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	Environment Canada (2007a), EPS 1/RM/21
Test endpoints	Survival and reproduction
Test acceptability criterion for controls	≥80% survival; ≥15 young per surviving control female; ≥60% of controls producing three or more broods

Table 3. Summary of test conditions for the 21-d *Daphnia magna* survival and reproduction toxicity test.

Test organism	*Daphnia magna*
Test organism source	In-house culture
Test organism age	< 24 h
Test type	Static-renewal
Test duration	21 d
Test chamber	250-mL glass beakers
Test solution volume	100 mL
Test concentrations (% sample)	Seven concentrations, plus laboratory control (Phase 1) Five concentrations, plus laboratory control (Phase 2)
Number of replicates	10
Control water	Moderately-hard reconstituted water (hardness 80-100 mg/L)
Test solution renewal	Three times per week
Test temperature	20 ± 2°C
Number of organisms/chamber	1
Feeding	Daily with *P. subcapitata* and YCT
Light intensity	400 to 800 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	ASTM (2004b)
Test endpoint	Survival and reproduction
Test acceptability criteria for controls	Survival ≥ 70%; ≥60 young per surviving control female

Table 4. Summary of test conditions for the 48-h *Brachionus calyciflorus* reproduction test.

Test organism	*Brachionus calyciflorus*
Test organism source	Brine Shrimp Direct
Test organism age	< 2 h-post hatch
Test type	Static
Test duration	48 h
Test chamber	Microplate
Test solution volume	0.5 mL
Test concentrations	7 concentrations, plus laboratory control
Number of replicates	8
Control water	Moderately-hard reconstituted water (hardness 80-100 mg/L)
Test solution renewal	None
Test temperature	25 ± 1°C
Number of organisms/chamber	1
Feeding	*P. subcapitata* at test initiation
Light intensity	None
Photoperiod	0 hours light/24 hours dark
Aeration	None
Test protocol	Snell and Moffat (1992); WDOE (2008)
Test endpoint	Growth Rate (intrinsic rate of population increase; r)
Test acceptability criteria for controls	r ≥ 0.7

Table 5. Summary of test conditions for the 120-h *Navicula pelliculosa* growth inhibition test.

Test organism	*Navicula pelliculosa*
Test organism source	In-house culture of strain #UTEXB674
Test organism age	Culture in logarithmic growth phase
Test type	Static
Test duration	120 h
Test chamber	250-mL Erlenmeyer flask
Test solution volume	100 mL
Test concentrations	Seven concentrations, plus laboratory control
Number of replicates	3 for treatments; 6 for control
Control water	ASTM Type 1 water nutrient addition
Test solution renewal	None
Test temperature	24 ± 2°C
Number of organisms/chamber	10,000 cells/mL
Light intensity	3600 to 4600 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	ASTM (2004a)
Test endpoint	Algal cell growth inhibition
Test acceptability criteria for controls	16-fold increase in number of diatoms

Table 6. Summary of test conditions for the 72-h *Pseudokirchneriella subcapitata* growth inhibition test.

Test organism	*Pseudokirchneriella subcapitata*
Test organism source	In-house culture
Test organism age	3 to 7-day old culture in logarithmic growth phase
Test type	Static
Test duration	72 h
Test chamber	Microplate
Test solution volume	220 µL
Test concentrations	Seven concentrations, plus laboratory control
Number of replicates	4 for treatments; 8 for control
Control/Dilution water	RO water supplemented with nutrients
Test solution renewal	None
Test temperature	24 ± 2°C
Number of organisms/chamber	10,000 cells/mL
Light intensity	3600 to 4600 lux
Photoperiod	Continuous light
Aeration	None
Test protocol	Environment Canada (2007b), EPS 1/RM/25
Test endpoint	Algal cell growth inhibition
Test acceptability criteria for controls	≥ 16-fold increase in number of algal cells; control must not exhibit a positive or negative trend with Mann-Kendall test; and the coefficient of variation of the control replicates must not exceed 20%.

2.3 Statistical Analysis

Statistical calculations were based on actual TDS values that were determined by summing the measured concentrations of individual ions present. This approach was considered a more accurate measure of the total dissolved solids present in the mixtures than a simple gravimetric procedure that involved filtration, drying and weighing the residual solids.

The data were analyzed using curve fitting such that the observed responses were modeled as a mathematical function of concentration, (Environment Canada 2005). Curve fitting allows for derivation of point estimates to identify concentrations most likely associated with specific levels of effect; the curve fits and point estimates were generally obtained using 3-parameter Log-Gompertz non-linear regressions. Gompertz distributions are attractive for this purpose because they do not assume symmetry around the mid-point of the response distribution. In rare cases, where the concentration-response precluded the use of non-linear regression (e.g., interrupted concentration-response), point estimates were estimated using ICP (linear interpolation) (Environment Canada 2005).

Statistical analyses for all the tests were performed using the software CETIS (Tidepool Scientific Software, 2011).

2.4 Quality Assurance/Quality Control (QA/QC)

Nautilus follows a comprehensive QA/QC program to ensure that all data generated are of high quality and are scientifically defensible. To meet these objectives, quality control procedures include the following:

- Negative controls to ensure that appropriate testing performance criteria are met;
- Positive controls to assess the health and sensitivity of the test organisms;
- Use of appropriate species, life stage and test methods to meet the study objectives;
- Appropriate number of replicates to allow the proper statistical analyses;
- Calibration and proper maintenance of instruments to ensure accurate measurements;
- Proper documentation and recordkeeping to allow traceability of performance;
- Adequate supervision and training of staff to ensure that methods are followed;
- Proper handling and storage of samples to ensure sample integrity;

- Procedures in place to address issues that may arise during testing and ensure the implementation of appropriate corrective actions; and,
- Rigorous review of data by a Registered Professional Biologist to ensure they are of good quality and are scientifically defensible prior to release to the client.

3.0 RESULTS

Results from the toxicity tests are provided in Appendices A through C, and are summarized below. Datasheets provided in the Appendices identify the water used in the tests as a "synthetic effluent", which is meant to refer to the synthetic lake water sample, prepared by addition of salts to RO water.

3.1 Phase 1

Survival of *C. dubia* was not adversely affected in TDS concentrations ≤ 1474 mg/L. Conversely, reproduction was affected, resulting in IC25 and IC50 estimates for reproduction of 875 and 1368 mg/L, respectively (Table 7). Similar results were obtained for reproduction of *D. magna* (Table 8). In this case, the IC25 and IC50 estimates for reproduction were 893 and >1474 mg/L. Survival of *D. magna* ranged from 60 to 100% in the test concentrations, but did not vary in a dose-dependent manner, suggesting that these were random mortalities rather than being associated with TDS.

In the case of *B. calyciflorus*, all concentrations of TDS had a lower intrinsic rate of reproduction than the control response (Table 9). However, this is considered to be a test artifact, rather than reflecting an adverse response to TDS, since there was no evidence of a concentration-response across the range of TDS from 132 to 1474 mg/L (i.e., there was no increase in adverse response as TDS increased from 132 to 1474 mg/L). Furthermore, the control water contained a higher concentration of TDS (~200 mg/L, with differing ionic composition to the sample) than the lowest test concentration of 132 mg/L, indicating that TDS could not explain the lower reproductive rate in the 132 mg/L TDS solution relative to the control. Consequently, the data were analyzed using the response in the 132 mg/L TDS as the control in order to account for this apparent artifact, resulting in point estimates (i.e., IC20, IC25 and IC50) that were greater than the highest concentration tested (i.e., >1474 mg/L TDS).

No adverse effects were observed with *N. pelliculosa* (Table 10) or *P. subcapitata* (Table 11), even at the highest concentration tested (i.e., approximately 1500 mg/L nominal TDS). Indeed, growth of both species was enhanced in all concentrations of the TDS mixture relative to the laboratory control.

Table 7. Toxicity test results for the 3-brood *Ceriodaphnia dubia* survival and reproduction test (Phase 1). Reproduction data are presented as mean ± SD.

Concentration (mg/L TDS)		Survival (%)	Reproduction (No. of Young/Female)
Nominal	Measured (Sum of Ions)		
Control	-	100	18.3 ± 8.9
132	131	90	15.1 ± 5.2
198	196	100	16.5 ± 3.3
296	287	100	19.5 ± 6.5
444	428	100	13.9 ± 5.6
667	650	100	15.5 ± 2.5
1000	974	100	11.9 ± 6.3
1500	1474	100	7.7 ± 3.9
Test endpoint (mg/L TDS)			
	LC20	>1474	--
	LC25	>1474	--
	LC50	>1474	--
	IC20 (95% CL)	--	778 (420 – 1060)
	IC25 (95% CL)	--	875 (569 – 1153)
	IC50 (95% CL)	--	1368 (1016 – 1842)

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits.

Table 8. Toxicity test results for the 21-d *Daphnia magna* survival and reproduction test (Phase 1). Reproduction data are presented as mean ± SD.

Concentration (mg/L TDS)		Survival (%)	Reproduction (No. of Young/Female)
Nominal	**Measured (Sum of Ions)**		
Control	-	100	110.4 ± 27.8
132	131	100	122.4 ± 20.5
198	196	90	99.4 ± 30.7
296	287	90	110.2 ± 12.2
444	428	70	94.1 ± 34.0
667	650	60	94.5 ± 10.4
1000	974	90	78.7 ± 9.1
1500	1474	80	76.1 ± 42.5
Test endpoint (mg/L TDS)			
	LC20 (95% CL)	662 (377 – 1771)	--
	LC25 (95% CL)	1080 (627 – 6209)	--
	LC50 (95% CL)	>1474	--
	IC20 (95% CL)	--	684 (415 – 984)
	IC25 (95% CL)	--	893 (595 – 1227)
	IC50 (95% CL)	--	>1474

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits

Table 9. Toxicity test results for the 48-h *Brachionus calyciflorus* reproduction test (Phase 1).

Concentration (mg/L TDS)		
Nominal	**Measured (Sum of Ions)**	**Intrinsic rate of reproduction (r) (Mean ± SD)**
Control	-	0.82 ± 0.14
132	131	0.67 ± 0.16
198	196	0.72 ± 0.10
296	287	0.44 ± 0.31
444	428	0.67 ± 0.18
667	650	0.56 ± 0.19
1000	974	0.52 ± 0.25
1500	1474	0.66 ± 0.14
Test endpoint (mg/L TDS)		
	IC20	>1474
	IC25	>1474
	IC50	>1474

IC = Inhibition Concentration; SD = Standard Deviation.

Table 10. Toxicity test results for the 120-h *Navicula pelliculosa* growth inhibition test (Phase 1).

Concentration (mg/L TDS)		
Nominal	**Measured (Sum of Ions)**	**Cell Yield (x 10^4 cells/mL) (Mean ± SD)**
Control	-	19.0 ± 2.4
132	196	28.7 ± 4.2
198	248	38.0 ± 12.5
296	453	35.3 ± 6.7
444	455	29.0 ± 5.6
667	629	34.3 ± 3.5
1000	968	24.7 ± 4.2
1500	1487	23.0 ± 7.9
Test endpoint (mg/L TDS)		
	IC20	> 1487
	IC25	> 1487
	IC50	> 1487

IC = Inhibition Concentration; SD = Standard Deviation.

Table 11. Toxicity test results for the 72-h *Pseudokirchneriella subcapitata* growth inhibition test (Phase 1).

Concentration (mg/L TDS)		
Nominal	**Measured (Sum of Ions)**	**Cell Yield (x 10^4 cells/mL) (Mean ± SD)**
Control	-	75.5 ± 5.3
132	131	214.3 ± 8.1
198	196	197.8 ± 11.3
296	287	186.5 ± 22.5
444	428	193.3 ± 8.8
667	650	167.3 ± 14.8
1000	974	181.5 ± 11.5
1500	1474	159.3 ± 17.5
Test endpoint (mg/L TDS)		
	IC20	>1474
	IC25	>1474
	IC50	>1474

IC = Inhibition Concentration; SD = Standard Deviation.

3.2 Phase 2

3.2.1 Ceriodaphnia dubia

Results for *C. dubia* are presented in Tables 12 - 15. Based on the IC25 estimates, elevated TDS dominated by calcium salts exhibited greater toxicity (i.e., lower IC25s) than sodium salts with the same anions (i.e., chloride or sulphate). For a given cation (i.e., Na or Ca), there did not appear to be a substantial difference in toxicity between the chloride and sulphate salts.

Table 12. Toxicity test results for the *Ceriodaphnia dubia* survival and reproduction test with NaCl (Phase 2).

Concentration (mg/L TDS)		NaCl	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	100	25.9 ± 2.1
450	460	100	21.2 ± 6.4
607	636	100	23.8 ± 3.7
817	852	100	19.3 ± 6.8
1132	1160	90	20.2 ± 5.8
1500	1561	100	9.2 ± 6.1
Test endpoint (mg/L TDS)			
	LC20	>1561	--
	LC25	>1561	--
	LC50	>1561	--
	IC20 (95% CL)	--	1170 (NA – 1513)
	IC25 (95% CL)	--	1234 (NA - 1563)
	IC50 (95% CL)	--	1482 (1144 - 1790)

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits; NA = Not available.

Table 13. Toxicity test results for the *Ceriodaphnia dubia* survival and reproduction test with Na_2SO_4 (Phase 2).

Concentration (mg/L TDS)		Na_2SO_4	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	100	25.9± 2.1
450	460	100	21.2 ± 6.4
607	623	100	21.9 ± 2.2
817	833	100	20.4 ± 4.7
1132	1200	100	19.7 ± 3.2
1500	1554	90	17.7 ± 7.1
Test endpoint (mg/L TDS)			
	LC20	>1554	--
	LC25	>1554	--
	LC50	>1554	--
	IC20 (95% CL)	--	758 (490 – 1086)
	IC25 (95% CL)	--	1131 (789 - 1542)
	IC50 (95% CL)	--	>1554

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits.

Table 14. Toxicity test results for the *Ceriodaphnia dubia* survival and reproduction test with $CaSO_4$ (Phase 2).

Concentration (mg/L TDS)		$CaSO_4$	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	100	25.9± 2.1
450	460	100	21.2 ± 6.4
607	628	90	14.8 ± 6.0
817	846	100	12.2 ± 6.0
1132	1173	90	15.2 ± 5.3
1500	1517	10	1.3 ± 4.1
Test endpoint (mg/L TDS)			
	LC20	1240 (1157 – 1298)	--
	LC25	1260 (1182-1316)	--
	LC50	1344 (1282-1401)	--
	IC20 (95% CL)	--	428 (265 – 578)
	IC25 (95% CL)	--	505 (353-652)
	IC50 (95% CL)	--	896 (768-1035)

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits.

Table 15. Toxicity test results for the *Ceriodaphnia dubia* survival and reproduction test with $CaCl_2$ (Phase 2).

Concentration (mg/L TDS)		$CaCl_2$	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	100	25.9± 2.1
450	460	100	21.2 ± 6.4
607	620	100	18.0 ± 3.7
817	845	90	15.7 ± 6.2
1132	1163	80	9.3 ± 7.9
1500	1516	100	4.8 ± 2.5
Test endpoint (mg/L TDS)			
	LC20	>1516	--
	LC25	>1516	--
	LC50	>1516	--
	IC20 (95% CL)	--	509 (379 – 627)
	IC25 (95% CL)	--	586 (464 - 700)
	IC50 (95% CL)	--	950 (846 - 1059)

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits.

3.2.2 Daphnia magna

Results for *D. magna* are presented in Tables 16 - 19. Interpreting the results from the 21-day *D. magna* tests is less straightforward than with the *C. dubia* because of intermittent mortalities present in the intermediate concentrations of most of the ions tested, and higher variability overall. Because reproductive output is calculated as a function of the initial number of organisms present, reduced survival reduces the overall number of young produced and, consequently, the calculated young production per initial female. This can result in reduced young production in individual concentrations due to random mortality, rather than associated with a response that is related to increasing test concentrations (see Tables 16 – 19). This level of uncertainty is reflected in the wide range in the confidence intervals for the point estimates such as the IC25.

The data for the test using NaCl were particularly problematic to analyze and had to be evaluated using linear interpolation, rather than non-linear regression, as a result of the variable concentration-response. The results from this test should be considered with caution, since the

low effect levels (such as IC20 and IC25) may have been considerably affected by 30 to 40% mortality that was observed in two of the middle test concentrations. These mortalities likely occurred by chance alone, rather than reflecting a toxicological property of the sample, based on the fact that there was no concentration-response associated with the effects (i.e., the rate of mortality did not increase with increasing concentration of TDS).

Regardless of the variability present within some of the *D. magna* tests, the data suggest a similar level of sensitivity to different salts, which is contrary to the findings using *C. dubia*. For example, if we look at responses in just the nominal TDS concentration of 1,132 mg/L where survival was consistently high across salts (i.e., 80 – 90%), young production across salts averaged approximately 44 young per female, with a low of 39 and a high of 49 depending on which salt was added. Thus, the reproductive rate associated with this concentration of TDS was relatively similar for the four salts.

Table 16. Toxicity test results for the 21-d *Daphnia magna* survival and reproduction test with NaCl (Phase 2).

Concentration (mg/L TDS)		NaCl	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	579	70	25.8 ± 29.8
817	817	60	25.4 ± 31.3
1132	1166	90	39.8 ± 26.7
1500	1556	100	47.7 ± 18.9
Test endpoint (mg/L TDS)			
	LC20	>1556	--
	LC25	>1556	--
	LC50	>1556	--
	IC20 (95% CL)	--	493 (443 – 539)
	IC25 (95% CL)	--	508 (463 - 569)
	IC50 (95% CL)	--	> 1556

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits.

Table 17. Toxicity test results for the 21-d *Daphnia magna* survival and reproduction test with Na_2SO_4 (Phase 2).

Concentration (mg/L TDS)		Na_2SO_4	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	625	90	59.0 ± 21.3
817	843	60	39.7 ± 35.5
1132	1193	80	43.0 ± 24.1
1500	1566	80	45.3 ± 22.6
Test endpoint (mg/L TDS)			
	LC20	804 (576 – NA)	--
	LC25	>1566	--
	LC50	>1566	--
	IC20 (95% CL)	--	766 (282 – 1296)
	IC25 (95% CL)	--	964 (507 - 1472)
	IC50 (95% CL)	--	> 1566

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits; NA = Not Available.

Table 18. Toxicity test results for the 21-d *Daphnia magna* survival and reproduction test with $CaSO_4$ (Phase 2).

Concentration (mg/L TDS)		$CaSO_4$	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	614	70	42.3 ± 32.4
817	828	100	59.6 ± 7.7
1132	1162	90	49.4 ± 22.2
1500	1531	80	51.0 ± 30.2
Test endpoint (mg/L TDS)			
	LC20	>1531	--
	LC25	>1531	--
	LC50	>1531	--
	IC20 (95% CL)	--	1235 (195 – 3067)
	IC25 (95% CL)	--	>1531
	IC50 (95% CL)	--	>1531

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits.

Table 19. Toxicity test results for the 21-d *Daphnia magna* survival and reproduction test with $CaCl_2$ (Phase 2).

Concentration (mg/L TDS)		$CaCl_2$	
		Mean ± SD	
Nominal	**Measured (Sum of Ions)**	**Survival (%)**	**Reproduction (No. of Young/Female)**
Control	-	90	63.5± 24.5
450	436	100	65.9 ± 12.6
607	607	100	57.8 ± 20.4
817	826	80	43.7 ± 32.9
1132	1160	80	43.2 ± 27.1
1500	1523	70	35.0 ± 30.2
Test endpoint (mg/L TDS)			
	LC20 (95% CL)	1247 (724 – NA)	--
	LC25(95% CL)	1423 (756 – NA)	--
	LC50	>1523	--
	IC20 (95% CL)	--	756 (332 – 1123)
	IC25 (95% CL)	--	888 (513-1240)
	IC50 (95% CL)	--	>1523

LC = Lethal Concentration; IC = Inhibition Concentration; SD = Standard Deviation; CL = Confidence Limits; NA = Not available.

4.0 IMPLICATIONS FOR RISK ASSESSMENT

The results of Phase 1 tests suggested that the cladocerans were the most sensitive of the species tested to elevated TDS. IC25 estimates for the reproductive endpoints for *C. dubia* and *D. magna* were significantly lower than estimates for chronic endpoints for the rotifer and algal species tested. The follow-up Phase 2 studies with individual salts using *C. dubia* suggested that: 1) calcium salts were more toxic than sodium salts, and 2) chloride was less toxic than sulphate. The *D. magna* tests were not as clear in their results, partly as a result of higher variability in the response of this test organism at intermediate test concentrations.

TDS concentrations associated with thresholds for adverse effects can be estimated based on point estimates associated with a specific, but presumably not biologically significant, level of effect. Risk assessments often utilize point estimates associated with a 20-percent effect level as an appropriate measures of effect to constitute a threshold for effect for aquatic organisms (e.g., BCMELP 1998). Consequently, IC20s for the different TDS mixtures were estimated from the fitted response curves and are summarized in Table 20, along with general observations regarding toxicity.

Overall, the data suggest that 1) there is considerable variability in sensitivity between species, and 2) there is also considerable variability in sensitivity to different salts, the extent of which may also vary between species. Collectively, these data suggest that water quality limits for TDS should consider site-specific issues with respect to actual ionic composition of a given discharge, as well as species present in the receiving environment.

Table 20. Summary of IC20 and LC20 concentrations associated with aquatic different species and different salt preparations. Phase 1 tests were conducted on the TDS base mixture and Phase 2 tests were conducted on the TDS base mixture augmented separately with different salts.

Test Species	Phase 1 Results	Phase 2 Results	Comments
Pseudokirchneriella subcapitata (green algae)	IC20 >1,474 mg/L	Not tested	All concentrations exceeded control
Brachionus calyciflorus (rotifer)	IC20 >1,474 mg/L	Not tested	No concentration-response for TDS
Navicula pelliculosa (diatom)	IC20 > 1,487mg/L	Not tested	All concentrations exceeded control
Ceriodaphnia dubia (cladoceran)	IC20 778 mg/L	IC20 NaCl salt: 1170 mg/L as TDS	
	LC20 >1474 mg/L	LC20 NaCl salt: >1561 mg/L as TDS	Calcium salts generally higher in
		IC20 Na_2SO_4 salt: 758 mg/L as TDS	toxicity than sodium salts; sodium
		LC20 Na_2SO_4 salt: >1554 mg/L as TDS	salts generally similar in sensitivity
		IC20 $CaSO_4$ salt: 428 mg/L as IC20	to synthetic effluent tested in Phase 1.
		LC20 $CaSO_4$ salt: 1240 mg/L as TDS	
		IC20 $CaCl_2$ salt: 509 mg/L as TDS	
		IC20 $CaCl_2$ salt: >1516 mg/L TDS	
Daphnia magna (cladoceran)	IC20 684 mg/L	IC20 NaCl salt: 493 mg/L as TDS	
	LC20 662 mg/L	LC20 NaCl salt: >1556 mg/L as TDS	Each of the four salts appeared
		IC20 Na_2SO_4 salt: 766 mg/L as TDS	similar in toxicity, and similar to the
		LC20 Na_2SO_4 salt: 804 mg/L as TDS	synthetic effluent tested in Phase 1.
		IC20 $CaSO_4$ salt: 1235 mg/L as IC20	The test using NaCl produced a high
		LC20 $CaSO_4$ salt: >1531 mg/L as TDS	degree of variability which
		IC20 $CaCl_2$ salt: 756 mg/L as TDS	complicates statistical analysis of that
		IC20 $CaCl_2$ salt: 1247 mg/L TDS	test.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

All the tests reported herein met the acceptability criteria for test validity specified in the respective protocols, and water quality parameters measured during the toxicity tests were within acceptable ranges.

Reference toxicant tests conducted during this testing program were generally all within the laboratory's historical range of values; however, insufficient numbers of reference toxicant data points were available for *B. calyciflorus* and *N. pelliculosa* to construct meaningful control charts. The reference toxicant test results are summarized in Table 21.

Table 21. Reference toxicant test results.

Test Species		Endpoint	Mean (2SD Range)	CV (%)	Test Date
C. dubia	Test 1	Survival (IC50): 1.6 g/L NaCl	1.8 (1.5 – 2.3) g/L NaCl	12	June 14, 2011
		Reproduction (IC50): 1.0 g/L NaCl	1.1 (0.9 – 1.5) g/L NaCl	13	
	Test 2	Survival (IC50): 1.7 g/L NaCl	1.8 (1.5 – 2.3) g/L NaCl	12	July 12, 2011
		Reproduction (IC50): 1.4 g/L NaCl	1.1 (0.9 – 1.5) g/L NaCl	15	
B. calyciflorus		Growth Rate (IC50): 3250 mg /L NaCl	[A]	[A]	July 6, 2011
N. pelliculosa		Growth (IC50): 33.0 µg/L Zn	[A]	[A]	October 20, 2011
P. subcapitata		Growth (IC50): 28.9 µg/L Zn	26.7 (14.4 – 49.4) µg/L Zn	36	June 27, 2011
D. magna	Test 1	Survival (LC50): 4.2 g/L NaCl	4.0 (3.6 – 4.4) g/L NaCl	5	July 12, 2011
	Test 2	Survival (LC50): 4.2 g/L NaCl	4.0 (3.6 – 4.4) g/L NaCl	6	September 14, 2011

([A]) Insufficient historical data points to generate mean, range and CV values for this test organism.

6.0 REFERENCES

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APPENDIX A – Phase I Toxicity Test Data

Ceriodaphnia dubia Summary Sheet

PHASE I

Client: GOLDER
Work Order No.: 11299

Start Date/Time: June 24, 2011 1115h
Set up by: KLB

Sample Information:

Sample ID: Synthetic Effluent (TDS)
Sample Date: prep. in-house
Date Received: NA
Sample Volume: NA

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 061411
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 26
Mortality (%) in previous 7 d: 0
Individual female # used ≥8 young on test day: 1, 2, 3, 4, 5, 6

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd68
Stock Solution ID: 11Na01
Date Initiated: June 14, 2011

7-d LC50 (95% CL): 1.6 (1.3-2.0) g/L NaCL
7-d IC50 (95% CL): 1.0 (0.9-1.1) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5-2.3) g/L NaCL CV (%): 12
7-d IC50 Reference Toxicant Mean and Historical Range: 1.1 (0.9-1.5) g/L NaCL CV (%): 13

Test Results:

	Survival	Reproduction
LC50 %(v/v) (95% CL)	>1474	
IC25 %(v/v) (95% CL)		~~461 (462 - 1271)~~ 875 (569 - 1153)
IC50 %(v/v) (95% CL)		~~1418 (1106 - 1817)~~ 1368 (1016 - 1842)

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: Synthetic Effluent
Work Order #: 11299

Start Date & Time: June 24/11 @ 1115h
Stop Date: June 30/11 @ 1500h
Test Species: *Ceriodaphnia dubia*

mg/L TDS Concentration 0	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.6	24.0	24.6	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0		
DO (mg/L)	7.8	7.1	8.1	7.0	~~8.5~~ 7.9	7.0	7.7	7.0	8.0	6.7	7.8	6.7		
pH	8.2	7.9	8.1	7.7	8.1	7.7	8.2	8.0	8.2	7.9	8.3	7.9		
Cond. (µS/cm)	214	216		219		216		216		216		225		
Initials	KLB	~		~		KLB		KLB		KLB		KLB		

132 Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.6	24.0	24.6	24.0	25.0	25.0	25.0	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	7.1	8.0	6.9	7.9	7.0	7.5	6.7	7.7	6.7	8.0	6.6		
pH	7.6	7.9	8.1	7.8	8.1	7.5	7.6	7.4	7.3	7.2	7.4	7.2		
Cond. (µS/cm)	256	267		258		274		261		257		257		
Initials	KLB	~		~		KLB		KLB		KLB		KLB		

444 Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.6	24.0	24.6	24.0	25.0	25.5	25.0	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	7.0	8.0	7.0	~~7.9~~	7.1	7.7	6.9	8.0	6.4	8.0	5.9		
pH	7.8	7.8	7.9	8.0	7.9	7.4	7.7	7.4	7.6	7.3	7.5	7.2		
Cond. (µS/cm)	820	838		845		827		824		821		814		
Initials	KLB	~		~		KLB		KLB		KLB		KLB		

Concentration 1500	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.6	24.0	24.6	24.0	25.0	25.5	25.0	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	7.1	8.0	7.0	7.9	7.1	7.6	6.5	8.1	6.2	8.0	5.7		
pH	7.9	7.8	8.0	8.2	8.0	7.9	8.0	7.8	7.9	7.7	7.9	7.6		
Cond. (µS/cm)	2560	2570		2600		2610		2560		2560		2510		
Initials	KLB	~		~		KLB		KLB		KLB		KLB		

	Control	KLB 15			
Hardness*	98				
Alkalinity*	82				

* mg/L as CaCO3

Analysts: KLB, AWO
Reviewed by: JGL
Date reviewed: Aug 25/11

Sample Description: 1) Chemical sample

Comments: Broodboard Used: 061411

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: Synthetic Effluent
Work Order: 11299

mg/L TDS

Start Date & Time: June 24 // 11 @ 1115h
Stop Date & Time: June 30 // 11 @ 1500h
Set up by: KLB

Concentration: 0

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	✓	3	✓	5	4	2	2	4	3	3	KLB
5	5	8	✓	8	6	✓	5	8	8	8	KLB
6	12	11	✓	17	12	4	12	12	11	10	KLB
7											
8											
Total	17	22	0	30	22	6	19	24	22	21	KLB

Concentration: 132

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	3	2	3	2	2	23 KLB	✓	✓	✓	4	KLB
5	X	6	5	4	6	✓	3	3	5	5	KLB
6	|	12	9	10	13	10	10	10	10	11	KLB
7	|										
8	|										
Total	3*	20	17	16	21	13	13	13	15	20	KLB

Concentration: 198

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	✓	3	✓	✓	3	✓	3	2	✓	✓	KLB
5	3	6	4	4	6	5	6	6	5	6	KLB
6	11	10	11	8	11	9	13	11	9	10	KLB
7											
8											
Total	14	19	15	12	20	14	22	19	14	16	KLB

Concentration: 296

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	3	✓	2	3	3	4	✓	4	3	4	KLB
5	5	5	4	7	5	7	4	6	7	8	KLB
6	13	✓	12	14	10	16	9	11	13	13	KLB
7											
8											
Total	21	5	18	24	18	27	13	21	23	25	KLB

Concentration: 444

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	2	2	2	2	3	4	✓	3	✓	KLB
5	4	5	4	4	4	3	6	3	5	6	KLB
6	6	10	10	✓	9	2	11	3	12	12	KLB
7											
8											
Total	12	17	16	6	15	8	21	6	20	18	KLB

Concentration: 667

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	2	2	3	✓	✓	2	✓	✓	✓	KLB
5	4	4	4	5	4	5	4	3	5	3	KLB
6	10	9	10	13	11	9	10	9	12	10	KLB
7											
8											
Total	16	15	16	21	15	14	16	12	17	13	KLB

Concentration: 1000

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	3	2	✓	3	2	2	2	2	2	KLB
5	4	4	3	5	6	5	5	5	4	4	KLB
6	✓	10	11	✓	11	✓	12	10	✓	✓	KLB
7											
8											
Total	6	17	16	5	20	7	19	17	6	6	KLB

Concentration: 500

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
5	2	5	2	2	✓	4	2	2	4	2	KLB
6	✓	7	9	8	6	✓	9	6	7	✓	KLB
7											
8											
Total	2	12	11	10	6	4	11	8	11	2	KLB

Concentration:

Days	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Notes: X = mortality.

Sample Description: 1) Chemical sample
Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: JGh

Date reviewed: Aug. 25/11

CETIS Analytical Report

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	04-3504-6398	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 10:44	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	09-2707-0292	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	24 Jun-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	30 Jun-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	12-7376-1788	**Code:**	TDS	**Client:**	Golder
Sample Date:	24 Jun-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:	24 Jun-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	Synthetic Effluent (TDS)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.958E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	>1474	N/A	N/A
EC10	>1474	N/A	N/A
EC15	>1474	N/A	N/A
EC20	>1474	N/A	N/A
EC25	>1474	N/A	N/A
EC40	>1474	N/A	N/A
EC50	>1474	N/A	N/A

6d Survival Rate Summary — Calculated Variate(A/B)

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Dilution Water	10	1	1	1	0	0	0.0%	0.0%	10	10
131		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
196		10	1	1	1	0	0	0.0%	0.0%	10	10
287		10	1	1	1	0	0	0.0%	0.0%	10	10
428		10	1	1	1	0	0	0.0%	0.0%	10	10
650		10	1	1	1	0	0	0.0%	0.0%	10	10
974		10	1	1	1	0	0	0.0%	0.0%	10	10
1474		10	1	1	1	0	0	0.0%	0.0%	10	10

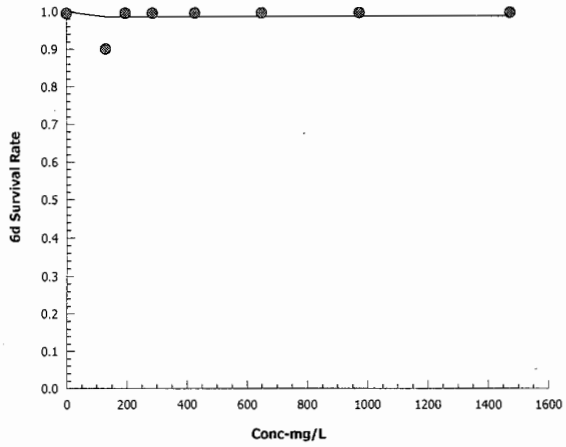
6d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Dilution Water	1	1	1	1	1	1	1	1	1	1
131		0	1	1	1	1	1	1	1	1	1
196		1	1	1	1	1	1	1	1	1	1
287		1	1	1	1	1	1	1	1	1	1
428		1	1	1	1	1	1	1	1	1	1
650		1	1	1	1	1	1	1	1	1	1
974		1	1	1	1	1	1	1	1	1	1
1474		1	1	1	1	1	1	1	1	1	1

Ceriodaphnia 7-d Survival and Reproduction Test **Nautilus Environmental**

Analysis ID:	04-3504-6398	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 10:44	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst:_____ QA: JGM Dec 16/11

Ceriodaphnia 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	11-5919-1502	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	27 Apr-12 9:18	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	09-2707-0292	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	24 Jun-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	30 Jun-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	12-7376-1788	**Code:**	TDS	**Client:**	Golder
Sample Date:	24 Jun-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:	24 Jun-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	Synthetic Effluent (TDS)		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Logistic EV [Y=A/(1+(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
10	-176.9	360.2	367	0.2230	Yes	1.195	2.342	0.3204	Non-Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
SNEC	881.2	577.2	1159
IC1	211	N/A	573.8
IC5	413	N/A	666.5
IC10	559.7	N/A	827.3
IC15	675.7	188.4	955.2
IC20	778.5	419.7	1060
IC25	875.2	568.8	1153
IC40	1160	885.9	1471
IC50	1368	1016	1842
IC60	1614	1120	2542
IC75	2140	1332	N/A
IC80	2406	1450	N/A
IC85	2772	1622	N/A
IC90	3346	1897	N/A
IC95	4535	2462	N/A
IC99	8876	4398	N/A

Ceriodaphnia 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID: 11-5919-1502 Endpoint: Reproduction CETIS Version: CETISv1.8.0
Analyzed: 27 Apr-12 9:18 Analysis: Nonlinear Regression Official Results: Yes

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	17.09	0.9979	15.11	19.08	17.13	<0.0001	Significant Parameter
C	2.458	1.099	0.269	4.646	2.236	0.0282	Significant Parameter
D	1368	200.5	969.3	1768	6.827	<0.0001	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	786.3618	786.3618	1	24.67	<0.0001	Significant
Lack of Fit	188.0383	37.60765	5	1.195	0.3204	Non-Significant
Pure Error	2266.4	31.47778	72			
Residual	2454.438	31.87582	77			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variances	Bartlett Equality of Variance	18.42	14.07	0.0102	Unequal Variances
	Mod Levene Equality of Variance	1.466	2.14	0.1931	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9744	0.9691	0.1080	Normal Distribution
	Anderson-Darling A2 Normality	0.696	2.492	0.0692	Normal Distribution
Control Trend	Mann-Kendall Trend	9	1.96	0.4677	Non-significant Trend in Controls

Reproduction Summary — Calculated Variate

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	10	18.3	0	30	2.801	8.858	48.4%	0.0%
131		10	15.1	3	21	1.656	5.238	34.69%	17.49%
196		10	16.5	12	22	1.035	3.274	19.85%	9.84%
287		10	19.5	5	27	2.056	6.502	33.34%	-6.56%
428		10	13.9	6	21	1.773	5.607	40.33%	24.04%
650		10	15.5	12	21	0.7782	2.461	15.88%	15.3%
974		10	11.9	5	20	2.002	6.332	53.21%	34.97%
1474		10	7.7	2	12	1.239	3.917	50.87%	57.92%

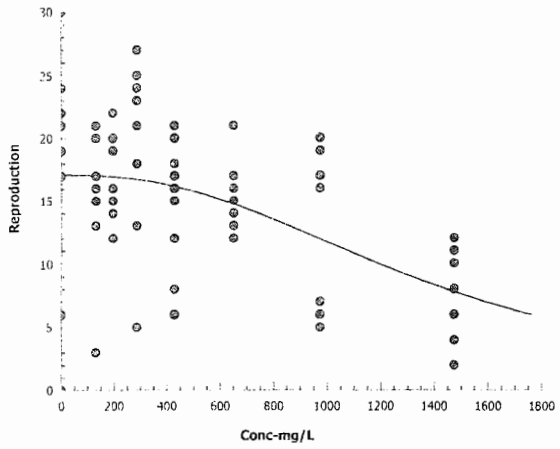
Reproduction Detail

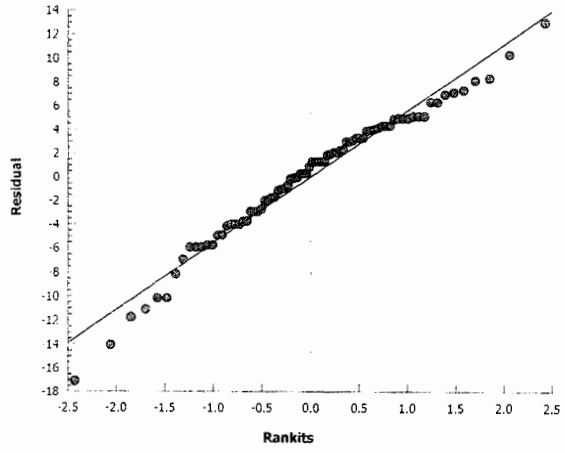
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Dilution Water	17	22	0	30	22	6	19	24	22	21
131		3	20	17	16	21	13	13	13	15	20
196		14	19	15	12	20	14	22	19	14	16
287		21	5	18	24	18	27	13	21	23	25
428		12	17	16	6	15	8	21	6	20	18
650		16	15	16	21	15	14	16	12	17	13
974		6	17	16	5	20	7	19	17	6	6
1474		2	12	11	10	6	4	11	8	11	2

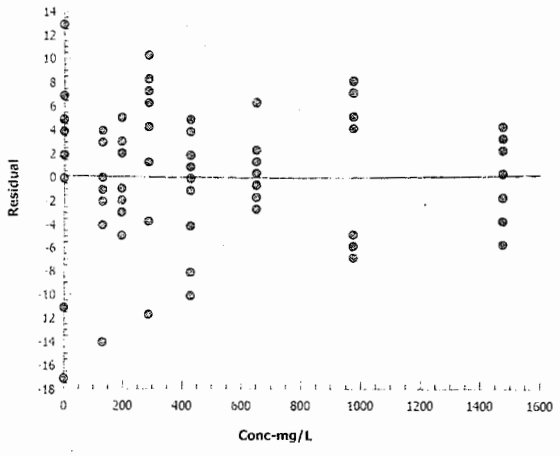
Ceriodaphnia 7-d Survival and Reproduction Test | **Nautilus Environmental**

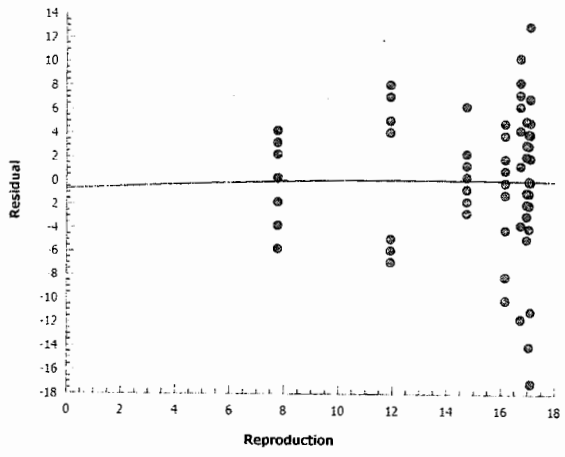
Analysis ID:	11-5919-1502	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	27 Apr-12 9:18	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

Graphics 3P Log-Logistic EV [Y=A/(1+(X/D)^C)]









Synthetic Effluent
Emulsified Stock

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 23-JUN-11
Report Date: 08-JUL-11 10:31 (MT)
Version: FINAL REV. 2

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1022276
Project P.O. #: NOT SUBMITTED
Job Reference:
Legal Site Desc:
C of C Numbers:

Comments:

08-JUL-11:
Revision 2: This revision replaces and supersedes all previous revision. This revision includes modified data for Total Dissolved Solids analysis. The new data derived from re-analysis.

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1022276-1	L1022276-2	L1022276-3	L1022276-4	L1022276-5
Description	TDS STOCK SOL	TDS STOCK SOL	TDS STOCK SOL	TDS STOCK SOL	TDS STOCK SOL
Sampled Date	22-JUN-11	22-JUN-11	22-JUN-11	22-JUN-11	22-JUN-11
Sampled Time					
Client ID	SYNTHETIC EFF-1500	SYNTHETIC EFF-1000	SYNTHETIC EFF-667	SYNTHETIC EFF-444	SYNTHETIC EFF-296
Grouping **Analyte**					
WATER					
Physical Tests Total Dissolved Solids (mg/L)	1678	1444	870	705	374
Anions and Nutrients Alkalinity, Total (as CaCO3) (mg/L)	110	77.7	47.9	32.2	21.6
Chloride (Cl) (mg/L)	708	464	310	201	136
Sulfate (SO4) (mg/L)	131	85.1	57.2	37.2	25.3
Total Metals Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium (Ca)-Total (mg/L)	282	187	127	85.6	56.9
Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Magnesium (Mg)-Total (mg/L)	36.9	24.0	16.3	10.9	7.15
Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)-Total (mg/L)	14:1	9.2	6.3	4.2	2.7
Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon (Si)-Total (mg/L)	0.076	<0.050	<0.050	<0.050	0.060
Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium (Na)-Total (mg/L)	168	110	74.9	49.9	33.0
Strontium (Sr)-Total (mg/L)	0.0446	0.0293	0.0203	0.0136	0.0090
Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1022276-6	L1022276-7			
Description	TDS STOCK SOL	TDS STOCK SOL			
Sampled Date	22-JUN-11	22-JUN-11			
Sampled Time					
Client ID	SYNTHETIC EFF-198	SYNTHETIC EFF-132			
Grouping / **Analyte**					
WATER					
Physical Tests					
Total Dissolved Solids (mg/L)	290	192			
Anions and Nutrients					
Alkalinity, Total (as CaCO3) (mg/L)	14.7	10.3			
Chloride (Cl) (mg/L)	93.2	62.5			
Sulfate (SO4) (mg/L)	17.3	11.5			
Total Metals					
Aluminum (Al)-Total (mg/L)	<0.20	<0.20			
Antimony (Sb)-Total (mg/L)	<0.20	<0.20			
Arsenic (As)-Total (mg/L)	<0.20	<0.20			
Barium (Ba)-Total (mg/L)	<0.010	<0.010			
Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050			
Bismuth (Bi)-Total (mg/L)	<0.20	<0.20			
Boron (B)-Total (mg/L)	<0.10	<0.10			
Cadmium (Cd)-Total (mg/L)	<0.010	<0.010			
Calcium (Ca)-Total (mg/L)	39.3	25.3			
Chromium (Cr)-Total (mg/L)	<0.010	<0.010			
Cobalt (Co)-Total (mg/L)	<0.010	<0.010			
Copper (Cu)-Total (mg/L)	<0.010	<0.010			
Iron (Fe)-Total (mg/L)	<0.030	<0.030			
Lead (Pb)-Total (mg/L)	<0.050	<0.050			
Lithium (Li)-Total (mg/L)	<0.010	<0.010			
Magnesium (Mg)-Total (mg/L)	4.99	3.35			
Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050			
Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030			
Nickel (Ni)-Total (mg/L)	<0.050	<0.050			
Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
Potassium (K)-Total (mg/L)	<2.0	<2.0			
Selenium (Se)-Total (mg/L)	<0.20	<0.20			
Silicon (Si)-Total (mg/L)	0.092	0.090			
Silver (Ag)-Total (mg/L)	<0.010	<0.010			
Sodium (Na)-Total (mg/L)	23.3	15.6			
Strontium (Sr)-Total (mg/L)	0.0064	<0.0050			
Thallium (Tl)-Total (mg/L)	<0.20	<0.20			
Tin (Sn)-Total (mg/L)	<0.030	<0.030			
Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
Vanadium (V)-Total (mg/L)	<0.030	<0.030			
Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Chain of Custody

Elevated Priority

L1022276-COFC

(1) British Columbia
8664 Commerce Court Suite 2
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

L1022276.

Date June 22/11 Page 1 of 1

Sample Collection By: EC

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	EDMUND CANARIA	Contact	EDMUND CANARIA
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	Synthetic Eff-1500	22-Jun-11			1L	1	TDS Stock Solutions	X	X	X	X	X	X	X	X			
2	Synthetic Eff-1000	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
3	Synthetic Eff-667	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
4	Synthetic Eff-444	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
5	Synthetic Eff-296	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
6	Synthetic Eff-198	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
7	Synthetic Eff-132	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11296-11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Total Dissolved Solids Project Study

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) June 22/11	(Printed Name) (Date)
(Company) Nautilus Environmental NAUTILUS	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) SH (Time)
(Printed Name) (Date)	(Printed Name) 5:45 PM June 22/11 (Date)
(Company)	(Company) 17.2°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Calculated TDS values

Initial Strength ; Reanalyzed

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1022276
Date Received	23-Jun-11 17:45
Date	30-Jun-11

RESULTS OF ANALYSIS

	SYNTHETIC EFF-	SYNTHETIC EFF-	SYNTHETIC EFF-	SYNTHETIC EFF-
Sample ID	1500	1000	667	444
Date Sampled	22-JUN-11	22-JUN-11	22-JUN-11	22-JUN-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1022276-1	L1022276-2	L1022276-3	L1022276-4
Matrix	Water	Water	Water	Water
Physical Tests				
Total Dissolved Solids	2350	1710	1140	827
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	110	77.7	47.9	32.2
Chloride (Cl)	708	464	310	201
Sulfate (SO4)	131	85.1	57.2	37.2
1.22 x Alkalinity	134.2	94.794	58.438	39.284
Total Metals				
Aluminum (Al)-Total				
Antimony (Sb)-Total				
Arsenic (As)-Total				
Barium (Ba)-Total				
Beryllium (Be)-Total				
Bismuth (Bi)-Total				
Boron (B)-Total				
Cadmium (Cd)-Total				
Calcium (Ca)-Total	282	187	127	85.6
Chromium (Cr)-Total				
Cobalt (Co)-Total				
Copper (Cu)-Total				
Iron (Fe)-Total				
Lead (Pb)-Total				
Lithium (Li)-Total				
Magnesium (Mg)-Total	36.9	24.0	16.3	10.9
Manganese (Mn)-Total				
Molybdenum (Mo)-Total				
Nickel (Ni)-Total				
Phosphorus (P)-Total				
Potassium (K)-Total	14.1	9.2	6.3	4.2
Selenium (Se)-Total				
Silicon (Si)-Total	0.076	<0.050	<0.050	<0.050
Silver (Ag)-Total				
Sodium (Na)-Total	168	110	74.9	49.9
Strontium (Sr)-Total	0.0446	0.0293	0.0203	0.0136
Thallium (Tl)-Total				
Tin (Sn)-Total				
Titanium (Ti)-Total				
Vanadium (V)-Total				
Zinc (Zn)-Total				
Total	1474	974	650	428

Initial stock

SYNTHETIC EFF-296	SYNTHETIC EFF-198	SYNTHETIC EFF-132
22-JUN-11 00:00	22-JUN-11 00:00	22-JUN-11 00:00
L1022276-5	L1022276-6	L1022276-7
Water	Water	Water
533	351	220
21.6	14.7	10.3
136	93.2	62.5
25.3	17.3	11.5
26.352	17.934	12.566
56.9	39.3	25.3
7.15	4.99	3.35
2.7	<2.0	<2.0
0.060	0.092	0.090
33.0	23.3	15.6
0.0090	0.0064	<0.0050
287	196	131

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 23-JUN-11
Report Date: 30-JUN-11 17:13 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1022276
Project P.O. #: NOT SUBMITTED
Job Reference:
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID	Description	Sampled Date	Sampled Time	Client ID	L1022276-1 TDS STOCK SOL 22-JUN-11 SYNTHETIC EFF-1500	L1022276-2 TDS STOCK SOL 22-JUN-11 SYNTHETIC EFF-1000	L1022276-3 TDS STOCK SOL 22-JUN-11 SYNTHETIC EFF-667	L1022276-4 TDS STOCK SOL 22-JUN-11 SYNTHETIC EFF-444	L1022276-5 TDS STOCK SOL 22-JUN-11 SYNTHETIC EFF-296
WATER											
Physical Tests	Total Dissolved Solids (mg/L)						2350	1710	1140	827	533
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	134.6					110	77.7	47.9	32.2	21.6
	Chloride (Cl) (mg/L)	735.2					708	464	310	201	136
	Sulfate (SO4) (mg/L)	128.7					131	85.1	57.2	37.2	25.3
Total Metals	Aluminum (Al)-Total (mg/L)						<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)						<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)						<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Beryllium (Be)-Total (mg/L)						<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)						<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)						<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	301.6					282	187	127	85.6	56.9
	Chromium (Cr)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)						<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)						<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	36.8					36.9	24.0	16.3	10.9	7.15
	Manganese (Mn)-Total (mg/L)						<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)						<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)						<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)						<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	13.8					14.1	9.2	6.3	4.2	2.7
	Selenium (Se)-Total (mg/L)						<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)						0.076	<0.050	<0.050	<0.050	0.060
	Silver (Ag)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	165.5					168	110	74.9	49.9	33.0
	Strontium (Sr)-Total (mg/L)						0.0446	0.0293	0.0203	0.0136	0.0090
	Thallium (Tl)-Total (mg/L)						<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)						<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)						<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)						<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)						<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1022276-6	L1022276-7			
Description	TDS STOCK SOL	TDS STOCK SOL			
Sampled Date	22-JUN-11	22-JUN-11			
Sampled Time					
Client ID	SYNTHETIC EFF-198	SYNTHETIC EFF-132			
Grouping / **Analyte**					
WATER					
Physical Tests					
Total Dissolved Solids (mg/L)	351	220			
Anions and Nutrients					
Alkalinity, Total (as CaCO3) (mg/L)	14.7	10.3			
Chloride (Cl) (mg/L)	93.2	62.5			
Sulfate (SO4) (mg/L)	17.3	11.5			
Total Metals					
Aluminum (Al)-Total (mg/L)	<0.20	<0.20			
Antimony (Sb)-Total (mg/L)	<0.20	<0.20			
Arsenic (As)-Total (mg/L)	<0.20	<0.20			
Barium (Ba)-Total (mg/L)	<0.010	<0.010			
Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050			
Bismuth (Bi)-Total (mg/L)	<0.20	<0.20			
Boron (B)-Total (mg/L)	<0.10	<0.10			
Cadmium (Cd)-Total (mg/L)	<0.010	<0.010			
Calcium (Ca)-Total (mg/L)	39.3	25.3			
Chromium (Cr)-Total (mg/L)	<0.010	<0.010			
Cobalt (Co)-Total (mg/L)	<0.010	<0.010			
Copper (Cu)-Total (mg/L)	<0.010	<0.010			
Iron (Fe)-Total (mg/L)	<0.030	<0.030			
Lead (Pb)-Total (mg/L)	<0.050	<0.050			
Lithium (Li)-Total (mg/L)	<0.010	<0.010			
Magnesium (Mg)-Total (mg/L)	4.99	3.35			
Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050			
Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030			
Nickel (Ni)-Total (mg/L)	<0.050	<0.050			
Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
Potassium (K)-Total (mg/L)	<2.0	<2.0			
Selenium (Se)-Total (mg/L)	<0.20	<0.20			
Silicon (Si)-Total (mg/L)	0.092	0.090			
Silver (Ag)-Total (mg/L)	<0.010	<0.010			
Sodium (Na)-Total (mg/L)	23.3	15.6			
Strontium (Sr)-Total (mg/L)	0.0064	<0.0050			
Thallium (Tl)-Total (mg/L)	<0.20	<0.20			
Tin (Sn)-Total (mg/L)	<0.030	<0.030			
Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
Vanadium (V)-Total (mg/L)	<0.030	<0.030			
Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Elevated Priority

Suite 2

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

L1022276. Date June 22/11 Page 1 of 1

Sample Collection By: ECC

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	EDMUND CANARIA	Contact	EDMUND CANARIA
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	Synthetic Eff-1500	22-Jun-11			1L	1	TDS Stock Solutions	X	X	X	X	X	X	X	X			
2	Synthetic Eff-1000	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
3	Synthetic Eff-667	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
4	Synthetic Eff-444	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
5	Synthetic Eff-296	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
6	Synthetic Eff-198	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
7	Synthetic Eff-132	22-Jun-11			1L	1		X	X	X	X	X	X	X	X			
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11296-11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Total Dissolved Solids Project Study

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) June 22/11	(Printed Name) (Date)
(Company) Nautilus Environmental NAUTILUS	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time)
(Printed Name) (Date)	(Printed Name) 5:45 pm June 22/11
(Company)	(Company) 17.2°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Daphnia magna Summary Sheet

Client: Golder
Work Order No.: 11300

Start Date/Time: June 29, 2011 1515 h
Test Species: *Daphnia magna*
Set up by: AWD, KLB

Test Validity Criteria:
≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:
T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Sample Information:

Sample ID: Synthetic effluent (TDS)
Sample Date: Prepared in-house
Date Received: NA
Sample Volume: -

Test Organism Information:

Broodstock No.:	061511
Age of young (Day 0):	< 24 hours
Avg No. young per brood in previous 7 d:	22
Mortality (%) in previous 7 d:	0
Days to first brood:	9

NaCl Reference Toxicant Results:

Reference Toxicant ID:	DM72	
Stock Solution ID:	NaCl	
Date Initiated:	July 12, 2011	
48-h LC50 (95% CL):	4.2 (3.7 - 4.8)	g/LNaCL

Reference Toxicant Mean and Historical Range: 4.0, 3.6 - 4.4 g/L NaCL
Reference Toxicant CV (%): 5

Test Results:

mg/L TDS	Survival	Reproduction
EC25 (95% CL)	1080 (627 - 6209)	
EC50 (95% CL)	> ~~1500~~ 1474	
IC25 (95% CL)		893 (595 - 1227)
IC50 (95% CL)		> 1474

Reviewed by: [signature]
Date reviewed: 22 Feb 2012

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Synthetic Effluent

Start Date: June 29/11
Termination Date: July 20/11
Test Organism: *Daphnia magna*

Dissolved Oxygen (mg/L)

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	8.5	9.0	8.7	8.8	8.9	8.4	8.3	8.6	8.3	8.0	8.5	7.8	8.0	8.4	8.6
132	8.8	8.9	8.6	8.5	8.8	8.5	8.4	8.7	8.2	8.1	8.6	7.9	8.1	8.5	8.7
198	8.9	8.8	8.7	8.6	8.7	8.4	8.4	8.7	8.3	8.1	8.6	8.0	8.1	8.6	8.6
296	8.9	8.9	8.6	8.6	8.8	8.4	8.5	8.8	8.3	8.1	8.9	8.0	8.1	8.6	8.6
444	8.8	8.9	8.5	8.7	8.7	8.3	8.5	8.8	8.2	8.1	8.8	7.9	8.2	8.6	8.5
667	8.8	9.0	8.6	8.6	8.9	8.4	8.5	8.7	8.2	8.2	8.7	8.0	8.3	8.5	8.6
1000	8.9	8.8	8.7	8.6	8.8	8.5	8.6	8.8	8.4	8.3	8.7	8.1	8.2	8.6	8.7
1500	8.8	8.9	8.6	8.6	8.8	8.5	8.6	8.6	8.1	8.1	8.9	8.1	8.2	8.6	8.6
Technician Initials	~	~		~	~	~	KLB		KLB		KLB	KLB		~	~

Dissolved Oxygen (mg/L)

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	8.9	8.3	8.8	8.5	8.6	8.6	8.3	7.6	8.6	8.5	8.4	8.0	8.4	7.6	8.3
132	8.7	8.3	8.8	8.5	8.7	9.0	8.2	7.8	8.9	8.5	8.3	8.1	8.5	7.6	8.2
198	8.6	8.3	8.8	8.5	8.8	9.0	8.2	7.8	8.9	8.4	8.1	8.1	8.7	7.6	8.2
296	8.6	8.3	8.9	8.5	8.8	9.0	8.3	7.8	8.9	8.3	8.2	8.2	8.8	7.8	8.3
444	8.7	8.3	8.9	8.5	8.7	9.0	8.2	8.0	8.8	8.4	8.1	8.3	8.8	7.6	8.2
667	8.6	8.3	8.9	8.5	8.8	9.0	8.1	8.0	8.6	8.3	8.2	8.3	8.8	7.6	8.1
1000	8.6	8.3	8.9	8.5	8.7	9.0	8.2	8.0	8.6	8.3	8.2	8.2	8.8	7.5	8.2
1500	8.6	8.3	8.9	8.5	8.7	9.0	8.2	7.9	8.7	8.3	8.1	8.2	8.8	7.5	8.2
Technician Initials	~	KLB		KLB	KLB		~	KLB		~	~	KLB		KLB	~

Comments:

Reviewed by: JBK

Date Reviewed: Aug 30/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: Synthetic Effluent
Sample ID: 11300

Start Date: June 29/11
Termination Date: July 20/11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Temperature (°C) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	21.0	22.0	21.5	20.0	20.0	19.0
132	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	20.5	22.0	21.5	20.0	20.0	19.0
198	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	20.5	22.0	21.5	20.0	20.0	19.0
296	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	20.5	22.0	21.5	20.0	20.0	19.0
444	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	20.5	22.0	21.5	20.0	20.0	19.0
667	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	20.5	22.0	21.5	20.0	20.0	19.0
1000	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	20.5	22.0	21.5	20.0	20.0	19.0
1500	20.0	19.5	19.0	21.0	19.0	20.5	20.0	21.5	20.0	21.0	22.0	21.5	20.0	20.0	19.0
Technician Initials	~	~	~		~	~	KLB		KLB	KLB		KLB	AM		AM

Concentration mg/L TDS	Temperature (°C) Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	20.0	20.5	20.5	21.0	21.0	21.0	20.0	21.5	20.5	20.0	20.5	20.5	20.5	21.0	20.5
132	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.5	21.0	21.0	20.5
198	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.0	21.0	21.0	20.5
296	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.5	21.0	21.0	20.5
444	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.0	21.0	21.0	20.5
667	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.0	21.0	21.0	20.5
1000	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.5	21.0	21.0	20.5
1500	20.0	20.5	20.5	21.0	21.0	21.5	20.0	21.5	20.5	20.0	20.5	20.5	21.0	21.0	20.5
Technician Initials	AM		KLB	KLB		KLB	AM		KLB	AM	AM		KLB	KLB	~

Comments:

Reviewed by: JGL

Date Reviewed: Aug. 30/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Cadler
W.O #: Synthetic Effluent
Sample ID: 11300

Start Date: June 29/11
Termination Date: July 20/11
Test Organism: *Daphnia magna*

pH

Day

Concentration mg/L TDS	0	1	2		3	4	5		6	7		8	9		10
			Old	New			Old	New		Old	New		Old	New	
Control	8.2	7.9	7.9	8.1	7.8	8.0	8.4	8.2	8.1	8.2	8.0	7.8	8.1	8.1	8.1
132	7.8	7.8	7.8	7.9	7.7	7.9	8.1	8.0	7.9	7.7	7.6	7.6	7.8	7.9	7.9
198	7.6	7.7	7.6	7.7	7.6	7.7	8.0	7.8	7.8	7.6	7.5	7.5	7.8	7.8	7.7
296	7.6	7.6	7.6	7.6	7.5	7.6	8.0	7.7	7.7	7.6	7.5	7.4	7.6	7.7	7.6
444	7.6	7.7	7.7	7.5	7.6	7.5	7.9	7.7	7.7	7.8	7.6	7.5	7.6	7.7	7.6
667	7.6	7.8	7.9	7.6	7.7	7.7	8.0	7.8	7.7	7.9	7.8	7.7	7.7	7.8	7.7
1000	7.8	7.8	7.9	7.7	7.7	7.8	8.2	7.9	7.9	8.1	7.9	7.8	7.8	7.9	7.8
1500	7.9	7.9	8.0	7.8	7.7	8.0	8.1	8.1	7.9	8.0	8.0	7.8	7.8	8.0	8.0
Technician Initials	~	~	~		~	~	KLB		KLB	KLB		KLB	~		~

pH

Day

Concentration	11	12		13	14		15	16		17	18	19		20	21
		Old	New		Old	New		Old	New			Old	New		
Control	7.9	8.0	8.1	7.9	8.0	8.2	7.8	8.0	8.0	7.9	7.9	8.0	8.1	8.0	7.9
132	7.8	7.7	7.8	7.7	7.9	7.7	7.6	7.3	7.3	7.6	7.7	7.6	7.3	7.3	7.5
198	7.7	7.6	7.6	7.6	7.6	7.5	7.5	7.3	7.3	7.4	7.4	7.3	7.3	7.3	7.4
296	7.6	7.6	7.6	7.5	7.5	7.4	7.5	7.4	7.4	7.3	7.3	7.4	7.5	7.4	7.3
444	7.6	7.6	7.5	7.6	7.6	7.4	7.4	7.5	7.5	7.4	7.5	7.4	7.6	7.5	7.6
667	7.8	7.9	7.8	7.8	7.7	7.6	7.6	7.7	7.7	7.5	7.6	7.6	7.8	7.6	7.7
1000	7.9	8.0	8.0	7.9	7.8	7.7	7.6	7.9	7.8	7.7	7.7	7.6	7.9	7.8	7.8
1500	8.0	8.0	8.0	8.0	7.9	7.9	7.7	7.8	7.9	7.8	7.9	7.8	8.0	7.8	7.9
Technician Initials	~	KLB		KLB	KLB		Ans	KLB		Ans	~	KLB		KLB	KLB

Comments:

Reviewed by: JGh

Date Reviewed: Aug-30/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: Synthetic Effluent
Sample ID: 11300

Start Date: June 23/11
Termination Date: July 20/11
Test Organism: *Daphnia magna*

Conductivity (µS)

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	341		365	361			487	351		422	354		402	336	
132	265		303	271			345	272		322	272		358	275	
198	389		446	390			456	393		438	392		432	400	
296	561		661	563			674	561		618	563		607	538	
444	829		845	835			945	836		900	838		828	845	
667	1224		1337	1221			1406	1226		1323	1237		1307	1242	
1000	1778		1835	1774			2010	1773		1908	1785		1803	1805	
1500	2610		2770	2600			2860	2590		2750	2610		2700	2620	
Technician Initials							KCB			KCB					

Conductivity (µS)

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control		430	332		396	344		401	346			398	352		392
132		339	269		314	270		304	270			310	272		301
198		484	392 KCB		438	393		433	390			435	394		424
296		712	~~835~~ 561		627	565		621	557			622	561		584
444		1003	~~838~~ 835		915	875		890	828			899	839		879
667		1471	1230		1345	1298		1319	1215			1330	1227		1283
1000		2050	1831		1911	1777		1874	1761			1897	1782		1842
1500		2870	2630		2730	~~2590~~ 2590 KCB		2690	2580			2710	2600		2690
Technician Initials		KCB			KCB			KCB				KCB			AM

Comments:

Reviewed by: JGH

Date Reviewed: Aug. 30/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: Synthetic Effluent
Work Order: 11300

Start Date & Time: June 29/11 @ 1515h
Stop Date & Time: July 20 / 11
Analysts: KLB, AMS

mg/L TDS NOMINAL

Days	Concentration: Control											Concentration: 132										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	^
2	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	~
3	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
4	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
5	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	10	0	15	0	8	13	0	0	15	AMS	0	0	0	0	0	0	0	15	2	0	AMS
10	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
11	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	AMS
12	37	37	50	28	10	19	30	18	18	33	KLB	14	15	31	20	16	44	52	27	17	98	KLB
13	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
14	0	21	0	23	0	24	0	Adj 23	19	0	AMS	16	24	18	28	0	0	0	25	31	0	AMS
15	33	0	D	0	10	19	34	34	25	22	AMS	0	33	31	31	32	23	28	0	31	29	AMS
16	0	27	0	0	0	0	0	0	0	0	KLB	41	0	0	0	0	0	0	0	0	0	KLB
17	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
18	41	20	35	31	22	0	32	24	27	28	~	30	32	21	26	44	34	22	24	9	34	~
19	0	0	0	0	0	15	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
20	0	29	0	24	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	19	0	0	KLB
21	25	0	15	0	0	23	14	13	24	15	KLB	30	19	18	23	12	15	10	0	16 KLB	14	AMS
Total	136	144	100	124	42	100	123	112	113	113	AMS	131	123	119	128	104	116	112	110	106	175	AMS

young

Notes: X = mortality.

Previous Brood Avg. young/daphnid: 22

Previous 7-d % mortality: 0

Brood Source: 061511

Days to 1st Brood: 9

Sample Description: ① Synthetically prepared sample

Comments:

Reviewed by: JGL

Date reviewed: Aug. 30/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Gold Coast
Sample ID: Synthetic Effluent
Work Order: 11300

Start Date & Time: June 29/11 @ 1515h
Stop Date & Time: July 20 / 11
Analysts: KLB, AMS

mg/L TDS

Days	Concentration: 198											Concentration: 256										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
2	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
3	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
4	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
5	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	0	0	0	0	0	11	0	0	15	AMS	13	0	0	0	10	0	0	10	0	18	AMS
10	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
11	0	0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
12	15	50	51	19	14	25	30	41	44	30	KLB	30	22	12	9	34	23	12	27	51	32	KLB
13	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
14	5X	0	0	26	0	0	0	0	0	19	AMS	0	24	29	33~	18	32	25	0	0	0	AMS
15		28	26	0	33	31	24	28	26	0	AMS	23	32	0	38	0	26	28	36	35	26	AMS
16		0	0	0	0	0	0	0	0	0	KLB	0	0	26	0	0	0	0	0	0	0	KLB
17		0	0	0	0	0	0	0	0	0	AMS	0	0	0	0	0	0	0	0	0	0	AMS
18		30	29	45	32	30	0	32	26	17	AMS	32	18	0	13	23	18	0	28	31	30	AMS
19		0	0	0	0	0	33	0	0	0	KLB	0	0	18	0	0	0	18	0	0	0	KLB
20		0	0	23	0	0	0	0	0	0	KLB	0	0	0	0	17	0	0	0	0	0	KLB
21		18	21	0	11	6	7	15	12	16	AMS	8	24	0	19	0	19	16	0X	11	8	AMS
Total	20X	126	127	113	90	92	105	116	108	97	AMS	106	120	85	112	102	118	116	101X	128	114	AMS

young

Notes: X = mortality.

Previous Brood Avg. young/daphnid: 22

Previous 7-d % mortality: 0

Brood Source: 061511

 # Days to 1st Brood: 9

Sample Description: ①

Comments:

Reviewed by: JGh

Date reviewed: Aug 30/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: Synthetic Effluent
Work Order: 11300

Start Date & Time: June 29/11 @ 1515h
Stop Date & Time: July 20 / 11
Analysts: KLB, Ans

mg/L TDS

Days	Concentration: 444											Concentration: 667										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
2	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
3	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
4	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
5	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	X	15	0	13	0	15	13	16	15	[illegible]	0	0	0	0	0	16	0	19	20	16	[illegible]
10	0	|	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
11	0	|	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
12	32	|	19	55	32	40	33	34	32	28	KLB	19	19	14	20	9	32	29	31	31	26	KLB
13	0	|	0	0	0	0	0	0	0	0	KLB	39	0	0	0	0	0	0	0	0	0	KLB
14	0	|	39	0	0	[illegible]	[illegible]	23	0	25	[illegible]	0	29	36	0	16	0	0	0	0	22	[illegible]
15	26	|	0	26	31	30	28	0	23	0	[illegible]	29	40	31	44	0	30	41	36	28	0	[illegible]
16	0	|	26	0	0	0	0	0	0	0	KLB	0	0	0	0	37	0	0	0	0	0	KLB
17	0	|	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	0	[illegible]
18	26	|	0	23	27	26	22	21	18	22	[illegible]	24	16	0	17	0	21	11	13	16	12	[illegible]
19	0	|	9	0	0	0	0	0	0	0	KLB	0	0	5	0	30	0	0	0	0	0	KLB
20	0	|	0	0	0	0	0	25	0	16	KLB	0	0	0	0	0	0	0	0	0	6	KLB
21	12	|	0 X	11	0	6	8	0	0 X	0	[illegible]	0	0	15	0 X	0	0	0 X	0 X	0 X	0	[illegible]
Total	96	0	108 X	115	103	102	106	116	89 X	106	[illegible]	111	104	101	81 X	92	99	81 X	95 X	95 X	82	[illegible]

young

Notes: X = mortality.

Previous Brood Avg. young/daphnid: 22
Previous 7-d % mortality: 0

Brood Source: 061511
 # Days to 1st Brood: 9

Sample Description: ①
Comments:

Reviewed by: JGH
Date reviewed: Aug. 30/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Gradient
Sample ID: Synthetic Effluent
Work Order: 11300

Start Date & Time: June 29/11 @ 1515h
Stop Date & Time: July 20 / 11
Analysts: KLB, Ans

mg/L TDS

Days	Concentration: 1000											Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	X	X	0	0	KLB
9	0	0	15	11	14	13	0	0	12	10		0	0	0	0	0	0			0	0	
10	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0			0	0	
11	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0			0	0	
12	15	47	32	24	36	36	26	31	29	25	KLB	8	49	12	14	14	53			7	18	KLB
13	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0			0	0	KLB
14	24	0	0	25	0	0	~~X~~0	8	19	28		28	0	31	24	22	0			29	0	
15	0	17	25	0	25	28	33	14	0	0		0	27	14	18	0	30			0	22	
16	0	0	0	0	0	0	0	0	0	0	KLB	24	0	0	0	24	0			15	0	KLB
17	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0			0	0	
18	15	8	10	10	14	18	15	23	11	10		0	2	23	9	0	30			0	34	
19	0	0	0	0	0	0	0	0	0	0	KLB	9	0	0	0	28	0			28	0	KLB
20	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0			0	0	KLB
21	15	5	0	0	0	0	0	19	0	0 X		13	0	19	17	10	15 ~~0~~			22	19	
Total	69	77	82	70	89	95	74	87	71	73 X		82	78	99	82	98	128	0 X	0 X	101	93	

young

Notes: X = mortality.

Previous Brood Avg. young/daphnid: 22
Previous 7-d % mortality: 0

Brood Source: 061511
 # Days to 1st Brood: 9

Sample Description: (1)
Comments:

Reviewed by: JGL
Date reviewed: Aug 30/11

CETIS Analytical Report

21
Daphnid 7-d Survival and Reproduction Test
10d

Nautilus Environmental

Analysis ID:	15-4121-0262	**Endpoint:**	21 7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 10:51	**Analysis:**	10d Linear Regression (MLE)	**Official Results:**	Yes
Batch ID:	03-0675-7463	**Test Type:**	Reproduction-Survival (7d) 21d	**Analyst:**	Krysta Banack
Start Date:	29 Jun-11 15:15	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	20 Jul-11 15:30	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	01-5273-5732	**Code:**	91A8FF4	**Client:**	Golder
Sample Date:	22 Jun-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:	22 Jun-11	**Source:**	Golder		
Sample Age:	7d 15h	**Station:**	Synthetic Effluent (TDS)		

Linear Regression Options

Model Function	Threshold Option	Threshold	Optimized	Pooled	Het Corr	Weighted
Log-Normal [NED=A+B*log(X)]	Control Threshold	1E-08	Yes	Yes	No	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Adj R2	F Stat	Critical	P-Value	Decision(α:5%)
4	-30.99	75.97	67.81	2.454	1.269					Lack of Fit Not Tested

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC10	183.3	19.25	333.8
EC15	375.2	131.2	651
EC20	662.8	376.6	1771
EC25	1080	626.7	6209
EC40	3695	1510	219300
EC50	7746	2419	1985000

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
Threshold	7.913E-09	2.821E-05	-2.82E-05	2.822E-05	0.0002805	0.9998	Non-Significant Parameter
Slope	0.7883	0.5266	0.2616	1.315	1.497	0.2088	Non-Significant Parameter
Intercept	1.934	1.438	0.4964	3.372	1.345	0.2498	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	0.6029335	0.6029335	1	0.3779	0.5720	Non-Significant
Residual	6.381402	1.595351	4			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Goodness-of-Fit	Pearson Chi-Sq GOF	6.382	9.488	0.1724	Non-Significant Heterogenity
	Likelihood Ratio GOF	6.78	9.488	0.1480	Non-Significant Heterogenity
Distribution	Shapiro-Wilk W Normality	0.8774	0.6146	0.2153	Normal Distribution

21 10d 7d Survival Rate Summary — Calculated Variate(A/B)

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
131		10	1	1	1	0	0	0.0%	0.0%	10	10
196		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
287		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
428		10	0.7	0	1	0.1528	0.483	69.01%	30.0%	7	10
650		10	0.6	0	1	0.1633	0.5164	86.07%	40.0%	6	10
974		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
1474		10	0.8	0	1	0.1333	0.4216	52.7%	20.0%	8	10

Daphnid 7-d Survival and Reproduction Test

Nautilus Environmental

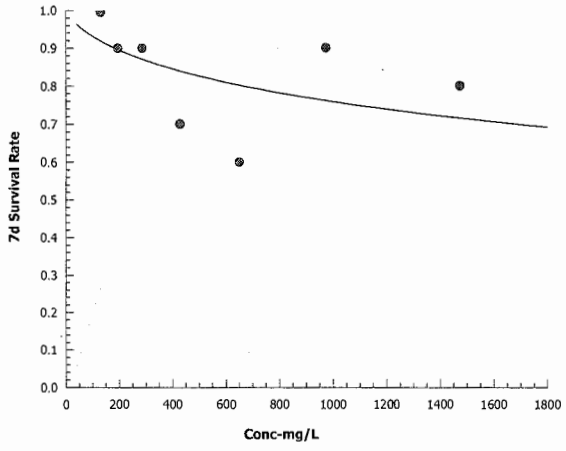
Analysis ID:	15-4121-0262	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 10:51	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes

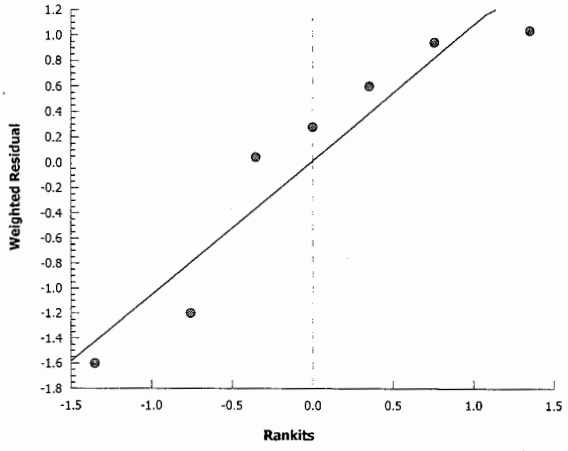
7d Survival Rate Detail

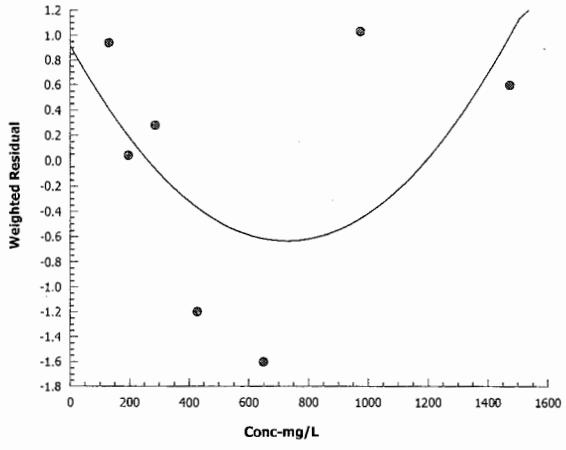
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	1	1	1	1	1	1	1	1	1
131		1	1	1	1	1	1	1	1	1	1
196		0	1	1	1	1	1	1	1	1	1
287		1	1	1	1	1	1	1	0	1	1
428		1	0	0	1	1	1	1	1	0	1
650		1	1	1	0	1	1	0	0	0	1
974		1	1	1	1	1	1	1	1	1	0
1474		1	1	1	1	1	1	0	0	1	1

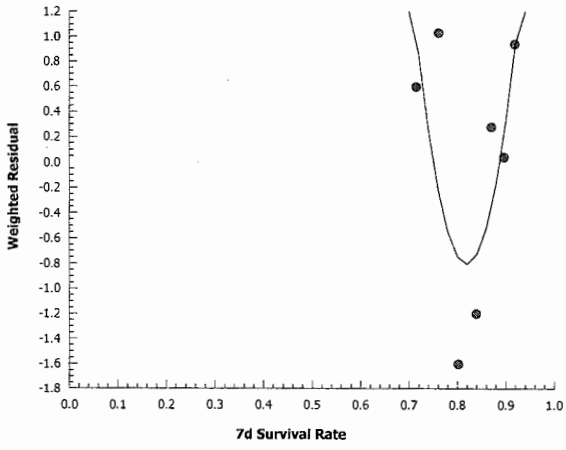
Graphics

Log-Normal [NED=A+B*log(X)]









21
Daphnid 7-d Survival and Reproduction Test

Nautilus Environmental

Analysis ID:	06-3060-5433	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:45	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	03-0675-7463	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	29 Jun-11 15:15	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	20 Jul-11 15:30	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	01-5273-5732	**Code:**	91A8FF4	**Client:**	Golder
Sample Date:	22 Jun-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:	22 Jun-11	**Source:**	Golder		
Sample Age:	7d 15h	**Station:**	Synthetic Effluent (TDS)		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
20	-299.5	605.3	612.1	0.1926	Yes	1.049	2.342	0.3957	Non-Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
SNEC	388.7	151.6	653.7
IC1	26.61	N/A	349
IC5	146.7	N/A	368.8
IC10	311.8	90.11	560.1
IC15	491	238.9	772.4
IC20	684.4	415.1	984.3
IC25	893	595.1	1227
IC40	1630	909.6	2573
IC50	2243	975.9	4383
IC60	3005	1031	8645
IC75	4637	1283	N/A
IC80	5421	1486	N/A
IC85	6441	1821	N/A
IC90	7889	2414	N/A
IC95	10390	3681	N/A
IC99	16310	7439	N/A

Analysis ID:	06-3060-5433	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:45	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	115	7.43	100.2	129.8	15.48	<0.0001	Significant Parameter
C	0.9547	0.4494	0.05988	1.85	2.125	0.0368	Significant Parameter
D	2243	727.3	795.3	3692	3.085	0.0028	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	14222.46	14222.46	1	20.85	<0.0001	Significant
Lack of Fit	3568.294	713.6587	5	1.049	0.3957	Non-Significant
Pure Error	48967.2	680.1	72			
Residual	52535.49	682.2791	77			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	3.867	3.306	0.0039	Outlier Detected
Variances	Mod Levene Equality of Variance	1.035	2.14	0.4146	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.8074	0.9691	<0.0001	Non-normal Distribution
	Anderson-Darling A2 Normality	5.017	2.492	<0.0001	Non-normal Distribution

Reproduction Summary — Calculated Variate

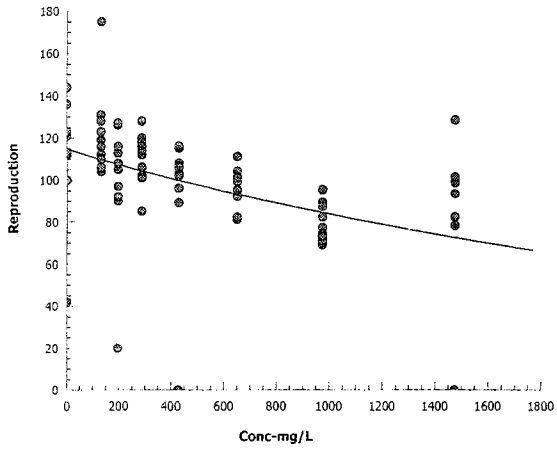
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	110.4	42	144	8.798	27.82	25.2%	0.0%
131		10	122.4	104	175	6.493	20.53	16.78%	-10.87%
196		10	99.4	20	127	9.712	30.71	30.9%	9.96%
287		10	110.2	85	128	3.844	12.15	11.03%	0.18%
428		10	94.1	0	116	10.76	34.02	36.16%	14.76%
650		10	94.5	81	111	3.287	10.39	11.0%	14.4%
974		10	78.7	69	95	2.864	9.056	11.51%	28.71%
1474		10	76.1	0	128	13.44	42.5	55.85%	31.07%

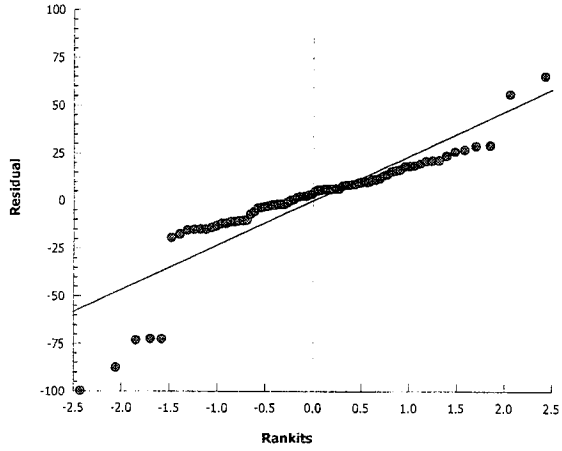
Reproduction Detail

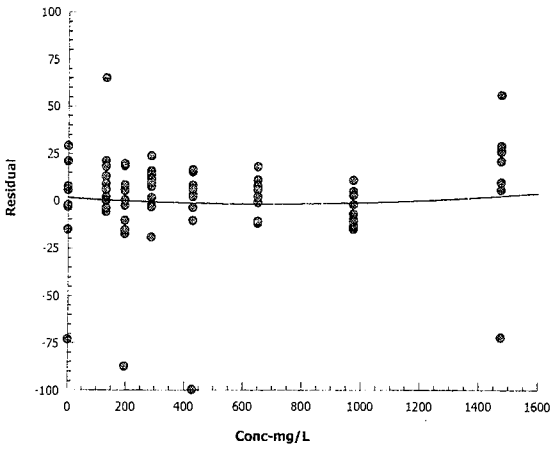
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	136	144	100	121	42	100	123	112	113	113
131		131	123	119	128	104	116	112	110	106	175
196		20	126	127	113	90	92	105	116	108	97
287		106	120	85	112	102	118	116	101	128	114
428		96	0	108	115	103	102	106	116	89	106
650		111	104	101	81	92	99	81	99	95	82
974		69	77	82	70	89	95	74	87	71	73
1474		82	78	99	82	98	128	0	0	101	93

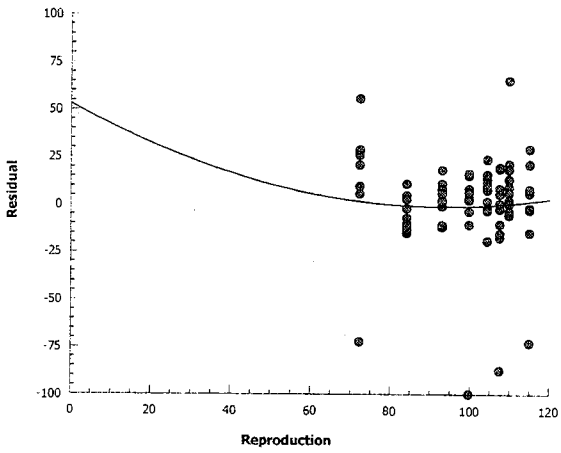
Analysis ID:	06-3060-5433	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:45	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

Graphics 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Brachionus ~~Brachinous~~ *calyciflorus* Summary Sheet

PHASE I

Client: Golder
Work Order No.: 11298

Start Date/Time: June 6, 2011
Test Species: B. calyciflorus
Set up by: BPL/KJL

Sample Information:

Sample ID: Synthetic Effluent
Sample Date: Prepared In-house
Date Received: NA
Sample Volume: NA

Test Organism Information:

Age of young (Day 0): < 0-2 h old neonates

NaCl Reference Toxicant Results:

Reference Toxicant ID: BC 03
Stock Solution ID: NaCl
Date Initiated: July 6, 2011
48-h LC50 (95% CL): 3250 (2542 - n/a) mg/L NaCl

Reference Toxicant Mean ± 2 SD: Not enough data points to generate baseline values
Reference Toxicant CV (%): —

Test Results: Growth Rate: IC25 > 1474 mg/L TDS
IC50 > 1474 mg/L TDS
Based on values calculated from sum of measured ions.

Reviewed by: JGu
Date reviewed: Aug. 30/11

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Golder Associates
Sample ID: ~~Synthetic Effluent~~
Work Order No.: 11298

Start Date/Time: July 6 2011 @ ~~1030~~ 1100 BRL BRL
Test Organism: *Brachionus Calyciflorus*
Set up by: BRL

DO meter: DO-1 pH meter: pH-1 Conductivity meter: C-1

Concentration (mg/L) TDS	Temperature (°C)		Dissolved oxygen (mg/L)		pH		Conductivity (µS/cm)	
	0	48	0	48	0	48	0	48
Control	25.0	25.0	8.1	8.0	7.9	7.6	334	468
132	26.0	25.0	8.1	7.9	7.1	7.3 ~~7.9~~ BRL	270	606
198	26.0	25.0	8.1	7.8	7.1	7.2	~~378~~	443
296	26.0	25.0	8.2	7.8	7.2	7.2	570	655
444	26.0	25.0	8.1	7.8	7.4	7.4	837	968
667	26.0	25.0	8.1	7.9	7.6	7.6	1234	1321
Technician Initials	KJL	BRL	KJL	BRL	KJL	BRL	KJL	BRL

	Hardness	Alkalinity
Control	94	38
Highest concentration	N/A	N/A

	Adjustment	Adjusted WQ
Temp (°C)	N/A	N/A
DO (mg/L)	N/A	N/A
pH	N/A	N/A
Cond (µS/cm)	N/A	N/A

Comments:

Reviewed by: JGL Aug 26/11

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Golder Associates
Sample ID: Synthetic Effluent
Work Order No.: 11298

Start Date/Time: July 6 2011 @ ~~1030~~ 1100 BRL
Test Organism: *Brachionus Calyciflorus*
Set up by: BRL

DO meter: DO-1 pH meter: pH-1 Conductivity meter: C-1

Concentration (mg/L) TDS	Temperature (°C)		Dissolved oxygen (mg/L)		pH		Conductivity (µS/cm)	
	0	48	0	48	0	48	0	48
1000	26.0	25.0	8.2	7.8	7.8	7.8	1796	2080
1500	26.0	25.0	8.1	7.8	7.9	7.9	2630	2980
Technician Initials	KJL	BRL	KJL	BRL	KJL	BRL	KJL	BRL

	Hardness	Alkalinity
Control	94	38
Highest concentration	N/A	N/A

	Adjustment	Adjusted WQ
Temp (°C)	N/A	N/A
DO (mg/L)	N/A	N/A
pH	N/A	N/A
Cond (µS/cm)	N/A	N/A

Comments:

Reviewed by: JOL Aug 26/11

Freshwater Acute Toxicity Test
B. Calyciflorus Survival

Client: Golder Associates
Sample ID: Synthetic Effluent
Work Order: 11298

Start Date & Time: July 6 2011 @ 1100
Stop Date & Time: July 8/2011 @ 1100
Set up by: BRL/KJL

Hrs	Concentration: Control									Concentration: 132 mg/L TDS								
	A	B	C	D	E	F	G	H	Init	A	B	C	D	E	F	G	H	Init
24	2	2	2	2	6	2	2	KJL 4	KJL	2	2	3	1	3	2	1	2	KJL
48	4	5	5	4	9	6	4	6	BRL	5	4	5	5	4	4	3	2	BRL

Hrs	Concentration: 198 mg/l TDS									Concentration: 296 mg/L TDS								
	A	B	C	D	E	F	G	H	Init	A	B	C	D	E	F	G	H	Init
24	1	0	2	2	3	2	1	2	KJL	1	2	1	2	1	KJL 2 0	2	0	KJL
48	0	0	BRL 4	5	5	4	3	5	BRL	1	BRL 5 2	2	5	2	0	2	0	BRL

Hrs	Concentration: 444 mg/L TDS									Concentration: 667 mg/L TDS								
	A	B	C	D	E	F	G	H	Init	A	B	C	D	E	F	G	H	Init
24	3	3	1	2	3	2	2	1	KJL	1	1	2	2	1	2	2	1	KJL
48	4	6	0	4	5	3	4	2	BRL	4	2	2	4	3	2	4	5	BRL

Sample Description:
Comments:

Reviewed by: JGh

Date reviewed: Aug 26/11

Freshwater Acute Toxicity Test
B. Calyciflorus Survival

Client: Golder Associates
Sample ID: Synthetic Effluent
Work Order: 11298

Start Date & Time: July 6 2011 @ 1100
Stop Date & Time: July 8/2011 @ 1100
Set up by: BPL/KJL

Hrs	Concentration: 1000 mg/L TDS									Concentration: 1500 mg/L TDS								
	A	B	C	D	E	F	G	H	Init	A	B	C	D	E	F	G	H	Init
24	1	2	1	2	2	2	1	2	KJL	2	1	2	1	1	1	2	2	KJL
48	2	1	3	5	4	3	3	4	BPL	5	3	6	3	3	BPL 53	4	4	BPL

Hrs	Concentration:									Concentration:								
	A	B	C	D	E	F	G	H	Init	A	B	C	D	E	F	G	H	Init
24																		
48																		

Hrs	Concentration:									Concentration:								
	A	B	C	D	E	F	G	H	Init	A	B	C	D	E	F	G	H	Init
24																		
48																		

Sample Description:
Comments:

Reviewed by: JOL

Date reviewed: Aug 26/11

CETIS Analytical Report

Rotifer 48-h Life Cycle Test — Nautilus Environmental

Analysis ID:	13-2313-9622	Endpoint:	Growth Rate-r	CETIS Version:	CETISv1.8.0
Analyzed:	16 Dec-11 10:49	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	01-6032-0570	Test Type:	Rotifer Growth	Analyst:	
Start Date:	06 Jul-11	Protocol:	SNELL/ET&C 11 (1992)	Diluent:	
Ending Date:	08 Jul-11	Species:	Brachionus calyciflorus	Brine:	
Duration:	48h	Source:		Age:	
Sample ID:	20-4998-7401	Code:	7A305349	Client:	Golder
Sample Date:	22 Jun-11	Material:	Total Dissolved Solids	Project:	TDS Study
Receive Date:		Source:	Golder		
Sample Age:	14d 0h	Station:	Synthetic Effluent (TDS)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.046E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	4.11	1.639	206.9
IC10	25.12	5.966	242.2
IC15	196.2	17.38	434
IC20	221.6	47.52	736.1
IC25	250.2	127.1	N/A
IC40	>1474	N/A	N/A
IC50	>1474	N/A	N/A

Results appear to be a testing artifact of a control being elevated in performance relative to all other treatments. See next page for response curve.

Growth Rate-r Summary — Calculated Variate

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	8	0.8224	0.6931	1.099	0.04961	0.1403	17.06%	0.0%
131		8	0.6737	0.3466	0.8047	0.05592	0.1582	23.48%	18.08%
196		6	0.725	0.5493	0.8047	0.04162	0.1019	14.06%	11.85%
287		6	0.4415	0	0.8047	0.1273	0.3117	70.6%	46.31%
428		7	0.668	0.3466	0.8959	0.06725	0.1779	26.63%	18.78%
650		8	0.5591	0.3466	0.8047	0.06679	0.1889	33.79%	32.01%
974		8	0.5232	0	0.8047	0.08904	0.2518	48.14%	36.38%
1474		8	0.6605	0.5493	0.8959	0.04777	0.1351	20.46%	19.69%

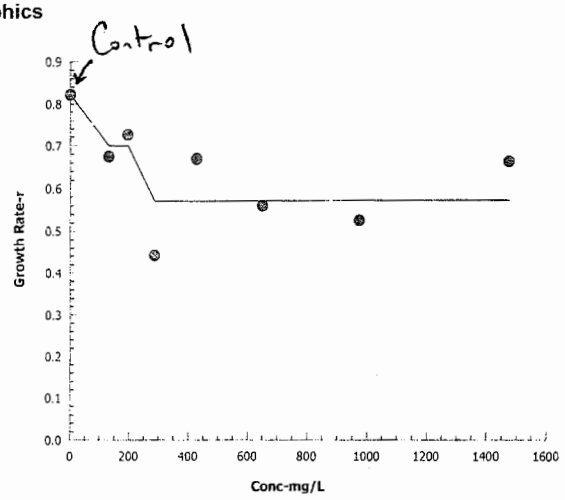
Growth Rate-r Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	Negative Control	0.6931	0.8047	0.8047	0.6931	1.099	0.8959	0.6931	0.8959
131		0.8047	0.6931	0.8047	0.8047	0.6931	0.6931	0.5493	0.3466
196		0.6931	0.8047	0.8047	0.6931	0.5493	0.8047		
287		0	0.8047	0.3466	0.8047	0.3466	0.3466		
428		0.6931	0.8959	0.6931	0.8047	0.5493	0.6931	0.3466	
650		0.6931	0.3466	0.3466	0.6931	0.5493	0.3466	0.6931	0.8047
974		0.3466	0	0.5493	0.8047	0.6931	0.5493	0.5493	0.6931
1474		0.8047	0.5493	0.8959	0.5493	0.5493	0.5493	0.6931	0.6931

Rotifer 48-h Life Cycle Test — **Nautilus Environmental**

Analysis ID:	13-2313-9622	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 10:49	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Control performance exceeds remaining concentrations, but no evidence of a concentration-response. Note that TDS of the control water is higher than the TDS in the lowest test concentration

Rotifer 48-h Life Cycle Test — Nautilus Environmental

Analysis ID:	07-5375-1390	Endpoint:	Growth Rate-r	CETIS Version:	CETISv1.8.0
Analyzed:	27 Apr-12 10:18	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	01-6032-0570	Test Type:	Rotifer Growth	Analyst:	
Start Date:	06 Jul-11	Protocol:	SNELL/ET&C 11 (1992)	Diluent:	
Ending Date:	08 Jul-11	Species:	Brachionus calyciflorus	Brine:	
Duration:	48h	Source:		Age:	
Sample ID:	20-4998-7401	Code:	7A305349	Client:	Golder
Sample Date:	22 Jun-11	Material:	Total Dissolved Solids	Project:	TDS Study
Receive Date:		Source:	Golder		
Sample Age:	14d 0h	Station:	Synthetic Effluent (TDS)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.017E+09	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Control Trend	Mann-Kendall Trend	-12		0.2732	Non-significant Trend in Controls

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	217.4	144.6	954.9
IC10	241.1	185.3	N/A
IC15	267.4	221.9	N/A
IC20	>1474	N/A	N/A
IC25	>1474	N/A	N/A
IC40	>1474	N/A	N/A
IC50	>1474	N/A	N/A

Analysis with control excluded and lowest test concentration of 131 mg/L TDS used as the control. This is considered reasonable since TDS in the control is higher than 131 mg/L.

Growth Rate-r Summary — Calculated Variate

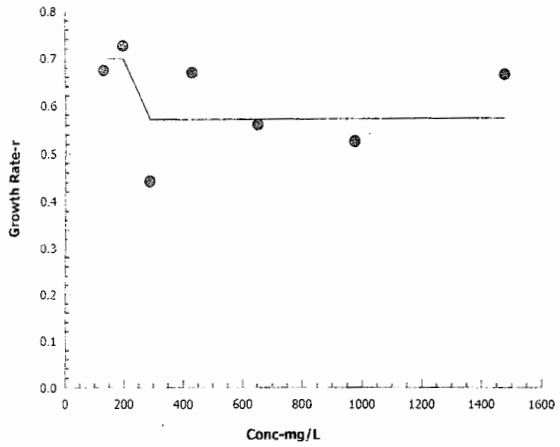
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
131		8	0.6737	0.3466	0.8047	0.05592	0.1582	23.48%	0.0%
196		6	0.725	0.5493	0.8047	0.04162	0.1019	14.06%	-7.61%
287		6	0.4415	0	0.8047	0.1273	0.3117	70.6%	34.46%
428		7	0.668	0.3466	0.8959	0.06725	0.1779	26.63%	0.85%
650		8	0.5591	0.3466	0.8047	0.06679	0.1889	33.79%	17.0%
974		8	0.5232	0	0.8047	0.08904	0.2518	48.14%	22.34%
1474		8	0.6605	0.5493	0.8959	0.04777	0.1351	20.46%	1.96%

Growth Rate-r Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
131		0.8047	0.6931	0.8047	0.8047	0.6931	0.6931	0.5493	0.3466
196		0.6931	0.8047	0.8047	0.6931	0.5493	0.8047		
287		0	0.8047	0.3466	0.8047	0.3466	0.3466		
428		0.6931	0.8959	0.6931	0.8047	0.5493	0.6931	0.3466	
650		0.6931	0.3466	0.3466	0.6931	0.5493	0.3466	0.6931	0.8047
974		0.3466	0	0.5493	0.8047	0.6931	0.5493	0.5493	0.6931
1474		0.8047	0.5493	0.8959	0.5493	0.5493	0.5493	0.6931	0.6931

Analysis ID:	07-5375-1390	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.0
Analyzed:	27 Apr-12 10:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Navicula pelliculosa Summary Sheet

Phase I

Client: Golder
Work Order No.: 11297

Start Date: Oct. 20, 2011
Set up by: ECC

Sample Information:

Sample ID: Synthetic Effluent - TDS
Sample Date: Prepared in-house
Date Received: —
Sample Volume: —

Test Organism Information:

Culture Date: Oct. 13, 2011
Age of culture (Day 0): 7 d

Zinc Reference Toxicant Results:

Reference Toxicant ID: NP03
Stock Solution ID: 11Zn01
Date Initiated: Oct. 20, 2011

72-h IC50 (95% CL): 33.0 (26.1 – 41.8) µg/L Zn

72-h IC50 Reference Toxicant Mean and Range: Not enough data points to generate a baseline value. CV (%): —

Test Results:

	Algal Growth
IC25 mg/L ~~N~~ TDS (95% CL)	> 1487
IC50 mg/L ~~N~~ TDS (95% CL)	~~1370 (378 – 5001)~~ >1487

Reviewed by: JGe

Date reviewed: Dec. 16/11

Diatom *(Navicula pelliculosa)* Growth Inhibition Toxicity Test
Water Quality Measurements

Client : Golder **Setup by:** ECC

Sample ID: Synthetic Effluent -TDS **Test Date/Time:** Oct. 20, 2011 / 1430h

Work Order No.: 11297 **Test Species:** *Navicula pelliculosa*

Culture Date: Oct. 13, 2011 **Age of Culture:** 7d **Culture Health:** Good

Culture Count: 1 129 2 122 **Average:** 125.5 **Culture Cell Density (c1):** 125.5 X10^4

v1 = 1000000 cells/ml x 100 ml / (c1) 125.5 X10^4 mL cells/ml = 47.8 mL

Time Zero Counts: 1 98 2 95 **Average:** 96.5 X10^4

No. of Cells/mL: 96.5 X10^4 **Initial Density:** # cells/mL ÷ 100 mL x 1 mL = 9650 cells/mL

Concentration Nominal (mg/L TDS)	Water Quality Measurements						
	pH	Temp (°C)					
	0 h	0 h	24 h	48 h	72 h	96 h	120 h
Control	7.5	22.5	24.5	24.5	24.5	25.0	25.5
132	7.5	22.5	24.5			25.0	25.5
198	7.4	22.5	24.5			25.0	25.5
296	7.4	22.5	24.5			25.0	25.5
444	7.5	22.5	24.5			25.0	25.5
667	7.6	22.5	24.5			25.0	25.5
1000	7.6	22.5	24.5			25.0	25.5
1500	7.6	22.5	24.5	24.5	24.5	25.0	25.5
Initials							

Light intensity (lux): ~~4420~~ 4420 **Date measured:** Oct. 20, 2011

Sample Description:

Comments: Initial pH of 8.7 – 9.9, treatments adjusted with HCl to pH 7.4–7.6

Reviewed: JGh **Date reviewed:** Dec. 16/11

Navicula pelliculosa Toxicity Test Data Sheet

~~96~~ 120-h Diatom Cell Counts

Client: Golder
Start Date/Time: Dec. 20, 2011 | 1430h
Work Order #: 11297
Termination Date: Dec 25, 2011
Sample ID: Synthetic Effluent
Test set up by: ECC
(mg/L TDS)

Concentration	Rep	Count 1	Count 2	Count 3	Count 4	Comments	Initials
Control	A	19	18				
	B	22	23	22			
	C	21	24				
	D	17	18				
	E	20	21	21			
	F	18	18				
	G						
	H						
132	A	29	32				
	B	33	34				
	C	24	26				
	D						
198	A	52	49				
	B	41	39				
	C	26	27	26			
	D						
296	A	30	29				
	B	35	48	44			
	C	38	36	40			
	D						
444	A	36	24				
	B	32	30				
	C	22	24	26			
	D						
667	A	35	29	32			
	B	38	41				
	C	35	34				
	D						
1000	A	29	24				
	B	31	27				
	C	22	21	21			
	D						
1500	A	21	20	22			
	B	18	19	18			
	C	32	31	35			
	D						

Comments:

Reviewed by: JOL
Date Reviewed: Dec. 16/11

***Navicula pelliculosa Cell* Counts**

Client: Golder
WO#: 11297
Sample ID: Synthetic Effluent

Start Date/Time: 20-Oct-11 @1430h
Termination Date: 25-Oct-11

Initial Cell Density: 9650 cell/mL

965000
100
1
9650

Concentration (mg/L TDS)	Rep	Count 1 (x 10^4)	Count 2 (x 10^4)	Count 3 (x 10^4)	Count 4 (x 10^4)	Mean (x 10^4)	Cell Yield (x 10^4) cell/mL		
Control	A	19	18			18.5	17.5	mean	19.0
	B	22	23	22		22.333333	21.4	SD	2.217982
	C	21	24			22.5	21.5	CV	11.70336
	D	17	18			17.5	16.5		
	E	20	21	21		20.666667	19.7		
	F	18	18			18	17.0		
132	A	29	32			30.5	29.5		
	B	33	34			33.5	32.5		
	C	24	26			25	24.0		
198	A	52	49			50.5	49.5		
	B	41	39			40	39.0		
	C	26	27	26		26.333333	25.4		
296	A	30	29			29.5	28.5		
	B	35	48	44		42.333333	41.4		
	C	38	36	40		38	37.0		
444	A	36	34			35	34.0		
	B	32	30			31	30.0		
	C	22	24	26		24	23.0		
667	A	35	29	32		32	31.0		
	B	38	41			39.5	38.5		
	C	35	34			34.5	33.5		
1000	A	29	24			26.5	25.5		
	B	31	27			29	28.0		
	C	22	21	21		21.333333	20.4		
1500	A	21	20	22		21	20.0		
	B	18	19	18		18.333333	17.4		
	C	32	31	35		32.666667	31.7		

JGL
Dec. 16/11

CETIS Analytical Report

Navicula pelliculosa Growth Inhibition — **Nautilus Environmental**

Analysis ID:	01-4761-3712	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 11:03	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	12-2624-5226	**Test Type:**	Cell Growth	**Analyst:**	
Start Date:	20 Oct-11	**Protocol:**	ASTM E1218-04 (2004)	**Diluent:**	Deionized Water
Ending Date:	25 Oct-11	**Species:**	Navicula pelliculosa	**Brine:**	
Duration:	5d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	06-2171-4766	**Code:**	Synthetic Eff	**Client:**	Golder
Sample Date:	10 Nov-11 11:44	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	10 Nov-11 11:44	**Source:**	Golder		
Sample Age:	N/A	**Station:**			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	71985307	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	701.7	181.5	1104
IC10	782.8	491.6	N/A
IC15	873.3	559.4	N/A
IC20	990.4	608.6	N/A
IC25	1471	226.1	N/A
IC40	>1487	N/A	N/A
IC50	>1487	N/A	N/A

All concentrations performed better than Control response, therefore, IC values are all > 1487 mg/L.

Cell Yield Summary — **Calculated Variate**

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	6	19	16	22	0.9661	2.366	12.45%	0.0%
196		3	28.67	24	32	2.404	4.163	14.52%	-50.88%
248		3	38	25	50	7.234	12.53	32.97%	-100.0%
453		3	35.33	28	41	3.844	6.658	18.84%	-85.96%
455		3	29	23	34	3.215	5.568	19.2%	-52.63%
629		3	34.33	31	38	2.028	3.512	10.23%	-80.7%
968		3	24.67	20	28	2.404	4.163	16.88%	-29.82%
1487		3	23	17	32	4.583	7.937	34.51%	-21.05%

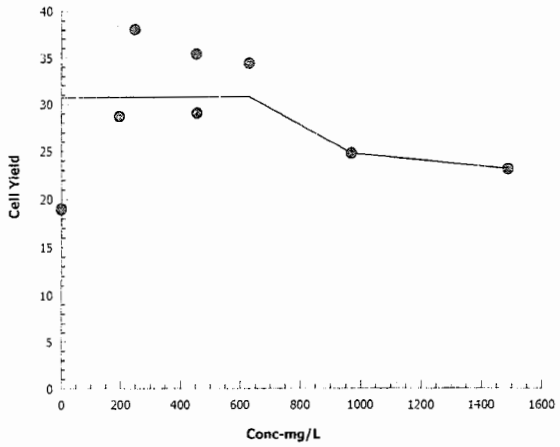
Cell Yield Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
0	Negative Control	18	21	22	16	20	17
196 ✓		30	32	24			
248 ✓		50	39	25			
453 ✓		28	41	37			
455 ✓		34	30	23			
629 ✓		31	38	34			
968 ✓		26	28	20			
1487 ✓		20	17	32			

Navicula pelliculosa Growth Inhibition — **Nautilus Environmental**

Analysis ID:	01-4761-3712	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 11:03	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



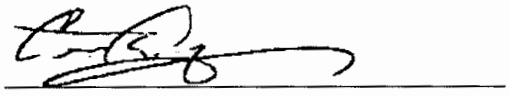
NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 21-OCT-11
Report Date: 28-OCT-11 16:55 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1075424
Project P.O. #: 065
Job Reference: 11297
C of C Numbers:
Legal Site Desc:



Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1075424-1	L1075424-2	L1075424-3	L1075424-4	L1075424-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	20-OCT-11	20-OCT-11	20-OCT-11	20-OCT-11	20-OCT-11
	Sampled Time					
	Client ID	1500	1000	667	444	296
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	110	72.2	47.7	31.2	28.6
	Chloride (Cl) (mg/L)	718	460	292	214	230
	Sulfate (SO4) (mg/L)	135	86	54.1	41.0	45.6
Total Metals	Calcium (Ca)-Total (mg/L)	266	175	115	80.0	66.9
	Magnesium (Mg)-Total (mg/L)	37.8	25.5	16.9	12.8	11.4
	Potassium (K)-Total (mg/L)	15.3	10.2	6.8	4.7	4.0
	Sodium (Na)-Total (mg/L)	181	123	85.9	64.6	60.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1075424-6	L1075424-7			
	Description	WATER	WATER			
	Sampled Date	20-OCT-11	20-OCT-11			
	Sampled Time					
	Client ID	198	132			
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	23.5	18.3			
	Chloride (Cl) (mg/L)	109	92.0			
	Sulfate (SO4) (mg/L)	22.3	17.3			
Total Metals	Calcium (Ca)-Total (mg/L)	37.0	21.7			
	Magnesium (Mg)-Total (mg/L)	7.17	5.19			
	Potassium (K)-Total (mg/L)	2.4	<2.0			
	Sodium (Na)-Total (mg/L)	41.3	37.7			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1075424-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfate (SO4)	MS-B	L1075424-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
<- Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1075424-COFC

① British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

Oct 21/11

Date _____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	L1075424 ①	Company	①
Address		Address	
City/State/Zip		City/State/Zip	
Contact		Contact	
Phone		Phone	
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides				Receipt Temperature (°C)
1	1500	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
2	1000	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
3	667	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
4	444	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
5	296	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
6	198	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
7	132	20-Oct-11			250 mL	1	TDS Phase 1	x	x	x	x	x	x	x				
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11297	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Total Dissolved Solids Project Study-Navicula pelliculosa

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) Oct 21/11	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) 17C (Time)
(Printed Name) (Date)	(Printed Name) RYAN (Date) Oct 21
(Company)	(Company) AS 12:00

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Summary of calculated TDS

Project	11297
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1075424
Date Received	21-Oct-11 12:00
Date	28-Oct-11

RESULTS OF ANALYSIS

Sample ID	1500	1000	667	444
Date Sampled	20-OCT-11	20-OCT-11	20-OCT-11	20-OCT-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1075424-1	L1075424-2	L1075424-3	L1075424-4
Matrix	Water	Water	Water	Water
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	110	72.2	47.7	31.2
Chloride (Cl)	718 ✓	460	292	214
Sulfate (SO4)	135 ✓	86	54.1	41.0
1.22 x Alkalinity	134.2 ✓	88.084	58.194	38.064
Total Metals				
Calcium (Ca)-Total	266 ✓	175	115	80.0
Magnesium (Mg)-Total	37.8 ✓	25.5	16.9	12.8
Potassium (K)-Total	15.3 ✓	10.2	6.8	4.7
Sodium (Na)-Total	181 ✓	123	85.9	64.6
TDS	1487 ✓	968	629	455

JGh
Dec. 16/11

296	198	132
20-OCT-11	20-OCT-11	20-OCT-11
00:00	00:00	00:00
L1075424-5	L1075424-6	L1075424-7
Water	Water	Water
28.6	23.5	18.3
230	109	92.0 ✓
45.6	22.3	17.3 ✓
34.892	28.67	22.326 ✓
66.9	37.0	21.7 ✓
11.4	7.17	5.19 ✓
4.0	2.4	<2.0
60.3	41.3	37.7 ✓
453	248	196 ✓

JGb
Dec. 16/11

Pseudokirchneriella subcapitata Summary Sheet

Phase I

Client: Golder
Work Order No.: 11296

Start Date: June 27, 2011
Set up by: ECC

Sample Information:

Sample ID: **Synthetic Effluet**
Sample Date: NA Prepared in house
Date Received: NA
Sample Volume: NA

Test Organism Information:

Culture Date: June 23, 2011
Age of culture (Day 0): 7 d

Zinc Reference Toxicant Results:

Reference Toxicant ID: SC72
Stock Solution ID: 11Zn01
Date Initiated: June 27, 2011

72-h IC50 (95% CL): 28.9 (25.0 - 33.4) ug/L Zn

72-h IC50 Reference Toxicant Mean and Range: 26.7, 14.4 - 49.4 CV (%): 36%
ug/L Zn

Test Results:

		Algal Growth (1)
IC25 (95% CL)	mg/L TDS	~~Nominal~~ ~~>2350~~ ~~1500~~ > 1474
IC50 (95% CL)	mg/L TDS	~~Nominal~~ ~~>2350~~ ~~1500~~ > 1474

(1) Value based on sum of Total ions.

Reviewed by: JGh

Date reviewed: Aug. 26/11

72-h Algal Growth Inhibition Toxicity Test
Water Quality Measurements

Client : GOLDER **Setup by:** ECC

Sample ID: Synthetic Effluent **Test Date/Time:** 27-Jun-11 / 1500h

Work Order No.: 11296 **Test Species:** *Pseudokirchneriella subcapitata*

Culture Date: June 23, 2011 **Age of Culture:** 4 d **Culture Health:** Good

Culture Count: 1 180 2 191 **Average:** 185.5 **Culture Cell Density (c1):** 185.5 x104

v1 = 220,000 cells/ml x 50 ml / (c1) 185.5X104 cells/ml = 5.9 mL

Time Zero Counts: 1 22 2 23 **Average:** 22.5 x104

No. of Cells/mL: 22.5 X104 **Initial Density:** # cells/mL ÷ 220 µL x 10 µL = 10,227 Cells/mL

Concentration NOMINAL (mg/L TDS)	Water Quality Measurements					Microplates rotated 2X per day?			
	pH	Temp (°C)							
	0 h	0 h	24 h	48 h	72 h	0 h	24 h	48 h	72 h
Control	6.6	24.5	24.5	24.0	24.0	✓	✓	✓	✓
132	6.6	24.5	24.5	24.0	24.0	✓	✓	✓	✓
198	6.7	24.5	24.5	24.0	24.0	✓	✓	✓	✓
296	6.9	24.5	24.5	24.0	24.0	✓	✓	✓	✓
444	7.0	24.5	24.5	24.0	24.0	✓	✓	✓	✓
667	7.2	24.5	24.5	24.0	24.0	✓	✓	✓	✓
1000	7.5	24.5	24.5	24.0	24.0	✓	✓	✓	✓
1500	7.7	24.5	24.5	24.0	24.0	✓	✓	✓	✓
Initials									

Initial control pH: Well 1: 6.5 Well 2: 6.5

Final control pH: Well 1: 6.5 Well 2: 6.5

Light intensity (lux): 3700 **Date measured:** June 27, 2011

Sample Description: Clear Solution

Comments:

Reviewed: JOL **Date reviewed:** Aug. 26/11

Pseudokirchneriella subcapitata Toxicity Test Data Sheet
72-h Algal Cell Counts

Client: Golder
Start Date/Time: 27-Jun-11 / 1500 h
Work Order #: 11296
Termination Date: 30-Jun-11
Sample ID: Synthetic Effluent
Test set up by: ECC
(mg/L TDS) NOMINAL

Concentration	Rep	Count 1	Count 2	Count 3	Count 4	Comments	Initials
Control	A	83					
	B	75					
	C	72					
	D	81					
	E	68	65				
	F	77					
	G	81					
	H	76					
132	A	198	210				
	B	218					
	C	223					
	D	216					
198	A	186					
	B	193					
	C	205					
	D	211					
296	A	174					
	B	199					
	C	164					
	D	213					
444	A	185					
	B	195					
	C	191					
	D	206					
667	A	162	176				
	B	146	155				
	C	166					
	D	183	192				
1000	A	189					
	B	193					
	C	167					
	D	181					
1500	A	171					
	B	157					
	C	131	142				
	D	176					

Comments:

Reviewed by: JCL
Date Reviewed: Aug. 26/11

***Pseudokirchneriella subcapitata* Algal Counts**

Client:	Golder	Start Date/Time:	27-Jun-11 @1500h		
WO#:	11296	Termination Date:	30-Jun-11		
Sample ID:	Synthetic Effluent				
		Initial Cell Density:	10227 cell/mL		225000
					0.22
NOMINAL					0.01

Concentration (mg/L TDS)	Rep	Count 1 ($x 10^4$)	Count 2 ($x 10^4$)	Count 3 ($x 10^4$)	Count 4 ($x 10^4$)	Mean ($x 10^4$)	Cell Yield ($x 10^4$) cell/mL		10227.27
Control	A	83				83	82.0	mean	75.4
	B	75				75	74.0	SD	5.421106
	C	72				72	71.0	CV	7.188388
	D	81				81	80.0		
	E	68	65			66.5	65.5		
	F	77				77	76.0		
	G	81				81	80.0		
	H	76				76	75.0		
132	A	198	210			204	203.0		
	B	218				218	217.0		
	C	223				223	222.0		
	D	216				216	215.0		
198	A	186				186	185.0		
	B	193				193	192.0		
	C	205				205	204.0		
	D	211				211	210.0		
296	A	174				174	173.0		
	B	199				199	198.0		
	C	164				164	163.0		
	D	213				213	212.0		
444	A	185				185	184.0		
	B	195				195	194.0		
	C	191				191	190.0		
	D	206				206	205.0		
667	A	162	176			169	168.0		
	B	146	155			150.5	149.5		
	C	166				166	165.0		
	D	183	192			187.5	186.5		
1000	A	189				189	188.0		
	B	193				193	192.0		
	C	167				167	166.0		
	D	181				181	180.0		
1500	A	171				171	170.0		
	B	157				157	156.0		
	C	131	142			136.5	135.5		
	D	176				176	175.0		

JCL
Aug. 26/11

CETIS Analytical Report

EC Alga Growth Inhibition Test — Nautilus Environmental

Analysis ID:	21-3920-4099	Endpoint:	Cell Yield	CETIS Version:	CETISv1.8.0
Analyzed:	16 Dec-11 10:16	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	08-7994-4610	Test Type:	Cell Growth	Analyst:	
Start Date:	27 Jun-11	Protocol:	EC/EPS 1/RM/25	Diluent:	Deionized Water
Ending Date:	30 Jun-11	Species:	Pseudokirchneriella subcapitata	Brine:	
Duration:	72h	Source:	In-House Culture	Age:	
Sample ID:	12-9165-3485	Code:	Synth Eff	Client:	Golder
Sample Date:	27 Jun-11	Material:	Total Dissolved Solids	Project:	TDS Study
Receive Date:	27 Jun-11	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.365E+09	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	2.251	2.991	0.7238	No Outliers Detected
Control Trend	Mann-Kendall Trend	-2		0.9049	Non-significant Trend in Controls

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	1249	878.9	N/A
IC10	>1474	N/A	N/A
IC15	>1474	N/A	N/A
IC20	>1474	N/A	N/A
IC25	>1474	N/A	N/A
IC40	>1474	N/A	N/A
IC50	>1474	N/A	N/A

All concentrations performed better than control response. Therefore IC values are all > 1474 mg/L

Cell Yield Summary — Calculated Variate

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	8	75.5	66	82	1.871	5.292	7.01%	0.0%
131		4	214.3	203	222	4.029	8.057	3.76%	-183.8%
196		4	197.8	185	210	5.662	11.32	5.73%	-161.9%
287		4	186.5	163	212	11.24	22.49	12.06%	-147.0%
428		4	193.3	184	205	4.423	8.846	4.58%	-156.0%
650		4	167.3	150	186	7.387	14.77	8.83%	-121.5%
973		4	181.5	166	192	5.737	11.47	6.32%	-140.4%
1474		4	159.3	136	175	8.731	17.46	10.97%	-110.9%

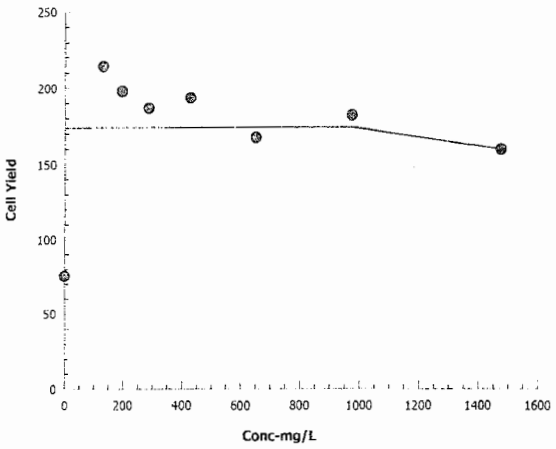
Cell Yield Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	Negative Control	82	74	71	80	66	76	80	75
131		203	217	222	215				
196		185	192	204	210				
287		173	198	163	212				
428		184	194	190	205				
650		168	150	165	186				
973		188	192	166	180				
1474		170	156	136	175				

EC Alga Growth Inhibition Test — **Nautilus Environmental**

Analysis ID:	21-3920-4099	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.0
Analyzed:	16 Dec-11 10:16	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



APPENDIX B – Phase 2 Toxicity Test Data: *Ceriodaphnia dubia*

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 11299

Start Date/Time: July 21, 2011 @1040 h
Set up by: KLB

Sample Information:

Sample ID: NaCl TDS
Sample Date: Prepared In-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 071211
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 24
Mortality (%) in previous 7 d: 0
Individual female # used ≥8 young on test day: 21, 22, 23, 26, 27, 29, 31, 32, 35, , 38, 39

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd70
Stock Solution ID: 11Na01
Date Initiated: July 12, 2011

7-d LC50 (95% CL): 1.7 (1.4 - 2.2) g/L NaCL
7-d IC50 (95% CL): 1.4 (1.2 - 1.6) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5 - 2.3) g/L NaCL CV (%): 12
7-d IC50 Reference Toxicant Mean and Historical Range: 1.1 (0.9 - 1.5) g/L NaCL CV (%): 15

Test Results:

mg/L TDS	Survival	Reproduction
LC50 ~~%(v/v)~~ (95% CL)	>1561	
IC25 ~~%(v/v)~~ mg/L (95% CL)		1234 (NA - 1563)
IC50 ~~%(v/v)~~ mg/L (95% CL)		1482 (1144 - 1790)

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: Nucl TDS
Work Order: 11299

Start Date & Time: July 21/11 @ 1040h
Stop Date & Time: July 27/11 @ 1230h
Set up by: KLB

mg/L TDS

Days	Concentration: 20% Perrier Control											Concentration: 450 (baseline)											Concentration: 607										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans
4	5	4	4	3	4	2	3	3	3	3	KJL	2	3	2	3	✓	✓	4	3	3	✓	KJL	4	2	2	4	2	3	✓	2	✓	✓	KJL
5	10	9	9	10	9	8	8	9	8	10	KLB	10	11	10	✓	2	5	10	8	7	2	KLB	11	10	8	9	9	10	5	10	5	7	KLB
6	13	14	15	15	14	12	12	14	14	12	KLB	10	16	12	13	9	13	13	15	15	11	KLB	13	11	14	14	14	14	15	14	11	15	KLB
7																																	
8																																	
Total	28	27	28	28	27	22	23	26	25	25	KLB	22	30	24	16	11	18	27	26	25	13	KLB	28	23	24	27	25	27	20	26	16	22	KLB

Days	Concentration: 817											Concentration: 1132											Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ans
4	2	2	✓	3	3	2	3	✓	✓	3	KJL	4	3	2	4	3	✓	✓	✓	2	✓	KJL	✓	✓	✓	✓	✓	✓	✓	✓	✓	2	KJL
5	6	6	4	7	6	8	9	9	4	9	KLB	9	8	5	6	5	4	3	6	6	4	KLB	✓	3	2	3	5	4	4	5	4	✓	KLB
6	✓	12	9	✓	13	15	14	15	14	15	KLB	12	16	17	15	X	12	12	13	14	17	KLB	✓	10	✓	10	8	✓	11	✓	14	7	KLB
7																																	
8																																	
Total	8	20	13	10	22	25	26	24	18	27	KLB	25	27	24	25	8*	16	15	19	22	21	KLB	0	13	2	13	13	4	15	5	18	9	KLB

Days	Concentration:											Concentration:											Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1																																	
2																																	
3																																	
4																																	
5																																	
6																																	
7																																	
8																																	
Total																																	

Notes: X = mortality.

Sample Description: Chemical Solution
Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: JGh

Date reviewed: Jan - 10/12

CETIS Analytical Report

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	19-5326-2796	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 16:23	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	05-0580-2498	**Code:**	NaCl	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
26	-6.887	31.77	19.15	0.7823	Yes				Lack of Fit Not Tested

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	611.9	N/A	1166
IC5	860.3	N/A	1230
IC10	1000	N/A	1356
IC15	1095	N/A	1447
IC20	1170	N/A	1513
IC25	1234	N/A	1563
IC40	1391	970.9	1676
IC50	1482	1144	1790
IC60	1572	1199	2117
IC75	1714	1225	N/A
IC80	1768	1251	N/A
IC85	1830	1302	N/A
IC90	1905	1388	N/A
IC95	2013	1538	N/A
IC99	2202	1815	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	23.2	1.64	17.99	28.42	14.15	0.0008	Significant Parameter
C	4.785	2.606	-3.51	13.08	1.836	0.1637	Non-Significant Parameter
D	1482	98.04	1170	1795	15.12	0.0006	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	145.9105	145.9105	1	19.97	0.0209	Significant
Residual	21.9228	7.3076	3			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Distribution	Shapiro-Wilk W Normality	0.9646	0.5128	0.8543	Normal Distribution

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	19-5326-2796	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 16:23	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

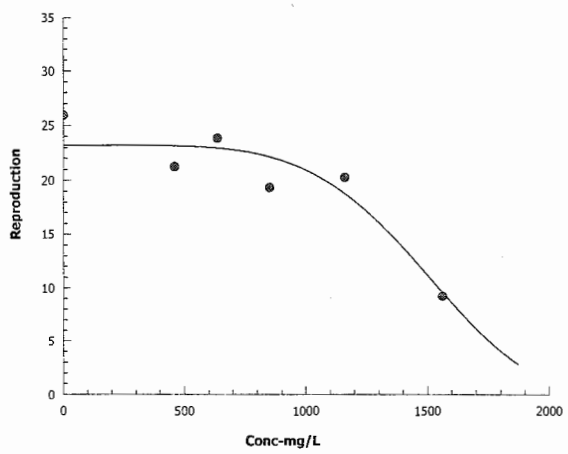
Reproduction Summary — **Calculated Variate**

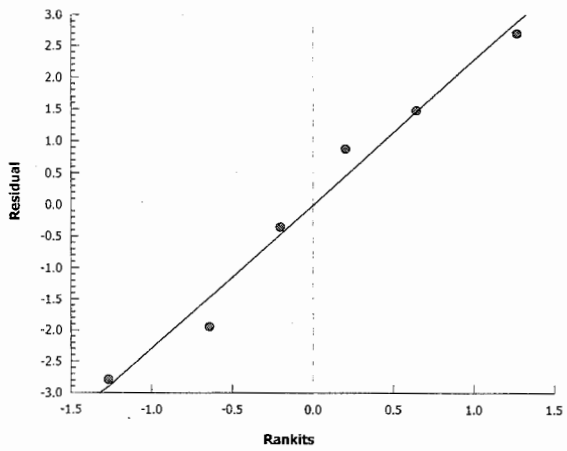
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	25.9	22	28	0.6741	2.132	8.23%	0.0%
460		10	21.2	11	30	2.015	6.374	30.06%	18.15%
636		10	23.8	16	28	1.172	3.706	15.57%	8.11%
852		10	19.3	8	27	2.166	6.848	35.48%	25.48%
1160		10	20.2	8	27	1.843	5.827	28.85%	22.01%
1561		10	9.2	0	18	1.931	6.106	66.37%	64.48%

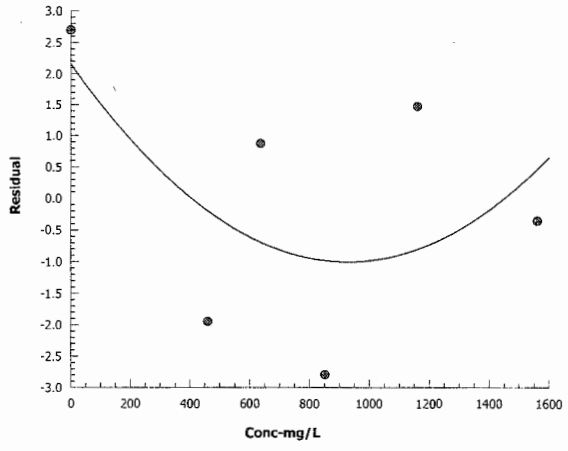
Reproduction Detail

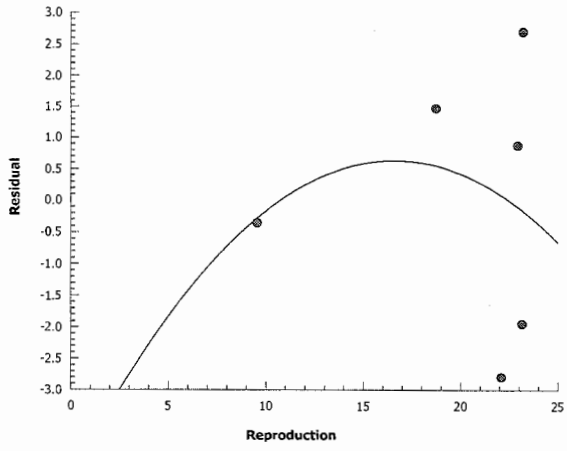
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	28	27	28	28	27	22	23	26	25	25
460		22	30	24	16	11	18	27	26	25	13
636		28	23	24	27	25	27	20	26	16	22
852		8	20	13	10	22	25	26	24	18	27
1160		25	27	24	25	8	16	15	19	22	21
1561		0	13	2	13	13	4	15	5	18	9

Graphics — 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Summary of calculated TDS

C. duben
Initial

Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1032207
Date Received	15-Jul-11 16:33
Date	25-Jul-11

RESULTS OF ANALYSIS

Sample ID	NACL-1500	NACL-1132	NACL-817	NACL-607
Date Sampled	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1032207-1	L1032207-2	L1032207-3	L1032207-4
Matrix	Water	Water	Water	Water
Physical Tests				
Total Dissolved Solids	1810	1540	1090	911
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	33.3	33.7	33.6	33.0
Chloride (Cl)	897	660	453	323
Sulfate (SO4)	39	39	38.5	38.6
Alk 1.22X	40.626	41.114	40.992	40.26
Total Metals				
Calcium (Ca)-Total	92.5	88.8	94.2	92.0
Magnesium (Mg)-Total	11.0	10.4	11.2	11.0
Potassium (K)-Total	6.5	6.2	6.7	6.7
Sodium (Na)-Total	488	319	208	119
Total TDS	1575	1165	853	631

JGL
Jan-10/12

TDS 450	LAB WATER
13-JUL-11	13-JUL-11
00:00	00:00
L1032207-5	L1032207-6
Water	Water
833	<10
33.4	<2.0
221	<0.50
38.6	<0.50
40.748	#VALUE!
90.0	<0.050
10.8	<0.10
6.6	<2.0
49.6	<2.0
457	#VALUE!

JBL
Jan. 10/12

Nacl
Final

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 15-JUL-11
Report Date: 25-JUL-11 12:41 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1032207
Project P.O. #: 065
Job Reference:
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1032207-1	L1032207-2	L1032207-3	L1032207-4	L1032207-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11
	Sampled Time					
	Client ID	NACL-1500	NACL-1132	NACL-817	NACL-607	TDS 450
Grouping	Analyte					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1810	1540	1090	911	833
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	33.3	33.7	33.6	33.0	33.4
	Chloride (Cl) (mg/L)	897	660	453	323	221
	Sulfate (SO4) (mg/L)	39	39	38.5	38.6	38.6
Total Metals	Calcium (Ca)-Total (mg/L)	92.5	88.8	94.2	92.0	90.0
	Magnesium (Mg)-Total (mg/L)	11.0	10.4	11.2	11.0	10.8
	Potassium (K)-Total (mg/L)	6.5	6.2	6.7	6.7	6.6
	Sodium (Na)-Total (mg/L)	488	319	208	119	49.6

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1032207-6
	Description	WATER
	Sampled Date	13-JUL-11
	Sampled Time	
	Client ID	LAB WATER
Grouping	**Analyte**	
WATER		
Physical Tests	Total Dissolved Solids (mg/L)	<10
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	<2.0
	Chloride (Cl) (mg/L)	<0.50
	Sulfate (SO4) (mg/L)	<0.50
Total Metals	Calcium (Ca)-Total (mg/L)	<0.050
	Magnesium (Mg)-Total (mg/L)	<0.10
	Potassium (K)-Total (mg/L)	<2.0
	Sodium (Na)-Total (mg/L)	<2.0

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1032207

Short Holding Time

Rush Processing

L1032207-COFC

Fax 403.922.5814

(1)

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 15/11

Date _____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	NaCl-1500	13-Jul-11			1 L	1	Stock Soln.	x	x	x	x	x	x	x	x			
2	NaCl-1132	13-Jul-11			1 L	1		x	x	x	x	x	x	x	x			
3	NaCl-817	13-Jul-11			1 L	1		x	x	x	x	x	x	x	x			
4	NaCl-607	13-Jul-11			1 L	1		x	x	x	x	x	x	x	x			
5	TDS 450	13-Jul-11			1 L	1		x	x	x	x	x	x	x	x			
6	Lab Water	13-Jul-11			1 L	1		x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11296-11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) July 15, 2011	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)
RECEIVED BY (COURIER)	**RECEIVED BY (LABORATORY)**
(Signature) (Time)	(Signature) Walter July 15, 11, 17:20. (Time)
(Printed Name) (Date)	(Printed Name) Temp = 16.8°C (Date)
(Company)	(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Summary of calculated TDS, test termination

C. dubois
D6

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038458
Date Received	29-Jul-11 12:39
Date	08-Aug-11

RESULTS OF ANALYSIS

Sample ID	NACL-1500 D6	NACL-1132 D6	NACL-817 D6	NACL-607 D6
Date Sampled	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1038458-1	L1038458-2	L1038458-3	L1038458-4
Matrix	Water	Water	Water	Water
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	34.2	34.2	33.6	33.4
Chloride (Cl)	915	675	466	333
Sulfate (SO4)	40	39	39.7	40.9
ALK 1.22x	41.724	41.724	40.992	40.748
Total Metals				
Calcium (Ca)-Total	85.5	83.4	89.4	91.4
Magnesium (Mg)-Total	10.1	9.81	10.6	10.8
Potassium (K)-Total	6.0	5.9	6.3	6.7
Sodium (Na)-Total	449	300	197	117
Total TDS	1547	1155	850	641

JGh
Jan-10/12

TDS 450 D6
27-JUL-11
00:00
L1038458-5
Water

34.2
225
39.9
41.724

89.2
10.7
6.9
49.6

463

JGh
Jan-10/12

C. dubra
Noel
Dang

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 08-AUG-11 12:12 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038458

Project P.O. #: 065 PHASE 2 WO#11299
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1038458-1	L1038458-2	L1038458-3	L1038458-4	L1038458-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11
	Sampled Time					
	Client ID	NACL-1500 D6	NACL-1132 D6	NACL-817 D6	NACL-607 D6	TDS 450 D6
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	34.2	34.2	33.6	33.4	34.2
	Chloride (Cl) (mg/L)	915	675	466	333	225
	Sulfate (SO4) (mg/L)	40	39	39.7	40.9	39.9
Total Metals	Calcium (Ca)-Total (mg/L)	85.5	83.4	89.4	91.4	89.2
	Magnesium (Mg)-Total (mg/L)	10.1	9.81	10.6	10.8	10.7
	Potassium (K)-Total (mg/L)	6.0	5.9	6.3	6.7	6.9
	Sodium (Na)-Total (mg/L)	449	300	197	117	49.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Nautilus Environmen

L1038458

vay East, Suite 2
4
96

1 British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

Date July 29/11 Page 1 of 1

Sample Collection By:

Report to:	1	Invoice To:	1
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides				Receipt Temperature (°C)
1	NaCl-1500 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
2	NaCl-1132 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
3	NaCl-817 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
4	NaCl-607 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
5	TDS 450 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 Phase 2 WO #: 11299	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time) July 29/11	(Signature) (Time)
(Printed Name) Edmund Canaria (Date)	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time) 12:39
(Printed Name) (Date)	(Printed Name) (Date) Jul 29
(Company)	(Company) ALS YOC

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 11299

Start Date/Time: July 21, 2011 @1040 h
Set up by: KLB

Sample Information:

Sample ID: Na_2SO_4 TDS
Sample Date: Prepared In-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 071211
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 24
Mortality (%) in previous 7 d: 0
Individual female # used ≥8 young on test day: 21, 22, 23, 26, 27, 29, 31, 32, 35, , 38, 39

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd70
Stock Solution ID: 11Na01
Date Initiated: July 12, 2011

7-d LC50 (95% CL): 1.7 (1.4 - 2.2) g/L NaCL
7-d IC50 (95% CL): 1.4 (1.2 - 1.6) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5 - 2.3) g/L NaCL CV (%): 12
7-d IC50 Reference Toxicant Mean and Historical Range: 1.1 (0.9 - 1.5) g/L NaCL CV (%): 15

Test Results:

mg/L TDS	Survival	Reproduction
LC50 ~~%(v/v)~~ (95% CL)	> 1554	
IC25 ~~%(v/v)~~ (95% CL)		1131 (789 – 1542)
IC50 ~~%(v/v)~~ (95% CL)		> 1554

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: Na_2SO_4 TDS
Work Order #: 11299
mg/L TDS

Start Date & Time: July 21/11 @ 1030h
Stop Date: July 27/11 @ 1300h
Test Species: *Ceriodaphnia dubia*

Concentration: 20% Perrier Ctrl	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	7.8	7.2	8.0	7.0	8.1	7.1	8.0	6.9	7.9	6.1	7.6	6.2		
pH	8.1	8.1	8.2	7.8	8.3	7.8	8.3	8.0	8.2	7.6	7.9	7.8		
Cond. (µS/cm)	216	214		219		221		218		218		222		
Initials	KLB	MJ		AMS		AT		KLB		KLB		KLB		

Concentration: 450	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	7.0	8.1	6.9	8.2	7.2	8.0	7.1	7.8	5.7	8.1	6.3		
pH	7.5	7.5	7.5	7.6	7.7	7.7	7.7	7.4	7.6	7.2	7.5	7.4		
Cond. (µS/cm)	869	899		906		907		893		862		858		
Initials	KLB	MJ		AMS		AT		KLB		KLB		KLB		

Concentration: 607	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	6.9	8.2	7.2	8.2	7.1	8.1	7.1	8.1	6.1	8.1	6.1		
pH	7.4	7.6	7.5	7.6	7.7	7.6	7.8	7.4	7.6	7.2	7.5	7.4		
Cond. (µS/cm)	1083	1098		1135		1104		1090		1087		1067		
Initials	KLB	MJ		AMS		AT		KLB		KLB		KLB		

Concentration: 1500	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	6.9	8.2	7.1	8.2	7.2	8.1	7.1	8.1	6.0	8.0	5.9		
pH	7.5	7.5	7.4	7.6	7.6	7.6	7.6	7.4	7.7	7.2	7.6	7.4		
Cond. (µS/cm)	2270	2310		2360		2300		2290		2290		2260		
Initials	KLB	MJ		AMS		AT		KLB		KLB		KLB		

	20% Perrier Control	~~450 mg/L TDS~~	~~1500 mg/L TDS~~	
Hardness*	98	—	—	
Alkalinity*	80	—	—	

Analysts: KLB/AMS
Reviewed by: JBL
Date reviewed: Jan. 9/12

* mg/L as $CaCO_3$
WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: Chemical Solution

Comments: Broodboard Used: 071211

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: Na_2SO_4 TDS
Work Order: 11299

mg/L TDS

Start Date & Time: July 21/11 @ 1030h
Stop Date & Time: July 27/11 @ 1300h
Set up by: KLB

Days	Concentration: 20% Perrier Control										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
4	5	4	4	3	4	2	3	3	3	3	KJL
5	10	9	9	10	9	8	8	9	8	10	KLB
6	13	14	15	15	14	12	12	14	14	12	KLB
7											
8											
Total	28	27	28	28	27	22	23	26	25	25	KLB

Days	Concentration: 450 (baseline)										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
4	2	3	2	3	✓	✓	4	3	3	✓	KJL
5	10	11	10	✓	2	5	10	8	7	2	KLB
6	10	16	12	13	9	13	13	15	15	11	KLB
7											
8											
Total	22	30	24	16	11	18	27	26	25	13	KLB

Days	Concentration: 607										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
4	3	2	✓	4	2	4	2	3	3	3	KJL
5	6	8	7	8	8	9	5	8	7	8	KLB
6	13	11	11	9	13	10	12	14	14	12	KLB
7											
8											
Total	22	21	18	21	23	23	19	25	24	23	KLB

Days	Concentration: 817										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
4	2	✓	3	3	3	✓	2	✓	✓	4	KJL
5	4	6	8	7	8	5	5	5	4	6	KLB
6	5	15	13	15	12	12	16	10	16	15	KLB
7											
8											
Total	11	21	24	25	23	17	23	15	20	25	KLB

Days	Concentration: 1132										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
4	✓	✓	✓	✓	3	✓	✓	✓	✓	3	KJL
5	6	4	7	5	8	6	6	6	5	7	KLB
6	12	12	13	13	13	14	13	14	11	16	KLB
7											
8											
Total	18	16	20	18	24	20	19	20	16	26	KLB

Days	Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AM
4	✓	3	✓	3	✓	3	✓	3	✓	✓	KJL
5	4	7	X	7	5	7	5	9	5	5	KLB
6	11	12	|	13	12	13	11	13	13	13	KLB
7			|								
8			|								
Total	15	22	0†	23	17	23	16	25	18	18	KLB

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Notes: X = mortality.

Sample Description: Chemical Solution
Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: JGL
Date reviewed: Jan. 9/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	02-2431-1811	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 16:20	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	03-1138-8745	**Code:**	Na2SO4	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
6	1.045	15.91	3.286	0.9311	Yes				Lack of Fit Not Tested

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	5.736	N/A	184
IC5	74.78	N/A	334.3
IC10	232.4	27.19	590.4
IC15	460.1	191.8	833.1
IC20	758.1	489.5	1086
IC25	1131	788.7	1542
IC40	2795	991.1	6099
IC50	4520	969.9	14790
IC60	7017	995.6	55640
IC75	13470	1455	N/A
IC80	17040	1904	N/A
IC85	22080	2734	N/A
IC90	29960	4425	N/A
IC95	45350	8834	N/A
IC99	89290	26680	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	25.85	0.7197	23.56	28.14	35.92	<0.0001	Significant Parameter
C	0.6348	0.1718	0.08799	1.182	3.695	0.0344	Significant Parameter
D	4520	1721	-955.8	9997	2.627	0.0785	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	36.13511	36.13511	1	69.57	0.0036	Significant
Residual	1.558226	0.5194087	3			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Distribution	Shapiro-Wilk W Normality	0.9484	0.5128	0.7273	Normal Distribution

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID: 02-2431-1811 **Endpoint:** Reproduction **CETIS Version:** CETISv1.8.0
Analyzed: 22 Nov-11 16:20 **Analysis:** Nonlinear Regression **Official Results:** Yes

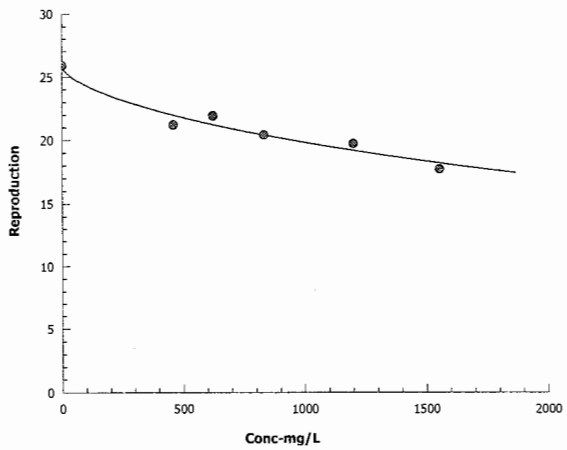
Reproduction Summary — **Calculated Variate**

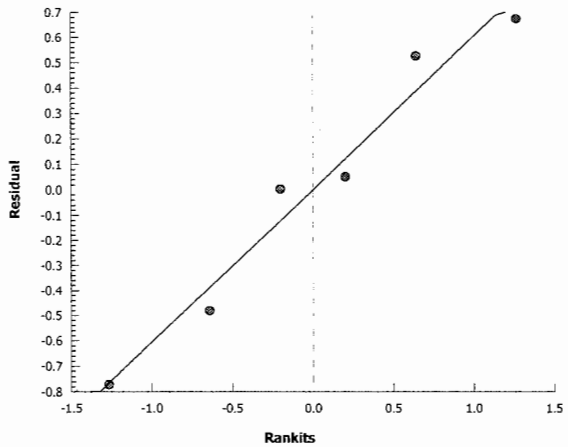
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	25.9	22	28	0.6741	2.132	8.23%	0.0%
460		10	21.2	11	30	2.015	6.374	30.06%	18.15%
623		10	21.9	18	25	0.6904	2.183	9.97%	15.44%
833		10	20.4	11	25	1.485	4.695	23.02%	21.24%
1200		10	19.7	16	26	1.012	3.199	16.24%	23.94%
1554		10	17.7	0	25	2.241	7.088	40.04%	31.66%

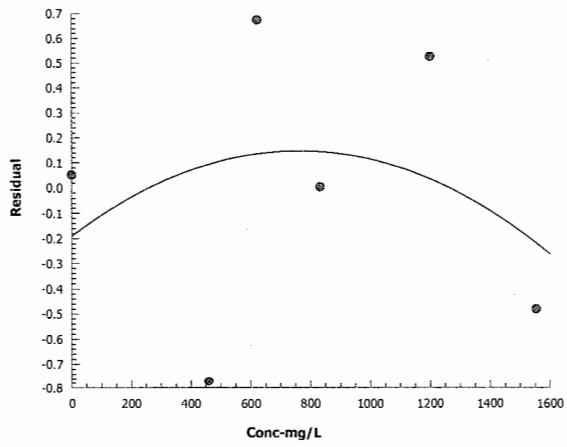
Reproduction Detail

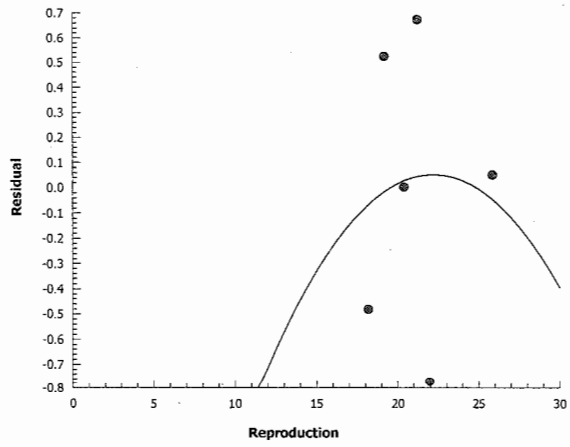
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	28	27	28	28	27	22	23	26	25	25
460		22	30	24	16	11	18	27	26	25	13
623		22	21	18	21	23	23	19	25	24	23
833		11	21	24	25	23	17	23	15	20	25
1200		18	16	20	18	24	20	19	20	16	26
1554		15	22	0	23	17	23	16	25	18	18

Graphics 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	15-8669-6976	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:11	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	03-1138-8745	**Code:**	Na2SO4	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	356499405	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	1366	1253	N/A
EC10	1554	1308	N/A
EC15	>1554	N/A	N/A
EC20	>1554	N/A	N/A
EC25	>1554	N/A	N/A
EC40	>1554	N/A	N/A
EC50	>1554	N/A	N/A

6d Survival Rate Summary — **Calculated Variate(A/B)**

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
460		10	1	1	1	0	0	0.0%	0.0%	10	10
623		10	1	1	1	0	0	0.0%	0.0%	10	10
833		10	1	1	1	0	0	0.0%	0.0%	10	10
1200		10	1	1	1	0	0	0.0%	0.0%	10	10
1554		10	0.9	0	1	0.1	0.3162	35.1%	10.0%	9	10

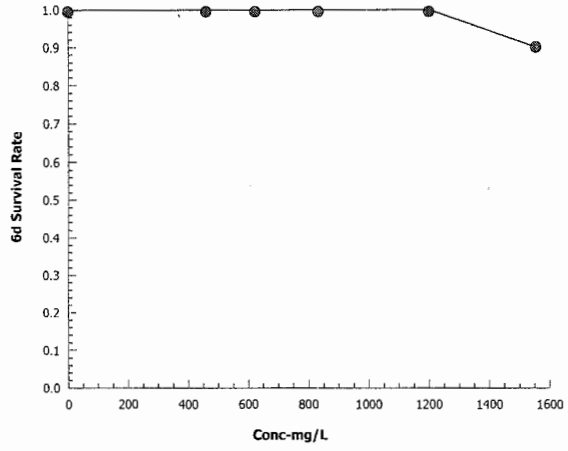
6d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	1	1	1	1	1	1	1	1	1
460		1	1	1	1	1	1	1	1	1	1
623		1	1	1	1	1	1	1	1	1	1
833		1	1	1	1	1	1	1	1	1	1
1200		1	1	1	1	1	1	1	1	1	1
1554		1	1	0	1	1	1	1	1	1	1

Ceriodaphnia 7-d Survival and Reproduction Test **Nautilus Environmental**

Analysis ID:	15-8669-6976	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:11	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Summary of calculated TDS

C. dubois
Initial

Project	065
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1032214
Date Received	15-Jul-11 16:52
Date	25-Jul-11

RESULTS OF ANALYSIS

Sample ID	NA2SO4-1500	NA2SO4-1132	NA2SO4-1132 (DUP)	NA2SO4-607
Date Sampled	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1032214-1	L1032214-2	L1032214-3	L1032214-4
Matrix	Water	Water	Water	Water
Physical Tests				
Total Dissolved Solids	1510	1120	824	746
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	36.9	35.8	34.7	34.5
Chloride (Cl)	226	230	222	223
Sulfate (SO4)	799	538	294	151
Alk 1.22X	45.018 ✓	43.676 ✓	42.334 ✓	42.09 ✓
Total Metals				
Calcium (Ca)-Total	90.2	93.4	92.9	91.7
Magnesium (Mg)-Total	10.6	11.0	10.9	10.7
Potassium (K)-Total	6.3	6.5	6.5	6.4
Sodium (Na)-Total	391	278	169	100
Total TDS	1568 ✓	1201 ✓	838 ✓	625 ✓

JOH
Jan. 9/12

Na2804
Initial

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 15-JUL-11
Report Date: 25-JUL-11 14:24 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1032214**
Project P.O. #: NOT SUBMITTED
Job Reference: 065
Legal Site Desc:
C of C Numbers:

Comments: Sample Na2SO4 - 817 was not received but was listed on the CoC.
2 samples Na2SO4 - 1132 were received, but listed on the Coc as one. The extra Na2SO4 - 1132 was analysed in the same way as the other samples received.

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L1032214-1 Description: WATER Sampled Date: 13-JUL-11 Sampled Time: Client ID: NA2SO4-1500	L1032214-2 WATER 13-JUL-11 NA2SO4-1132	L1032214-3 WATER 13-JUL-11 NA2SO4-1132 (DUP)	L1032214-4 WATER 13-JUL-11 NA2SO4-607	
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1510	1120	824	746	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	36.9	35.8	34.7	34.5	
	Chloride (Cl) (mg/L)	226	230	222	223	
	Sulfate (SO4) (mg/L)	799	538	294	151	
Total Metals	Calcium (Ca)-Total (mg/L)	90.2	93.4	92.9	91.7	
	Magnesium (Mg)-Total (mg/L)	10.6	11.0	10.9	10.7	
	Potassium (K)-Total (mg/L)	6.3	6.5	6.5	6.4	
	Sodium (Na)-Total (mg/L)	391	278	169	100	

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1032214

Short Holding Time ntal

Rush Processing

TESTI

California
5550 Morehousi
San Diego, CA 9
Phone 858.587.
Fax 858.587.3961

Fax 253.922.5814

sh Columbia
Commerce Court
by, British Columbia, Canada V5A 4N3
e 604.420.8773
Fax 604.357.1361

Chain of Custody

July 15/11 Date _____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	Na2SO4-1500	13-Jul-11			1 L	1	Stock Soln.	X	X	X	X	X	X	X	X			
2	Na2SO4-1132	13-Jul-11			1 L	1	↓	X	X	X	X	X	X	X	X			
3	Na2SO4-817	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
4	Na2SO4-607	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11296-11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)

(Signature) (Time)

(Printed Name) Edmund Canaria (Date) July 15, 2011

(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (LABORATORY)

(Signature) Courier - July/11 (Time) 15:40

(Printed Name) (Date)

(Company) Temp = 10.7°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Summary of calculated TDS, test termination

C. dubé
DC

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038456
Date Received	29-Jul-11 12:39
Date	08-Aug-11

RESULTS OF ANALYSIS

Sample ID	NA2SO4-1500 D6	NA2SO4-1132 D6	NA2SO4-817 D6	NA2SO4-607 D6
Date Sampled	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1038456-1	L1038456-2	L1038456-3	L1038456-4
Matrix	Water	Water	Water	Water
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	36.8	36.3	35.1	33.9
Chloride (Cl)	227	228	226	223
Sulfate (SO4)	786	537	293	154
Alk 1.22x	44.896 ✓	44.286 ✓	42.822 ✓	41.358 ✓
Total Metals				
Calcium (Ca)-Total	86.5	91.0	87.0	86.1
Magnesium (Mg)-Total	10.3	11.0	10.5	10.3
Potassium (K)-Total	6.2	6.6	6.3	6.5
Sodium (Na)-Total	378	281	161	98.4
Total TDS	1539 ✓	1199 ✓	827 ✓	620 ✓

JCL
Jan. 9/12

C- arbia
Na2SO4
Day 6

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 08-AUG-11 12:07 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038456

Project P.O. #: 065 PHASE 2 WO#:11299
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1038456-1	L1038456-2	L1038456-3	L1038456-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11	
	Sampled Time					
	Client ID	NA2SO4-1500 D6	NA2SO4-1132 D6	NA2SO4-817 D6	NA2SO4-607 D6	
Grouping	Analyte					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	36.8	36.3	35.1	33.9	
	Chloride (Cl) (mg/L)	227	228	226	223	
	Sulfate (SO4) (mg/L)	786	537	293	154	
Total Metals	Calcium (Ca)-Total (mg/L)	86.5	91.0	87.0	86.1	
	Magnesium (Mg)-Total (mg/L)	10.3	11.0	10.5	10.3	
	Potassium (K)-Total (mg/L)	6.2	6.6	6.3	6.5	
	Sodium (Na)-Total (mg/L)	378	281	161	98.4	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environ

L1038456

TESTING LOCATION (Please Circle)

L1038456-COFC

hington (1)
Pacific Highway East, Suite 2
na, WA 98424
: 253.922.4296
53.922.5814

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
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Chain of Custody

July 29/11 Date Page 1 of 1

Sample Collection By:

Report to: (1)		Invoice To: (1)	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides				Receipt Temperature (°C)
1	Na2SO4-1500 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
2	Na2SO4-1132 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
3	Na2SO4-817 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
4	Na2SO4-607 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
5																		
6																		
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 Phase 2 WO #: 11299	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)

(Signature) (Time) July 29/11

(Printed Name) Edmund Canaria (Date)

(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (LABORATORY)

(Signature) (Time) 12:39

(Printed Name) (Date) Jul 29

(Company) ACS 15°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 11299

Start Date/Time: July 21, 2011 @1040 h
Set up by: KLB

Sample Information:

Sample ID: CaSO4 TDS
Sample Date: Prepared In-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 071211
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 24
Mortality (%) in previous 7 d: 0
Individual female # used ≥8 young on test day: 21, 22, 23, 26, 27, 29, 31, 32, 35, , 38, 39

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd70
Stock Solution ID: 11Na01
Date Initiated: July 12, 2011

7-d LC50 (95% CL): 1.7 (1.4 - 2.2) g/L NaCL
7-d IC50 (95% CL): 1.4 (1.2 - 1.6) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5 - 2.3) g/L NaCL CV (%): 12
7-d IC50 Reference Toxicant Mean and Historical Range: 1.1 (0.9 - 1.5) g/L NaCL CV (%): 15

Test Results:

mg/L TDS	Survival	Reproduction
LC50 ~~%(v/v)~~ Ca (95% CL)	1344 (1282 - 1401)	
IC25 ~~%(v/v)~~ Ca (95% CL)		505 (353 - 652)
IC50 ~~%(v/v)~~ Ca (95% CL)		896 (768 - 1035)

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: CaSO4 TDS
Work Order #: 11299

Start Date & Time: July 21/11 @ 1100h
Stop Date: July 27th @ 1315h
Test Species: *Ceriodaphnia dubia*

mg/L TDS

Concentration: 20% Perrier Ctrl	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	7.8	7.2	8.0	7.0	8.1	7.1	8.0	6.9	7.9	6.1	7.6	6.2		
pH	8.1	8.1	8.2	8.3	8.3	7.8	8.3	8.0	8.3	7.6	7.9	7.8		
Cond. (µS/cm)	216	21[illegible]		219		221		218		218		222		
Initials	KLB							CLB		KLB		KLB		

Concentration: 450	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	7.0	8.1	6.9	8.2	7.2	8.1	7.1	7.8	5.7	8.1	6.3		
pH	7.5	7.5	7.5	7.6	7.7	7.7	7.9	7.4	7.6	7.2	7.5	7.4		
Cond. (µS/cm)	869	899		9[illegible]		907		893		862		858		
Initials	KLB							KLB		KLB		KLB		

Concentration: 607	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	6.8	8.1	7.2	8.2	6.9	8.0	6.4	8.0	5.7	8.2	6.1		
pH	7.4	7.5	7.4	7.5	7.6	7.4	7.7	7.2	7.6	7.1	7.4	7.4		
Cond. (µS/cm)	1074	1097		1128		1102		1098		1077		1086		
Initials	KLB							KLB		KLB		KLB		

Concentration: 1500	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	6.3	8.2	7.1	8.1	7.0	8.1	6.4	8.0	6.0	8.2	6.1		
pH	7.4	7.4	7.4	7.5	7.6	7.4	7.6	7.3	7.6	7.2	7.4	7.4		
Cond. (µS/cm)	2030	2050		2090		2050		2060		2030		2010		
Initials	KLB							KLB		KLB		KLB		

	20% Perrier Control	~~450 mg/L TDS~~	~~1500 mg/L TDS~~ KLB	
Hardness*	98	—	—	
Alkalinity*	80	—	—	

Analysts: KLB/AWD
Reviewed by: JOL
Date reviewed: Jan. 9/12

* mg/L as CaCO3
WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: Chemical Solution

Comments: **Broodboard Used:** 07/11

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: CaSO4 TDS
Work Order: 11299

mg/L TDS

Start Date & Time: July 21/11 @ 1100h
Stop Date & Time: July 27/11 @ 1315h
Set up by: KLB

Days	Concentration: 20% Perrier Control											Concentration: 450 (baseline)											Concentration: 607										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams
4	5	4	4	3	4	2	3	3	3	3	KJL	2	3	2	3	✓	✓	4	3	3	✓	KJL	✓	✓	✓	2	✓	X	✓	✓	3	3	KJL
5	10	9	9	10	9	8	8	9	8	10	KLB	10	11	10	✓	2	5	10	8	7	2	KLB	10	9	9	10	4	|	6	✓	7	6	KLB
6	13	14	15	15	14	12	12	14	14	12	KLB	10	16	12	13	9	13	13	15	15	11	KLB	10	8	12	6	9	|	10	13	5	7	KLB
7																																	
8																																	
Total	28	27	28	28	27	22	23	26	25	25	KLB	22	30	24	16	11	18	27	26	25	13	KLB	20	19	21	18	13	0*	16	13	15	16	KLB

Days	Concentration: 817											Concentration: 1132											Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Ams
4	3	4	3	3	✓	@	4	2	2	2	KJL	4	✓	3	3	3	✓	✓	✓	✓	✓	KJL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KJL
5	2	✓	5	7	3	5	✓	8	2	4	KLB	6	5	9	X	5	9	5	7	6	7	KLB	X	✓	X	✓	✓	✓	X	✓	✓	7	KLB
6	3	14	6	✓	10	✓	6	15	✓	7	KLB	10	9	✓	|	11	3	12	11	10	14	KLB	|	✓	|	X	✓	✓	|	✓	✓	6	KLB
7															|								|		|				|			
8															|								|		|				|			
Total	8	18	14	10	13	7	10	25	4	13	KLB	20	14	12	3*	19	12	17	18	16	21	KLB	0*	0	0*	0*	0	0	0*	0	0	13	KLB

Days	Concentration:											Concentration:											Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1																																	
2																																	
3																																	
4																																	
5																																	
6																																	
7																																	
8																																	
Total																																	

Notes: X = mortality.

Sample Description: chemical solution
Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: JGh
Date reviewed: Jan. 9/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	01-8456-8331	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 16:29	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	00-1554-1905	**Code:**	CaSO4	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
7	-136.7	279.9	285.7	0.5632	Yes	7.956	2.776	0.0002	Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	56.45	N/A	338
IC5	163.7	N/A	364.6
IC10	261.9	N/A	428.8
IC15	347.5	166.2	502.8
IC20	427.5	265.2	577.8
IC25	504.6	353.3	651.5
IC40	734.2	604	870.3
IC50	896.1	767.7	1035
IC60	1075	923.4	1249
IC75	1409	1157	1765
IC80	1553	1250	2056
IC85	1729	1363	2551
IC90	1963	1518	N/A
IC95	2331	1780	N/A
IC99	3086	2384	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	25.72	1.891	21.94	29.51	13.6	<0.0001	Significant Parameter
C	1.531	0.3491	0.8323	2.23	4.387	<0.0001	Significant Parameter
D	896.1	98.43	699	1093	9.104	<0.0001	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	2882.939	2882.939	1	78.09	<0.0001	Significant
Lack of Fit	645.0612	215.0204	3	7.956	0.0002	Significant
Pure Error	1459.4	27.02593	54			
Residual	2104.461	36.92037	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variances	Bartlett Equality of Variance	10.63	11.07	0.0592	Equal Variances
	Mod Levene Equality of Variance	1.797	2.386	0.1290	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.969	0.9605	0.1305	Normal Distribution
	Anderson-Darling A2 Normality	0.6743	2.492	0.0784	Normal Distribution

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID: 01-8456-8331 **Endpoint:** Reproduction **CETIS Version:** CETISv1.8.0
Analyzed: 22 Nov-11 16:29 **Analysis:** Nonlinear Regression **Official Results:** Yes

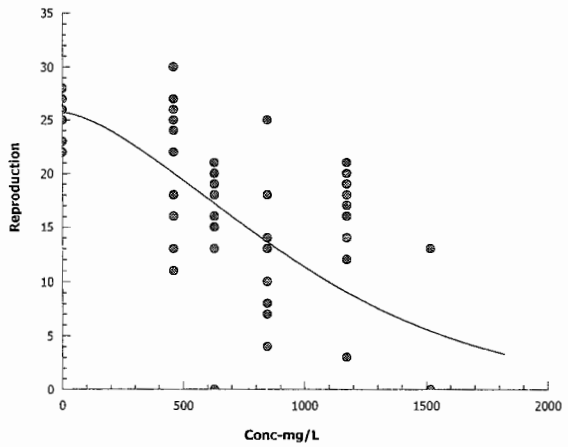
Reproduction Summary — **Calculated Variate**

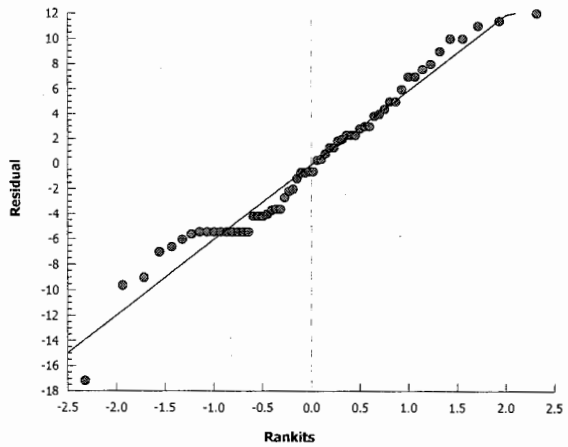
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	25.9	22	28	0.6741	2.132	8.23%	0.0%
460		10	21.2	11	30	2.015	6.374	30.06%	18.15%
628		10	14.8	0	21	1.896	5.996	40.52%	42.86%
846		10	12.2	4	25	1.896	5.996	49.15%	52.9%
1173		10	15.2	3	21	1.679	5.308	34.92%	41.31%
1517		10	1.3	0	13	1.3	4.111	316.2%	94.98%

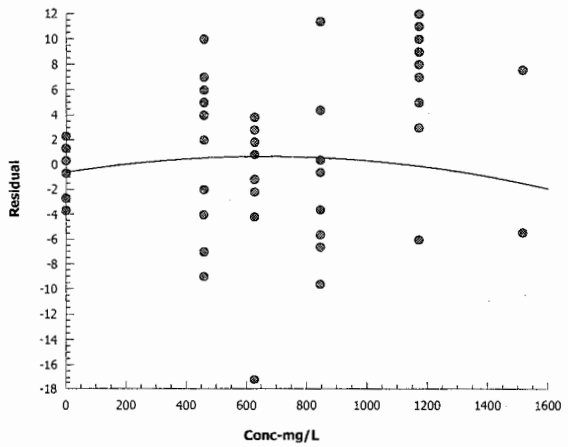
Reproduction Detail

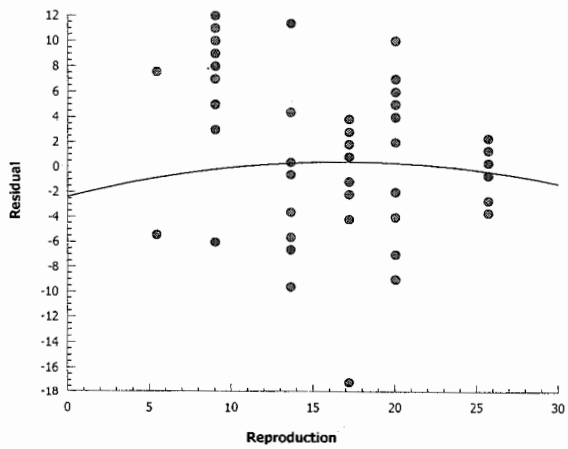
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	28	27	28	28	27	22	23	26	25	25
460		22	30	24	16	11	18	27	26	25	13
628		20	19	21	18	13	0	16	13	15	13
846		8	18	14	10	13	7	10	25	4	13
1173		20	14	12	3	19	12	17	18	16	21
1517		0	0	0	0	0	0	0	0	0	13

Graphics 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	02-6700-9182	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:12	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	00-1554-1905	**Code:**	CaSO4	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Linear Regression Options

Model Function	Threshold Option	Threshold	Optimized	Pooled	Het Corr	Weighted
Log-Normal [NED=A+B*log(X)]	Control Threshold	1E-08	Yes	Yes	No	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Adj R2	F Stat	Critical	P-Value	Decision(α:5%)
15	-10.92	51.85	26.68	-2.921	0.04147	0.5527				Lack of Fit Not Tested

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC10	1189	1091	1252
EC15	1217	1128	1277
EC20	1240	1157	1298
EC25	1260	1182	1316
EC40	1312	1245	1367
EC50	1344	1282	1401

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
Threshold	0.025	0.02469	0.0003143	0.04969	1.013	0.4178	Non-Significant Parameter
Slope	24.11	7.87	16.24	31.98	3.064	0.0921	Non-Significant Parameter
Intercept	-70.44	24.69	-95.13	-45.75	-2.853	0.1041	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	9.789411	9.789411	1	6.942	0.1189	Non-Significant
Residual	2.820484	1.410242	2			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Goodness-of-Fit	Pearson Chi-Sq GOF	2.82	5.991	0.2441	Non-Significant Heterogenity
	Likelihood Ratio GOF	2.345	5.991	0.3097	Non-Significant Heterogenity
Extreme Value	Grubbs Extreme Value	1.826	1.715	<0.0001	Outlier Detected
Distribution	Shapiro-Wilk W Normality	0.7787	0.3395	0.0537	Normal Distribution

6d Survival Rate Summary — Calculated Variate(A/B)

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
460		10	1	1	1	0	0	0.0%	0.0%	10	10
628		10	0.9	0	1	0.1	0.3162	35.1%	10.0%	9	10
846		10	1	1	1	0	0	0.0%	0.0%	10	10
1173		10	0.9	0	1	0.1	0.3162	35.1%	10.0%	9	10
1517		10	0.1	0	1	0.1	0.3162	316.0%	90.0%	1	10

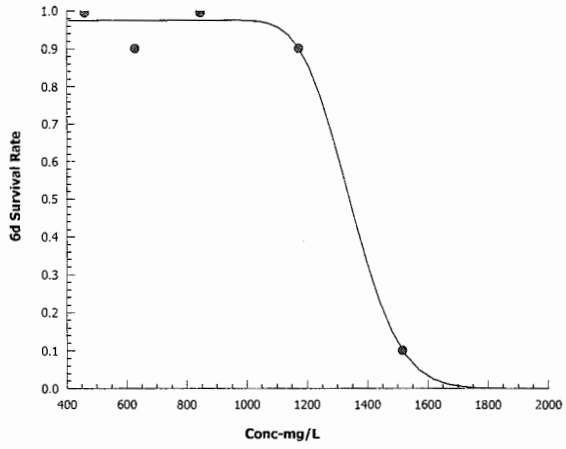
Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

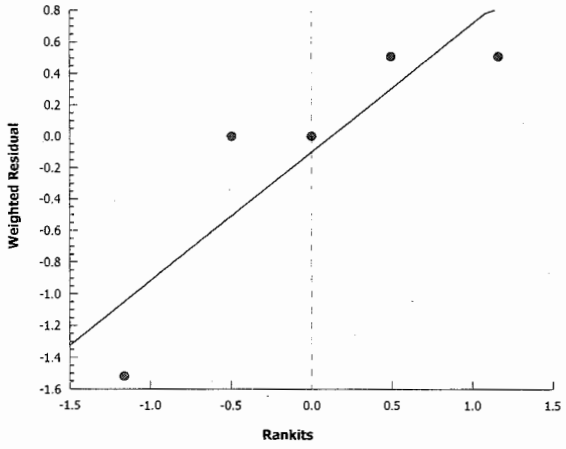
Analysis ID:	02-6700-9182	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:12	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes

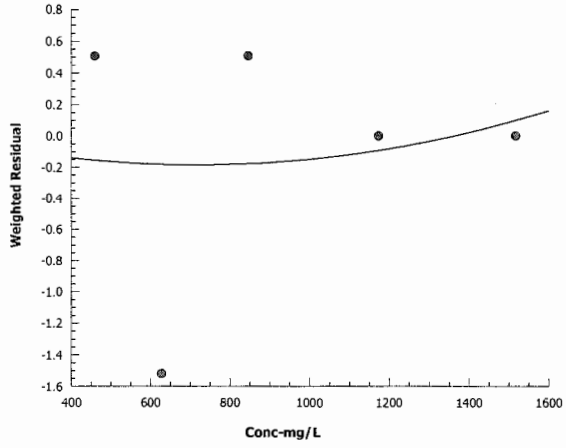
6d Survival Rate Detail

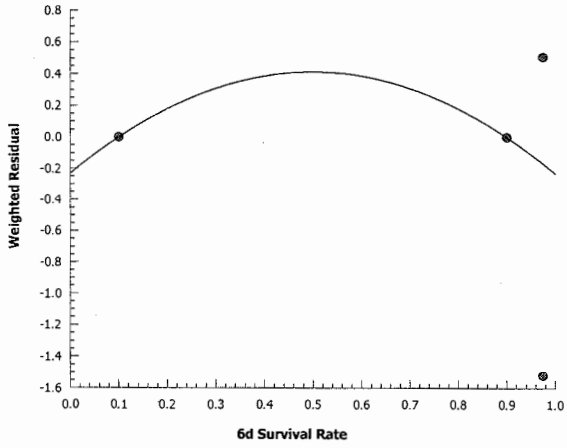
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	1	1	1	1	1	1	1	1	1
460		1	1	1	1	1	1	1	1	1	1
628		1	1	1	1	1	0	1	1	1	1
846		1	1	1	1	1	1	1	1	1	1
1173		1	1	1	0	1	1	1	1	1	1
1517		0	0	0	0	0	0	0	0	0	1

Graphics Log-Normal [NED=A+B*log(X)]









Summary of calculated TDS at test initiation

C. dubin
Initial

Project	065
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1032211
Date Received	15-Jul-11 16:48
Date	25-Jul-11

RESULTS OF ANALYSIS

Sample ID	CASO4-1500	CASO4-1132	CASO4-817	CASO4-607
Date Sampled	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1032211-1	L1032211-2	L1032211-3	L1032211-4
Matrix	Water	Water	Water	Water
Physical Tests				
Total Dissolved Solids	1920	1490	1220	979
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	40.7	38.4	36.3	34.5
Chloride (Cl)	225	225	228	220
Sulfate (SO4)	816	546	318	154
Alk 1.22X	49.654 ✓	46.848 ✓	44.286 ✓	42.09 ✓
Total Metals				
Calcium (Ca)-Total	408	300	203	144
Magnesium (Mg)-Total	11.1	11.0	10.8	11.2
Potassium (K)-Total	6.9	6.6	6.6	6.8
Sodium (Na)-Total	50.1	49.3	49.9	52.0
Total TDS	1567 ✓	1185 ✓	861 ✓	630 ✓

JOL
Jan-9/12

Carey
Initial

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 15-JUL-11
Report Date: 25-JUL-11 12:59 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1032211
Project P.O. #: NOT SUBMITTED
Job Reference: 065
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1032211-1	L1032211-2	L1032211-3	L1032211-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11	
	Sampled Time					
	Client ID	CASO4-1500	CASO4-1132	CASO4-817	CASO4-607	
Grouping	Analyte					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1920	1490	1220	979	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	40.7	38.4	36.3	34.5	
	Chloride (Cl) (mg/L)	225	225	228	220	
	Sulfate (SO4) (mg/L)	816	546	318	154	
Total Metals	Calcium (Ca)-Total (mg/L)	408	300	203	144	
	Magnesium (Mg)-Total (mg/L)	11.1	11.0	10.8	11.2	
	Potassium (K)-Total (mg/L)	6.9	6.6	6.6	6.8	
	Sodium (Na)-Total (mg/L)	50.1	49.3	49.9	52.0	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	Sample was Filtered and Preserved at the laboratory - total metals

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1032211

Short Holding Time

Rush Processing

TES

California
5550 Morehouse Dr
San Diego, CA
Phone 858.587.7333
Fax 858.587.3961

Fax 253.922.5814

British Columbia
8564 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 15/11

Date _____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	CaSO4-1500	13-Jul-11			1 L	1	Stock Solns.	X	X	X	X	X	X	X	X			
2	CaSO4-1132	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
3	CaSO4-817	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
4	CaSO4-607	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
5																		
6																		
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11296-11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) July 15, 2011	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) Walter Tully S. (Time)
(Printed Name) (Date)	(Printed Name) (Date) 15:20.
(Company)	(Company) Temp = 16.7°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Summary of calculated TDS at test termination

C-dubai D6

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038460
Date Received	29-Jul-11 12:39
Date	08-Aug-11

RESULTS OF ANALYSIS

Sample ID	CASO4-1500 D6	CASO4-1132 D6	CASO4-817 D6	CASO4-607 D6
Date Sampled	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1038460-1	L1038460-2	L1038460-3	L1038460-4
Matrix	Water	Water	Water	Water
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	41.1	38.7	36.5	34.5
Chloride (Cl)	232	233	230	239
Sulfate (SO4)	781	535	305	152
ALK 1.22x	50.142 ✓	47.214 ✓	44.53 ✓	42.09 ✓
Total Metals				
Calcium (Ca)-Total	344	281	187	129
Magnesium (Mg)-Total	9.51	10.5	10.2	10.2
Potassium (K)-Total	5.8	6.4	6.2	6.3
Sodium (Na)-Total	44.5	47.1	46.6	46.7
Total TDS	1467 ✓	1160 ✓	830 ✓	625 ✓

JOL
Jan. 9/12

C. dunbar
ca804
Day 2

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 08-AUG-11 17:02 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038460

Project P.O. #: 065 PHASE 2 WO#: 11299
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID Description Sampled Date Sampled Time Client ID	L1038460-1 WATER 27-JUL-11 CASO4-1500 D6	L1038460-2 WATER 27-JUL-11 CASO4-1132 D6	L1038460-3 WATER 27-JUL-11 CASO4-817 D6	L1038460-4 WATER 27-JUL-11 CASO4-607 D6	
WATER							
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)		41.1	38.7	36.5	34.5	
	Chloride (Cl) (mg/L)		232	233	230	239	
	Sulfate (SO4) (mg/L)		781	535	305	152	
Total Metals	Calcium (Ca)-Total (mg/L)		344	281	187	129	
	Magnesium (Mg)-Total (mg/L)		9.51	10.5	10.2	10.2	
	Potassium (K)-Total (mg/L)		5.8	6.4	6.2	6.3	
	Sodium (Na)-Total (mg/L)		44.5	47.1	46.6	46.7	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Nautilus Environmental

L1038460

L1038460-COFC

way East, Suite 2
24
296
4

(1) British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 29/11 Date _____ Page ___ of ___

Sample Collection By:

Report to:	(2)	Invoice To:	(1)
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides				Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	CaSO4-1500 D6	27-Jul-11			1 L	1	Day 6	x	x	x	x	x	x	x				
2	CaSO4-1132 D6	27-Jul-11			1 L	1	Day 6	x	x	x	x	x	x	x				
3	CaSO4-817 D6	27-Jul-11			1 L	1	Day 6	x	x	x	x	x	x	x				
4	CaSO4-607 D6	27-Jul-11			1 L	1	Day 6	x	x	x	x	x	x	x				
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 Phase 2 WO #: 11299	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia* Day 6

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) July 29/11	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time) 12:39
(Printed Name) (Date)	(Printed Name) (Date) Jul 29
(Company)	(Company) ALS 15°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 11299

Start Date/Time: July 21, 2011 @1040 h
Set up by: KLB

Sample Information:

Sample ID: $CaCl_2$ TDS
Sample Date: Prepared In-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 071211
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 24
Mortality (%) in previous 7 d: 0
Individual female # used ≥8 young on test day: 21, 22, 23, 26, 27, 29, 31, 32, 35, , 38, 39

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd70
Stock Solution ID: 11Na01
Date Initiated: July 12, 2011

7-d LC50 (95% CL): 1.7 (1.4 - 2.2) g/L NaCl
7-d IC50 (95% CL): 1.4 (1.2 - 1.6) g/L NaCl

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5 - 2.3) g/L NaCl CV (%): 12
7-d IC50 Reference Toxicant Mean and Historical Range: 1.1 (0.9 - 1.5) g/L NaCl CV (%): 15

Test Results:

mg/L TDS	Survival	Reproduction
LC50 %(v/v) (95% CL)	> 1516	
IC25 %(v/v) (95% CL)		586 (465 - 700)
IC50 %(v/v) (95% CL)		950 (846 - 1059)

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: $CaCl_2$ TDS
Work Order #: 11299

Start Date & Time: July 21/11 @ 1050h
Stop Date: July 27/11 @ 1045h
Test Species: *Ceriodaphnia dubia*

mg/L TDS
20% Perrier Carb

Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	7.8	7.7	8.0	7.0	8.1	7.1	8.0	6.9	7.9	6.1	7.6	6.2		
pH	8.1	8.1	8.2	7.8	8.3	7.8	8.3	8.0	8.2	7.6	7.9	7.8		
Cond. (µS/cm)	216	216		219		221		218		218		222		
Initials	KLB	AWD		AWD		AWD		KLB		KLB		KLB		

Concentration	Days													
450	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	7.0	8.1	6.9	8.2	7.2	8.0	7.1	7.8	5.7 (5.1)	8.1	6.3		
pH	7.5	7.5	7.5	7.6	7.7	7.7	7.7	7.4	7.6	7.2	7.5	7.4		
Cond. (µS/cm)	869	899		902		907		893		862		858		
Initials	KLB	AWD		AWD		AWD		KLB		KLB		KLB		

Concentration	Days													
607	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	6.7	8.1	7.2	8.2	6.9	8.0	5.9	8.0	6.0	8.2	6.0		
pH	7.4	7.5	7.5	7.5	7.7	7.6	7.7	7.2	7.7	7.1	7.5	7.4		
Cond. (µS/cm)	1191	1224		1234		1260		1245		1214		1207		
Initials	KLB	AWD		AWD		AWD		KLB		KLB		KLB		

Concentration	Days													
1500	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	24.5	24.0	24.5	24.0	25.0	24.0	25.0	24.0	25.0		
DO (mg/L)	8.0	6.7	8.2	7.2	8.2	7.0	8.1	6.2	8.0	6.1	8.3	5.9		
pH	7.3	7.4	7.3	7.5	7.6	7.5	7.6	7.2	7.6	7.0	7.2	7.4		
Cond. (µS/cm)	2920	2990		2980		3000		3000		2940		2920		
Initials	KLB	AWD		AWD		AWD		KLB		KLB		KLB		

	20% Perrier Control	~~450 mg/L TDS~~	~~1500 mg/L TDS~~ KLB	
Hardness*	98	—	—	
Alkalinity*	80	—	—	

* mg/L as $CaCO_3$

Analysts: KLB/AWD

Reviewed by: JBL
Date reviewed: Jan 10/12

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5

Sample Description: Chemical Solution

Comments: Broodboard Used: 07121

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: $CaCl_2$ TDS
Work Order: 11299

Start Date & Time: July 21/11 @ 1050h
Stop Date & Time: July 27/11 @ 1045h
Set up by: KLB

mg/L TDS

Days	Concentration: 20% Perrier Control										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
4	5	4	4	3	4	2	3	3	3	3	KLB
5	10	9	9	10	9	8	8	9	8	10	KLB
6	13	14	15	15	14	12	12	14	14	12	KLB
7											
8											
Total	28	27	28	28	27	22	23	26	25	25	KLB

Days	Concentration: 450 (baseline)										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
4	2	3	2	3	✓	✓	4	3	3	✓	KLB
5	10	11	10	✓	2	5	10	8	7	2	KLB
6	10	16	12	13	9	13	13	15	15	11	KLB
7											
8											
Total	22	30	24	16	11	18	27	26	25	13	KLB

Days	Concentration: 607										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
4	✓	2	✓	✓	✓	3	✓	✓	3	✓	KLB
5	14	6	7	4	7	9	7	9	11	6	KLB
6	10	11	11	10	11	11	14	5	14	11	KLB
7											
8											
Total	14	19	18	14	18	23	18	14	25	17	KLB

Days	Concentration: 817										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
4	✓	2	✓	✓	✓	2	2	2	✓	3	KLB
5	5	9	6	X	7	5	6	5	4	6	KLB
6	9	11	7	|	12	10	10	10	12	12	KLB
7				|						
8				|						
Total	14	22	13	0†	19	17	18	17	16	21	KLB

Days	Concentration: 1132										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
4	✓	✓	✓	3	3	✓	✓	✓	✓	✓	KLB
5	3	3	3	7	6	3	✓	3	✓	✓	KLB
6	8	9	4	12	11	9	✓	6	X	X	KLB
7									|	|	
8									|	|	
Total	11	12	7	22	20	12	0	9	0†	0†	KLB

Days	Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	AMS
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
5	2	2	✓	✓	3	2	✓	2	2	✓	KLB
6	5	6	4	3	4	3	✓	4	✓	6	KLB
7											
8											
Total	7	8	4	3	7	5	0	6	2	6	KLB

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Notes: X = mortality.

Sample Description: Chemical solution
Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: JGh
Date reviewed: Jan 10/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	15-1130-6300	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 16:32	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	00-4730-2427	**Code:**	CaCl2	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
6	-126.7	259.8	265.7	0.6521	Yes	0.2014	2.776	0.8950	Non-Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	92.76	N/A	376.1
IC5	227.1	N/A	407.2
IC10	337.3	141	475.5
IC15	428	280.7	551.6
IC20	509.4	378.9	626.9
IC25	585.7	464.5	699.6
IC40	802.9	698.1	909.2
IC50	949.5	845.6	1059
IC60	1107	987.2	1238
IC75	1389	1205	1630
IC80	1508	1290	1828
IC85	1651	1391	2116
IC90	1836	1526	2816
IC95	2122	1743	N/A
IC99	2687	2216	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	25.73	1.574	22.57	28.88	16.34	<0.0001	Significant Parameter
C	1.82	0.3473	1.125	2.516	5.242	<0.0001	Significant Parameter
D	949.5	77.43	794.4	1105	12.26	<0.0001	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	2976.01	2976.01	1	112.6	<0.0001	Significant
Lack of Fit	16.67346	5.55782	3	0.2014	0.8950	Non-Significant
Pure Error	1490.3	27.59815	54			
Residual	1506.974	26.43813	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variances	Bartlett Equality of Variance	21.03	11.07	0.0008	Unequal Variances
	Mod Levene Equality of Variance	2.708	2.386	0.0296	Unequal Variances
Distribution	Shapiro-Wilk W Normality	0.9721	0.9605	0.1852	Normal Distribution
	Anderson-Darling A2 Normality	0.7674	2.492	0.0458	Non-normal Distribution

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	15-1130-6300	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 16:32	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

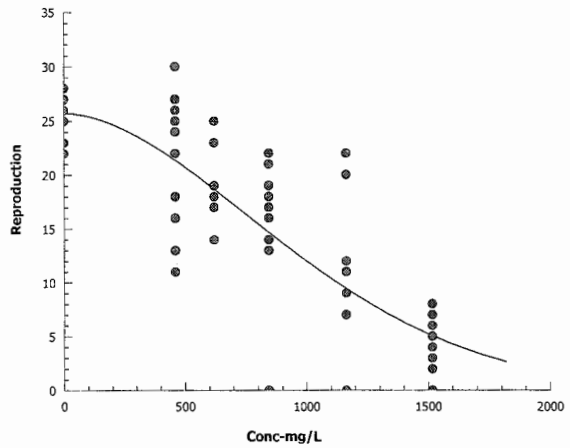
Reproduction Summary — **Calculated Variate**

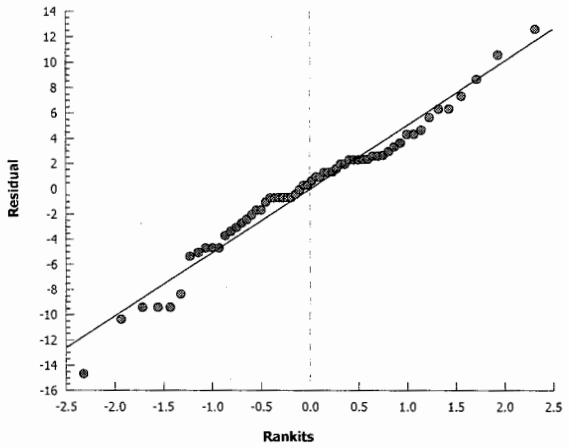
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	25.9	22	28	0.6741	2.132	8.23%	0.0%
460		10	21.2	11	30	2.015	6.374	30.06%	18.15%
620		10	18	14	25	1.174	3.712	20.62%	30.5%
845		10	15.7	0	22	1.955	6.183	39.38%	39.38%
1163		10	9.3	0	22	2.49	7.875	84.67%	64.09%
1516		10	4.8	0	8	0.8	2.53	52.7%	81.47%

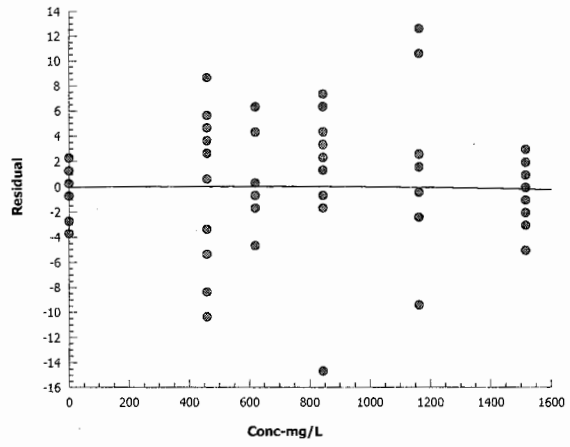
Reproduction Detail

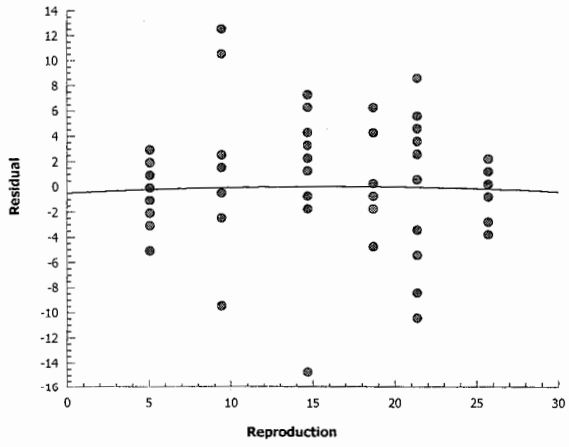
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	28	27	28	28	27	22	23	26	25	25
460		22	30	24	16	11	18	27	26	25	13
620		14	19	18	14	18	23	18	14	25	17
845		14	22	13	0	19	17	18	17	16	21
1163		11	12	7	22	20	12	0	9	0	0
1516		7	8	4	3	7	5	0	6	2	6

Graphics — 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









CETIS Analytical Report

Ceriodaphnia 7-d Survival and Reproduction Test

Nautilus Environmental

Analysis ID:	11-3712-8163	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:09	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	15-9277-5186	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	21 Jul-11	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	TDS 450
Ending Date:	27 Jul-11	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	
Sample ID:	00-4730-2427	**Code:**	CaCl2	**Client:**	Golder
Sample Date:	13 Jul-11	**Material:**	chemical	**Project:**	TDS Study
Receive Date:		**Source:**	Golder		
Sample Age:	8d 0h	**Station:**	Synthetic Effluent (TDS)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	539407193	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	723.8	669.9	N/A
EC10	1516	723.8	N/A
EC15	>1516	N/A	N/A
EC20	>1516	N/A	N/A
EC25	>1516	N/A	N/A
EC40	>1516	N/A	N/A
EC50	>1516	N/A	N/A

6d Survival Rate Summary

Calculated Variate(A/B)

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
460		10	1	1	1	0	0	0.0%	0.0%	10	10
620		10	1	1	1	0	0	0.0%	0.0%	10	10
845		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
1163		10	0.8	0	1	0.1333	0.4216	52.7%	20.0%	8	10
1516		10	1	1	1	0	0	0.0%	0.0%	10	10

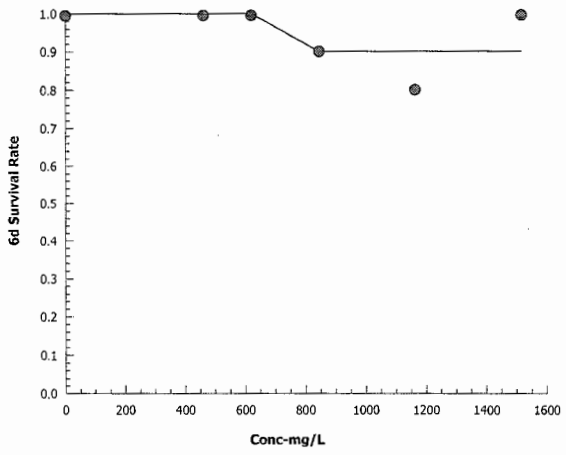
6d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	1	1	1	1	1	1	1	1	1
460		1	1	1	1	1	1	1	1	1	1
620		1	1	1	1	1	1	1	1	1	1
845		1	1	1	0	1	1	1	1	1	1
1163		1	1	1	1	1	1	1	1	0	0
1516		1	1	1	1	1	1	1	1	1	1

Ceriodaphnia 7-d Survival and Reproduction Test 4 6d **Nautilus Environmental**

Analysis ID:	11-3712-8163	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 15:09	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Summary of calculated TDS at test initiation

C dukes
Initial

Project	065
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1032215
Date Received	15-Jul-11 16:55
Date	25-Jul-11

RESULTS OF ANALYSIS

Sample ID	CACL2-1500	CACL2-1132	CACL2-817	CACL2-607
Date Sampled	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1032215-1	L1032215-2	L1032215-3	L1032215-4
Matrix	Water	Water	Water	Water
Physical Tests				
Total Dissolved Solids	3050	2020	1640	1280
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	30.8	31.7	32.5	32.7
Chloride (Cl)	910	654	467	325
Sulfate (SO4)	37	35	38.4	37.6
Alk 1.22x	37.576	38.674	39.65	39.894
Total Metals				
Calcium (Ca)-Total	467	355	226	156
Magnesium (Mg)-Total	10.8	11.3	10.9	11.4
Potassium (K)-Total	6.5	6.8	6.6	6.9
Sodium (Na)-Total	50.4	52.7	50.1	54.6
Total TDS	1519	1153	839	631

JCH
Jan. 10/12

CaCl2
Initial

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 15-JUL-11
Report Date: 25-JUL-11 12:55 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1032215**
Project P.O. #: NOT SUBMITTED
Job Reference: 065
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1032215-1	L1032215-2	L1032215-3	L1032215-4	
Description	WATER	WATER	WATER	WATER	
Sampled Date	13-JUL-11	13-JUL-11	13-JUL-11	13-JUL-11	
Sampled Time					
Client ID	CACL2-1500	CACL2-1132	CACL2-817	CACL2-607	
Grouping / **Analyte**					
WATER					
Physical Tests Total Dissolved Solids (mg/L)	3050	2020	1640	1280	
Anions and Nutrients Alkalinity, Total (as CaCO3) (mg/L)	30.8	31.7	32.5	32.7	
Chloride (Cl) (mg/L)	910	654	467	325	
Sulfate (SO4) (mg/L)	37	35	38.4	37.6	
Total Metals Calcium (Ca)-Total (mg/L)	467	355	226	156	
Magnesium (Mg)-Total (mg/L)	10.8	11.3	10.9	11.4	
Potassium (K)-Total (mg/L)	6.5	6.8	6.6	6.9	
Sodium (Na)-Total (mg/L)	50.4	52.7	50.1	54.6	

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1032215

Short Holding Time

Rush Processing

Chain of Custody

Cali tal
5550
San L
Phone 858.587.7333
Fax 858.587.3961

Phone 253.922.4296
Fax 253.922.5814

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

July 15/11

Date_____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	CaCl2-1500	13-Jul-11			1 L	1	Stock Solns.	X	X	X	X	X	X	X	X			
2	CaCl2-1132	13-Jul-11			1 L	1	↓	X	X	X	X	X	X	X	X			
3	CaCl2-817	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
4	CaCl2-607	13-Jul-11			1 L	1		X	X	X	X	X	X	X	X			
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 WO #: 11296-11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) July 15 2011	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) Courier July 15 11:11 (Time)
(Printed Name) (Date)	(Printed Name) (Date)
(Company)	(Company) Temp : 10.2°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Summary of calculated TDS at test termination

C - dubai
D6

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038457
Date Received	29-Jul-11 12:39
Date	08-Aug-11

RESULTS OF ANALYSIS

Sample ID	CACL2-1500 D6	CACL2-1132 D6	CACL2-817 D6	CACL2-607 D6
Date Sampled	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1038457-1	L1038457-2	L1038457-3	L1038457-4
Matrix	Water	Water	Water	Water
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	30.6	31.8	32.3	33.0
Chloride (Cl)	923	693	473	338
Sulfate (SO4)	39	39	39.8	39.8
Alk 1.22x	37.332 ✓	38.796	39.406	40.26
Total Metals				
Calcium (Ca)-Total	449	336	229	131
Magnesium (Mg)-Total	10.4	10.7	11.1	9.39
Potassium (K)-Total	6.3	6.5	6.7	5.8
Sodium (Na)-Total	48.4	47.7	50.5	44.1
Total TDS	1513	1172	850	608

JCh
Jan-10/12

C - duplicate
Caller
Day 6

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 08-AUG-11 12:10 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038457

Project P.O. #: 065 PHASE 2 WO#:11299
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1038457-1	L1038457-2	L1038457-3	L1038457-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	27-JUL-11	27-JUL-11	27-JUL-11	27-JUL-11	
	Sampled Time					
	Client ID	CACL2-1500 D6	CACL2-1132 D6	CACL2-817 D6	CACL2-607 D6	
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	30.6	31.8	32.3	33.0	
	Chloride (Cl) (mg/L)	923	693	473	338	
	Sulfate (SO4) (mg/L)	39	39	39.8	39.8	
Total Metals	Calcium (Ca)-Total (mg/L)	449	336	229	131	
	Magnesium (Mg)-Total (mg/L)	10.4	10.7	11.1	9.39	
	Potassium (K)-Total (mg/L)	6.3	6.5	6.7	5.8	
	Sodium (Na)-Total (mg/L)	48.4	47.7	50.5	44.1	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Nautilus Environ

L1038457

...lton
...ic Highway East, Suite 2
...VA 98124
...922.4296
...22.5814

(1) British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 29/11 Date ____ Page 1 of 1

Sample Collection By:

Report to: (1)		Invoice To: (1)	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides				Receipt Temperature (°C)
1	CaCl2-1500 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
2	CaCl2-1132 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
3	CaCl2-817 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
4	CaCl2-607 D6	27-Jul-11			1 L	1	Day 6	X	X	X	X	X	X	X				
5																		
6																		
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.: 065 Phase 2 WO #: 11299	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *C. dubia*

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time) July 29/11	(Signature) (Time)
(Printed Name) Edmund Canaria (Date)	(Printed Name) (Date)
(Company) Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time) 12:39
(Printed Name) (Date)	(Printed Name) (Date)
(Company)	(Company) ALS

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

APPENDIX C – Phase 2 Toxicity Test Data – ***Daphnia magna***

Daphnia magna Summary Sheet

Client: Golder
Work Order No.: 11300

Start Date/Time: Sept 14, 2011
Test Species: *Daphnia magna*
Set up by: AWD

Sample Information:

Sample ID: NaCl TDS
Sample Date: Prepared in-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:
≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:
T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 091311 ABS, CO
Age of young (Day 0): < 24 hours
Avg No. young per brood in previous 7 d: -
Mortality (%) in previous 7 d: -
Days to first brood: -

NaCl Reference Toxicant Results:

Reference Toxicant ID: DM74
Stock Solution ID: NaCl
Date Initiated: September 14, 2011
48-h LC50 (95% CL): 4.2 (3.7 - 4.8) g/LNaCL

Reference Toxicant Mean and Historical Range: 4.0, 3.6 - 4.4 g/L NaCL
Reference Toxicant CV (%): 6

Test Results:

mg/L TDS	Survival	Reproduction
EC25 (95% CL)	>1556	
EC50 (95% CL)	>1556	
IC25 (95% CL)		508 (463 - 569)
IC50 (95% CL)		>1556

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: NaCl TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Temperature (°C) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	KLB 10-9 Old	KLB 10-9 New	KLB 11/10
Control	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	20.0	20.0	19.5	18.0	19.5
450 ~~132~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.0	19.5
607 ~~198~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.0	19.5
817 ~~266~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.0	19.5
1132 ~~444~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.0	19.5
1500 ~~687~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.0	19.5
~~1000~~	~~20.0~~														
~~1500~~															
Technician Initials							KLB		KLB				KLB		

Concentration mg/L TDS	Temperature (°C) Day KLB 12/11	KLB 13/12 Old	KLB 13/12 New	KLB 14/13	KLB 15/14 Old	KLB 15/14 New	KLB 16/15	KLB 17/16 Old	KLB 17/16 New	KLB 18/17	KLB 19/18	KLB 20/19 Old	KLB 20/19 New	KLB 21/20	21
Control	20.0	20.5	18.5	20.0	20.0	20.0	19.5	20.5	19.5	21.0	20.5	20.0	21.0	20.0	20.5
450 ~~132~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.5	19.5	21.0	20.5	20.0	21.0	20.0	20.5
607 ~~198~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.5	19.0	21.0	20.5	20.0	20.5	20.0	20.5
817 ~~266~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	21.0	20.5	20.0	20.5	20.0	20.5
1132 ~~444~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	21.0	20.5	20.0	20.5	20.0	20.5
1500 ~~687~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	21.0	20.5	20.0	20.5	20.0	20.5
1000							~~19.5~~ 500								
1500															
Technician Initials		KLB	KLB	GHP		GHP	KLB			KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JGh

Date Reviewed: Jan. 12/12

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: NaCl TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Dissolved Oxygen (mg/L)

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	9.0	8.9	8.7	9.0	8.6	8.9	8.9	9.1	8.8	8.8	9.1	8.5	8.3	8.7	8.8
450 ~~482~~	9.0	9.0	8.8	9.0	8.7	8.5	8.9	9.1	8.8	8.8	9.1	8.6	8.4	9.1	8.8
607 ~~698~~	9.0	9.0	8.9	9.0	8.8	8.7	8.9	9.1	8.8	8.9	9.1	8.6	8.5	9.0	8.9
817 ~~296~~	9.1	8.9	8.9	9.1	8.7	8.6	8.9	9.1	8.7	8.9	9.2	8.6	8.7	8.9	8.9
1132 ~~444~~	9.1	9.0	8.9	9.1	8.7	8.6	8.9	9.1	8.7	8.8	9.2	8.5	8.7	8.9	8.9
1500 ~~687~~	9.1	9.0	8.9	9.1	8.7	8.6	8.9	9.1	8.7	8.9	9.2	8.6	8.7	8.9	8.9
1000															
1500															
Technician Initials	AM	AM	AM		AM	AM	KLB		KLB	AM		AM	KLB		AM

Dissolved Oxygen (mg/L)

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	8.5	8.0	8.3	7.9	7.8	8.5	8.1	7.5	8.8	8.0	7.6	7.9	8.2	8.0	7.1
450 ~~482~~	8.6	8.0	9.1	8.1	7.6	9.1	8.3	8.0	8.9	8.0	7.8	8.1	8.4	8.0	7.1
607 ~~698~~	8.6	8.4	9.1	8.4	8.5	9.1	8.4	8.3	8.9	7.8	7.8	8.5	8.6	8.1	7.5
817 ~~296~~	8.7	8.5	9.0	8.4	8.4	9.1	8.3	8.3	8.9	~~7.2~~ 7.6	7.8	8.4	8.6	8.2	7.5
1132 ~~444~~	8.6	8.5	9.0	8.4	8.4	9.1	8.3	8.4	9.0	~~7.2~~ 7.6	7.6	8.4	8.7	8.2	7.6
1500 ~~687~~	8.6	8.3	9.0	8.3	8.4	9.1	8.6	8.2	9.0	~~7.2~~ 7.6	7.7	8.5	8.7	8.2	7.5
1000															
1500															
Technician Initials	AM	KLB		KLB	GHP		GHP	KLB		KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JGh

Date Reviewed: Jan. 12/12

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Nacl TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

pH

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	~~8.1~~	8.1	7.9	7.9	7.9	8.3	8.0	7.9	7.8	7.9	7.6	7.5	7.7	7.9	7.9
~~132~~															
450 ~~198~~	8.1	8.0	7.8	7.6	7.9	8.2	7.7	7.3	7.8	7.6	7.5	7.4	7.5	7.6	7.6
607 ~~296~~	7.5	8.0	7.8	7.3	7.8	7.9	7.6	7.2	7.6	7.6	7.4	7.4	7.6	7.3	7.6
817 ~~444~~	7.4	7.9	7.6	7.3	7.8	7.9	7.7	7.2	7.6	7.6	7.4	7.3	7.6	7.3	7.6
1132 ~~667~~	7.4	7.9	7.9	7.2	7.7	7.9	7.7	7.2	7.5	7.6	7.3	7.3	7.6	7.3	7.6
1500 ~~1000~~	7.4	7.9	7.9	7.3	7.6	7.9	7.7	7.2	7.5	7.7	7.3	7.2	7.6	7.4	7.6
~~1500~~															
Technician Initials	AF						KLB		KLB				KLB		

pH

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	~~7.9~~	7.8	8.0	8.1	7.9	8.1	7.8	7.9	7.8	7.9	7.8	7.7	7.9	7.8	7.7
450 ~~132~~	~~7.6~~	7.5	7.5	7.7	7.5	7.5	7.5	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5
607 ~~198~~	7.8	7.6	7.3	7.6	7.8	7.4	7.5	7.5	7.3	7.4	7.4	7.6	7.6	7.6	7.6
817 ~~296~~	~~7.8~~	7.6	7.3	7.6	7.7	7.4	7.5	7.5	7.3	7.5	7.5	7.6	7.5	7.6	7.6
1132 ~~444~~	~~7.8~~	7.6	7.3	7.6	7.7	7.4	7.6	7.5	7.3	7.6	7.6	7.6	7.5	7.6	7.5
1500 ~~667~~	7.9	7.6	7.3	7.6	7.6	7.4	7.5	7.5	7.3	7.6	7.6	7.5	7.5	7.5	7.5
~~1000~~															
~~1500~~															
Technician Initials	AF	KLB		KLB	GHP		GHP	KLB		KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JGK

Date Reviewed: Jan-12/12

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: NaCl TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Conductivity (µS)

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	343		422	348			638	349		385	345		360	350	
450 ~~182~~ M	465		847	850			750	836		832	845		835	817	
607 ~~198~~ M	1039		1154	1152			1146	1136		1173	1126		1159	1123	
817 ~~296~~ M	1518		1582	1563			1513	1544		1588	1607		1532	1527	
1132 ~~444~~ M 2180	~~2744~~		2130	2200			2170	2180		2222	2180		2190	2190	
1500 ~~667~~ M	2820		2860	2860			2770	2830		2880	2830		2800	2840	
~~1000~~ M															
~~1500~~ M															
Technician Initials	AM		M				KLB			M			KLB		

Conductivity (µS)

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control		362	360		359	359		362	339			504	344		361
450 ~~132~~ KLB		836	835		825	829		822	840			916	845		849
607 ~~198~~ KLB		1163	1133		1102	1129		1094	1138			1201	1143		1206
817 ~~296~~ KLB		1530	1540		1499	1535		1506	1553			1518	1542		1508
1132 ~~444~~ KLB		2160	2180		2130	2170		2140	2180			2160	2180		2171
1500 ~~667~~ KLB		2800	2830		2760	2820		2760	2830			2730	2830		2760
~~1000~~ KLB															
~~1500~~ KLB															
Technician Initials	M	KLB			GHP			KLB				GHP			KLB

Comments:

Reviewed by: JBL

Date Reviewed: Jan. 12/12

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: NaCl
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: Control											Concentration: 450										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
2	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	X	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
8	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
9	8	|	6	0	0	6	6	0	0	0	~	0	0	0	0	0	4	0	0	0	0	~
10	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
11	0	|	0	0	10	0	0	10	11	7	KLB	12	0	0	0	0	0	0	0	0	0	KLB
12	20	|	0	0	0	15	16	0	0	0	GHP	0	0	5	0	0	14	8	10	14	8	GHP
13	0	|	0	12	0	0	0	0	0	12	KLB	0	0	0	0	0	0	0	0	0	0	KLB
14	0	|	14	0	25	0	0	20	16	0	GHP	23	0	0	0	9	0	13	7	0	0	GHP
15	28	|	0	0	0	0	25	0	0	0	GHP	0	7	21	8	0	16	0	0	18	12	GHP
16	0	|	0	22	0	22	0	0	0	20	KLB	13	0	0	0	0	0	0	0	0	0	KLB
17	0	|	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
18	22	|	14	0	8	0	23	11	13	0	KLB	0	16	21	19	24	0	18	8	24	33	KLB
19	0	|	0	31	0	23	0	0	0	19	GHP	27	0	0	0	0	28	0	0	0	0	GHP
20	0	|	36	0	24	0	0	24	35	0	KLB	0	0	0	0	28	0	38	0	0	0	KLB
21	5	|	0	0	0	0	22	0	0	0	KLB	0	24	27	23	0	0	0	33	28	29	KLB
Total	83	0[X]	64	65	67	66	92	65	75	58	KLB	75	47	74	50	61	62	~~77~~ 67	58	84	81	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: NaCl TDS solution
Comments:

Reviewed by: JGh

Date reviewed: Jan. 12/12

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: NaCl
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 607											Concentration: 817										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	X	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	|	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	|	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	|	0	0	0	KLB	0	11	0	0	X	0	0	0	0	0	KLB
9	0	X	0	0	0	0	|	0	0	X	KLB	0	0	0	0	|	0	0	0	0	0	KLB
10	0	|	0	0	0	0	|	0	0	|	~	0	0	0	0	|	0	0	0	0	0	~
11	0	|	0	0	0	0	|	0	0	|	~	0	0	0	0	|	0	0	0	0	0	~
12	0	|	0	0	14	0	|	0	0	|	GHP	0	0	0	0	|	0	X	9	0	2	GHP
13	0	|	0	0	0	0	|	0	0	|	KLB	0	17	0	0	|	0	|	17	0	X	KLB
14	0	|	4	5	0	8	|	0	11	|	GHP	9	0	0	8	|	0	|	0	0	|	GHP
15	0	|	0	0	21	0	|	0	0	|	GHP	0	0	0	6	|	0	|	0	0	|	GHP
16	0	|	0	0	0	0	|	0	0	|	KLB	0	19	0	0	|	0	|	8	0	|	KLB
17	0	|	6	0	0	0	|	0	0	|	KLB	0	0	0	0	|	0	|	0	0	|	KLB
18	0	|	0	18	0	15	|	0	21	|	KLB	15	0	9	14	|	X	|	0	0	|	KLB
19	8	|	0	0	27	0	|	0	0	|	GHP	0	26	0	0	|	|	|	35	0	|	GHP
20	0	|	0	32	0	34	|	0	34	|	KLB	27	0	0	28	|	|	|	0	0	|	KLB
21	0	|	0	0	0	0	|	0	0	|	KLB	0	0	0	0	|	|	|	0	0	|	KLB
Total	8	0*	10	55	62	57	0*	0	66	0*	KLB	51	73	9	50	0*	0*	0*	69	0	2*	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: NaCl TDS solution
Comments:

Reviewed by: JGh

Date reviewed: Jan. 12/12

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: NaCl
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 1132											Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	0	0	0	0	0	0	0	0	0	KLB	0	3	6	10	0	0	0	0	0	0	KLB
10	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
11	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
12	8	0	5	13	0	0	0	0	0	X	GHP	9	3	11	0	6	0	0	0	14	0	GHP
13	0	0	0	17	0	0	0	0	0	|	KLB	0	10	0	21	0	0	0	0	0	0	KLB
14	8	0	0	0	7	0	14	0	0	|	GHP	16	0	0	~~0~~ LOST	4	0	3	0	0	0	GHP
15	0	0	0	0	0	0	0	10	7	|	GHP	0	0	17	0	0	0	0	0	23	14	GHP
16	0	0	12	0	0	0	0	0	0	|	KLB	0	13	0	15	0	0	0	0	0	0	KLB
17	0	0	0	0	0	0	0	0	0	|	KLB	0	0	0	0	0	0	0	0	0	0	KLB
18	11	0	0	0	15	0	35	14	16	|	KLB	13	0	0	0	7	16	18	0	22	21	KLB
19	0	0	21	0	0	0	0	0	0	|	GHP	0	23	21	24	0	0	0	13	0	0	GHP
20	27	0	0	36	0	17	31	0	0	|	KLB	33	0	0	0	0	0	21	0	0	0	KLB
21	0	0	0	0	29	0	0	19	26	|	KLB	0	0	0	0	12	14	0	0	0	21	KLB
Total	54	0	38	66	51	17	80	43	49	0*	KLB	71	52	55	70	29	30	42	13	59	56	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: NaCl TDS solution
Comments:

Reviewed by: JOL

Date reviewed: Jan. 12/12

CETIS Analytical Report

Daphnid 7-d Survival and Reproduction Test

Nautilus Environmental

Analysis ID:	02-1408-7642	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 14:54	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	08-0977-2183	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	<24h
Sample ID:	09-0178-0722	**Code:**	35C014F2	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	NaCl TDS		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.211E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	477	457.9	N/A
EC10	521.8	480.9	N/A
EC15	570.8	505	N/A
EC20	>1556	N/A	N/A
EC25	>1556	N/A	N/A
EC40	>1556	N/A	N/A
EC50	>1556	N/A	N/A

7d Survival Rate Summary

Calculated Variate(A/B)

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	0.9	0	1	0.1	0.3162	35.1%	0.0%	9	10
436		10	1	1	1	0	0	0.0%	-11.1%	10	10
579		10	0.7	0	1	0.1528	0.483	69.0%	22.2%	7	10
817		10	0.6	0	1	0.1633	0.5164	86.1%	33.3%	6	10
1166		10	0.9	0	1	0.1	0.3162	35.1%	0.0%	9	10
1556		10	1	1	1	0	0	0.0%	-11.1%	10	10

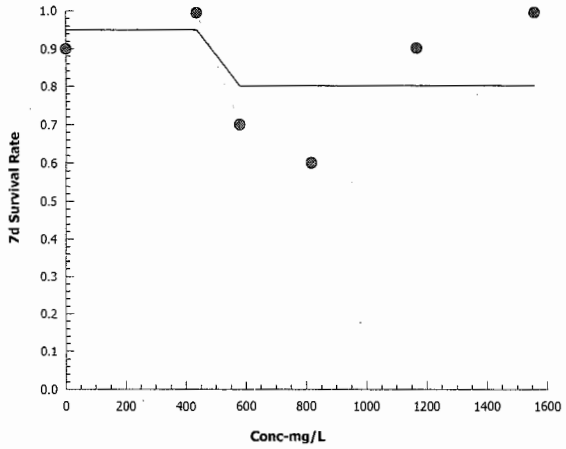
7d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	0	1	1	1	1	1	1	1	1
436		1	1	1	1	1	1	1	1	1	1
579		1	0	1	1	1	1	0	1	1	0
817		1	1	1	1	0	0	0	1	1	0
1166		1	1	1	1	1	1	1	1	1	0
1556		1	1	1	1	1	1	1	1	1	1

Daphnid 7-d Survival and Reproduction Test | **Nautilus Environmental**

Analysis ID:	02-1408-7642	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 14:54	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Daphnid 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	08-7063-0213	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:17	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	08-0977-2183	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	<24h
Sample ID:	09-0178-0722	**Code:**	35C014F2	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	NaCl TDS		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.994E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	449.5	4.336	459.1
IC10	463.5	27.47	484.9
IC15	477.9	150.9	511.4
IC20	492.7	443.4	539.4
IC25	508	463.1	568.8
IC40	556.8	512.3	N/A
IC50	>1556	N/A	N/A

Reproduction Summary — **Calculated Variate**

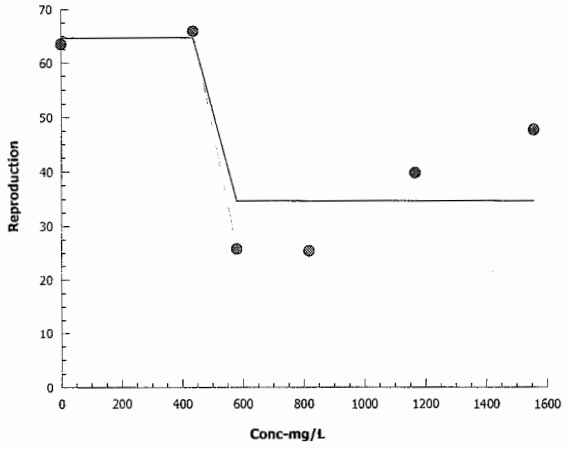
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	63.5	0	92	7.753	24.52	38.61%	0.0%
436		10	65.9	47	84	3.968	12.55	19.04%	-3.78%
579		10	25.8	0	66	9.417	29.78	115.4%	59.37%
817		10	25.4	0	73	9.902	31.31	123.3%	60.0%
1166		10	39.8	0	80	8.443	26.7	67.08%	37.32%
1556		10	47.7	13	71	5.97	18.88	39.58%	24.88%

Reproduction Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	83	0	64	65	67	66	92	65	75	58
436		75	47	74	50	61	62	67	58	84	81
579		8	0	10	55	62	57	0	0	66	0
817		51	73	9	50	0	0	0	69	0	2
1166		54	0	38	66	51	17	80	43	49	0
1556		71	52	55	70	29	30	42	13	59	56

Analysis ID:	08-7063-0213	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:17	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Summary of calculated TDS at test initiation

D. magna

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038455
Date Received	29-Jul-11 12:35
Date	08-Aug-11

RESULTS OF ANALYSIS

Sample ID	NACL-1500 D0	NACL-1132 DM	NACL-817 DM	NACL-607 DM	450
Date Sampled	29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11	
Time Sampled	00:00	00:00	00:00	00:00	
ALS Sample ID	L1038455-1	L1038455-2	L1038455-3	L1038455-4	
Matrix	Water	Water	Water	Water	
Physical Tests					
Total Dissolved Solids	1800	1440	1080	918	
Anions and Nutrients					
Alkalinity, Total (as CaCO3)	- 22.7	22.6	22.4	22.0	
Chloride (Cl)	897	666	450	301	
Sulfate (SO4)	37	36	37.2	35.1	
Alk 1.22 x	27.694 ✓	27.572 ✓	27.328 ✓	26.84 ✓	
Total Metals					
Calcium (Ca)-Total	87.6	86.6	86.6	86.3	
Magnesium (Mg)-Total	10.9	10.7	10.8	10.8	
Potassium (K)-Total	4.2	4.2	4.2	4.2	
Sodium (Na)-Total	492	335	201	115	
Total TDS	1556	1166	817	579	436

JCH
Jan. 12/12

TDS 450 DM
29-JUL-11
00:00
L1038455-5
Water

753

22.6
218
38.0
27.572 ✓

86.9
10.9
4.3
50.3

436

JOL
Jan 12/12

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 08-AUG-11 12:04 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038455

Project P.O. #: 065 D0DM P2 WO#11300
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: Discrepancy between CoC and sample label:
CoC: NaCl-1500 DO
Label: NaCl-1500 DM

Sample was logged in according to CoC: NaCl-1500 DO

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1038455-1	L1038455-2	L1038455-3	L1038455-4	L1038455-5
Description	WATER	WATER	WATER	WATER	WATER
Sampled Date	29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11
Sampled Time					
Client ID	NACL-1500 D0	NACL-1132 DM	NACL-817 DM	NACL-607 DM	TDS 450 DM
Grouping / Analyte					
WATER					
Physical Tests					
Total Dissolved Solids (mg/L)	1800	1440	1080	918	753
Anions and Nutrients					
Alkalinity, Total (as CaCO3) (mg/L)	22.7	22.6	22.4	22.0	22.6
Chloride (Cl) (mg/L)	897	666	450	301	218
Sulfate (SO4) (mg/L)	37	36	37.2	35.1	38.0
Total Metals					
Calcium (Ca)-Total (mg/L)	87.6	86.6	86.6	86.3	86.9
Magnesium (Mg)-Total (mg/L)	10.9	10.7	10.8	10.8	10.9
Potassium (K)-Total (mg/L)	4.2	4.2	4.2	4.2	4.3
Sodium (Na)-Total (mg/L)	492	335	201	115	50.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Nautilus Environ

L1038455

shington
Pacific Highway East, Suite 2
ma, WA 98424
e 253.922.4296
253.922.5814

(1) British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 29/11 Date Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	NaCl-1500 D0	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
2	NaCl-1132 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
3	NaCl-817 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
4	NaCl-607 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
5	TDS 450 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.:065 D0DM P2 WO #: 11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *D. magna*

RELINQUISHED BY (CLIENT)

(Signature) (Time) July 29/11

(Printed Name) Edmund Canaria (Date)

(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (LABORATORY)

(Signature) (Time) 12:35

(Printed Name) Ryan D (Date) Jul 29/11

(Company) ALS Global

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Daphnia magna Summary Sheet

Client: Golder
Work Order No.: 11300

Start Date/Time: Sept 14, 2011
Test Species: *Daphnia magna*
Set up by: AWD

Sample Information:

Sample ID: Na_2SO_4 TDS
Sample Date: Prepared in-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:
≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:
T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 091311 ABS, CO
Age of young (Day 0): < 24 hours
Avg No. young per brood in previous 7 d: -
Mortality (%) in previous 7 d: -
Days to first brood: -

NaCl Reference Toxicant Results:

Reference Toxicant ID: DM74
Stock Solution ID: Na_2SO_4
Date Initiated: September 14, 2011
48-h LC50 (95% CL): 4.2 (3.7 - 4.8) g/LNaCL

Reference Toxicant Mean and Historical Range: 4.0, 3.6 - 4.4 g/L NaCL
Reference Toxicant CV (%): 6

Test Results:	mg/L TDS	Survival	Reproduction
	EC25 (95% CL)	> 1566	
	EC50 (95% CL)	> 1566	
	IC25 (95% CL)		964 (507 - 1472)
	IC50 (95% CL)		> 1566

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Na_2SO_4 & Cotton TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

	Temperature (°C)														
	Day														
Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	~~9~~ 9 Old	9 New	~~10~~ 10
Control	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	20.0	20.0	19.5	19.5	19.5
450 ~~132~~	20.0	19.5	20.0	20.0	19.5	19.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	19.5	19.5
607 ~~198~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	19.5	19.5
817 ~~286~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	19.5	19.5
1132 ~~444~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	19.5	19.5
1500 ~~607~~	20.0	19.5	20.0	20.0	19.5	20.5	20.0	19.5	20.0	20.0	19.5	20.0	19.5	19.5	19.5
1000	~~Dry~~								~~Dry~~ KLB						
1500															
Technician Initials	AA	AA	AA		AA	AA	KLB		KLB	AA		AA	KLB		AA

	Temperature (°C)														
	Day														
Concentration mg/L TDS	~~KLB 12~~ 11	~~KLB 13~~ 12 Old	~~KLB 13~~ 12 New	~~KLB 14~~ 13	~~KLB 15~~ 14 Old	~~KLB 15~~ 14 New	~~KLB 16~~ 15	~~KLB 17~~ 16 Old	~~KLB 17~~ 16 New	~~KLB 18~~ 17	~~KLB 19~~ 18	~~KLB 20~~ 19 Old	~~KLB 20~~ 19 New	~~KLB 21~~ 20	21
Control	20.0	20.5	19.5	20.0	20.0	20.0	19.5	20.5	19.5	21.0	20.5	20.0	21.0	20.0	20.5
450 ~~132~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.5	19.5	21.0	20.5	20.0	21.0	20.0	20.5
607 ~~817~~ ~~198~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.5	19.0	21.0	20.5	20.0	20.5	20.0	20.5
817 ~~1132~~ ~~286~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	20.5	20.5	20.0	20.5	20.0	21.0
1132 ~~444~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	20.5	20.5	20.0	20.5	20.0	21.0
1500 ~~607~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	20.5	20.5	20.0	20.5	20.0	21.0
1000						~~Dry~~ GHP									
1500															
Technician Initials	AA	KLB	KLB	GHP			GHP	KLB		KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JBe

Date Reviewed: Nov. 8/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Na2SO4 TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

pH

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	8.1	8.1	7.9	7.9	7.9	8.3	8.0	7.9	7.8	7.9	7.6	7.5	7.7	7.9	7.9
~~182~~															
450 ~~198~~	8.1	8.0	7.8	7.6	7.9	8.2	7.7	7.3	7.8	7.6	7.5	7.4	7.5	7.6	7.6
607 ~~296~~	7.6	8.0	7.8	7.2	7.8	7.9	7.8	7.2	7.6	7.5	7.8	7.4	7.7	7.4	7.7
817 ~~444~~	7.4	7.9	7.8	7.3	7.6	8.0	7.8	7.2	7.6	7.6	7.8	7.3	7.7	7.4	7.7
1132 ~~667~~	7.3	8.0	7.7	7.3	7.7	8.0	7.7	7.3	7.6	7.6	7.3	7.2	7.7	7.4	7.6
1500 ~~1000~~	7.2	8.0	7.8	7.2	7.6	8.0	7.7	7.3	7.6	7.6	7.3	7.3	7.7	7.4	7.8
~~1500~~															
Technician Initials	AM	AM	AM		AM	AM	KLB		KLB	AM		AM	KLB		AM

pH

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	~~7.9~~ 8.1	7.8	8.0 KLB	8.1	7.9	8.1	7.8	7.9	7.8	7.9	7.8	7.7	7.9	7.8	7.7
450 ~~182~~	7.6	7.5	7.5	7.7	7.5	7.5	7.5	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5
607 ~~198~~	7.7	7.6	7.4	7.7	7.6	7.4	7.6	7.5	7.3	7.6	7.6	7.5	7.6	7.5	7.5
817 ~~296~~	7.7	7.7	7.4	7.7	7.6	7.4	7.6	7.6	7.3	7.6	7.6	7.6	7.6	7.6	7.6
1132 ~~444~~	7.8	7.7	7.4	7.7	7.6	7.4	7.6	7.6	7.3	7.6	7.6	7.6	7.6	7.6	7.6
1500 ~~667~~	7.8	7.7	7.4	7.7	7.6	7.4	7.6	7.6	7.3	7.6	7.6	7.6	7.6	7.6	7.6
~~1000~~															
1500															
Technician Initials	AM		KLB	KLB	GHP		GHP		KLB	KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JBL

Date Reviewed: Nov-8/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Na2SO4 TDS

Start Date: Sept 14/11
Termination Date: ~~Oct 5/11~~
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Dissolved Oxygen (mg/L) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	9.0	8.9	~~8.0~~ 8.7	9.0	8.6	8.4	8.9	9.1	8.6	8.8	9.1	8.5	8.3	8.7	8.8
450 ~~332~~ A	9.0	~~8.9~~ 9.0	8.8	9.0	8.9	8.5	8.9	9.1	8.7	8.8	9.1	8.5	8.4	9.1	8.8
632 ~~498~~ A	9.1	8.9	8.9	8.9	8.7	8.6	8.9	9.1	8.7	8.8	9.1	8.6	8.3	9.1	8.9
817 ~~296~~ A	9.1	8.9	8.9	9.0	8.6	8.6	8.9	9.1	8.8	8.7	9.2	8.6	8.4	9.1	8.9
1132 ~~444~~ A	9.1	8.9	8.8	9.1	8.5	8.6	8.9	9.1	8.8	8.9	9.2	8.5	8.5	9.1	8.9
1500 ~~887~~ A	9.1	8.9	8.9	9.0	8.6	8.6	8.9	9.1	8.8	8.9	9.2	8.5	8.8	9.1	8.9
1000 A															
1500 A															
Technician Initials	AM	A	A		A	A	KCB		KCB	A		A	KCB		A

Concentration mg/L TDS	Dissolved Oxygen (mg/L) Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	8.5	8.0	8.3	7.9	7.8	8.5	8.1	7.5	8.8	8.0	7.6	7.9	8.2	8.0	7.1
450 ~~332~~ A	8.6	8.0	9.1 KCB	8.1	7.6	9.1	8.3	8.0	8.9	8.0	7.8	8.1	8.4	8.0	7.1
632 ~~498~~ A	8.5	8.3	~~9.7~~ 9.1	8.1	8.1	9.1	8.4	8.0	9.0	8.1	7.8	8.4	8.4	7.9	7.3
817 ~~296~~ A	8.5	8.3	9.0	8.3	8.2	9.1	8.6	8.2	9.0	7.9	7.8	8.7	8.5	8.0	7.6
1132 ~~444~~ A	8.6	8.4	9.2	8.3	8.3	9.1	8.5	8.1	9.0	7.9	7.7	8.4	8.5	8.1	7.6
1500 ~~887~~ A	8.6	8.4	9.1	8.3	8.3	9.1	8.5	8.3	8.9	7.8	7.7	8.5	8.6	8.1	7.5
1000 A															
1500 A															
Technician Initials	A	KCB		KCB	GHP		GHP	KCB		KCB	KCB	GHP		KCB	KCB

Comments:

Reviewed by: JGW

Date Reviewed: Nov. 8/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Na_2SO_4 TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Conductivity (µS)

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	343		422	348			638	~~2350~~ 349		389	345		360	350	
450 ~~182~~	445		842	850			750	836		832	826		835	817	
607 ~~198~~	1109		1042	1045			1051	1036		1031	1029		1040	1021	
817 ~~296~~	1323		1296	1322			1297	1313		1314	1304		1315	1296	
1132 ~~444~~	1748		1616	1753			1721	1732		1750	1730		1695	1715	
1500 ~~667~~	2230		1995	2230			2200	2210		2225	~~1947~~ 2200		2210	2190	
~~1000~~															
~~1500~~															
Technician Initials	AM		AS				KCB			AS			KCB		

Conductivity (µS)

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
~~Control~~ ECO Control		362	360		357	359		362	339			504	344		361
450 ~~432~~ KCB		836	835		875	829		822	840			916	845		849
607 ~~498~~ KCB		1045	1032		991	1024		977	1034			1089	1050		1090
817 296 KCB		1301	1310		1285	1306		1287	1311			1284	1315		1271
1132 ~~444~~ KCB		1718	1733		1691	1731		1707	1731			1715	1731		1716
1500 667 KCB		2210	2210		2170	~~2300~~ GHP 2300		2190	2210			2170	2220		2182
~~1000~~ KCB															
~~1500~~ KCB															
Technician Initials	AM	KCB			GHP			KCB				GHP			KCB

Comments:

Reviewed by: JGH

Date Reviewed: Nov. 8/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: Na_2SO_4
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: Control											Concentration: 450										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
2	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	X	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
8	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
9	8	|	6	0	0	6	6	0	0	0	~	0	0	0	0	0	4	0	0	0	0	~
10	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
11	0	|	0	0	10	0	0	10	11	7	KLB	12	0	0	0	0	0	0	0	0	0	KLB
12	20	|	0	0	0	15	16	0	0	0	GHP	0	0	5	0	0	14	8	10	14	8	GHP
13	0	|	0	12	0	0	0	0	0	12	KLB	0	0	0	0	0	0	0	0	0	0	KLB
14	0	|	14	0	25	0	0	20	16	0	GHP	23	0	0	0	9	0	13	7	0	0	GHP
15	28	|	0	0	0	0	25	0	0	0	GHP	0	7	21	8	0	16	0	0	18	12	GHP
16	0	|	0	22	0	22	0	0	0	20	KLB	13	0	0	0	0	0	0	0	0	0	KLB
17	0	|	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
18	22	|	14	0	8	0	23	11	13	0	KLB	0	16	31	19	24	0	18	8	24	33	KLB
19	0	|	0	31	0	23	0	0	0	19	GHP	27	0	0	0	0	28	0	0	0	0	GHP
20	0	|	36	0	24	0	0	24	35	0	KLB	0	0	0	0	28	0	28	0	0	0	KLB
21	5	|	0	0	0	0	22	0	0	0	KLB	0	24	27	23	0	0	0	33	28	29	KLB
Total	83	0[X]	64	65	67	66	92	65	75	58	KLB	75	47	74	50	61	62	~~77~~ KLB 67	58	84	81	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: Na_2SO_4 TDS solution
Comments:

Reviewed by: JBL

Date reviewed: Nov. 8/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: Na_2SO_4
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 607											Concentration: 817										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	X	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	0	0	0	0	KLB	|	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	|	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	|	0	0	0	0	0	0	0	0	0	KLB
9	0	5	0	0	0	0	0	0	0	0	KLB	|	0	0	0	0	X	4	0	0	X	KLB
10	0	0	0	0	0	0	0	0	0	0	~	|	0	0	0	0	|	0	0	0	|	~
11	0	0	0	0	0	0	0	0	0	0	~	|	0	0	0	12	|	0	0	0	|	~
12	0	18	0	0	0	6	0	0	0	0	GHP	|	0	0	3	0	|	14	0	16	|	GHP
13	0	0	12	0	0	0	6	0	0	6	KLB	|	12	0	4	0	|	0	0	0	|	KLB
14	3	0	0	7	9	16	0	11	17	14	GHP	|	0	0	0	16	|	14	0	12	|	GHP
15	0	18	0	0	3	0	0	0	0	0	GHP	|	0	0	0	0	|	a1	0	0	|	GHP
16	15	0	21	0	0	0	17	0	0	0	KLB	|	16	X	17	0	|	0	0	0	|	KLB
17	0	0	0	0	0	0	0	0	0	0	KLB	|	0	|	0	0	|	0	0	0	|	KLB
18	0	24	0	X	20	18	0	15	14	24	KLB	|	0	|	0	9	|	0	32	10	|	KLB
19	0	0	35	|	0	0	36	0	0	0	GHP	|	19	|	30	0	|	24	0	0	|	GHP
20	0	0	0	|	0	0	0	32	37	0	KLB	|	0	|	0	43	|	0	0	43	|	KLB
21	27	21	0	|	25	33	0	0	0	31	KLB	|	0	|	0	0	|	0	34	0	|	KLB
Total	35 KLB 45	86	68	7X	57	73	59	58	68	69	KLB	0X	47	0X	54	79	0X	63 77 KLB	66	74	0X	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: Na_2SO_4 TDS solution
Comments:

Reviewed by: JGH

Date reviewed: Nov. 8/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID:
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 1132											Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	X	0	0	0	0	X	0	0	0	0	KLB	0	4	0	5	0	0	0	0	0	0	KLB
10	|	0	0	0	0	|	0	0	0	0	~	2	0	0	0	0	0	0	0	0	0	~
11	|	0	0	0	0	|	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
12	|	0	0	0	0	|	0	0	0	KLB 33	GHP	0	13	7	0	15	0	5	2	2	0	GHP
13	|	0	0	0	0	|	0	0	0	15	KLB	0	0	0	X	0	0	19	12	0	0	KLB
14	|	9	9	8	6	|	4	8	0	0	GHP	13	0	0	|	0	3	0	0	14	6	GHP
15	|	0	0	0	0	|	0	0	11	0	GHP	0	0	0	|	0	3	0	0	0	0	GHP
16	|	0	18	0	14	|	0	0	0	21	KLB	0	19	0	|	19	0	17	18	0	0	KLB
17	|	0	0	0	0	|	0	0	0	0	KLB	0	0	0	|	0	0	0	0	0	0	KLB
18	|	17	0	22	0	|	11	20	33	0	KLB	14	0	18	|	0	7	0	0	17	X	KLB
19	|	0	0	0	32	|	0	0	0	0	GHP	0	21	0	|	24	0	29	21	0	|	GHP
20	|	29	35	30	0	|	26	29	0	0	KLB	28	0	29	|	0	0	0	0	0	|	KLB
21	|	0	0	0	0	|	0	0	30	0	KLB	0	0	0	|	0	22	0	0	25	|	KLB
Total	0[X]	55	62	60	52	0[X]	41	57	64	KLB 49 39	KLB	57	57	54	5[X]	58	35	70	53	58	6[X]	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description:
Comments:

Reviewed by: JCH

Date reviewed: Nov. 8/11

CETIS Analytical Report

Daphnid 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	05-4986-9632	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 14:50	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	11-9549-4085	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	
Sample ID:	03-6577-0218	**Code:**	15CD35EA	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	Na2SO4 TDS		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.914E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	613.9	467.4	818.2
EC10	677.6	501	1483
EC15	737.9	537	N/A
EC20	803.6	575.6	N/A
EC25	>1566	N/A	N/A
EC40	>1566	N/A	N/A
EC50	>1566	N/A	N/A

7d Survival Rate Summary — **Calculated Variate(A/B)**

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	0.9	0	1	0.1	0.3162	35.1%	0.0%	9	10
436		10	1	1	1	0	0	0.0%	-11.1%	10	10
625		10	0.9	0	1	0.1	0.3162	35.1%	0.0%	9	10
843		10	0.6	0	1	0.1633	0.5164	86.1%	33.3%	6	10
1193		10	0.8	0	1	0.1333	0.4216	52.7%	11.1%	8	10
1566		10	0.8	0	1	0.1333	0.4216	52.7%	11.1%	8	10

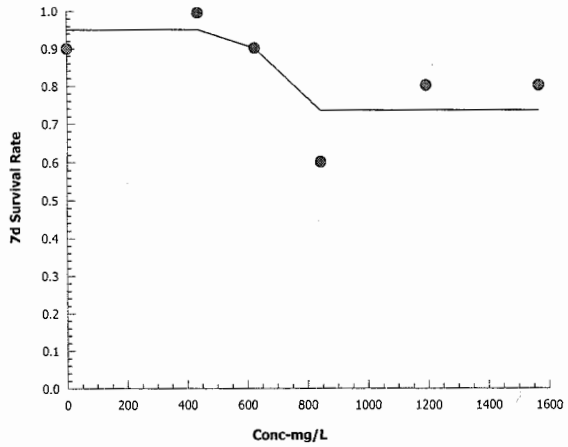
7d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	0	1	1	1	1	1	1	1	1
436		1	1	1	1	1	1	1	1	1	1
625		1	1	1	0	1	1	1	1	1	1
843		0	1	0	1	1	0	1	1	1	0
1193		0	1	1	1	1	0	1	1	1	1
1566		1	1	1	0	1	1	1	1	1	0

Daphnid 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	05-4986-9632	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 14:50	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Daphnid 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-1912-4153	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:15	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	11-9549-4085	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	
Sample ID:	03-6577-0218	**Code:**	15CD35EA	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	Na2SO4 TDS		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
21	-220.7	447.9	453.7	0.0728	Yes	1.378	2.776	0.2593	Non-Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	46.22	N/A	794.7
IC5	202.3	N/A	781.4
IC10	388.3	N/A	958.5
IC15	575	37.48	1138
IC20	766.2	282	1296
IC25	964.4	507.1	1472
IC40	1622	698.8	2875
IC50	2139	550.2	5438
IC60	2754	382.8	N/A
IC75	4007	340.3	N/A
IC80	4587	457.5	N/A
IC85	5324	699.4	N/A
IC90	6345	1160	N/A
IC95	8053	2149	N/A
IC99	11890	4909	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	65.74	7.684	50.36	81.13	8.556	<0.0001	Significant Parameter
C	1.104	0.8365	-0.571	2.779	1.32	0.1922	Non-Significant Parameter
D	2139	977.9	180.7	4097	2.187	0.0328	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	4023.856	4023.856	1	6.63	0.0126	Significant
Lack of Fit	2460.277	820.0923	3	1.378	0.2593	Non-Significant
Pure Error	32131.6	595.0296	54			
Residual	34591.88	606.8751	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variances	Mod Levene Equality of Variance	1.602	2.386	0.1754	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.8482	0.9605	<0.0001	Non-normal Distribution
	Anderson-Darling A2 Normality	3.612	2.492	<0.0001	Non-normal Distribution

Daphnid 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-1912-4153	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:15	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

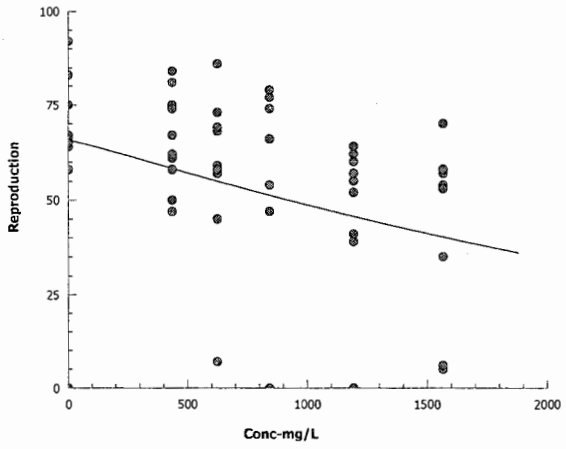
Reproduction Summary — **Calculated Variate**

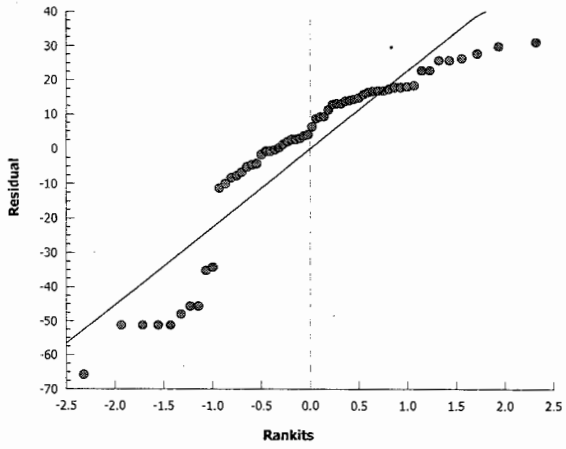
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	63.5	0	92	7.753	24.52	38.61%	0.0%
436		10	65.9	47	84	3.968	12.55	19.04%	-3.78%
625		10	59	7	86	6.743	21.32	36.14%	7.09%
843		10	39.7	0	79	11.24	35.54	89.51%	37.48%
1193		10	43	0	64	7.623	24.11	56.06%	32.28%
1566		10	45.3	5	70	7.162	22.65	49.99%	28.66%

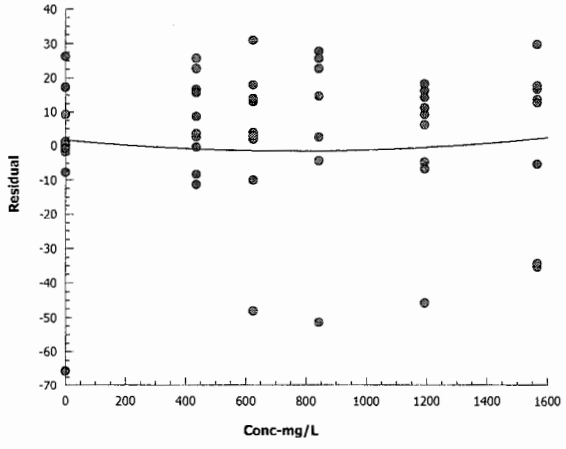
Reproduction Detail

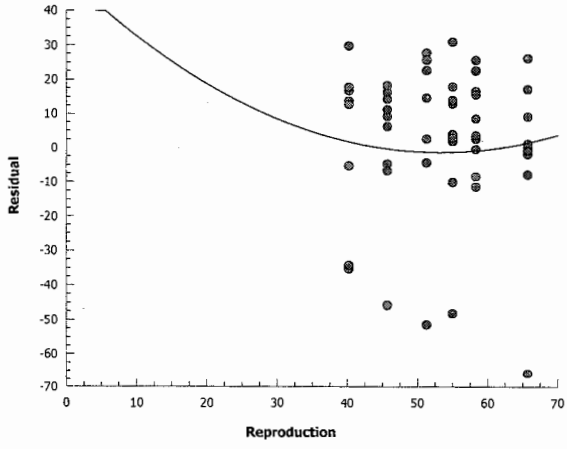
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	83	0	64	65	67	66	92	65	75	58
436		75	47	74	50	61	62	67	58	84	81
625		45	86	68	7	57	73	59	58	68	69
843		0	47	0	54	79	0	77	66	74	0
1193		0	55	62	60	52	0	41	57	64	39
1566		57	57	54	5	58	35	70	53	58	6

Graphics — 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Summary of calculated TDS at test initiation

D. magna

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038452
Date Received	29-Jul-11 12:25
Date	05-Aug-11

RESULTS OF ANALYSIS

Sample ID	NA2SO4-1500 DM	NA2SO4-1132 DM	NA2SO4-817DM	NA2SO4-607 DM	450
Date Sampled	29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11	
Time Sampled	00:00	00:00	00:00	00:00	
ALS Sample ID	L1038452-1	L1038452-2	L1038452-3	L1038452-4	
Matrix	Water	Water	Water	Water	
Physical Tests					
Total Dissolved Solids	1470	1100	786	693	
Anions and Nutrients					
Alkalinity, Total (as CaCO3)	28.0	26.2	25.0	24.1	
Chloride (Cl)	226	226	224	227	
Sulfate (SO4)	830	541	309	156	
Alk 1.22x	34.16	31.964	30.5	29.402	
Total Metals					
Calcium (Ca)-Total	80.6	89.5	87.9	90.3	
Magnesium (Mg)-Total	9.98	11.0	10.8	11.0	
Potassium (K)-Total	3.9	4.2	4.2	4.3	
Sodium (Na)-Total	381	289	177	107	
Total TDS	1566 ✓	1193 ✓	843 ✓	625 ✓	436

JGW
Nov. 8/11

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 05-AUG-11 12:31 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038452
Project P.O. #: 065 D0DM P2 WO#11300
Job Reference:
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L1038452-1 Description: WATER Sampled Date: 29-JUL-11 Sampled Time: Client ID: NA2SO4-1500 DM	L1038452-2 WATER 29-JUL-11 NA2SO4-1132 DM	L1038452-3 WATER 29-JUL-11 NA2SO4-817DM	L1038452-4 WATER 29-JUL-11 NA2SO4-607 DM
WATER					
Physical Tests	Total Dissolved Solids (mg/L)	1470	1100	786	693
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	28.0	26.2	25.0	24.1
	Chloride (Cl) (mg/L)	226	226	224	227
	Sulfate (SO4) (mg/L)	830	541	309	156
Total Metals	Calcium (Ca)-Total (mg/L)	80.6	89.5	87.9	90.3
	Magnesium (Mg)-Total (mg/L)	9.98	11.0	10.8	11.0
	Potassium (K)-Total (mg/L)	3.9	4.2	4.2	4.3
	Sodium (Na)-Total (mg/L)	381	289	177	107

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

LOCATION (Please Circle)

L1038452

Suite 2 (1) **British Columbia**
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 29/11 Date Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	Na2SO4-1500 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
2	Na2SO4-1132 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
3	Na2SO4-817 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
4	Na2SO4-607 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.:065 D0DM P2 WO #: 11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *D. magna*

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) Edmund Canaria (Date) July 29/11
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) (Time) 12:25
(Printed Name) RAW D (Date) Jul 29/11
(Company) ALS GLOBAL 8°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Daphnia magna Summary Sheet

Client: Golder
Work Order No.: 11300

Start Date/Time: Sept 14, 2011
Test Species: *Daphnia magna*
Set up by: AWD

Test Validity Criteria:
≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:
T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Sample Information:

Sample ID: $CaSO_4$ TDS
Sample Date: Prepared in-house
Date Received: NA
Sample Volume: -

Test Organism Information:

Broodstock No.: 091311 ABS, CO
Age of young (Day 0): < 24 hours
Avg No. young per brood in previous 7 d: -
Mortality (%) in previous 7 d: -
Days to first brood: -

NaCl Reference Toxicant Results:

Reference Toxicant ID: DM74
Stock Solution ID: $CaSO_4$
Date Initiated: September 14, 2011
48-h LC50 (95% CL): 4.2 (3.7 - 4.8) g/LNaCL

Reference Toxicant Mean and Historical Range: 4.0, 3.6 - 4.4 g/L NaCL
Reference Toxicant CV (%): 6

Test Results:

mg/L TDS	Survival	Reproduction
EC25 (95% CL)	> 1531	
EC50 (95% CL)	> 1531	
IC25 (95% CL)		> 1531
IC50 (95% CL)		> 1531

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Co Soil TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Dissolved Oxygen (mg/L) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	9.0	8.9	8.7	9.0	8.6	8.4	8.9	9.1	8.6	8.8	9.1	8.5	8.3	8.7	8.8
450 ~~132~~	9.0	9.0	8.8	9.0	8.7	8.5	8.9	9.1	8.6	8.8	9.1	8.5	8.4	9.1	8.8
617 ~~198~~	9.1	9.0	8.8	9.0	8.7	8.6	8.9	9.1	8.6	8.9	9.2	8.6	8.6	8.9	8.9
917 ~~296~~	9.1	9.0	8.8	9.1	8.6	8.7	8.9	9.1	8.6	8.9	9.2	8.6	8.7	8.9	8.9
1132 ~~444~~	9.1	8.9	8.9	9.1	8.6	8.7	8.9	9.1	8.7	8.9	9.2	8.7	8.7	9.0	8.8
1583 ~~687~~	9.1	8.9	8.8	9.1	8.6	8.7	8.9	9.1	8.6	8.8	9.2	8.6	8.8	9.1	8.9
~~1000~~															
~~1500~~															
Technician Initials							KLB		KLB				KLB		

Concentration mg/L TDS	Dissolved Oxygen (mg/L) Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	8.5	8.0	8.3	7.9	7.8	8.5	8.1	7.5	8.8	8.0	7.6	7.9	8.2	8.0	7.1
450 ~~132~~	8.6	8.0	9.1	8.1	7.6	9.1	8.3	8.0	8.9	8.0	7.8	8.1	8.4	8.0	7.1
617 ~~198~~	8.6	8.0	9.1	8.3	8.0	9.1	8.4	7.5	9.0	7.5	7.5	8.5	8.5	7.9	7.3
917 ~~296~~	8.6	8.1	9.1	8.3	8.1	9.1	8.6	8.1	9.0	7.6	7.5	8.6	8.6	7.8	7.4
1132 ~~444~~	8.7	8.2	9.2	8.3	7.9	9.1	8.4	8.0	9.0	7.5	7.5	8.5	8.6	7.9	7.4
1583 ~~687~~	8.7	8.6	9.1	8.3	7.9	9.1	8.4	7.9	9.1	7.5	7.5	8.6	8.6	8.0	7.5
~~1000~~															
~~1500~~															
Technician Initials		KLB		KLB	GHP		GHP	KLB		KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JGL

Date Reviewed: Oct-31/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Cgsoy TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

pH

Day

Concentration mg/L TDS	0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	~~8.1~~	8.1	7.9	7.9	7.9	8.3	8.0	7.9	7.8	7.9	7.6	7.5	7.7	7.9	7.5
~~132~~															
450 ~~198~~	8.1	8.0	7.8	7.6	7.9	8.2	8.0 KLB 7.7	7.3	7.8	7.6	7.5	7.4	7.5	7.6	7.6
607 ~~296~~	7.6	8.0	7.8	7.5	7.8	8.0	7.9	7.3	7.6	7.6	7.4	7.3	7.4	7.3	7.6
817 ~~444~~	7.4	7.9	7.8	7.4	7.7	8.0	7.7	7.2	7.5	7.5	7.4	7.4	7.4	7.3	7.5
1132 ~~667~~	7.4	8.0	7.7	7.3	7.6	8.0	7.8	7.3	7.5	7.4	7.3	7.3	7.4	7.3	7.5
1500 ~~1000~~	7.3	7.9	7.6	7.3	7.7	8.0	7.7	7.3	7.5	7.4	7.3	7.3	7.6	7.3	7.5
~~1500~~															
Technician Initials	AM	AM	AM		AM	AM	KLB		KLB	AM		AM	KLB		AM

pH

Day

Concentration mg/L TDS	11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	~~7.9~~ 7.8	7.8	8.0	8.1	7.9	8.1	7.8	7.9	7.8	7.9	7.8	7.7	7.9	7.8	7.7
450 ~~132~~	7.7	7.5	7.5	7.7	7.5	7.5	7.5	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5
607 ~~198~~	7.7	7.5	7.4	7.6	7.4	7.4	7.4	7.5	7.3	7.4	7.4	7.6	7.5	7.6	7.5
817 ~~296~~	7.7	7.5	7.3	7.6	7.5	7.4	7.5	7.5	7.3	7.4	7.4	7.5	7.5	7.5	7.5
1132 ~~444~~	7.6	7.4	7.3	7.6	7.5	7.4	7.5	7.5	7.3	7.3	7.3	7.5	7.5	7.5	7.4
1500 ~~667~~	7.6	7.6	7.4	7.6	7.5	7.3	7.5	7.5	7.3	7.3	7.3	7.5	7.5	7.5	7.3
~~1000~~															
~~1500~~															
Technician Initials	AM	KLB		KLB	GHP		GHP	KLB		KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JGH

Date Reviewed: Oct 31/11

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 41300
Sample ID: CaSO4 TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Conductivity (µS) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	343		422	348			638	349		389	345	350	360	350	
450 ~~182~~	545		542	550			750	836		832	825	817 KLB	835	817	
607 ~~198~~	1036		1072	1040			1068	1029		1022	1035	1154	1025	~~1154~~ KLB 1014	
817 ~~266~~	1272		1324	1275			1273	1266		1282	1251		1268	~~1560~~ KLB 1252	
1132 ~~444~~	1615		1756	1613			~~1950~~ KLB 1605			1613	1600		1587	1587	
1500 ~~667~~	1956		1998	1975			1950	1950		1971	1950		1986	1927	
~~1000~~															
~~1500~~															
Technician Initials	AM		M				KLB			M		~~KLB~~ KLB	KLB		

Concentration mg/L TDS	Conductivity (µS) Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control		362	360		357	359		362	339			504	344		361
450 ~~132~~ KLB		836	835		825	829		822	840			916	~~854~~ KLB		849
607 ~~198~~ KLB		1028	1025		1000	1022		1000	1026			1116	1031		1092
817 ~~266~~ KLB		1275	1261		1242	1259		1251	1259			1274	1260		1281
1139 ~~444~~ KLB		1592	1604		1561	1597		1570	1602			1586	1596		1661
1500 ~~667~~ KLB		1959	1948		1905	1945		1906	1944			1922	1945		1901
~~1000~~ KLB															
~~1500~~ KLB															
Technician Initials	M	KLB			GHP			KLB				GHP			KLB

Comments:

Reviewed by: JGK

Date Reviewed: Oct. 31/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: $CaSO_4$
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: Control											Concentration: 450										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
2	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	X	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
8	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
9	8	|	6	0	0	6	6	0	0	0	~	0	0	0	0	0	4	0	0	0	0	~
10	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
11	0	|	0	0	10	0	0	10	11	7	KLB	12	0	0	0	0	0	0	0	0	0	KLB
12	20	|	0	0	0	15	16	0	0	0	GHP	0	0	5	0	0	14	8	10	14	8	GHP
13	0	|	0	12	0	0	0	0	0	12	KLB	0	0	0	0	0	0	0	0	0	0	KLB
14	0	|	14	0	25	0	0	20	16	0	GHP	23	0	0	0	9	0	13	7	0	0	GHP
15	28	|	0	0	0	0	25	0	0	0	GHP	0	7	21	8	0	16	0	0	18	12	GHP
16	0	|	0	22	0	22	0	0	0	20	KLB	13	0	0	0	0	0	0	0	0	0	KLB
17	0	|	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
18	32	|	14	0	8	0	23	11	13	0	KLB	0	16	31	19	24	0	18	8	24	32	KLB
19	0	|	0	31	0	23	0	0	0	19	GHP	27	0	0	0	0	28	0	0	0	0	GHP
20	0	|	36	0	24	0	0	24	35	0	KLB	0	0	0	0	28	0	28	0	0	0	KLB
21	5	|	0	0	0	0	22	0	0	0	KLB	0	24	27	23	0	0	0	33	28	29	KLB
Total	83	0[x]	64	65	67	66	92	65	75	58	KLB	75	47	74	50	61	62	~~77~~ KLB 67	58	84	81	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: $CaSO_4$ TDS solution
Comments:

Reviewed by: JBL

Date reviewed: Oct. 31/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: $CaSO_4$
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 607											Concentration: 817										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	X	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	|	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	|	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	|	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	7	0	0	7	0	|	0	0	X	X	KLB	6	0	0	0	3	0	0	0	0	0	KLB
10	0	0	0	0	0	|	0	0	|	|	~	0	0	0	0	0	0	0	0	0	0	~
11	0	0	0	0	0	|	0	0	|	|	~	0	0	0	0	0	0	0	0	0	0	~
12	19	0	12	0	5	|	5	6	|	|	GHP	16	0	0	0	17	0	0	0	8	0	GHP
13	0	0	0	16	14	|	0	0	|	|	KLB	0	0	0	11	0	7	12	0	0	0	KLB
14	0	13	11	0	0	|	11	8	|	|	GHP	0	10	12	0	0	0	0	10	0	14	GHP
15	0	0	0	0	0	|	0	0	|	|	GHP	11	0	0	0	24	0	0	0	11	0	GHP
16	22	0	0	17	15	|	0	0	|	|	KLB	0	0	0	9	0	16	19	0	0	0	KLB
17	0	0	0	0	0	|	0	0	|	|	KLB	0	0	0	0	0	0	0	0	0	0	KLB
18	0	26	23	0	0	|	19	0	|	|	KLB	0	23	31	0	0	0	0	15	19	20	KLB
19	26	0	0	22	23	|	0	11	|	|	GHP	20	0	0	31	29	34	32	0	0	0	GHP
20	0	0	0	0	0	|	0	0	|	|	KLB	0	35	0	0	0	0	0	23	0	25	KLB
21	0	26	32	0	0	|	27	0	|	|	KLB	0	0	21	0	0	0	0	0	22	0	KLB
Total	74	65	78	62	57	0^X	62	25	0^X	0^X	KLB	53	68	64	51	73	57	63	48	60	59	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: $CaSO_4$ TDS solution
Comments:

Reviewed by: JGL

Date reviewed: Oct. 31/11

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: $CaSO_4$
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 1132											Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	0	0	0	0	x	0	0	0	0	KLB	0	0	0	0	0	3	0	0	0	0	KLB
10	0	0	0	0	0	|	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
11	0	0	0	0	0	|	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
12	6	0	5	7	12	|	0	0	11	0	GHP	x	6	6	5	6	16	0	0	6	0	GHP
13	14	0	0	13	0	|	0	0	0	0	KLB	|	0	13	0	0	0	11	0	0	0	KLB
14	0	4	14	0	0	|	8	12	0	11	GHP	|	19	0	9	9	0	0	13	21	0	GHP
15	0	0	0	0	20	|	0	0	21	0	GHP	|	0	0	0	0	28	0	0	0	0	GHP
16	17	0	14	14	0	|	0	0	0	0	KLB	|	20	24	0	0	0	22	0	0	0	KLB
17	0	0	0	0	0	|	0	0	0	0	KLB	|	0	0	0	0	0	0	0	0	0	KLB
18	0	9	0	0	27	|	17	25	29	20	KLB	|	0	0	16	19	0	0	22	26	0	KLB
19	25	0	21	26	0	|	0	0	0	0	GHP	|	34	24	0	8	34	33	0	0	0	GHP
20	0	0	0	0	0	|	0	0	0	24	KLB	|	0	0	0	8	0	0	0	0	0	KLB
21	0	13	0	0	12	|	15	16	12	0	KLB	|	0	0	23	0	0	0	21	25	0	KLB
Total	62	26	54	60	71	0*	40	53	73	55	KLB	0*	79	61	53	36	81	66	56	78	0	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: $CaSO_4$ TDS solution
Comments:

Reviewed by: JGh

Date reviewed: Oct-31/11

CETIS Analytical Report

Daphnid, 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	15-2187-2215	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Oct-11 12:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	08-0977-2183	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	<24h
Sample ID:	00-2088-3771	**Code:**	13EA93B	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	CaSO4 TDS		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	685940762	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	500	475	1531
EC10	573.4	517.4	N/A
EC15	>1531	N/A	N/A
EC20	>1531	N/A	N/A
EC25	>1531	N/A	N/A
EC40	>1531	N/A	N/A
EC50	>1531	N/A	N/A

7d Survival Rate Summary — **Calculated Variate(A/B)**

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
436	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
614		10	0.7	0	1	0.1528	0.483	69.01%	30.0%	7	10
828		10	1	1	1	0	0	0.0%	0.0%	10	10
1162		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
1531		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10

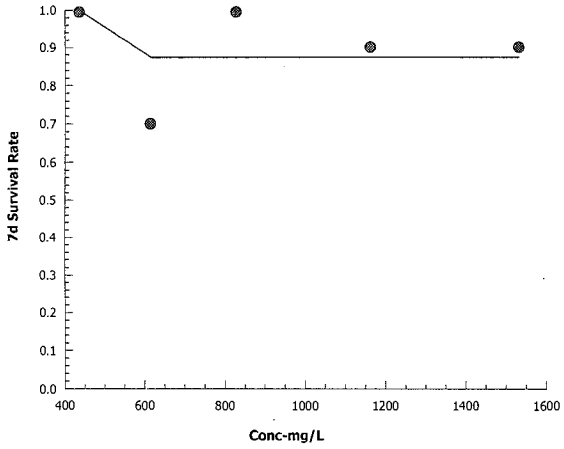
7d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
436	Negative Control	1	1	1	1	1	1	1	1	1	1
614		1	1	1	1	1	0	1	1	0	0
828		1	1	1	1	1	1	1	1	1	1
1162		1	1	1	1	1	0	1	1	1	1
1531		0	1	1	1	1	1	1	1	1	1

Daphnid 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	15-2187-2215	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	13 Oct-11 12:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Daphnid 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	06-9327-3578	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:12	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	08-0977-2183	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	<24h
Sample ID:	00-2088-3771	**Code:**	13EA93B	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	CaSO4 TDS		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
11	-218.7	443.9	449.7	0.0043	Yes	1.787	2.776	0.1606	Non-Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	12.46	N/A	1296
IC5	139.6	N/A	1627
IC10	406	N/A	1987
IC15	772	74.29	2018
IC20	1235	195.2	3067
IC25	1800	N/A	6918
IC40	4217	N/A	N/A
IC50	6631	N/A	N/A
IC60	10030	N/A	N/A
IC75	18530	N/A	N/A
IC80	23120	N/A	N/A
IC85	29500	N/A	N/A
IC90	39320	N/A	N/A
IC95	58080	N/A	N/A
IC99	109900	9692	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	63.93	7.519	48.87	78.98	8.502	<0.0001	Significant Parameter
C	0.6745	0.9733	-1.275	2.623	0.693	0.4911	Non-Significant Parameter
D	6631	16350	-26100	39360	0.4056	0.6865	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	1280.36	1280.36	1	2.254	0.1388	Non-Significant
Lack of Fit	2923.523	974.5077	3	1.787	0.1606	Non-Significant
Pure Error	29452.3	545.413	54			
Residual	32375.82	567.9969	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variances	Mod Levene Equality of Variance	1.801	2.386	0.1282	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.8398	0.9605	<0.0001	Non-normal Distribution
	Anderson-Darling A2 Normality	3.742	2.492	<0.0001	Non-normal Distribution

Daphnid 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID: 06-9327-3578 **Endpoint:** Reproduction **CETIS Version:** CETISv1.8.0
Analyzed: 22 Nov-11 17:12 **Analysis:** Nonlinear Regression **Official Results:** Yes

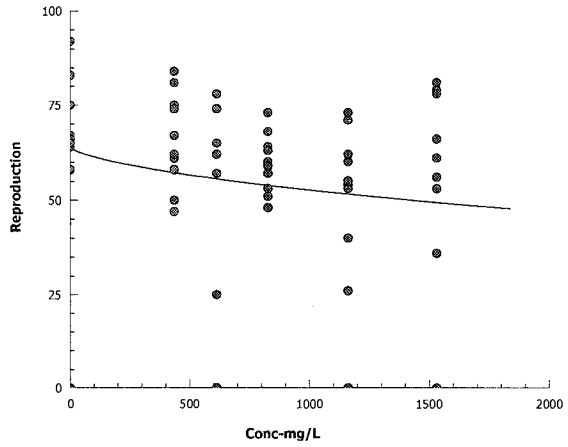
Reproduction Summary — **Calculated Variate**

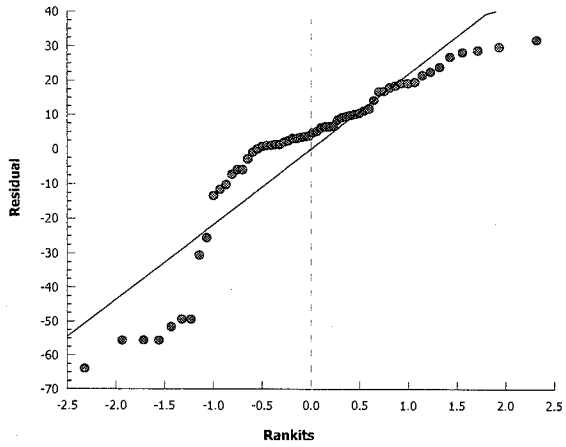
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	63.5	0	92	7.753	24.52	38.61%	0.0%
436		10	65.9	47	84	3.968	12.55	19.04%	-3.78%
614		10	42.3	0	78	10.25	32.41	76.62%	33.39%
828		10	59.6	48	73	2.45	7.749	13.0%	6.14%
1162		10	49.4	0	73	7.021	22.2	44.94%	22.2%
1531		10	51	0	81	9.542	30.17	59.16%	19.69%

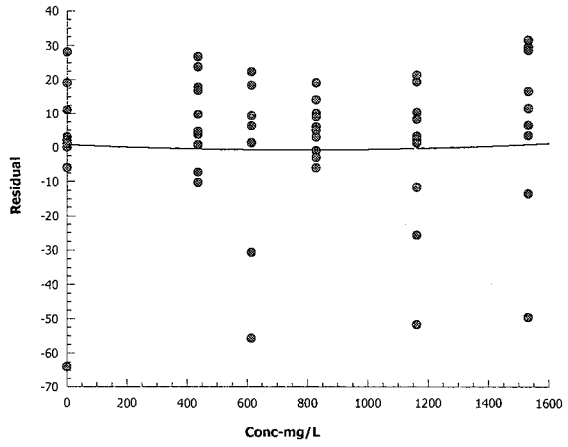
Reproduction Detail

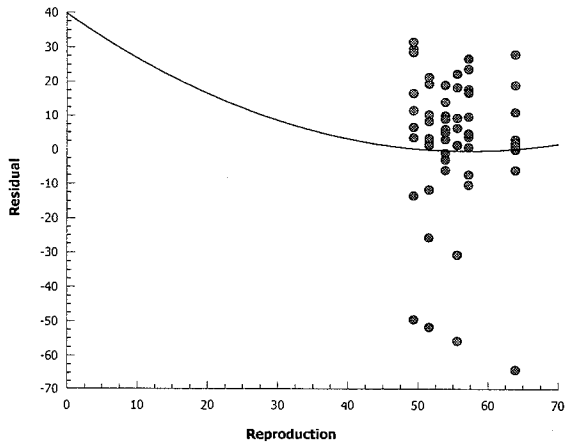
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	83	0	64	65	67	66	92	65	75	58
436		75	47	74	50	61	62	67	58	84	81
614		74	65	78	62	57	0	62	25	0	0
828		53	68	64	51	73	57	63	48	60	59
1162		62	26	54	60	71	0	40	53	73	55
1531		0	79	61	53	36	81	66	56	78	0

Graphics 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Summary of calculated TDS at test initiation D. magna

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038454
Date Received	29-Jul-11 12:35
Date	05-Aug-11

RESULTS OF ANALYSIS

Sample ID	CASO4-1500 DM	CASO4-1132 DM	CASO4-817 DM	CASO4-607 DM	450
Date Sampled	29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11	
Time Sampled	00:00	00:00	00:00	00:00	
ALS Sample ID	L1038454-1	L1038454-2	L1038454-3	L1038454-4	
Matrix	Water	Water	Water	Water	
Physical Tests					
Total Dissolved Solids	1800	1450	729	931	
Anions and Nutrients					
Alkalinity, Total (as CaCO3)	31.3	28.7	26.4	25.0	
Chloride (Cl)	223	221	221	221	
Sulfate (SO4)	811	545	310	157	
Alk 1.22 x	38.186	35.014	32.208	30.5	
Total Metals					
Calcium (Ca)-Total	395	296	200	140	
Magnesium (Mg)-Total	10.8	10.9	10.8	11.2	
Potassium (K)-Total	4.3	4.3	4.2	4.4	
Sodium (Na)-Total	49.0	49.5	49.3	50.1	
Tototal TDS	1531 ✓	1162 ✓	828 ✓	614 ✓	436

YGU
Oct. 31/11

659 3/35 450

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 05-AUG-11 12:36 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038454
Project P.O. #: 065 D0DM P2 WO#11300
Job Reference:
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1038454-1 WATER 29-JUL-11 CASO4-1500 DM	L1038454-2 WATER 29-JUL-11 CASO4-1132 DM	L1038454-3 WATER 29-JUL-11 CASO4-817 DM	L1038454-4 WATER 29-JUL-11 CASO4-607 DM
Sample ID		L1038454-1	L1038454-2	L1038454-3	L1038454-4
Description		WATER	WATER	WATER	WATER
Sampled Date		29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11
Sampled Time					
Client ID		CASO4-1500 DM	CASO4-1132 DM	CASO4-817 DM	CASO4-607 DM
WATER					
Physical Tests	Total Dissolved Solids (mg/L)	1800	1450	729	931
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	31.3	28.7	26.4	25.0
	Chloride (Cl) (mg/L)	223	221	221	221
	Sulfate (SO4) (mg/L)	811	545	310	157
Total Metals	Calcium (Ca)-Total (mg/L)	395	296	200	140
	Magnesium (Mg)-Total (mg/L)	10.8	10.9	10.8	11.2
	Potassium (K)-Total (mg/L)	4.3	4.3	4.2	4.4
	Sodium (Na)-Total (mg/L)	49.0	49.5	49.3	50.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environ

L1038454

TESTING LOCATION (Please Circle)

L1038454-COFC

shington
Pacific Highway East, Suite 2
ma, WA 98424
e 253.922.4296
253.922.5814

(1) **British Columbia**
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 29/11 Page 1 of 1

Sample Collection By:

Report to: (1)		Invoice To: (1)	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	CaSO4-1500 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
2	CaSO4-1132 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
3	CaSO4-817 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
4	CaSO4-607 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	X	X	X	X	X	X	X	X			
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.:065 D0DM P2 WO #: 11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *D. magna*

RELINQUISHED BY (CLIENT)

(Signature) (Time) July 29/11

(Printed Name) Edmund Canaria (Date)

(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (LABORATORY)

(Signature) (Time) Jul 29/11

(Printed Name) Ryan D (Date) 12:35

(Company) ALS

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Daphnia magna Summary Sheet

Client: Golder
Work Order No.: 11300

Start Date/Time: Sept 14, 2011
Test Species: *Daphnia magna*
Set up by: AWD

Sample Information:

Sample ID: $CaCl_2$ TDS
Sample Date: Prepared in-house
Date Received: NA
Sample Volume: -

Test Validity Criteria:
≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:
T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 091311 ABS, CO
Age of young (Day 0): < 24 hours
Avg No. young per brood in previous 7 d: -
Mortality (%) in previous 7 d: -
Days to first brood: -

NaCl Reference Toxicant Results:

Reference Toxicant ID: DM74
Stock Solution ID: $CaCl_2$
Date Initiated: September 14, 2011
48-h LC50 (95% CL): 4.2 (3.7 - 4.8) g/LNaCL

Reference Toxicant Mean and Historical Range: 4.0, 3.6 - 4.4 g/L NaCL
Reference Toxicant CV (%): 6

Test Results:

mg/L TDS	Survival	Reproduction
EC25 (95% CL)	> 1523	
EC50 (95% CL)	> 1523	
IC25 (95% CL)		888 (513 - 1240)
IC50 (95% CL)		> 1523

Reviewed by: [signature]

Date reviewed: 22 Feb 2012

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: $CaCl_2$ TDS

Start Date: Sept 17/11
Termination Date: Oct 5 / 11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Temperature (°C) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	KLB 9 Old	KLB 9 New	KLB 10
Control	20.0	19.5	20.0	20.0	19.5	20.6	20.0	19.5	20.0	20.0	20.0	20.0	19.5	18.5	19.5
450 ~~132~~	20.0	19.5	20.0	20.0	19.5	20.6	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.5	19.5
607 ~~198~~	20.0	19.5	20.0	20.0	19.5	20.6	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.5	19.5
817 ~~266~~	20.0	19.5	20.0	20.0	19.5	20.6	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.5	19.5
1132 ~~444~~	20.0	19.5	20.0	20.0	19.5	20.6	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.5	19.5
1500 ~~687~~	20.0	19.5	20.0	20.0	19.5	20.6	20.0	19.5	20.0	20.0	19.5	20.0	19.5	18.5	19.5
~~1000~~															
~~1500~~															
Technician Initials							KLB		KLB				KLB		

Concentration mg/L TDS	Temperature (°C) Day KLB 11	KLB ~~12~~ 12 Old	KLB ~~12~~ 12 New	KLB ~~13~~ 13	KLB ~~14~~ 14 Old	KLB ~~14~~ 14 New	KLB ~~15~~ 15	KLB ~~16~~ 16 Old	KLB ~~16~~ 16 New	KLB ~~17~~ 17	KLB ~~18~~ 18	KLB ~~20~~ 19 Old	KLB ~~20~~ 19 New	KLB ~~21~~ 20	21
Control	20.0	20.5	18.5	20.0	20.0	20.0	19.5	20.5	19.5	21.0	20.5	20.0	21.0	20.0	20.5
450 ~~132~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.5	19.5	21.0	20.5	20.0	21.0	20.0	20.5
607 ~~198~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.5	19.0	20.5	20.5	20.0	20.0	20.0	20.5
817 ~~266~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	20.5	20.5	20.0	20.0	20.0	20.5
1132 ~~444~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	20.5	20.5	20.0	20.0	20.0	20.5
1500 ~~687~~	20.0	20.0	18.5	20.0	20.0	20.0	19.5	20.0	19.0	20.5	20.5	20.0	20.0	20.0	20.5
~~1000~~															
~~1500~~															
Technician Initials		KLB		KLB	GHP		GHP	KLB		KLB	KLB	GHP		KLB	KLB

Comments:

Reviewed by: JBH

Date Reviewed: Jan. 13/12

21-Day Daphnia magna Toxicity Test Data Sheet

Client: bdder
W.O #: 11300
Sample ID: CaCl2 TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

pH

Concentration mg/L TDS	Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	~~8~~ 8.1	8.1	7.9	7.9	7.9	8.3	8.0	7.9	7.8	7.9	7.6	7.5	7.7	7.9	7.9
~~432~~															
450 ~~198~~	8.1	8.0	7.8	7.6	7.9	8.2	7.7	7.3	7.8	7.6	7.5	7.4	7.5	7.6	7.6
607 ~~295~~	7.6	8.0	7.8	7.3	7.8	8.0	7.7	7.2	7.7	7.5	7.3	7.4	7.6	7.4	7.6
817 ~~444~~	7.5	7.9	7.7	7.4	7.8	7.9	7.6	7.2	7.7	7.5	7.2	7.3	7.5	7.4	7.5
1132 ~~667~~	7.5	7.8	7.7	7.2	7.7	7.9	7.6	7.2	7.6	7.5	7.2	7.3	7.4	7.3	7.5
1500 ~~1000~~	7.4	7.8	7.6	7.2	7.8	7.8	7.6	7.2	7.6	7.5	7.2	7.3	7.4	7.3	7.5
~~1500~~															
Technician Initials	A~	~	~		~	~	KCB		KCB	~		~	KCB		~

pH

Concentration mg/L TDS	Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	~~7.7~~ 7.9	7.8	8.0	8.1	7.9	8.1	7.8	7.9	7.8	7.9	7.8	7.7	7.9	7.8	7.7
450 ~~132~~	7.7	7.5	7.5	7.7	7.5	7.5	7.5	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5
607 ~~198~~	7.6	7.5	7.4	7.5	7.5	7.4	7.5	7.4	7.3	7.4	7.4	7.5	7.5	7.5	7.4
817 ~~295~~	7.6	7.4	7.4	7.5	7.5	7.4	7.4	7.4	7.3	7.4	7.4	7.5	7.4	7.5	7.4
1132 ~~444~~	7.5	7.4	7.3	7.4	7.5	7.4	7.4	7.4	7.2	7.4	7.4	7.4	7.4	7.4	7.4
1500 ~~667~~	7.6	7.4	7.3	7.4	7.4	7.3	7.3	7.3	7.2	7.3	7.3	7.3	7.3	7.3	7.3
~~1000~~															
~~1500~~															
Technician Initials	A~	KCB		KCB	GHP		GHP	KCB		KCB	KCB	GHP		KCB	KCB

Comments:

Reviewed by: JGh

Date Reviewed: Jan. 13/12

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: Cyprus TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Dissolved Oxygen (mg/L) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	9.0	8.9	8.7	9.0	8.6	8.4	8.9	9.1	8.6	8.8	9.1	8.5	8.2	8.7	8.8
450 ~~132~~ A	9.0	~~8.9~~ 9.0	8.8	9.0	8.3	8.5	8.9	9.1	8.7	8.8	9.1	8.5	8.4	9.1	8.8
634 ~~198~~ M	9.0	8.9	8.8	9.1	8.6	8.5	8.9	9.1	8.7	8.7	9.2	8.6	8.6	9.1	8.9
817 ~~296~~ M	9.1	8.9	8.9	9.0	8.6	8.6	8.9	9.1	8.6	8.3	9.2	8.6	8.6	9.0	8.8
1132 ~~444~~ M	9.1	8.9	8.8	9.1	8.5	8.7	8.9	9.1	8.8	8.7	9.1	8.5	8.6	9.0	8.8
1530 ~~687~~ M	9.1	8.9	8.8	9.1	8.4	8.7	8.9	9.1	8.8	8.7	9.1	8.6	8.7	9.1	8.8
~~1000~~ M															
~~1500~~ M															
Technician Initials	AM	M	M		M	M	KLB		KCB	M		M	KLB		M

Concentration mg/L TDS	Dissolved Oxygen (mg/L) Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control	8.6	8.0	8.3	7.9	7.8	8.5	8.1	7.5	8.8	8.0	7.6	7.9	8.2	8.0	7.1
450 ~~132~~ M	8.6	8.0	9.1	8.1	7.6	9.1	8.3	8.0	8.9	8.0	7.8	8.1	8.4	8.0	7.1
634 ~~198~~ M	8.4	8.1	9.2	8.3	8.5	9.1	8.1	7.8	8.9	7.8	7.7	8.2	8.5	8.1	7.0
817 ~~296~~ M	8.7	8.4	9.1	8.3	8.4	9.1	8.4	8.3	8.9	7.7	7.7	8.5	8.5	8.1	7.0
1132 ~~444~~ M	8.7	8.2	9.2	8.4	8.4	9.1	8.3	7.8	9.0	7.7	7.6	8.5	8.5	8.1	7.0
1530 ~~687~~ M	8.9	8.4	9.1	8.4	8.4	9.1	8.4	7.9	8.9	7.7	7.6	8.6	8.6	8.1	7.0
~~1000~~ M															
~~1500~~ M															
Technician Initials	M	KLB		KLB	GHP		GHP	KLB		KCB	KCB	GHP		KCB	KCB

Comments:

Reviewed by: JGL

Date Reviewed: Jan. 13/12

21-Day Daphnia magna Toxicity Test Data Sheet

Client: Golder
W.O #: 11300
Sample ID: CaCl2 TDS

Start Date: Sept 14/11
Termination Date: Oct 5/11
Test Organism: *Daphnia magna*

Concentration mg/L TDS	Conductivity (µS) Day 0	1	2 Old	2 New	3	4	5 Old	5 New	6	7 Old	7 New	8	9 Old	9 New	10
Control	343		422	348			638	349		389	~~332~~ 340		300	350	
450 ~~182~~	445		502	850			750	836		832	825		835	817	
607 ~~198~~	1166		1232	1187			1240	1172		1157	1163		1079	1154	
817 ~~296~~	1585		1606	1599			1732	1581		1534	1573		1621	1560	
1132 ~~444~~	2190		2222	2220			~~1582~~ 2180	2180		2200	2180		2120	2160	
1500 ~~667~~	2910		2900	2940			2830	2890		2820	2880		2870	2870	
~~1000~~															
~~1500~~															
Technician Initials	AM						KLB						KCB		

Concentration mg/L TDS	Conductivity (µS) Day 11	12 Old	12 New	13	14 Old	14 New	15	16 Old	16 New	17	18	19 Old	19 New	20	21
Control		362	360		357	359		362	339			504	348		361
450 ~~132~~ KLB		836	835		825	829		822	840			916	845		849
607 ~~198~~ KLB		1219	1169		1146	1165		1143	1173			1222	1176		1232
817 ~~296~~ KLB		1607	1585		1559	1578		1558	1587			1573	1589		1575
1132 ~~444~~ KLB		2210	2190		2150	2180		2160	2190			2160	2240		2162
1500 ~~667~~ KLB		2900	2900		2850	2890		2840	2890			2870	2890		2855
~~1000~~ KLB															
~~1500~~ KLB															
Technician Initials	AM	KLB			GHP			KLB				GHP			KLB

Comments:

Reviewed by: JGh

Date Reviewed: Jan. 13/12

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: $CaCl_2$
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: Control											Concentration: 450										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
2	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	X	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
8	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
9	8	|	0	0	0	6	6	0	0	0	~	0	0	0	0	0	4	0	0	0	0	~
10	0	|	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
11	0	|	0	0	10	0	0	10	11	7	KLB	12	0	0	0	0	0	0	0	0	0	KLB
12	20	|	0	0	0	15	16	0	0	0	GHP	0	0	5	0	0	14	8	10	14	8	GHP
13	0	|	0	12	0	0	0	0	0	12	KLB	0	0	0	0	0	0	0	0	0	0	KLB
14	0	|	14	0	25	0	0	20	16	0	GHP	23	0	0	0	9	0	13	7	0	0	GHP
15	28	|	0	0	0	0	25	0	0	0	GHP	0	7	21	8	0	16	0	0	18	12	GHP
16	0	|	0	22	0	22	0	0	0	20	KLB	13	0	0	0	0	0	0	0	0	0	KLB
17	0	|	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
18	22	|	14	0	8	0	23	11	13	0	KLB	0	16	21	19	24	0	18	8	24	32	KLB
19	0	|	0	31	0	23	0	0	0	19	GHP	27	0	0	0	0	28	0	0	0	0	GHP
20	0	|	36	0	24	0	0	24	35	0	KLB	0	0	0	0	28	0	28	0	0	0	KLB
21	5	|	0	0	0	0	22	0	0	0	KLB	0	24	27	23	0	0	0	33	28	29	KLB
Total	83	0[X]	64	65	67	66	92	65	75	58	KLB	75	47	74	50	61	62	~~7~~ KLB 7	58	84	81	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: $CaCl_2$ TDS solution
Comments:

Reviewed by: JGh

Date reviewed: Jan. 13/12

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: $CaCl_2$
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 607											Concentration: 817										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	0	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	0	0	0	0	0	0	0	8	0	KLB	6	X	0	6	0	0	0	0	0	0	KLB
10	0	0	0	0	0	0	0	0	6	0	~	0	|	0	0	0	0	0	0	0	0	~
11	0	0	0	0	0	0	0	0	0	0	~	0	|	0	0	0	0	0	0	0	0	~
12	15	0	0	0	5	13	0	5	7	11	GHP	0	|	0	0	8	13	0	5	4	2	GHP
13	0	0	0	0	0	14	0	0	0	0	KLB	0	|	0	0	0	0	0	0	0	0	KLB
14	8	14	0	11	25	0	6	0	0	0	GHP	6	|	9	12	0	15	0	0	14	0	GHP
15	0	0	0	0	0	0	0	19	19	15	GHP	0	|	0	6	19	4	0	15	0	X	GHP
16	0	0	0	0	0	2	11	0	0	0	KLB	0	|	15	2	0	0	0	0	0	|	KLB
17	0	0	0	0	0	0	0	0	0	0	KLB	0	|	0	0	0	0	0	0	0	|	KLB
18	19	26	23	15	18	0	2	0	0	20	KLB	13	|	0	8	25	22	0	23	22	|	KLB
19	0	0	0	0	0	26	0	0	20	0	GHP	0	|	0	0	0	0	0	0	0	|	GHP
20	34	32	36	3	38	6	25	0	0	0	KLB	8	|	33	27	0	0	0	0	30	|	KLB
21	0	0	0	0	0	0	0	0	0	27	KLB	0	|	0	0	25	30	0	22	0	|	KLB
Total	76	72	59	29	86	61	44	24	54	73	KLB	33	0^x	57	49	77	84	0	65	70	2^x	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: $CaCl_2$ TDS solution
Comments:

Reviewed by: JGh

Date reviewed: Jan. 13/12

21-d Chronic Freshwater Toxicity Test
Daphnia magna Reproduction Data

Client: Golder
Sample ID: $CaCl_2$
Work Order: 11300

Start Date & Time: Sept 14/11
Stop Date & Time: October 5/11
Analysts: KLB, AWD, GHP

mg/L TDS

Days	Concentration: 1132											Concentration: ~~HS~~ KLB 1500										
	A	B	C	D	E	F	G	H	I	J	Init	A	B	C	D	E	F	G	H	I	J	Init
1	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
2	0	0	0	0	0	0	0	0	0	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
3	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
4	0	0	0	0	0	0	0	0	0	0	~	0	0	0	0	0	0	0	0	0	0	~
5	0	0	0	0	0	0	0	0	X	0	GHP	0	0	0	0	0	0	0	0	0	0	GHP
6	0	0	0	0	0	0	0	0	|	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
7	0	0	0	0	0	0	0	0	|	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
8	0	0	0	0	0	0	0	0	|	0	KLB	0	0	0	0	0	0	0	0	0	0	KLB
9	0	0	0	0	0	0	0	0	|	8	KLB	0	0	0	0	X	5	0	0	X	0	KLB
10	0	0	0	0	0	0	0	0	|	0	~	8	0	0	0	|	0	0	0	|	0	~
11	0	0	0	0	0	0	0	0	|	0	~	0	0	0	0	|	0	0	0	|	0	~
12	4	3	0	0	5	0	0	0	|	16	GHP	18	0	0	0	|	0	0	0	|	0	GHP
13	0	8	0	0	17	0	0	0	|	0	KLB	0	0	0	3	|	7	6	0	|	0	KLB
14	0	0	10	0	0	0	0	6	|	0	GHP	0	6	0	0	|	0	0	0	|	0	GHP
15	21	0	0	0	0	6	0	0	|	19	GHP	0	0	17	0	|	0	0	0	|	0	GHP
16	0	0	0	12	10	0	0	0	|	0	KLB	18	0	0	20	|	18	13	0	|	0	KLB
17	0	0	0	0	0	0	0	0	|	0	KLB	0	0	0	0	|	0	0	0	|	0	KLB
18	20	4	19	0	0	14	X	14	|	18	KLB	0	12	23	0	|	0	0	0	|	X	KLB
19	0	0	0	27	34	0	|	0	|	0	GHP	31	0	0	33	|	23	33	3	|	|	GHP
20	0	13	29	0	0	0	|	32	|	0	KLB	0	33	0	0	|	0	0	0	|	|	KLB
21	15	0	0	0	0	27	|	0	|	21	KLB	0	0	20	0	|	0	0	0	|	|	KLB
Total	60	28	58	39	66	47	0[x]	52	0[x]	82	KLB	75	51	60	56	0[x]	53	52	3	0[x]	0[x]	KLB

Notes: X = mortality.

Previous Brood
Avg. young/daphnid: N/A

Previous 7-d
% mortality: N/A

Brood Source: 091311 ABS

 # Days to 1st Brood: N/A

Sample Description: $CaCl_2$ TDS Solution
Comments:

Reviewed by: JGh

Date reviewed: Jan. 13/12

CETIS Analytical Report

Daphnid 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	00-6605-6966	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 14:53	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	08-0977-2183	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	<24h
Sample ID:	12-7600-2600	**Code:**	4C0E4128	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	CaCl2		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.385E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	663.7	634.3	1329
EC10	725.8	662.9	N/A
EC15	793.6	692.7	N/A
EC20	1247	723.8	N/A
EC25	1423	756.4	N/A
EC40	>1523	N/A	N/A
EC50	>1523	N/A	N/A

7d Survival Rate Summary — Calculated Variate(A/B)

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	0.9	0	1	0.1	0.3162	35.14%	0.0%	9	10
436		10	1	1	1	0	0	0.0%	-11.11%	10	10
607		10	1	1	1	0	0	0.0%	-11.11%	10	10
826		10	0.8	0	1	0.1333	0.4216	52.7%	11.11%	8	10
1160		10	0.8	0	1	0.1333	0.4216	52.7%	11.11%	8	10
1523		10	0.7	0	1	0.1528	0.483	69.01%	22.22%	7	10

7d Survival Rate Detail

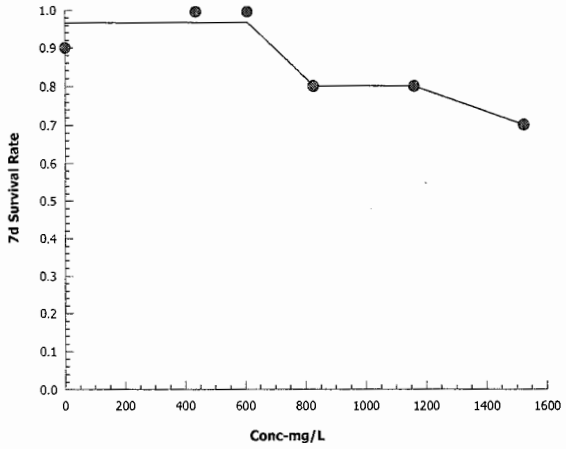
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	0	1	1	1	1	1	1	1	1
436		1	1	1	1	1	1	1	1	1	1
607		1	1	1	1	1	1	1	1	1	1
826		1	0	1	1	1	1	1	1	1	0
1160		1	1	1	1	1	1	0	1	0	1
1523		1	1	1	1	0	1	1	1	0	0

Daphnid 7-d Survival and Reproduction Test

Nautilus Environmental

Analysis ID:	00-6605-6966	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Feb-12 14:53	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Daphnid 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	15-4929-7388	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:18	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes
Batch ID:	08-0977-2183	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	
Start Date:	14 Sep-11	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	05 Oct-11	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	<24h
Sample ID:	12-7600-2600	**Code:**	4C0E4128	**Client:**	Golder
Sample Date:	14 Sep-11	**Material:**	Total Dissolved Solids	**Project:**	TDS Study
Receive Date:	14 Sep-11	**Source:**	Golder		
Sample Age:	N/A	**Station:**	CaCl2		

Non-Linear Regression Options

Model Function	X Transform	Y Transform	Weighting Function	PTBS Function
3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]	None	None	Normal [W=1]	Off [Y*=Y]

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
16	-222	450.5	456.3	0.1318	Yes	0.5031	2.776	0.6818	Non-Significant Lack of Fit

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC1	106.5	N/A	771.6
IC5	298.4	N/A	739.8
IC10	470.4	N/A	855.9
IC15	618.7	93.66	995.9
IC20	756	331.5	1123
IC25	887.7	513	1240
IC40	1276	884.1	1697
IC50	1548	963.5	2276
IC60	1846	981.9	3437
IC75	2399	1058	N/A
IC80	2636	1138	N/A
IC85	2925	1275	N/A
IC90	3306	1510	N/A
IC95	3905	1968	N/A
IC99	5125	3070	N/A

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
A	65.86	7.625	50.59	81.12	8.637	<0.0001	Significant Parameter
C	1.582	0.969	-0.3586	3.522	1.632	0.1081	Non-Significant Parameter
D	1548	331.3	884.4	2211	4.672	<0.0001	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	6947.435	6947.435	1	10.96	0.0016	Significant
Lack of Fit	982.848	327.616	3	0.5031	0.6818	Non-Significant
Pure Error	35164.7	651.1981	54			
Residual	36147.55	634.1675	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variances	Mod Levene Equality of Variance	1.358	2.386	0.2547	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9372	0.9605	0.0041	Non-normal Distribution
	Anderson-Darling A2 Normality	1.487	2.492	0.0002	Non-normal Distribution

Daphnid 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	15-4929-7388	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.0
Analyzed:	22 Nov-11 17:18	**Analysis:**	Nonlinear Regression	**Official Results:**	Yes

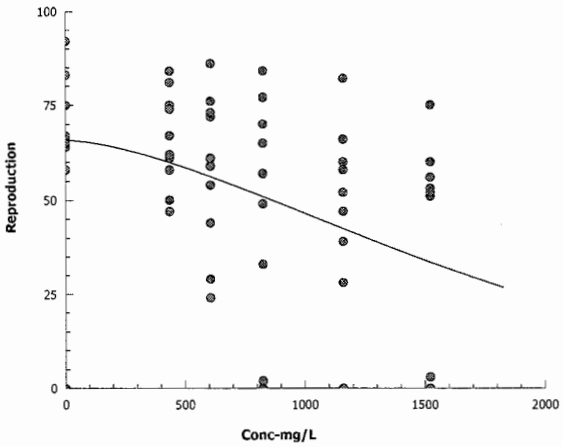
Reproduction Summary — Calculated Variate

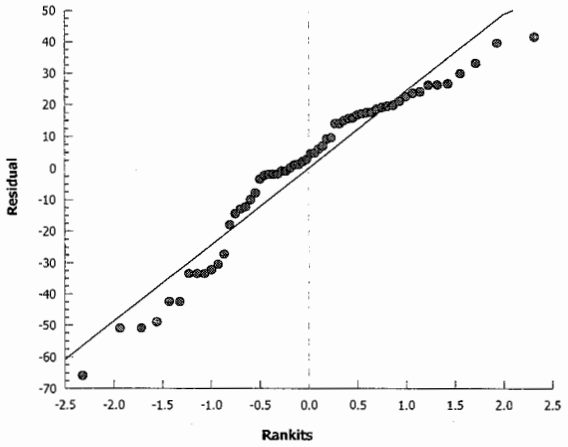
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	63.5	0	92	7.753	24.52	38.61%	0.0%
436		10	65.9	47	84	3.968	12.55	19.04%	-3.78%
607		10	57.8	24	86	6.453	20.41	35.3%	8.98%
826		10	43.7	0	84	10.41	32.92	75.34%	31.18%
1160		10	43.2	0	82	8.563	27.08	62.68%	31.97%
1523		10	35	0	75	9.565	30.25	86.42%	44.88%

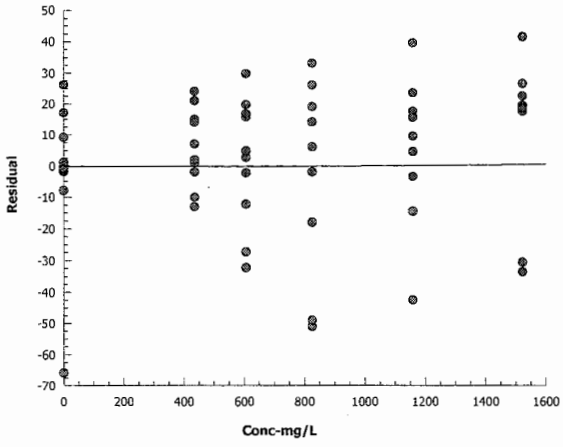
Reproduction Detail

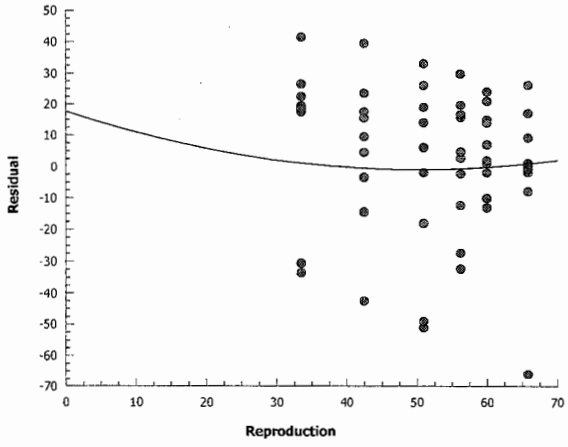
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	83	0	64	65	67	66	92	65	75	58
436		75	47	74	50	61	62	67	58	84	81
607		76	72	59	29	86	61	44	24	54	73
826		33	0	57	49	77	84	0	65	70	2
1160		60	28	58	39	66	47	0	52	0	82
1523		75	51	60	56	0	53	52	3	0	0

Graphics — 3P Log-Gompertz EV [Y=A*exp(log(0.5)(X/D)^C)]









Summary of calculated TDS at test initiation

Project	
Report To	Edmund Canaria, NAUTILUS ENVIRONMENTAL
ALS File No.	L1038453
Date Received	29-Jul-11 12:25
Date	05-Aug-11

RESULTS OF ANALYSIS

Sample ID	CACL2-1500 DM	CACL2-1132 DM	CACL2-817 DM	CACL2-607 DM
Date Sampled	29-JUL-11	29-JUL-11	29-JUL-11	29-JUL-11
Time Sampled	00:00	00:00	00:00	00:00
ALS Sample ID	L1038453-1	L1038453-2	L1038453-3	L1038453-4
Matrix	Water	Water	Water	Water
Physical Tests				
Total Dissolved Solids	3370	2540	1660	1190
Anions and Nutrients				
Alkalinity, Total (as CaCO3)	19.5	20.6	21.4	22.1
Chloride (Cl)	934	695	468	330
Sulfate (SO4)	38	38	37.8	36.5
Alk 1.22x	23.79	25.132	26.108	26.962
Total Metals				
Calcium (Ca)-Total	464	338	229	149
Magnesium (Mg)-Total	10.5	10.6	10.8	10.8
Potassium (K)-Total	4.2	4.2	4.2	4.2
Sodium (Na)-Total	48.1	49.2	50.1	49.3
Total TDS	1523	1160	826	607
Target	1500	1132	817	607
%	1.506	2.485159011	1.102570379	-0.039209226

450

430

Dmagna

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-11
Report Date: 05-AUG-11 12:34 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1038453
Project P.O. #: 065 D0DM P2 WO#11300
Job Reference:
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1038453-1 WATER 29-JUL-11 CACL2-1500 DM	L1038453-2 WATER 29-JUL-11 CACL2-1132 DM	L1038453-3 WATER 29-JUL-11 CACL2-817 DM	L1038453-4 WATER 29-JUL-11 CACL2-607 DM	
Sample ID						
Description						
Sampled Date						
Sampled Time						
Client ID						
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	3370	2540	1660	1190	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	19.5	20.6	21.4	22.1	
	Chloride (Cl) (mg/L)	934	695	468	330	
	Sulfate (SO4) (mg/L)	38	38	37.8	36.5	
Total Metals	Calcium (Ca)-Total (mg/L)	464	338	229	149	
	Magnesium (Mg)-Total (mg/L)	10.5	10.6	10.8	10.8	
	Potassium (K)-Total (mg/L)	4.2	4.2	4.2	4.2	
	Sodium (Na)-Total (mg/L)	48.1	49.2	50.1	49.3	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

TESTING LOCATION (Please Circle)

Nautilus Environmental

L1038453

n
ighway East, Suite 2
8424
2.4296
814

(1) **British Columbia**
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

July 29/11 Date Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact	Edmund Canaria	Contact	Edmund Canaria
Phone	604-420-8773	Phone	604-420-8773
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	TDS			Receipt Temperature (°C)
1	CaCl2-1500 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	x	x	x	x	x	x	x	x			
2	CaCl2-1132 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	x	x	x	x	x	x	x	x			
3	CaCl2-817 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	x	x	x	x	x	x	x	x			
4	CaCl2-607 DM	29-Jul-11			1 L	1	Daphnia magna test stock soln	x	x	x	x	x	x	x	x			
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	PO No.:065 D0DM P2 WO #: 11300	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Phase 2 Total Dissolved Solids Project Study- *D. magna*

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) Edmund Canaria (Date) July 29/11
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) Ryan D (Time) 12:25
(Printed Name) RyanD (Date) Jul 29/11
(Company) ALS Cool 8°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

APPENDIX C

NAUTILUS (2011) LABORATORY REPORT: TOTAL DISSOLVED SOLIDS (TDS) TOXICITY TESTING WITH LARVAL *CHIRONOMUS DILUTUS*

Nautilus Environmental

Total Dissolved Solids (TDS) Toxicity Testing With Larval *Chironomus dilutus*

Final Toxicity Test Report

Report date: April 4, 2011

Submitted to:

GOLDER ASSOCIATES
Burnaby, BC

Burnaby Laboratory
8664 Commerce Court
Burnaby, BC
V5A 4N7

Nautilus Environmental

WO#: 11103

Ms. Cathy McPherson
Golder Associates
500 - 4260 Still Creek Drive
Burnaby, BC
V5C 6C6

April 4, 2011

Dear Ms. McPherson:

Re: Toxicity testing of Total Dissolved Solids (TDS) with *Chironomus dilutus*

Nautilus Environmental is pleased to provide you with the results of the toxicological evaluation of a laboratory-prepared sample, with average measured total dissolved solids of 2100 mg/L, using larval *Chironomus dilutus* (previously known as *Chironomus tentans).* The *C. dilutus* survival and growth test was conducted following modified Environment Canada methods. All test acceptability criteria specified by Environment Canada protocol were met. A summary of the test methods and results are provided in the following report.

Please feel free to contact the undersigned at 604-420-8773 should you have any questions or require any additional information.

Nautilus Environmental

Edmund Canaria, R.P. Bio
Senior Environmental Biologist

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1.0 INTRODUCTION

Nautilus Environmental conducted toxicity tests for Golder Associates on a laboratory-prepared sample with average total dissolved solids (TDS) of 2115 mg/L. Larval chironomids *(Chironomus dilutus)* were exposed for ten days to a series of TDS concentrations and evaluated for adverse effects on survival and growth. The test was initiated on March 4, 2011 and completed on March 14, 2011.

The following report describes the results of this toxicity test; results presented herein only relate to the sample tested. Copies of laboratory data sheets and statistical analyses are provided in Appendix A and results of analytical chemistry are provided in Appendix B.

2.0 METHODS

2.1 Sample Preparation

The TDS sample was prepared using reagent-grade sodium, potassium, calcium and magnesium salts. The salts (NaCl, KCl, $CaCl_2$, $CaSO_4$, $MgSO_4$ and $NaHCO_3$) were dissolved in distilled water with amounts based on the ratio of major cations and anions currently present at the site, and targeting a nominal TDS concentration of 1,500 mg/L. One batch of the TDS solution was prepared for use throughout the toxicity test and was analyzed for ionic composition by ALS Laboratory Group to verify the concentrations of major ions.

2.2 10-d *Chironomus dilutus* Survival and Growth Toxicity Test

The 10-d *C. dilutus* test was conducted according to procedures modified from those described by Environment Canada (1997) for tests using sediment samples. Modifications included exposure of the chironomids to contaminants (in this case, major ions contributing to TDS) introduced into the overlying water with control sediment provided as substrate; renewal of test solutions three times per week with freshly-prepared TDS solutions; and use of four test replicates. Methods and test conditions for the toxicity test are summarized in Table 1. Statistical analyses were performed using CETIS (Tidepool Scientific Software, 2009). All test concentrations were analyzed for TDS at test initiation and termination by ALS Laboratory Group.

Chironomus dilutus larvae were obtained from Aquatic BioSystems. The organisms were acclimated overnight to test conditions prior to use in the toxicity tests. Testing was conducted at 23 ± 1°C, under 16:8 light:dark photoperiod. Substrate for the chironomids was provided using sand collected from an uncontaminated site at Yaquina Bay, OR. This sand was rinsed thoroughly with dechlorinated city water and then with distilled water prior to mixing with small amount of peat moss (approximately 5% wet weight). Each test replicate received 100 mL of this control sand and 175 mL of overlying water. Four replicates of seven nominal TDS concentrations were prepared following a 0.67 times dilution factor (132, 198, 296, 444, 667, 1000 and 1500 mg/L). The dilution water used in preparing the test concentrations was dechlorinated city tapwater, which contains a very low concentration of dissolved ions, and the negative control treatment was moderately hard water prepared by addition of reagent grade salts to dechlorinated tapwater to achieve a hardness between 80 and 100 mg/L.

Ten 3rd instar chironomid larvae were exposed in each replicate for 10 days. Each replicate received 6.0 mg Tetramin daily. The test solutions were renewed three times per week and gentle aeration was provided to each replicate during the exposure period. Water quality parameters (temperature, dissolved oxygen, pH and conductivity) were monitored in each concentration before and after solution renewal.

After 10 days of exposure, the contents of each replicate were gently sieved and the number of live and dead organisms enumerated and recorded. Surviving chironomid larvae from each replicate were dried in a 60°C oven overnight, and weighed. Test endpoints were survival and growth. Statistical calculations of point estimates were based on average measured TDS concentrations. The test acceptance criteria were ≥70% surviving larvae and ≥0.6 mg/worm in the negative control.

A potassium chloride reference toxicant test was initiated concurrently with the test. Test organisms were exposed to 0, 1.25, 2.5, 5, 10 and 20 g/L KCl for 96 h and the results of this test were compared with historical data to determine whether the sensitivity of the organisms was within acceptable limits. For the reference toxicant test to be considered valid, the control survival must be ≥ 90%.

2.3 Quality Assurance/Quality Control (QA/QC)

Nautilus follows a comprehensive QA/QC program to ensure that all data generated are of high quality and are scientifically defensible. To meet these objectives, Nautilus has implemented a number of quality control procedures that include the following:

- Negative controls to ensure that appropriate testing performance criteria are met;
- Positive controls to assess the health and sensitivity of the test organisms;
- Use of appropriate species, life stage and test methods to meet the study objectives;
- Appropriate number of replicates to allow the proper statistical analyses;
- Calibration and proper maintenance of instruments to ensure accurate measurements;
- Proper documentation and recordkeeping to allow traceability of performance;
- Adequate supervision and training of staff to ensure that methods are followed;
- Proper handling and storage of samples to ensure sample integrity;
- Procedures in place to address issues that may arise during testing and ensure the implementation of appropriate corrective actions; and
- Rigorous review of data by a Registered Professional Biologist to ensure they are of good quality and are scientifically defensible prior to release to the client.

Table 1. Summary of test conditions for the 10-d *Chironomus dilutus* survival and growth toxicity test.

Test organism	*Chironomus dilutus*
Test organism source	Aquatic BioSystems, Fort Collins, CO
Test organism age	3rd Instar
Test type	Static-renewal
Test duration	10 days
Test vessel	375-mL glass jars
Test Treatment	100 mL sediment; 175 mL overlying water
Test Concentrations	7, plus a negative control
Test replicates	4 replicates per concentration
No. of organisms	10 per replicate
Control/dilution water	Moderately hard synthetic water/dechlorinated city water
Test solution renewal	3 times per week
Test temperature	23 ± 1°C
Feeding	6.0 mg Tetramin in 1.5 mL suspension per replicate daily
Light intensity	500 to 1000 lux at water surface
Photoperiod	16 hours light/8 hours dark
Aeration	Gentle aeration throughout test
Test protocol	Modified from Environment Canada (1997), EPS 1/RM/32
Test endpoint	Survival and dry weight
Test acceptability criteria for controls	Mean control survival of ≥70%; and ≥0.6 mg/worm dry weight
Reference toxicant	KCl

3.0 RESULTS

3.1 10-d *Chironomus dilutus* Survival and Growth Toxicity Test

Results of the 10-d *C. dilutus* toxicity test are summarized in Table 2. No adverse effects were observed on survival or growth of chironomid larvae in the test. The 10-d EC25 and EC50 values for survival were both ≥2,115 mg/L TDS, and the 10-d IC25 and IC50 for dry weight were also both ≥2,115 mg/L TDS on the basis of measured values.

Measured values of TDS were relatively similar at test initiation and termination, but were somewhat higher than targeted (Table 2). The measured composition of individual ions in the prepared sample was in good agreement with the targeted values of the major ions; these data are presented in Table 3. It is not known why the TDS values exceeded those targeted on the basis of measured concentrations of major ions (i.e., the TDS exceeds the sum of major ions), however, it is possible that formation of hydroxides during the evaporative process used in analysis of TDS may have contributed to the measured TDS. Regardless, the measurements of individual ions demonstrate that the solution was prepared appropriately; the instrumentation associated with measurement of these values is expected to be more accurate than the TDS measurement, which uses a gravimetric process following evaporation.

3.2 Quality Assurance/Quality Control

The test results reported for the 10-d C. *dilutus* met the acceptability criteria for test validity specified in the protocol. The reference toxicant test results are summarized in Table 4. Results of the reference toxicant tests conducted during the testing program were all within the acceptable historical range (mean ± 2SD), indicating that the organisms used in the toxicity tests were of acceptable quality and sensitivity. Water quality parameters measured during the toxicity tests were within acceptable ranges.

Table 2. Toxicity test results and summary of TDS measured values for the 10-d *Chironomus dilutus* survival and growth toxicity test.

Test Concentration Nominal Values (mg/L TDS)	Test Concentration Measured Values (mg/L TDS)			Survival (%) (Mean ± SD)	Dry Weight (mg) (Mean ± SD)
	Day 0	Day 10	Mean		
Control	179	230	205	80.0 ± 8.2	2.34 ± 0.39
132	207	215	211	85.0 ± 17.3	2.30 ± 0.47
198	312	279	296	87.5 ± 9.6	2.17 ± 0.25
296	441	394	418	82.5 ± 5.0	2.36 ± 0.17
444	662	584	623	80.0 ± 14.1	2.28 ± 0.18
667	982	903	942	82.5 ± 12.6	2.24 ± 0.37
1000	1440	1360	1400	82.5 ± 9.6	2.03 ± 0.29
1500	2150	2080	2115	80.0 ± 8.2	2.31 ± 0.38

Test Endpoint	Survival (mg/L measured TDS)	Dry Weight (mg/L measured TDS)
EC25	>2,115	NA
EC50	>2,115	NA
IC25	NA	>2,115
IC50	NA	>2,115

EC = Effect Concentration; SD = Standard Deviation; NA = Not Applicable

Table 3. Target and measured values for major ions in the TDS sample used in the 10-d *Chironomus dilutus* survival and growth toxicity test.

Parameter	Target TDS Values (mg/L)	Measured TDS Values (mg/L)
Cl^-	722.9	720.0
SO_4^{-2}	132.0	126.0
Ca^{+2}	320.9	299.0
Mg^{+2}	18.9	19.1
K^+	17.8	18.5
Na^+	169.8	175.0
Alkalinity (as $CaCO_3$)	113.2	35.3

Table 4. Reference toxicant test results.

Test Species	LC50 (95% CL)	Acceptable Range	CV(%)	Initiation Date
C. dilutus	6.1 (5.0 – 7.4) g/L KCl	4.5 – 9.8 g/L KCl	21	March 4, 2011

CV = Coefficient of Variation; LC = Lethal Concentration; CL = Confidence Limits

4.0 REFERENCES

Environment Canada. 1997. Biological test method: test for survival and growth in sediment using the larvae of freshwater midges *(Chironomus tentans* and *Chrironomus riparius)*. Environmental Protection Series EPS 1/RM/32. December 1997. Environment Canada, Method Development and Application Section, Environmental Technology Centre, Ottawa, ON. 131 pp.

Tidepool Scientific Software. 2009. CETIS comprehensive environmental toxicity information system. Tidepool Scientific Software, McKinleyville, CA. 222 pp.

APPENDIX A – *Chironomus dilutus* Toxicity Test Data

Chironomus dilutus Sediment Test Summary Sheet

Client: Golder
Work Order No.: 11103

Start Date: 04-Mar-11
Set up by: EGS/ECC

Sample Information:

Sample ID: TDS
Sample Date: 04-Mar-11
Date Received: N/A
Sample Volume: N/A

Test Organism Information:

Species: *Chironomus dilutus*
Supplier: Aquatic Biosystems, CO.
Date received: 03-Mar-11
Age or size (Day 0): 3rd Instar

NaCl Reference Toxicant Results:

Reference Toxicant ID: KCl
Stock Solution ID: N/A
Date Initiated: 04-Mar-11

96-h LC50 (95% CL): 6.1 g/L KCl (5.0 – 7.4) g/L KCl

96-h LC50 Reference Toxicant Mean and Range: 6.7 (4.5-9.8) g/L KCl CV (%): 21

Test Results: Mean a

Nominal Values (mg/L TDS)	Measured Values (mg/L TDS)	Survival ± SD (%)	Average Dry Wt. ± SD (mg)
Control	204.5	80.0 ± 8.2	2.34 ± 0.39
132	211.0	85.0 ± 17.3	2.30 ± 0.47
198	295.5	87.5 ± 9.6	2.17 ± 0.25
296	417.5	82.5 ± 5.0	2.36 ± 0.17
444	623.0	80.0 ± 14.1	2.28 ± 0.18
667	942.5	82.5 ± 12.6	2.24 ± 0.37
1000	1400.0	82.5 ± 9.6	2.03 ± ~~0.86~~ 0.29
1500	2115.0	80.0 ± 8.2	2.31 ± 0.38

Reviewed by: JGh

Date reviewed: March 31, 2011

10-d Chironomid Sediment Toxicity Test Data Sheet

Freshwater Sediment 10-d Water Quality

Client: GOLDER
W.O #: TDS Sample 11103

Start Date: March 4/11
Termination Date: March 14/11
Test Organism: *Chironomus dilutus*

Temperature (°C)

Sample ID (mg/L TDS)	Day													
	0	1	2	3		4	5		6	7		8	9	10
				Old	New		Old	New		Old	New			
Control	23.0	24.0	23.5	23.5	23.5	23.5	22.0	23.0	22.5	22.0	22.5	22.0	22.0	22.0
132	24.0	24.0	23.5	23.5	23.0	23.5	22.5	22.5	22.5	22.0	22.0	22.0	22.0	22.0
198	24.0	24.0	23.5	23.5	23.0	23.5	22.5	22.5	22.5	22.0	22.0	22.0	22.0	22.0
296	24.0	24.0	23.5	23.5	23.5	23.5	22.5	22.5	22.5	22.0	22.0	22.0	22.0	22.5
444	24.0	24.0	23.5	23.5	23.5	23.5	22.5	22.5	22.5	22.0	22.0	22.0	22.0	22.0
667	24.0	24.0	23.5	23.5	23.0	23.5	22.5	22.5	22.5	22.0	22.0	22.0	22.0	22.5
1000	24.0	24.0	23.5	23.5	23.0	23.5	22.5	22.5	22.5	22.0	22.0	22.0	22.0	22.5
1500	24.0	24.0	23.5	23.5	23.0	23.5	22.5	22.0	23.0	22.5	22.0	22.0	22.0	22.5
Technician Initials	QW	~	~	QW	QW	QW	QW	QW	QW	KJL	KJL	~	~	QW

Conductivity (µS)

Sample ID (mg/L TDS)	Day													
	0	1	2	3		4	5		6	7		8	9	10
				Old	New		Old	New		Old	New			
Control	245	257	278	289	329	314	323	326	351	348	330	358	359	379
132	239	340	256	263	280	282	293	278	299	314	286	315	326	336
198	349	342	351	360	401	389	398	404	419	424	407	443	445	457
296	491	474	479	484	518	547	548	577	589	601	588	614	619	633
444	715	708	710	720	882	790	799	845	841	860	842	873	879	891
667	1040	1020	1029	1026	1206	1145	1148	1206	1197	1212	1221	1263	1271	1254
1000	1512	1487	1486	1499	1756	1669	1670	1751	1747	1763	1766	1809	1799	1815
1500	2150	2120	2140	2160	2550	2440	2420	2540	2540	2580	2570	2630	2640	2660
Technician Initials	QW	~	~	QW	QW	QW	QW	QW	QW	KJL	KJL	~	~	QW

Comments: TDS Sample initial WQ = T° = 23.0°C, DO = 8.4 mg/L, pH = 7.4, COND = 2520 µS
Control is synthetic moderately hard water.
Dilutions are completed with dechlorinated water as dilution water.

Reviewed by: JGH

Date Reviewed: March 31, 2011

10-d Chironomid Sediment Toxicity Test Data Sheet

Freshwater Sediment 10-d Water Quality

Client: GOLDER
W.O #: TDS sample 11103

Start Date: March 4/11
Termination Date: March 14/11
Test Organism: *Chironomus dilutus*

Dissolved Oxygen (mg/L)

Sample ID (mg/L TDS)	Day													
	0	1	2	3		4	5		6	7		8	9	10
				Old	New		Old	New		Old	New			
Control	7.3	~~7.8~~	8.1	7.6	8.1	8.0	8.1	8.6	7.8	8.1	8.3	8.4	8.2	7.9
132	7.4	7.9	8.0	7.4	8.2	8.1	8.2	8.5	7.8	8.1	8.5	8.3	8.1	7.8
198	7.4	7.9	8.1	7.3	8.1	8.0	8.2	8.5	7.8	8.1	8.4	8.4	8.2	7.8
296	7.4	~~7.9~~	8.0	7.4	8.1	8.0	8.3	8.5	7.8	8.1	8.4	8.3	8.2	7.8
444	7.5	7.8	8.1	7.3	8.1	8.1	7.7	8.6	7.8	8.1	8.4	8.3	8.2	7.9
667	7.5	~~7.8~~	8.0	7.3	8.1	8.1	7.8	8.6	7.8	8.1	8.4	8.4	8.1	7.9
1000	7.4	~~7.8~~	8.0	7.3	8.1	8.0	8.1	8.6	7.9	8.2	8.4	8.2	8.1	7.5
1500	7.5	~~7.8~~	8.0	7.4	8.2	8.1	8.1	8.6	7.8	8.2	8.4	8.2	8.2	7.9
Technician Initials		~	~							KSL	KSL	~	~	

pH

Sample ID (mg/L TDS)	Day													
	0	1	2	3		4	5		6	7		8	9	10
				Old	New		Old	New		Old	New			
Control	7.4	7.5	7.6	7.6	7.9	7.8	7.8	7.9	7.9	8.0	8.0	7.8	8.0	8.0
132	5.0	6.1	6.6	6.8	7.3	7.1	7.3	7.5	7.4	7.5	7.5	7.5	7.6	7.7
198	5.0	5.9	6.5	6.8	7.3	7.1	7.2	7.4	7.4	7.5	7.5	7.4	7.6	7.6
296	4.9	5.8	6.6	6.7	7.3	7.1	7.2	7.4	7.4	7.5	7.5	7.4	7.5	7.6
444	5.0	6.0	6.4	6.6	7.4	7.1	7.2	7.4	7.4	7.5	7.5	7.4	7.6	7.6
667	5.0	6.1	6.5	6.6	7.5	7.1	7.2	7.5	7.4	7.5	7.6	7.5	7.7	7.6
1000	5.2	6.4	6.6	6.6	7.6	7.3	7.3	7.5	7.5	7.6	7.6	7.5	7.7	7.6
1500	6.4	6.8	7.0	7.0	7.6	7.5	7.5	7.6	7.6	7.7	7.7	7.8	7.7	7.8
Technician Initials		~	~							KSL	KSL	~	~	

Comments:

Reviewed by: JGL

Date Reviewed: March 31, 2011

10-d Chironomid Sediment Toxicity Test Data Sheet

Freshwater Sediment 10-d Survival and Weight

Client: Golder
W.O. #: 11103
Test Condition: TDS Sample

Start Date: 04-Mar-11
Termination Date: 14-Mar-11
Test Organism: *Chironomus dilutus*

Sample ID (mg/L TDS)	Pan No.	Rep	No. alive	No. dead	No. missing	Initials	Pan weight (mg)	Pan + organism (mg)	No. weighed	Initials
Control	1	A	① 7 8	0	2	qw	1319.97	1339.92	7	qw
	2	B	8	0	2	↓	1303.53	1319.25	8 qw	↓
	3	C	① 7	0	3		1318.50	1333.16	6	
	4	D	9	0	1	▽	1322.83	1344.77	9	▽
		E						41a		
132	5	A	9	0	1	qw	1318.43	1337.83	9	qw
	6	B	① 9	0	1	↓	1303.07	1323.60	8	↓
	7	C	6	0	4		1313.51	1330.18	6	
	8	D	10	0	0	▽	1320.60	1337.68	10	▽
		E								
198	9	A	8	0	2	qw	1313.65	1333.44	8	qw
	10	B	8	0	2	↓	1308.36	1326.28	8	↓
	11	C	10	0	0		1317.18	1337.69	10	
	12	D	① 9	0	1	▽	1322.64	1337.90	8	▽
		E								
296	13	A	① 9	0	1	qw	1309.88	1327.63	8	qw
	14	B	8	0	2	↓	1315.67	1335.42	8	↓
	15	C	8	0	2		1308.79	1326.51	8	
	16	D	① 8	0	2	▽	1317.05	1334.82	7	▽
		E								

Comments: ① one pupa
Reweigh: Pan 5 = 1337.67 mg Pan 11 = 1337.49 mg

Reviewed by: JGh

Date Reviewed: March 31, 2011

10-d Chironomid Sediment Toxicity Test Data Sheet

Freshwater Sediment 10-d Survival and Weight

Client: Golder

WO #: 11103

Sample ID: TDS Sample

Start Date: March 4th, 2011

Termination Date: March 14, 2011

Test Organism: ~~C. tentans~~ Chironomus dilutus

Sample ID (mg/L TDS)	Pan No.	Rep	No. alive	No. dead	No. missing	Initials	Pan weight (mg)	Pan + organism (mg)	No. weighed	Initials
444	17	A	7	0	3	KJL	1305.26	1319.58	7	QW
	18	B	10	0	0	KJL	1301.12	1323.78	10	
	19	C	7	0	3	KJL	1322.78	1340.03	7	
	20	D	8	0	2	KJL	1318.04	1336.96	8	
		E								
667	21	A	8	0	2	KJL	1316.51	1332.97	8	QW
	22	B	8	0	2		1319.92	1337.30	8	
	23	C	7	0	3		1309.38	1325.98	6	
	24	D	10	0	0		1320.36	1339.84	10	
		E								
1000	25	A	9	0	1	QW	1318.74	1340.02	9	QW
	26	B	8	0	2		1333.31	1346.64	8	
	27	C	9	0	1		1339.51	1357.92	9	
	28	D	7	0	3		1312.17	1326.44	7	
		E								
1500	29	A	9	0	1	QW	1305.73	1324.50	9	QW
	30	B	8	0	2		1322.60	1341.21	8	
	31	C	8	0	2		1341.95	1357.83	8	
	32	D	7	0	3		1336.72	1356.62	7	
		E								

Comments: Done pupa
Reweigh: Pan 23 = 1325.73 mg Pan 26 = 1346.44 mg

Reviewed by: JGL

Date Reviewed: March 31, 2011

Mean TDS Analytical Results

CETIS Analytical Report

Chironomus 10-d Survival and Growth Sediment Test — **Nautilus Environmental**

Analysis ID:	12-5825-6910	**Endpoint:**	10d Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Mar-11 16:01	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	09-3453-2214	**Test Type:**	Growth-Survival (10d)	**Analyst:**	
Start Date:	04 Mar-11	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Dechlorinated Tap Water
Ending Date:	14 Mar-11	**Species:**	Chironomus ~~tentans~~ dilutus	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	
Sample ID:	18-9110-4553	**Code:**	11103MEANS	**Client:**	Golder
Sample Date:	04 Mar-11	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:		**Source:**	Golder		
Sample Age:	N/A	**Station:**	Total Dissolved Solids		

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run	2115	>2115	N/A		15.1%

Equal Variance t Two-Sample Test

Control	vs	Conc-mg/L	Test Stat	Critical	DF	MSD	P-Value	Decision(α:5%)
204.5		211	-0.6941	1.943	6	0.2391	0.7432	Non-Significant Effect
204.5		295.5	-1.173	1.943	6	0.1743	0.8573	Non-Significant Effect
204.5		417.5	-0.456	1.943	6	0.1236	0.6678	Non-Significant Effect
204.5		623	-0.1044	1.943	6	0.2187	0.5399	Non-Significant Effect
204.5		942.5	-0.3901	1.943	6	0.203	0.6450	Non-Significant Effect
204.5		1400	-0.4342	1.943	6	0.1588	0.6603	Non-Significant Effect
204.5		2115	0	1.943	6	0.145	0.5000	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Control Trend	15	2		0.7826	Non-significant Trend in Controls

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.04174913	0.005964162	7	0.2574	0.9645	Non-Significant Effect
Error	0.5561171	0.02317155	24			
Total	0.5978662	0.02913571	31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	4.949	18.48	0.6662	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9717	0.9081	0.5482	Normal Distribution

Chironomus 10-d Survival and Growth Sediment Test — **Nautilus Environmental**

Analysis ID: 12-5825-6910 **Endpoint:** 10d Survival Rate **CETIS Version:** CETISv1.8.0
Analyzed: 23 Mar-11 16:01 **Analysis:** Parametric-Two Sample **Official Results:** Yes

10d Survival Rate Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
204.5	Negative Control	4	0.8	0.7689	0.8311	0.7	0.9	0.04082	0.08165	10.21%	0.0%
211		4	0.85	0.7841	0.9159	0.6	1	0.0866	0.1732	20.38%	-6.25%
295.5		4	0.875	0.8386	0.9114	0.8	1	0.04787	0.09574	10.94%	-9.38%
417.5		4	0.825	0.806	0.844	0.8	0.9	0.025	0.05	6.06%	-3.13%
623		4	0.8	0.7462	0.8538	0.7	1	0.07071	0.1414	17.68%	0.0%
942.5		4	0.825	0.7771	0.8729	0.7	1	0.06292	0.1258	15.25%	-3.13%
1400		4	0.825	0.7886	0.8614	0.7	0.9	0.04787	0.09574	11.61%	-3.13%
2115		4	0.8	0.7689	0.8311	0.7	0.9	0.04082	0.08165	10.21%	0.0%

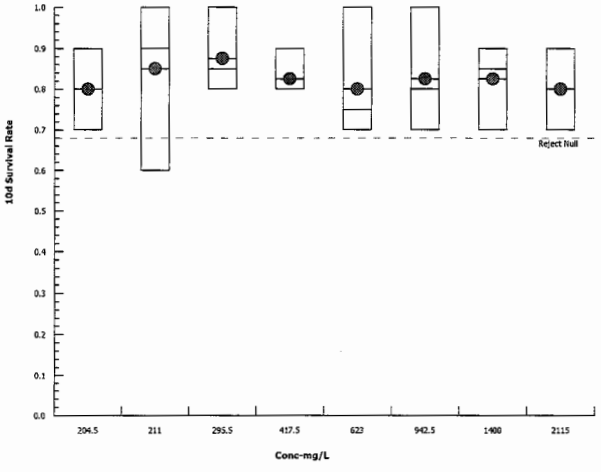
Angular (Corrected) Transformed Summary

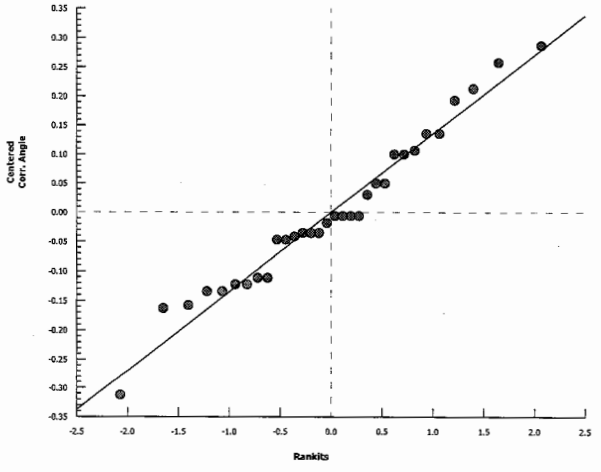
Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
204.5	Negative Contr	4	1.114	1.073	1.154	0.9912	1.249	0.05277	0.1055	9.48%	0.0%
211		4	1.199	1.114	1.284	0.8861	1.412	0.1112	0.2223	18.54%	-7.67%
295.5		4	1.219	1.164	1.274	1.107	1.412	0.07256	0.1451	11.91%	-9.45%
417.5		4	1.143	1.116	1.17	1.107	1.249	0.03547	0.07095	6.21%	-2.6%
623		4	1.125	1.05	1.201	0.9912	1.412	0.09938	0.1988	17.66%	-1.06%
942.5		4	1.154	1.086	1.223	0.9912	1.412	0.09013	0.1803	15.62%	-3.66%
1400		4	1.149	1.102	1.197	0.9912	1.249	0.06237	0.1247	10.86%	-3.19%
2115		4	1.114	1.073	1.154	0.9912	1.249	0.05277	0.1055	9.48%	0.0%

10d Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
204.5	Negative Control	0.8	0.8	0.7	0.9
211		0.9	0.9	0.6	1
295.5		0.8	0.8	1	0.9
417.5		0.9	0.8	0.8	0.8
623		0.7	1	0.7	0.8
942.5		0.8	0.8	0.7	1
1400		0.9	0.8	0.9	0.7
2115		0.9	0.8	0.8	0.7

Graphics





Mean TDS Analytical Results

CETIS Analytical Report

Chironomus 10-d Survival and Growth Sediment Test — **Nautilus Environmental**

Analysis ID:	08-7657-6084	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Mar-11 16:02	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	09-3453-2214	**Test Type:**	Growth-Survival (10d)	**Analyst:**	
Start Date:	04 Mar-11	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Dechlorinated Tap Water
Ending Date:	14 Mar-11	**Species:**	Chironomus tentans	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	
Sample ID:	18-9110-4553	**Code:**	11103MEANS	**Client:**	Golder
Sample Date:	04 Mar-11	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:		**Source:**	Golder		
Sample Age:	N/A	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.146E+09	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Control Trend	Mann-Kendall Trend	-2		0.7391	Non-significant Trend in Controls

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	1015	N/A	N/A
IC10	>2115	N/A	N/A
IC15	>2115	N/A	N/A
IC20	>2115	N/A	N/A
IC25	>2115	N/A	N/A
IC40	>2115	N/A	N/A
IC50	>2115	N/A	N/A

Mean Dry Weight-mg Summary — **Calculated Variate**

Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
204.5	Negative Control	4	2.341	1.965	2.85	0.1973	0.3945	16.85%	0.0%
211		4	2.302	1.708	2.778	0.2365	0.4729	20.54%	1.65%
295.5		4	2.168	1.908	2.474	0.1225	0.2451	11.3%	7.38%
417.5		4	2.36	2.215	2.539	0.08401	0.168	7.12%	-0.84%
623		4	2.285	2.046	2.464	0.08952	0.179	7.84%	2.37%
942.5		4	2.236	1.948	2.767	0.1827	0.3654	16.34%	4.47%
1400		4	2.029	1.666	2.364	0.1427	0.2855	14.07%	13.33%
2115		4	2.31	1.985	2.843	0.1915	0.3831	16.58%	1.32%

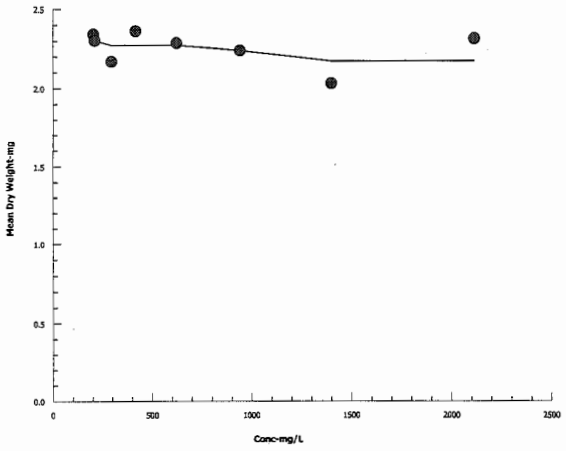
Mean Dry Weight-mg Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
204.5	Negative Control	2.85	1.965	2.443	2.104
211		2.156	2.566	2.778	1.708
295.5		2.474	2.24	2.051	1.908
417.5		2.219	2.469	2.215	2.539
623		2.046	2.266	2.464	2.365
942.5		2.057	2.173	2.767	1.948
1400		2.364	1.666	2.046	2.039
2115		2.086	2.326	1.985	2.843

Chironomus 10-d Survival and Growth Sediment Test — **Nautilus Environmental**

Analysis ID:	08-7657-6084	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.0
Analyzed:	23 Mar-11 16:02	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Client: GOLDER

W.O.#: 11103

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Sample ID	Sample Date	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity ($mg/LCaCO_3$)		Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness ($mg/L\ CaCO_3$)	Technician
MHW Control water	Mar 4/11	50	3.1	3.3	58		50	4.7	94	KJL
Dechlor Dilution water	Mar 4/11	50	0.4	0.5	6		50	0.6	12	KJL

Notes:

Reviewed by: JCL

Date Reviewed: March 31, 2011

APPENDIX B – Analytical Chemistry Data

Day 0 – TDS

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7
Phone: 604-420-8773

Date Received: 04-MAR-11
Report Date: 10-MAR-11 17:37 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L983610
Project P.O. #: 065
Job Reference:
Legal Site Desc:
C of C Numbers: 1

Can Dang
Senior Account Manager

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ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	Sample ID	L983610-1	L983610-2	L983610-3	L983610-4	L983610-5
		Description					
		Sampled Date	04-MAR-11	04-MAR-11	04-MAR-11	04-MAR-11	04-MAR-11
		Sampled Time					
		Client ID	CONTROL	132	198	296	444
WATER							
Physical Tests	Total Dissolved Solids (mg/L)		179	207	312	441	662

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	Sample ID	L983610-6	L983610-7	L983610-8		
		Description					
		Sampled Date	04-MAR-11	04-MAR-11	04-MAR-11		
		Sampled Time					
		Client ID	667	1000	1500		
WATER							
Physical Tests	Total Dissolved Solids (mg/L)		982	1440	2150		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

1

GLOSSARY OF REPORT TERMS

Surrogate A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg milligrams per kilogram based on dry weight of sample.
mg/kg wwt milligrams per kilogram based on wet weight of sample.
mg/kg lwt milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L milligrams per litre.
< - Less than.
D.L. The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

L983610

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washir
5009 Pac
Tacoma,
Phone 2
Fax 253.

\4N3

Chain of Custody

Date_____Page___of___

Sample Collection By:

Report to:		Invoice To:	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact		Contact	
Phone		Phone	
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Total Dissolved Solids (TDS)	Receipt Temperature (°C)
1	Control	4-Mar-11		Water	125 mL	1	Day 0	X	
2	132	4-Mar-11		Water	125 mL	1	Day 0	X	
3	198	4-Mar-11		Water	125 mL	1	Day 0	X	
4	296	4-Mar-11		Water	125 mL	1	Day 0	X	
5	444	4-Mar-11		Water	125 mL	1	Day 0	X	
6	667	4-Mar-11		Water	125 mL	1	Day 0	X	
7	1000	4-Mar-11		Water	125 mL	1	Day 0	X	
8	1500	4-Mar-11		Water	125 mL	1	Day 0	X	
9									
10									

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:	Gen Lab	Total No. of Containers	
PO No.:	PO No.: 065 WO #:	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: *Chironomus tentans* TDS Study, Day 0 TDS values

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria	(Printed Name) (Date)
(Company): Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time)
(Printed Name) (Date)	(Printed Name) (Date) Anna 04-Mar-11
(Company)	(Company) 7:05 20°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Day 10 - TPS

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7
Phone: 604-420-8773

Date Received: 14-MAR-11
Report Date: 21-MAR-11 15:41 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L985945
Project P.O. #: 065/WO#11102
Job Reference:
Legal Site Desc:
C of C Numbers:

Can Dang
Senior Account Manager

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ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L985945-1	L985945-2	L985945-3	L985945-4	L985945-5
Description					
Sampled Date	14-MAR-11	14-MAR-11	14-MAR-11	14-MAR-11	14-MAR-11
Sampled Time					
Client ID	CONTROL-10	DECHLORINATED WATER	132-10	198-10	296-10
Grouping **Analyte**					
WATER					
Physical Tests Total Dissolved Solids (mg/L)	230	24	215	279	394

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

TESTING LOCATION (Please Circle)

L985945.

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773

Chain of Custody

Date_____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact		Contact	
Phone		Phone	
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Total Dissolved Solids (TDS)	Shipt Temperature (°C)
1	Control-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
2	Dechlorinated Water	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
3	132-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
4	198-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
5	296-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
6	444-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
7	667-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
8	1000-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
9	1500-10	14-Mar-11			125ml Bottle	1	10-d *C. dilutus* Sediment Test	x	
10									

L985945-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	Project #: 065 WO #: 11102	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: TDS Toxicity Project

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time) 18:30
(Printed Name) Elysia (Date) March 14/11	(Printed Name) CARLY (Date) MAR 14
(Company)	(Company) 20.°C

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time)
(Printed Name) (Date)	(Printed Name) (Date)
(Company)	(Company)

Day 10 — TDS

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7
Phone: 604-420-8773

Date Received: 10-MAR-11
Report Date: 16-MAR-11 16:59 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L985427
Project P.O. #: 11102
Job Reference: 065
Legal Site Desc:
C of C Numbers: 1

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L985427-1				
	Description					
	Sampled Date	04-MAR-11				
	Sampled Time					
	Client ID	TDS SAMPLE				
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	35.3				
	Chloride (Cl) (mg/L)	720				
	Sulfate (SO4) (mg/L)	126				
Total Metals	Calcium (Ca)-Total (mg/L)	299				
	Magnesium (Mg)-Total (mg/L)	19.1				
	Potassium (K)-Total (mg/L)	18.5				
	Sodium (Na)-Total (mg/L)	175				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	APHA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
CL-COL-VA	Water	Chloride by Colorimetric	APHA 4500 E. CHLORIDE
This analysis is carried out using procedures adapted from APHA Method 4500 "Chloride". Chloride is determined using the ferricyanide colourimetric method.			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
SO4-TUR-VA	Water	Sulphate(SO4) by Turbidity	APHA 4500-SO4 E. SULPHATE
This analysis is carried out using procedures adapted from APHA Method 4500-SO4 "Sulphate". Sulphate is determined using the turbidimetric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
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N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

L985427

C S S P Fs.

L985427-COFC

2 (1) **British Columbia**
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773

Chain of Custody

March 10/11

Date _____ Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company	(1)	Company	(1)
Address		Address	
City/State/Zip		City/State/Zip	
Contact		Contact	
Phone		Phone	
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Sulphates	Total Na	Total Ca	Total Mg	Alkalinity						Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	TDS Sample	04-Mar-11			1 L bottle	1	10-d *C. dilutus* Sediment Test	X	X	X	X	X						
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:	Project #: 065 WO #: 11102	Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: TDS Toxicity Project.

RELINQUISHED BY (CLIENT)	RELINQUISHED BY (COURIER)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Edmund Canaria (Date) March 10/11	(Printed Name) (Date)
Nautilus Environmental	(Company)

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time)
(Printed Name) Robyn. (Date) 10-MAR-11.	(Printed Name) (Date)
(Company) 22° 19.50	(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

APPENDIX D

NAUTILUS (2013A) LABORATORY REPORT: EVALUATION OF THE CHRONIC TOXICITY OF TOTAL DISSOLVED SOLIDS TO EARLY LIFE STAGES OF LAKE TROUT AND ARCTIC GRAYLING

Nautilus Environmental

Evaluation of the effect of acclimation on sensitivity of *Ceriodaphnia dubia* to total dissolved solids

Final Report

Report date:
March 18, 2013

Submitted to:

Golder Associates
Burnaby, BC

8664 Commerce Court
Burnaby, BC
V5A 4N7

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1.0 INTRODUCTION

Nautilus Environmental conducted toxicity tests for Golder Associates Ltd. (Golder) to evaluate the effects of a site-specific mixture of Total Dissolved Solids (TDS) on *Ceriodaphnia dubia* and, in particular, to evaluate the effect of acclimation on their sensitivity. *C. dubia* are sensitive to ionic strength and were the most sensitive species in prior tests conducted with synthetic lake water for this project (Nautilus Environmental 2011, 2012). However, *C. dubia* are also known to acclimate to differing ionic strengths in some cases (Lasier and Hardin 2010), and Soucek and Kennedy (2005) reported that acclimation of *C. dubia* appeared to have a small effect in terms of reducing toxicity of sulphate, although the differences observed were not statistically significant. Furthermore, the toxicity test method for this species advises acclimation of organisms for at least two generations to hardness conditions that are being used for testing (Environment Canada 2007). Consequently, the present study was conducted to investigate whether *C. dubia* would acclimate to the ionic balance associated with Snap Lake, resulting in decreased sensitivity.

In order to establish the effect of acclimation on sensitivity to TDS, four consecutive three-brood survival and reproduction tests were conducted using *C. dubia*, in which each test was initiated using offspring that were produced in corresponding TDS concentrations from the previous test. Thus, the organisms were exposed using four successive generations to a range of TDS concentrations. If acclimation reduced the sensitivity of this species to TDS, we would expect to see a reduction in toxicity over the four generations of exposure.

This report describes the results of these toxicity tests. Copies of laboratory data sheets and statistical analyses are provided in Appendix A. Results of analytical chemistry are provided in Appendix B.

2.0 METHODS

2.1 Synthetic lake water and test solution preparation

The composition of the synthetic lake water used for the study was based on concentrations of major ions present in Snap Lake. The synthetic lake water was prepared by dissolving reagent-grade sodium, potassium, calcium, and magnesium salts (i.e., NaCl, KCl, $MgCl_2.6H_2O$, $MgSO_4$, $CaCl_2.2H_2O$, and $NaHCO_3$) in reverse osmosis-treated (RO) water; concentrations of salts added to prepare the water are summarized in Table 1. The nominal TDS concentration of the synthetic lake water was approximately 1500 mg/L, with individual ions present in ratios representative of the current site-specific receiving environment conditions.

Dilutions of the synthetic lake water were then prepared using deionized water and with a 0.67 times dilution factor to achieve a nominal concentration series of 1500, 1000, 667, 444, and 296 mg TDS/L. The test solutions were analyzed for ionic composition by ALS Laboratory Group (Burnaby, BC) to verify the concentrations of the major ions, which were then used to calculate TDS concentrations. One batch of the TDS solutions was prepared for use throughout the acclimation process; the solutions were stored at 4 ± 2°C.

The TDS concentrations were also measured gravimetrically and these data are provided in the report appendices for information purposes, but were not used in the statistical analyses of the data. Actual measured TDS concentrations presented in this report were calculated from measured concentrations of ionic constituents (spreadsheets showing these TDS calculations, as well as the ALS analytical reports, are provided in the report appendices).

Table 1. Concentrations (mg/L) of salts used to prepare synthetic TDS mixtures.

Constituent added	Addition rate (mg/L)
NaCl	291.8
KCl	26.3
$MgCl_2.6H_2O$	35.2
$MgSO_4$	161.3
$CaCl_2.2H_2O$	1106.1
$NaHCO_3$	185.3
Total (excluding hydration water)	1516.2

2.2 Toxicity tests

Survival and reproduction tests were conducted using *C. dubia* according to test conditions summarized in Table 2, which are based on Environment Canada (2007) procedures. At the end of each test, neonates produced in each test concentration were used to initiate the exposure of the same concentration in the subsequent test of the next generation. For example, neonates produced in the third brood on Day 6 or 7 of the exposure to 1500 mg/L TDS were used to initiate the second generation exposure to 1500 mg/L TDS. Testing continued in this manner for four consecutive generations.

Statistical calculations were based on actual TDS concentrations that were determined by summing the measured concentrations of individual ions present. This approach was considered a more accurate measure of the TDS present in the mixtures than a simple gravimetric procedure that involved filtration, drying, and weighing the residual solids, which has been shown previously to be inaccurate for the ionic blend associated with Snap Lake.

Statistical analyses for all the tests were performed using the software CETIS (Tidepool Scientific Software 2012).

Table 2. Summary of test conditions: *Ceriodaphnia dubia* survival and reproduction test.

Test type	Static renewal (daily)
Endpoints	Survival and reproduction
Organism source	In-house culture
Organism age	<24 hr old neonates produced within 12 hr
Feeding	*Pseudokirchneriella subcapitata* and digested yeast, cerophyll and trout chow (dYCT)
Test chamber	20 mL test tube
Test volume	15 mL
Test temperature	25 ± 1°C
Control/Dilution water	20% Perrier/deionized water
Number of organisms/replicate	1
Number of replicates	10
Photoperiod	16 hours light/8 hours dark
Aeration	None
Statistical software	CETIS
Test protocol	Environment Canada (2007)
Test acceptability criterion for controls	≥80% survival; ≥15 young per surviving control female that produced 3 broods; 60% of controls producing three or more broods
Reference Toxicant	Sodium chloride

2.3 QA/QC

Nautilus follows a comprehensive QA/QC program to ensure that all data generated are of high quality and are scientifically defensible. To meet these objectives, Nautilus has implemented a number of quality control procedures:

- Negative controls to ensure that appropriate testing performance criteria are met;
- Positive controls to assess the health and sensitivity of the test organisms;
- Use of appropriate species, life stage, and test methods to meet the study objectives;
- Appropriate number of replicates to allow the proper statistical analyses;
- Calibration and proper maintenance of instruments to ensure accurate measurements;
- Proper documentation and recordkeeping to allow traceability of performance;
- Adequate supervision and training of staff to ensure that methods are followed;
- Proper handling and storage of samples to ensure sample integrity;
- Procedures in place to address issues that may arise during testing and ensure the implementation of appropriate corrective actions; and,
- Rigorous review of data by a Registered Professional Biologist to ensure they are of good quality and are scientifically defensible prior to release to the client.

3.0 RESULTS AND DISCUSSION

Results of the toxicity tests are shown in Tables 3 through 6 for the four generations of exposure. In the first generation exposure, the organisms in the lowest TDS concentration (302 mg/L) all died after the first day of exposure. The cause of this is unknown; however, this did not have any relationship to TDS, since higher concentrations of TDS did not elicit an adverse response. It appears that this most likely was a handling error. The 302 mg/L concentration in the second generation test was initiated with organisms from the control in the first generation test. This did not have any impact on the findings of the testing program.

The IC20 for reproduction in the first week of exposure was higher than it had been in previous tests; the IC20 reported previously for this TDS blend was 720 mg/L (Nautilus Environmental 2012), whereas in the first week of the current set of tests, the IC20 was 1323 mg/L. In the subsequent three weeks, the IC20 was lower, although variable between weeks.

Reproduction in the highest (1538 mg/L TDS) test solution showed a decline through the four weeks of testing, with average reproduction of 10.1, 6.1, 5.3, and 2.0 offspring per adult produced during the four generations.

In the second highest (i.e., 1031 mg/L TDS) test solution, average reproduction was 17.1, 18.8, 8.9, and 14.3 offspring per adult, which was similar to control performance in the first, second, and fourth generation, but was lower than control performance in the third generation test. In fact, performance in the TDS solutions was generally poorer in the third generation test than in any of the other three generations, producing an IC20 for reproduction of 320 mg/L. This would appear to be an artifactual result, rather than a true estimate of the reproduction IC20 for TDS, since both earlier and later generations produced higher effect endpoints.

Regardless of the unusual response observed in the third generation test, the geometric mean of the four reported IC20 values from the four generations of testing was 796 mg/L, which was similar to the IC20 of 720 mg/L reported previously (Nautilus Environmental 2012), and there was no pattern of decreasing sensitivity with increasing acclimation time. Consequently, it does not appear that *C. dubia* were able to acclimate to higher ionic strength with the balance of ions associated with Snap Lake. There are a limited number of studies with which to compare this finding. Soucek and Kennedy (2005) reported decreased acute sensitivity of this species to sulphate following acclimation; however, the effect was not statistically significant, and may not have been a real effect. Lasier and Hardin (2010) reported differing sensitivities of this species to

effluents when cultured in different hardness waters, but this was not observed in all cases. Thus, it appears likely that acclimation of this species may occur in response to changes in some TDS mixtures, but not others.

Table 3. First generation results for the *Ceriodaphnia dubia* acclimation test with TDS.

Concentration (mg/L TDS)	Survival (%)	Reproduction (mean ± SD)
Control; 167	100	14.3 ± 2.3 *
302	No data	No data
464	100	13.9 ± 2.6
705	100	14.2 ± 2.6
1031	100	17.1 ± 2.2
1538	100	10.1 ± 2.8
Test endpoint		
LC50	>1538	--
IC20 (95% CL)	--	1323 (1247 – 1504)
IC50	--	>1538

IC = Inhibition Concentration.
LC = Lethal Concentration.
SD = Standard Deviation.
CL = Confidence Limits.
* Note that although the average control reproduction was less than 15 young per adult overall, the reproduction was 14.8 for the adults that had produced three broods at the time the test was terminated, and was considered an acceptable test, since this rounds up to 15 young per female.

Table 4. Second generation results for the *Ceriodaphnia dubia* acclimation test with TDS.

Concentration (mg/L TDS)	Survival (%)	Reproduction (mean ± SD)
Control; 167	100	15.2 ± 2.0
302	100	25.8 ± 4.6
464	90	20.2 ± 5.7
705	90	27.7 ± 4.6
1031	90	18.9 ± 8.3
1538	60	6.1 ± 5.1
Test endpoint		
LC50	>1538	--
IC20 (95% CL)	--	1068 (857 – 1160)
IC50 (95% CL)	--	1315 (1168 – 1415)

IC = Inhibition Concentration.
LC = Lethal Concentration.
SD = Standard Deviation.
CL = Confidence Limits.

Table 5. Third generation results for the *Ceriodaphnia dubia* acclimation test with TDS.

Concentration (mg/L TDS)	Survival (%)	Reproduction (mean ± SD)
Control; 167	100	19.9 ± 2.5
302	100	16.4 ± 5.4
464	100	11.7 ± 2.3
705	80	14.1 ± 8.1
1031	100	8.9 ± 8.3
1538	70	5.3 ± 4.9
Test endpoint		
LC50	>1538	--
IC20 (95% CL)	--	320 (242 – 417)
IC50 (95% CL)	--	933 (598 – 1241)

IC = Inhibition Concentration.
LC = Lethal Concentration.
SD = Standard Deviation.
CL = Confidence Limits.

Table 6. Fourth generation results for the *Ceriodaphnia dubia* acclimation test with TDS.

Concentration (mg/L TDS)	Survival (%)	Reproduction (mean ± SD)
Control; 167	100	15.7 ± 2.1
302	100	25.4 ± 3.9
464	90	22.8 ± 6.9
705	100	21.4 ± 3.7
1031	100	14.3 ± 4.5
1538	80	2.0 ± 2.7
Test endpoint		
LC50	>1538	--
IC20 (95% CL)	--	888 (811 – 983)
IC50 (95% CL)	--	1160 (1065 – 1218)

IC = Inhibition Concentration.
LC = Lethal Concentration.
SD = Standard Deviation.
CL = Confidence Limits.

3.1 QA/QC

The health history of the test organisms used in the exposures was acceptable and met the requirements of the Environment Canada protocol. The test met all control acceptability criteria and water quality parameters remained within acceptable ranges specified in the protocol throughout the test. Uncertainty associated with this test is best described by the confidence intervals surrounding the IC25 and IC50 estimates.

Results of the reference toxicant tests conducted during the testing program are summarized in Table 7. Results for these tests fell within the acceptable range for organism performance of mean and range, based on historical results obtained by the laboratory with this test. Thus, the sensitivity of the organisms evaluated in the reference toxicant tests was appropriate.

Table 7. Reference toxicant test results.

Test Endpoint	Result	Acceptable Range	CV (%)	Test Date
Ceriodaphnia dubia 7d IC50	1.7 g/L NaCl	0.9 – 1.7 g/L NaCl	18	July 12, 2012
Ceriodaphnia dubia 7d IC50	1.0 g/L NaCl	0.9 – 1.8 g/L NaCl	19	August 10, 2012

4.0 REFERENCES

Environment Canada. 2007. Biological Test Method: Test of Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia*. EPS 1/RM/21, Second Edition. Ottawa, ON, Canada.

Lasier PJ, Hardin IR. 2010. Observed and predicted reproduction of *Ceriodaphnia dubia* exposed to chloride, sulfate and bicarbonate. *Environ Toxicol Chem* 29:347-358.

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Nautilus Environmental. 2012. Evaluation of the effects of Total Dissolved Solids (TDS) on aquatic organisms. Final Report. April 27, 2012. Prepared for Golder Associates, Burnaby, BC.

Soucek DJ, Kennedy AJ. 2005. Effect of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates. *Environ Toxicol Chem* 24:1204-1210.

Tidepool Scientific Software. 2012. CETIS comprehensive environmental toxicity information system, version 1.8.4.29 Tidepool Scientific Software, McKinleyville, CA. 222 pp.

APPENDIX A – *Ceriodaphnia dubia* toxicity test data

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 12360

Start Date/Time: July 14/12@ 0955h
Set up by: AWD

Sample Information:

Sample ID: TDS Project
Sample Date: July 12/12
Date Received: N/A
Sample Volume: 10L

Test Organism Information:

Broodstock No.: 70412
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 21
Mortality (%) in previous 7 d: 5
Individual female # used ≥8 young on test day: 1,2,10,11,14,20

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd83
Stock Solution ID: 12Na01
Date Initiated: ~~March 8/12~~ July 12/12

7-d LC50 (95% CL): 2.0 (1.9-2.3) g/L NaCL
7-d IC50 (95% CL): 1.7 (1.4-1.9) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5-2.3) g/L NaCL CV (%): 11
7-d IC50 Reference Toxicant Mean and Historical Range: 1.2 (0.9-1.7) g/L NaCL CV (%): 18

Test Results:

	Survival	Reproduction
LC50 mg/L TDS (95% CL)	>1538	
IC25 mg/L TDS (95% CL)		~~1396 (1283-N/A)~~ KB 1405 (1310-N/A)
IC50 mg/L TDS (95% CL)		>1538

Reviewed by: JBL
Date reviewed: Oct. 3/12

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: July 19/12 0955h
Stop Date & Time: July 26/12 1150h
Test Species: *Ceriodaphnia dubia*

mg/L TDS Concentration	Days													
	0	1		2		3		4		5		6		7
Control	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	24.5	25.0	24.5	25.0	24.0	25.5	24.0	25.0
DO (mg/L)	8.0	7.6	8.0	7.0	8.0	6.9	8.0	6.8	8.2	6.2	7.7	6.0	8.3	6.3
pH	8.1	7.7	8.2	7.9	8.3	7.7	8.0	7.9	8.3	7.7	8.1	7.7	8.1	7.6
Cond. (µS/cm)	221	221		207		203		212		214		211		217
Initials	~	~		KLB		KLB		KLB		KLB		KLB		~

Concentration 296	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	25.5		24.0 KLB					KLB		
DO (mg/L)	8.1	7.5	8.1	7.0	7.5									
pH	7.2	7.4	7.3	7.6	7.7									
Cond. (µS/cm)	637	618		663										
Initials	~	~		KLB										

Concentration 444	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.0	24.0	25.0	26.0	25.0	26.0	25.0	26.0	25.0	24.0	25.5	24.0	25.0
DO (mg/L)	8.2	7.5	8.1	7.0	7.5	7.0	7.1	7.3	8.1	6.9	8.3	6.8	8.2	6.4
pH	7.3	7.4	7.4	7.6	7.7	7.4	7.6	7.6	7.6	7.5	7.5	7.4	7.6	7.4
Cond. (µS/cm)	934	938		968		927		920		933		931		883
Initials	~	~		KLB		KLB		KLB		KLB		KLB		~

Concentration 667	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.0	24.0	25.0	26.0	25.0	26.0	25.0	26.0	25.0	24.0	25.5	24.0	25.0
DO (mg/L)	8.2	7.4	8.1	7.1	7.5	7.0	8.0	7.3	8.1	6.6	8.3	6.2	8.2	6.4
pH	7.3	7.6	7.4	7.7	7.8	7.5	7.7	7.6	7.7	7.5	7.7	7.4	7.8	7.3
Cond. (µS/cm)	1376	1377		1419		1370		1355		1367		1374		1308
Initials	~	~		KLB		KLB		KLB		KLB		KLB		~

	Control	1500 mg/L TDS		
Hardness*	100	810		
Alkalinity*	88	130		

Analysts: KLB, JW, AWD
Reviewed by: JBL
Date reviewed: Sep-25/12

* mg/L as CaCO3
WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: Chemical (salts)

Comments: **Broodboard Used:** 070412

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: July 14/12 @ 0955h
Stop Date & Time: July 21/12 @ 1150h
Test Species: *Ceriodaphnia dubia*

mg/L TDS Concentration 1000	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	25.5	25.5	25.0	26.0	25.0	26.0	25.0	26.0	25.0	24.0	25.5	24.0	25.0
DO (mg/L)	8.2	7.4	8.1	7.1	7.4	7.0	8.1	7.2	8.1	6.6	8.3	6.4	8.2	6.5
pH	7.8	7.9	7.5	7.8	7.9	7.6	7.8	7.7	7.8	7.6	7.8	7.6	7.9	7.5
Cond. (µS/cm)	1953	1968		2010		1957		1951		1927		1958		1859
Initials	M	~		KUB		KUB		KUB		KUB		KUB		~

Concentration 1500	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	25.5	25.5	25.0	26.0	25.0	26.0	25.0	26.0	25.0	24.0	25.5	24.0	25.0
DO (mg/L)	8.1	7.3	8.1	7.2	7.5	7.1	8.2	7.5	8.1	6.9	8.3	7.0	8.2	6.5
pH	7.9	8.0	7.9	8.0	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.6	7.8	7.6
Cond. (µS/cm)	2870	2880		2910		2850		2840		2800		2840		2710
Initials	~	~		KUB		KUB		KUB		KUB		KUB		~

Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

	Control	1500 mg/L TDS		
Hardness*	100	810		
Alkalinity*	88	130		

* mg/L as CaCO3

Analysts: KUB, JW, AWD
Reviewed by: JOE
Date reviewed: Sep-25/12

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: chemical (salts)

Comments: Broodboard Used: 070412

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: TDS
Work Order: 12360

Start Date & Time: July 14/12 @ 0955h
Stop Date & Time: July 24/12 @1150h
Set up by: AWD

mg/L TDS

Days	Concentration: Control										
	A	B	C	D	E	F	G	H	I	J	Init
1											~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	2	2	2	2	2	3	✓	2	2	KLB
5	5	5	3	5	3	3	6	5	5	✓	KLB
6	✓	✓	✓	✓	✓	✓	✓	5	✓	3	KLB
7	9	8	7	8	8	10	9	✓	9	8	~
8					13 KLB					13 KLB	
Total	16	15	12	15	~~14~~	15	18	10	16	~~13~~	~

Days	Concentration: 296										
	A	B	C	D	E	F	G	H	I	J	Init
1											~
2	①										KLB
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration: 444										
	A	B	C	D	E	F	G	H	I	J	Init
1											~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	✓	3	✓	✓	2	3	2	2	2	KLB
5	6	4	6	4	4	5	6	6	4	✓	KLB
6	✓	8	✓	6	8	8	✓	✓	✓	7	KLB
7	5	✓	9	✓	✓	✓	6	5	7	9	~
8											
Total	13	12	18	10	12	15	15	13	13	18	KLB

Days	Concentration: 667										
	A	B	C	D	E	F	G	H	I	J	Init
1											~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	2	2	3	2	2	3	2	4	2	KLB
5	4	5	4	✓	4	4	5	3	7	✓	KLB
6	✓	✓	✓	7	✓	✓	✓	✓	✓	6	KLB
7	8	5	7	8	7	7	7	5	7	8	~
8											
Total	14	12	13	18	13	13	15	10	18	16	KLB

Days	Concentration: 1000										
	A	B	C	D	E	F	G	H	I	J	Init
1											~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	2	2	3	3	2	3	3	2	✓	3 KLB	KLB
5	5	6	5	5	4	✓	5	5	5	~~6~~ 4	KLB
6	✓	✓	✓	✓	✓	7	✓	✓	9	✓	KLB
7	9	8	9	9	7	10	8	10	7	9	~
8											
Total	16	16	17	17	13	20	16	17	21	18	KLB

Days	Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init
1											~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
4	✓	✓	✓	✓	✓	✓	2	✓	✓	✓	KLB
5	3	2	4	2	3	2	4	3	✓	4	KLB
6	6	4	✓	8	6	7	✓	6	3	✓	KLB
7			7	✓	✓	8	5	✓	6	6	~
8											
Total	~~8~~ 9 KLB	6	11	10	9	17	11	9	9	10	KLB

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Notes: X = mortality.

Sample Description: ~~In house~~ KLB ① 296 mg/L chemical (salts) reps missing/dead. Could not find the dead neonates ~~that could be because they are so small~~ KLB

Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: [signature]

Date reviewed: Oct-3/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-5121-2858	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:25	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	04-9186-6248	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	14 Jul-12 09:55	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	21 Jul-12 11:50	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 2h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	10h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	330381	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	>1538	N/A	N/A
EC10	>1538	N/A	N/A
EC15	>1538	N/A	N/A
EC20	>1538	N/A	N/A
EC25	>1538	N/A	N/A
EC40	>1538	N/A	N/A
EC50	>1538	N/A	N/A

7d Survival Rate Summary — **Calculated Variate(A/B)**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
167	Lab Water	10	1	1	1	0	0	0.0%	0.0%	10	10
464		10	1	1	1	0	0	0.0%	0.0%	10	10
705		10	1	1	1	0	0	0.0%	0.0%	10	10
1031		10	1	1	1	0	0	0.0%	0.0%	10	10
1538		10	1	1	1	0	0	0.0%	0.0%	10	10

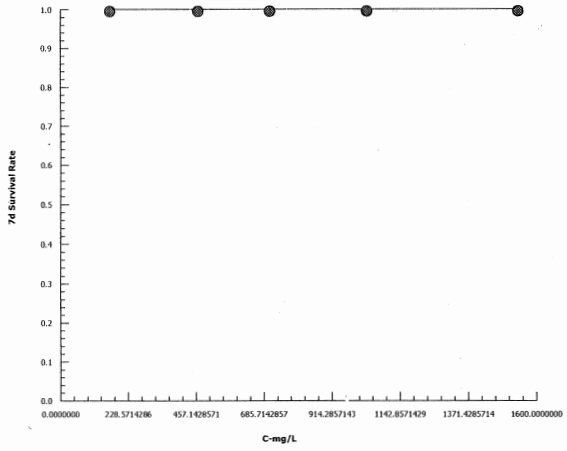
7d Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	1	1	1	1	1	1	1	1	1	1
464		1	1	1	1	1	1	1	1	1	1
705		1	1	1	1	1	1	1	1	1	1
1031		1	1	1	1	1	1	1	1	1	1
1538		1	1	1	1	1	1	1	1	1	1

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-5121-2858	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:25	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	16-3171-1125	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	28 Sep-12 15:15	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	04-9186-6248	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	14 Jul-12 09:55	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	21 Jul-12 11:50	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 2h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	10h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	716023	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	1097	432	1133
IC10	1168	1105	1245
IC15	1243	1184	1368
IC20	1323	1247	1504
IC25	1408	1310	N/A
IC40	>1538	N/A	N/A
IC50	>1538	N/A	N/A

Reproduction Summary — **Calculated Variate**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
167	Lab Water	10	14.3	10	18	0.7311	2.312	16.17%	0.0%
464		10	13.9	10	18	0.8226	2.601	18.71%	2.8%
705		10	14.2	10	18	0.8138	2.573	18.12%	0.7%
1031		10	17.1	13	21	0.7063	2.234	13.06%	-19.58%
1538		10	10.1	6	17	0.8876	2.807	27.79%	29.37%

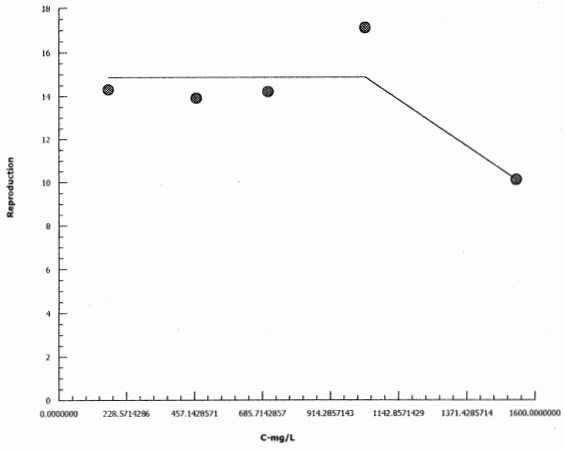
Reproduction Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	16	15	12	15	13	15	18	10	16	13
464		13	12	18	10	12	15	15	13	13	18
705		14	12	13	18	13	13	15	10	18	16
1031		16	16	17	17	13	20	16	17	21	18
1538		9	6	11	10	9	17	11	9	9	10

Ceriodaphnia 7-d Survival and Reproduction Test **Nautilus Environmental**

Analysis ID:	16-3171-1125	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	28 Sep-12 15:15	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst:_____ QA: JOL 9/28/12

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 12360

Start Date/Time: July 21/12 @ 1315h
Set up by: AWD

Sample Information:

Sample ID: TDS PROJECT
Sample Date: July 12/12
Date Received: N/A
Sample Volume: 10L

Test Organism Information:

Broodstock No.:
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d:
Mortality (%) in previous 7 d:
Individual female # used ≥8 young on test day

Young taken from c71412 test, each concentration from c71412 used to seed the same concentration for this test.

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd83
Stock Solution ID: 12Na01
Date Initiated: ~~March 8/12~~ July 12/12

7-d LC50 (95% CL): 2.0 (1.9-2.3) g/L NaCL
7-d IC50 (95% CL): 1.7 (1.4-1.9) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.8 (1.5-2.3) g/L NaCL CV (%): 11
7-d IC50 Reference Toxicant Mean and Historical Range: 1.2 (0.9-1.7) g/L NaCL CV (%): 18

Test Results:

	Survival	Reproduction
LC50 %(v/v) (95% CL)	71538	
IC25 %(v/v) (95% CL)		1218 (1136-1313)
IC50 %(v/v) (95% CL)		1440 (1316 - N/A)

Reviewed by: JCL
Date reviewed: Oct. 4/12

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: July 24/12 @ 1315h
Stop Date & Time: July 28/12 @ 1230h
Test Species: *Ceriodaphnia dubia*

mg/L TDS	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
control 20% Perrier	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	24.7	25.0	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.5	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	6.8	7.9	7.3	8.1	7.5	8.3	6.9	8.0	7.0	8.0	6.8	8.1	7.0
pH	8.4	7.7	8.2	7.6	8.2	7.4	7.8	7.4	8.1	7.3	8.1	7.6	8.2 JW	~~8.2~~ 7.9
Cond. (µS/cm)	209	206		207		208		220		219		220	JW	~~225~~ 215
Initials	~	~		KEB		KEB		KEB		KEB		KEB		JW

	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
296mg/L	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	24.6	25.0	24.5	25.0	24.0	25.0	25.5	25.0	25.0	25.5	26.0	25.0	26.0	25.0
DO (mg/L)	8.0	6.9	7.9	6.8	8.3	7.6	7.3	6.9	8.2	7.0	7.5	6.1	7.4	5.2
pH	6.9	6.9	7.0	7.3	7.4	7.3	7.5	7.1	7.5	7.1	7.5	7.2	7.4	7.3
Cond. (µS/cm)	637	641		600		621		616		622		621		605
Initials	~	~		KEB		KEB		KEB		KEB		KEB		JW

	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
444mg/L	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	24.5	25.0	24.5	25.0	24.6	25.0	25.5	25.0	25.0	25.5	26.0	25.0	26.0	25.0
DO (mg/L)	8.0	6.8	7.9	6.9	8.3	7.6	7.3	6.8	8.2	7.0	7.5	5.8	7.5	5.2
pH	7.1	7.2	7.1	7.3	7.4	7.3	7.6	7.2	7.5	7.2	7.5	7.2	7.5	7.2
Cond. (µS/cm)	922	931		938		949		934		952		941		906
Initials	~	~		KEB		KEB		KEB		KEB		KEB		JW

	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
667mg/L	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	24.5	25.0	24.5	25.0	24.0	25.0	25.5	25.0	25.5	25.5	26.0	25.0	26.0	25.0
DO (mg/L)	8.0	6.9	7.8	6.8	8.3	7.6	7.3	6.7	8.2	7.0	7.5	6.0	7.6	5.0
pH	7.3	7.4	7.2	7.5	7.5	7.4	7.7	7.3	7.6	7.4	7.6	7.4	7.6	7.4
Cond. (µS/cm)	1352	1361		1357		1384		1354		1383		1366		1342
Initials	~	~		KEB		KEB		KEB		KEB		KEB		JW

	Control	1500mg/L TDS		
Hardness*	100	810		
Alkalinity*	84	130		

* mg/L as CaCO3

Analysts: JW, KEB, AWD

Reviewed by: JGh

Date reviewed: Sep. 25/12

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5

Sample Description: Chemical (salts)

Comments: **Broodboard Used:** from TDS Test 07-1412

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: July 24/12 @ 1315h
Stop Date & Time: July 28/12 @ 1230h
Test Species: *Ceriodaphnia dubia*

mg/L TDS Concentration 1000mg/L	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	24.5	25.0	24.6	25.0	24.0	25.0	25.5	25.0	25.0	25.9	26.0	25.0	26.0	25.0
DO (mg/L)	8.2	7.0	7.8	6.9	8.3	7.3 JW	7.4	6.5	8.2	7.0	7.5	6.2	7.6	5.3
pH	7.3	7.4	7.4	7.7	7.8	7.87	7.9	7.6	7.8	7.6	7.8	7.6	7.8	7.5
Cond. (µS/cm)	~~1953~~ 1924	1951		1942		1976		1947		1973		1954		1918
Initials	~	~		KUB		KUB		KUB		KUB		KUB		JW

Concentration 1500mg/L	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	24.6	25.0	24.6	25.0	24.0	25.0	25.0	25.0	25.5	25.5	26.0	25.0	26.0	25.0
DO (mg/L)	8.2	6.9	7.8	6.8	8.3	7.1	7.5	6.5	8.2	7.1	7.5	6.2	7.6	5.7
pH	7.8	7.8	7.7	7.7	7.8	7.7	7.8	7.6	7.8	7.6	7.7	7.6	7.7	7.6
Cond. (µS/cm)	2810	2850		2820		2860		2820		2850		2800		2750
Initials	~	~		KUB		KUB		KUB		KUB		KUB		JW

Concentration	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

Concentration	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

	Control	1500mg/L TDS		
Hardness*	100	810		
Alkalinity*	84	130		

Analysts: JW, KUB, AWD
Reviewed by: JGU
Date reviewed: Sep. 25/12

* mg/L as CaCO3
WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: chemical (salts)

Comments: **Broodboard Used:** From TDS test 071412

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Lolan
Sample ID: TDS
Work Order: 12360

Start Date & Time: July 24 / 12 @ 1354
Stop Date & Time: July 28 / 12 @ 1230h
Set up by: ~

Days	Concentration: Control										
	A*	B*	C*	D	E	F*	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KUB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KUB
4	3	2	2	4	3	2	2	2	3	3	KUB
5	6	5	5	7	6	7	✓	✓	6	6	JW
6	✓	✓	✓	6	6	✓	6	5	✓	✓	KUB
7	7	6	6	✓	✓	4	8	9	5	10	JW
8											
Total	16	13	13	17	15	13	16	16	14	19	JW

Days	Concentration: 296mg/L										
	A	B	C	D	E	F	G	H*	I*	J*	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KUB
3	✓	✓	✓	4	✓	✓	✓	✓	✓	✓	JW
4	4	5	4	✓	4	✓	✓	5	✓	5	JW
5	8	9	10	10	8	6	6	8	3	12	JW
6	11	13	10	14	16	9	10	✓	6	✓	KUB
7	✓	✓	12	15	15	10	14	11	7	16	JW
8											
Total	23	27	24	28	28	25	30	24	16	33	KUB

Days	Concentration: 444mg/L										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KUB
3	✓	✓	4	✓	✓	✓	✓	✓	✓	✓	JW
4	4	4	✓	2	5	4	4	3	4	3	JW
5	8	8	8	8	3	7	8	3	7	7	JW
6	10	9	14	13	✓	11	✓	6	11	11	KUB
7	✓	✓	14	9	X	✓	13	✓	✓	✓	JW
8					1						
Total	22	21	26	23	8X	22	25	12	22	21	KUB

Days	Concentration: 667										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KUB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	4	JW
4	4	5	6	4	3	6	✓	5	6	✓	JW
5	5	10	8	10	6	✓	5	10	✓	8	JW
6	13	✓	✓	✓	9	10	11	✓	11	13	JW
7	12	15	14	15	X	15	15	16	15	15	JW
8					1						
Total	22	30	28	29	18X	31	31	31	32	25	KUB

Days	Concentration: ~~667~~ 1500 mg/L										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	KUB
3	✓	✓	✓	✓	✓	|	✓	✓	✓	✓	JW
4	✓	3	✓	4	4	|	4	3	4	~~3~~ 2	KUB
5	6	8	3	✓	9	|	✓	10	9	~~86~~	JW
6	8	✓	7	9	✓	|	11	✓	✓	6	KUB
7	✓	14	4	9	12	|	9	10	14	8	JW
8						|			15 KUB	
Total	14	25	14	22	25	0^	24	23	27	~~14~~	KUB

Days	Concentration: 1500										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	~
2	✓	✓	✓	~~✓~~	✓	✓	✓	✓	✓	✓	KUB
3	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	JW
4	✓	✓	✓	X	3	|	✓	✓	X	✓	KUB
5	4	✓	2	|	X	|	✓	2	|	3	JW
6	✓	3	✓	|	|	|	4	6	|	8	KUB
7	7	8	3	|	|	|	8	✓	|	✓	
8											
Total	11	11	5	0^	3^	0^	12	8	0^	11	KUB

Notes: X = mortality.

Sample Description: Chemical (salts)
Comments:

Reviewed by: JGH
Date reviewed: Oct. 3/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	13-7789-8189	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:34	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes
Batch ID:	00-1912-4148	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	21 Jul-12 13:15	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	28 Jul-12 12:30	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 23h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	7d 13h	**Station:**	Total Dissolved Solids		

Linear Regression Options

Model Function	Threshold Option	Threshold	Optimized	Pooled	Het Corr	Weighted
Log-Gompertz [log(-log(1-P)=A+B*log(X)]	Control Threshold	1E-07	Yes	Yes	No	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Adj R2	F Stat	Critical	P-Value	Decision(α:5%)
5	-17.35	52.7	40.08	3.376		0.7509				Lack of Fit Not Tested

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	493.4	0.0235	803.4
EC10	722.2	3.446	1071
EC15	908.5	60.61	1458
EC20	1074	334.7	2696
EC25	1229	680.1	8536
EC40	1666	1123	347300
EC50	1958	1286	2839000

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
Threshold	9.48E-08	9.74E-05	-0.00019	0.000191	0.000974	0.9993	Non-Significant Parameter
Slope	4.349	2.053	0.3265	8.372	2.119	0.1243	Non-Significant Parameter
Intercept	-14.68	6.252	-26.94	-2.431	-2.349	0.1004	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	8.941088	8.941088	1	17.07	0.0257	Significant
Residual	1.571042	0.523681	3			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Goodness-of-Fit	Pearson Chi-Sq GOF	1.571	7.815	0.6660	Non-Significant Heterogenity
	Likelihood Ratio GOF	1.736	7.815	0.6290	Non-Significant Heterogenity
Distribution	Shapiro-Wilk W Normality	0.9725	0.5128	0.9086	Normal Distribution

7d Survival Rate Summary — **Calculated Variate(A/B)**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
167	Lab Water	10	1	1	1	0	0	0.0%	0.0%	10	10
302		10	1	1	1	0	0	0.0%	0.0%	10	10
464		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
705		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
1031		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
1538		10	0.6	0	1	0.1633	0.5164	86.07%	40.0%	6	10

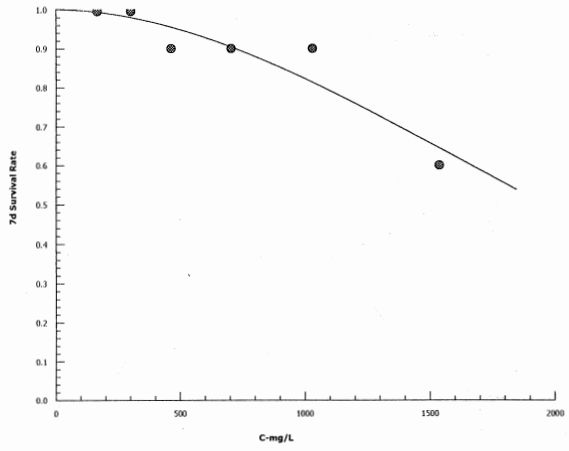
Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

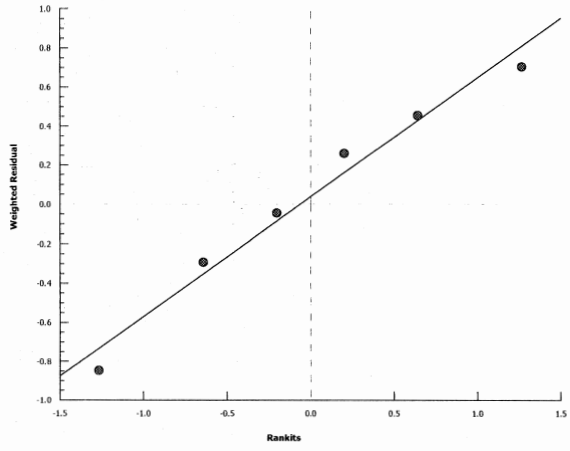
Analysis ID: 13-7789-8189 **Endpoint:** 7d Survival Rate **CETIS Version:** CETISv1.8.4
Analyzed: 11 Sep-12 12:34 **Analysis:** Linear Regression (MLE) **Official Results:** Yes

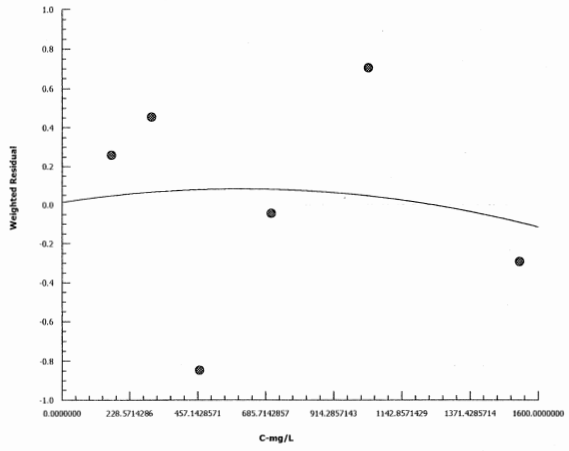
7d Survival Rate Detail

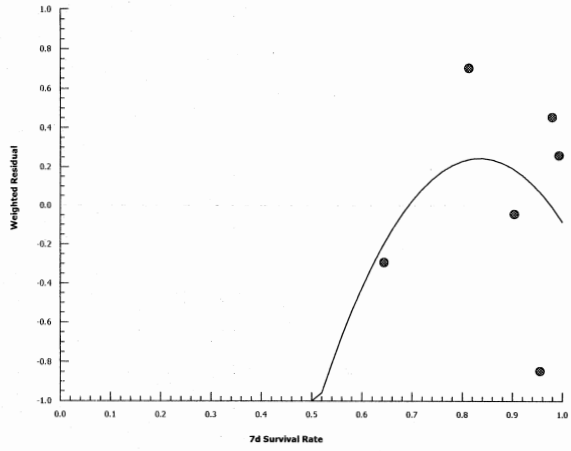
C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	1	1	1	1	1	1	1	1	1	1
302		1	1	1	1	1	1	1	1	1	1
464		1	1	1	1	0	1	1	1	1	1
705		1	1	1	1	0	1	1	1	1	1
1031		1	1	1	1	1	0	1	1	1	1
1538		1	1	1	0	0	0	1	1	0	1

Graphics Log-Gompertz [log(-log(1-P)=A+B*log(X)]









Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	09-2460-4686	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	28 Sep-12 15:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	00-1912-4148	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	21 Jul-12 13:15	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	28 Jul-12 12:30	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 23h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	7d 13h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1626249	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	800.5	740.3	1062
IC10	908.9	777.5	1094
IC15	1031	816.4	1126
IC20	1068	857.4	1160
IC25	1105	900.3	1195
IC40	1227	1046	1322
IC50	1315	1168	1415

Reproduction Summary — **Calculated Variate**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
167	Lab Water	10	15.2	13	19	0.6289	1.989	13.08%	0.0%
302		10	25.8	16	33	1.459	4.614	17.88%	-69.74%
464		10	20.2	8	26	1.8	5.692	28.18%	-32.89%
705		10	27.7	18	32	1.461	4.62	16.68%	-82.24%
1031		10	18.9	0	27	2.61	8.252	43.66%	-24.34%
1538		10	6.1	0	12	1.609	5.087	83.39%	59.87%

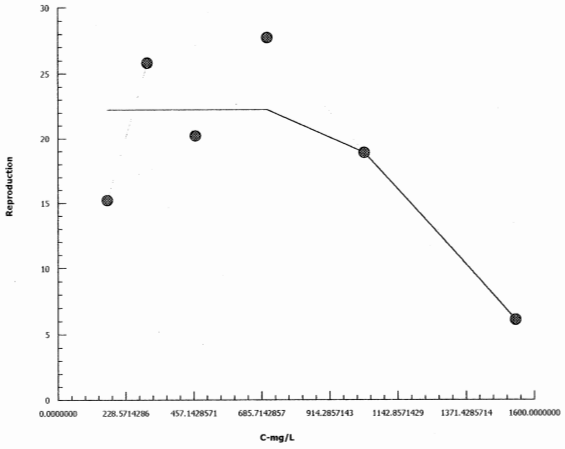
Reproduction Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	16	13	13	17	15	13	16	16	14	19
302		23	27	24	28	28	25	30	24	16	33
464		22	21	26	23	8	22	25	12	22	21
705		22	30	28	29	18	31	31	31	32	25
1031		14	25	14	22	25	0	24	23	27	15
1538		11	11	5	0	3	0	12	8	0	11

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	09-2460-4686	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	28 Sep-12 15:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	11-8713-3348	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	04 Oct-12 9:15	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	00-1912-4148	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	21 Jul-12 13:15	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	28 Jul-12 12:30	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 23h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	7d 13h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2059684	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	1066	269.1	1074
IC10	1102	992.6	1127
IC15	1140	1067	1178
IC20	1178	1105	1240
IC25	1218	1136	1313
IC40	1347	1245	N/A
IC50	1440	1316	N/A

Reproduction Summary — **Calculated Variate**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
167	Lab Water	10	15.2	13	19	0.6289	1.989	13.08%	0.0%
302		10	15.2	13	19	0.6289	1.989	13.08%	0.0%
464		10	15.2	13	19	0.6289	1.989	13.08%	0.0%
705		10	15.2	13	19	0.6289	1.989	13.08%	0.0%
1031		10	15.2	13	19	0.6289	1.989	13.08%	0.0%
1538		10	6.1	0	12	1.609	5.087	83.39%	59.87%

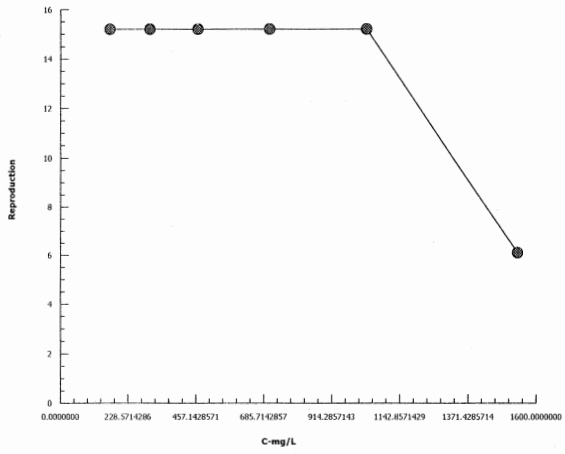
Reproduction Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	16	13	13	17	15	13	16	16	14	19
302		16	13	13	17	15	13	16	16	14	19
464		16	13	13	17	15	13	16	16	14	19
705		16	13	13	17	15	13	16	16	14	19
1031		16	13	13	17	15	13	16	16	14	19
1538		11	11	5	0	3	0	12	8	0	11

Ceriodaphnia 7-d Survival and Reproduction Test **Nautilus Environmental**

Analysis ID:	11-8713-3348	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	04 Oct-12 9:15	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst:_____ QA: JGL Oct-4/12

Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 12360

Start Date/Time: July 28/12 @ 1200h
Set up by: JW

Sample Information:

Sample ID: TDS Project
Sample Date: July 12/12
Date Received: N/A
Sample Volume: 10L

Test Organism Information:

Broodstock No.:
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d:
Mortality (%) in previous 7 d:
Individual female # used ≥8 young on test day

Young taken from 07212 test. Each concentration from 07212 used to seed the same concentration for this test.

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd84
Stock Solution ID: 12Na01
Date Initiated: August 10/12

7-d LC50 (95% CL): 1.7 (1.4-2.1) g/L NaCL
7-d IC50 (95% CL): 1.0 (0.7-1.2) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.9 (1.5-2.3) g/L NaCL CV (%): 11
7-d IC50 Reference Toxicant Mean and Historical Range: 1.3 (0.9-1.8) g/L NaCL CV (%): 19

Test Results:

	Survival	Reproduction
LC50 mg/L TDS (95% CL)	>1538	
IC25 mg/L TDS (95% CL)		361.9 (265.9 - 714.6) ~~1103 (913-1207)~~ KW
IC50 mg/L TDS (95% CL)		933.1 (597.6-1241) ~~1313 (1212-1418)~~ KW

Reviewed by: JOL

Date reviewed: Oct. 3/12

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: July 28/12 @ 1200h
Stop Date & Time: Aug 3/12 @ 1700h
Test Species: *Ceriodaphnia dubia*

mg/L TDS	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
control	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	24.0	25.0	24.0	26.0	24.0	26.0	24.0	25.5	24.0	26.0	24.0	25.5		
DO (mg/L)	8.2	7.5	8.1	7.2	8.1	6.9	7.8	6.8	8.2	6.9	7.9	7.1		
pH	8.2	8.2	8.3	8.1	8.2	7.9	8.2	7.8	8.2	7.2	8.1	7.7		
Cond. (µS/cm)	220	220		220		220		215		220		329		
Initials	JW	KLB		KLB		JW		KLB		JW		^		

	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
296mg/L	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	25.0	25.0	25.0	26.0	26.0	26.0	24.0	25.5	25.0	26.0	25.0	25.5		
DO (mg/L)	8.0	7.0	8.1	6.9	7.9	7.0	8.3	7.1	8.0	6.4	7.6	7.2		
pH	7.6	7.3	7.5	7.4	7.7	7.3	7.4	7.6	7.5	7.2	7.7	7.4		
Cond. (µS/cm)	626	623		623		605		624		635		618		
Initials	JW	KLB		KLB		JW		JW		JW		^		

	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
444mg/L	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	25.0	25.0	26.0	26.0	26.0	26.0	24.0	25.5	25.0	26.0	25.0	25.5		
DO (mg/L)	8.0	7.0	8.1	6.9	7.9	7.0	8.4	7.0	8.1	6.6	7.7	7.2		
pH	7.8	7.5	7.7	7.6	7.7	7.4	7.5	7.5	7.7	7.3	7.6	7.4		
Cond. (µS/cm)	947	941		946		926		934		958		925		
Initials	JW	KLB		KLB		JW		JW		JW		^		

	Days													
Concentration	**0**	**1**		**2**		**3**		**4**		**5**		**6**		**7**
667mg/L	**init.**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**old**	**new**	**final**
Temperature (°C)	25.0	25.0	26.0	26.0	26.0	26.0	24.0	25.5	25.0	26.0	25.0	25.5		
DO (mg/L)	7.9	7.0	8.1	7.1	7.9	6.9	8.4	7.0	8.1	6.7	7.7	7.1		
pH	7.9	7.6	7.8	7.6	7.8	7.5	7.6	7.5	7.8	7.5	7.7	7.4		
Cond. (µS/cm)	1386	1371		1389		1360		1384		1400		1357		
Initials	JW	KLB		KLB		JW		JW		JW		^		

	Control	1500 mg/L TDS		
Hardness*	100	810		
Alkalinity*	84	130		

Analysts: KLB, JW, AWD
Reviewed by: JGa
Date reviewed: Sept 25/12

* mg/L as CaCO3

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5

Sample Description: in house prepared TDS solution

Comments: **Broodboard Used:** From Golder TDS test 072112 (see log book for tt. info)

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: July 28/12 @ 1200h
Stop Date & Time: Aug 3/12 @ 1400h
Test Species: *Ceriodaphnia dubia*

mg/L TDS Concentration 1000mg/L	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	25.5	25.0	25.5	26.0	26.0	26.0	24.0	25.5	25.0	26.0	25.0	25.5		
DO (mg/L)	7.9	7.0	8.0	7.0	7.8	6.9	8.4	7.0	8.1	6.8	7.7	7.2		
pH	8.1	7.9	7.9	7.8	8.0	7.7	7.8	7.7	8.0	7.8	7.9	7.5		
Cond. (µS/cm)	1958	1962		1964		1932		1949		1997		1940		
Initials	JW	KUB		KUB		JW		JW		JW		—		

Concentration 1500mg/L	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	25.0	25.0	25.5	26.0	26.0	26.0	24.0	25.5	25.0	26.0	25.0	25.5		
DO (mg/L)	8.0	7.1	8.0	7.0	7.8	7.0	8.4	7.0	8.2	6.9	7.7	7.2		
pH	7.9	7.8	7.8	7.8	7.9	7.7	7.7	7.7	7.8	7.7	7.8	7.6		
Cond. (µS/cm)	2880	2820		2830		2770		2780		2890		2800		
Initials	JW	KUB		KUB		JW		JW		JW		—		

Concentration	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

Concentration	Days 0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

	Control	1500mg/L TDS		
Hardness*	100	810		
Alkalinity*	84	130		

* mg/L as CaCO3

Analysts: KUB, JW, AWS
Reviewed by: JOH
Date reviewed: Sept. 25/12

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: In house prepared TDS solution

Comments: **Broodboard Used:** From Golder TDS test 072112 (see logbook for t.t. info)

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: ~~Eto~~ KLB Golder
Sample ID: TDS
Work Order: 12360

Start Date & Time: July 28/12 @ 1200h
Stop Date & Time: Aug 3/12 @ 1400h
Set up by: JW

mg/L TDS

Days	Concentration: Control										
	(A)	(B)	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	3	✓	✓	✓	4	JW
4	5	3	4	3	4	✓	4	5	4	✓	KLB
5	7	7	7	3	8	7	6	8	7	7	JW
6	11	11	8	8	10	10	9	7	11	8	~
7											
8											
Total	23	21	19	14	22	20	19	20	22	19	KLB

Days	Concentration: 296mg/L										
	A	B	(C)	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	4	4	✓	✓	✓	✓	✓	JW
4	5	4	4	✓	✓	4	4	✓	4	4	KLB
5	✓	✓	7	8	8	✓	✓	4	9	7	JW
6	8	9	12	8	13	9	7	9	9	✓	~
7											
8											
Total	13	13	23	20	25	13	11	13	22	11	KLB

Days	Concentration: 444mg/L										
	(A)	B	C	D	E	F	G	(H)	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
4	5	3	4	4	5	2	5	3	4	4	KLB
5	✓	6	7	7	9	6	9	✓	7	7	JW
6	10	/	/	/	/	/	/	10	/	/	~
7											
8											
Total	15	9	11	11	14	8	14	13	11	11	KLB

Days	Concentration: 667 mg/L										
	(A)	(B)	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	3	✓	X	✓	3	✓	2	✓	✓	X	JW
4	✓	✓	|	✓	✓	4	✓	4	4	|	KLB
5	6	3	|	6	7	7	9	7	7	|	JW
6	12	8	|	7	9	7	11	8	7	|	~
7			|							|	
8			|							|	
Total	21	11	0X	13	19	18	22	19	18	0X	KLB

Days	Concentration: ~~667mg/L~~ KLB 1000 mg/L										Init
	(A)	B	C	D	E	(F)	G	H	I	J	~~Init~~ KLB
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
4	4	~~✓~~	~~✓~~	4	~~✓~~	✓	2	✓	3	✓	KLB
5	6	~~6v~~ KLB	~~6v~~ KLB	6	~~6v~~ KLB	6	7	2	5	✓	JW
6	10	/	/	/	/	12	8	8	6	✓	~
7											
8											
Total	20	0	0	10	0	18	17	10	14	0	KLB

Days	~~A~~ KLB ~~L~~	~~B~~ ~~M~~	~~C~~ ~~N~~	~~D~~ ~~O~~ KLB	E KLB	F	G	H	(I)	J	Init
	1500 mg/L										
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
2	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	KLB
3	✓	✓	X	✓	✓	|	✓	X	✓	✓	JW
4	✓	✓	|	4	✓	|	✓	|	✓	✓	KLB
5	~~6v~~ KLB	✓	|	~~6v~~ KLB	2	|	✓	|	4	5	JW
6	/	7	|	7	8	|	5	|	6	5	~
7			|			|					
8			|			|					
Total	0	7	0X	11	10	0X	5	0X	10	10	KLB

Notes: X = mortality.

Sample Description: ~~Chemical salts~~ KLB In house prepared TDS solution
Comments: ~~Used~~ Aug 3/12 used 0 test tubes for yng w/ TDS test ~~sx~~ set up on Aug 3/12.

Reviewed by: JGM
Date reviewed: Sept-25/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-9871-6695	**Endpoint:**	6d Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:42	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes
Batch ID:	01-6140-8862	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	28 Jul-12 12:00	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	03 Aug-12 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 2h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	14d 12h	**Station:**	Total Dissolved Solids		

Linear Regression Options

Model Function	Threshold Option	Threshold	Optimized	Pooled	Het Corr	Weighted
Log-Angle [Asin(P^0.5)=A+B*log(X)]	Control Threshold	1E-07	No	Yes	No	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Adj R2	F Stat	Critical	P-Value	Decision(α:5%)
43	-13.81	35.62	31.21	2.464		0.5328				Lack of Fit Not Tested

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	594.8	229.6	1007
EC10	807.3	479.4	2127
EC15	1027	660.9	4976
EC20	1267	803.5	11310
EC25	1532	932.3	24570
EC40	2555	1317	208500
EC50	3516	1607	806800

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
Slope	0.7255	0.2839	0.1691	1.282	2.555	0.0629	Non-Significant Parameter
Intercept	-1.787	0.8091	-3.373	-0.2015	-2.209	0.0917	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	7.241482	7.241482	1	6.702	0.0608	Non-Significant
Residual	4.322154	1.080539	4			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Goodness-of-Fit	Pearson Chi-Sq GOF	4.322	9.488	0.3642	Non-Significant Heterogenity
	Likelihood Ratio GOF	5.399	9.488	0.2488	Non-Significant Heterogenity
Distribution	Shapiro-Wilk W Normality	0.9676	0.5128	0.8761	Normal Distribution

6d Survival Rate Summary — **Calculated Variate(A/B)**

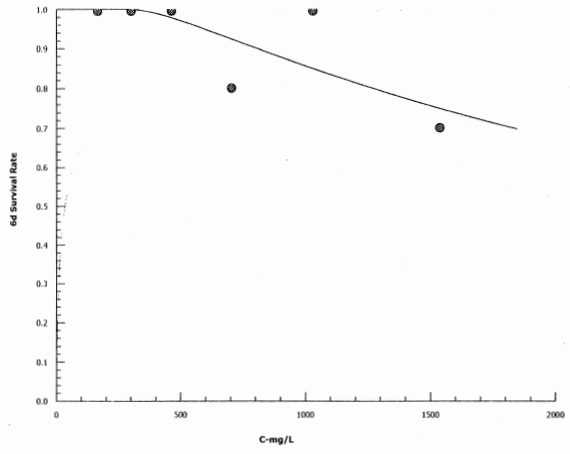
C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
167	Lab Water	10	1	1	1	0	0	0.0%	0.0%	10	10
302		10	1	1	1	0	0	0.0%	0.0%	10	10
464		10	1	1	1	0	0	0.0%	0.0%	10	10
705		10	0.8	0	1	0.1333	0.4216	52.7%	20.0%	8	10
1031		10	1	1	1	0	0	0.0%	0.0%	10	10
1538		10	0.7	0	1	0.1528	0.483	69.01%	30.0%	7	10

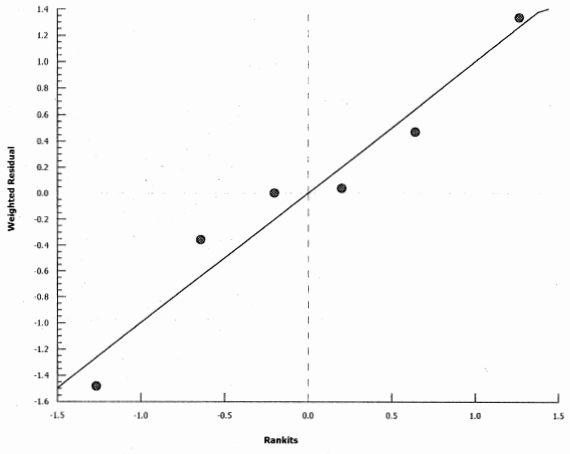
Analysis ID: 17-9871-6695 **Endpoint:** 6d Survival Rate **CETIS Version:** CETISv1.8.4
Analyzed: 11 Sep-12 12:42 **Analysis:** Linear Regression (MLE) **Official Results:** Yes

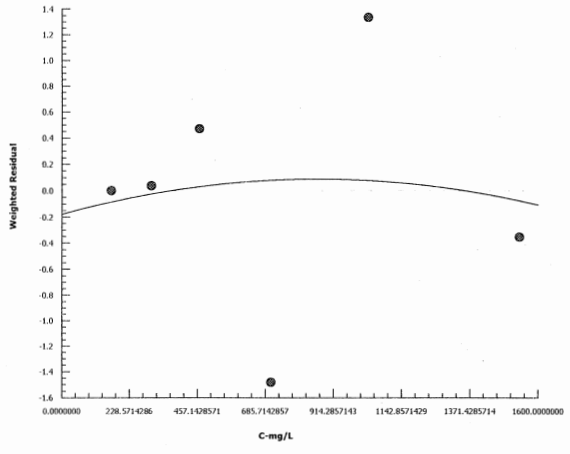
6d Survival Rate Detail

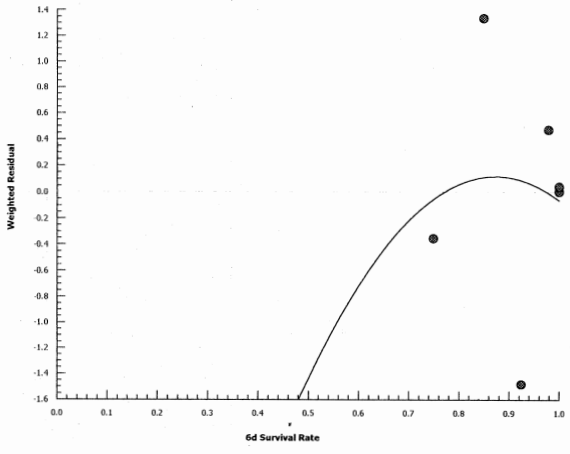
C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	1	1	1	1	1	1	1	1	1	1
302		1	1	1	1	1	1	1	1	1	1
464		1	1	1	1	1	1	1	1	1	1
705		1	1	0	1	1	1	1	1	1	0
1031		1	1	1	1	1	1	1	1	1	1
1538		1	1	0	1	1	0	1	0	1	1

Graphics Log-Angle [Asin(P^0.5)=A+B*log(X)]









CETIS Analytical Report

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	02-5820-2266	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:43	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	01-6140-8862	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	28 Jul-12 12:00	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	03 Aug-12 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 2h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	14d 12h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	290764	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	197.7	183.3	321.3
IC10	233.9	201.2	344.8
IC15	276.8	220.8	382.4
IC20	320.3	242.3	416.9
IC25	361.9	265.9	714.6
IC40	772.3	416.8	1100
IC50	933.1	597.6	1241

Reproduction Summary — **Calculated Variate**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
167	Lab Water	10	19.9	14	23	0.7951	2.514	12.64%	0.0%
302		10	16.4	11	25	1.72	5.441	33.17%	17.59%
464		10	11.7	8	15	0.7157	2.263	19.34%	41.21%
705		10	14.1	0	22	2.575	8.144	57.76%	29.15%
1031		10	8.9	0	20	2.618	8.279	93.02%	55.28%
1538		10	5.3	0	11	1.542	4.877	92.03%	73.37%

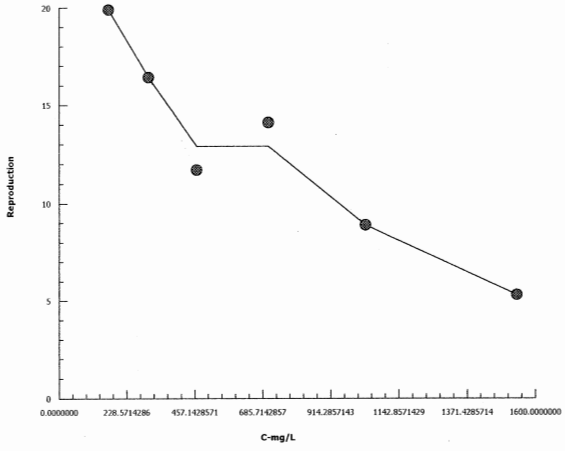
Reproduction Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	23	21	19	14	22	20	19	20	22	19
302		13	13	23	20	25	13	11	13	22	11
464		15	9	11	11	14	8	14	13	11	11
705		21	11	0	13	19	18	22	19	18	0
1031		20	0	0	10	0	18	17	10	14	0
1538		0	7	0	11	10	0	5	0	10	10

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	02-5820-2266	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:43	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Ceriodaphnia dubia Summary Sheet

Client: Golder
Work Order No.: 12360

Start Date/Time: August 31/12 @ 1350h
Set up by: AWD

Sample Information:

Sample ID: TDS Project
Sample Date: July 12/12
Date Received: N/A
Sample Volume: 10L

Test Organism Information:

Broodstock No.:
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d:
Mortality (%) in previous 7 d:
Individual female # used ≥8 young on test day

Young taken from 072812. test. Each concentration from 072812 used to seed the same concentration for this test.

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd84
Stock Solution ID: 12Na01
Date Initiated: August 10/12

7-d LC50 (95% CL): 1.7 (1.4-2.1) g/L NaCL
7-d IC50 (95% CL): 1.0 (0.7-1.2) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.9 (1.5-2.3) g/L NaCL CV (%): 11
7-d IC50 Reference Toxicant Mean and Historical Range: 1.3 (0.9-1.8) g/L NaCL CV (%): 19

Test Results:

	Survival	Reproduction
LC50 mg/L TDS (95% CL)	>1538	
IC25 mg/L TDS (95% CL)		1119 (976.4 - 1159) ~~941 (858-1047)~~ KLB
IC50 mg/L TDS (95% CL)		1272 (1189 - 1318) ~~1160 (1065-1218)~~ KLB

Reviewed by: JGL

Date reviewed: Oct. 3/12

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: Aug 3/12 @ 1350h
Stop Date & Time: Aug 10/12 @ 1200h
Test Species: *Ceriodaphnia dubia*

mg/L TDS Concentration Control	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.5	24.0	25.0	24.0	25.0
DO (mg/L)	8.1	7.2	7.9	7.2	8.1	7.2	7.9	6.9	7.9	6.8	8.1	7.0	8.3	7.5
pH	8.1	7.6	8.1	7.7	8.2	7.7	8.2	7.6	8.1	7.8	8.2	7.8	8.2	7.7
Cond. (µS/cm)	221	219		221		221		219		215		211		231
Initials	^	~		~		^		KUB		KUB		KUB		KUB

296 Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	24.5	25.0	25.0	25.0	25.0	25.0	25.0	26.0	25.5	24.5	25.0	25.0	25.0
DO (mg/L)	8.1	7.3	8.0	7.3	8.1	7.2	7.9	7.0	7.4	6.7	7.7	6.6	8.2	6.4
pH	7.4	7.5	7.5	7.4	7.5	7.5	7.4	7.5	7.5	7.4	7.6	7.3	7.6	7.3
Cond. (µS/cm)	627	612		628		630		629		620		610		582
Initials	^	~		^		^		KUB		KUB		KUB		KUB

444 Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	24.5	25.0	25.0	25.0	25.0	25.0	25.0	26.0	25.5	25.5	25.0	25.0	25.0
DO (mg/L)	8.1	7.3	8.0	7.3	8.0	7.1	7.9	6.9	7.4	5.5	7.7	5.7	8.2	5.2
pH	7.4	7.5	7.5	7.5	7.6	7.6	7.6	7.5	7.6	7.2	7.6	7.2	7.5	7.2
Cond. (µS/cm)	956	935		958		955		956		933		934		891
Initials	~	^		^		~		KUB		KUB		KUB		KUB

667 Concentration	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	24.5	25.0	25.0	25.0	25.0	25.0	25.0	26.0	25.5	25.5	25.0	25.0	25.0
DO (mg/L)	8.1	7.2	8.0	7.3	8.0	7.2	7.9	6.9	7.4	5.6	7.7	5.8	8.2	5.3
pH	7.4	7.5	7.6	7.4	7.6	7.5	7.6	7.5	7.7	7.4	7.7	7.3	7.6	7.2
Cond. (µS/cm)	1381	1354		1379		1381		1390		1363		1362		1319
Initials	~	~		~		~		KUB		KUB		KUB		KUB

	Control	1500mg/L TDS		
Hardness*	100	810		
Alkalinity*	82	130		

Analysts: KUB, AWO
Reviewed by: JOL
Date reviewed: Sept 27/12

* mg/L as CaCO3
WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: Chemical salts

Comments: **Broodboard Used:** Ø Used TDS kit 072812 yng

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: 12360

Start Date & Time: Aug 3/12 @ 1350h
Stop Date & Time: Aug 10/12 @ 1200h
Test Species: *Ceriodaphnia dubia*

Concentration 1000mg/L	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	24.6	25.0	25.0	25.0	25.0	25.0	25.0	25.5	25.5	26.0	25.0	25.0	25.0
DO (mg/L)	8.1	7.2	8.0	7.3	8.0	7.1	8.0	7.0	7.4	6.7	7.7	6.8	8.2	6.6
pH	7.7	7.6	7.7	7.6	7.7	7.6	7.6	7.5	7.9	7.7	7.9	7.7	7.8	7.7
Cond. (µS/cm)	1968	1943		1974		1977		1994		1941		1931		1841
Initials	~	~		~		~		KLB		KLB		KLB		KLB

Concentration 1500mg/L	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.5	24.5	25.0	25.0	25.0	25.0	25.0	25.0	25.5	25.5	25.5	25.0	25.0	25.0
DO (mg/L)	8.1	7.2	8.0	7.4	8.0	7.2	8.0	7.0	7.4	5.6	7.7	5.8	8.2	5.9
pH	7.7	7.6	7.6	7.7	7.7	7.7	7.6	7.6	7.7	7.5	7.8	7.5	7.7	7.5
Cond. (µS/cm)	2830	2800		2860		2830		2890		2800		2790		2630
Initials	~	~		~		~		KLB		KLB		KLB		KLB

Concentration	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

Concentration	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

	Control	1500 mg/L TDS		
Hardness*	100	810		
Alkalinity*	82	130		

Analysts: KLB, AWD
Reviewed by: JOL
Date reviewed: Sep- 27/12

* mg/L as CaCO3
WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5
Sample Description: chemical solids

Comments: **Broodboard Used:** 4mg from 072812 TDS test

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Golder
Sample ID: TDS
Work Order: 12360

Start Date & Time: Aug 3) 12 @ 1350h
Stop Date & Time: Aug 10/12 @ 1200h
Set up by:

TDS

Days	Concentration: Control										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
4	3	3	3	3	3	4	2	4	4	4	KLB
5	7	8	7	7	6	8	6	8	8	7	KLB
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLB
7	4	3	4	5	5	6	8	8	5	4	KLB
8											
Total	14	14	14	15	14	18	16	20	17	15	KLB

Days	Concentration: 296mg/L										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
2	✓	✓ KLB	✓	✓	✓	✓	✓	✓	✓	✓	^
3	3	5 5	3	✓	✓	✓	✓	✓	✓	✓	^
4	6	✓	✓	3	✓	4	✓	4	✓	✓	KLB
5	✓	7	7	8	4	7	6	8	6	6	KLB
6	10	12	11	✓	11	✓	11	✓	11	11	KLB
7	14	13	11	12	11	15	13	13	12	14	KLB
8											
Total	19	24	21	23	26	26	30	25	29	31	KLB

Days	Concentration: 444mg/L										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
3	✓	✓	✓	4	✓	✓	✓	✓	✓	✓	^
4	4	6	✓	6	4	✓	4	6	4	5	KLB
5	10	10	4	✓	8	6	12	10	12	12	KLB
6	✓	✓	9	11	✓	✓	✓	✓	X	✓	KLB
7	10	12	✓	9	11	7	13	15	|	13	KLB
8											
Total	24	28	13	21	23	13	29	31	16	30	KLB

1000 ~

Days	Concentration: 667										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
4	4	4	✓	3	2	3	4	5	4	4	KLB
5	7	8	3	6	5	7	7	✓	✓	7	KLB
6	✓	✓	9	✓	✓	✓	12	12	10	6	KLB
7	10	9	11	11	9	10	✓	12	10	✓	KLB
8							23				
Total	21	21	23	20	16	20	~~20~~ 23 KLB	29	24	17	KLB

Days	Concentration: ~~687~~ mg/L										
	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
4	2	2	3	3	2	✓	✓	✓	✓	✓	KLB
5	6	✓	5	5	5	5	5	2	✓	4	KLB
6	✓	5	✓	9	11	10	9	7	4	11	KLB
7	9	9	10	✓	✓	✓	✓	✓	✓	✓	KLB
8											
Total	17	16	18	17	18	15	14	9	4	15	KLB

Days	A B C 1500 mg/L										
	~~K~~ L	M	N	O	P	F	G	K	I	J	Init
1	A ✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	^
4	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	KLB
5	2	2	✓	✓	|	✓	✓	✓	3	3	KLB
6	✓	✓	✓	2	|	✓	✓	✓	✓	6	KLB
7	✓	✓	2	✓	|	X	✓	✓	✓	✓	KLB
8					|	|				
Total	2	2	2	2	0	0X	0	0	3	9	KLB

Notes: X = mortality.

Sample Description: chemical salts
Comments:

Reviewed by: JGL
Date reviewed: Sep 27/12

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	18-2465-9387	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:53	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	01-3910-9841	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	03 Aug-12 13:50	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	10 Aug-12 12:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 22h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	20d 14h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	155283	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	1073	374.4	N/A
EC10	1210	1031	N/A
EC15	1364	1139	N/A
EC20	1538	1210	N/A
EC25	>1538	N/A	N/A
EC40	>1538	N/A	N/A
EC50	>1538	N/A	N/A

7d Survival Rate Summary — **Calculated Variate(A/B)**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
167	Lab Water	10	1	1	1	0	0	0.0%	0.0%	10	10
302		10	1	1	1	0	0	0.0%	0.0%	10	10
464		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
705		10	1	1	1	0	0	0.0%	0.0%	10	10
1031		10	1	1	1	0	0	0.0%	0.0%	10	10
1538		10	0.8	0	1	0.1333	0.4216	52.7%	20.0%	8	10

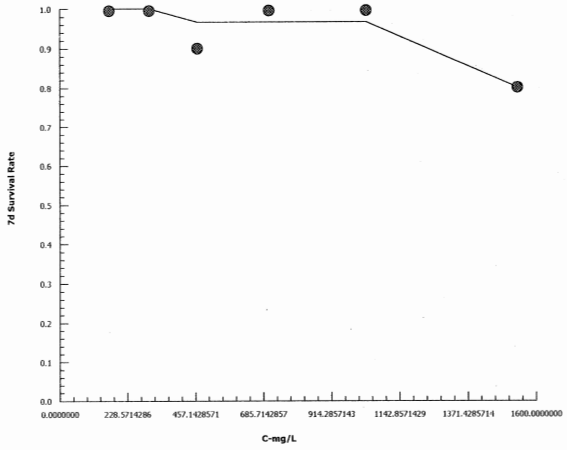
7d Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	1	1	1	1	1	1	1	1	1	1
302		1	1	1	1	1	1	1	1	1	1
464		1	1	1	1	1	1	1	1	0	1
705		1	1	1	1	1	1	1	1	1	1
1031		1	1	1	1	1	1	1	1	1	1
1538		1	1	1	1	0	0	1	1	1	1

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	18-2465-9387	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:53	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	12-5421-6076	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:53	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	01-3910-9841	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	03 Aug-12 13:50	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	10 Aug-12 12:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 22h	**Source:**		**Age:**	
Sample ID:	19-3334-1216	**Code:**	733C7220	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	20d 14h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	335935	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	746.9	557.2	763.8
IC10	791.2	692.3	827.4
IC15	838.2	754.6	904.6
IC20	888	810.6	982.9
IC25	940.7	857.7	1047
IC40	1083	971	1145
IC50	1160	1065	1218

Reproduction Summary — **Calculated Variate**

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
167	Lab Water	10	15.7	14	20	0.6506	2.058	13.11%	0.0%
302		10	25.4	19	31	1.222	3.864	15.21%	-61.78%
464		10	22.8	13	31	2.18	6.893	30.23%	-45.22%
705		10	21.4	16	29	1.166	3.688	17.23%	-36.31%
1031		10	14.3	4	18	1.415	4.473	31.28%	8.92%
1538		10	2	0	9	0.8563	2.708	135.4%	87.26%

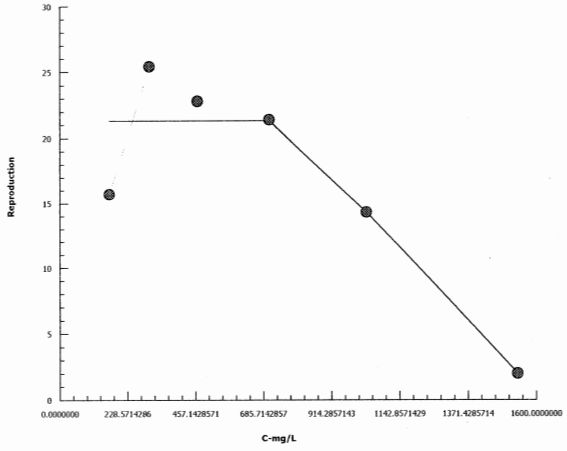
Reproduction Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	14	14	14	15	14	18	16	20	17	15
302		19	24	21	23	26	26	30	25	29	31
464		24	28	13	21	23	13	29	31	16	30
705		21	21	23	20	16	20	23	29	24	17
1031		17	16	18	17	18	15	14	9	4	15
1538		2	2	2	2	0	0	0	0	3	9

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	12-5421-6076	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	11 Sep-12 12:53	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Ceriodaphnia 7-d Survival and Reproduction Test

Nautilus Environmental

Analysis ID:	17-2798-5119	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	28 Sep-12 15:25	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	03-8374-3543	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Krysta Banack
Start Date:	03 Aug-12 13:50	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	
Ending Date:	10 Aug-12 12:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 22h	**Source:**		**Age:**	
Sample ID:	11-3258-0385	**Code:**	4381CE21	**Client:**	Golder
Sample Date:	14 Jul-12	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	14 Jul-12	**Source:**	Golder		
Sample Age:	20d 14h	**Station:**	Total Dissolved Solids		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	322116	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	872.5	254.1	1055
IC10	1037	654.2	1079
IC15	1064	831.8	1104
IC20	1091	892.1	1130
IC25	1119	976.4	1159
IC40	1208	1112	1246
IC50	1272	1189	1318

Reproduction Summary

Calculated Variate

C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
167	Lab Water	10	15.7	14	20	0.6506	2.058	13.11%	0.0%
302		10	15.7	14	20	0.6506	2.058	13.11%	0.0%
464		10	15.7	14	20	0.6506	2.058	13.11%	0.0%
705		10	15.7	14	20	0.6506	2.058	13.11%	0.0%
1031		10	14.3	4	18	1.415	4.473	31.28%	8.92%
1538		10	2	0	9	0.8563	2.708	135.4%	87.26%

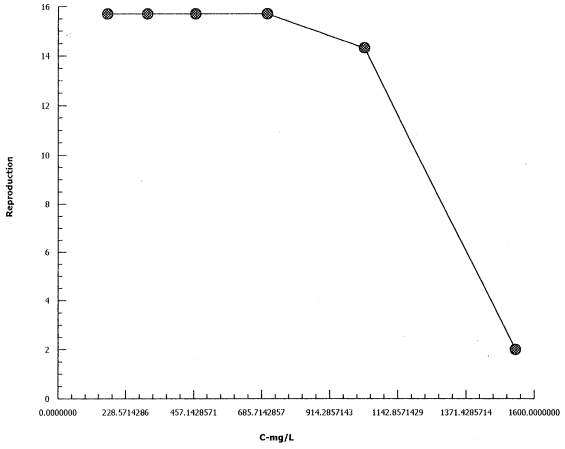
Reproduction Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
167	Lab Water	14	14	14	15	14	18	16	20	17	15
302		14	14	14	15	14	18	16	20	17	15
464		14	14	14	15	14	18	16	20	17	15
705		14	14	14	15	14	18	16	20	17	15
1031		17	16	18	17	18	15	14	9	4	15
1538		2	2	2	2	0	0	0	0	3	9

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-2798-5119	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.4
Analyzed:	28 Sep-12 15:25	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst:_____ QA: JGH Oct-3/12

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Banack
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 30-JUL-12
Report Date: 07-AUG-12 15:42 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1186819

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1186819-1 CHEM 21-JUL-12 CONTROL 20% PERRIER	L1186819-2 CHEM 21-JUL-12 296 MG/L	L1186819-3 CHEM 21-JUL-12 444 MG/L	L1186819-4 CHEM 21-JUL-12 667 MG/L	L1186819-5 CHEM 21-JUL-12 1000 MG/L
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	115	555	871	1340	1980
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	88.9	23.1	34.6	48.6	80.1
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.50 DLM	<0.50 DLM	<1.0 DLM
	Chloride (Cl) (mg/L)	5.42	142	224	336	493
	Fluoride (F) (mg/L)	0.030	<0.020	<0.20 DLM	<0.20 DLM	<0.40 DLM
	Nitrate (as N) (mg/L)	0.347	0.0123	<0.050 DLM	<0.050 DLM	<0.10 DLM
	Nitrite (as N) (mg/L)	0.0036	<0.0010	<0.010 DLM	<0.010 DLM	<0.020 DLM
	Sulfate (SO4) (mg/L)	8.45	25.1	39.2	59.1	86
Total Metals	Calcium (Ca)-Total (mg/L)	40.7	62.2	92.6	142	199
	Magnesium (Mg)-Total (mg/L)	1.28	7.46	11.2	17.5	24.9
	Potassium (K)-Total (mg/L)	<2.0	2.8	4.3	6.6	9.5
	Sodium (Na)-Total (mg/L)	2.7	34.3	50.4	84.7	121

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1186819-6				
	Description	CHEM				
	Sampled Date	21-JUL-12				
	Sampled Time					
	Client ID	1500 MG/L				
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	3040				
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	107				
	Bromide (Br) (mg/L)	<1.0 DLM				
	Chloride (Cl) (mg/L)	743				
	Fluoride (F) (mg/L)	<0.40 DLM				
	Nitrate (as N) (mg/L)	<0.10 DLM				
	Nitrite (as N) (mg/L)	<0.020 DLM				
	Sulfate (SO4) (mg/L)	131				
Total Metals	Calcium (Ca)-Total (mg/L)	292				
	Magnesium (Mg)-Total (mg/L)	38.2				
	Potassium (K)-Total (mg/L)	14.7				
	Sodium (Na)-Total (mg/L)	189				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SPL	Sample was Preserved at the laboratory - total metals

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted For Sample Matrix Effects

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-BR-IC-VA	Water	Bromide by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-F-IC-VA	Water	Fluoride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Short Holding Time

Rush Processing

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4

Date: July 30/12 Page 1 of 1

L11868 19-COFC

Sample Collection By:		
	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A 4N7	Burnaby, BC, V5A 4N7
Contact	Krysta Banack	Krysta Banack
Phone	604- 420- 8773	604- 420- 8773
Email	krysta@nautilusenvironmental.com	krysta@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Alkalinity	TDS				Receipt Temperature (°C)
								QUIRED											
1	Control 20% Perrier	July 21/12	-	Chem	250 mL	2	Day0 Ceri0	X	X	X	X	X	X	X	X				
2	296 mg/L	July 21/12	-	Chem	250 mL	2		X	X	X	X	X	X	X	X				
3	444 mg/L	July 21/12	-	Chem	250 mL	2		X	X	X	X	X	X	X	X				
4	667 mg/L	July 21/12	-	Chem	250 mL	2		X	X	X	X	X	X	X	X				
5	1000 mg/L	July 21/12	-	Chem	250 mL	2		X	X	X	X	X	X	X	X				
6	1500 mg/L	July 21/12	-	Chem	250 mL	2	↓	X	X	X	X	X	X	X	X				
7																			
8																			
9																			
10																			

PROJECT INFORMATION	SAMPLE RECEIPT	RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:	Signature:	Signature:
P.O. No.:	Good Condition?	Print: Krysta Banack	Print:
Shipped Via:	Matches Schedule?	Company: Nautilus Environmental	Company:
		Time/Date: July 30 /12 @ 1700	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

Attn: Can Dang

L1186819

RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
Signature:	Signature:
Print:	Print:
Company:	Company:
Time/Date:	Time/Date: July 30 17:00 temp 17.6

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Banack
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 30-JUL-12
Report Date: 08-AUG-12 10:16 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1186820

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1186820-1 CHEM 28-JUL-12 CONTROL 20% PERRIER	L1186820-2 CHEM 28-JUL-12 296 MG/L	L1186820-3 CHEM 28-JUL-12 444 MG/L	L1186820-4 CHEM 28-JUL-12 667 MG/L	L1186820-5 CHEM 28-JUL-12 1000 MG/L
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	88.7	24.5	34.7	48.7	77.9
	Chloride (Cl) (mg/L)	5.44	137	218	321	483
	Sulfate (SO4) (mg/L)	8.96	24.5	38.2	56.8	84
Total Metals	Calcium (Ca)-Total (mg/L)	39.4	53.6	87.7	143	190
	Magnesium (Mg)-Total (mg/L)	1.44	6.68	10.7	17.7	23.6
	Potassium (K)-Total (mg/L)	<4.0 DLA	<4.0 DLA	4.8	7.2	9.4
	Sodium (Na)-Total (mg/L)	<4.0 DLA	32.2	51.2	83.9	107

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1186820-6				
	Description	CHEM				
	Sampled Date	28-JUL-12				
	Sampled Time					
	Client ID	1500 MG/L				
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	82.6				
	Chloride (Cl) (mg/L)	735				
	Sulfate (SO4) (mg/L)	129				
Total Metals	Calcium (Ca)-Total (mg/L)	260				
	Magnesium (Mg)-Total (mg/L)	34.1				
	Potassium (K)-Total (mg/L)	13.3				
	Sodium (Na)-Total (mg/L)	155				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit Adjusted For required dilution

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

L1186820-COFC

Date: July 30/12 Page 1 of 1

Sample Collection By:		
	Report to:	**Invoice to:**
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A 4N7	Burnaby, BC, V5A 4N7
Contact	Krysta Banack	Krysta Banack
Phone	604- 420- 8773	604- 420- 8773
Email	krysta@nautilusenvironmental.com	krysta@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Alkalinity					Receipt Temperature (°C)
1	Control 20% Perrier	July 28/12	-	Chem	250 mL	1	Day 7 Ceriodaphnia	X	X	X	X	X	X	X					
2	296 mg/L	July 28/12	-	Chem	250 mL	1		X	X	X	X	X	X	X					
3	444 mg/L	July 28/12	-	Chem	250 mL	1		X	X	X	X	X	X	X					
4	667 mg/L	July 28/12	-	Chem	250 mL	1		X	X	X	X	X	X	X					
5	1000 mg/L	July 28/12	-	Chem	250 mL	1		X	X	X	X	X	X	X					
6	1500 mg/L	July 28/12	-	Chem	250 mL	1		X	X	X	X	X	X	X					
7																			
8																			
9																			
10																			

PROJECT INFORMATION	SAMPLE RECEIPT	RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	**Total # Containers:**	**Signature:**	**Signature:**
P.O. No.:	**Good Condition?**	**Print:** Krysta Banack	**Print:**
Shipped Via:	**Matches Schedule?**	**Company:** Nautilus Environmental	**Company:**
		Time/Date: July 30 /12 @ 1700	**Time/Date:**
		RECEIVED BY (COURIER)	**RECEIVED BY (LABORATORY)**
		Signature:	**Signature:**
		Print:	**Print:**
		Company:	**Company:**
		Time/Date:	**Time/Date:** July 30 17:00 temp 17.6

SPECIAL INSTRUCTIONS/COMMENTS:

Attn: Can Dang

L1186820

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Banack
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 10-AUG-12
Report Date: 20-AUG-12 20:07 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1192375

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1192375-1 CHEM 03-AUG-12 CONTROL	L1192375-2 CHEM 03-AUG-12 296 TDS	L1192375-3 CHEM 03-AUG-12 444 TDS	L1192375-4 CHEM 03-AUG-12 667 TDS	L1192375-5 CHEM 03-AUG-12 1000 TDS
WATER						
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	92.0	29.9	42.3	57.9	80.5
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	92.0	29.9	42.3	57.9	80.5
	Chloride (Cl) (mg/L)	34.5	139	222	334	489
	Sulfate (SO4) (mg/L)	11.6	25.0	37.9	57.7	82
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	37.1	59.9	92.1	133	201
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	2.35	7.11	11.2	16.3	24.8
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	17.0	3.3	4.6	7.2	10.3
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	1.12	0.239	0.232	0.234	0.259
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	11.4	33.1	48.7	76.2	116
	Strontium (Sr)-Total (mg/L)	0.179	0.0202	0.0264	0.0355	0.0533
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	0.0535	0.0719	0.0058	0.0695	0.0076

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1192375-6				
	Description	CHEM				
	Sampled Date	03-AUG-12				
	Sampled Time					
	Client ID	1500 TDS				
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	80.7				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	80.7				
	Chloride (Cl) (mg/L)	726				
	Sulfate (SO4) (mg/L)	125				
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20				
	Antimony (Sb)-Total (mg/L)	<0.20				
	Arsenic (As)-Total (mg/L)	<0.20				
	Barium (Ba)-Total (mg/L)	<0.010				
	Beryllium (Be)-Total (mg/L)	<0.0050				
	Bismuth (Bi)-Total (mg/L)	<0.20				
	Boron (B)-Total (mg/L)	<0.10				
	Cadmium (Cd)-Total (mg/L)	<0.010				
	Calcium (Ca)-Total (mg/L)	268				
	Chromium (Cr)-Total (mg/L)	<0.010				
	Cobalt (Co)-Total (mg/L)	<0.010				
	Copper (Cu)-Total (mg/L)	<0.010				
	Iron (Fe)-Total (mg/L)	<0.030				
	Lead (Pb)-Total (mg/L)	<0.050				
	Lithium (Li)-Total (mg/L)	<0.010				
	Magnesium (Mg)-Total (mg/L)	35.4				
	Manganese (Mn)-Total (mg/L)	<0.0050				
	Molybdenum (Mo)-Total (mg/L)	<0.030				
	Nickel (Ni)-Total (mg/L)	<0.050				
	Phosphorus (P)-Total (mg/L)	<0.30				
	Potassium (K)-Total (mg/L)	15.9				
	Selenium (Se)-Total (mg/L)	<0.20				
	Silicon (Si)-Total (mg/L)	0.243				
	Silver (Ag)-Total (mg/L)	<0.010				
	Sodium (Na)-Total (mg/L)	166				
	Strontium (Sr)-Total (mg/L)	0.0757				
	Thallium (Tl)-Total (mg/L)	<0.20				
	Tin (Sn)-Total (mg/L)	<0.030				
	Titanium (Ti)-Total (mg/L)	<0.010				
	Vanadium (V)-Total (mg/L)	<0.030				
	Zinc (Zn)-Total (mg/L)	<0.0050				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

C1192375

Date : Aug 10/12 Page 1 of 1

Sample Collection By:							ANALYSES REQUIRED											Receipt Temperature (°C)
	Report to:				Invoice to:													
Company	Nautilus Environmental				Nautilus Environmental													
Address	8664 Commerce Court				8664 Commerce Court													
City/Prov/Postal Code	Burnaby, BC, V5A 4N7				Burnaby, BC, V5A 4N7													
Contact	Krysta Banack				Krysta Banack													
Phone	604- 420- 8773				604- 420- 8773													
Email	krysta@nautilusenvironmental.com				krysta@nautilusenvironmental.com													

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Alkalinity					
1	Control	Aug 3/12	-	Chem	125mL	1	TDS Day 6	X	X	X	X	X	X	X					
2	296 TDS	Aug 3/12	-	Chem	125mL	1	TDS Day 6	X	X	X	X	X	X	X					
3	444 TDS	Aug 3/12	-	Chem	125mL	1	TDS Day 6	X	X	X	X	X	X	X					
4	667 TDS	Aug 3/12	-	Chem	125mL	1	TDS Day 6	X	X	X	X	X	X	X					
5	1000 TDS	Aug 3/12	-	Chem	125mL	1	TDS Day 6	X	X	X	X	X	X	X					
6	1500 TDS	Aug 3/12	-	Chem	125mL	1	TDS Day 6	X	X	X	X	X	X	X					
7																			
8																			
9																			
10																			

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature:	Signature:
P.O. No.:	Good Condition?		Print: Krysta Banack	Print:
Shipped Via:	Matches Schedule?		Company: Nautilus Environmental	Company:
			Time/Date: Aug 10/12 @ 1600h	Time/Date:
SPECIAL INSTRUCTIONS/COMMENTS:			RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
			Signature:	Signature:
Attn: Can Dang			Print:	Print: Brit 22.2
			Company:	Company:
			Time/Date:	Time/Date: Aug 10 16:15

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Banack
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 10-AUG-12
Report Date: 17-AUG-12 16:29 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1192743

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: Due to laboratory error, all samples were accidently preserved with nitric acid and hence we were unable to perform all the water quality tests.

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L1192743-1	L1192743-2	L1192743-3	L1192743-4	L1192743-5
	Description:	CHEM	CHEM	CHEM	CHEM	CHEM
	Sampled Date:	10-AUG-12	10-AUG-12	10-AUG-12	10-AUG-12	10-AUG-12
	Sampled Time:					
	Client ID:	CONTROL	296 MG/L TDS	444 MG/L TDS	667 MG/L TDS	1000 MG/L TDS
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	36.1	56.2	90.5	136	186
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	1.55	6.82	11.2	16.8	23.2
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	8.2	5.1	5.1	7.8	9.8
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	1.18	0.216	0.200	0.233	0.262
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	3.9	32.3	51.7	78.9	109
	Strontium (Sr)-Total (mg/L)	0.179	0.0183	0.0268	0.0371	0.0509
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	0.0050	<0.0050	<0.0050	<0.0050	0.0068

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1192743-6				
	Description	CHEM				
	Sampled Date	10-AUG-12				
	Sampled Time					
	Client ID	1500 MG/L TDS				
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20				
	Antimony (Sb)-Total (mg/L)	<0.20				
	Arsenic (As)-Total (mg/L)	<0.20				
	Barium (Ba)-Total (mg/L)	<0.010				
	Beryllium (Be)-Total (mg/L)	<0.0050				
	Bismuth (Bi)-Total (mg/L)	<0.20				
	Boron (B)-Total (mg/L)	<0.10				
	Cadmium (Cd)-Total (mg/L)	<0.010				
	Calcium (Ca)-Total (mg/L)	269				
	Chromium (Cr)-Total (mg/L)	<0.010				
	Cobalt (Co)-Total (mg/L)	<0.010				
	Copper (Cu)-Total (mg/L)	<0.010				
	Iron (Fe)-Total (mg/L)	<0.030				
	Lead (Pb)-Total (mg/L)	<0.050				
	Lithium (Li)-Total (mg/L)	<0.010				
	Magnesium (Mg)-Total (mg/L)	36.6				
	Manganese (Mn)-Total (mg/L)	<0.0050				
	Molybdenum (Mo)-Total (mg/L)	<0.030				
	Nickel (Ni)-Total (mg/L)	<0.050				
	Phosphorus (P)-Total (mg/L)	<0.30				
	Potassium (K)-Total (mg/L)	14.3				
	Selenium (Se)-Total (mg/L)	<0.20				
	Silicon (Si)-Total (mg/L)	0.234				
	Silver (Ag)-Total (mg/L)	<0.010				
	Sodium (Na)-Total (mg/L)	170				
	Strontium (Sr)-Total (mg/L)	0.0791				
	Thallium (Tl)-Total (mg/L)	<0.20				
	Tin (Sn)-Total (mg/L)	<0.030				
	Titanium (Ti)-Total (mg/L)	<0.010				
	Vanadium (V)-Total (mg/L)	<0.030				
	Zinc (Zn)-Total (mg/L)	<0.0050				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

C1192743

Date : Aug 10/12 Page 1 of 1

Sample Collection By:							...SES REQUIRED											Receipt Temperature (°C)
	Report to:				**Invoice to:**													
Company	Nautilus Environmental				Nautilus Environmental													
Address	8664 Commerce Court				8664 Commerce Court													
City/Prov/Postal Code	Burnaby, BC, V5A 4N7				Burnaby, BC, V5A 4N7													
Contact	Krysta Banack				Krysta Banack													
Phone	604- 420- 8773				604- 420- 8773													
Email	krysta@nautilusenvironmental.com				krysta@nautilusenvironmental.com													
	SAMPLE ID	**DATE**	**TIME**	**MATRIX**	**CONTAINER TYPE**	**# OF CONTAINERS**	**COMMENTS**	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Alkalinity					
1	Control	Aug 10/12	-	Chem	125mL	1	Day 7 Cerio	X	X	X	X	X	X	X					
2	296 mg/L TDS	Aug 10/12	-	Chem	125mL	1	Day 7 Cerio	X	X	X	X	X	X	X					
3	444 mg/L TDS	Aug 10/12	-	Chem	125mL	1	Day 7 Cerio	X	X	X	X	X	X	X					
4	667 mg/L TDS	Aug 10/12	-	Chem	125mL	1	Day 7 Cerio	X	X	X	X	X	X	X					
5	1000 mg/L TDS	Aug 10/12	-	Chem	125mL	1	Day 7 Cerio	X	X	X	X	X	X	X					
6	1500 mg/L TDS	Aug 10/12	-	Chem	125mL	1	Day 7 Cerio	X	X	X	X	X	X	X					
7																			
8																			
9																			
10																			

PROJECT INFORMATION	**SAMPLE RECEIPT**		**RELIQUINSHED BY (CLIENT)**	**RELIQUINSHED BY (COURIER)**
Client:	**Total # Containers:**		**Signature:** KBanack	**Signature:**
P.O. No.:	**Good Condition?**		**Print: Krysta Banack**	**Print:**
Shipped Via:	**Matches Schedule?**		**Company: Nautilus Environmental**	**Company:**
			Time/Date: Aug 10/12 @ 1600h	**Time/Date:**
SPECIAL INSTRUCTIONS/COMMENTS:			**RECEIVED BY (COURIER)**	**RECEIVED BY (LABORATORY)**
			Signature:	**Signature:**
Attn: Can Dang			**Print:**	**Print:** Britt 22.2°C
			Company:	**Company:**
			Time/Date:	**Time/Date:** Aug 10 16:15

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

Client: Golder

W.O.#: 12360

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Sample ID	Sample Date	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)		Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
TDS 1500 mg/L	July 14/12	10 ①	1.4	1.5	130		10 ①	8.1	810	JW
20% Perrier Control	July 14/12	50	4.5 sub	4.6	88		50	5.0	100	KB
20% Perrier Control	July 21/12	50	~~4.4~~ 4.3	4.4	84		50	5.0	100	KB
20% Perrier Control	July 28/12	50	4.3	4.4	84		50	5.0	100	KB
20% Perrier Control	Aug 3/12	50	4.2	4.3	82		50	5.0	100	KB
20% Perrier Control	Aug 6/12	50	4.2	4.3	82		50	5.0	100	KB

Notes: ① Diluted to 100 mL w/ DI H_2O.

Reviewed by: JOh

Date Reviewed: Sep. 25/12

APPENDIX B – Chain-of-custody form

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:							ANALYSES REQUIRED													Receipt Temperature (°C)
	Report to:				Invoice to:		7-d Cecio													
Company																				
Address																				
City/Prov/Postal Code																				
Contact																				
Phone																				
Email																				
	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS													
1	1500 mg/L TDS	July 12/12	—	—	—	—	Made in House	X												
2																				
3								W.O. 123660												
4																				
5																				
6																				
7																				
8																				
9																				
10																				

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature:	Signature:
P.O. No.:	Good Condition?		Print:	Print:
Shipped Via:	Matches Schedule?		Company:	Company:
			Time/Date:	Time/Date:
SPECIAL INSTRUCTIONS/COMMENTS:			RECEIVED BY (COURIER)	RECEIVED BY (LABORATORY)
			Signature:	Signature:
			Print:	Print:
			Company:	Company:
			Time/Date:	Time/Date:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

APPENDIX E

NAUTILUS (2013B) LABORATORY REPORT: EVALUATION OF THE EFFECT OF ACCLIMATION ON SENSITIVITY OF *CERIODAPHNIA DUBIA* TO TOTAL DISSOLVED SOLIDS

Nautilus Environmental

Evaluation of the chronic toxicity of Total Dissolved Solids to early life stages of Lake Trout and Arctic Grayling

Final Report

Report date:
September 26, 2013

Submitted to:

Golder Associates
Burnaby, BC

8664 Commerce Court
Burnaby, BC
V5A 4N7

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1.0 INTRODUCTION

Early life stages of salmonids have been identified as being potentially sensitive to elevated concentrations of total dissolved solids (TDS) in early life stage exposures (Weber-Scannell and Duffy, 2007). However, results from various studies have provided conflicting evidence in this regard.

Chapman et al. (2000) reported that Rainbow Trout were relatively insensitive to TDS, with no adverse effects on embryo development or growth of fry occurring at concentrations as high as 2,000 mg/L. Brix et al. (2010) reported no adverse effect on fertilization of either Arctic Grayling or Dolly Varden char in TDS concentrations of up to 2,782 and 1,817 mg/L, respectively. These authors noted the importance of milt age in successfully conducting tests of fertilization success, and indicated that lower effects concentrations reported by Stekoll et al. (2009) [on fish species not found in Snap Lake] may have been confounded by poor milt quality.

Different fish species and life stages may be more or less sensitive to TDS, since TDS is a blend of ions, typically consisting of Ca, Mg, Na, K, SO_4, Cl, F, NO_3, and HCO_3, which varies considerably in composition between sites. Thus, TDS can be comprised of a wide variety of relative proportions of these ionic constituents, and these differences have been shown to alter sensitivity of freshwater organisms.

In order to investigate sensitivity to TDS of salmonids associated with Snap Lake operations, toxicity tests were conducted using early life stages of a spring spawning (Arctic Grayling) and a fall spawning salmonid (Lake Trout) exposed to a range of concentrations of TDS, with a composition specific to that of Snap Lake. The tests were initiated using eggs and milt, and continued through hatching until 30 days following initiation of feeding, encompassing the embryo-alevin-fry stages described in Environment Canada (1998). Tests were conducted using both dry-fertilized eggs (i.e., eggs that were fertilized in the absence of water, prior to exposure to the test solutions), as well as using an exposure that incorporated fertilization in the test solutions (wet fertilization). This approach was designed to enable a comparison to establish the sensitivity of the fertilization endpoint, as well as of the remaining early life stages.

2.0 METHODS

2.1 Adult collection

2.1.1 Lake Trout collection

Lake Trout were collected from Shuswap Lake using panels of either 1-inch (25-mm) or 1.5-inch (38-mm) stretched mesh gillnet. Gillnet sets of approximately 30 minutes were used over cobble that was known to be used for spawning. Adult fish were entangled in the gillnet by hooking their teeth and jaw in the mesh, and were held in lake water for up to two hours in a live-well on the boat prior to spawning.

Ripe individuals were stripped by application of gentle pressure to the abdomen, starting behind the pectoral fins and progressing towards the urogenital pore. Eggs were collected in hard plastic Ziploc containers and milt in amber glass bottles; gametes from each adult fish were kept separate. The adults were held in well-oxygenated water and allowed to recover for a few minutes until the fish appeared to be able to swim normally, prior to release.

The initial sampling event was on November 15, 2012. Eggs were collected from five females (one of which produced only a small number of eggs, and was not used) and milt from eight males. The gametes were held in a cooler and delivered the following morning to the Nautilus Environmental laboratory in Burnaby, BC. Wet and dry fertilization tests were initiated between 1:00 and 2:30 pm on November 16.

Although the egg quality was good, the motility of the sperm (evaluated by mixing a small amount of milt with water on a slide under a microscope) from the November 15 sampling was absent in six of the eight samples of milt, and fair-to-poor in the other two samples. As a result, the milt was not expected to be sufficiently motile for the wet fertilization test, since this procedure requires actively swimming milt to accomplish fertilization (Brix et al. 2010). The milt from the two males that produced some motility was used to initiate both wet and dry fertilization tests and, although the dry fertilization test produced acceptable fertilization (i.e., met the requirements of >70% fertilized eggs, as specified in Environment Canada [1998]), the wet fertilization test produced practically no fertilization and was discontinued after about two weeks of exposure.

Consequently, a second sampling event was conducted on November 19, during which a toxicologist from Nautilus Environmental participated in the collection of adult fish and initiated the exposure on-site on the day of collection in order to reduce the holding time of the milt and meet the recommendation of Brix et al. (2010) that milt be held for <6 hours. Eggs from three female fish and milt from four males were collected between 2:00 and 3:00 pm. A wet fertilization test was initiated upon arrival at the dock between 5:30 and 6:00 pm. A dry fertilization test was initiated at approximately 6:30 pm. The eggs were then held in their test solutions in a cooler overnight, and were transported by road to the Nautilus Environmental laboratory the following morning. In this case, the wet fertilization test was successful, but the dry fertilization test produced poor fertilization. Consequently, the outcome of the November 15 and 19 tests was that one successful wet fertilization test and one successful dry fertilization test were performed, but these tests used eggs from different batches of adults.

2.1.2 Arctic Grayling collection

Arctic Grayling were collected by electrofishing in a tributary to the Sukunka River, near Chetwynd, BC, on May 21, 2013. A toxicologist from Nautilus Environmental participated in the fish collection so that the fertilization exposures could be initiated as soon as practical following collection. Fish collection occurred between 10:00 am and noon, during which time fish were held in a pen constructed using a small seine net at the side of the river. The adults were anaesthetized using clove oil at approximately noon and stripped in a similar manner to the procedures described above for Lake Trout, with the exception that as a result of limited milt production from each male, milt was collected using a glass Pasteur pipette as it was expressed from the male and placed into individual 20-mL glass vials. Eggs were collected successfully from two female fish and milt from four males. The fish were revived following spawning in the pen and released after approximately one hour once they had fully recovered.

Efforts to collect additional female fish were not successful and, consequently, since sufficient eggs had been obtained for 3 replicates of 30 eggs (rather than 4 replicates of 30 eggs, as originally planned) for each of the wet and dry fertilization exposures, the test was initiated using this modification to the study design.

The eggs were fertilized for the wet and dry fertilization tests upon arrival in Fort St John, between 5:00 and 6:00 pm on the day of collection. The eggs were held in a refrigerator overnight at approximately 6°C in their test solutions, and transported in a cooler by air to the Nautilus Environmental laboratory the following day.

2.2 Toxicity test solutions

The composition of the synthetic lake water used for the study was based on concentrations of major ions present in Snap Lake. The synthetic lake water was prepared by dissolving reagent-grade sodium, potassium, calcium, and magnesium salts (i.e., NaCl, KCl, $MgCl_2.6H_2O$, $MgSO_4$, $CaCl_2.2H_2O$, and $NaHCO_3$) in dechlorinated municipal tapwater; concentrations of salts added to prepare the water are summarized in Table 1. The nominal TDS concentration of the synthetic lake water was approximately 1,500 mg/L, with individual ions present in ratios representative of the current site-specific receiving environment conditions in Snap Lake.

Dilutions of the synthetic lake water were then prepared using dechlorinated municipal (Metro Vancouver) tapwater, which is a very soft water (hardness of approximately 12 mg/L as $CaCO_3$), and with a 0.67 times dilution factor to achieve a nominal concentration series of 1,500, 1,000, 667, 444, and 296 mg TDS/L. The test solutions were analyzed for ionic composition at test initiation and termination, as well as at two intermediate periods for the Lake Trout test and one intermediate period for the Arctic Grayling test. Analytical chemistry was performed by ALS Laboratory Group (Burnaby, BC) to verify the concentrations of the major ions, which were then used to calculate TDS concentrations.

The TDS concentrations were also measured gravimetrically. These data are provided in the report appendices for information purposes, but were not used in the statistical analyses of the data. Actual measured TDS concentrations presented in this report were calculated from measured concentrations of ionic constituents (spreadsheets showing these TDS calculations, as well as the ALS analytical reports, are provided in the report appendices).

Table 1. Concentrations (mg/L) of salts used to prepare synthetic TDS mixtures.

Constituent added	Addition rate (mg/L)
NaCl	291.8
KCl	26.3
$MgCl_2.6H_2O$	35.2
$MgSO_4$	161.3
$CaCl_2.2H_2O$	1,106.1
$NaHCO_3$	185.3
Total (excluding hydration water)	1,516.2

2.3 Test procedures

The toxicity tests were conducted according to procedures summarized in Table 2, which were adapted from Environment Canada (1998) test methods for embryo-alevin-fry lifestages of Rainbow Trout.

Dry fertilization was accomplished following procedures specified in Environment Canada (1998). Eggs from each female fish were fertilized separately in the Ziploc containers that they were collected in, using milt pooled from multiple males and delivered with a glass Pasteur pipette. The eggs and milt were gently mixed and the containers were left for approximately 20 minutes for fertilization to occur, at which time the eggs were transferred into rearing chambers (4-L food-grade plastic tubs) containing the test solutions, so that water hardening, which involves swelling of the egg and hardening of the chorion resulting from water intake, would take place in the presence of the test solutions.

Wet fertilization was performed using procedures that were adapted from Stekoll et al. (2009) and Brix et al. (2010). For each replicate, 30 eggs were placed on one side of a 175-mL glass container and 20 µL of milt was delivered using a pipette to the other side of the container; there was no opportunity for the milt to contact the eggs or ovarian fluid prior to introduction of the test solution. Test solution was then added to the containers using a volumetric pipettor. In the case of Lake Trout, 50 mL of test solution was introduced, whereas for Arctic Grayling, 20 mL of test solution was delivered, since these eggs were much smaller. The containers were then mixed by swirling, and left for approximately 5 to 10 minutes, at which point approximately 80% of the solutions was decanted and replaced with fresh solution to remove the majority of the remaining milt. The eggs were then transferred in these solutions to 250-mL (for Lake Trout) or 125-mL (for Arctic Grayling) disposable plastic containers, filled completely with additional test solution, and lids were attached such that there was no head space. This procedure ensured that the exposure to the test solutions was initiated prior to fertilization.

Four replicates were used for the Lake Trout tests and three for the Arctic Grayling tests, each containing 30 eggs. The Arctic Grayling test was initiated with three replicates rather than four because, as previously noted, insufficient adults had been caught to provide sufficient eggs for four replicates.

The eggs were introduced into the test containers using a blocked design, with each replicate containing eggs from a single female fish. In this manner, the performance of the individual

fish could be accounted for in the event that any of the females produced poor quality eggs. In the case of the wet fertilization test using Lake Trout, because only three adult females had been caught, replicates A and B were initiated using eggs from the first female, whereas replicates C and D were initiated with eggs from the second and third female, respectively. For the Arctic Grayling tests, only two adults were caught; the first female was used for replicates A and B, and the second female was used for replicate C.

The test containers were randomized within each test set-up to account for subtle temperature variations within the environmental chamber. The fish were reared in an environmental chamber with air conditioning and a digital thermostat; temperature was maintained at 7 ± 1°C. Prior to hatching of the fish, the chamber was kept dark (24-hr) and sufficient low-level lighting was provided during water renewals by a single incandescent bulb. The test containers were placed on shelves and black plastic was used to shield the containers. Following hatch, the chamber was placed on a 16:8 hr light:dark photoperiod using low-level lighting and the black plastic was removed.

Test chambers were provided with continuous aeration just below the surface of the water using thin plastic tubing. Aeration was sufficient to maintain dissolved oxygen concentrations close to saturation, while providing gentle mixing of the water in the test containers throughout the exposure period.

Approximately 80% of the test solutions were renewed three times per week with freshly-prepared solutions until the fish reached the swim-up stage and feeding commenced, at which point, solution renewals were performed daily for the next 30 days of feeding. For the first nine days of feeding of the Lake Trout, a 50% solution renewal was performed on a daily basis; however, this was increased to 80% daily renewal thereafter (see Section 3.1 for details of the rationale for this procedural modification) and throughout the feeding period associated with the Arctic Grayling tests. Prior to each solution replacement, temperature, pH, and dissolved oxygen were measured in both the water in the test containers and the freshly prepared solutions, and mortalities were recorded and removed at each solution renewal. Care was taken to make sure that the embryos were not disturbed by turbulence during the solution renewal process.

Once yolk sac absorption was complete, the fry were fed daily using freshly-hatched *Artemia* nauplii. Lake Trout were fed with 2 mL of concentrated <24-hr old *Artemia* for the first five days of feeding, and then 4 mL of *Artemia* per day on days 6 and 7. This feeding rate was

reduced back to 2 mL per day after day 7 of feeding and for the remainder of the exposure, because a number of mortalities were observed in three of the test replicates that appeared to be related to a build-up of excess food in the test containers. Arctic Grayling were fed with 1 mL of concentrated <24-hr old *Artemia* per day for the first 10 days of feeding, 1.5 mL for the next 10 days, and 2 mL for the final 10 days of the test. The tests ended 30 days following initiation of feeding. At the end of the tests, percent surviving fish, and growth metrics (length and dry weight) were evaluated as test endpoints. Observations were also made of any visible deformities.

Statistical calculations were based on measured TDS concentrations determined as the average of measurements conducted at the start, interim periods and end of the tests. Statistical analyses for the test results were performed using CETIS (Tidepool Scientific Software 2012).

Table 2. Summary of test conditions: embryo-alevin-fry toxicity test.

Test organism source	Wild collected Lake Trout (Shuswap Lake) and Arctic Grayling (Sukunka River tributary)
Test organism age	Eggs and milt; initiated using both wet and dry fertilization
Test type	Static-renewal (three times per week, except daily during the 30-day feeding period)
Test duration	Fertilization to 30 days post-swim-up
Test vessel	4-L plastic containers
Test volume	2 L
Test replicates	4 replicates for Lake Trout; 3 replicates for Arctic Grayling
No. of organisms	30 per replicate
Test temperature	7 ± 1°C
Feeding	*Artemia* fed daily for 30 days following swim-up
Photoperiod	24 hours dark until hatch; 16:8 hr light:dark thereafter
Aeration	Gentle aeration throughout test
Test protocol	Environment Canada (1998)
Test endpoints	Survival, length, dry weight of fry
Test acceptability criterion for controls	≥65% normal surviving fry

2.4 QA/QC

Nautilus follows a comprehensive QA/QC program to ensure that all data generated are of high quality and are scientifically defensible. To meet these objectives, Nautilus implements a number of quality control procedures:

- Negative controls to ensure that appropriate testing performance criteria are met;
- Positive controls to assess the health and sensitivity of the test organisms;
- Use of appropriate species, life stage, and test methods to meet the study objectives;
- Appropriate number of replicates to allow for proper statistical analyses;
- Calibration and proper maintenance of instruments to ensure accurate measurements;
- Proper documentation and recordkeeping to allow traceability of performance;
- Adequate supervision and training of staff to ensure that methods are followed;
- Proper handling and storage of samples to ensure sample integrity;
- Procedures in place to address issues that may arise during testing and ensure the implementation of appropriate corrective actions; and,
- Rigorous review of data by a Registered Professional Biologist to ensure they are of good quality and are scientifically defensible prior to release to the client.

3.0 RESULTS AND DISCUSSION

Copies of bench-sheets from the tests and printouts of statistical analyses are provided in Appendices A and B for the Lake Trout and Arctic Grayling tests, respectively. Results of analytical confirmations of TDS concentrations in the test solutions are provided in Appendix C.

The results of toxicity tests using Lake Trout are shown in Tables 3 and 4 for the dry and wet fertilization tests, respectively. In the dry fertilization test, the most sensitive endpoint was survival, which produced an LC20 of 991 mg/L TDS; length and dry weight of surviving fry were not adversely affected, resulting in point estimates for growth (i.e., IC20 and IC50 for length and dry weight of fish) exceeding the highest TDS test concentration (i.e., >1,490 mg/L). In the wet fertilization test, the LC20 for survival and the point estimates (IC20 and IC50) for growth were each >1,484 mg/L.

The results for toxicity tests using Arctic Grayling are provided in Tables 5 and 6 for the dry and wet fertilization tests, respectively. No adverse effects were observed in either test, resulting in LC20 estimates for survival and IC20 estimates for growth of >1,419 mg/L TDS for the dry fertilization test and >1,414 mg/L TDS for the wet fertilization test.

In addition to these standard endpoints, other observations were made regarding the frequency of deformities and behaviour of hatched fish. The overall deformity rate was <1% for both species and there were no observations of abnormal behaviour. Consequently, statistical analyses of these data were not conducted.

The LC20 and IC20 are presented here as reasonable thresholds for adverse effects from these tests since the data were analyzed using linear interpolation rather than the probit method because of a failure of fit of the probit model. Endpoints such as the LC10 can provide misleading results when analyzed using linear interpolation, particularly since this degree of adverse effect falls well within the range of normal responses for a control exposure (Environment Canada, 2005).

The results presented here demonstrate that fertilization was not affected by exposure to the TDS test solutions, since the wet fertilization exposure was not more sensitive than the dry fertilization test, although it should be noted that the results from the wet and dry fertilization tests using Lake Trout were not directly comparable, since they were initiated on different days using gametes from different fish. Regardless, there was no evidence of increased sensitivity

associated with the fertilization endpoint, and these results are consistent with those reported by Brix et al. (2010), who reported that fertilization of Arctic Grayling and Dolly Varden eggs was not adversely affected at TDS concentrations of 2,782 and 1,817 mg/L, respectively.

The results reported here are not consistent with those reported by Stekoll et al. (2009) for exposures using eggs of various anadromous salmon species, which indicated that TDS concentrations as low as 250 mg/L impaired fertilization of salmon eggs, and produced subsequent developmental effects on the developing fry. This difference may reflect species-specific differences in sensitivity between the Pacific salmon species tested by Stekoll et al. (2009) and the species tested here, may reflect differences in TDS composition between Snap Lake and the solutions tested by Stekoll et al. (2009), and/or may provide support for the hypothesis presented by Brix et al. (2010) that the results presented by Stekoll et al. (2009) were confounded by poor milt quality. Regardless of the reason(s) for this difference, the results presented here demonstrate that fertilization of Lake Trout and Arctic Grayling was not sensitive to exposure to TDS having the ionic composition found in Snap Lake, and that a reasonable estimate of the threshold for adverse effects on this species was 991 and >1,484 mg/L TDS in the two tests conducted using Lake Trout, and >1,419 and >1,414 mg/L TDS in the two tests using Arctic Grayling.

Table 3. Results of the Lake Trout dry fertilization embryo-alevin-fry test using TDS.

TDS Concentration (mg/L)		Survival	Dry weight	Total length
Nominal	Measured	(%)	(mg)	(mm)
Control	21	80.8 ± 12.6	35.9 ± 1.9	33.8 ± 0.8
296	314	75.0 ± 20.8	36.1 ± 2.7	33.6 ± 0.6
444	452	68.3 ± 27.6	39.1 ± 6.2	34.2 ± 0.3
667	674	76.7 ± 15.6	36.4 ± 1.8	34.1 ± 0.3
1,000	995	64.2 ± 17.9	39.1 ± 1.9	33.9 ± 0.5
1,500	1,490	65.0 ± 37.2	39.8 ± 5.3	33.6 ± 0.3
Point estimates (mg/L measured TDS)				
	LC50	>1,490	--	--
	LC20	991 (NC)	--	--
	IC50	--	>1,490	>1,490
	IC20	--	>1,490	>1,490

NC Not calculable

Table 4. Results of the Lake Trout wet fertilization embryo-alevin-fry test using TDS.

TDS Concentration (mg/L)		Survival	Dry weight	Total length
Nominal	Measured	(%)	(mg)	(mm)
Control	22	89.2 ± 5.0	33.3 ± 1.2	32.4 ± 0.5
296	312	87.5 ± 8.3	32.6 ± 1.8	32.4 ± 0.3
444	451	86.7 ± 8.2	34.5 ± 3.4	32.5 ± 0.7
667 *	671	73.3 ± 0.0	36.4 ± 3.2	32.9 ± 0.7
1,000 *	994	83.3 ± 9.4	33.6 ± 5.4	32.7 ± 1.2
1,500	1,484	80.0 ± 23.7	35.3 ± 4.5	32.7 ± 0.8
Point estimates (mg/L measured TDS)				
	LC50	>1,484	--	--
	LC20	>1,484	--	--
	IC50	--	>1,484	>1,484
	IC20	--	>1,484	>1,484

* One replicate of the 671 mg/L treatment and two replicates of the 994 mg/L treatment were excluded as a result of mortalities associated with over-feeding of the fry during a 3-day period of the exposure.

Table 5. Results of the Arctic Grayling dry fertilization embryo-alevin-fry test using TDS.

TDS Concentration (mg/L)		Survival	Dry weight	Total length
Nominal	Measured	(%)	(mg)	(mm)
Control	22	82.2 ± 3.8	7.2 ± 0.5	21.0 ± 0.3
296	325	91.1 ± 6.9	7.2 ± 1.0	21.0 ± 0.4
444	454	84.4 ± 6.9	7.5 ± 0.3	21.4 ± 0.2
667	646	93.3 ± 5.8	7.1 ± 0.6	21.0 ± 0.5
1,000	957	75.0 ± 23.7	8.1 ± 0.9	21.5 ± 0.1
1,500	1,419	88.9 ± 11.7	7.3 ± 1.4	21.0 ± 0.1
Point estimates (mg/L measured TDS)				
	LC50	>1,419	--	--
	LC20	>1,419	--	--
	IC50	--	>1,419	>1,419
	IC20	--	>1,419	>1,419

Table 6. Results of the Arctic Grayling wet fertilization embryo-alevin-fry test using TDS.

TDS Concentration (mg/L)		Survival	Dry weight	Total length
Nominal	Measured	(%)	(mg)	(mm)
Control	23	77.0 ± 11.3	7.3 ± 0.5	21.4 ± 0.5
296	326	68.7 ± 18.4	7.9 ± 0.6	21.3 ± 0.4
444	453	78.1 ± 16.2	7.4 ± 0.8	21.0 ± 0.6
667	650	76.8 ± 9.1	7.6 ± 0.7	21.3 ± 0.3
1,000	954	83.7 ± 4.3	7.6 ± 0.5	21.4 ± 0.1
1,500	1,414	73.0 ± 9.3	7.8 ± 0.6	21.1 ± 0.4
Point estimates (mg/L measured TDS)				
	LC50	>1,414	--	--
	LC20	>1,414	--	--
	IC50	--	>1,414	>1,414
	IC20	--	>1,414	>1,414

3.1 QA/QC

Measured TDS concentrations were in good agreement with target concentrations, and measurements conducted at the end of the test were similar to those measured at test initiation and at intermediate periods during the tests, indicating that the exposure concentrations were consistent.

The performance of the control treatments met acceptance criteria specified in the test method and the water quality (pH, temperature, dissolved oxygen) remained within acceptable ranges during the tests, with the exception of occasional temperature measurements of 8.5°C in the Lake Trout test and a measurement during the first two days of the Arctic Grayling test of 5.5°C which marginally deviated from the target range of 7±1°C. These minor temperature deviations would not be expected to have any bearing on the outcome of testing.

Three replicates in the Lake Trout wet fertilization test (one replicate of the 671 mg/L TDS exposure and two replicates of the 994 mg/L TDS exposure) exhibited a significant number of mortalities over a three-day period between the 7th and 9th day of feeding that appears to have been related to over-feeding of the fry. A number of mortalities were observed in these replicates at the same time, and their presence was associated with build-up of a significant quantity of uneaten *Artemia* nauplii in the bottom of these test containers. The feeding rate had been increased just prior to this event, and was reduced following this occurrence in both the wet and dry fertilization tests, and the water renewal volume was increased from 50% to 80% renewal for the remainder of the test. The rate of mortalities was low in these replicates for the remainder of exposure following this change to the procedure. The fact that mortalities ceased following the change in procedure, and the fact that mortalities were not observed in a dose-dependent manner, indicated that this effect was most likely an artifact of the over-feeding, rather than being associated with exposure to the test solutions. Consequently, these three test replicates were excluded during statistical analyses of the test data for the wet fertilization test.

A container that Arctic Grayling eggs were transported in for one of the replicates of the 954 mg/L TDS from the wet fertilization exposure broke during transportation from the field to the laboratory. Consequently, there were only two replicates for this test concentration, rather than three.

Reference toxicant (positive control) tests were not conducted in the current investigation since the species evaluated here are not routinely tested in the laboratory and, consequently, there were no historical data with which to compare the sensitivity of the test organisms.

4.0 REFERENCES

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APPENDIX A – Toxicity test data for Lake Trout

Lake Trout

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements
~~(Dry Fertilization)~~

Client: Golder
Sample ID: Synthetic Effluent-TDS
Work Order #: n/a

Start Date & Time: Nov 16/12 @ 1415h + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: S. namaycush

Control Concentration (mg/L TDS)	Days													
	0	JAB 3		JAB 5		7 JAB		10 JAB		12 JAB		14 JAB		17
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	8.0	7.5	8.0	7.5	7.5	8.0	7.5	7.5	7.5	7.5	7.0	7.5	7.5	8.0
DO (mg/L)	12.0	11.9	11.3	12.1	12.1	12.0	11.7	11.9	11.9	12.1	12.1	12.0	12.0	11.8
pH	7.1	~~6.77~~ JAB	6.9	7.1	7.1	7.3	7.1	7.1	7.1	7.3	7.2	7.0	7.1	7.0
Cond. (µS/cm)	32	31		34		33		32		30		32		33
Initials	JAB	JAB		JAB		JAB		JAB		JBF		JAB		JAB

296 Concentration	Days													
	0	JAB 3		5 JAB		7 JAB		10 JAB		12 JAB		14 JAB		17
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	8.0	8.0	7.5	7.5	8.0	7.5	7.5	7.5	7.5	7.0	7.5	7.5	8.0
DO (mg/L)	12.0	11.8	11.4	12.1	12.1	12.0	11.6	11.9	11.9	12.1	12.1	12.0	12.0	11.8
pH	7.3	~~6.77~~ JAB	6.9	7.3	7.3	7.4	7.3	7.4	7.4	7.3	7.1	7.3	7.2	7.2
Cond. (µS/cm)	623	606		601		617		618		611		624		621
Initials	JAB	JAB		JAB		JAB		JAB		JBF		JAB		JAB

667 Concentration	Days													
	0	JAB 3		5 JAB		7 JAB		10 JAB		12 JAB		14 JAB		17
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	8.0	7.5	7.5	7.5	8.0	7.5	8.0	7.5	7.5	7.0	7.5	7.5	8.0
DO (mg/L)	12.0	11.7	11.6	12.1	12.1	12.0	11.8	11.9	11.9	12.1	11.8	12.0	12.0	11.8
pH	7.4	~~7.35~~ JAB	7.3	7.3	7.4	7.5	7.5	7.5	7.5	7.4	7.6	7.5	7.6	7.4
Cond. (µS/cm)	1312	1287		1311		1284		1279		1272		1268		1275
Initials	JAB	JAB		JAB				JAB		JBF		JAB		JAB

1500 Concentration	Days													
	0	JAB 3		JAB 5		7 JAB		10 JAB		12 JAB		14 JAB		17
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	8.0	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.5	7.0	7.5	7.5	8.0
DO (mg/L)	12.0	11.8	11.4	12.1	12.1	12.0	11.8	11.9	11.9	12.1	11.8	12.0	12.0	11.8
pH	7.6	~~7.79~~ JAB	7.7	7.6	7.6	7.8	7.7	7.8	7.7	7.6	7.6	7.7	7.7	7.6
Cond. (µS/cm)	2770	2760		2540		2710		2690		2640		2650		2630
Initials	JAB	JAB		JAB		JAB		JAB		JBF		JAB		JAB

DO meter: DO-1 pH meter: pH - 1 Conductivity meter: C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JAB, JBF
Reviewed by: [illegible]
Date reviewed: 17/6/13

Sample Description: TDS: 1500, 1000, 667, 444, 296 mg/L

Comments: "Days" refer to duration of dry fertilization test. For wet fertilization, subtract three, since the wet fertilization test was initiated three days after dry.

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements
~~(Wet Fertilization)~~

Client: Golder
Sample ID: Synthetic Effluent-TDS
Work Order #: n/a
Start Date & Time: Nov 16/12 @ 14:15h + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: S. ramaycush

Control Concentration (mg/L TDS)	Days													
	17	19 8 JAB		JBF 8 21		24 10 JAB		26 11 JAB		28 12 JAB		31 13 JAB		33 14 JAB
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	7.5	7.5	7.5	7.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.5
DO (mg/L)	12.0	11.7	11.9	12.0	11.9	11.5	11.6	11.4	11.9	11.9	12.1	11.8	11.7	11.9
pH	7.0	7.2	7.1	7.0	6.8	6.7	6.8	6.7	6.7	6.9	7.0	6.5	7.0	7.0
Cond. (µS/cm)	~~33~~	31		30		32		30		31		29		30
Initials	JAB	JAB		JBF		JAB		JAB		JAB		JAB		JAB

296 Concentration	Days													
	17	19 8 JAB		JBF 8 21		24 10 JAB		26 11 JAB		28 12 JAB		31 13 JAB		33 14 JAB
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	8.0	7.5	7.5	7.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.5
DO (mg/L)	12.0	11.7	12.0	11.7	11.9	11.4	11.7	11.9	11.8	12.0	12.1	11.8	11.7	11.6
pH	7.3	7.5	7.3	6.7	6.9	7.1	7.0	7.2	7.0	7.3	7.2	7.4	7.4	7.1
Cond. (µS/cm)		603		584		600		601		605		603		617
Initials	JAB	JAB		JBF		JAB		JAB		JAB		JAB		JAB

667 Concentration	Days													
	17	19 8 JAB		JBF 8 21		24 10 JAB		26 11 JAB		28 12 JAB		31 13 JAB		33 14 JAB
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	8.0	7.5	7.5	7.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
DO (mg/L)	11.9	11.7	12.0	11.8	11.9	11.6	11.6	11.9	11.8	11.7	12.1	11.8	11.7	11.7
pH	7.4	7.6	7.4	7.3	~~6.9~~ ①	7.4	7.5	7.4	7.3	7.4	7.2	7.6	7.7	7.4
Cond. (µS/cm)		1269		~~726~~ 1261		1232		1233		1241		1253		1297
Initials	JAB	JAB		JBF		JAB		JAB		JAB		JAB		JAB

1500 Concentration	Days													
	17	19 8 JAB		JBF 8 21		24 10 JAB		26 11 JAB		28 12 JAB		31 13 JAB		14 JAB
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5	8.0	7.5	7.5	7.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
DO (mg/L)	11.9	11.7	12.0	12.0	11.9	11.6	11.6	11.9	11.9	11.9	12.1	11.8	11.7	11.9
pH	7.5	7.6	7.7	7.7	7.5	7.7	7.7	7.7	7.6	7.6	7.4	7.8	7.9	7.6
Cond. (µS/cm)		2660		2630		2650		2590		2620		2610		2680
Initials	JAB	JAB		JBF		JAB		JAB		JAB		JAB		JAB

DO meter: DO-1 **pH meter:** pH - 1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JAB, JBF
Reviewed by: [illegible]
Date reviewed: 17/6/13

Sample Description: Total Dissolved Solids

Comments: ① 7.2

JAB

~~7-d~~ Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: n/a

Start Date & Time: November 16/12 @ 1415h + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S.namaycush*

mg/L TDS Concentration Control	Days													
	33	34		35		36		37		38		39		40
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	8.0		8.0	7.5	7.5		7.5		7.5	7.5	7.5		8.0	7.5
DO (mg/L)	11.3		11.5	11.8	11.5		11.6		11.5	11.5	11.7		11.2	11.7
pH	7.0		7.0	7.0	7.1		6.8		6.8	6.7	7.4		6.7	6.9
Cond. (µS/cm)			32	29						30				29
Initials	JAB	JAB		JAB		~		~		JJT		JJT		JAB

mg/L TDS Concentration 296	Days													
	33	34		35		36		37		38		39		40
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	8.0		8.0	8.0	7.5		7.5		7.5	7.5	7.5		7.5	8.0
DO (mg/L)	11.4		11.4	11.8	11.6		11.5		11.5	11.6	11.7		11.4	11.7
pH	6.9		7.2	6.9	7.2		6.7		6.9	7.0	7.3		6.6	7.3
Cond. (µS/cm)			621	611						631				633
Initials	JAB	JAB		JAB		—		~		JJT		JJT		JAB

mg/L TDS Concentration 667	Days													
	33	34		35		36		37		38		39		40
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5		8.0	8.0	7.5		7.5		7.5	7.5	7.5		7.5	8.0
DO (mg/L)	11.5		11.5	11.7	11.6		11.5		11.4	11.8	11.7		11.5	11.8
pH	7.2		7.3	7.3	7.4		~~7.3~~ 7		7.4	7.4	7.5		7.0	7.4
Cond. (µS/cm)			1297	1274						1283				1286
Initials	JAB	JAB		JAB		~		~		JJT		JJT		JAB

mg/L TDS Concentration 1500	Days													
	33	34		35		36		37		38		39		40
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)	7.5		8.0	8.0	7.5		~~7.5~~ 7.5		7.5	8.0	7.5		7.5	7.5
DO (mg/L)	11.7	Yong	11.8	12.0	11.7		11.6		11.2	11.6	11.7		11.5	11.7
pH	7.4		7.5	7.4	7.6		7.6		7.7	7.7	7.7		7.4	7.7
Cond. (µS/cm)			2710	2720						2690				2680
Initials	JAB	JAB		JAB		~		~		JJT		JJT		JAB

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JAB, JJT, AWD

Reviewed by: [illegible]

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

~~7 d~~ JAB Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: n/a

Start Date & Time: November 16/12 @ 1415h + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S.namaycush*

mg/L TDS Concentration Control	Days														
	40	41		~~JAB 42~~ 41		42		43		44		45		46	
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	old KLB
Temperature (°C)	7.5				7.5	8.0	7.5		~~7.5~~ 8.5		8.0	7.5	7.5	8.0	
DO (mg/L)	11.4		JAB		12.0	11.8	12.0		11.8		11.8	11.7	11.6	11.4	
pH	7.2				6.9	7.1	7.1		7.5		7.3	7.1	7.0	7.3	
Cond. (µS/cm)						29						29		—	
Initials	JAB	JAB		JAB		JAB		JJT		JJT		JAB		KLB	

mg/L TDS Concentration 296	Days														
	40	41		~~JAB 42~~ 41		42		43		44		45		46	
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	old KLB
Temperature (°C)	7.5				7.5	8.0	7.5		7.5		7.5	7.5	7.5	8.0	
DO (mg/L)	11.5				12.0	11.8	12.1		11.8		11.9	11.6	11.7	12.1	
pH	7.3		JAB		7.2	7.3	7.3		7.3		7.3	7.4	7.4	7.1	
Cond. (µS/cm)						613						595		—	
Initials	JAB	JAB		JAB		JAB		JJT		JJT		JAB		KLB	

mg/L TDS Concentration 667	Days														
	40	41		~~JAB 42~~ 41		42		43		44		45		46	
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	old KLB
Temperature (°C)	7.5				7.5	8.0	7.5		7.5		7.5	7.5	7.5	8.0	
DO (mg/L)	11.4		JAB		12.1	11.8	12.1		11.9		11.9	11.7	11.6	12.1	
pH	7.4				7.3	7.4	7.4		7.5		7.5	7.6	7.5	7.4	
Cond. (µS/cm)						1303						1267		—	
Initials	JAB	JAB		JAB		JAB		JJT		JJT		JAB		KLB	

mg/L TDS Concentration 1500	Days														
	40	41		~~JAB 42~~ 41		42		43		44		45		46	
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	old KLB
Temperature (°C)	7.5				7.5	8.0	7.5		7.5		7.5	8.0	7.5	8.0	
DO (mg/L)	11.4		JAB		12.1	11.8	12.1		11.9		12.0	11.7	11.6	12.1	
pH	7.6				7.5	7.4	7.6		7.7		7.8	7.7	7.7	7.5	
Cond. (µS/cm)						2710						2640		—	
Initials	JAB	JAB		JAB		JAB		JJT		JJT		JAB		KLB	

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JAB, JJT, KLB
Reviewed by: [illegible]
Date reviewed: 17/6/13

Sample Description: TDS

Comments:

~~7-d~~ JAB Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: n/a

Start Date & Time: November 16/12 @ 1415h + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S.hamaycush*

mg/L TDS Concentration Control	Days													
		47		48		49		50		51		52		53
	old	new	old	new	old	new	old	new	old	new	old	new	old	~~new~~ old JBF
Temperature (°C)		8.0	7.5	/	8.0	7.5	7.5	|	7.5	|	7.5	7.5	7.5	8.5
DO (mg/L)		11.7	12.0	/	11.9	12.1	12.1	|	11.8	|	11.6	11.9	12.0	12.1
pH		6.6	6.9	/	6.8	7.1	7.2	|	7.1	|	7.0	7.1	7.2	6.7
Cond. (µS/cm)		30		35		30		|		|	31		31
Initials		JAB		JBF		JAB		~		~		JAB		JBF

mg/L TDS Concentration 296	Days													
		47		48		49		50		51		52		53
	old	new	old	new	old	new	old	new	old	new	old	new	old	~~new~~ old JBF
Temperature (°C)		7.5	7.5	/	7.5	7.5	7.5	|	7.5	|	7.5	7.5	7.5	8.0
DO (mg/L)		12.1	12.0	/	12.1	12.1	12.1	|	11.7	|	11.5	11.9	12.0	12.1
pH		7.1	7.2	/	7.2	7.5	7.4	|	7.4	|	7.4	7.3	7.4	7.2
Cond. (µS/cm)		621		618		593		|		|	631		627
Initials		JAB		JBF		JAB		~		~		JAB		JBF

mg/L TDS Concentration 667	Days													
		47		48		49		50		51		52		53
	old	new	old	new	old	new	old	new	old	new	old	new	old	~~new~~ old JBF
Temperature (°C)		8.0	7.5	/	7.5	8.0	7.5	|		|	7.5	7.5	7.5	8.0
DO (mg/L)		12.0	11.9	/	12.0	12.1	12.1	|	11.4	|	11.6	11.9	11.9	12.2
pH		7.3	7.2	/	7.3	7.6	7.6	|	7.7	|	7.5	7.4	7.5	7.3
Cond. (µS/cm)		1256		1261		1281		|		|	1264		1273
Initials		JAB		JBF		JAB		~		~		JAB		JBF

mg/L TDS Concentration 1500	Days													
		47		48		49		50		51		52		53
	old	new	old	new	old	new	old	new	old	new	old	new	old	~~new~~ old JBF
Temperature (°C)		8.0	7.5	/	8.0	8.0	8.0	|	7.5	|	7.5	7.5	7.5	8.0
DO (mg/L)		12.0	11.9	/	11.9	12.1	12.1	|	11.2	|	11.4	11.9	12.0	12.1
pH		7.6	7.5	/	7.6	7.8	7.7	|	7.8	|	7.7	7.7	7.7	7.6
Cond. (µS/cm)		2680		2580		2680		|		|	2660		2700
Initials		JAB		JBF		JAB		~		~		JAB		JBF

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JAB, AWD, JBF

Reviewed by: M

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

~~7-d~~ JAB Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: n/a

Start Date & Time: November 16/12 @ 1415h + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S.hamaycush*

mg/L TDS Concentration	Days														
		54		55		56		59		61		63			
Control	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.0	7.5		8.0	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.5		
DO (mg/L)		11.9	11.7		11.6	11.8	11.4	11.6	11.9	12.0	11.9	12.0	11.8		
pH		6.7	6.6		6.9	6.7	6.7	7.1	6.7	6.8	7.2	7.1	7.1		
Cond. (µS/cm)		32				31		32		32		33			
Initials		JAB		JAB		JAB		JAB		JAB		JAB			

mg/L TDS Concentration	Days														
		54		55		56		59		61		63			
296	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.5	7.5		7.5	7.0	7.5	7.5	7.5	7.5	7.5	8.0	7.5		
DO (mg/L)		11.9	11.7		11.6	11.8	11.4	11.7	11.9	12.0	11.9	12.2	11.9		
pH		7.3	7.2		7.2	7.2	7.1	7.3	7.3	7.2	7.4	7.4	7.4		
Cond. (µS/cm)		656				653		618		629		642			
Initials		JAB		JAB		JAB		JAB		JAB		JAB			

mg/L TDS Concentration	Days														
		54		55		56		59		61		63			
667	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.5	7.5		7.5	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.5		
DO (mg/L)		11.9	11.7		11.6	11.7	11.5	11.7	11.9	12.0	11.9	12.2	11.9		
pH		7.5	7.5		7.3	7.4	7.3	7.6	7.5	7.6	7.6	7.6	7.6		
Cond. (µS/cm)		1283				1297		1289		1306		1296			
Initials		JAB		JAB		JAB		JAB		JAB		JAB			

mg/L TDS Concentration	Days														
		54		55		56		59		61		63			
1500	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.5	7.5		7.5	7.5	7.5	8.0	7.5	8.0	7.5	7.5	7.5		
DO (mg/L)		11.9	11.7		11.6	11.6	11.5	11.7	11.9	12.0	11.9	12.2	11.9		
pH		7.8	7.8		7.7	7.7	7.5	7.7	7.7	7.8	7.7	7.7	7.6		
Cond. (µS/cm)	~~27~~ JAB	2730				2700		2680		2710		2740			
Initials		JAB		JAB		JAB		JAB		JAB		JAB			

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JAB
Reviewed by: M
Date reviewed: 17/6/13

Sample Description: TDS

Comments:

~~7-d~~ Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16/12 @1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. hamaycush*

mg/L TDS Concentration Control	Days													
		66		68		70		73		75		77		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.0	8.0	
DO (mg/L)		12.2	12.0	12.2	12.1	12.2	12.1	12.1	11.7	12.0	11.6	12.0	12.2	
pH		7.1	7.2	6.7	6.7	7.0	6.7	6.7	7.1	6.7	7.0	7.0	6.7	
Cond. (µS/cm)		34		33		33		33		32		34		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration 296	Days													
		66		68		70		73		75		77		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	7.5	7.5	7.5	~~7.5~~	7.5	7.5	7.5	7.5	7.5	7.0	8.0	
DO (mg/L)		12.2	12.2	12.2	12.2	12.2	12.2	11.9	11.8	12.0	11.6	12.0	12.2	
pH		7.0	7.1	7.2	7.0	7.5	7.0	7.4	7.4	7.3	7.4	7.2	7.1	
Cond. (µS/cm)		652		624		632		621		625		608		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration 667	Days													
		66		68		70		73		75		77		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.0	7.5	7.0	8.0	
DO (mg/L)		12.2	12.0	12.2	12.2	12.2	12.0	12.0	11.9	12.0	11.7	12.1	12.2	
pH		7.3	7.5	7.1	7.3	7.5	7.3	7.6	7.5	7.5	7.5	7.5	7.3	
Cond. (µS/cm)		1318		1305		1294		1296		1301		1315		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration 1500	Days													
		66		68		70		73		75		77		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.0	8.0	
DO (mg/l)		12.2	12.1	12.2	12.2	12.2	12.2	11.8	11.8	11.8	11.6	12.2	12.2	
pH		7.8	7.8	7.5	7.6	7.6	7.6	7.7	7.8	7.7	7.8	7.6	7.6	
Cond. (µS/cm)		2760		2740		2730		2730		2730		2680		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

DO meter: DO-2 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF

Reviewed by: [illegible]

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

~~7-d~~ Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16/12 @1415 +Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. namaycush*

mg/L TDS Concentration Control	Days													
		JBF 6680		82		84		87		89		91		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.0	8.0	7.0	7.5	7.0	7.5	7.0	7.5	7.5	7.5	8.0	8.0	
DO (mg/L)		12.0	12.1	11.9	12.2	12.1	11.5	12.2	12.2	11.9	11.7	12.2	11.8	
pH		6.8	6.9	6.6	6.9	6.6	7.1 JBF	7.1	7.2	6.7	7.0	6.5	7.0	
Cond. (µS/cm)		35		33		35		36		34		34		
Initials		JBF		JBF		JBF 35 JBF		JBF		JBF		JBF		

mg/L TDS Concentration 296	Days													
		JBF 6680		82		84		87		89		91		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	7.5	7.0	7.5	7.0	7.5	7.5	7.5	7.5	7.5	7.5	8.0	
DO (mg/L)		12.2	12.1	11.9	12.1	12.0	11.6	12.2	12.2	11.8	11.7	12.1	11.9	
pH		7.2	7.1	7.0	7.0	7.2	7.0	7.2	7.1	7.4	7.0	7.4	7.2	
Cond. (µS/cm)		615		615		618		627		618		615		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration 667	Days													
		JBF 66 80		82		84		87		89		91		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.0	7.5	7.0	7.5	7.0	7.5	7.0	7.5	7.5	7.5	7.5	7.5	
DO (mg/L)		12.2	12.0	11.9	12.1	11.9	11.6	12.2	12.2	11.8	11.6	12.1	11.7	
pH		7.7	7.4	7.5	7.2	7.5	7.1	7.4	7.4	7.7	7.4	7.6	7.3	
Cond. (µS/cm)		1304		1271		1277		1283		1279		1276		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration 1500	Days													
		JBF 6680		82		84		87		89		91		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.5	7.5	
DO (mg/L)		12.2	12.0	12.0	12.0	11.6	11.8	12.2	12.2	11.8	11.5	12.0	11.6	
pH		7.7	7.7	7.5	7.5	7.5	7.6	7.6	7.7	7.8	7.4	7.6	7.6	
Cond. (µS/cm)		~~2760~~ ①		2700		2710		2720		2700		2700		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF

Reviewed by: M

Date reviewed: 17/6/13

Sample Description: TDS

Comments: ① 2700 @ 7.1

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. namaycush*

mg/L TDS Concentration	Days													
		94		96		98		101		103		105		
Control	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.1	8.0	7.5	8.0	7.5	8.0	7.0	7.5	7.0	8.0	7.5	
DO (mg/L)		12.1	12.1	11.7	11.9	11.6	12.0	11.6	12.2	12.0	12.0	11.9	11.9	
pH		7.1	6.8	7.1	6.7	7.1	6.8	6.7	7.0	7.3	7.2	6.9	7.2	
Cond. (µS/cm)		36		36		38		39		38		38		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration	Days													
		94		96		98		101		103		105		
296	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.5	8.0	7.5	8.0	7.5	7.5	7.0	7.5	7.4	7.5	7.5	
DO (mg/L)		12.0	12.0	11.4	11.9	11.8	12.1	12.0	12.0	12.1	12.1	11.8	11.8	
pH		7.3	7.1	7.4	7.4	7.3	6.7	6.9	7.3	7.1	7.1	7.2	7.3	
Cond. (µS/cm)		627		612		609		640		629		621		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration	Days													
		94		96		98		101		103		105		
667	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	7.5	7.5	8.0	7.5	7.5	7.0	7.5	7.0	7.5	7.5	
DO (mg/L)		12.0	12.0	11.5	11.9	11.9	12.1	11.9	12.1	12.2	12.1	11.8	12.0	
pH		7.5	7.4	7.7	7.8	7.6	6.9	7.1	7.6	7.3	7.3	7.4	7.5	
Cond. (µS/cm)		1298		1293		1292		1292		1315		1280		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

mg/L TDS Concentration	Days													
		94		96		98		101		103		105		
1500	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.5	7.5	7.5	8.0	7.5	7.5	7.0	7.5	7.5	7.5	8.0	
DO (mg/L)		12.0	12.1	11.6	11.8	11.7	12.1	11.8	12.2	12.2	12.2	11.8	11.9	
pH		7.9	7.9	7.9	7.8	7.9	7.6	7.6	7.7	7.7	7.7	7.6	7.7	
Cond. (µS/cm)		2710		2720		2730		JBF 2740		2750		2730		
Initials		JBF		JBF		JBF		JBF		JBF		JBF		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF

Reviewed by: [illegible]

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. namaycush*

mg/L TDS Concentration Control	Days													
		108		110		112		JAB H5 113		JAB H7 114		JBF H9 115		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	7.5	7.5	7.5	7.0	7.5		7.3		9.5	7.0	
DO (mg/L)		12.1	12.1	12.1	12.1	11.8	11.8	12.7		11.2		11.8	12.1	
pH		7.1	7.0	7.0	6.9	7.1	7.0	7.0		7.2		7.0	6.2	
Cond. (µS/cm)		36		34		34						32		
Initials		JBF		JBF		JAB		~		~		JBF		

mg/L TDS Concentration 296	Days													
		108		110		112		113 H5 JAB		JAB H7 114		JBF H9 115		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	7.5	7.0	7.5	7.5	7.0		7.5		7.5	7.5	
DO (mg/L)		12.1	12.1	12.1	12.1	11.7	11.8	10.8		11.3		11.8	12.1	
pH		7.2	7.4	7.2	7.3	7.4	7.4	7.1		7.2		7.1	6.8	
Cond. (µS/cm)		636		625		638						640		
Initials		JBF		JBF		JAB		~		~		JBF		

mg/L TDS Concentration 667	Days													
		108		110		112		113 H5 JAB		114 H7 JAB		JBF H9 115		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	7.5	7.0	7.5	7.5	7.5		7.5		7.5	7.0	
DO (mg/L)		12.1	12.1	12.1	12.1	11.8	11.9	10.8		11.2		11.8	12.1	
pH		7.5	7.8	7.4	7.7	7.6	7.5	7.4		7.4		7.3	7.2	
Cond. (µS/cm)		1302		1302		1313						1284		
Initials		JBF		JBF		JAB		~		~		JBF		

mg/L TDS Concentration 1500	Days													
		108		110		112		113 H5 JAB		114 H7 JAB		JBF H9 115		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.5	7.5	7.5	7.5	8.0	7.5		7.5		7.5	7.5	
DO (mg/L)		12.1	12.1	11.9	12.1	11.8	11.8	12.7		11.1		11.8	12.0	
pH		7.8	7.8	7.8	7.7	7.8	7.7	7.6		7.8		7.7	7.7	
Cond. (µS/cm)		2750		2760		2700						2710		
Initials		JBF		JBF		JAB		~		~		JBF		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF, JAB, AWD

Reviewed by:

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. hamaycush*

mg/L TDS Concentration Control	Days														
		116		117		118		119		120		121		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	8.0	7.0	7.5	7.5	7.5	8.0	7.5	|	7.5	|	
DO (mg/L)		12.0	12.2	11.2	12.2	11.9	12.1	11.8	11.9	10.6	|	11.8	|	
pH		7.1	6.7	7.0	6.8	6.8	6.7	6.7	6.5	6.8	|	6.8	|	
Cond. (µS/cm)		33		JBF 36		34		33		~		~		
Initials		JBF		JBF		JBF		JBF						

mg/L TDS Concentration 296	Days														
		116		117		118		119		120		121		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	8.0	7.0	7.5	7.5	7.5	7.5	7.8	|	7.5	|	
DO (mg/L)		12.0	12.2	11.1	12.1	11.9	12.1	11.7	12.1	10.8	|	11.7	|	
pH		7.2	7.1	6.9	7.1	7.0	7.1	6.9	7.1	6.8	|	6.8	|	
Cond. (µS/cm)		642		622		637		618		~		~		
Initials		SBF		SBF		SBF		SBF						

mg/L TDS Concentration 667	Days														
		116		117		118		119		120		121		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.0	8.0	7.0	7.5	7.5	7.5	7.5	7.5	|	7.5	|	
DO (mg/L)		11.8	12.1	11.0	12.1	11.9	11.7	11.9	12.1	10.8	|	11.8	|	
pH		7.4	7.4	7.1	7.4	7.2	7.3	7.1	7.4	7.2	|	7.3	|	
Cond. (µS/cm)		1312		1273		1312		1279		~		~		
Initials		SBF		SBF		SBF		SBF						

mg/L TDS Concentration 1500	Days														
		116		117		118		119		120		121		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.5	8.0	7.0	7.5	7.5	7.5	7.5	7.5	|	7.5	|	
DO (mg/L)		10.9	12.1	11.1	12.1	11.9	11.9	11.8	12.1	11.0	|	11.8	|	
pH		7.5	7.8	7.3	7.6	7.4	7.5	7.3	7.5	7.4	|	7.4	|	
Cond. (µS/cm)		2720		2730		2740		2710		~		~		
Initials		SBF		SBF		SBF		SBF						

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF, AWD

Reviewed by: [signature]

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. hamaycush*

mg/L TDS Concentration Control		Days												
		122		123		124		125		126		127		128
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.0	7.5	7.5	7.5	7.5
DO (mg/L)		11.4	11.9	11.9	12.2	12.1	12.1	11.1	11.8	11.7	12.0	11.6	12.0	11.0
pH		6.8	6.4	7.1	6.6	6.7	6.6	6.5	6.8	7.1	7.0	7.0	7.0	7.2
Cond. (µS/cm)		34		30		32		31		30		30		30
Initials		JBF		JBF		JAB		JBF		JAB		JAB		

mg/L TDS Concentration 296		Days												
		122		123		124		125		126		127		128
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	8.0	7.5	7.5	7.0	7.0	8.0	7.5	7.5	7.5	7.5	7.5	7.5
DO (mg/L)		11.7	12.0	11.9	12.0	12.1	12.1	11.6	11.9	12.1	12.1	11.4	12.0	11.4
pH		7.0	6.8	7.3	6.8	7.2	7.1	6.8	7.3	7.1	7.2	7.2	7.1	7.2
Cond. (µS/cm)		629		612		633		633		622		624		633
Initials		JBF		JBF		JAB		JBF		JAB		JAB		

mg/L TDS Concentration 667		Days												
		122		123		124		125		126		127		128
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	8.0	7.5	7.5	7.0	7.0	8.0	7.5	7.0	7.5	7.5	7.5	7.5
DO (mg/L)		11.5	11.9	11.8	12.0	12.1	12.1	11.7	11.9	11.8	12.1	11.6	12.0	11.0
pH		7.4	7.3	7.4	7.3	7.4	7.4	7.0	7.5	7.4	7.5	7.3	7.2	7.3
Cond. (µS/cm)		1293		1293		1285		1280		1265		1275		1268
Initials		JBF		JBF		JAB		JBF		JAB		JAB		

mg/L TDS Concentration 1500		Days												
		122		123		124		125		126		127		129
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		7.5	7.5	7.5	7.5	7.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
DO (mg/L)		11.4	11.9	11.7	12.1	12.1	12.1	11.8	11.9	12.2	12.1	11.6	12.0	11.2
pH		7.7	7.7	7.7	7.8	7.7	7.7	7.5	7.6	7.6	7.7	7.7	7.6	7.7
Cond. (µS/cm)		2710		2710		2710		2730		2690		2684		2680
Initials		JBF		JBF		JAB		JBF		JAB		JAB		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF, JAB, AWD

Reviewed by: [illegible]

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. namaycush*

mg/L TDS Concentration Control	Days													
	~~128~~	~~128~~ JBF		129		130		131		132		133		134
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	~~7.5~~		/	7.5	8.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
DO (mg/L)	11.0		/	10.0	12.1	12.0	11.9	11.7	11.8	12.0	12.1	12.2	12.2	11.5
pH	7.0		/	6.9	6.9	7.0	6.8	7.0	7.1	7.1	7.2	7.0	6.9	7.0
Cond. (µS/cm)	—		/	30		29		29		29		29		29
Initials	~		/	JBF		JBF		JAB		JAB		JAB		~

mg/L TDS Concentration 296	Days													
	128			129		130		131		132		133		134
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5		/	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
DO (mg/L)	10.2		/	11.9	12.0	12.0	11.8	11.6	11.8	12.0	11.9	12.2	12.1	11.6
pH	7.3		/	6.9	7.1	7.1	7.2	7.3	7.2	7.4	7.3	7.3	7.1	7.0
Cond. (µS/cm)	—		/	618		616		612		630		635		—
Initials	~		/	JBF		JBF		JAB		JAB		JAB		~

mg/L TDS Concentration 667	Days													
	128			129		130		131		132		133		134
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5		/	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
DO (mg/L)	11.1		/	11.8	12.0	11.9	11.8	11.7	11.8	12.0	11.9	12.2	12.1	11.6
pH	7.4		/	7.3	7.4	7.3	7.3	7.4	7.4	7.7	7.6	7.5	7.4	7.4
Cond. (µS/cm)	—		/	1280		1257		1266		1253		1294		—
Initials	~		/	JBF		JBF		JAB		JAB		JAB		~

mg/L TDS Concentration 1500	Days													
	128			~~129~~ ~~128~~ JBF		130		131		132		133		134
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5		/	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.0	7.5
DO (mg/L)	11.3		/	11.7	12.1	11.8	12.1	11.6	11.8	12.0	12.1	11.9	11.8	11.6
pH	7.7		/	7.5	7.6	7.6	7.6	7.6	7.7	7.9	7.8	7.7	7.8	7.7
Cond. (µS/cm)	—		/	2690		JBF 2690		2710		2700		2740		—
Initials	~		/	JBF		JBF		JAB		JAB		JAB		~

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: JBF, JAB, AWD

Reviewed by: M

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. namaycush*

Concentration	Days														
Control	134	135 ~~134~~ JAB		136 ~~135~~ JAB		137 ~~136~~ JAB		JAB ~~137~~ 138		JAB ~~138~~ 139		JAB ~~139~~ 140		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.5	7.5	7.5	8.0	7.5	8.0	
DO (mg/L)	11.8	11.9	11.9	11.8	12.1	11.0	12.3	12.0	12.2	12.0	12.0	11.9	11.8	
pH	7.0	7.0	7.0	6.9	7.1	6.6	7.0	6.8	6.9	7.0	6.9	7.0	7.1	
Cond. (µS/cm)	29	30 ~~33~~	~	30		30		28		29		32		
Initials	~	~		JAB		JBF		JBF		JBF		JBF		

mg/L TDS Concentration	Days														
296	134	135 ~~134~~ JAB		136 ~~135~~ JAB		137 ~~136~~ JAB		JAB ~~137~~ 138		JAB ~~138~~ 139		JAB ~~139~~ 140		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5	7.5	7.5	7.5	7.5	8.0	7.5	7.5	7.5	7.5	7.5	7.5	8.0	
DO (mg/L)	11.8	11.9	12.0	11.9	12.1	11.8	12.3	11.9	12.2	12.0	12.2	11.9	11.9	
pH	7.4	7.2	7.3	7.2	7.1	6.8	7.1	6.8	6.9	7.4	7.0	7.1	7.3	
Cond. (µS/cm)	~~638~~ 638	650		634		620		629		621		608		
Initials	~	~		JAB		JBF		JBF		JBF		JBF		

mg/L TDS Concentration	Days														
667	134	135 ~~134~~ JAB		136 ~~135~~ JAB		137 ~~136~~ JAB		JAB ~~137~~ 138		JAB ~~138~~ 139		JAB ~~139~~ 140		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.0	
DO (mg/L)	11.8	11.8	12.0	11.8	12.1	11.9	12.3	11.9	12.2	12.0	12.2	11.8	11.7	
pH	7.5	7.5	7.4	7.4	7.4	7.1	7.5	7.2	7.4	7.5	7.6	7.3	7.7	
Cond. (µS/cm)	~~1250~~	1280		1287		1275		1276		1290		1316		
Initials	~	~		JAB		JBF		JBF		JBF		JBF		

mg/L TDS Concentration	Days														
1500	134	135 ~~134~~ JAB		136 ~~135~~ JAB		137 ~~136~~ JAB		JAB ~~137~~ 138		JAB ~~138~~ 139		JAB ~~139~~ 140		
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8.0	
DO (mg/L)	11.8	11.9	12.0	11.9	12.1	12.1	12.3	11.9	12.2	12.0	12.2	11.9	11.6	
pH	7.9	7.8	7.9	7.8	7.8	7.5	7.6	7.5	7.6	7.8	7.8	7.6	7.9	
Cond. (µS/cm)	2750	~~2350~~		2700		2710		2710		2720		2690		
Initials	~	~		JAB		JBF		JBF		JBF		JBF		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: AWD, JAB, JBF

Reviewed by: M

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

Embryo-Alevin-Fry Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415 + Nov 19/12
Stop Date & Time: Apr 5 + Apr 10/13
Test Species: *S. hamaycush*

Concentration Control		Days												
		141 ~~140~~ JAB		142 ~~141~~ JAB		143 ~~142~~ JAB		144 ~~143~~ JAB		145 ~~144~~ JAB				
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		~~25~~	~~26~~	~~26~~	~~25~~	7.5	7.5	7.5	7.5	8.0				
DO (mg/L)		~~11.1~~	~~11.7~~	~~10.0~~	11.6	12.0	12.2	11.8	11.5	11.4				
pH		~~7.0~~	~~7.0~~	~~7.2~~	6.9	6.9	7.0	7.2	6.8	7.0				
Cond. (µS/cm)		32		33		34		32		43				
Initials		~		~		JBF		JBF		JBF				

mg/L TDS Concentration 296		Days												
		141 ~~140~~ JAB		142 ~~141~~ JAB		143 ~~142~~ JAB		144 ~~143~~ JAB		145 ~~144~~ JAB				
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		~~26~~	~~25~~	~~25~~	~~25~~	7.5	7.5	7.5	7.5	8.0				
DO (mg/L)		~~11.2~~	~~11.8~~	11.2	11.7	11.9	12.2	11.8	11.9	12.0				
pH		~~7.1~~	~~7.2~~	7.2	6.9	7.2	7.3	7.3	7.2	7.2				
Cond. (µS/cm)		639		641		618		602		602				
Initials		~		~		JBF		JBF		JBF				

mg/L TDS Concentration 667		Days												
		141 ~~140~~ JAB		142 ~~141~~ JAB		143 ~~142~~ JAB		144 ~~143~~ JAB		145 ~~144~~ JAB				
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		~~25~~	~~26~~	~~25~~	~~25~~	7.5	7.5	7.5	7.5	7.5				
DO (mg/L)		~~11.2~~	~~11.8~~	11.2	11.6	11.8	12.2	11.7	11.9	12.1				
pH		~~7.2~~	~~7.4~~	7.4	7.3	7.5	7.7	7.5	7.6	7.4				
Cond. (µS/cm)		1293		1293		1280		1287		1276				
Initials		~		~		JBF		JBF		JBF				

mg/L TDS Concentration 1500		Days												
		141 ~~140~~ JAB		142 ~~141~~ JAB		143 ~~142~~ JAB		144 ~~143~~ JAB		145 ~~144~~ JAB				
	init.	old	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)		~~25~~	~~25~~	~~26~~	~~26~~	7.5	7.5	7.5	7.5	7.4				
DO (mg/L)		10.6	11.8	11.2	11.6	11.8	12.2	11.6	11.9	12.1				
pH		~~7.8~~ 7.7		~~7.7~~	~~7.7~~	7.8	7.8	7.7	7.7	7.8				
Cond. (µS/cm)		2666		2670		2700		2760		2670				
Initials		~		~		JBF		JBF		JBF				

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11-16			
Alkalinity*	2-11			

* mg/L as CaCO3

Analysts: AWD, JBF

Reviewed by: [illegible]

Date reviewed: 17/6/13

Sample Description: TDS

Comments:

TDS-Dry Fertilization-Summary

Lake Trout

CETIS Summary Report

Report Date: 13 Jun-13 10:17 (p 1 of 1)
Test Code: TDSDryAna1 | 05-4417-8593

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — Nautilus Environmental

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
00-4343-4708	Mean Dry Weight-mg	1489.9	>1489.9	N/A	17.8%		Dunnett's Multiple Comparison Test
07-7145-2634	Survival Rate	673.6	995.1	818.7	N/A		Fisher Exact/Bonferroni-Holm Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
12-7859-3716	Mean Dry Weight-mg	IC5	>1490	N/A	N/A		Linear Interpolation (ICPIN)
		IC10	>1490	N/A	N/A		
		IC15	>1490	N/A	N/A		
		IC20	>1490	N/A	N/A		
		IC25	>1490	N/A	N/A		
		IC40	>1490	N/A	N/A		
		IC50	>1490	N/A	N/A		
18-9235-1054	Su. .val Rate	EC5	138.3	N/A	1732		Linear Interpolation (ICPIN)
		EC10	435.8	N/A	N/A		
		EC15	812	N/A	N/A		
		EC20	991	N/A	N/A		
		EC25	>1490	N/A	N/A		
		EC40	>1490	N/A	N/A		
		EC50	>1490	N/A	N/A		

Mean Dry Weight-mg Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	35.93	35.21	36.65	34.12	38.64	0.959	1.918	5.34%	0.0%
313.5		4	36.12	35.12	37.11	32.57	38.7	1.336	2.672	7.4%	-0.52%
452		4	39.13	36.81	41.46	33.71	48.12	3.115	6.229	15.92%	-8.92%
673.6		4	36.39	35.7	37.08	34.1	38.4	0.9222	1.844	5.07%	-1.28%
995.1		4	39.06	38.36	39.76	37.29	41.57	0.9326	1.865	4.78%	-8.72%
1489.9		4	39.78	37.79	41.77	34.36	47.03	2.663	5.326	13.39%	-10.71%

Survival Rate Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	0.8083	0.7613	0.8553	0.7	0.9333	0.06292	0.1258	15.57%	0.0%
313.5		4	0.75	0.6723	0.8277	0.5	0.9667	0.1041	0.2082	27.76%	7.22%
452		4	0.6833	0.5804	0.7862	0.3	0.9	0.1378	0.2755	40.32%	15.46%
673.6		4	0.7667	0.7083	0.825	0.6333	0.9333	0.07817	0.1563	20.39%	5.16%
995.1		4	0.6417	0.5747	0.7086	0.4	0.8333	0.08962	0.1792	27.93%	20.62%
1489.9		4	0.65	0.5112	0.7888	0.1333	0.9667	0.1858	0.3717	57.18%	19.59%

CETIS Summary Report

Report Date: 13 Jun-13 10:20 (p 1 of 1)
Test Code: TDSDryAna1a | 00-6156-7410

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
06-7300-9035	~~Mean Dry Weight mg~~ Length (mm)	1489.9	>1489.9	N/A	2.49%		Dunnett's Multiple Comparison Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
08-2373-5647	~~Mean Dry Weight mg~~ Mean Length (mm)	IC5	>1490	N/A	N/A		Linear Interpolation (ICPIN)
		IC10	>1490	N/A	N/A		
		IC15	>1490	N/A	N/A		
		IC20	>1490	N/A	N/A		
		IC25	>1490	N/A	N/A		
		IC40	>1490	N/A	N/A		
	Length (mm)	IC50	>1490	N/A	N/A		

Mean ~~Dry Weight mg~~ Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	33.75	33.47	34.03	32.67	34.41	0.3796	0.7593	2.25%	0.0%
313.5		4	33.6	33.38	33.81	33.13	34.45	0.2931	0.5861	1.75%	0.46%
452		4	34.22	34.12	34.31	33.88	34.5	0.1276	0.2552	0.75%	-1.38%
673.6		4	34.11	33.99	34.22	33.86	34.53	0.1487	0.2974	0.87%	-1.05%
995.1		4	33.88	33.68	34.08	33.25	34.55	0.2717	0.5434	1.6%	-0.39%
1489.9		4	33.58	33.46	33.69	33.14	33.84	0.1555	0.311	0.93%	0.51%

TDS-Dry Fertilization-Survival

CETIS Analytical Report

Report Date: 27 Sep-13 11:39 (p 1 of 1)
Test Code: TDSDryAna1 | 05-4417-8593

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	07-7145-2634	Endpoint:	Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:13	Analysis:	STP 2x2 Contingency Tables	Official Results:	Yes
Batch ID:	17-5590-1162	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	16 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	05 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	140d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	00-4740-7229	Code:	2D3607D	Client:	Golder
Sample Date:	16 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	16 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU
Untransformed		C > T	Not Run	673.6	995.1	818.7	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	Decision(0.05)
21.2		313.5	0.1753	0.3505	Non-Significant Effect
21.2		452	0.01871	0.0561	Non-Significant Effect
21.2		673.6	0.2641	0.2641	Non-Significant Effect
21.2		995.1	0.002893	0.0145	Significant Effect
21.2		1489.9	0.004323	0.0173	Significant Effect

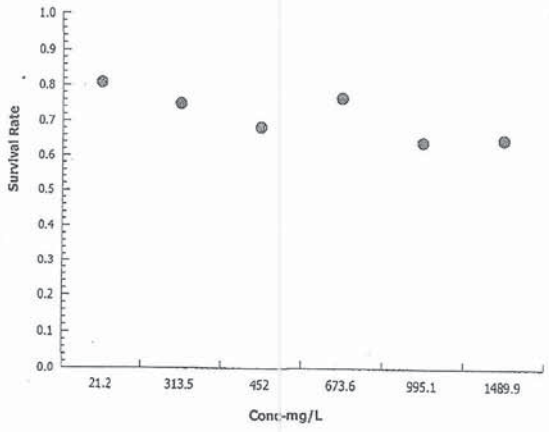
Data Summary

Conc-mg/L	Control Type	No-Resp	Resp	Total
21.2	Negative Contr	97	23	120
313.5		90	30	120
452		82	38	120
673.6		92	28	120
995.1		77	43	120
1489.9		78	42	120

Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.2	Negative Control	0.7	0.7	0.9	0.9333
313.5		0.5	0.6667	0.8667	0.9667
452		0.3	0.6667	0.8667	0.9
673.6		0.6333	0.6333	0.9333	0.8667
995.1		0.4	0.6667	0.8333	0.6667
1489.9		0.1333	0.6333	0.9667	0.8667

Graphics



CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	18-9235-1054	Endpoint:	Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:14	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	17-5590-1162	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	16 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	05 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	140d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	00-4740-7229	Code:	2D3607D	Client:	Golder
Sample Date:	16 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	16 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.880E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	138.3	N/A	1732
EC10	435.8	N/A	N/A
EC15	812	N/A	N/A
EC20	991	N/A	N/A
EC25	>1490	N/A	N/A
EC40	>1490	N/A	N/A
EC50	>1490	N/A	N/A

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
21.2	Negative Control	4	0.8083	0.7	0.9333	0.06292	0.1258	15.57%	0.0%	97	120
313.5		4	0.75	0.5	0.9667	0.1041	0.2082	27.76%	7.22%	90	120
452		4	0.6833	0.3	0.9	0.1378	0.2755	40.32%	15.46%	82	120
673.6		4	0.7667	0.6333	0.9333	0.07817	0.1563	20.39%	5.16%	92	120
995.1		4	0.6417	0.4	0.8333	0.08962	0.1792	27.93%	20.62%	77	120
1489.9		4	0.65	0.1333	0.9667	0.1858	0.3717	57.18%	19.59%	78	120

Survival Rate Detail

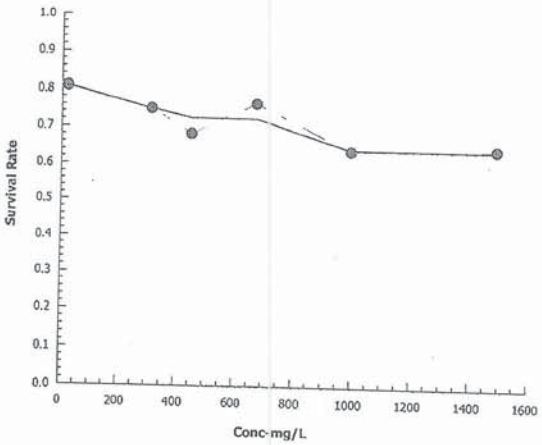
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.2	Negative Control	0.7	0.7	0.9	0.9333
313.5		0.5	0.6667	0.8667	0.9667
452		0.3	0.6667	0.8667	0.9
673.6		0.6333	0.6333	0.9333	0.8667
995.1		0.4	0.6667	0.8333	0.6667
1489.9		0.1333	0.6333	0.9667	0.8667

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	18-9235-1054	Endpoint:	Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:14	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes

Graphics



Analyst:_____ QA:_____

TDS-Dry Fertilization-Dry Weight

CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — Nautilus Environmental

Analysis ID:	00-4343-4708	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:13	Analysis:	Parametric-Control vs Treatments	Official Results:	Yes
Batch ID:	17-5590-1162	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	16 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	05 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	140d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	00-4740-7229	Code:	2D3607D	Client:	Golder
Sample Date:	16 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	16 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run	1489.9	>1489.9	N/A		17.8%

Dunnett's Multiple Comparison Test

Control	vs	Conc-mg/L	Test Stat	Critical	DF	MSD	P-Value	Decision(α:5%)
21.2		313.5	-0.07019	2.407	6	6.401	0.8532	Non-Significant Effect
21.2		452	-1.205	2.407	6	6.401	0.9902	Non-Significant Effect
21.2		673.6	-0.1731	2.407	6	6.401	0.8792	Non-Significant Effect
21.2		995.1	-1.177	2.407	6	6.401	0.9894	Non-Significant Effect
21.2		1489.9	-1.447	2.407	6	6.401	0.9952	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	62.28046	12.45609	5	0.8806	0.5138	Non-Significant Effect
Error	254.6073	14.14485	18			
Total	316.8877	26.60094	23			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	8.375	15.09	0.1368	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9158	0.884	0.0472	Normal Distribution

Mean Dry Weight-mg Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	35.93	35.2	36.66	34.12	38.64	0.959	1.918	5.34%	0.0%
313.5		4	36.12	35.1	37.13	32.57	38.7	1.336	2.672	7.4%	-0.52%
452		4	39.13	36.76	41.5	33.71	48.12	3.115	6.229	15.92%	-8.92%
673.6		4	36.39	35.69	37.09	34.1	38.4	0.9222	1.844	5.07%	-1.28%
995.1		4	39.06	38.35	39.77	37.29	41.57	0.9326	1.865	4.78%	-8.72%
1489.9		4	39.78	37.75	41.8	34.36	47.03	2.663	5.326	13.39%	-10.71%

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

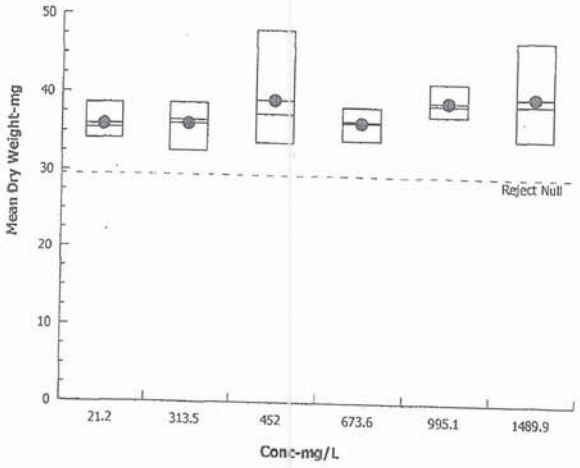
Nautilus Environmental

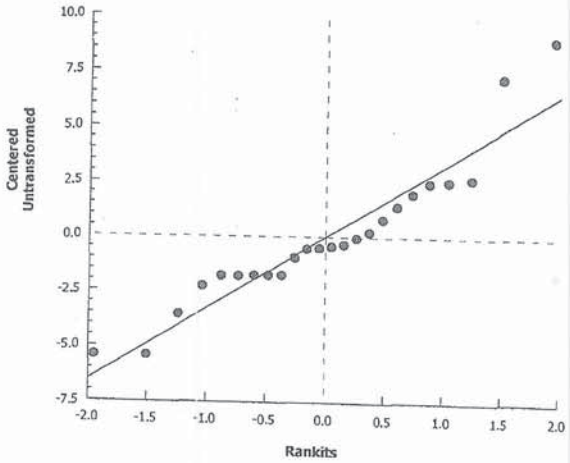
Analysis ID:	00-4343-4708	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:13	Analysis:	Parametric-Control vs Treatments	Official Results:	Yes

Mean Dry Weight-mg Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.2	Negative Control	35.59	38.64	35.37	34.12
313.5		37.52	38.7	35.68	32.57
452		48.12	37.38	37.33	33.71
673.6		37.2	38.4	34.1	35.87
995.1		41.57	37.29	38.1	39.28
1489.9		47.03	39.72	34.36	37.99

Graphics





CETIS Analytical Report

Nautilus Environmental

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Analysis ID:	12-7859-3716	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:14	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	17-5590-1162	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	16 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	05 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	140d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	00-4740-7229	Code:	2D3607D	Client:	Golder
Sample Date:	16 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	16 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.015E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1490	N/A	N/A
IC10	>1490	N/A	N/A
IC15	>1490	N/A	N/A
IC20	>1490	N/A	N/A
IC25	>1490	N/A	N/A
IC40	>1490	N/A	N/A
IC50	>1490	N/A	N/A

Mean Dry Weight-mg Summary

			Calculated Variate						
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	35.93	34.12	38.64	0.959	1.918	5.34%	0.0%
313.5		4	36.12	32.57	38.7	1.336	2.672	7.4%	-0.52%
452		4	39.13	33.71	48.12	3.115	6.229	15.92%	-8.92%
673.6		4	36.39	34.1	38.4	0.9222	1.844	5.07%	-1.28%
995.1		4	39.06	37.29	41.57	0.9326	1.865	4.78%	-8.72%
1489.9		4	39.78	34.36	47.03	2.663	5.326	13.39%	-10.71%

Mean Dry Weight-mg Detail

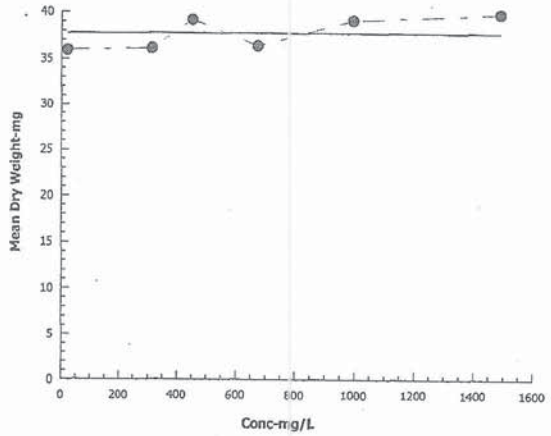
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.2	Negative Control	35.59	38.64	35.37	34.12
313.5		37.52	38.7	35.68	32.57
452		48.12	37.38	37.33	33.71
673.6		37.2	38.4	34.1	35.87
995.1		41.57	37.29	38.1	39.28
1489.9		47.03	39.72	34.36	37.99

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	12-7859-3716	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:14	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes

Graphics



TDS-Dry Fertilization - Length

CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	06-7300-9035	Endpoint:	~~Mean Dry Weight mg~~ Mean Length (mm) JAB	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:15	Analysis:	Parametric-Control vs Treatments	Official Results:	Yes
Batch ID:	14-2835-1467	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	16 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	05 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	140d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	09-2811-9699	Code:	3751FB93	Client:	Golder
Sample Date:	16 Nov-13	Material:	Total Dissolved Solids	Project:	
Receive Date:	16 Nov-13	Source:	Golder		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run	1489.9	>1489.9	N/A		2.49%

Dunnett's Multiple Comparison Test

Control	vs	Conc-mg/L	Test Stat	Critical	DF	MSD	P-Value	Decision(α:5%)
21.2		313.5	0.4435	2.407	6	0.8412	0.6718	Non-Significant Effect
21.2		452	-1.331	2.407	6	0.8412	0.9932	Non-Significant Effect
21.2		673.6	-1.016	2.407	6	0.8412	0.9835	Non-Significant Effect
21.2		995.1	-0.372	2.407	6	0.8412	0.9198	Non-Significant Effect
21.2		1489.9	0.4936	2.407	6	0.8412	0.6503	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.393388	0.2786777	5	1.141	0.3751	Non-Significant Effect
Error	4.396575	0.2442542	18			
Total	5.789963	0.5229319	23			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	4.978	15.09	0.4185	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9846	0.884	0.9634	Normal Distribution

Mean ~~Dry Weight mg~~ Length (mm) JAB Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	33.75	33.46	34.04	32.67	34.41	0.3796	0.7593	2.25%	0.0%
313.5		4	33.6	33.37	33.82	33.13	34.45	0.2931	0.5861	1.75%	0.46%
452		4	34.22	34.12	34.31	33.88	34.5	0.1276	0.2552	0.75%	-1.38%
673.6		4	34.11	33.99	34.22	33.86	34.53	0.1487	0.2974	0.87%	-1.05%
995.1		4	33.88	33.67	34.09	33.25	34.55	0.2717	0.5434	1.6%	-0.39%
1489.9		4	33.58	33.46	33.7	33.14	33.84	0.1555	0.311	0.93%	0.51%

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — Nautilus Environmental

Analysis ID:	06-7300-9035	Endpoint:	~~Mean Dry Weight mg~~ Mean Length (mm)	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:15	Analysis:	Parametric-Control vs Treatments	Official Results:	Yes

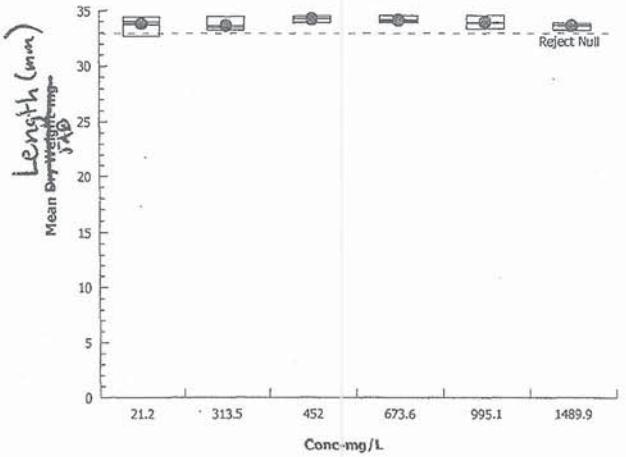
JAD

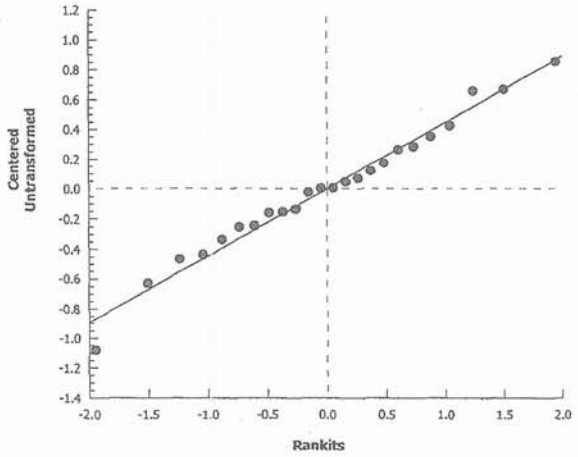
Mean ~~Dry Weight mg~~ Length (mm) Detail

JAD

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.2	Negative Control	32.67	34.1	34.41	33.82
313.5		33.13	34.45	33.46	33.34
452		34.22	34.5	33.88	34.26
673.6		33.95	34.53	33.86	34.08
995.1		34	33.25	33.72	34.55
1489.9		33.75	33.84	33.14	33.58

Graphics





Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — Nautilus Environmental

Analysis ID:	08-2373-5647	Endpoint:	Mean ~~Dry Weight-mg~~ JAB Length (mm)	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:15	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	14-2835-1467	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	16 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	05 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	140d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	09-2811-9699	Code:	3751FB93	Client:	Golder
Sample Date:	16 Nov-13	Material:	Total Dissolved Solids	Project:	
Receive Date:	16 Nov-13	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	884983027	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1490	N/A	N/A
IC10	>1490	N/A	N/A
IC15	>1490	N/A	N/A
IC20	>1490	N/A	N/A
IC25	>1490	N/A	N/A
IC40	>1490	N/A	N/A
IC50	>1490	N/A	N/A

Mean ~~Dry Weight-mg~~ JAB Length (mm) Summary

Conc-mg/L	Control Type	Count	Calculated Variate: Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
21.2	Negative Control	4	33.75	32.67	34.41	0.3796	0.7593	2.25%	0.0%
313.5		4	33.6	33.13	34.45	0.2931	0.5861	1.75%	0.46%
452		4	34.22	33.88	34.5	0.1276	0.2552	0.75%	-1.38%
673.6		4	34.11	33.86	34.53	0.1487	0.2974	0.87%	-1.05%
995.1		4	33.88	33.25	34.55	0.2717	0.5434	1.6%	-0.39%
1489.9		4	33.58	33.14	33.84	0.1555	0.311	0.93%	0.51%

Mean ~~Dry Weight-mg~~ JAB Length (mm) Detail

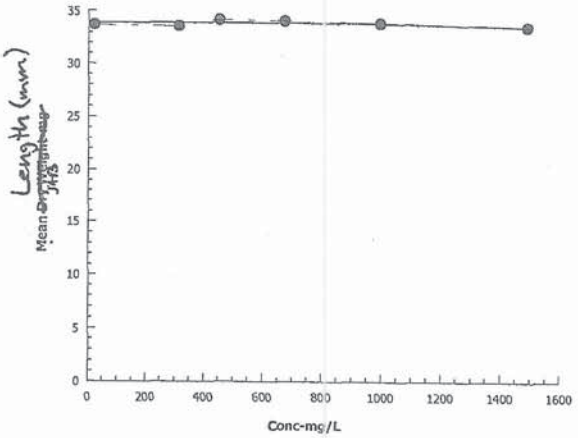
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.2	Negative Control	32.67	34.1	34.41	33.82
313.5		33.13	34.45	33.46	33.34
452		34.22	34.5	33.88	34.26
673.6		33.95	34.53	33.86	34.08
995.1		34	33.25	33.72	34.55
1489.9		33.75	33.84	33.14	33.58

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	08-2373-5647	Endpoint:	Mean ~~Dry Weight mg~~ JAB Length (mm)	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:15	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes

Graphics



Chronic Freshwater Toxicity Test
Daily Mortality
(~~Wet~~ Dry Fertilization)

Client: Golder
Sample ID: Synthetic Effluent-TDS – Dry Fertilization #1
Work Order #: n/a
Start Date & Time: Nov 16/12 @ 1415h
Stop Date: April 5/13
Test Species: Sinamaycush

Reps A-D

Treatments (mg/L TDS)	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		3 JAB	5 JAB	7 JAB	10 JAB	12 JAB	14	17				
Control	1	0	0	0	0	1	0	0	1	n/a	0	30
	2	↓	↓	↓	↓	0	↓	1	1	↓	↓	↓
	3					0		1	1			
	4					0		1	1			
296	1					4		4	8			
	2					0		0	0			
	3					0		0	0			
	4					0		0	0			
444	1					0		2	2			
	2					0		0	0			
	3					0		0	0			
	4					0		0	0			
667	1					0		3	3			
	2					0		0	0			
	3					0		1	1			
	4					0		0	0			
1000	1					0		6	6			
	2					0		0	0			
	3					0		0	0			
	4					0		0	0			
1500	1					0		8	8			
	2					0		0	0			
	3					0		0	0			
	4	↓	↓	↓	↓	0	↓	1	1	↓	↓	↓
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB

Comments:

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** Nov 16/12 @ 1415h

Sample ID: Synthetic Effluent- TDS Dry Fertilization #1 **Stop Date:** ~~Dec 19/12 @ 1315h~~ JAB Apr 5/13

Work Order #: n/a **Test Species:** S. namaycush

Reps A→D

Treatments mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		19	21	24	26	28	31	33				
Control	1	0	0	0	0	0	0	0	0 (4)	0	0	30
	2			1		0	0		1 (4)			
	3			0		0	0		0 (4)			
	4			0		0	0		0 (4)			
296	1			2		1	0		3 (8)			
	2			0		1	1		2			
	3			0		1	0		1			
	4			0		0	0		0			
444	1			1		1	3		5 (8)			
	2			0		0	0		0			
	3			1		0	0		1			
	4			0		0	0		0			
667	1			0		0	1		1 (3)			
	2			0		0	0		0			
	3			0		0	0		0 (4)			
	4			0		0	0		0			
1000	1			3		1	1		5 (6)			
	2			0		0	0		0			
	3			0		0	0		0			
	4			0		0	0		0			
1500	1			4		1	4		9 (10)			
	2			0		0	0		0			
	3			0		0	0		0			
	4			0		0	0		0 (4)			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JBF	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** Nov 16/12 @1415h

Sample ID: Synthetic Effluent- TDS - Dry Fertilization #21 JAB **Stop Date:** April 5/13

Work Order #: n/a **Test Species:** S. namaycush

Reps A-D

Treatments mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		35	38	40	42	45	47	49				
Control	1	0	1	0	0	4	0	2	7 (+1)	0		
	2	1	1	0	|	2	|	1	5 (+2)	0		
	3	0	0	0	|	0	|	0	0 (+1)	0		
	4	0	0	0	|	0	|	0	0 (+1)	0		
296	1	0	0	0	↓	0	|	1	1 (+11)	1		
	2	0	0	0	2	2	|	1	5 (+2)	1		
	3	0	0	0	0	0	|	0	0 (+1)	0		
	4	0	0	0	0	0	|	0	0	0		
444	1	6	4	2	0	0	|	1	7 (+9)	0		
	2	0	3	1	1	1	|	4	10 (+10)	1		
	3	0	0	0	0	0	|	0	0 (+1)	0		
	4	0	1	0	0	0	|	0	1	0		
667	1	0	0	0	0	1	|	1	2 (+4)	1		
	2	0	0	0	4	3	|	1	8	1		
	3	0	0	0	6	0	|	0	0 (+1)	1		
	4	0	0	0	0	2	|	0	2	0		
1000	1	0	2	2	0	0	|	0	4 (+11)	0		
	2	0	0	0	1	4	|	4	9	1		
	3	0	0	0	0	0	|	0	0	1		
	4	0	0	0	0	0	|	0	0	0		
1500	1	3	0	0	1	1	|	1	6 (+17)	1		
	2	0	0	0	2	0	|	7	9	0		
	3	0	1	0	0	0	|	0	1	0		
	4	0	0	0	0	0	↓	0	0 (+1)	0		
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB		

Comments:

Reviewed by: [illegible] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** November 16/12 @ 1415h
Sample ID: Synthetic Effluent- TDS Dry Fertilization **Stop Date:** April 5/13
Work Order #: n/a **Test Species:** S. namaycush

Treatments (Black) mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		52	54	56	59	61	63	66				
Control	1	0	0	0	0	0	1	0	1 (+8)	0 (0)		
	2	↓	↓	↓	1	0	0	0	1 (+7)	(0)		
	3				0	0	0	0	0 (+1)	(0)		
	4				0	0	0	0	0 (+1)	(0)		
296	1				1	0	3	0	4 (+3)	(+1)		
	2				0	0	1	0	1 (+1)	(+1)		
	3				0	0	0	0	0 (+1)	0		
	4				0	0	0	0	0 (0)	0		
444	1				1	0	1	1	3 (+1)	0		
	2				0	↓	0	0	0 (+0)	(+1)		
	3				0		0	1	1 (+1)	0		
	4				0		0	0	0 (+1)	0		
667	1				1		0	0	1 (+6)	(+1)		
	2				0		↓	0	0 (+8)	(+1)		
	3				0			0	0 (+1)	(+1)		
	4				0	↓	↓	0	0 (+3)	0		
1000	1				0	0	1	1	2 (+5)	0		
	2				0	0	0	0	0 (+9)	(+1)		
	3				0	1	0	0	1 (0)	(+1)		
	4				1	1	0	0	2 (0)	0		
1500	1				0	1	0	0	1 (+23)	(+1)		
	2				0	0	1	1	2 (+9)	0		
	3				0	0	0	0	0 (+1)	0		
	4	↓	↓	↓	1	0	0	0	1 (+1)	0		
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB	JAB	JBF	JBF	JBF	JAB	JAB		

Comments:

Reviewed by: JB **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Start Date & Time: November 16/12 @1415
Sample ID: Synthetic Effluent - TDS - Dry Fert
Stop Date: April 5/13
Work Order #: n/a
Test Species: *S. namaycush*

Concentration (Black) mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		68	70	73	75	77	80	82				
Control	1	0	0	0	0	0	0	0	0			
	2	↓	↓	1	0	↓	↓	↓	1			
	3	↓	↓	0	1	↓	↓	↓	1			
	4	↓	↓	0	0	↓	↓	↓	0			
296	1	↓	↓	0	1	↓	↓	↓	1			
	2	↓	↓	0	0	↓	↓	↓	0			
	3	↓	↓	1	↓	↓	↓	↓	1			
	4	↓	↓	0	↓	↓	↓	↓	0			
444	1	↓	↓	1	↓	↓	1	1	3			
	2	↓	↓	0	↓	↓	0	0	0			
	3	↓	↓	↓	1	↓	↓	↓	1			
	4	↓	↓	↓	0	↓	↓	↓	0			
667	1	↓	↓	↓	↓	↓	↓	↓	0			
	2	↓	↓	↓	↓	↓	↓	↓	0			
	3	↓	↓	↓	↓	↓	↓	↓	0			
	4	↓	↓	↓	1	↓	↓	↓	1			
1000	1	↓	↓	↓	0	↓	↓	↓	0			
	2	↓	↓	↓	↓	↓	↓	↓	0			
	3	↓	↓	↓	↓	↓	↓	↓	0			
	4	↓	↓	↓	↓	↓	↓	↓	0			
1500	1	↓	↓	↓	↓	↓	↓	↓	0			
	2	↓	↓	↓	↓	↓	↓	↓	0			
	3	↓	↓	↓	↓	↓	↓	↓	0			
	4	↓	↓	↓	1	↓	↓	↓	1			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JBF	JBF	JBF	JBF	JBF	JBF	JBF				

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - Dry Fert
Work Order #: n/a

Start Date & Time: November 16, 2012 @1415
Stop Date: April 5/13
Test Species: *S. hamaycush*

Concentration Mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		84	87	89	91	94	96	98				
Control	1	0	0	0	0	0	0	0	0			
	2								0			
	3								0			
	4								0			
296	1								0			
	2								0			
	3								0			
	4								0			
444	1								0			
	2		↓						0			
	3								1			
	4		0						0			
667	1								0			
	2								0			
	3								0			
	4								0			
1000	1								0			
	2								0			
	3		↓						0			
	4		1						1			
1500	1		0						0			
	2		↓						0			
	3								0			
	4	↓	↓	↓	↓	↓	↓	↓	0			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		DBF	SBF	SBF	SBF	SBF	SBF	SBF				

Comments:

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - Dry Fert.
Work Order #: n/a

Start Date & Time: November 16. 2012 @ 1415
Stop Date: April 5/13
Test Species: *S. namaycush*

Concentration (Black) Mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		101	103	105	108	110	112	115 ~~116~~ JBF				
Control	1	0	0	0	0	0	0	0	0			
	2		1				0		1			
	3		0				1		1			
	4						1	↓	1			
296	1						0	1	1			
	2						0	0	0			
	3						0		0			
	4						1		1			
444	1						0		0			
	2						0		0			
	3				↓		0		0			
	4				1	↓	1	↓	2			
667	1	↓			0	1	0	1	2			
	2	1				0	0	0	1			
	3	0					0		0			
	4						0		0			
1000	1						0		0			
	2						0		0			
	3	↓					0	↓	0			
	4	1					1	5	7			
1500	1	0					0	0	0			
	2	0					0		0			
	3	0					0		0			
	4	0	↓	↓	↓	↓	0	↓	0			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JBF	JBF	JBF	JBF	JBF	JAB	JBF				

Comments: _____

Reviewed by: KL **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - Dry Fert.
Work Order #: N/A

Start Date & Time: November 16, 2012 @ 1415h
Stop Date: April 5/13
Test Species: *S. namaycush*

Concentration (Black) mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		117	119	122	123 ~~124~~ JAB	124 ~~126~~ JBF	125 ~~128~~ JBF	126 ~~131~~ JAB				
Control	1	0	0	0	0	0	0	0	0			
	2								0			
	3								0			
	4								0			
296	1								0			
	2								0			
	3								0			
	4								0			
444	1	1	1						2			
	2	0	0						0			
	3								0			
	4								0			
667	1			1					1			
	2			0					0			
	3								0			
	4				1				1			
1000	1				0				0			
	2								0			
	3								0			
	4								0			
1500	1								0			
	2								0			
	3								0			
	4								0			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JBF	JBF	JBF	JAB	JBF	JBF	JAB				

Comments: _____

Reviewed by: M **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic Effluent- TDS - Dry
Work Order #: n/a

Start Date & Time: November 16, 2012 @ 1415h
Stop Date: April 5/13
Test Species: S. namaycush

Treatments (black) mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		127	128	129	130	131	132	133				
Control	1	0	0	0	0	0	0	0	0			
	2								0			
	3								0			
	4								0			
296	1								0			
	2								0			
	3								0			
	4								0			
444	1								0			
	2								0			
	3								0			
	4								0			
667	1								0			
	2								0			
	3								0			
	4								0			
1000	1								0			
	2								0			
	3								0			
	4								0			
1500	1								0			
	2								0			
	3								0			
	4								0			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	n	JBF	JBF	JAB	JAB	~				

Comments:

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic Effluent- TDS-Dry
Work Order #: n/a

Start Date & Time: Nov 16/12 @ 1415h
Stop Date: Apr 5/13
Test Species: S. namaycush

Treatments mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		134	135	136	137	138	139	140				
Control	1	0	0	0	0	0	0	0	0			
	2								0			
	3								0			
	4								0			
296	1				0				0			
	2				0				0			
	3				0				0			
	4				0				0			
444	1				1				1			
	2				0				0			
	3								0			
	4								0			
667	1								0			
	2								0			
	3								0			
	4								0			
1000	1				JAB				0			
	2								0			
	3								0			
	4								0			
1500	1								0			
	2								0			
	3								0			
	4								0			
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JBF	JBF	JBF	~	~				

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Hatched

Client: Golder
Sample ID: Synthetic Effluent- TDS - Dry fert
Work Order #: n/a
Start Date & Time: November 16/12 @ 1415h
Stop Date: Apr 5/13
Test Species: Sinamaycush

Treatments (Black) mg/L TDS	Rep	Day of Test - No. of Hatched							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		59	61	63	66	68	70	73				
Control	1	0	0	0	1	6	6	14				
	2	0	0	0	1	6	8	14				
	3	9	10	10	13	13	20	27				
	4	2	3	3	3	11	13	23				
296	1	0	0	0	0	6	6	15				
	2	0	0	0	0	16	17	21				
	3	4	5	6	10	12	17	26				
	4	0	0	0	0	16	21	30				
444	1	0	0	0	0	3	7	12				
	2	0	0	2	3	15	17	18				
	3	0	0	0	2	3	17	26				
	4	1	1	5	12	12	14	21				
667	1	0	0	0	0	12	14	20				
	2	0	0	2	9	9	12	20				
	3	0	0	0	4	5	11	22				
	4	0	0	0	2	7	8	24				
1000	1	0	0	0	0	2	8	10				
	2	0	1	1	2 3	4	5	10				
	3	0	0	3	3	8	12	19				
	4	5	7	8	8 12	16	16	24				
1500	1	0	0	0	0	0	0	3				
	2	1	1	3	3	7	11	18				
	3	0	0	0	1	6	6	29				
	4	0	0	0	7	9	9	21				
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JBF	JBF	JBF	JBF	JBF				

Comments:

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Hatched

Client: Golder
Sample ID: Synthetic Effluent- TDS - Dry Fert
Work Order #: n/a
Start Date & Time: November 16/12 @ 1415
Stop Date: Apr 5/13
Test Species: S. Namaycush

Treatments (Black) mg/L TDS	Rep	Day of Test - No. of Hatched							Total Dead Fish JAB	Total Undeveloped JAB	Total No. Fry JAB	Total Exposed JAB
		75	77	80	82 (4)	84	87	89				
Control	1	21/21	21/21	21	21							
	2	16/21	18/21	21	21							
	3	27/27	27/27	27	27							
	4	28/29	29/29	29	29							
296	1	15/16	16/16	16	16							
	2	21/21	21/21	21	21							
	3	28/28	28/28	28	28							
	4	30/30	30/30	30	30							
444	1	12/12	12/12	11/11	10/10							
	2	19/19	N/A	19	19							
	3	26/27	27/27	27	27							
	4	28/29	29/29	29	29							
667	1	22/22	22/22	22	22							
	2	20/20	20/20	20	20							
	3	27/27	27/27	27	27							
	4	27/27	27/27	27 (3)	27							
1000	1	11/12	12/12	~~11/11~~ (3)	~~12/12~~ (3)							
	2	12/20	17/20	18/20	20 (3)							
	3	23/25	25/25	25	25							
	4	30/30	30/30	30	30							
1500	1	5/5	5/5	5	5							
	2	18/19	19/19	19	19							
	3	29/29 (1)	29/29	29	29							
	4	~~18/19~~ (1)	~~24/27~~	26/27	27							
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JBF	JBF	JBF	JBF	~~JBF~~						

Comments: (1) 22/27 (2) 12/12 (3) 12
(4) All Trout hatched

Reviewed by: [signature]
Date reviewed: 7/6/13

Embryo-Alevin-Fry Toxicity Test Data Sheet

Fry ~~Swim-up~~ Survival and Dry Weight

Client: Golder ~~Teck~~ JAB

Start Date: NOV 16/12

Work Order No.: n/a

Termination Date: April 5/13

Dry Fert

Sample ID	Rep	Pan No. Blue	No. Alive	Initials	Pan weight	Pan + organism	No. weighed	Initials
Control	A	1	21	JBF	1073.22	1820.70	21	JBF
	B	2	21		1061.89	1873.24	21	
	C	3	27		1063.58	2018.63	27	
	D	4	28		1065.19	2020.44	28	
296	A	5	15		1098.20	1661.05	15	
	B	6	20		1084.57	1858.50	20	
	C	7	26		1053.34	1980.92	26	
	D	8	29		1043.42	1987.92	29	
444	A	9	9		1068.04	1501.08	9	
	B	10	20		1016.94	1764.53 ①	20	
	C	11	26		1103.51	2073.98	26	
	D	12	27		1037.00	1947.22	27	
667	A	13	19		1031.61	1738.38	19	
	B	14	19		1037.29	1766.81	19	
	C	15	28		1004.48	1959.21	28	
	D	16	26		996.18	1928.75 ②	26	
1000	A	17	12		994.21	1493.11	12	
	B	18	20		994.92	1740.69	20	
	C	19	25		1004.67	1957.13	25	
	D	20	20		1003.32	1788.94	20	
1500	A	21	4		1002.90	1191.02	4	
	B	22	19		1040.84	1795.51	19	
	C	23	29		1031.08	2027.60	29	
	D	24	26	↓	1093.37	2081.25 ③	26	↓

Comments:

Reviewed by:

Date Reviewed: 17/6/2013

Reweigh

① 1767.81 ② 1934.36 ③ 2088.94

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- Control A
Stop Date: Apr 5/13
Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	~~35~~ 17	21	4.48	0.21	SJBF
2	~~34~~ 33				
3	~~34~~ 33				
4	~~34~~ 33				
5	32				
6	33				
7	34				
8	34				
9	33				
10	33				
11	34				
12	34				
13	33				
14	35				
15	33				
16	33				
17	34				
18	35				
19	34				
20	33				
21	33				
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: M
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- Control B
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	21	JBF ~~21~~ 4.90	~~4.90~~ JBF	JBF
2	34			0.23	
3	33				
4	35				
5	35				
6	34				
7	34				
8	33				
9	34				
10	35				
11	35				
12	34				
13	35				
14	36				
15	35				
16	34				
17	33				
18	32				
19	35				
20	32				
21	34				
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h

Sample ID: Dry Fert- Control C

Stop Date: Apr 5/13

Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	27	5.83	0.22	JBF
2	34				
3	34				
4	34				
5	36				
6	34				
7	36				
8	34				
9	35				
10	35				
11	34				
12	35				
13	33				
14	35				
15	33				
16	33				
17	35				
18	35				
19	34				
20	35				
21	34				
22	34				
23	34				
24	35				
25	35				
26	34				
27	34				
28					
29					
30					

Reviewed by: N

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h

Sample ID: Dry Fert- Control D

Stop Date: Apr 5/13

Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	28	6.10	0.22	SBF
2	32				
3	33				
4	34				
5	33				
6	34				
7	33				
8	32				
9	36				
10	35				
11	34				
12	36				
13	35				
14	34				
15	36				
16	33				
17	32				
18	34				
19	33				
20	35				
21	34				
22	34				
23	34				
24	33				
25	35				
26	34				
27	34				
28	33				
29					
30					

Reviewed by: M

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Dry Fert- 296 A

Start Date & Time: Nov 16/12 @ 1415h
Stop Date: Apr 5/13
Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	15	3.39	0.23	JBF
2	34				
3	34				
4	34				
5	34				
6	34				
7	34				
8	32				
9	34				
10	33				
11	33				
12	33				
13	33				
14	34				
15	27				
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 296 B
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	20	4.76	0.24	SBF
2	34				
3	35				
4	36				
5	34				
6	34				
7	33				
8	34				
9	35				
10	35				
11	35				
12	35				
13	34				
14	34				
15	34				
16	35				
17	36				
18	33				
19	35				
20	34				
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Dry Fert- 296 C

Start Date & Time: Nov 16/12 @ 1415h
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	26	5.61	0.22	JBF
2	34				
3	34				
4	33				
5	33				
6	33				
7	33				
8	34				
9	33				
10	33				
11	35				
12	35				
13	33				
14	33				
15	33				
16	33				
17	33				
18	34				
19	34				
20	33				
21	32				
22	33				
23	34				
24	33				
25	35				
26	35				
27					
28					
29					
30					

Reviewed by: N

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 296 D
Stop Date: Apr 5/13
Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	29	6.11	0.21	SBF
2	33				
3	34				
4	34				
5	33				
6	31				
7	34				
8	34				
9	34				
10	33				
11	34				
12	32				
13	33				
14	33				
15	34				
16	33				
17	34				
18	34				
19	34				
20	32				
21	33				
22	34				
23	34				
24	32				
25	34				
26	33				
27	34				
28	33				
29	32				
30					

Reviewed by: M
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 444 A
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	9	2.50	0.28	JBF
2	33				
3	35				
4	34				
5	36				
6	35				
7	34				
8	34				
9	33				
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: M
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Dry Fert- 444 B

Start Date & Time: Nov 16/12 @ 1415h
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	20	4.71	0.24	SBF
2	36				
3	34				
4	34				
5	34				
6	34				
7	35				
8	34				
9	36				
10	35				
11	35				
12	35				
13	34				
14	33				
15	35				
16	34				
17	34				
18	34				
19	34				
20	35				
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: M

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 444 C
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	26	5.85	0.23	SBF
2	33				
3	34				
4	33				
5	33				
6	35				
7	36				
8	35				
9	34				
10	34				
11	34				
12	35				
13	33				
14	34				
15	33				
16	34				
17	34				
18	34				
19	35				
20	33				
21	34				
22	33				
23	33				
24	33				
25	34				
26	34				
27					
28					
29					
30					

Reviewed by: N
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h

Sample ID: Dry Fert- 444 D

Stop Date: Apr 5/13

Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	27	5.77	0.21	JBF
2	34				
3	34				
4	34				
5	36				
6	35				
7	35				
8	35				
9	33				
10	34				
11	34				
12	33				
13	35				
14	35				
15	33				
16	34				
17	35				
18	33				
19	34				
20	35				
21	34				
22	35				
23	35				
24	35				
25	33				
26	34				
27	33				
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @1415h
Sample ID: Dry Fert- 667 A
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	19	4.33	0.23	JDF
2	35				
3	34				
4	33				
5	34				
6	34				
7	32				
8	32				
9	34				
10	35				
11	35				
12	34				
13	35				
14	35				
15	34				
16	34				
17	34				
18	33				
19	34				
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 667 B
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	19	4.42	0.23	SBF
2	35				
3	35				
4	34				
5	35				
6	34				
7	34				
8	36				
9	35				
10	33				
11	35				
12	35				
13	36				
14	33				
15	34				
16	35				
17	34				
18	34				
19	34				
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 667 C
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	28	5.90	0.21	JBF
2	34				
3	33				
4	34				
5	33				
6	33				
7	34				
8	35				
9	34				
10	35				
11	33				
12	34				
13	34				
14	34				
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18	32				
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26	33				
27	35				
28	33				
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Reviewed by: [illegible]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Dry Fert- 667 D

Start Date & Time: Nov 16/12 @ 1415h
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	26	5.93	0.23	SBF
2	34				
3	33				
4	34				
5	35				
6	34				
7	34				
8	34				
9	35				
10	34				
11	34				
12	35				
13	34				
14	34				
15	33				
16	34				
17	33				
3	34				
19	34				
20	35				
21	35				
22	32				
23	35				
24	35				
25	34				
26	35				
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h

Sample ID: Dry Fert- 1000 & SBF A

Stop Date: Apr 5/13

Test Species: Sinamaycosh

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	12	3.01	0.25	SBF
2	34				
3	34				
4	33				
5	35				
6	34				
7	36				
8	35				
9	29				
10	35				
11	34				
12	34				
13					
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Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @1415h
Sample ID: Dry Fert- 1000 B
Stop Date: Apr 5/13
Test Species: S. mamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	20	4.50	0.22	JBL
2	34				
3	33				
4	34				
5	34				
6	33				
7	34				
8	33				
9	33				
10	34				
11	31				
12	34				
13	34				
14	32				
15	33				
16	33				
17	34				
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Reviewed by: M
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h

Sample ID: Dry Fert- 1000 ~~X~~ JBF C

Stop Date: Apr 5/13

Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	25	5.62	0.22	JBF
2	34				
3	35				
4	33				
5	33				
6	33				
7	34				
8	34				
9	34				
10	34				
1	34				
12	33				
13	35				
14	34				
15	33				
16	34				
17	33				
18	33				
19	35				
20	33				
21	34				
22	33				
23	33				
24	34				
25	34				
26					
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 1000 D
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	20	4.65	0.23	SBF
2	35				
3	35				
4	34				
5	34				
6	35				
7	35				
8	35				
9	34				
10	34				
11	35				
12	35				
13	34				
14	34				
15	35				
16	34				
17	35				
18	33				
19	36				
20	35				
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @1415h
Sample ID: Dry Fert- 1500 A
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	35	4	1.12	0.28	JBF
2	33				
3	34				
4	33				
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
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27					
28					
29					
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Reviewed by: [illegible]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 1500 B
Stop Date: Apr 5/13
Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	19	4.47	0.24	SBF
2	34				
3	34				
4	34				
5	34				
6	34				
7	35				
8	34				
9	34				
10	35				
11	35				
12	34				
13	33				
14	34				
15	32				
16	33				
17	33				
18	34				
19	34				
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
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Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 1500C
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	29	6.08	0.21	JBF
2	34				
3	33				
4	33				
5	33				
6	33				
7	34				
8	33				
9	32				
10	33				
11	34				
12	33				
13	32				
14	33				
15	33				
16	34				
17	33				
18	34				
19	33				
20	33				
21	33				
22	33				
23	34				
24	33				
25	32				
26	33				
27	33				
28	33				
29	33				
30					

Reviewed by: M
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 16/12 @ 1415h
Sample ID: Dry Fert- 1500 D
Stop Date: Apr 5/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	36	26	5.88	0.23	SBF
2	33				
3	34				
4	34				
5	35				
6	35				
7	33				
8	33				
9	34				
10	35				
11	34				
12	34				
13	33				
14	34				
15	33				
16	34				
17	34				
18	30				
19	34				
20	33				
21	25				
22	SBF ~~33~~ 33				
23	36				
24	33				
25	35				
26	36				
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 17/6/13

TDS-Wet Fertilization-Summary

CETIS Summary Report

Report Date: 13 Jun-13 10:28 (p 1 of 1)
Test Code: TDSWetAna1 | 10-9682-9969

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
19-0916-6279	Mean Dry Weight-mg	1483.9	>1483.9	N/A	17.1%		Dunnett's Multiple Comparison Test
04-4108-4140	Survival Rate	1483.9	>1483.9	N/A	N/A		Fisher Exact/Bonferroni-Holm Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
02-3010-6748	Mean Dry Weight-mg	IC5	>1484	N/A	N/A		Linear Interpolation (ICPIN)
		IC10	>1484	N/A	N/A		
		IC15	>1484	N/A	N/A		
		IC20	>1484	N/A	N/A		
		IC25	>1484	N/A	N/A		
		IC40	>1484	N/A	N/A		
		IC50	>1484	N/A	N/A		
06-1942-5468	Survival Rate	EC5	498.3	N/A	N/A		Linear Interpolation (ICPIN)
		EC10	625.8	346	N/A		
		EC15	>1484	N/A	N/A		
		EC20	>1484	N/A	N/A		
		EC25	>1484	N/A	N/A		
		EC40	>1484	N/A	N/A		
		EC50	>1484	N/A	N/A		

Mean Dry Weight-mg Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	33.31	32.85	33.78	31.72	34.71	0.6223	1.245	3.74%	0.0%
311.5		4	32.6	31.92	33.29	30.65	34.68	0.9122	1.824	5.6%	2.12%
450.9		4	34.54	33.28	35.81	29.97	37.43	1.695	3.39	9.81%	-3.7%
670.8		3	36.43	35.22	37.64	32.69	38.42	1.871	3.241	8.9%	-9.38%
993.5		2	33.63	31.6	35.66	29.79	37.47	3.837	5.426	16.13%	-0.96%
1483.9		4	35.3	33.61	36.98	32.52	42.04	2.261	4.522	12.81%	-5.96%

Survival Rate Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	0.8917	0.873	0.9103	0.8333	0.9333	0.025	0.05	5.61%	0.0%
311.5		4	0.875	0.8439	0.9061	0.7667	0.9667	0.04167	0.08333	9.52%	1.87%
450.9		4	0.8667	0.8362	0.8972	0.8	0.9667	0.04082	0.08165	9.42%	2.8%
670.8		3	0.7333	0.7333	0.7333	0.7333	0.7333	0	0	0.0%	17.76%
993.5		2	0.8333	0.7981	0.8685	0.7667	0.9	0.06667	0.09428	11.31%	6.54%
1483.9		4	0.8	0.7114	0.8886	0.4667	1	0.1186	0.2373	29.66%	10.28%

Analyst:_____ QA: M

CETIS Summary Report

Report Date: 13 Jun-13 10:29 (p 1 of 1)
Test Code: TDSWetAna1a | 18-1247-1069

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
07-3730-3854	~~Mean Dry Weight-mg~~ Length (mm) JAB	1483.9	>1483.9	N/A	3.6%		Dunnett's Multiple Comparison Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
09-6019-3189	~~Mean Dry Weight-mg~~ Length (mm) JAB	IC5	>1484	N/A	N/A		Linear Interpolation (ICPIN)
		IC10	>1484	N/A	N/A		
		IC15	>1484	N/A	N/A		
		IC20	>1484	N/A	N/A		
		IC25	>1484	N/A	N/A		
		IC40	>1484	N/A	N/A		
		IC50	>1484	N/A	N/A		

~~Mean Dry Weight-mg~~ Length (mm) Summary JAB

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	32.36	32.18	32.54	31.82	32.96	0.2399	0.4798	1.48%	0.0%
311.5		4	32.4	32.3	32.5	32.15	32.78	0.134	0.2679	0.83%	-0.13%
450.9		4	32.48	32.22	32.74	31.66	33.17	0.3473	0.6945	2.14%	-0.39%
670.8		3	32.91	32.64	33.18	32.09	33.41	0.4133	0.7158	2.18%	-1.71%
993.5		2	32.73	32.27	33.19	31.85	33.61	0.88	1.244	3.8%	-1.15%
1483.9		4	32.67	32.38	32.95	32.04	33.79	0.3853	0.7707	2.36%	-0.95%

TDS-Wet Fertilization-Survival

CETIS Analytical Report

Report Date: 27 Sep-13 12:07 (p 1 of 1)
Test Code: TDSWetAna1 | 10-9682-9969

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	04-4108-4140	Endpoint:	Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:24	Analysis:	STP 2x2 Contingency Tables	Official Results:	Yes
Batch ID:	03-6132-4444	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	19 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	10 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	142d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	14-8207-3278	Code:	TDS-Wet-Ana1	Client:	Golder
Sample Date:	19 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	19 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU
Untransformed		C > T	Not Run	1483.9	>1483.9	N/A	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	Decision(0.05)
21.9		311.5	0.4205	0.4205	Non-Significant Effect
21.9		450.9	0.3463	0.6926	Non-Significant Effect
21.9		670.8	0.002648	0.0132	Significant Effect
21.9		993.5	0.1913	0.5740	Non-Significant Effect
21.9		1483.9	0.03641	0.1456	Non-Significant Effect

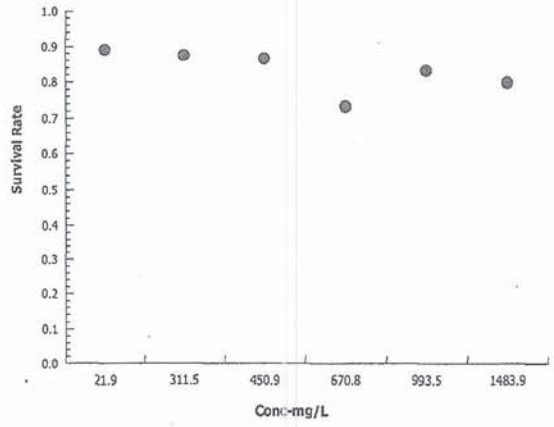
Data Summary

Conc-mg/L	Control Type	No-Resp	Resp	Total
21.9	Negative Contr	107	13	120
311.5		105	15	120
450.9		104	16	120
670.8		66	24	90
993.5		50	10	60
1483.9		96	24	120

Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.9	Negative Control	0.9333	0.9333	0.8667	0.8333
311.5		0.8667	0.9667	0.9	0.7667
450.9		0.9667	0.8	0.9	0.8
670.8		0.7333	0.7333	0.7333	
993.5		0.9	0.7667		
1483.9		0.8	1	0.9333	0.4667

Graphics



CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — Nautilus Environmental

Analysis ID:	06-1942-5468	Endpoint:	Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:27	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	03-6132-4444	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	19 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	10 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	142d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	14-8207-3278	Code:	TDS-Wet-Ana1	Client:	Golder
Sample Date:	19 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	19 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.883E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	498.3	N/A	N/A
EC10	625.8	346	N/A
EC15	>1484	N/A	N/A
EC20	>1484	N/A	N/A
EC25	>1484	N/A	N/A
EC40	>1484	N/A	N/A
EC50	>1484	N/A	N/A

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
21.9	Negative Control	4	0.8917	0.8333	0.9333	0.025	0.05	5.61%	0.0%	107	120
311.5		4	0.875	0.7667	0.9667	0.04167	0.08333	9.52%	1.87%	105	120
450.9		4	0.8667	0.8	0.9667	0.04082	0.08165	9.42%	2.8%	104	120
670.8		3	0.7333	0.7333	0.7333	0	0	0.0%	17.76%	66	90
993.5		2	0.8333	0.7667	0.9	0.06667	0.09428	11.31%	6.54%	50	60
1483.9		4	0.8	0.4667	1	0.1186	0.2373	29.66%	10.28%	96	120

Survival Rate Detail

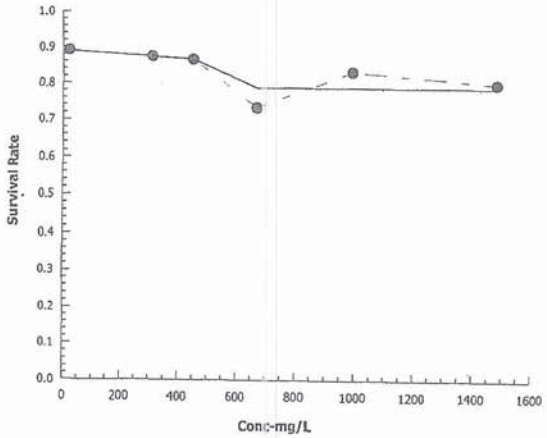
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.9	Negative Control	0.9333	0.9333	0.8667	0.8333
311.5		0.8667	0.9667	0.9	0.7667
450.9		0.9667	0.8	0.9	0.8
670.8		0.7333	0.7333	0.7333	
993.5		0.9	0.7667		
1483.9		0.8	1	0.9333	0.4667

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	06-1942-5468	Endpoint:	Survival Rate	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:27	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes

Graphics



TDS-Fertilization Wet- Dry Weight

CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	19-0916-6279	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:27	Analysis:	Parametric-Control vs Treatments	Official Results:	Yes
Batch ID:	03-6132-4444	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	19 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	10 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	142d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	14-8207-3278	Code:	TDS-Wet-Ana1	Client:	Golder
Sample Date:	19 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	19 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run	1483.9	>1483.9	N/A		17.1%

Dunnett's Multiple Comparison Test

Control	vs	Conc-mg/L	Test Stat	Critical	DF	MSD	P-Value	Decision(α:5%)
21.9		311.5	0.3052	2.465	6	5.708	0.7484	Non-Significant Effect
21.9		450.9	-0.5327	2.465	6	5.708	0.9528	Non-Significant Effect
21.9		670.8	-1.249	2.465	5	6.165	0.9932	Non-Significant Effect
21.9		993.5	-0.1125	2.465	4	6.991	0.8798	Non-Significant Effect
21.9		1483.9	-0.8573	2.465	6	5.708	0.9795	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	34.15862	6.831725	5	0.637	0.6750	Non-Significant Effect
Error	160.8773	10.72515	15			
Total	195.0359	17.55688	20			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	5.239	15.09	0.3874	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9738	0.871	0.8157	Normal Distribution

Mean Dry Weight-mg Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	33.31	32.84	33.78	31.72	34.71	0.6223	1.245	3.74%	0.0%
311.5		4	32.6	31.91	33.3	30.65	34.68	0.9122	1.824	5.6%	2.12%
450.9		4	34.54	33.25	35.83	29.97	37.43	1.695	3.39	9.81%	-3.7%
670.8		3	36.43	35.2	37.67	32.69	38.42	1.871	3.241	8.9%	-9.38%
993.5		2	33.63	31.57	35.69	29.79	37.47	3.837	5.426	16.13%	-0.96%
1483.9		4	35.3	33.58	37.02	32.52	42.04	2.261	4.522	12.81%	-5.96%

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID: 19-0916-6279
Analyzed: 13 Jun-13 10:27

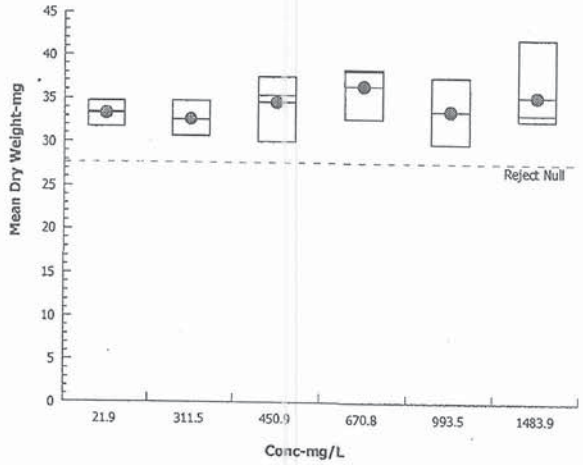
Endpoint: Mean Dry Weight-mg
Analysis: Parametric-Control vs Treatments

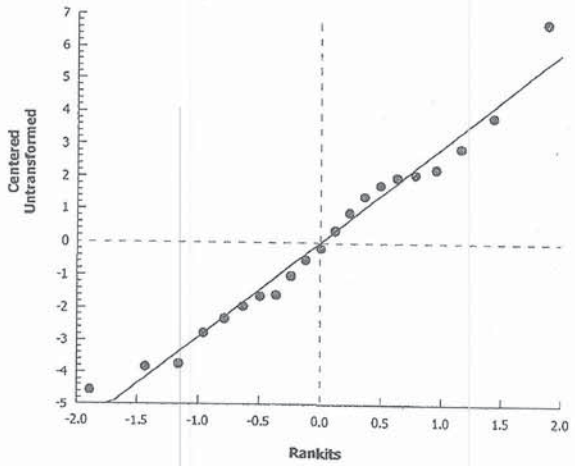
CETIS Version: CETISv1.8.0
Official Results: Yes

Mean Dry Weight-mg Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.9	Negative Control	31.72	33.68	33.14	34.71
311.5		31.59	30.65	33.5	34.68
450.9		29.97	36.78	34	37.43
670.8		32.69	38.19	38.42	
993.5		29.79	37.47		
1483.9		32.52	32.96	33.66	42.04

Graphics





CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	02-3010-6748	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:27	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	03-6132-4444	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	19 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	10 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	142d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	14-8207-3278	Code:	TDS-Wet-Ana1	Client:	Golder
Sample Date:	19 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	19 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	43224713	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1484	N/A	N/A
IC10	>1484	N/A	N/A
IC15	>1484	N/A	N/A
IC20	>1484	N/A	N/A
IC25	>1484	N/A	N/A
IC40	>1484	N/A	N/A
IC50	>1484	N/A	N/A

Mean Dry Weight-mg Summary

			Calculated Variate						
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	33.31	31.72	34.71	0.6223	1.245	3.74%	0.0%
311.5		4	32.6	30.65	34.68	0.9122	1.824	5.6%	2.12%
450.9		4	34.54	29.97	37.43	1.695	3.39	9.81%	-3.7%
670.8		3	36.43	32.69	38.42	1.871	3.241	8.9%	-9.38%
993.5		2	33.63	29.79	37.47	3.837	5.426	16.13%	-0.96%
1483.9		4	35.3	32.52	42.04	2.261	4.522	12.81%	-5.96%

Mean Dry Weight-mg Detail

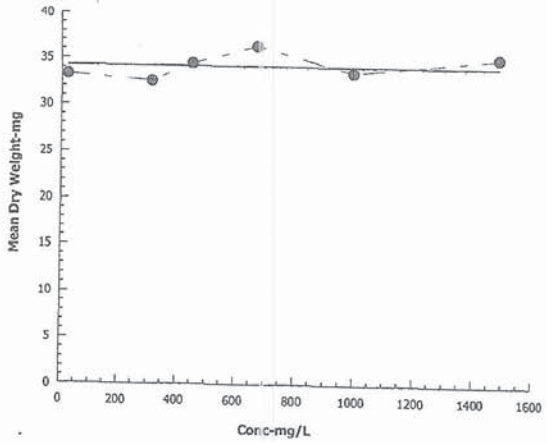
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.9	Negative Control	31.72	33.68	33.14	34.71
311.5		31.59	30.65	33.5	34.68
450.9		29.97	36.78	34	37.43
670.8		32.69	38.19	38.42	
993.5		29.79	37.47		
1483.9		32.52	32.96	33.66	42.04

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	02-3010-6748	Endpoint:	Mean Dry Weight-mg	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:27	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes

Graphics



TDS - Wet Fertilization - Length

CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	07-3730-3854	Endpoint:	Mean ~~Dry Weight mg~~ Length (mm)	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:29	Analysis:	Parametric-Control vs Treatments	Official Results:	Yes
Batch ID:	06-0872-4759	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	19 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	10 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	142d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	12-2451-6863	Code:	TDS Wet Ana 1a	Client:	Golder
Sample Date:	19 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	19 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Data Transform	Zeta	Alt Hyp	MC Trials	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run	1483.9	>1483.9	N/A		3.6%

Dunnett's Multiple Comparison Test

Control	vs Conc-mg/L	Test Stat	Critical	DF	MSD	P-Value	Decision(α:5%)
21.9	311.5	-0.08988	2.465	6	1.166	0.8742	Non-Significant Effect
21.9	450.9	-0.2643	2.465	6	1.166	0.9124	Non-Significant Effect
21.9	670.8	-1.082	2.465	5	1.259	0.9890	Non-Significant Effect
21.9	993.5	-0.6432	2.465	4	1.428	0.9641	Non-Significant Effect
21.9	1483.9	-0.6503	2.465	6	1.166	0.9648	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.759733	0.1519466	5	0.3398	0.8809	Non-Significant Effect
Error	6.708246	0.4472164	15			
Total	7.467979	0.599163	20			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	4.127	15.09	0.5313	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9645	0.871	0.6113	Normal Distribution

Mean ~~Dry Weight mg~~ Length (mm) Summary

Conc-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	32.36	32.18	32.54	31.82	32.96	0.2399	0.4798	1.48%	0.0%
311.5		4	32.4	32.3	32.5	32.15	32.78	0.134	0.2679	0.83%	-0.13%
450.9		4	32.48	32.22	32.75	31.66	33.17	0.3473	0.6945	2.14%	-0.39%
670.8		3	32.91	32.64	33.18	32.09	33.41	0.4133	0.7158	2.18%	-1.71%
993.5		2	32.73	32.26	33.2	31.85	33.61	0.88	1.244	3.8%	-1.15%
1483.9		4	32.67	32.37	32.96	32.04	33.79	0.3853	0.7707	2.36%	-0.95%

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID: 07-3730-3854
Analyzed: 13 Jun-13 10:29

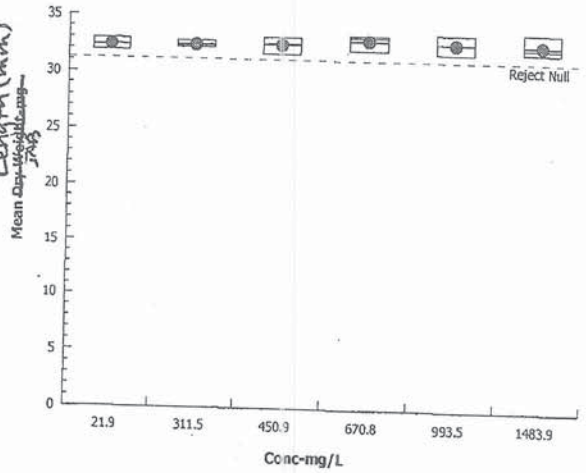
Endpoint: Mean ~~Dry Weight mg~~ JAD Length (mm)
Analysis: Parametric-Control vs Treatments

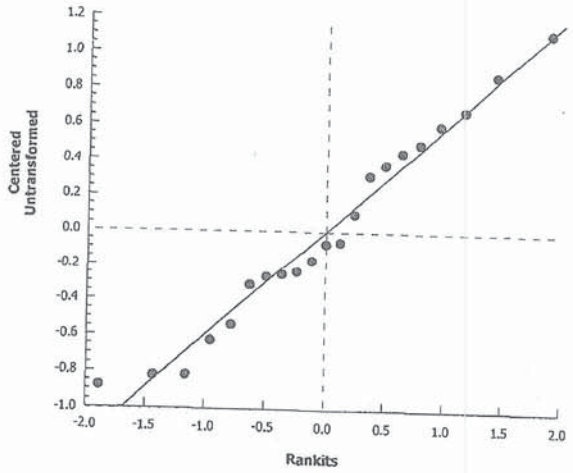
CETIS Version: CETISv1.8.0
Official Results: Yes

Mean ~~Dry Weight mg~~ JAD Length (mm) Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.9	Negative Control	32.46	31.82	32.19	32.96
311.5		32.15	32.34	32.33	32.78
450.9		31.66	32.17	32.93	33.17
670.8		33.23	32.09	33.41	
993.5		31.85	33.61		
1483.9		32.04	32.4	32.43	33.79

Graphics





CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	09-6019-3189	Endpoint:	Mean ~~Dry Weight-mg~~ JAB Length (mm)	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:29	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes
Batch ID:	06-0872-4759	Test Type:	Survival-Development-Growth	Analyst:	
Start Date:	19 Nov-12	Protocol:	EC/EPS 1/RM/28	Diluent:	Dechlorinated Tap Water
Ending Date:	10 Apr-13	Species:	Salvelinus namaycush (Lake Trout)	Brine:	
Duration:	142d 0h	Source:	Sushwap Lake	Age:	
Sample ID:	12-2451-6863	Code:	TDS Wet Ana 1a	Client:	Golder
Sample Date:	19 Nov-12	Material:	Total Dissolved Solids	Project:	
Receive Date:	19 Nov-12	Source:	Golder		
Sample Age:	N/A	Station:			

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	875981250	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1484	N/A	N/A
IC10	>1484	N/A	N/A
IC15	>1484	N/A	N/A
IC20	>1484	N/A	N/A
IC25	>1484	N/A	N/A
IC40	>1484	N/A	N/A
IC50	>1484	N/A	N/A

Mean ~~Dry Weight-mg~~ JAB Length (mm) Summary

Conc-mg/L	Control Type	Count	Calculated Variate						
			Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
21.9	Negative Control	4	32.36	31.82	32.96	0.2399	0.4798	1.48%	0.0%
311.5		4	32.4	32.15	32.78	0.134	0.2679	0.83%	-0.13%
450.9		4	32.48	31.66	33.17	0.3473	0.6945	2.14%	-0.39%
670.8		3	32.91	32.09	33.41	0.4133	0.7158	2.18%	-1.71%
993.5		2	32.73	31.85	33.61	0.88	1.244	3.8%	-1.15%
1483.9		4	32.67	32.04	33.79	0.3853	0.7707	2.36%	-0.95%

Mean ~~Dry Weight-mg~~ JAB Length (mm) Detail

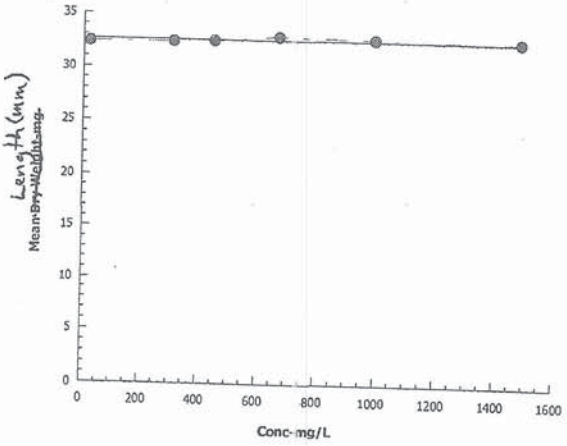
Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
21.9	Negative Control	32.46	31.82	32.19	32.96
311.5		32.15	32.34	32.33	32.78
450.9		31.66	32.17	32.93	33.17
670.8		33.23	32.09	33.41	
993.5		31.85	33.61		
1483.9		32.04	32.4	32.43	33.79

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	09-6019-3189	Endpoint:	Mean ~~Dry Weight mg~~ JAB Length (mm)	CETIS Version:	CETISv1.8.0
Analyzed:	13 Jun-13 10:29	Analysis:	Linear Interpolation (ICPIN)	Official Results:	Yes

Graphics



Analyst:_____ QA: JAB

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** Nov 19/12 @ 1500h
Sample ID: Synthetic Effluent- TDS - Nutrification **Stop Date:** Apr 10/13
Work Order #: n/a #2 **Test Species:** S. namaycush

Treatments Brown mg/L TDS		Rep	Day of Test - No. of Mortalities 2	4	7	9	11	14	16	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	E	1	0	0	0	0	0	0	0	0	n/a	0	30
	F	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	G	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	H	4	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
296	E	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	F	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	G	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	H	4	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
444	E	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	F	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	G	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	H	4	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
667	E	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	F	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	G	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	H	4	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
1000	E	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	F	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	G	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	H	4	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
1500	E	1	↓	↓	↓	↓	↓	0	↓	↓	↓	↓	↓
	F	2	↓	↓	↓	↓	↓	0	↓	↓	↓	↓	↓
	G	3	↓	↓	↓	↓	↓	0	↓	↓	↓	↓	↓
	H	4	↓	↓	↓	↓	↓	1	↓	1	↓	↓	↓
		1											
		2											
		3											
		4											
		1											
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		3											
		4											
Tech Initials			JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** Nov 19/12 @ 1500h
Sample ID: Synthetic Effluent- TDS - Wet Fertilization #2 **Stop Date:** Apr 10/13
Work Order #: nla **Test Species:** S. namaycush

Treatments Brown mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			18	21	23	25	28	30	32				
Control	E	1	0	0	0	0	0	0	0	0	0	0	30
	F	2		0									
	G	3		0									
	H	4		0									
296	E	1		0									
	F	2		0									
	G	3		0			↓						
	H	4		0						↓			
444	E	1		0			1			1			
	F	2		1			0			1			
	G	3		0						0			
	H	4		0									
667	E	1		0									
	F	2		0									
	G	3		0									
	H	4		0									
1000	E	1		0									
	F	2		0									
	G	3		0			↓			↓			
	H	4		0			1			1			
1500	E	1		0			0			0			
	F	2		0						0			
	G	3		0						0			
	H	4	↓	0	↓	↓	↓	↓	↓	0 (A)	↓	↓	↓
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			SBF	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** Nov 19/12 @1500h
Sample ID: Synthetic Effluent- TDS - Wet Fertilization #2 **Stop Date:** Apr 10/13
Work Order #: n/a **Test Species:** S. namaycush

Treatments Brown mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		35	37	39	42	44	46	49				
Control E	1	0	0	0	1	0	0	0	1	1		
F	2			0	0		0		0	1		
G	3				0		1		1	0		
H	4				0		0		0	4		
296 E	1				0		0		0	1		
F	2				0		0		0	0		
G	3				0		0		0	0		
H	4				0		1 (a)		1	2		
444 E	1				0		0		0 (1)	0		
F	2				0		0		0 (1)	2		
G	3				0		0		0	0		
H	4			↓	0		1		1	3		
667 E	1			1	0		0		1	2		
F	2			0	0		0		0	1		
G	3			1	0		3		4	1		
H	4			0	0		1		1	6		
1000 E	1			0	0		0		0	1		
F	2				1		0		1	2		
G	3				1		2		3	1		
H	4	↓			1		1		2 (1)	4		
1500 E	1	2			0		0		2	1		
F	2	0			0		0		0	0		
G	3	0			0		0		0	2		
H	4	0	↓	↓	0	↓	1	↓	1 (1)	13		
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB	JAB		

Comments: (a) eyed

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** Nov 19/12 @ 1500h

Sample ID: Synthetic Effluent- TDS Wet Fertilization **Stop Date:** Apr 10/13

Work Order #: n/a **Test Species:** S. namaycush

Treatments mg/L TDS		Rep	Day of Test - No. of Mortalities 51	53	56	58	60	63	65	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	E	1	0	0	0	0	0	0	0	0			
	F	2	↓	↓	↓	↓	↓	↓	↓	↓			
	G	3	↓	↓	↓	↓	↓	↓	↓	↓			
	H	4	↓	↓	↓	↓	↓	↓	↓	↓			
296	E	1	↓	↓	↓	↓	↓	↓	↓	↓			
	F	2	↓	↓	↓	↓	↓	↓	↓	↓			
	G	3	↓	↓	↓	↓	↓	↓	↓	↓			
	H	4	↓	↓	↓	↓	↓	↓	↓	↓			
444	E	1	↓	↓	↓	↓	↓	↓	↓	↓			
	F	2	↓	↓	↓	↓	↓	↓	↓	↓			
	G	3	↓	↓	↓	↓	↓	↓	↓	↓			
	H	4	↓	↓	↓	↓	↓	↓	↓	↓			
667	E	1	↓	↓	↓	↓	↓	↓	↓	↓			
	F	2	↓	↓	↓	↓	↓	↓	↓	↓			
	G	3	↓	↓	↓	↓	↓	↓	↓	↓			
	H	4	↓	↓	↓	↓	↓	↓	1	1			
1000	E	1	↓	↓	↓	↓	↓	↓	1	1			
	F	2	↓	↓	↓	↓	↓	↓	0	0			
	G	3	↓	↓	↓	↓	↓	↓	0	0			
	H	4	↓	↓	↓	↓	↓	↓	0	0			
1500	E	1	↓	↓	↓	↓	↓	↓	0	0			
	F	2	↓	↓	↓	↓	↓	↓	●	0			
	G	3	↓	↓	↓	↓	↓	↓	0	0			
	H	4	↓	↓	↓	↓	↓	↓	1	1			
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JAB	JAB	JAB	JBF	JBF	JBF	JBF	JAB			

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder **Start Date & Time:** November 19/12 @1500
Sample ID: Synthetic Effluent - TDS - Wet Fert **Stop Date:** Apr 10/13
Work Order #: n/a **Test Species:** *S. namaycush*

Concentration (Brown) mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			67	70	72	74	77	79	81				
Control	E	1	0	0	0	0	1	0	0				
	F	2	↓	↓	↓	↓	0	↓	↓				
	G	3					↓						
	H	4											
296	E	1											
	F	2					↓						
	G	3			↓		2						
	H	4			1	↓	0						
444	E	1			0		0+DF						
	F	2		↓	0	1	0						
	G	3		1	1	0	1						
	H	4		0	0	↓	0						
667	E	1		0	1								
	F	2		0	0								
	G	3		0	1								
	H	4		1	0								
1000	E	1		0	↓								
	F	2		↓	↓								
	G	3			↓		↓						
	H	4			↓		↓						
1500	E	1			↓		1						
	F	2			↓		6						
	G	3			↓		0						
	H	4	↓	↓	↓	↓	0	↓	↓				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JBF	JBF	JBF	JBF	JBF	JBF	JBF				

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - wet Fert
Work Order #: n/a

Start Date & Time: November ~~16~~ 19 2012 @ ~~1415~~ JAB 1500h
Stop Date: Apr 16/13 SBF
Test Species: *S. hamaycush*

Concentration (Brown) Mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			84	86	88	91	93	95	98				
Control	E	1	0	0	0	0	0	0	0				
	F	2	↓	↓	↓	↓	↓	1	0				
	G	3	↓	↓	↓	↓	↓	0	1				
	H	4	↓	↓	↓	↓	↓	↓	0				
296	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3	↓	↓	↓	↓	↓	↓	↓				
	H	4	1	↓	↓	↓	↓	↓	↓				
444	E	1	0	↓	↓	0	↓	↓	↓				
	F	2	1	↓	↓	1	↓	↓	↓				
	G	3	0	↓	↓	0	↓	↓	↓				
	H	4	0	↓	↓	0	↓	↓	↓				
667	E	1	0	↓	↓	0	↓	↓	1				
	F	2	0	↓	↓	1	↓	↓	0				
	G	3	1	↓	↓	0	↓	↓	↓				
	H	4	0	↓	↓	↓	↓	↓	↓				
1000	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	↓	1				
	G	3	↓	↓	↓	↓	↓	↓	1				
	H	4	↓	↓	↓	↓	↓	↓	0				
1500	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3	↓	↓	↓	↓	↓	↓	↓				
	H	4	↓	↓	↓	↓	↓	↓	↓				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			SBF	SBF	SBF	SBF	SBF	SBF	SBF				

Comments:

Reviewed by: M **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - Wet Fert.
Work Order #: n/a

Start Date & Time: November ~~16~~ 19, 2012 @ ~~1415~~ JAB 1500 h
Stop Date: Apr 10/13 JBF
Test Species: *S. namaycush*

Concentration (Brown) Mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			100	102	105	107	109	112	~~114~~ ~~116~~ JBF				
Control	E	1	0	0	0	0	0	0	0				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3	↓	↓	↓	↓	↓	↓	↓				
	H	4	↓	↓	↓	↓	↓	1	↓				
296	E	1	↓	↓	↓	↓	↓	0	↓				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3	1	↓	↓	↓	↓	↓	↓				
	H	4	0	↓	↓	↓	↓	↓	↓				
444	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3	↓	↓	↓	↓	↓	↓	↓				
	H	4	↓	↓	↓	↓	↓	↓	↓				
667	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	1	↓				
	G	3	↓	↓	↓	↓	↓	0	↓				
	H	4	↓	↓	↓	↓	↓	↓	↓				
1000	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	4	1				
	G	3	↓	↓	↓	↓	↓	3	↓				
	H	4	↓	↓	↓	↓	↓	0	↓				
1500	E	1	↓	↓	↓	↓	↓	↓	↓				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3	↓	↓	↓	↓	↓	↓	↓				
	H	4	↓	↓	↓	↓	↓	↓	↓				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JBF	JBF	JBF	JBF	JAB	JBF	JBF				

Comments: _____

Reviewed by: _____ **Date reviewed:** 17/1/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - Wet Fert.
Work Order #: N/A

Start Date & Time: November 19, 2012 @1500h
Stop Date: Apr 10/13
Test Species: *S. namaycush*

Concentration (Brown) mg/L TDS		Rep	Day of Test - No. of Mortalities 116	119 (~~118~~) SBF	121 (~~121~~) SBF JAB	122 (~~123~~) JBF	123 (~~126~~) SBF	124 (~~127~~) JAB	125 (~~130~~)	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	E	1	0	1	~~0~~	0	0	0	0				
	F	2	↓	0	0	↓	↓	↓	↓				
	G	3		1	1								
	H	4		0	0								
296	E	1											
	F	2											
	G	3											
	H	4											
444	E	1											
	F	2											
	G	3											
	H	4											
667	E	1	1										
	F	2	~~30~~ 30	210									
	G	3	0	0									
	H	4	0	0									
1000	E	1	0	0									
	F	2	10①	70①									
	G	3	30①	170①									
	H	4	0	0									
1500	E	1											
	F	2											
	G	3											
	H	4	↓	↓	↓	↓	↓	↓	↓				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			SBF	SBF	JAB	SBF	JAB	JAB					

Comments: ① Artemia Feeding rate determined to be too high, reduced. Water renewal completed twice on Day 119 to remove excess artemia and potentially high ammonia levels. Please see attached CAR form.

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic - TDS - Wet Fert.
Work Order #: N/A

Start Date & Time: November 19, 2012 @1500h
Stop Date: Apr 10/13
Test Species: *S. hamaycush*

Concentration (Brown) mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			~~133~~ ~~132~~ JBF	~~135~~ JBF	~~437~~	~~139~~ JBF	~~142~~	~~144~~	~~146~~ JBF				
Control	E	1	0	0	0	0	0	0	0				
	F	2											
	G	3											
	H	4											
296	E	1											
	F	2											
	G	3											
	H	4											
444	E	1				V							
	F	2				1							
	G	3				0							
	H	4				1							
667	E	1											
	F	2											
	G	3											
	H	4											
1000	E	1											
	F	2											
	G	3											
	H	4											
1500	E	1											
	F	2											
	G	3											
	H	4	↓	↓	↓	↓	↓	↓	↓				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JBF	JBF	JAD	JAD	~	~	JAD				

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic Effluent- TDS- Wet
Work Order #: n/a
Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

Treatments mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			133	134	135	136	137	138	139				
Control	E	1	0	0	0	0	0	0	0				
	F	2	↓	↓	↓	↓	↓	↓	↓				
	G	3											
	H	4											
296	E	1											
	F	2						↓					
	G	3						1					
	H	4	↓					0					
444	E	1	JAB 0							JAB			
	F	2	0										
	G	3											
	H	4											
667	E	1											
	F	2											
	G	3								JAB			
	H	4		↓									
1000		1		1									
		2		0									
		3											
		4											
1500		1											
		2											
		3											
		4	↓	↓	↓	↓	↓	↓	↓				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JBF	JBF	DBF	~	~	JBF	JBF				

Comments:

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: Synthetic Effluent- TDS -Wet
Work Order #: n/a

Start Date & Time: Nov 19/12 @1500h
Stop Date: Apr 10/13
Test Species: Sinamagcush

Treatments mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		140	141	142								
Control	1	0	0	0								
	2	↓	↓	0								
	3			0								
	4			0								
296	1			0								
	2			0								
	3			0								
	4			0								
444	1			1								
	2			0								
	3			0								
	4			0								
667	1			0								
	2			0								
	3			1								
	4			0								
1000	1			0								
	2			0								
	3			0								
	4			0								
1500	1			0								
	2			0								
	3		↓	0								
	4	↓		0								
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB								

Comments:

Reviewed by: M **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Hatched

Client: Golder
Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Synthetic Effluent- TDS Wet Fert
Stop Date: Apr 10/13
Work Order #: n/a
Test Species: S. namaycush

Treatments (brown) mg/L TDS		Rep	Day of Test - No. of Hatched							~~Total~~ Dead Fish JAB	~~Total~~ Undeveloped JAB	~~Total No.~~ Fry JAB	~~Total~~ Exposed JAB
			56	58	60	63	65	67	70				
Control	E	1	0	0	2	2	3	3	10				
	F	2			0	0	0	3	8				
	G	3			0	0	0	0	0				
	H	4			0	0	0	0	12				
296	E	1			1	1	1	1	7				
	F	2			0	0	0	0	3				
	G	3			0	0	1	1	5				
	H	4			0	0	0	0	2				
444	E	1			0	0	0	0	5				
	F	2			1	1	4	7	7				
	G	3			1	1	4	5	10				
	H	4			0	0	1	1	6				
667	E	1			2	2	4	4	11				
	F	2			0	0	0	0	0				
	G	3			0	0	5	5	5				
	H	4			0	0	0	0	0				
1000	E	1			0	0	7	7	11				
	F	2			0	0	1	1	8				
	G	3			0	0	0	0	1				
	H	4			0	0	0	0	9				
1500	E	1			2	2	2	2	15				
	F	2			0	0	9	9	11				
	G	3			0	0	0	0	0				
	H	4	↓	↓	0	0	1	1	1				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JAB	JBF	JBF	JBF	JBF	JBF	JBF				

Comments:

Reviewed by: _____ **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Daily Hatched

Client: Golder
Start Date & Time: November 19/12 @ 1500
Sample ID: Synthetic Effluent- TDS ~ wet Fert
Stop Date: Apr 10/13
Work Order #: n/a
Test Species: S. namaycush

Treatments (brown) mg/L TDS		Rep	Day of Test - No. of Hatched							Total Dead Fish JAB	Total Undeveloped JAB	Total No. Fry JAB	Total Exposed JAB
			72	74	77	79	81	84	86 ②				
Control	E	1	10	11	26/28	27/28	28	28	28				
	F	2	12	12/[illegible]	18/29	A/29	A/29	25/29	29				
	G	3	7	8	9/29	24/29	28/29	29	29				
	H	4	13	15/26	16/26	16/26	7/26	26	26				
296	E	1	9	[illegible]	A/28	27/28	28	28	28				
	F	2	3	6	11/30	27/30	30	30	30				
	G	3	8	14	[illegible]	[illegible]	28	28	28				
	H	4	4	[illegible]	7/25	20/25	24/25	25	25	25			
444	E	1	12	13	21/29	29/29	29	29	29				
	F	2	[illegible]	6	18/27	20/27	27	27	27				
	G	3	JBF 12	21/28	24/27	27/27	27	27	27				
	H	4	6	9/25	[illegible]	16/25	25	25	25				
667	E	1	12	15	25/26	26/26	26	26	26				
	F	2	2	11	29/29	29/29	29	29	29				
	G	3	5	12	A/25	23/25	25	25	25				
	H	4	12	12/22	22/22	22/22	22	22	22				
1000	E	1	16	26/28	28/28	28/28	28	28	28				
	F	2	8	13	13/27	13/27	22/27	26/27	27				
	G	3	3	5	20/28	27/28	28	28	28				
	H	4	12	[illegible]	22/23	23/23	23	23	23				
1500	E	1	16	A/25	24/24	24/24	24	24	24				
	F	2	12	24/29	28/29	29/A	29	29	29				
	G	3	1	11	24/28	28/28	28	28	28				
	H	4	1	[illegible]	A/A	14/14	A	14	14				
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JBF	JBF	JBF	JBF	JBF	JBF	JBF				

Comments: ① 21/28
② All trout hatched at day 86

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test Data Sheet

Fry ~~Swim-up~~ Survival and Dry Weight

Client: Golder

Work Order No.: n/a

Start Date: Nov. 19/12

Termination Date: Apr 10/13

Wet Fert

Sample ID	Rep	Pan No. Black	No. Alive	Initials	Pan weight	Pan + organism	No. weighed	Initials
Control	A E	1	28	JBF	1043.47	1931.67	28	JBF
	B F	2	28		1038.74	1973.71	28	
	C G	3	26		996.11	1857.62	26	
	D H	4	25		1030.28	1898.01	25	
296	A E	5	26		1036.83	1858.13	26	
	B F	6	29		1048.42	1937.16	① 29	
	C G	7	27		1024.78	1929.26	27	
	D H	8	23		1040.04	1837.73	23	
444	A E	9	29		1036.78	1906.04	29	
	B F	10	24		1000.64	1883.28	24	
	C G	11	27		1044.75	1962.74	27	
	D H	12	24		1048.62	1946.85	③ 24	
667	A E	13	22		1029.30	1749.47	22	
	B F	14	3		1032.40	1189.22	3	
	C G	15	22		1011.40	1851.48	22	
	D H	16	22		1015.22	1860.50	22	
1000	A E	17	27		1038.34	1872.76	27	
	B F	18	5		996.04	1254.89	5	
	C G	19	5		1002.41	1266.49	5	
	D H	20	23		1015.63	1877.36	23	
1500	A E	21	24		1033.70	1814.27	24	
	B F	22	30		1004.38	1993.26	30	
	C G	23	28		1048.40	1990.75	28	
	D H	24	14	↓	1036.48	1625.07	③ 14	↓

Thermome: Calibrated Thermometer DO meter: DO-1 pH meter: _____

Comments: ① 1 abnormal swimming on bottom, bent, bleeding on dorsal side

Reviewed by: _____ Date Reviewed: 17/6/13

Re-weigh ① 1954.21 ② 1963.82 ③ 1634.31

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- Control SBF A E

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	28	5.54	0.20	SBF
2	33				
3	32				
4	33				
5	33				
6	33				
7	31				
8	32				
9	31				
10	33				
11	32				
12	32				
13	32				
14	32				
15	31				
16	33				
17	33				
18	32				
19	34				
20	34				
21	32				
22	33				
23	33				
24	32				
25	33				
26	32				
27	33				
28	32				
29					
30					

Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- Control JBF BF

Start Date & Time: Nov 19/12 @1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	28	5.61	0.20	JBF
2	31				
3	32				
4	32				
5	32				
6	32				
7	31				
8	33				
9	32				
10	33				
11	30				
12	31				
13	32				
14	31				
15	31				
16	32				
17	31				
18	32				
19	33				
20	32				
21	32				
22	31				
23	31				
24	31				
25	32				
26	32				
27	33				
28	33				
29					
30					

Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Wet Fert- Control G
Stop Date: Apr 10/13
Test Species: Oncorhynchus

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	26	5.36	0.21	SBF
2	32				
3	33				
4	32				
5	32				
6	33				
7	34				
8	33				
9	32				
10	32				
11	32				
12	31				
13	31				
14	33				
15	32				
16	32				
17	32				
18	33				
19	32				
20	33				
21	33				
22	30				
23	32				
24	31				
25	32				
26	33				
27					
28					
29					
30					

Reviewed by: N
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Wet Fert- Control H
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	25	SBF ~~0.~~ 5.22	0.21	SBF
2	32				
3	31				
4	33				
5	32				
6	32				
7	34				
8	33				
9	34				
10	35				
11	33				
12	32				
13	34				
14	33				
15	34				
16	33				
17	32				
18	33				
19	34				
20	33				
21	33				
22	34				
23	32				
24	33				
25	33				
26					
27					
28					
29					
30					

Reviewed by: M
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 296 E

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	26	5.34	0.21	VBF
2	32				
3	32				
4	33				
5	33				
6	33				
7	32				
8	32				
9	32				
10	31				
11	33				
12	31				
13	32				
14	32				
15	33				
16	32				
17	32				
18	31				
19	32				
20	32				
21	32				
22	32				
23	32				
24	33				
25	33				
26	32				
27					
28					
29					
30					

Reviewed by: MZ

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 296 F

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	31	29	6.66	0.23	JBF
2	33				
3	33				
4	33				
5	33				
6	32				
7	33				
8	32				
9	32				
10	33				
11	32				
12	32				
13	33				
14	30				
15	33				
16	33				
17	34				
18	33				
19	33				
20	33				
21	33				
22	32				
23	32				
24	31				
25	32				
26	32				
27	32				
28	32				
29	31				
30					

Reviewed by: R

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Wet Fert- 296 G
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	27.	5.39	0.20	JRF
2	33				
3	31				
4	32				
5	32				
6	31				
7	32				
8	31				
9	33				
10	32				
11	32				
12	33				
13	34				
14	31				
15	33				
16	32				
17	32				
18	31				
19	35				
20	33				
21	32				
22	32				
23	32				
24	33				
25	33				
26	33				
27	32				
28					
29					
30					

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 296 H

Start Date & Time: Nov 19/12 @1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	23	4.97	0.22	SBF
2	32				
3	32				
4	34				
5	33				
6	33				
7	33				
8	33				
9	32				
10	32				
11	33				
12	34				
13	33				
14	32				
15	32				
16	33				
17	33				
18	32				
19	33				
20	34				
21	33				
22	32				
23	33				
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26					
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28					
29					
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Reviewed by: [illegible]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 444 E

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	30	29	5.54	0.19	JBF
2	30				
3	33				
4	32				
5	33				
6	32				
7	31				
8	32				
9	31				
10	32				
11	31				
12	33				
13	33				
14	32				
15	31				
16	31				
17	32				
18	33				
19	32				
20	32				
21	31				
22	32				
23	31				
24	31				
25	30				
26	31				
27	32				
28	32				
29	32				
30					

Reviewed by: M

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 444 F

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	24	5.42	0.23	JBF
2	32				
3	30				
4	33				
5	31				
6	30				
7	32				
8	33				
9	33				
10	34				
11	33				
12	33				
13	33				
14	33				
15	31				
16	32				
17	33				
18	31				
19	32				
20	32				
21	32				
22	32				
23	32				
24	33				
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 11/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 444 G

Start Date & Time: Nov 19/12 @1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	27	5.80	0.21	JBF
2	33				
3	34				
4	32				
5	33				
6	32				
7	32				
8	32				
9	33				
10	34				
11	33				
12	34				
13	32				
14	33				
15	33				
16	32				
17	32				
18	34				
19	34				
20	33				
21	32				
22	33				
23	33				
24	34				
25	34				
26	32				
27	33				
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 444 H

Start Date & Time: Nov 19/12 @1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	24	5.48	0.23	JBF
2	32				
3	34				
4	32				
5	35				
6	32				
7	34				
8	33				
9	33				
10	34				
11	32				
12	33				
13	33				
14	33				
15	34				
16	34				
17	34				
18	33				
19	32				
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22	33				
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24	33				
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30					

Reviewed by: [illegible]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 667 E

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	22	4.63	0.21	SBF
2	33				
3	33				
4	34				
5	33				
6	33				
7	34				
8	33				
9	33				
10	33				
11	33				
12	34				
13	32				
14	33				
15	33				
16	32				
17	33				
18	34				
19	35				
20	30				
21	35				
22	34				
23					
24					
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26					
27					
28					
29					
30					

Reviewed by: M **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 667 F

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	37	3	0.81 ~~0.27~~ SBF	0.27	SBF
2	34				
3	34				
4					
5					
6					
7					
8					
9					
10					
11					
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Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 667 G

Start Date & Time: Nov 19/12 @1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	22	5.10	0.23	JBF
2	31				
3	33				
4	32				
5	32				
6	32				
7	32				
8	32				
9	31				
10	32				
1	33				
12	31				
13	32				
14	31				
15	33				
16	33				
17	33				
18	32				
19	31				
20	33				
21	33				
22	32				
23					
24					
25					
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27					
28					
29					
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Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Wet Fert- 667 H
Stop Date: Apr 10/13
Test Species: S.namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	22	5.12	0.23	JBF
2	34				
3	34				
4	34				
5	34				
6	33				
7	34				
8	33				
9	33				
10	33				
11	33				
12	34				
13	33				
14	32				
15	34				
16	33				
17	33				
18	33				
19	33				
20	34				
21	35				
22	33				
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Reviewed by: N
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Wet Fert- 1000 E
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	29	27	5.28	0.20	JBF
2	32				
3	32				
4	32				
5	32				
6	31				
7	31				
8	31				
9	32				
10	32				
11	32				
12	31				
13	33				
14	33				
15	32				
16	33				
17	32				
18	32				
19	34				
20	31				
21	32				
22	31				
23	32				
24	31				
25	33				
26	32				
27	32				
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 1000 F

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: Sinomaycosh

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	5	1.40	0.28	SBF
2	32				
3	35				
4	33				
5	32				
6					
7					
8					
9					
10					
11					
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Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 1000 G

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	5	1.46	0.29	JBF
2	35				
3	34				
4	34				
5	34				
6					
7					
8					
9					
10					
11					
12					
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Reviewed by: [signature]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @1500h
Sample ID: Wet Fert- 1000 H **Stop Date:** Apr 10/13
Test Species: S. mamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	34	23	5.21	0.23	JBF
2	33				
3	34				
4	34				
5	34				
6	33				
7	34				
8	34				
9	34				
10	33				
11	34				
12	34				
13	33				
14	33				
15	34				
16	33				
17	34				
18	34				
19	32				
20	35				
21	34				
22	33				
23	33				
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature] **Date reviewed:** 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: Nov 19/12 @ 1500h
Sample ID: Wet Fert- 1500 E
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	31	24	5.95	0.25	JBE
2	32				
3	32				
4	31				
5	31				
6	32				
7	33				
8	32				
9	32				
10	32				
11	33				
12	32				
13	32				
14	31				
15	33				
16	33				
17	34				
18	32				
19	32				
20	32				
21	32				
22	31				
23	30				
24	34				
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]
Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 1500 F

Start Date & Time: Nov 19/12 @ 1500h

Stop Date: Apr 10/13

Test Species: Sinamaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	32	30	6.22	0.21	SBF
2	32				
3	33				
4	33				
5	32				
6	34				
7	33				
8	32				
9	32				
10	32				
11	32				
12	33				
13	33				
14	33				
15	32				
16	33				
17	33				
18	33				
19	32				
20	32				
21	32				
22	33				
23	32				
24	32				
25	32				
26	32				
27	31				
28	32				
29	33				
30	32				

Reviewed by: N

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 1500 G

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. salmaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	28	5.83	0.21	JRF
2	32				
3	32				
4	32				
5	33				
6	33				
7	33				
8	32				
9	33				
10	33				
11	33				
12	32				
13	32				
14	33				
15	33				
16	32				
17	33				
18	32				
19	31				
20	32				
21	33				
22	34				
23	33				
24	33				
25	31				
26	33				
27	30				
28	32				
29					
30					

Reviewed by: [illegible]

Date reviewed: 17/6/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Wet Fert- 1500 H

Start Date & Time: Nov 19/12 @ 1500h
Stop Date: Apr 10/13
Test Species: S. namaycush

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	33	14	3.47	0.25	JBF
2	34				
3	33				
4	34				
5	35				
6	33				
7	33				
8	34				
9	34				
10	35				
11	33				
12	33				
13	35				
14	34				
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Reviewed by: [signature]

Date reviewed: 17/6/13

APPENDIX B – Toxicity test data for Arctic grayling

APPENDIX B – Toxicity test data for Arctic Grayling

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Dry - Arctic Grayling
Work Order #: n/a

Start Date & Time: May 21/13 @ 1800h
Stop Date & Time: July 29/13
Test Species: T. arcticus

TDS (mg/L) Concentration Control	Days 0 (1) init.	1 (1) new	1 (1) old	2 new	2 old	3 new	3 old	4 new	4 old	5 new	5 old	6 new	6 old	7 new
Temperature (°C)	8.5	|	5.5	7.0	5.5	6.0	6.0	|	6.0	|	6.0	7.5	6.5	6.5
DO (mg/L)		|		11.6	11.7	11.2	11.6	|	11.9	|	12.0	11.5	11.9	12.1
pH		|		7.2	7.2	7.0	7.2	|	7.3	|	7.2	7.4	7.3	7.2
Cond. (µS/cm)				30	47	29						30		
Initials				JAB		AWD								

TDS (mg/L) Concentration 296	Days 0 init.	1 new	1 old	2 new	2 old	3 new	3 old	4 new	4 old	5 new	5 old	6 new	6 old	7 new
Temperature (°C)	8.5	|	5.5	7.0	5.5	6.0	6.0	|	6.0	|	6.0	7.5	6.5	6.5
DO (mg/L)		|		11.6	11.9	11.2	11.6	|	11.8	|	11.9	11.5	11.9	12.1
pH		|		7.5	7.3	7.4	7.6	|	7.6	|	7.7	7.5	7.7	7.3
Cond. (µS/cm)				627	634		633					623		
Initials				JAB										

TDS (mg/L) Concentration 667	Days 0 init.	1 new	1 old	2 new	2 old	3 new	3 old	4 new	4 old	5 new	5 old	6 new	6 old	7 new
Temperature (°C)	8.5	|	5.5	7.0	5.5	6.0	6.0	|	6.0	|	6.0	7.5	6.5	6.5
DO (mg/L)		|		11.8	12.0	11.2	11.6	|	11.9	|	11.8	11.5	11.9	12.1
pH		|		7.8	7.6	7.8	8.0	|	7.9	|	8.0	7.7	7.8	7.6
Cond. (µS/cm)			1271	~~810~~ 1310 JAB	1314		1285					1284		
Initials				JAB										

TDS (mg/L) Concentration 1500	Days 0 init.	1 new	1 old	2 new	2 old	3 new	3 old	4 new	4 old	5 new	5 old	6 new	6 old	7 new
Temperature (°C)	8.5	|	5.5	7.0	5.5	6.0	6.0	|	6.0	|	6.0	7.5	6.5	6.5
DO (mg/L)		|		11.9	11.8	11.2	11.5	|	11.9	|	11.9	11.5	11.9	12.1
pH		|		7.9	7.8	8.0	8.1	|	8.2	|	8.2	7.9	8.0	7.9
Cond. (µS/cm)				2700	2740	2700						2680		
Initials				JAB										

DO meter: DO-1 pH meter: pH-1 Conductivity meter: C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, ECC, AWD, JRE
Reviewed by:
Date reviewed: 30/8/13

Sample Description: TDS

Comments: (1) Data recorded at test initiation in Ft. St. John and on arrival at laboratory on Day 1.

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Dry
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		8.0	6.0		6.5	7.5	6.5		6.0		6.5	7.0	6.0	
DO (mg/L)		11.4	12.0		12.2	12.0	12.3		12.0		12.1	11.8	12.1	
pH		7.2	7.1		7.3	6.9	7.2		7.2		7.2	6.7	6.7	
Cond. (µS/cm)		29				28						29		
Initials		JAB		JAB		JAB		AM		AM		JAB		

TDS (mg/L) Concentration 296	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	6.5		6.5	7.5	6.5		6.0		6.0	7.0	6.0	
DO (mg/L)		11.5	11.8		12.0	12.1	12.3		11.9		12.1	11.8	12.1	
pH		7.4	7.3		7.5	7.5	7.4		7.3		7.4	7.2	7.1	
Cond. (µS/cm)		629				635						631		
Initials		JAB		JAB		JAB		AM		AM		JAB		

TDS (mg/L) Concentration 667	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	6.0		6.5	7.5	6.5		6.0		6.0	7.0	6.5	
DO (mg/L)		11.3	11.9		12.1	12.1	12.3		12.1		12.1	11.8	12.1	
pH		7.5	7.4		7.7	7.6	7.7		7.6		7.7	7.5	7.4	
Cond. (µS/cm)		1245				1249						1296		
Initials		JAB		JAB		JAB		AM		AM		JAB		

TDS (mg/L) Concentration 1500	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	6.0		6.5	7.5	6.5		6.0		6.0	7.0	6.5	
DO (mg/L)		11.8	12.0		12.1	12.1	12.3		12.1		12.1	11.8	12.0	
pH		7.8	7.8		8.0	7.8	7.9		7.9		7.9	7.7	7.6	
Cond. (µS/cm)		2650				2640						2680		
Initials		JAB		JAB		JAB		AM		AM		JAB		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, AWD

Reviewed by: M

Date reviewed: 30/8/13

Sample Description: TDS 1500 mg/L

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry ~~(A-C)~~ DATA (D-F)
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.0	6.0	6.0		6.0	7.0	7.0		6.0		6.0	
DO (mg/L)			11.8	11.6	11.8		12.3	11.7	11.9		12.0		12.1	
pH			7.2	7.0	6.9		6.9	7.0	7.0		7.2		7.2	
Cond. (µS/cm)				29				29						
Initials		JAB		AWP		JAB		JAB		AWP		AWP		

TDS (mg/L) Concentration 296	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.0	6.0	6.0		6.5	7.0	6.5		6.0		6.0	
DO (mg/L)			11.9	11.6	11.8		12.3	11.7	11.9		11.9		12.2	
pH			7.3	7.2	7.2		7.1	7.4	7.3		7.4		7.4	
Cond. (µS/cm)				619				637						
Initials		JAB		AWP		JAB		JAB		AWP		AWP		

TDS (mg/L) Concentration 667	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.0	6.0	6.0		6.5	7.0	6.5		6.0		6.0	
DO (mg/L)			12.0	11.6	11.9		12.3	11.8	11.9		12.0		12.1	
pH			7.5	7.4	7.6		7.4	7.6	7.5		7.6		7.5	
Cond. (µS/cm)				1283				1272						
Initials		JAB		AWP		JAB		JAB		AWP		AWP		

TDS (mg/L) Concentration 1500	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.5	6.0	6.0		6.0	7.0	6.5		6.0		6.0	
DO (mg/L)			11.9	11.6	11.8		12.3	11.8	11.9		12.0		12.1	
pH			7.9	7.7	8.0		7.7	7.9	7.8		7.9		7.8	
Cond. (µS/cm)				2670				2660						
Initials		JAB		AWP		JAB		JAB		AWP		AWP		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, AWP
Reviewed by: M
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry (D-F)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.5	6.5		6.0	7.8	6.5		12.2	8.0	6.5		6.0	6.0	
DO (mg/L)		12.0	12.1		12.4	12.1	12.3		6.7	11.9	12.3		12.0	12.1	
pH		7.1	6.9		7.2	7.2	7.3		7.1	7.1	7.2		7.1	7.3	
Cond. (µS/cm)		30				30				29				—	
Initials		JAB								JAB					

TDS (mg/L) Concentration 296	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		8.0	6.0		6.0	7.5	6.5		12.3	7.5	6.5		6.0	6.0	
DO (mg/L)		12.0	12.3		12.3	12.2	12.1		6.6	12.2	12.3		12.0	12.0	
pH		7.4	7.5		7.6	7.6	7.5		7.3	7.4	7.2		7.3	7.4	
Cond. (µS/cm)		619				629				624				—	
Initials		JAB								JAB					

TDS (mg/L) Concentration 667	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.0	6.0		6.5	7.5	6.4		12.1	7.5	6.5		6.0	6.0	
DO (mg/L)		12.0	12.3		12.2	12.1	12.3		6.7	12.2	12.3		12.0	11.9	
pH		7.7	7.6		7.7	7.8	7.7		7.6	7.6	7.5		7.6	7.7	
Cond. (µS/cm)						1284				1253				—	
Initials		JAB								JAB					

TDS (mg/L) Concentration 1500	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.0	6.5		6.5	7.3	6.5		12.3	7.0	6.5		6.0	6.0	
DO (mg/L)		12.0	12.2		12.3	12.1	12.3		6.5	12.2	12.3		12.1	12.1	
pH		7.9	7.9		7.8	7.8	7.8		7.8	7.8	7.9		7.8	7.8	
Cond. (µS/cm)		2650				2670				2670				—	
Initials		JAB								JAB					

DO meter: DO-1/2 **pH meter:** pH-1/2 **Conductivity meter:** C-1/2

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, ECC, AWD

Reviewed by:

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry (D-F)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		26 ①		27		28		29		30		31		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)				8.0	6.5		6.0	7.5	6.0		6.0	7.5	6.5	
DO (mg/L)				11.6	12.2		12.1	11.8	12.3		11.9	11.9	12.3	
pH				7.0	6.9		7.1	6.9	6.7		7.1	6.9	6.8	
Cond. (µS/cm)				29				29				29		
Initials				JAB		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 296	Days													
		26		27		28		29		30		31		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)				7.0	6.5		6.5	7.5	6.5		6.0	7.5	6.5	
DO (mg/L)				11.6	12.1		12.1	11.7	12.3		12.0	12.1	12.4	
pH				7.3	7.2		7.3	7.4	7.2		7.4	7.4	7.3	
Cond. (µS/cm)				638				642				633		
Initials				JAB		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 667	Days													
		26		27		28		29		30		31		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)				7.0	6.5		6.5	7.5	6.5		6.0	7.0	6.5	
DO (mg/L)				11.6	12.1		12.2	11.9	12.2		12.0	12.1	12.3	
pH				7.6	7.6		7.5	7.8	7.6		7.5	7.8	7.7	
Cond. (µS/cm)				1272				1304				1290		
Initials				JAB		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 1500	Days													
		26		27		28		29		30		31		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)				7.0	6.5		6.0	7.5	6.0		6.5	7.0	6.5	
DO (mg/L)				11.6	12.1		12.1	12.1	12.2		11.9	12.1	12.3	
pH				7.9	7.9		7.8	7.9	7.8		7.8	8.0	7.9	
Cond. (µS/cm)				2690				2730				2740		
Initials				JAB		JAB		JAB		JAB		JAB		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB

Reviewed by: M
Date reviewed: 30/8/13

Sample Description: TDS

Comments: ① See previous datasheet

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry (D-F)
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.5	6.5	7.0	6.0	7.0	6.5	8.0	7.5	
DO (mg/L)			11.8		11.8	12.1	12.1	12.0	12.2	12.1	12.2	11.8	11.9	
pH			7.0		7.0	6.9	7.0	6.9	7.0	6.8	6.7	7.1	7.0	
Cond. (µS/cm)						29		30		30		30		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 296	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.0	6.0	7.0	6.0	7.0	6.5	8.0	7.5	
DO (mg/L)			11.9		11.9	12.3	11.9	11.9	12.2	12.1	12.2	11.8	11.9	
pH			7.1		7.2	7.4	7.3	7.3	7.3	7.3	7.2	7.4	7.84	
Cond. (µS/cm)						617		613		631		618		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 667	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.0	6.0	7.0	6.5	7.0	6.5	8.0	7.5	
DO (mg/L)			11.9		11.8	12.2	12.3	12.0	12.2	12.1	12.2	11.8	11.9	
pH			7.6		7.6	7.6	7.6	7.5	7.5	7.6	7.4	7.7	7.5	
Cond. (µS/cm)						1290		1275		1274		1296		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 1500	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.0	6.0	7.0	6.5	7.0	6.5	8.0	7.5	
DO (mg/L)			11.9		11.8	12.0	12.0	12.0	12.2	12.1	12.2	11.8	11.9	
pH			7.9		7.9	7.9	7.9	7.8	7.8	7.8	7.8	7.9	7.7	
Cond. (µS/cm)						2710		2690		2710		2730		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

DO meter: DO-1 **pH meter:** pH-2 **Conductivity meter:** C-2

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: AWD, JAB
Reviewed by: M
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.0	7.8	7.8
DO (mg/L)	11.9	12.2	12.0	11.8	11.9	11.8	JW 11.9	12.1	11.7	12.0	11.7	11.9
pH	6.8	6.7	6.9	7.1	6.9	7.0	7.6.7	7.0	6.8	6.7	8.0	7.5
Cond. (µS/cm)	30		30		31		30		31		30	
Initials	JAB		AW		AW		JW		JAB			

TDS (mg/L) Concentration 296	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.0	7.2	7.2
DO (mg/L)	11.9	12.2	12.0	11.9	11.9	11.9	11.9	12.2	11.8	12.0	11.7	11.9
pH	7.3	7.2	7.3	7.4	7.2	7.3	7.6	7.5	7.3	7.2	8.0	7.5
Cond. (µS/cm)	628		647		655		652		645		627	
Initials	JAB		AW		AW		JW		JAB			

TDS (mg/L) Concentration 667	Days											
	38 7.5		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	8.0	8.0	7.5	8.0	7.5	8.0	7.5	7.5	7.5	7.5	7.5
DO (mg/L)	11.9	12.2	12.0	11.8	11.9	11.9	12.0	12.2	11.9	12.1	11.8	11.9
pH	7.6	7.5	7.7	7.8	7.6	7.7	7.7	7.7	7.6	7.5	8.0	7.5
Cond. (µS/cm)	1314		1300		1296		1309		1313		1283	
Initials	JAB		AW		AW		JW		JAB			

TDS (mg/L) Concentration 1500	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	7.5	7.0	7.7	7.7
DO (mg/L)	11.9	12.2	12.0	11.8	11.8	11.8	12.2	12.2	12.0	12.1	11.8	11.9
pH	7.8	7.8	7.5	8.0	7.9	7.9	7.9	7.9	7.8	7.8	8.0	7.5
Cond. (µS/cm)	2750		2700		~~2~~ 3200		2720		2710		2660	
Initials	JAB		AW		AW		JW		JAB			

DO meter: DO-2 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	10			
Alkalinity	8			

* mg/L as CaCO3

Analysts: JAB, JW, AWD, ECC

Reviewed by: [illegible]

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry (D-F)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control		Days												
		44		45		46		47		48		49		
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	7.5	8.0	7.5	
DO (mg/L)		11.4	12.0	11.7	11.8	11.8	11.8	11.9	11.8	11.7	11.9	11.7	11.8	
pH		6.8	6.8	6.7	6.9	7.1	7.0	7.1	7.1	6.9	6.7	7.0	6.9	
Cond. (µS/cm)		30		29		30		30		30		29		
Initials		JAB		JAB		AWD		AWD		JAB		JAB		

TDS (mg/L) Concentration 296		Days												
		44		45		46		47		48		49		
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	7.5	8.0	7.0	8.0	8.0	8.0	8.0	8.0	7.0	8.0	7.5	
DO (mg/L)		11.7	11.8	11.7	12.0	11.9	11.8	11.9	11.7	11.9	11.9	11.7	11.9	
pH		7.2	7.3	7.5	7.3	7.2	7.3	7.3	7.4	7.3	7.2	7.4	7.3	
Cond. (µS/cm)		613		618		613		616		612		620		
Initials		JAB		JAB		AWD		AWD		JAB		JAB		

TDS (mg/L) Concentration 667		Days												
		44		45		46		47		48		49		
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	7.5	8.0	7.5	
DO (mg/L)		11.8	11.9	11.7	12.0	11.8	11.8	11.0	11.8	11.8	11.9	11.7	11.8	
pH		7.5	7.5	7.8	7.7	7.6	7.6	7.5	7.7	7.6	7.5	7.7	7.5	
Cond. (µS/cm)		1290		1252		1240		1247		1265		1228		
Initials		JAB		JAB		AWD		AWD		JAB		JAB		

TDS (mg/L) Concentration 1500		Days												
		44		45		46		47		48		49		
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	7.5	8.0	7.5	
DO (mg/L)		11.7	11.8	11.8	11.9	11.8	11.9	11.9	11.8	12.0	11.9	11.8	11.8	
pH		7.8	7.7	7.9	7.9	7.8	7.9	7.9	7.9	7.8	7.8	7.9	7.8	
Cond. (µS/cm)		2660		2650		2610		2615		2640		2630		
Initials		JAB		JAB		AWD		AWD		JAB		JAB		

DO meter: DO-2 **pH meter:** pH-1 **Conductivity meter:** ~~JAB, AWD~~ C-1

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: JAB, AWD

Reviewed by: [illegible]

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days												
	50		51		52		53		54		55		
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5		7.5	
DO (mg/L)	11.8	12.1	11.9	12.1	11.8	12.0	11.8	11.8	11.9	11.9			
pH	6.9	7.2	6.8	7.1	7.0	7.2	6.9	7.1	7.0	7.1		7.3	
Cond. (µS/cm)	31		30		30		30		30				
Initials					JAB						JAB		

TDS (mg/L) Concentration 296	Days												
	50		51		52		53		54		55		
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5		7.5	
DO (mg/L)	11.8	12.1	11.9	12.1	11.8	12.0	11.8	11.8	11.9	11.8			
pH	7.3	7.2	7.2	7.3	7.4	7.4	7.3	7.2	7.3	7.3		7.4	
Cond. (µS/cm)	612		615		630		621		635				
Initials					JAB						JAB		

TDS (mg/L) Concentration 667	Days												
	50		51		52		53		54		55		
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5		7.5	
DO (mg/L)	11.8	12.1	11.8	12.0	11.8	12.0	11.8	11.8	11.9	11.8			
pH	7.6	7.5	7.6	7.5	7.7	7.6	7.6	7.7	7.5	7.6		7.7	
Cond. (µS/cm)	1256		1263		1250		1253		1264				
Initials					JAB						JAB		

TDS (mg/L) Concentration 1500	Days												
	50		51		52		53		54		55		
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5		7.5	
DO (mg/L)	11.8	12.1	11.8	12.0	11.8	12.0	11.8	11.7	11.9	11.9			
pH	7.8	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.9	7.8		8.0	
Cond. (µS/cm)	2610		2590		2600		2590		2600				
Initials					JAB						JAB		

DO meter: DO-1/2 **pH meter:** pH-1/2 **Conductivity meter:** C-1/2

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: JAB, AWD, ECC

Reviewed by:

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: GOLDER
Sample ID: TDS - DRY
Work Order #:

Start Date & Time: May 21/13 1500h
Stop Date & Time: July 26/13
Test Species: T. arcticus

TDS (mg/L) Concentration: CONTROL

	Days													
		56		57		58		59		60		61		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		8.0	7.0	8.0	7.5	8.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	
DO (mg/L)		11.8	12.0	11.6	11.9	11.7	11.9	11.8	11.8	11.8	11.7	11.8	11.9	
pH		6.8	7.2	7.0	7.1	7.0	6.9	7.2	6.9	7.0	7.0	7.0	7.1	
Cond. (µS/cm)		31		31		30		30		30		30		
Initials				JAB		JAB								

Concentration: 296

	Days													
		56		57		58		59		60		61		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		8.0	7.0	8.0	7.0	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0	
DO (mg/L)		11.8	12.0	11.6	11.9	11.8	11.9	11.8	11.8	11.8	11.7	11.8	11.7	
pH		7.1	7.3	7.3	7.4	7.3	7.4	7.4	7.3	7.3	7.2	7.3	7.4	
Cond. (µS/cm)		616		638		611		616		619		622		
Initials				JAB		JAB								

Concentration: 667

	Days													
		56		57		58		59		60		61		
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		8.0	7.0	8.0	7.5	8.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	
DO (mg/L)		11.9	12.1	11.7	11.8	11.8	11.9	11.8	11.7	11.8	11.8	11.8	11.8	
pH		7.6	7.5	7.5	7.6	7.7	7.6	7.6	7.5	7.6	7.5	7.6	7.6	
Cond. (µS/cm)		1259		1232		1247		1246		1252		1259		
Initials				JAB		JAB								

Concentration: 1500

	Days													
	14	~~15~~ 56		~~15~~ 57		~~17~~ 58		~~18~~ 59		~~19~~ 60		~~20~~ 61		~~21~~
	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		8.0	7.0	8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0	
DO (mg/L)		11.9	12.1	11.7	11.9	11.8	11.9	11.8	11.8	11.8	11.7	11.8	11.8	
pH		7.8	7.8	7.8	7.8	7.9	7.8	7.9	7.9	7.8	7.9	7.9	7.9	
Cond. (µS/cm)		2650		2660		2650		2690		2650		2650		
Initials				JAB		JAB								

DO meter: DO-1 **pH meter:** pH - 1 **Conductivity meter:** C-1

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: JAB, ECC, AWD

Reviewed by:

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry D-F
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.7	11.8	11.4	11.7	11.4	11.6	11.6	11.7	11.8	11.7	11.5	11.6
pH	6.9	7.1	7.0	7.2	6.9	6.7	6.8	6.9	6.9	7.2	6.9	6.9
Cond. (µS/cm)	30		29		28		28		27		27	
Initials	JAB		JAB		JAB		JAB		JAB		EMM	

TDS (mg/L) Concentration 296	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.0	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.6	11.8	11.4	11.7	11.3	11.5	11.6	11.7	11.8	11.9	11.8	11.7
pH	7.4	7.3	7.3	7.4	7.5	7.2	7.5	7.3	7.4	7.5	7.4	7.3
Cond. (µS/cm)	612		603		629		617		623		624	
Initials	JAB		JAB		JAB		JAB		JAB		EMM	

TDS (mg/L) Concentration 667	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.6	11.8	11.4	11.7	11.4	11.6	11.6	11.7	11.8	11.9	11.8	11.7
pH	7.7	7.5	7.5	7.6	7.8	7.4	7.8	7.5	7.7	7.7	7.6	7.5
Cond. (µS/cm)	1241		1238		1261		1254		1253		1246	
Initials	JAB		JAB		JAB		JAB		JAB		EMM	

TDS (mg/L) Concentration 1500	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	7.5	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.6	11.9	11.4	11.7	11.5	11.6	11.6	11.7	11.8	12.0	11.8	11.9
pH	7.8	7.8	7.7	7.8	7.9	7.7	7.9	7.9	7.9	7.9	7.9	7.8
Cond. (µS/cm)	2630		2640		2650		2630		2630		2630	
Initials	JAB		JAB		JAB		JAB		JAB		EMM	

DO meter: DO-1/2 **pH meter:** pH-1/2 **Conductivity meter:** C-1/2

	Control	Control		
Hardness*	10	9		
Alkalinity*	8	6		

* mg/L as CaCO3

Analysts: JAB, EMM

Reviewed by: M

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Dry D-F
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days												
	68		69		70								
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	7.0	8.0 JW		7.5									
DO (mg/L)	12.0	~~12.7~~ 11.8		11.6									
pH	7.6	7.5		6.8									
Cond. (µS/cm)	27												
Initials	JW		JAB										

TDS (mg/L) Concentration 296	Days												
	68		69		70								
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.0	8.0 JW		7.0									
DO (mg/L)	11.7	~~12.0~~ 11.8		11.5									
pH	7.6	7.4		7.3									
Cond. (µS/cm)	637												
Initials	JW		JAB										

TDS (mg/L) Concentration 667	Days												
	68		69		70								
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.0	8.0		7.5									
DO (mg/L)	11.8	9.3		11.5									
pH	7.8	7.3		7.6									
Cond. (µS/cm)	1259												
Initials	JW		JAB										

TDS (mg/L) Concentration 1500	Days												
	68		69		70								
	new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)	8.6	8.0		7.5									
DO (mg/L)	11.8	11.8		11.6									
pH	7.89	7.9		7.9									
Cond. (µS/cm)	JW 2610												
Initials	JW		JAB										

DO meter: DO-1/2 **pH meter:** pH-1/2 **Conductivity meter:** C-1/2

	Control			
Hardness*	9			
Alkalinity*	6			

* mg/L as CaCO3

Analysts: JW, JAB

Reviewed by: [illegible]
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	05-7830-0979	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	07 Aug-13 13:57	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	00-8443-0726	**Test Type:**	Survival-Development-Growth	**Analyst:**	Jacob Frank
Start Date:	21 May-13 18:00	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	29 Jul-13	**Species:**	Thymallus arcticus (Arctic Grayling)	**Brine:**	
Duration:	68d 6h	**Source:**	Field Collected	**Age:**	
Sample ID:	13-3370-8332	**Code:**	4F7EC62C	**Client:**	Golder
Sample Date:	21 May-13	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	21 May-13	**Source:**	Golder		
Sample Age:	18h	**Station:**	Dry Fertilization		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	823030	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	873.6	492.4	N/A
EC10	>1419	N/A	N/A
EC15	>1419	N/A	N/A
EC20	>1419	N/A	N/A
EC25	>1419	N/A	N/A
EC40	>1419	N/A	N/A
EC50	>1419	N/A	N/A

Survival Rate Summary

			Calculated Variate(A/B)								
C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
21.8	Negative Control	3	0.8222	0.8	0.8667	0.02222	0.03849	4.68%	0.0%	74	90
325.1		3	0.9111	0.8333	0.9667	0.04006	0.06939	7.62%	-10.81%	82	90
453.7		3	0.8444	0.7667	0.9	0.04006	0.06939	8.22%	-2.7%	76	90
646.1		3	0.9333	0.9	1	0.03333	0.05773	6.19%	-13.51%	85	91
956.6		3	0.7498	0.4828	0.9333	0.1366	0.2366	31.56%	8.81%	67	89
1419.3		3	0.8889	0.7667	1	0.06759	0.1171	13.17%	-8.11%	80	90

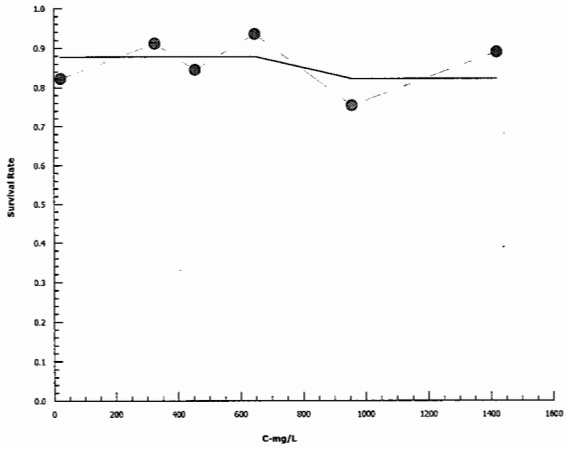
Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
21.8	Negative Control	0.8	0.8667	0.8
325.1		0.9333	0.9667	0.8333
453.7		0.8667	0.7667	0.9
646.1		0.9	0.9	1
956.6		0.8333	0.4828	0.9333
1419.3		0.7667	1	0.9

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	05-7830-0979	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.4
Analyzed:	07 Aug-13 13:57	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Salmonid Embryo-Alevin-Fry Survival Development and Growth Test

Nautilus Environmental

Analysis ID:	00-2418-9697	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.4
Analyzed:	07 Aug-13 13:57	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	00-8443-0726	**Test Type:**	Survival-Development-Growth	**Analyst:**	Jacob Frank
Start Date:	21 May-13 18:00	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	29 Jul-13	**Species:**	Thymallus arcticus (Arctic Grayling)	**Brine:**	
Duration:	68d 6h	**Source:**	Field Collected	**Age:**	
Sample ID:	13-3370-8332	**Code:**	4F7EC62C	**Client:**	Golder
Sample Date:	21 May-13	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	21 May-13	**Source:**	Golder		
Sample Age:	18h	**Station:**	Dry Fertilization		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	673725	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1419	N/A	N/A
IC10	>1419	N/A	N/A
IC15	>1419	N/A	N/A
IC20	>1419	N/A	N/A
IC25	>1419	N/A	N/A
IC40	>1419	N/A	N/A
IC50	>1419	N/A	N/A

Mean Dry Weight-mg Summary

			Calculated Variate						
C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
21.8	Negative Control	3	7.158	6.862	7.714	0.2778	0.4812	6.72%	0.0%
325.1		3	7.234	6.47	8.352	0.5711	0.9892	13.67%	-1.06%
453.7		3	7.553	7.189	7.845	0.1927	0.3338	4.42%	-5.51%
646.1		3	7.072	6.549	7.751	0.3556	0.6159	8.71%	1.22%
956.6		3	8.091	7.463	9.154	0.5346	0.9259	11.44%	-13.03%
1419.3		3	7.331	5.673	8.25	0.8308	1.439	19.63%	-2.41%

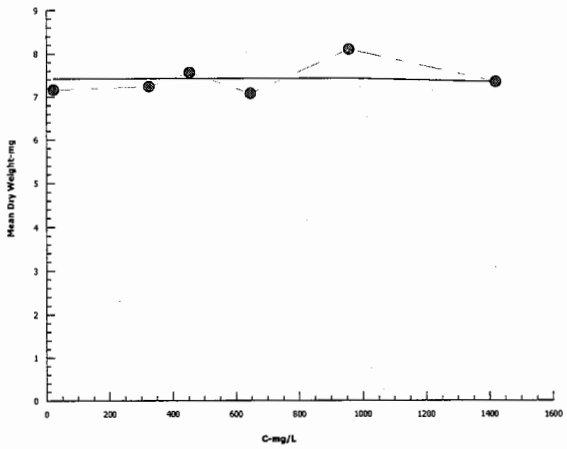
Mean Dry Weight-mg Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
21.8	Negative Control	6.862	6.899	7.714
325.1		6.881	6.47	8.352
453.7		7.189	7.845	7.624
646.1		7.751	6.914	6.549
956.6		7.656	9.154	7.463
1419.3		8.07	5.673	8.25

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test **Nautilus Environmental**

Analysis ID:	00-2418-9697	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.4
Analyzed:	07 Aug-13 13:57	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	20-3219-3433	**Endpoint:**	Mean ~~Dry Weight mg~~ JAB Length (mm)	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 14:09	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	16-4012-9116	**Test Type:**	Survival-Development-Growth	**Analyst:**	Jacob Frank
Start Date:	21 May-13 18:00	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	29 Jul-13	**Species:**	Thymallus arcticus (Arctic Grayling)	**Brine:**	
Duration:	68d 6h	**Source:**	Field Collected	**Age:**	
Sample ID:	02-7455-0878	**Code:**	105D505E	**Client:**	Golder
Sample Date:	21 May-13	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	21 May-13	**Source:**	Golder		
Sample Age:	18h	**Station:**	TDS Dry Length		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1.489E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1419	N/A	N/A
IC10	>1419	N/A	N/A
IC15	>1419	N/A	N/A
IC20	>1419	N/A	N/A
IC25	>1419	N/A	N/A
IC40	>1419	N/A	N/A
IC50	>1419	N/A	N/A

Mean ~~Dry Weight mg~~ Length (mm) Summary

			Calculated Variate						
Conc-mg/L	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
21.8	Negative Control	3	20.97	20.62	21.29	0.194	0.336	1.6%	0.0%
325.1		3	21.01	20.64	21.48	0.2483	0.4301	2.05%	-0.17%
453.7		3	21.42	21.17	21.63	0.1338	0.2318	1.08%	-2.13%
646.1		3	21.04	20.45	21.44	0.3001	0.5198	2.47%	-0.32%
956.6		3	21.52	21.43	21.68	0.07878	0.1365	0.63%	-2.64%
1419.3		3	20.99	20.89	21.17	0.09172	0.1589	0.76%	-0.08%

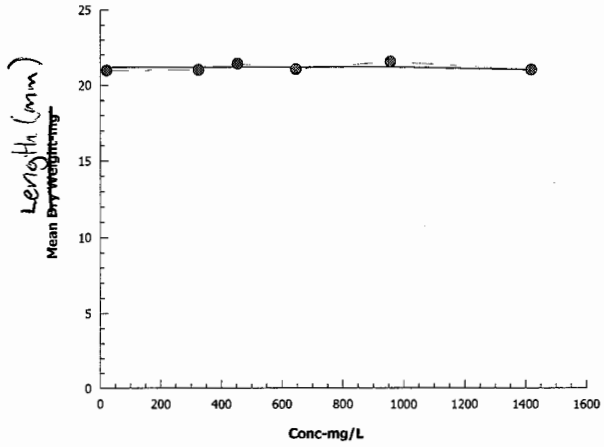
Mean ~~Dry Weight mg~~ JAB Length (mm) Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3
21.8	Negative Control	21	20.62	21.29
325.1		20.64	20.9	21.48
453.7		21.45	21.17	21.63
646.1		21.22	21.44	20.45
956.6		21.68	21.43	21.46
1419.3		21.17	20.9	20.89

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test **Nautilus Environmental**

Analysis ID:	20-3219-3433	**Endpoint:**	Mean ~~Dry Weight mg~~ SRB Length (mm)	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 14:09	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Embryo-Alevin-Fry Toxicity Test Data Sheet

Swim-up Survival and Dry Weight

Client: Golder

Work Order No.: n/a

Start Date: May 21/13

Termination Date: July 29/13

Sample ID	Rep	Pan No. Black	No. Alive	Initials	Pan weight	Pan + organism	No. weighed	Initials
Control	D	1	24	JAB	1004.75	1169.45	24	SBF
	E	2	26		997.39	1176.77	26	
	F	3	24		1002.68	1187.81	24	
					~~1002.68~~ SBF			
296	D	4	28		1016.40	1209.08	28	
	E	5	29		1019.24	1206.87	29	
	F	6	25		987.85	1196.64	25	
444	D	7	JAB ~~25~~ 26		① ~~994.59~~ SBF	1181.50	26	
	E	8	23		1002.51	1182.94	23	
	F	9	27		1035.08	1240.94	27	
667	D	10	27		1006.98	1216.25	27	
	E	11	27		1025.87	1212.56	27	
	F	12	31		1041.46	1244.49	31	
1000	D	13	25		1024.13	1215.52	25	
	E	14	14		1020.34	1148.50	14	
	F	15	28		997.27	1206.23	28	
1500	D	16	23		1062.56	1248.18	23	
	E	17	30		1056.44	1226.63	30	
	F	18	27	↓	989.55	1212.31	27	↓

Thermome Calibrated Thermometer DO meter: DO-1 pH meter: pH-1

Comments: Dry Fertilization

Reviewed by: [signature] Date Reviewed: 30/8/13

① 994.59

Arctic Grayling Alevin Assessment

Client: Golder
W.O. #: n/a
Test ID: TDS Early Alevin Fry - Dry Fertilization
Date Measured: July 29/13

Test Concentration (mg/L TDS)	Replicate	Abnormal Fry	Normal Fry
Control	D	0	24
	E	0	26
	F	0	24
296	D	0	28
	E	0	29
	F	0	25
444	D	0	26
	E	0	23
	F	0	27
667	D	0	27
	E	0	27
	F	0	31
1000	D	0	25
	E	0	14
	F	0	28
1500	D	0	23
	E	0	30
	F	0	27

JL 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: Control D - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	24	0.95		
2	22				
3	21				
4	21				
5	21				
6	22				
7	21				
8	23				
9	20				
10	20				
11	21				
12	20				
13	20				
14	21				
15	21				
16	22				
17	22				
18	20				
19	21				
20	21				
21	22				
22	20				
23	20				
24	21				
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: Control E - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	26	1.13		
2	21				
3	18				
4	22				
5	18				
6	23				
7	20				
8	21				
9	20				
10	22				
11	23				
12	DW & 19				
13	21				
14	21				
15	20				
16	21				
17	20				
18	21				
19	21				
20	20				
21	20				
22	18				
23	21				
24	21				
25	22				
26	21				
27					
28					
29					
30					

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Control F - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	24	1.13		
2	22				
3	21				
4	22				
5	20				
6	20				
7	21				
8	21				
9	22				
10	22				
11	21				
12	21				
13	22				
14	22				
15	21				
16	20				
17	21				
18	21				
19	21				
20	23				
21	21				
22	22				
23	21				
24	22				
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 296 D - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	20	28	1.16		
2	26				
3	19				
4	22				
5	19				
6	21				
7	22				
8	21				
9	21				
10	20				
11	21				
12	21				
13	21				
14	20				
15	22				
16	21				
17	19				
18	21				
19	21				
20	22				
21	20				
22	21				
23	21				
24	20				
25	21				
26	20				
27	20				
28	21				
29					
30					

Reviewed by: [illegible] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 296 E - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	20	29	1.14		
2	19				
3	21				
4	21				
5	20				
6	21				
7	21				
8	21				
9	21				
10	22				
11	21				
12	21				
13	20				
14	20				
15	21				
16	21				
17	21				
18	21				
19	22				
20	21				
21	22				
22	21				
23	21				
24	21				
25	23				
26	21				
27	21				
28	20				
29	20				
30					

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 296 F - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	25	1.33		
2	22				
3	22				
4	22				
5	22				
6	21				
7	21				
8	21				
9	23				
10	22				
11	21				
12	20				
13	22				
14	22				
15	22				
16	20				
17	20				
18	22				
19	22				
20	22				
21	21				
22	22				
23	21				
24	21				
25	21				
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 444 D - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	26	1.21		
2	21				
3	21				
4	21				
5	22				
6	21				
7	21				
8	23				
9	21				
10	21				
11	22				
12	22				
13	22				
14	22				
15	22				
16	21				
17	20				
18	21				
19	21				
20	22				
21	21				
22	21				
23	22				
24	21				
25	20				
26	22				
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 444 E - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	19	23	1.09		
2	22				
3	21				
4	20				
5	22				
6	21				
7	22				
8	21				
9	22				
10	23				
11	22				
12	21				
13	19				
14	19				
15	21				
16	21				
17	23				
18	21				
19	21				
20	21				
21	22				
22	22				
23	21				
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 444 F - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	27	1.33		
2	22				
3	22				
4	22				
5	21				
6	22				
7	21				
8	21				
9	21				
10	22				
11	22				
12	22				
13	22				
14	21				
15	22				
16	21				
17	23				
18	21				
19	21				
20	21				
21	22				
22	22				
23	22				
24	23				
25	22				
26	21				
27	20				
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 667 A - Dry Fertilization
D

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	27	1.26		
2	22				
3	21				
4	22				
5	22				
6	20				
7	21				
8	22				
9	23				
10	21				
11	21				
12	20				
13	21				
14	20				
15	23				
16	21				
17	22				
18	21				
19	21				
20	21				
21	21				
22	21				
23	20				
24	21				
25	21				
26	21				
27	22				
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 667 E - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	27	1.15		
2	22				
3	20				
4	21				
5	23				
6	21				
7	22				
8	22				
9	22				
10	23				
11	23				
12	20				
13	21				
14	21				
15	21				
16	22				
17	21				
18	20				
19	23				
20	21				
21	21				
22	21				
23	22				
24	21				
25	22				
26	21				
27	21				
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 667 F - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	31	1.24		
2	20				
3	20				
4	21				
5	22				
6	21				
7	20				
8	21				
9	19				
10	21				
11	21				
12	19				
13	20				
14	20				
15	20				
16	22				
17	22				
18	21				
19	20				
20	22				
21	21				
22	21				
23	20				
24	21				
25	22				
26	21				
27	18				
28	16				
29	21				
30	19				
	21				

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1000D - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	25	1.16		
2	21				
3	21				
4	21				
5	22				
6	21				
7	23				
8	21				
9	23				
10	22				
11	21				
12	22				
13	22				
14	21				
15	22				
16	22				
17	21				
18	22				
19	22				
20	22				
21	23				
22	22				
23	21				
24	20				
25	22				
26					
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 1000E - Dry Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	14	0.73		
2	20				
3	21				
4	21				
5	22				
6	22				
7	21				
8	22				
9	23				
10	21				
11	21				
12	21				
13	21				
14	23				
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1000F - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	28	1.34		
2	22				
3	21				
4	22				
5	22				
6	22				
7	21				
8	21				
9	22				
10	22				
11	21				
12	21				
13	20				
14	20				
15	22				
16	22				
17	21				
18	23				
19	20				
20	22				
21	22				
22	22				
23	21				
24	21				
25	22				
26	22				
27	21				
28	22				
29					
30					

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1500D - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	23	1.11		
2	21				
3	22				
4	22				
5	21				
6	21				
7	20				
8	21				
9	22				
10	21				
11	21				
12	21				
13	22				
14	22				
15	21				
16	22				
17	22				
18	22				
19	21				
20	17				
21	22				
22	20				
23	22				
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1500 E- Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	30	1.24		
2	19				
3	21				
4	20				
5	21				
6	22				
7	22				
8	22				
9	21				
10	20				
11	21				
12	20				
13	21				
14	21				
15	19				
16	21				
17	22				
18	22				
19	22				
20	21				
21	21				
22	20				
23	21				
24	20				
25	20				
26	21				
27	22				
28	21				
29	21				
30	21				

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1500F - Dry Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	27	1.19		
2	21				
3	21				
4	21				
5	20				
6	21				
7	19				
8	23				
9	20				
10	21				
11	22				
12	21				
13	21				
14	21				
15	21				
16	21				
17	18				
18	21				
19	21				
20	22				
21	22				
22	22				
23	21				
24	21				
25	21				
26	20				
27	20				
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Grayling-Dry(D-F)
Work Order #: n/a

Start Date & Time: May 21/13 @ 1800h
Stop Date: July 29/13
Test Species: T. arcticus

Concentration		Rep	Day 2	3	4	5	6	7	8	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	D	1	0	0	0	0	0	0	0	0			
	E	2	0	↓	↓	↓	↓	↓	↓	0			
	F	3	0	↓	↓	↓	↓	↓	↓	0			
		4		↓	↓	↓	↓	↓	↓				
296	D	1	0	↓	↓	↓	↓	↓	↓	0			
	E	2	0	↓	↓	↓	↓	↓	↓	0			
	F	3	0	↓	↓	↓	↓	↓	↓	0			
		4		↓	↓	↓	↓	↓	↓				
444	D	1	0	↓	↓	↓	↓	↓	↓	0			
	E	2	0	↓	↓	↓	↓	↓	↓	0			
	F	3	0	↓	↓	↓	↓	↓	↓	0			
		4		↓	↓	↓	↓	↓	↓				
667	D	1	0	↓	↓	↓	↓	↓	↓	0			
	E	2	0	↓	↓	↓	↓	↓	↓	0			
	F	3	0	↓	↓	↓	↓	↓	↓	0			
		4		↓	↓	↓	↓	↓	↓				
1000	D	1	0	↓	↓	↓	↓	↓	↓	0			
	E	2	0	↓	↓	↓	↓	↓	↓	0			
	F	3	0	↓	↓	↓	↓	↓	↓	0			
		4		↓	↓	↓	↓	↓	↓				
1500	D	1	0	↓	↓	↓	1	↓	↓	1			
	E	2	0	↓	↓	↓	0	↓	↓	0			
	F	3	0	↓	↓	↓	0	↓	↓	0			
		4											
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JAB	A	[illegible]	[illegible]	[illegible]	[illegible]	JAB	JAB			

Comments:

Reviewed by: [illegible] **Date reviewed:** 10/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Dry (D-F)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments		Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
			9	10	11	12	13	14①	15				
Ctrl	D	1	0	0	0	0	0	0	0	0			
	E	2	↓	0	|	|	|	|	0	0			
	F	3	↓	0	|	|	|	|	1	1			
		4			|	|	|	|	0				
296	D	1	0	0	|	|	|	|	|	0			
	E	2	↓	0	|	|	|	|	|	0			
	F	3	↓	0	|	|	|	|	|	0			
		4			|	|	|	|	|				
444	D	1	0	0	|	|	|	|	|	0			
	E	2	↓	0	|	|	|	|	|	0			
	F	3	↓	0	|	|	|	|	|	0			
		4			|	|	|	|	|				
667	D	1	0	0	|	|	|	|	|	0			
	E	2	↓	0	|	|	|	|	|	0			
	F	3	↓	0	|	|	|	|	|	0			
		4			|	|	|	|	|				
1000	D	1	0	0	|	|	|	|	|	0			
	E	2	↓	0	|	|	|	|	|	0			
	F	3	↓	0	|	|	|	|	|	0			
		4			|	|	|	|	|				
1500	D	1	0	0	|	|	|	|	|	0			
	E	2	↓	0	|	|	|	|	|	0			
	F	3	↓	0	↓	↓	↓	↓	↓	0			
		4											
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JAB	JAB	A-	A-	JAB	JAB	JAB	JAB			

Comments: ① some observation of eyed embryos

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Dry D-F reps
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		16	17	18	19	20	21	22				
Control	D 1	0	0	0	0	0	2	0	2			
	E 2	↓	↓	↓	↓	↓	0	4	4			
	F 3	↓	↓	↓	↓	↓	↓	0	0			
	JAB 4	↓	↓	↓	↓	↓	↓	↓				
296	D 1	↓	↓	↓	↓	↓	↓	1	1			
	E 2	↓	↓	↓	↓	↓	↓	0	0			
	F 3	↓	↓	↓	↓	↓	↓	1	1			
	JAB 4	↓	↓	↓	↓	↓	↓	↓				
444	D 1	↓	↓	↓	↓	↓	↓	3	3			
	E 2	↓	↓	↓	↓	↓	2	0	2			
	F 3	↓	↓	↓	↓	↓	0	1	1			
	JAB 4	↓	↓	↓	↓	↓	↓	↓				
667	D 1	↓	↓	↓	↓	↓	↓	3	3			
	E 2	↓	↓	↓	↓	↓	↓	3	3			
	F 3	↓	↓	↓	↓	↓	↓	0	0			
	JAB 4	↓	↓	↓	↓	↓	↓	↓				
1000	D 1	↓	↓	↓	↓	↓	2	2	4			
	E 2	↓	↓	↓	↓	↓	0	0	0			
	F 3	↓	↓	↓	↓	↓	0	1	1			
	JAB 4	↓	↓	↓	↓	↓	~~0~~	↓				
1500	D 1	↓	↓	↓	↓	↓	1	3	4			
	E 2	↓	↓	↓	↓	↓	0	1	1			
	F 3	↓	↓	↓	↓	↓	1	1	2			
	JAB 4	↓	↓	↓	↓	↓	~~0~~	0				
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	AM	AM	JAB	[illegible]	[illegible]	JAB			

Comments:

Reviewed by: TR **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: GOLDER
Sample ID: TDS DF reps (DRY)
Work Order #: n/a

Start Date & Time: May 21/13 @ 1800h
Stop Date: July 29/13
Test Species: T. articus

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		23	24	25	26	27	28	29				
CONTROL	D 1	0	0	0	0	0	0	0	0			
	E 2	↓	↓	↓	↓	↓	↓	↓	0			
	F 3	↓	↓	↓	↓	↓	↓	↓	0			
	4	—	—	—	—	—	—	—				
296	D 1	↓	↓	↓	↓	00	0②	↓	0			
	E 2	↓	↓	↓	↓	↓	↓	↓	0			
	F 3	↓	↓	↓	↓	↓	↓	↓	0			
	4	—	—	—	—	—	—	—				
444	D 1	0	0	↓	↓	↓	↓	0①	0			
	E 2	3	1	↓	↓	↓	↓	↓	4			
	F 3	0	0	↓	↓	↓	↓	↓	0			
	4	—	—	—	—	—	—	—				
667	D 1	↓	0	↓	↓	↓	↓	↓	0			
	E 2	↓	↓	↓	↓	↓	↓	↓	0			
	F 3	↓	↓	↓	↓	↓	↓	↓	0			
	4	—	—	—	—	—	—	—				
1000	D 1	↓	↓	↓	↓	↓	↓	↓	0			
	E 2	↓	↓	↓	↓	↓	↓	↓	0			
	F 3	↓	↓	↓	↓	↓	↓	↓	0			
	4	—	—	—	—	—	—	—				
1500	D 1	↓	↓	↓	↓	↓	↓	↓	0			
	E 2	↓	↓	↓	↓	↓	↓	↓	0			
	F 3	↓	↓	↓	↓	↓	↓	↓	0			
	4	—	—	—	—	—	—	—				
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		[illegible]	JAB	[illegible]	[illegible]	JAB	JAB	JAB	JAB			

Comments: ① 1 hatched alevin ② 2 hatched alevin

Reviewed by: [illegible] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Dry
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		30	31	32	33	34	35	36				
Control D	1	0	0	0	0	0	0	0	0			
E	2						0	0	0			
F	3						0	0	0			
	4											
296 D	1						0	0	0			
E	2						0	0	0			
F	3						0	0	0			
	4											
444 D	1						0	1	1			
E	2						0	0	0			
F	3						0	0	0			
	4											
667 D	1						0	0	0			
E	2						0	0	0			
F	3						0	0	0			
	4											
1000 D	1						0	0	0			
E	2						2	1	3			
F	3						0	0	0			
	4											
1500 D	1						0	0	0			
E	2						0	0	0			
F	3						0	0	0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	AMS	AM	JAB	JAB	JAB				

Comments:

Reviewed by: [signature] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS – Dry
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		37	38	39	40	41	42	43				
Control D	1	0	0	0	0	0	0	0	0			
E	2	0	0	0			0	0	0			
F	3	0	0	0			1	0	1			
	4											
296 D	1	0	0	0			0	0	0			
E	2	0	0	1			0	1	2			
F	3	0	0	0			0	0	0			
	4											
444 D	1	0	0	0			1	0	1			
E	2	0	0	0			0	0	0			
F	3	1	0	0			0	0	1			
	4											
667 D	1	0	0	0	1		0	0	1			
E	2	0	0	0	3		0	0	0			
F	3	0	0	0	0		0	0	0			
	4											
1000 D	1	0	0	0	0		0	0	0			
E	2	1	4	0	0		1	2	8			
F	3	0	0	0	0		0	0	0			
	4											
1500 D	1	0	0	0	0		1	0	1			
E	2	0	0	0	0		0	0	0			
F	3	0	0	0	0	↓	0	0	0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	AMS	AMS	JW	JAB	[illegible]	JAB			

Comments:

Reviewed by: [illegible] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		44	45	46	47	48	49	50				
Control ~~AD~~	1	0	0	0	1	0	0	0	1			
BE	2	0			0				0			
CF	3	0							0			
	4											
296 D	1	0						1	1			
E	2	0						0	0			
F	3	0							0			
	4											
444 D	1	0							0			
E	2	0							0			
F	3	0							0			
	4											
667 D	1	0							0			
E	2	0							0			
F	3	0							0			
	4											
1000 D	1	0		0					0			
E	2	2		2					4			
F	3	0		0					0			
	4											
1500 D	1	0		1					1			
E	2	0		0					0			
F	3	0		0					0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	[illegible]	[illegible]	JAB	JAB	[illegible]	JAB			

Comments:

Reviewed by: [illegible] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS – DRY
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		51	52	53	54	55	56	57				
Control	D 1	0	0	0	0	0	0	1	1			
	E 2			0		0	0	0	0			
	F 3			3		6	0	0	3			
	4											
296	D 1			0		0	0	0	0			
	E 2					1		0	1			
	F 3					0		0	0			
	4											
444	D 1					0		0	0			
	E 2					0		0	0			
	F 3					1		0	1			
	4											
667	D 1					0		0	0			
	E 2					0		0	0			
	F 3					0		0	0			
	4											
1000	D 1					0		0	0			
	E 2					0		0	0			
	F 3					1		0	1			
	4											
1500	D 1					0		0	0			
	E 2					0		0	0			
	F 3					0		0	0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		KM	JAB	JAB	JAB	JAB	KM	JAB	JAB			

Comments:

Reviewed by: [signature] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Dry
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities 58	59	60	61	62	63	64	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	DA	0	0	0	0	0	0	0	0			
	EZ		0		0				0			
	FB		1		1				2			
	4											
296	DA		0		0				0			
	EZ		0						0			
	FB		0						0			
	4											
444	DA		0						0			
	EZ		0						0			
	FB		0						0			
	4											
667	DA		0						0			
	EZ		0						0			
	FB		0						0			
	4											
1000	DA		0						0			
	EZ		0						0			
	FB		0						0			
	4											
1500	DA	1	0						1			
	EZ	0	0						0			
	FB	0	0						0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	AM	AM	AM	JAB	RW	JAB	JAB			

Comments:

Reviewed by: JR **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Dry
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		65	66	67	68	69	70	71				
Control	DA	0	0	0	0	0						
	EZ	0			1	0						
	FB	0			0	0						
	4											
296	DA	0			0	0						
	EZ	0			0	0						
	FB	0			0	0						
	4											
444	DA	0			0	0						
	EZ	0			0	0						
	FB	0			0	0						
	4											
667	DA	0			0	0						
	EZ	0			0	0						
	FB	1			0	0						
	4											
1000	DA	0			0	0						
	EZ	0			0	0						
	FB	0			0	0						
	4											
1500	DA	0			0	0						
	EZ	0			0	0						
	FB	0	↓	↓	0	0						
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	EMM	JW	JAB						

Comments:

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Hatched

Client: Golder
Sample ID: TDS - Dry
Work Order #: n/a

Start Date & Time: May 21/13 @ 1800h
Stop Date: July 29/13
Test Species: T. arctius

Treatments mg/L TDS	Rep	Day of Test - No. of Hatched							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		30	31	34	35	36	37	38				
Control D	1	1	1	4	6	8	10	~~20~~ >280①				
E	2	0	0	0	19①	19	20	26				
F	3	0	0	2	11	~~14~~ 14	21①	23				
	4											
296	1	3	3	12	21①	28	29	29				
	2	0	0	0	13	21①	29	29				
	3	0	0	17①	18	25	25	25				
	4											
444	1	0	0	11	25①	27	27	27				
	2	1	1	4	12①	23	23	23				
	3	0	0	0	15①	26	28	28				
	4											
667	1	3	3	19①	26	27	27	27				
	2	0	0	2	17①	25	27	27				
	3	0	0	0	30①	30	31	31				
	4											
1000	1	2	2	9	26①	26	26	26				
	2	0	0	1	20①	25	26	25				
	3	0	0	18①	27	30	30	30				
	4											
1500	1	4	4	19①	25	25	26	26				
	2	3	3	9	30①	30	30	30				
	3	1	3	5	15①	15	17	27				
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB	JAB	JAB	JAB	JAB				

Comments: ① > 50% hatched

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Dry (D→F)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Hatched							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		41 ①										
Control D	1	28										
E	2	26										
F	3	29										
	4											
296	1	29										
	2	~~29~~ 30										
	3	25										
	4											
444	1	27										
	2	23										
	3	28										
	4											
667	1	27										
	2	27										
	3	31										
	4											
1000	1	26										
	2	25										
	3	30										
	4											
1500	1	26										
	2	30										
	3	27										
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB										

Comments: ① all embryos hatched

Reviewed by: M **Date reviewed:** 30/8/13

~~7-d~~ JAG Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Arctic Grayling-Wet
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: T. arcticus

TDS (mg/L) Concentration Control	Days													
	0①	1②		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	~~old~~ new
Temperature (°C)	8.5		5.5	7.0	5.5	6.0	6.0		6.0		6.0	7.5	6.5	6.5
DO (mg/L)				11.8	12.0	11.2	11.5		11.7		11.9	11.5	11.9	12.1
pH				7.2	7.3	7.0	7.2		7.3		7.3	7.4	7.3	7.2
Cond. (µS/cm)				31	44							30		
Initials				JAB										

TDS (mg/L) Concentration 296	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	~~old~~ new
Temperature (°C)	8.5		5.5	7.0	5.5	6.0	6.0		6.0		6.0	7.5	6.5	6.5
DO (mg/L)				11.6	12.1	11.2	11.6		11.8		11.8	11.5	11.9	12.1
pH				7.5	7.4	7.4	7.4		7.5		7.6	7.5	7.6	7.4
Cond. (µS/cm)				627	636							623		
Initials				JAB										

TDS (mg/L) Concentration 667	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	~~old~~ new
Temperature (°C)	8.5		5.5	7.0	5.5	6.0	6.0		6.0		6.0	7.5	6.5	6.5
DO (mg/L)				11.8	11.8	11.2	11.6		11.9		11.9	11.5	11.9	12.1
pH				7.8	7.6	7.8	7.9		7.9		8.0	7.7	7.8	7.6
Cond. (µS/cm)				1271	1311							1284		
Initials				JAB										

TDS (mg/L) Concentration 1500	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	~~old~~ new
Temperature (°C)	8.5		5.5	7.0	5.5	6.0	6.0		6.0		6.0	7.5	6.5	6.5
DO (mg/L)				12.0	12.1	11.2	11.6		11.9		11.9	11.5	11.9	12.1
pH				8.0	7.9	8.0	8.1		8.2		8.2	7.9	8.0	7.9
Cond. (µS/cm)				2690	2740							2680		
Initials				JAB										

DO meter: DO-1 pH meter: pH-1 Conductivity meter: C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, ECC, AWA, JRE

Reviewed by:

Date reviewed: 30/8/13

Sample Description: TDS

Comments: ① Measured at test initiation in Fort St. John. ② Measured upon arrival at lab.

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Wet
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		8.0	6.0	|	6.0	7.5	6.5	|	6.0	|	6.0	7.0	6.5	
DO (mg/L)		11.4	12.0	|	12.4	12.0	12.3	|	12.1	|	12.1	11.8	12.0	
pH		7.2	7.2	|	7.3	6.9	7.2	|	7.2	|	7.1	6.7	6.7	
Cond. (µS/cm)		29				28						29		
Initials		JAB		JAB		JAB		A		A		JAB		

TDS (mg/L) Concentration 296	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	6.5	|	6.5	7.5	6.0	|	6.0	|	6.0	7.0	6.0	
DO (mg/L)		11.5	12.0	|	12.1	12.1	12.3	|	12.1	|	12.1	11.8	12.0	
pH		7.4	7.2	|	7.4	7.5	7.5	|	7.4	|	7.3	7.2	7.1	
Cond. (µS/cm)		629				635						631		
Initials		JAB		JAB		JAB		A		A		JAB		

TDS (mg/L) Concentration 667	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	6.0	|	6.5	7.5	7.0	|	6.0	|	6.0	7.0	6.5	
DO (mg/L)		11.3	12.0	|	12.1	12.1	12.1	|	12.1	|	12.1	11.8	12.0	
pH		7.5	7.5	|	7.7	7.6	7.6	|	7.7	|	7.8	7.5	7.3	
Cond. (µS/cm)		1245				1249						1296		
Initials		JAB		JAB		JAB		A		A		JAB		

TDS (mg/L) Concentration 1500	Days													
		8		9		10		11		12		13		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)		7.5	6.5	|	6.5	7.5	6.5	|	6.0	|	6.0	7.0	6.0	
DO (mg/L)		11.8	12.1	|	12.2	12.1	12.3	|	12.1	|	11.9	11.8	12.0	
pH		7.8	7.7	|	8.0	7.8	7.9	|	8.0	|	7.9	7.7	7.6	
Cond. (µS/cm)		2650				2640						2680		
Initials		JAB		JAB		JAB		A		A		JAB		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as $CaCO_3$

Analysts: JAB, AWD
Reviewed by: M
Date reviewed: Aug 8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Wet (A→C)
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.0	6.0	6.0		6.5	7.0	6.5		6.0		6.0	
DO (mg/L)			11.9	11.6	11.9		12.3	11.7	11.9		12.0		12.1	
pH			7.3		7.2		7.0	7.0	7.0		7.2		7.2	
Cond. (µS/cm)				29				29						
Initials		JAB		AW		JAB		JAB		AW		AW		

TDS (mg/L) Concentration 296	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.0	6.0	6.0		6.0	7.0	6.0		6.0		6.0	
DO (mg/L)			11.7	11.6	11.9		12.3	11.7	11.9		12.0		12.1	
pH			7.3	7.2	7.4		7.0	7.4	7.3		7.3		7.4	
Cond. (µS/cm)				~~629~~ 619				637						
Initials		JAB		AW		JAB		JAB		AW		AW		

TDS (mg/L) Concentrat on 667	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.5	6.0	6.0		6.5	7.0	7.0		6.0		6.0	
DO (mg/L)			11.8	11.6	11.9		12.3	11.8	11.9		12.1		12.0	
pH			7.6	7.4	7.7		7.5	7.6	7.5		7.7		7.7	
Cond. (µS/cm)				1283				1272						
Initials		JAB		AW		JAB		JAB		AW		AW		

TDS (mg/L) Concentration 1500	Days													
		14		15		16		17		18		19		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			6.0	6.0	6.0		6.5	7.0	6.5		6.0		6.0	
DO (mg/L)			11.8	11.6	12.0		12.3	11.8	11.9		12.1		12.0	
pH			7.8	7.7	8.0		7.8	7.9	7.8		7.9		7.9	
Cond. (µS/cm)				2670				2660						
Initials		JAB		AW		JAB		JAB		AW		AW		

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, AWO
Reviewed by: [illegible]
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Wet (A→C)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.5	6.5		6.0	7.8	6.3		12.2	8.0	6.5		6.0	6.0	
DO (mg/L)		12.0	12.2		12.1	12.1	12.3		6.8	11.9	12.3		12.1	12.0	
pH		7.1	6.9		7.2	7.2	7.3		7.1	7.1	7.1		7.2	7.2	
Cond. (µS/cm)		30				30				29				—	
Initials		JAB								JAB					

TDS (mg/L) Concentration 296	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		8.0	7.0		6.0	7.5	6.5		12.3	7.5	6.5		6.0	6.0	
DO (mg/L)		12.0	12.1		12.2	12.2	12.3		6.7	12.2	12.3		11.9	12.1	
pH		7.4	7.3		7.5	7.6	7.4		7.3	7.4	7.3		7.4	7.3	
Cond. (µS/cm)		619				629				624				—	
Initials		JAB								JAB					

TDS (mg/L) Concentration 667	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.0	6.5		6.0	7.5	6.4		12.1	7.5	6.5		6.0	6.0	
DO (mg/L)		12.0	12.2		12.3	12.1	12.2		6.9	12.2	12.3		12.2	12.1	
pH		7.7	7.6		7.7	7.8	7.6		7.6	7.6	7.6		7.6	7.7	
Cond. (µS/cm)		1348				1284				1253					
Initials		JAB								JAB					

TDS (mg/L) Concentration 1500	Days														
		20		21		22		23		24		25		26	
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		7.0	6.5		6.5	7.3	6.7		12.1	7.0	6.5		6.0	6.0	
DO (mg/L)		12.0	12.2		12.3	12.1	12.1		6.8	12.2	12.3		12.0	12.0	
pH		7.9	7.8		7.9	7.8	7.8		7.8	7.8	7.8		7.9	7.9	
Cond. (µS/cm)		2650				2670				2670				—	
Initials		JAB								JAB					

DO meter: DO-2 **pH meter:** pH-2 **Conductivity meter:** C-2

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB, ECC, AWD

Reviewed by:
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS -Wet (A→C)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days														
		① 26		27		28		29		30		31			
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)				8.0	6.5		6.0	7.5	6.5		6.0	7.5	6.5		
DO (mg/L)				11.6	12.1		12.2	11.8	12.2		11.9	11.9	12.3		
pH				7.0	6.9		7.2	6.9	6.8		7.0	6.9	6.8		
Cond. (µS/cm)				29				29				29			
Initials				JAB		JAB		JAB		JAB		JAB			

TDS (mg/L) Concentration 296	Days														
		26		27		28		29		30		31			
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)				7.0	6.5		6.5	7.5	6.5		6.5	7.5	6.5		
DO (mg/L)				11.6	12.1		12.2	11.7	12.2		12.0	12.1	12.3		
pH				7.3	7.3		7.4	7.4	7.3		7.3	7.4	7.3		
Cond. (µS/cm)				638				642				633			
Initials				JAB		JAB		JAB		JAB		JAB			

TDS (mg/L) Concentration 667	Days														
		26		27		28		29		30		31			
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)				7.0	6.5		6.5	7.5	6.5		6.0	7.0	6.5		
DO (mg/L)				11.6	12.2		12.2	11.9	12.2		12.1	12.1	12.2		
pH				7.6	7.5		7.6	7.8	7.6		7.6	7.8	7.7		
Cond. (µS/cm)				1272				1304				1290			
Initials				JAB		JAB		JAB		JAB		JAB			

TDS (mg/L) Concentration 1500	Days														
		26		27		28		29		30		31			
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)				7.0	6.5		6.5	7.5	6.5		6.5	7.0	6.5		
DO (mg/L)				11.6	12.2		12.2	12.1	12.2		11.9	12.1	12.3		
pH				7.9	7.8		7.8	7.9	7.7		7.8	8.0	7.9		
Cond. (µS/cm)				2690				2730				2740			
Initials				JAB		JAB		JAB		JAB		JAB			

DO meter: DO-1 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	11			
Alkalinity*	10			

* mg/L as CaCO3

Analysts: JAB

Reviewed by: M

Date reviewed: 30/8/13

Sample Description: TDS

Comments: ① See previous datasheet

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Wet (4-C)
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.5	6.5	7.0	6.5	7.0	6.5	8.0	7.5	
DO (mg/L)			11.8		11.9	12.1	12.4	12.0	12.2	12.1	12.1	11.9	11.8	
pH			7.1		7.0	6.9	7.0	6.9	7.1	6.8	6.7	7.1	7.1	
Cond. (µS/cm)						29		30		30		30		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 296	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.0	6.0	7.0	6.0	7.0	6.0	8.0	7.5	
DO (mg/L)			11.9		11.8	12.3	12.2	11.9	12.2	12.1	12.2	11.8	11.9	
pH			7.2		7.3	7.4	7.5	7.3	7.3	7.3	7.2	7.4	7.3	
Cond. (µS/cm)						617		613		631		618		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 667	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.0	6.0	7.0	6.0	7.0	6.5	8.0	7.5	
DO (mg/L)			11.9		11.8	12.2	12.0	12.0	12.2	12.1	12.2	11.8	12.0	
pH			7.6		7.7	7.6	7.7	7.5	7.8	7.6	7.5	7.7	7.6	
Cond. (µS/cm)						1290		1275		1274		1296		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

TDS (mg/L) Concentration 1500	Days													
		32		33		34		35		36		37		
	init.	new	old	new	old	new	old	new	old	new	old	new	old	new
Temperature (°C)			7.0		7.0	7.0	6.0	7.0	6.0	7.0	6.5	8.0	7.5	
DO (mg/L)			11.9		11.9	12.0	12.2	12.0	12.2	12.1	12.2	11.8	12.0	
pH			7.9		7.9	7.9	7.8	7.8	7.8	7.8	7.8	7.9	7.7	
Cond. (µS/cm)						2710		2690		2710		2730		
Initials		AWD		AWD		JAB		JAB		JAB		JAB		

DO meter: DO-1 **pH meter:** pH-2 **Conductivity meter:** C-2

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: AWD, JAB
Reviewed by: M
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Wet
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.0	7.8	7.1
DO (mg/L)	11.9	12.1	12.0	11.8	11.9	11.8	11.9	12.2	11.7	12.1	11.7	11.9
pH	6.8	6.8	6.9	7.0	6.9	7.0	6.7	7.0	6.8	6.7	8.0	7.56
Cond. (µS/cm)	30		30		31		30		31		30	
Initials	JAB		AW		AW		JW		JAB			

TDS (mg/L) Concentration 296	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.0	7.2	7.2
DO (mg/L)	11.9	12.2	12.0	11.8	11.9	11.8	11.9	12.2	11.8	12.1	11.7	11.9
pH	7.3	7.4	7.3	7.4	7.2	7.3	7.6	7.5	7.3	7.3	8.0	7.56
Cond. (µS/cm)	628		647		655		652		645		627	
Initials	JAB		AW		AW		JW		JAB			

TDS (mg/L) Concentration 667	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	7.5	7.0	7.5	7.5
DO (mg/L)	11.9	12.2	12.0	11.9	11.9	11.9	12.0	12.1	11.9	12.0	11.8	11.9
pH	7.6	7.6	7.7	7.8	7.6	7.6	7.7	7.7	7.6	7.5	8.0	7.56
Cond. (µS/cm)	1314		1300		1296		1305		1313		1283	
Initials	JAB		AW		AW		JW		JAB			

TDS (mg/L) Concentration 1500	Days											
	38		39		40		41		42		43	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	7.5	7.0	7.7	7.7
DO (mg/L)	11.9	12.2	12.0	11.9	11.8	11.9	12.2	12.1	12.0	11.9	11.8	11.9
pH	7.8	7.9	7.9	8.0	7.9	8.0	7.9	7.9	7.8	7.8	8.0	7.56
Cond. (µS/cm)	2750		2700		2700		2720		2710		2660	
Initials	JAB		AW		AW		JW		JAB			

DO meter: DO-2 **pH meter:** pH-1 **Conductivity meter:** C-1

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: JAB, JW, AW, DCC
Reviewed by: M
Date reviewed: Jul 18/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS -Wet (A→C)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days											
	44		45		46		47		48		49	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	8.0	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.5
DO (mg/L)	11.4	12.0	11.7	11.9	11.8	11.9	11.9	11.7	11.7	11.9	11.7	11.9
pH	6.8	6.7	6.7	7.0	7.1	7.0	7.1	7.1	6.9	6.7	7.0	6.8
Cond. (µS/cm)	30		29		30		30		30		29	
Initials	JAB		JAB		↑		↑		JAB		JAB	

TDS (mg/L) Concentration 296	Days											
	44		45		46		47		48		49	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	7.5	8.0	7.0
DO (mg/L)	11.7	12.0	11.7	11.9	11.9	11.9	11.9	11.8	11.9	11.9	11.7	11.9
pH	7.2	7.3	7.5	7.2	7.1	7.3	7.3	7.4	7.3	7.3	7.4	7.3
Cond. (µS/cm)	613		618		613		616		612		620	
Initials	JAB		JAB		↑		↑		JAB		JAB	

TDS (mg/L) Concentration 667	Days											
	44		45		46		47		48		49	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	7.5	8.0	7.5
DO (mg/L)	11.8	11.9	11.7	11.9	11.8	11.9	11.9	11.8	11.8	11.9	11.7	11.9
pH	7.5	7.5	7.8	7.6	7.6	7.6	7.5	7.7	7.6	7.5	7.7	7.5
Cond. (µS/cm)	1290		1252		1240		1247		1265		1228	
Initials	JAB		JAB		↑		↑		JAB		JAB	

TDS (mg/L) Concentration 1500	Days											
	44		45		46		47		48		49	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	7.5	8.0	7.5
DO (mg/L)	11.7	11.9	11.8	12.0	11.8	11.9	11.9	11.9	12.0	11.9	11.8	11.9
pH	7.8	7.7	7.9	7.9	7.8	7.9	7.9	7.9	7.8	7.8	7.9	7.8
Cond. (µS/cm)	2660		2650		2610		2615		2640		2630	
Initials	JAB		JAB		↑		↑		JHB		JAB	

DO meter: DO-2 **pH meter:** pH-1 **Conductivity meter:** ~~JAB~~ JAB, AWD C-1

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: JAB, AWD
Reviewed by: [illegible]
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - WET
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days											
	50		51		52		53		54		55	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.8	12.1	11.9	12.1	11.8	12.0	11.8	11.7	11.9	11.8	11.6	11.8
pH	6.9	7.2	6.8	7.1	7.0	7.1	6.9	7.1	7.0	7.1	7.2	7.2
Cond. (µS/cm)	31		30		30		30		30		31	
Initials					JAB						JAB	

TDS (mg/L) Concentration 296	Days											
	50		51		52		53		54		55	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.8	12.1	11.9	12.1	11.8	12.0	11.8	11.8	11.9	11.8	11.5	11.8
pH	7.3	7.2	7.2	7.3	7.4	7.4	7.3	7.3	7.3	7.4	7.4	7.5
Cond. (µS/cm)	612		615		630		621		635		643	
Initials					JAB						JAB	

TDS (mg/L) Concentration 667	Days											
	50		51		52		53		54		55	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.8	12.1	11.8	12.0	11.8	12.0	11.8	11.8	11.9	11.9	11.5	11.7
pH	7.6	7.5	7.6	7.5	7.7	7.6	7.6	7.6	7.5	7.6	7.8	7.7
Cond. (µS/cm)	1256		1263		1250		1253		1264		1254	
Initials					JAB						JAB	

TDS (mg/L) Concentration 1500	Days											
	50		51		52		53		54		55	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.8	12.1	11.8	12.0	11.8	12.0	11.8	11.8	11.9	11.9	11.7	11.7
pH	7.8	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.9	7.9	7.9	8.0
Cond. (µS/cm)	2610		2590		2600		2590		2600		2660	
Initials					JAB						JAB	

DO meter: DO-2 **pH meter:** pH-1 **Conductivity meter:** C-2

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: ECC, JAB, AWD

Reviewed by: M

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Wafer Quality Measurements

Client: GOLDER
Sample ID: TDS-WET
Work Order #:

Start Date & Time: May 21/13 1800h
Stop Date & Time: July 29/13
Test Species: T. arthreus

TDS (mg/L) Concentration CONTROL		Days													
		56		57		58		59		60		61			
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		8.0	7.0	8.0	7.0	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0		
DO (mg/L)		11.8	12.0	11.6	11.9	11.7	11.9	11.8	11.8	11.8	11.9	11.8	11.8		
pH		6.8	7.2	7.0	7.1	7.0	7.0	7.2	7.0	7.0	7.0	7.0	7.1		
Cond. (µS/cm)		31		31		30		30		30		30			
Initials				JAB		JAB									

Concentration 296		Days													
		56		57		58		59		60		61			
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		8.0	7.0	8.0	7.0	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0		
DO (mg/L)		11.8	12.0	11.6	11.9	11.8	11.7	11.8	11.8	11.8	11.6	11.8	11.9		
pH		7.1	7.3	7.3	7.3	7.3	7.4	7.4	7.3	7.3	7.2	7.3	7.3		
Cond. (µS/cm)		616		638		611		615		619		622			
Initials				JAB		JAB									

Concentration 667		Days													
		56		57		58		59		60		61			
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		8.0	7.0	8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0		
DO (mg/L)		11.9	12.1	11.7	11.9	11.8	11.9	11.8	11.8	11.8	11.7	11.8	11.8		
pH		7.6	7.5	7.5	7.5	7.7	7.6	7.6	7.5	7.6	7.5	7.6	7.5		
Cond. (µS/cm)		1259		1232		1247		1276		1252		1259			
Initials				JAB		JAB									

Concentration 1500		Days													
		~~14~~ ~~15~~ 56		~~16~~ 57		~~17~~ 58		~~18~~ 59		~~19~~ 60		~~20~~ 61		~~21~~	
	old	new	old	new	old	new	old	new	old	new	old	new	old	new	
Temperature (°C)		8.0	7.0	8.0	7.5	8.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0		
DO (mg/L)		11.9	12.1	11.7	11.8	11.8	11.9	11.8	11.9	11.8	11.7	11.8	11.8		
pH		7.8	7.8	7.8	7.9	7.9	7.8	7.9	7.9	7.9	7.8	7.9	7.9		
Cond. (µS/cm)		2650		2660		2650		2640		~~2655~~ 2650		2650			
Initials				JAB		JAB									

DO meter: DO-1 pH meter: pH - 1 Conductivity meter: C-1

	Control			
Hardness*	10			
Alkalinity*	8			

* mg/L as CaCO3

Analysts: JAB, AWD, ECC

Reviewed by: M

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS-Wet A-C
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.0	8.0	7.0	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.7	11.8	11.4	11.6	11.4	11.6	11.6	11.7	11.8	11.8	11.5	11.7
pH	6.9	7.1	7.0	7.1	6.9	6.8	6.8	6.9	6.9	7.1	6.9	7.0
Cond. (µS/cm)	30		29		28		28		27		27	
Initials	JAB		JAB		JAB		JAB		JAB		Emm	

TDS (mg/L) Concentration 296	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.0	8.0	7.0	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.6	11.8	11.4	11.5	11.3	11.5	11.6	11.7	11.8	11.9	11.8	11.6
pH	7.4	7.3	7.3	7.4	7.5	7.2	7.5	7.3	7.4	7.4	7.4	7.3
Cond. (µS/cm)	612		603		624		617		623		624	
Initials	JAB		JAB		JAB		JAB		JAB		Emm	

TDS (mg/L) Concentration 667	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	8.0	7.0	8.0	7.0	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.6	11.8	11.4	11.6	11.4	11.6	11.6	11.7	11.8	11.9	11.8	11.8
pH	7.7	7.6	7.5	7.6	7.8	7.4	7.8	7.4	7.7	7.5	7.6	7.4
Cond. (µS/cm)	1241		1238		1261		1254		1253		1246	
Initials	JAB		JAB		JAB		JAB		JAB		Emm	

TDS (mg/L) Concentration 1500	Days											
	62		63		64		65		66		67	
	new	old	new	old	new	old	new	old	new	old	new	old
Temperature (°C)	8.0	7.5	7.5	7.5	8.0	7.5	8.0	7.5	8.0	7.5	8.0	7.5
DO (mg/L)	11.6	11.8	11.4	11.7	11.5	11.7	11.6	11.7	11.8	11.9	11.8	11.9
pH	7.8	7.8	7.7	7.8	7.9	7.7	7.9	7.9	7.9	7.9	7.9	7.8
Cond. (µS/cm)	2630		2640		2650		2630		2630		2630	
Initials	JAB		JAB		JAB		JAB		JAB		Emm	

DO meter: DO-1/2 **pH meter:** pH-1/2 **Conductivity meter:** C-1/2

	Control	Control-2		
Hardness*	10	9		
Alkalinity*	8	8		

* mg/L as CaCO3

Analysts: JAB, Emm

Reviewed by: M

Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Golder
Sample ID: TDS - Wet A-C
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date & Time: July 29/13
Test Species: *T. arcticus*

TDS (mg/L) Concentration Control		Days												
		68		69		70								
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		7.0	8.0 JW		7.5									
DO (mg/L)		12.0	~~12.00~~		11.6									
pH		7.6	7.4		6.9									
Cond. (µS/cm)		27												
Initials		JW		JAB										

① 11.8

TDS (mg/L) Concentration 296		Days												
		68		69		70								
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	8.0		7.0									
DO (mg/L)		11.7	11.8		11.6									
pH		7.6	7.4		7.3									
Cond. (µS/cm)		637												
Initials		JW		JAB										

TDS (mg/L) Concentration 667		Days												
		68		69		70								
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	8.0 JW		7.0									
DO (mg/L)		11.8	~~9.62.0~~ JW		11.6									
pH		7.8	7.7 ②		7.6									
Cond. (µS/cm)		1259												
Initials		JW		JAB										

② 11.8

TDS (mg/L) Concentration 1500		Days												
		68		69		70								
		new	old	new	old	new	old	new	old	new	old	new	old	
Temperature (°C)		8.0	8.0		7.5									
DO (mg/L)		11.8	11.6		11.6									
pH		7.9	8.0		7.8									
Cond. (µS/cm)		2610												
Initials		JW		JAB										

DO meter: DO-1/2 **pH meter:** pH-1/2 **Conductivity meter:** C-1/2

	Control			
Hardness*	4			
Alkalinity*	6			

* mg/L as CaCO3

Analysts: JAB, JW
Reviewed by: M
Date reviewed: 30/8/13

Sample Description: TDS

Comments:

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	02-4067-7477	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 16:34	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	10-0229-7069	**Test Type:**	Survival-Development-Growth	**Analyst:**	Jacob Frank
Start Date:	21 May-13 18:00	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	29 Jul-13	**Species:**	Thymallus arcticus (Arctic Grayling)	**Brine:**	
Duration:	68d 6h	**Source:**	Field Collected	**Age:**	
Sample ID:	09-1194-3943	**Code:**	365B2907	**Client:**	Golder
Sample Date:	21 May-13	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	21 May-13	**Source:**	Golder		
Sample Age:	18h	**Station:**	Wet Fertilization		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	157777171	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
EC5	1408	N/A	N/A
EC10	>1414	N/A	N/A
EC15	>1414	N/A	N/A
EC20	>1414	N/A	N/A
EC25	>1414	N/A	N/A
EC40	>1414	N/A	N/A
EC50	>1414	N/A	N/A

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
23.2	Negative Control	3	0.7699	0.7	0.9	0.06511	0.1128	14.65%	0.0%	70	91
326		3	0.6874	0.5	0.8621	0.1047	0.1814	26.39%	10.72%	61	89
453.1		3	0.781	0.6667	0.9667	0.09366	0.1622	20.77%	-1.44%	71	91
649.9		3	0.7678	0.6667	0.8438	0.05266	0.0912	11.88%	0.27%	70	91
954.4		2	0.8366	0.8065	0.8667	0.03011	0.04258	5.09%	-8.66%	51	61
1414.2		3	0.7295	0.6552	0.8333	0.0535	0.09267	12.7%	5.25%	65	89

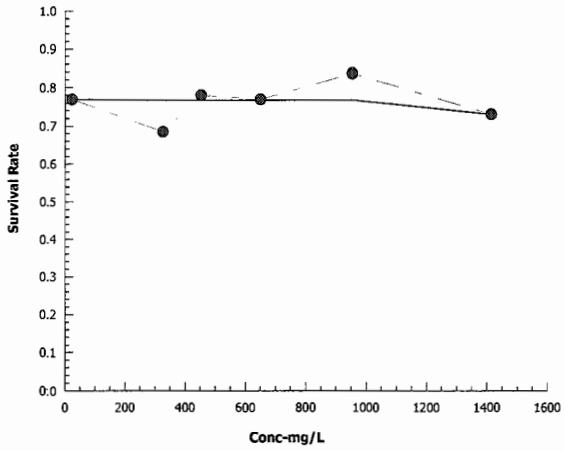
Survival Rate Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3
23.2	Negative Control	0.7	0.9	0.7097
326		0.5	0.7	0.8621
453.1		0.9667	0.7097	0.6667
649.9		0.7931	0.6667	0.8438
954.4		0.8065	0.8667	
1414.2		0.6552	0.7	0.8333

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	02-4067-7477	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 16:34	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	13-6661-3811	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 16:34	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	10-0229-7069	**Test Type:**	Survival-Development-Growth	**Analyst:**	Jacob Frank
Start Date:	21 May-13 18:00	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	29 Jul-13	**Species:**	Thymallus arcticus (Arctic Grayling)	**Brine:**	
Duration:	68d 6h	**Source:**	Field Collected	**Age:**	
Sample ID:	09-1194-3943	**Code:**	365B2907	**Client:**	Golder
Sample Date:	21 May-13	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	21 May-13	**Source:**	Golder		
Sample Age:	18h	**Station:**	Wet Fertilization		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2.097E+09	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1414	N/A	N/A
IC10	>1414	N/A	N/A
IC15	>1414	N/A	N/A
IC20	>1414	N/A	N/A
IC25	>1414	N/A	N/A
IC40	>1414	N/A	N/A
IC50	>1414	N/A	N/A

Mean Dry Weight-mg Summary

			Calculated Variate						
Conc-mg/L	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
23.2	Negative Control	3	7.343	6.817	7.64	0.2635	0.4563	6.22%	0.0%
326		3	7.858	7.31	8.527	0.3565	0.6175	7.86%	-7.02%
453.1		3	7.404	6.462	7.983	0.475	0.8228	11.11%	-0.83%
649.9		3	7.615	6.943	8.333	0.4022	0.6966	9.15%	-3.7%
954.4		2	7.62	7.273	7.966	0.3467	0.4903	6.43%	-3.77%
1414.2		3	7.757	7.192	8.443	0.366	0.634	8.17%	-5.65%

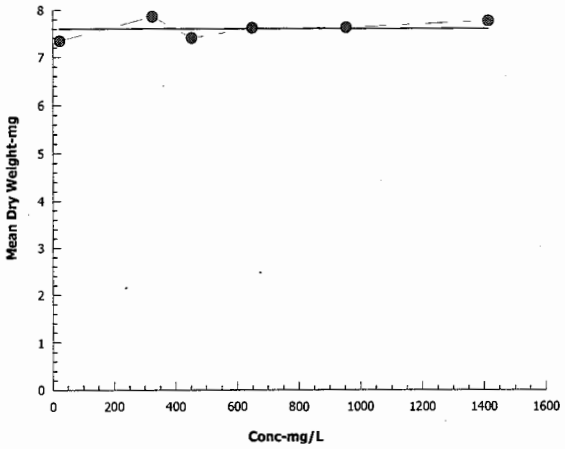
Mean Dry Weight-mg Detail

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3
23.2	Negative Control	7.57	6.817	7.64
326		8.527	7.736	7.31
453.1		6.462	7.766	7.983
649.9		7.568	8.333	6.943
954.4		7.966	7.273	
1414.2		8.443	7.638	7.192

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	13-6661-3811	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 16:34	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test — **Nautilus Environmental**

Analysis ID:	18-2143-2064	**Endpoint:**	Mean ~~Dry Weight-mg~~ Length (mm)	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 16:35	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	00-4322-9549	**Test Type:**	Survival-Development-Growth	**Analyst:**	Jacob Frank
Start Date:	21 May-13 18:00	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	29 Jul-13	**Species:**	Thymallus arcticus (Arctic Grayling)	**Brine:**	
Duration:	68d 6h	**Source:**	Field Collected	**Age:**	
Sample ID:	07-4811-1500	**Code:**	2C97468C	**Client:**	Golder
Sample Date:	21 May-13	**Material:**	Total Dissolved Solids	**Project:**	
Receive Date:	21 May-13	**Source:**	Golder		
Sample Age:	18h	**Station:**	TDS Wet-Length		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	541631000	200	Yes	Two-Point Interpolation

Point Estimates

Level	mg/L	95% LCL	95% UCL
IC5	>1414	N/A	N/A
IC10	>1414	N/A	N/A
IC15	>1414	N/A	N/A
IC20	>1414	N/A	N/A
IC25	>1414	N/A	N/A
IC40	>1414	N/A	N/A
IC50	>1414	N/A	N/A

Mean ~~Dry Weight-mg~~ Length (mm) Summary (JAB)

			Calculated Variate						
Conc-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
23.2	Negative Control	3	21.39	20.96	21.86	0.2603	0.4509	2.11%	0.0%
326		3	21.3	20.9	21.67	0.2226	0.3855	1.81%	0.45%
453.1		3	20.99	20.28	21.5	0.367	0.6357	3.03%	1.87%
649.9		3	21.3	20.95	21.56	0.1818	0.3148	1.48%	0.44%
954.4		2	21.39	21.31	21.48	0.08504	0.1203	0.56%	-0.01%
1414.2		3	21.06	20.6	21.38	0.2368	0.4102	1.95%	1.54%

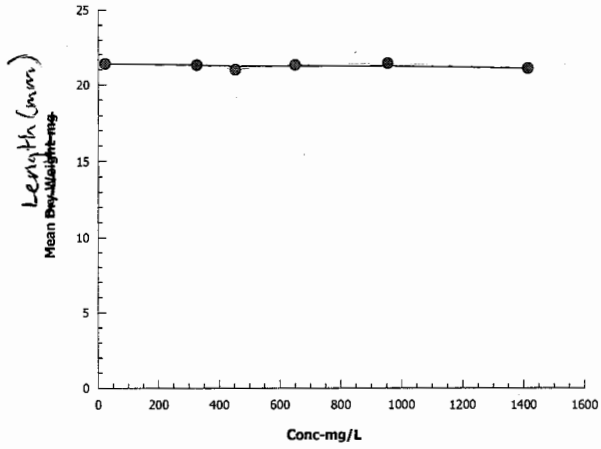
Mean ~~Dry Weight-mg~~ Length (mm) Detail (JAB)

Conc-mg/L	Control Type	Rep 1	Rep 2	Rep 3
23.2	Negative Control	21.86	20.96	21.36
326		21.67	20.9	21.32
453.1		20.28	21.5	21.2
649.9		21.39	20.95	21.56
954.4		21.48	21.31	
1414.2		21.21	21.38	20.6

Salmonid Embryo-Alevin-Fry Survival Development and Growth Test **Nautilus Environmental**

Analysis ID:	18-2143-2064	**Endpoint:**	Mean ~~Dry Weight-mg~~ Length(mm)	**CETIS Version:**	CETISv1.8.0
Analyzed:	07 Aug-13 16:35	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Embryo-Alevin-Fry Toxicity Test Data Sheet

Swim-up Survival and Dry Weight

Client: Golder

Work Order No.: n/a

Start Date: May 21/13

Termination Date: July 29/13

Sample ID	Rep	Pan No. Brown	No. Alive	Initials	Pan weight	Pan + organism	No. weighed	Initials
Control	A	1	21	JAB	1005.94	1164.92	21	JBF
	B	2	27		1010.94	1195.01	27	
	C	3	22		1002.50	1170.59	22	
296	A	4	15		985.87	1113.78	15	
	B	5	21		996.75	1159.21	21	
	C	6	25		984.22	1166.98	25	
444	A	7	29		981.07	1168.47	29	
	B	8	22		989.05	1159.90	22	
	C	9	20		1010.07	1169.74	20	
667	A	~~4~~ 10	23		1002.98	1177.05	23	
	B	JBF ~~10~~ 11	20		1006.52	1173.19	20	
	C	JBF ~~11~~ 12	27		1005.20	1192.65	27	
1000	A	—						
	B	~~12~~ 13	25		1004.73	1203.89	25	
	C	JBF ~~13~~ 14	26		1017.15	1206.25	26	
1500	A	~~14~~ 15	19		1002.93	1163.34	19	
	B	JBF ~~15~~ 16	21		992.17	1152.57	21	
	C	JBF ~~16~~ 17	25	↓	1030.07	1209.86	25	↓

Thermome Calibrated Thermometer DO meter: DO-1 pH meter: pH-1

Comments: Net Fertilization

Reviewed by: [illegible] Date Reviewed: 30/8/13

Arctic Grayling Alevin Assessment

Client: Golder
W.O. #: n/a
Test ID: TDS Early Alevin Fry - Wet Fertilization
Date Measured: July 29/13

Test Concentration (mg/L TDS)	Replicate	Abnormal Fry	Normal Fry
Control	A	0	21
	B	0	27
	C	0	22
	~~D~~		
296	A	0	15
	B	0	21
	C	0	25
	~~D~~		
444	A	0	29
	B	0	22
	C	0	20
	~~D~~		
667	A	0	23
	B	1	19
	C	0	27
	~~D~~		
1000	~~A~~		
	B	0	25
	C	0	26
	~~D~~		
1500	A	0	19
	B	0	21
	C	0	25
	~~D~~		

30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: Control A - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	21	0.92		
2	22				
3	22				
4	22				
5	20				
6	21				
7	22				
8	22				
9	22				
10	23				
11	20				
12	21				
13	22				
14	22				
15	22				
16	23				
17	22				
18	22				
19	23				
20	22				
21	22				
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: Control B - Wet Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	27	1.13		
2	21				
3	20				
4	20				
5	20				
6	21				
7	22				
8	21				
9	22				
10	21				
11	22				
12	22				
13	20				
14	21				
15	19				
16	21				
17	22				
18	21				
19	21				
20	21				
21	21				
22	22				
23	20				
24	21				
25	21				
26	21				
27	21				
28					
29					
30					

Reviewed by: [illegible]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: Control C - Wet Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	22	1.03		
2	19				
3	23				
4	21				
5	20				
6	21				
7	22				
8	22				
9	21				
10	22				
11	23				
12	23				
13	19				
14	21				
15	21				
16	22				
17	22				
18	22				
19	21				
20	22				
21	21				
22	20				
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 296 A - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	15	0.79		
2	22				
3	22				
4	21				
5	22				
6	22				
7	22				
8	22				
9	21				
10	20				
11	22				
12	21				
13	22				
14	22				
15	22				
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 296 B - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	21	0.98		
2	21				
3	21				
4	21				
5	19				
6	22				
7	22				
8	20				
9	21				
10	21				
11	21				
12	22				
13	21				
14	21				
15	19				
16	21				
17	20				
18	19				
19	22				
20	21				
21	23				
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 296 C - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	25	1.17		
2	21				
3	22				
4	22				
5	22				
6	22				
7	21				
8	20				
9	20				
10	23				
11	21				
12	21				
13	16				
14	21				
15	22				
16	22				
17	22				
18	21				
19	22				
20	21				
21	22				
22	22				
23	23				
24	22				
25	21				
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 444 A - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	29	1.18		
2	20				
3	20				
4	20				
5	19				
6	21				
7	21				
8	21				
9	21				
10	21				
11	21				
12	20				
13	21				
14	21				
15	19				
16	21				
17	22				
18	20				
19	20				
20	20				
21	21				
22	21				
23	21				
24	20				
25	19				
26	19				
27	19				
28	19				
29	20				
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 444 B - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	22	0.94		
2	21				
3	21				
4	21				
5	21				
6	22				
7	22				
8	21				
9	21				
10	22				
11	22				
12	22				
13	22				
14	22				
15	22				
16	21				
17	21				
18	20				
19	22				
20	22				
21	22				
22	21				
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 444 C- Wet Fertilization **Stop Date:** July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	20	20	1.01		
2	19				
3	22				
4	22				
5	22				
6	21				
7	23				
8	21				
9	23				
10	22				
11	20				
12	21				
13	22				
14	23				
15	21				
16	21				
17	21				
18	21				
19	21				
20	18				
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 667 A - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	20	23	1.06		
2	21				
3	22				
4	22				
5	21				
6	22				
7	22				
8	21				
9	21				
10	21				
11	20				
12	20				
13	22				
14	21				
15	22				
16	22				
17	22				
18	22				
19	23				
20	22				
21	20				
22	21				
23	22				
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 667 B - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	20	~~1.05~~ 0.95		
2	20		YL		
3	10				
4	23				
5	22				
6	22				
7	21				
8	21				
9	21				
10	23				
11	22				
12	21				
13	21				
14	21				
15	21				
16	23				
17	22				
18	21				
19	21				
20	22				
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: M

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 667 C - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	27	1.21		
2	22				
3	20				
4	23				
5	21				
6	22				
7	22				
8	22				
9	20				
10	22				
11	22				
12	22				
13	22				
14	22				
15	22				
16	20				
17	23				
18	22				
19	21				
20	22				
21	21				
22	20				
23	22				
24	22				
25	22				
26	20				
27	22				
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 1000B- Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	25	1.22		
2	21				
3	22				
4	22				
5	22				
6	22				
7	20				
8	21				
9	23				
10	22				
11	21				
12	23				
13	21				
14	20				
15	22				
16	22				
17	22				
18	21				
19	21				
20	21				
21	21				
22	21				
23	22				
24	22				
25	21				
26					
27					
28					
29					
30					

Reviewed by: [illegible]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1000C- Wet Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	21	26	1.19		
2	21				
3	22				
4	22				
5	22				
6	22				
7	21				
8	21				
9	22				
10	21				
11	22				
12	21				
13	19				
14	23				
15	20				
16	20				
17	21				
18	22				
19	21				
20	22				
21	21				
22	21				
23	21				
24	23				
25	22				
26	20				
27					
28					
29					
30					

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Sample ID: 1500Å - Wet Fertilization

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	19	0.91		
2	21				
3	21				
4	19				
5	22				
6	22				
7	22				
8	22				
9	20				
10	21				
11	21				
12	21				
13	21				
14	21				
15	21				
16	22				
17	21				
18	22				
19	21				
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1500B - Wet Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	22	21	0.98		
2	22				
3	22				
4	22				
5	21				
6	20				
7	22				
8	23				
9	23				
10	21				
11	20				
12	20				
13	21				
14	21				
15	21				
16	20				
17	23				
18	22				
19	22				
20	21				
21	20				
22					
23					
24					
25					
26					
27					
28					
29					
30					

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Length, Weight and Growth

Start Date & Time: May 21/13 @1800h
Sample ID: 1500 C- Wet Fertilization
Stop Date: July 29/13
Test Species: *T. arcticus*

	Length (mm)	# Weighed	Total Weight (g) (wet)	Weight per organism	Initials
1	23	25	1.04		
2	22				
3	19				
4	20				
5	18				
6	20				
7	20				
8	21				
9	21				
10	20				
11	20				
12	21				
13	20				
14	22				
15	22				
16	21				
17	21				
18	21				
19	19				
20	20				
21	20				
22	21				
23	22				
24	20				
25	21				
26					
27					
28					
29					
30					

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Grayling-Wet (A-C)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: T. arcticus

Concentration	Rep	Day 2	3	4	5	6	7	8	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	1	0	0	0	0	1	0	0	1	n/a	n/a	
	2	0				0			0			
	3	0							0			
	4											
296	1	0							0			
	2	0							0			
	3	0							0			
	4											
444	1	0							0			
	2	1							1			
	3	0							0			
	4											
667	1	0						0	0			
	2	0						1	1			
	3	0					↓	0	0			
	4											
1000	1	~~~										
	2	1	0	0	0	1	0	0	2			
	3	0						0	0			
	4											
1500	1	0						0	0			
	2	0						0	0			
	3	0	↓	↓	↓	↓		1	1			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	m	m	m			JAB	JAB			

Comments:

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Wet (A-C)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		9	10	11	12	13	14 (1)	15				
Ctrl	1	0	1	0	0	0	0	0	1			
	2	↓	0						0			
	3	↓	1						1			
	4											
296	1	0	0						0			
	2	↓	0						0			
	3	↓	0						0			
	4											
444	1	0	0						0			
	2	↓	0						0			
	3	↓	0						0			
	4											
667	1	0	0						0			
	2	↓	0						0			
	3	↓	0			↓	↓	↓	0			
	4											
1000	1	~~0~~ JAB	—	—	—	—	—	—	—			
	2	JAB 0	0	0	0	0	0	0	0			
	3	↓	0	0	0	0	↓	↓	0			
	4											
1500	1	0	0	0	0	2			2			
	2	↓	0	0	0	0			0			
	3	↓	0	0	0	0	↓	↓	0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	AO	AO	JAB	JAB	JAB	JAB			

Comments: (1) some observation of eyed embryo

Reviewed by: [signature] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Wet A->C reps
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		16	17	18	19	20	21	22				
Control	A 1	0	0	0	0	0	0	2	4			
	B 2	↓	↓	↓	↓	1	~~1~~	1	2			
	C 3	↓	↓	↓	↓	1	↓	2	3			
	~~JAB~~ 4	↓	↓	↓	↓		↓					
296	1	↓	↓	↓	↓	0	3	1	4			
	2	↓	↓	↓	↓	0	0	6	6			
	3	↓	↓	↓	↓	0	↓	2	2			
	~~JAB~~ 4	↓	↓	↓	↓		↓					
444	1	↓	↓	↓	↓	0	0	0	0			
	2	↓	↓	↓	↓	1	2	4	7			
	3	↓	↓	↓	↓	0	2	8	10			
	~~JAB~~ 4	↓	↓	↓	↓							
667	1	↓	↓	↓	↓	1	0	6	7			
	2	↓	↓	↓	↓	0	1	7	8			
	3	↓	↓	↓	↓	0	0	2	2			
	4	↓	↓	↓	↓							
1000	1	↓	↓	↓	↓	0	~~0~~	—	—			
	2	↓	↓	↓	↓	1	0	~~0~~	4			
	3	↓	↓	↓	↓	0	3	0	3			
	~~JAB~~ 4	↓	↓	↓	↓							
1500	1	↓	↓	↓	↓	1	0	3	4			
	2	↓	↓	↓	↓	0	2	4	6			
	3	↓	↓	↓	↓	1	0	4	5			
	~~JAB~~ 4	↓	↓	↓	↓							
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	AM	AM	JAB	[illegible]	[illegible]	JAB			

Comments:

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: GOLDER
Sample ID: TDS A-C reps (WET)
Work Order #: n/a
Start Date & Time: May 21/13 @ 1800h
Stop Date: July 29/13.
Test Species: T. arthus

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		23	24	25	26	27	28	29				
CONTROL	A1	0	0	0	0	0	0	0	0			
	B2	0							0			
	C3	1							1			
	4											
296	1	0							0			
	2								0			
	3								0			
	4											
444	1								0			
	2								0			
	3								0			
	4											
667	1								0			
	2								0			
	3								0			
	4											
1000	1											
	2								0			
	3								0			
	4											
1500	1								0			
	2								0			
	3								0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		EW	JAB	AM	AM	JAB	JAB	JAB	JAB			

① 1 hatched ② three hatched

Comments:

Reviewed by: VR **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS – Wet
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Mortalities							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		30	31	32	33	34	35	36				
Control A	1	0	0	0	0	0	0	0	0			
B	2						0	0	0			
C	3						0	0	0			
	4											
296	1						1	0	2			
	2		0				0	0	0			
	3						0	0	0			
	4											
444	1						0	0	0			
	2						0	0	0			
	3						0	0	0			
	4											
667	1						0	0	0			
	2						1	0	1			
	3						0	0	0			
	4											
1000	1											
	2						0	0	0			
	3						0	0	0			
	4											
1500	1						0	1	1			
	2						0	1	1			
	3						0	0	0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	AM	—	JAB	JAB	JAB	JAB			

Comments: _____

Reviewed by: _____ **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Wet
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			37	38	39	40	41	42	43				
Control	A	1	0	0	0	0	0	0	0	0			
	B	2	0	0	|	0	|	0	0	0			
	C	3	0	0	|	0	|	0	0	0			
		4			|		|						
296	A	1	0	0	|	0	|	0	0	0			
	B	2	0	0	|	0	|	0	0	0			
	C	3	0	0	|	1	|	1	0	2			
		4			|		|						
444	A	1	0	0	|	0	|	0	0	0			
	B	2	0	0	|	0	|	0	0	0			
	C	3	0	0	|	0	|	0	0	0			
		4			|		|						
667	A	1	0	0	|	0	|	0	0	0			
	B	2	0	0	|	0	|	0	0	0			
	C	3	0	0	|	0	↓	1	0	1			
		4			|								
1000	A	1	JAB 0	0	|	0				—			
	B	2	0	0	|	0	0	0	0	0			
	C	3	0	0	|	0	0	0	0	0			
		4			|								
1500	A	1	0	0	|	1	0	0	0	1			
	B	2	0	0	|	0	0	0	0	0			
	C	3	0	0	|	0	0	0	0	0			
		4			|								
		1			|								
		2			|								
		3			|								
		4			|								
		1			|								
		2			|								
		3			|								
		4			|								
Tech Initials			JAB	JAB	AS	AS	JW	JAB	KM	JAB			

Comments:

Reviewed by: JL **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS		Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
			44	45	46	47	48	49	50				
Control	A	1	0	0	0	0	0	0	0	0			
	B	2	0	↓	↓	↓	↓	↓	↓	0			
	C	3	0	↓	↓	↓	↓	↓	↓	0			
		4											
296	A	1	1	↓	↓	↓	↓	↓	↓	1			
	B	2	0	↓	↓	↓	↓	↓	↓	0			
	C	3	0	↓	↓	↓	↓	↓	↓	0			
		4											
444	A	1	0	↓	↓	↓	↓	↓	↓	0			
	B	2	0	↓	↓	↓	↓	↓	1	1			
	C	3	0	↓	↓	↓	↓	↓	0	0			
		4											
667	A	1	0	↓	↓	↓	↓	↓	↓	0			
	B	2	1	↓	↓	↓	↓	↓	↓	1			
	C	3	0	↓	↓	↓	↓	↓	↓	0			
		4											
1000	A	1	—	—	—	—	—	—	—	—			
	B	2	0	0	0	0	0	0	0	0			
	C	3	0	↓	↓	↓	↓	↓	↓	0			
		4											
1500	A	1	0	↓	↓	↓	↓	↓	1	1			
	B	2	0	↓	↓	↓	↓	↓	1	1			
	C	3	0	↓	↓	↓	↓	↓	0	0			
		4											
		1											
		2											
		3											
		4											
		1											
		2											
		3											
		4											
Tech Initials			JAB	JAB	AM	AO	JAB	JAB		JAB			

Comments: ① One fish darker than normal / scarfacing.

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS – WET
Work Order #: n/a
Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities 51	52	53	54	55	56	57	Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
Control	A1	0	0	0	0	0	1	0	1			
	B2		↓	↓	↓	0	0	0	0			
	C3		↓	↓	↓	0	0	0	0			
	4											
296	A1		1	0	1	0	1①	2	5			
	B2		0		0	0	0	0	0			
	C3				0	0	0①	1	1			
	4											
444	A1				0	0	0	0	0			
	B2				0	0	0	0	0			
	C3			↓	0	0	0	0	0			
	4											
667	A1			0	0	0	0	0	0			
	B2			0		0	0	0	0			
	C3			1		0	0	0	1			
	4											
1000	A1								–			
	B2			0		0	0	0	0			
	C3			0		0	0	0	0			
	4											
1500	A1			1	↓	0	0	0	1			
	B2			0	1	0	0	0	1			
	C3	↓	↓	0	0	0	0	1	1			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		[illegible]	JAB	AM	AM	JAB	[illegible]	JAB	JAB			

Comments: ① One fish lysing at bottom, inactive / occasional movement.

Reviewed by: [signature]
Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Wet
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		58	59	60	61	62	63	64				
Control	A	0	0	0	0	0	0	0	0			
	B		0		0		0		0			
	C		1		0		1		2			
	4		0									
296	A		0		1		0		1			
	B		1		0		1		2			
	C		2				0		0			
	4											
444	A								0			
	B								0			
	C								0			
	4											
667	A								0			
	B								0			
	C								0			
	4											
1000	A		✓						0			
	B		✓						0			
	C		1						1			
	4		0									
1500	A		0						0			
	B		0						0			
	C		0						0			
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	AM	AM	AM	JAB	[illegible]	JAB	JAB			

Comments:

Reviewed by: M **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS - Wet
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Concentration mg/L TDS	Rep	Day of Test - No. of Mortalities							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		65	66	67	68	69	70	71				
Control	A1	0	0	0	1	1						
	B2	0			0	0						
	C3	0			0	1						
	4	—	—	—	—	—	—	—				
296	A1	0			0	1						
	B2	0			0	0						
	C3	0			0	0						
	4	—	—	—	—	—	—	—				
444	A1	0			0	0						
	B2	0			0	0						
	C3	0			0	0						
	4	—	—	—	—	—	—	—				
667	A1	1			0	0						
	B2	0			0	0						
	C3	0			0	0						
	4	—	—	—	—	—	—	—				
1000	A1	0	—	—	—	—	—	—				
	B2	0			0	0						
	C3	0			0	0						
	4	—	—	—	—	—	—	—				
1500	A1	0			0	0						
	B2	0			0	0						
	C3	0	↓	↓	0	0						
	4	—	—	—	—	—	—	—				
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	[illegible]	JW	JAB						

Comments:

Reviewed by: [signature] **Date reviewed:** 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Hatched

Client: Golder
Sample ID: TDS-Wet
Work Order #: n/a

Start Date & Time: May 21/13 @ 1800h
Stop Date: July 29/13
Test Species: T. arcticus

Treatments mg/L TDS	Rep	Day of Test - No. of Hatched							Total Dead Fish	Total Undeveloped	Total No. Fry	Total Exposed
		30	31	34	35	36	37	38				
Control A	1	0	0	0	10	16©	16	23				
B	2	0	0	0	14©	20	26	~~26~~ 27				
C	3	0	0	0	11	16©	16	26				
	4											
296	1	0	0	~~2~~ 17©	17	19	24	24				
	2	3	3	3	11	19©	20	24				
	3	0	0	0	17©	24	25	27				
	4											
444	1	0	0	4	27©	30	30	30				
	2	1	4	4	13©	18	21	24				
	3	0	0	3	9	14©	14	19				
	4											
667	1	0	0	10	22©	22	22	22				
	2	0	0	14©	20	20	20	20				
	3	1	1	21©	29	29	29	29				
	4											
1000	1											
	2	1	5	22©	25	25	25	25				
	3	1	1	12	17©	25	27	27				
	4											
1500	1	1	1	12©	20	20	23	23				
	2	3	4	22©	23	23	23	23				
	3	0	0	17©	23	24	24	24				
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB	JAB	JAB	JAB	JAB	JAB	JAB				

Comments: © > 50% hatched

Reviewed by: [signature]

Date reviewed: 30/8/13

Embryo-Alevin-Fry Toxicity Test
Daily Mortality

Client: Golder
Sample ID: TDS-Wet (A→C)
Work Order #: n/a

Start Date & Time: May 21/13 @1800h
Stop Date: July 29/13
Test Species: *T. arcticus*

Treatments	Rep	Day of Test - No. of Hatched							Total Dead Eggs/ Embryos Alevins	Total Undeveloped/ Unhatched Embryos	Total No. Alevins	Total Exposed
		41 ①										
Control A	1	24										
B	2	28										
C	3	26										
	4											
296 A	1	24										
B	2	24										
C	3	27										
	4											
444 A	1	30										
B	2	24										
C	3	20										
	4											
667 A	1	22										
B	2	20										
C	3	29										
	4											
1000 A	1	—										
B	2	25										
C	3	27										
	4											
1500 A	1	23										
B	2	23										
C	3	25										
	4											
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials		JAB										

Comments: ① all embryos hatched

Reviewed by: [signature]

Date reviewed: 7/18/13

APPENDIX C – Analytical chemistry data

NAUTILUS ENVIRONMENTAL
ATTN: Edmund Canaria
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 19-NOV-12
Report Date: 23-NOV-12 12:01 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1239070
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

TDS
Dry + Wet
Initial

Lake Trout tests

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1239070-1	L1239070-2	L1239070-3	L1239070-4	L1239070-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	16-NOV-12	16-NOV-12	16-NOV-12	16-NOV-12	16-NOV-12
	Sampled Time	1500	1000	667	444	296
	Client ID					
Grouping	Analyte					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	116	83.4	58.1	38.8	29.2
	Chloride (Cl) (mg/L)	764	508	334	221	148
	Sulfate (SO4) (mg/L)	142	94	62.2	40.8	28.3
Total Metals	Calcium (Ca)-Total (mg/L)	287	197	143	94.9	65.7
	Magnesium (Mg)-Total (mg/L)	39.2	25.2	17.5	11.3	7.71
	Potassium (K)-Total (mg/L)	19.3	13.0	9.3	6.0	4.1
	Sodium (Na)-Total (mg/L)	185	125	91.0	58.8	37.9

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1239070-6				
	Description	Water				
	Sampled Date	16-NOV-12				
	Sampled Time					
	Client ID	CONTROL				
Grouping	Analyte					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	8.2				
	Chloride (Cl) (mg/L)	3.27				
	Sulfate (SO4) (mg/L)	1.02				
Total Metals	Calcium (Ca)-Total (mg/L)	4.18				
	Magnesium (Mg)-Total (mg/L)	0.20				
	Potassium (K)-Total (mg/L)	<2.0				
	Sodium (Na)-Total (mg/L)	<2.0				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

L1239070

L1239070-COFC

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

Date Nov16/12 Page 1 of 1

Sample Collection By:

Report to:		Invoice To:	
Company		Company	
Address		Address	
City/State/Zip		City/State/Zip	
Contact		Contact	
Phone		Phone	
Email	edmund@nautilusenvironmental.com	Email	edmund@nautilusenvironmental.com

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides				Receipt Temperature (°C)
1	1500	16-Nov-12			125 mL	1	Day 0	x	x	x	x	x	x	x				
2	1000	16-Nov-12			125 mL	1	Day 0	x	x	x	x	x	x	x				
3	667	16-Nov-12			125 mL	1	Day 0	x	x	x	x	x	x	x				
4	444	16-Nov-12			125 mL	1	Day 0	x	x	x	x	x	x	x				
5	296	16-Nov-12			125 mL	1	Day 0	x	x	x	x	x	x	x				
6	Control	16-Nov-12			250 mL	1	Day 0	x	x	x	x	x	x	x				
7																		
8																		
9																		
10																		

PROJECT INFORMATION

Client:	
PO No.:	PO No.: 065 WO #: 12300
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

RELINQUISHED BY (CLIENT)

(Signature) Josh Baker (Time) 1630h

(Printed Name) ~~Edmund Canasia~~ Josh Baker (Date) Nov16/12

(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

SPECIAL INSTRUCTIONS/COMMENTS: Total Dissolved Solids Project Study-Lake Trout

RECEIVED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (LABORATORY)

(Signature) AT (Time) 9:53 am

(Printed Name) Amy T. (Date) Nov. 19

(Company) 14.6°C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 28-JAN-13
Report Date: 13-FEB-13 16:14 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1262932
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 1, 2
Legal Site Desc:

Comments: Please note we received two bottles for each ALS identified sample L1262932-1 to 6 and they were analyzed as separate samples as per client.

TDS
Intermediate
Jan 23/13
Lake trout tests

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1262932-1 Water 23-JAN-13 15:15 CONTROL OLD DRY	L1262932-2 Water 23-JAN-13 15:15 CONTROL OLD WET	L1262932-3 Water 23-JAN-13 15:15 296 OLD DRY	L1262932-4 Water 23-JAN-13 15:15 296 OLD WET	L1262932-5 Water 23-JAN-13 15:15 444 OLD DRY
Sample ID / **Description** / **Sampled Date** / **Sampled Time** / **Client ID**						
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	11.4	11.1	33.7	33.8	43.4
	Chloride (Cl) (mg/L)	2.72	4.39	153	155	230
	Sulfate (SO4) (mg/L)	2.45	2.71	28.3	28.8	39.5
Total Metals	Calcium (Ca)-Total (mg/L)	4.34	5.17	73.1	71.3	101
	Magnesium (Mg)-Total (mg/L)	0.26	0.35	8.14	7.92	11.3
	Potassium (K)-Total (mg/L)	<2.0	<2.0	3.3	3.2	4.5
	Sodium (Na)-Total (mg/L)	2.4	2.9	37.7	36.5	52.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1262932-6 Water 23-JAN-13 15:15 444 OLD WET	L1262932-7 Water 23-JAN-13 15:15 667 OLD DRY	L1262932-8 Water 23-JAN-13 15:15 667 OLD WET	L1262932-9 Water 23-JAN-13 15:15 1000 OLD DRY	L1262932-10 Water 23-JAN-13 15:15 1000 OLD WET
Sample ID		L1262932-6	L1262932-7	L1262932-8	L1262932-9	L1262932-10
Description		Water	Water	Water	Water	Water
Sampled Date		23-JAN-13	23-JAN-13	23-JAN-13	23-JAN-13	23-JAN-13
Sampled Time		15:15	15:15	15:15	15:15	15:15
Client ID		444 OLD WET	667 OLD DRY	667 OLD WET	1000 OLD DRY	1000 OLD WET
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	42.9	62.7	58.6	82.9	85.5
	Chloride (Cl) (mg/L)	227	337	338	505	511
	Sulfate (SO4) (mg/L)	39.0	57.9	58.1	85	86
Total Metals	Calcium (Ca)-Total (mg/L)	98.9	148	150	211	209
	Magnesium (Mg)-Total (mg/L)	11.0	16.7	16.9	24.2	23.8
	Potassium (K)-Total (mg/L)	4.3	6.6	6.7	9.5	9.4
	Sodium (Na)-Total (mg/L)	50.3	78.2	79.2	114	112

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1262932-11 Water 23-JAN-13 15:15 1500 OLD DRY	L1262932-12 Water 23-JAN-13 15:15 1500 OLD WET	L1262932-13 Water 23-JAN-13 15:00 CONTROL NEW	L1262932-14 Water 23-JAN-13 15:00 296 NEW	L1262932-15 Water 23-JAN-13 15:00 444 NEW
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	120	117	10.4	32.2	42.4
	Chloride (Cl) (mg/L)	752	757	1.70	149	214
	Sulfate (SO4) (mg/L)	127	128	1.86	27.4	36.7
Total Metals	Calcium (Ca)-Total (mg/L)	306	318	3.75	66.7	97.2
	Magnesium (Mg)-Total (mg/L)	35.4	37.3	0.20	7.48	10.8
	Potassium (K)-Total (mg/L)	13.9	14.4	<2.0	2.9	4.2
	Sodium (Na)-Total (mg/L)	166	172	2.9	36.1	52.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1262932-16	L1262932-17	L1262932-18		
	Description	Water	Water	Water		
	Sampled Date	23-JAN-13	23-JAN-13	23-JAN-13		
	Sampled Time	15:00	15:00	15:00		
	Client ID	667 NEW	1000 NEW	1500 NEW		
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	57.6	84.6	118		
	Chloride (Cl) (mg/L)	325	491	760		
	Sulfate (SO4) (mg/L)	54.5	83	129		
Total Metals	Calcium (Ca)-Total (mg/L)	145	212	310		
	Magnesium (Mg)-Total (mg/L)	16.5	24.1	37.2		
	Potassium (K)-Total (mg/L)	6.4	9.4	14.1		
	Sodium (Na)-Total (mg/L)	78.9	115	172		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Sulfate (SO4)	DLM	L1262932-1, -10, -11, -12, -18, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1262932-13, -14, -15, -16, -17, -18
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1262932-13, -14, -15, -16, -17, -18

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted For Sample Matrix Effects
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

L1262932

TESTING LOCAT

L1262932-COFC

California
5550 Morehouse Drive, Suite 1
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Fax 253.922.5814

ia
ourt
olumbia, Canada V5A 4N3
773
Fax 604.357.1361

Chain of Custody

Date Jan 28/13 Page 1 of 2

Sample Collection By: JBF

Report to:		Invoice To:	
Company	Nautilus Environmental	Company	
Address	8664 Commerce Court	Address	
City/State/Zip	Burnaby, BC V5A 4N3	City/State/Zip	
Contact	Josh Baker, James Elphick	Contact	
Phone	604 420 8773	Phone	
Email	josh@nautilusenvironmental.com	Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Chlorides	Total Sulphates				Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	Control	Jan 23/13	1515	Water	125 mL	1	Old Solution	x	x	x	x	x	x	x				
2	296	Jan 23/13	1515	Water	125 mL	1	Old Solution	x	x	x	x	x	x	x				
3	444	Jan 23/13	1515	Water	125 mL	1	Old Solution	x	x	x	x	x	x	x				
4	667	Jan 23/13	1515	Water	125 mL	1	Old Solution	x	x	x	x	x	x	x				
5	1000	Jan 23/13	1515	Water	125 mL	1	Old Solution	x	x	x	x	x	x	x				
6	1500	Jan 23/13	1515	Water	125 mL	1	Old Solution	x	x	x	x	x	x	x				
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:		Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)		RELINQUISHED BY (COURIER)	
(Signature)	(Time) 1730h	(Signature)	(Time)
(Printed Name) Josh Baker	(Date) Jan 28/13	(Printed Name)	(Date)
(Company) Nautilus Environmental		(Company)	

RECEIVED BY (COURIER)		RECEIVED BY (LABORATORY)	
(Signature)	(Time)	(Signature) Geoff	(Time) 19:20
(Printed Name)	(Date)	(Printed Name) Jan 28	(Date) 8.0 °C
(Company)		(Company)	

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Nautilus Environmental

L1262932-COFC

Chain of Custody

...y East, Suite 2
...l
...l6
Fax 858.587.3961

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Date Jan 28/13 Page 2 of 2

Sample Collection By: JBF

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	ANALYSES REQUIRED: Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Chlorides	Total Sulphates				Receipt Temperature (°C)
1	Control	Jan 23/13	1500	Water	125 mL	1	New Solution	x	x	x	x	x	x	x				
2	296	Jan 23/13	1500	Water	125 mL	1	New Solution	x	x	x	x	x	x	x				
3	444	Jan 23/13	1500	Water	125 mL	1	New Solution	x	x	x	x	x	x	x				
4	667	Jan 23/13	1500	Water	125 mL	1	New Solution	x	x	x	x	x	x	x				
5	1000	Jan 23/13	1500	Water	125 mL	1	New Solution	x	x	x	x	x	x	x				
6	1500	Jan 23/13	1500	Water	125 mL	1	New Solution	x	x	x	x	x	x	x				
7																		
8																		
9																		
10																		

PROJECT INFORMATION

Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature)	(Time) 1730h
(Printed Name) Josh Baker	(Date) Jan 28/13
(Company) Nautilus Environmental	

RELINQUISHED BY (COURIER)

(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RECEIVED BY (COURIER)

(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RECEIVED BY (LABORATORY)

(Signature) Geoff	(Time) 19:20
(Printed Name) Jan. 28	(Date) 8.0 °C
(Company)	

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 06-MAR-13
Report Date: 14-MAR-13 11:19 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1276405

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 1, 2, 3
Legal Site Desc:

TDS
Dry + Wet
Intermediate (2)
Mar 6/13

Lake trout tests

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L1276405-1 Description: Water Sampled Date: 06-MAR-13 Sampled Time: 10:00 Client ID: CONTROL - NEW	L1276405-2 Water 06-MAR-13 10:00 296 - NEW	L1276405-3 Water 06-MAR-13 10:00 444 - NEW	L1276405-4 Water 06-MAR-13 10:00 667 - NEW	L1276405-5 Water 06-MAR-13 10:00 1000 - NEW
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	19	439	618	850	1250
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	10.1	32.1	42.6	64.2	90.1
	Chloride (Cl) (mg/L)	1.61	148	221	326	500
	Sulfate (SO4) (mg/L)	2.81	27.9	39.6	57.5	86
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	4.58	64.7	94.0	135	203
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	0.21	7.18	10.8	15.7	23.8
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	<2.0	3.1	4.5	6.5	9.8
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	1.64	1.65	1.67	1.65	1.68
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	<2.0	35.8	48.4	74.6	113
	Strontium (Sr)-Total (mg/L)	0.0138	0.0327	0.0422	0.0548	0.0766
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L1276405-6 Description: Water Sampled Date: 06-MAR-13 Sampled Time: 10:00 Client ID: 1500 - NEW	L1276405-7 Water 06-MAR-13 10:00 CONTROL - DRY OLD	L1276405-8 Water 06-MAR-13 10:00 296 - DRY OLD	L1276405-9 Water 06-MAR-13 10:00 444 - DRY OLD	L1276405-10 Water 06-MAR-13 10:00 667 - DRY OLD
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1970	26	469	601	842
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	126	14.7	35.6	45.1	70.1
	Chloride (Cl) (mg/L)	755	3.42	153	225	333
	Sulfate (SO4) (mg/L)	130	2.77	28.4	39.8	58.2
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	300	5.60	67.6	95.9	142
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	36.1	0.31	7.47	10.9	16.3
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	14.4	<2.0	3.0	4.4	6.5
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	1.70	1.80	1.74	1.73	1.73
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	169	2.6	36.5	51.3	75.8
	Strontium (Sr)-Total (mg/L)	0.108	0.0149	0.0338	0.0425	0.0567
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1276405-11	L1276405-12	L1276405-13	L1276405-14	L1276405-15
Description	Water	Water	Water	Water	Water
Sampled Date	06-MAR-13	06-MAR-13	06-MAR-13	06-MAR-13	06-MAR-13
Sampled Time	10:00	10:00	10:00	10:00	10:00
Client ID	1000 - DRY OLD	1500 - DRY OLD	CONTROL - WET OLD	296 - WET OLD	444 - WET OLD
Grouping / Analyte					
WATER					
Physical Tests Total Dissolved Solids (mg/L)	1190	1870	30	437	585
Anions and Nutrients Alkalinity, Total (as CaCO3) (mg/L)	90.0	124	14.6	36.4	45.5
Chloride (Cl) (mg/L)	501	778	4.05	152	220
Sulfate (SO4) (mg/L)	85	133	2.74	28.4	38.4
Total Metals Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium (Ca)-Total (mg/L)	204	300	5.78	68.1	96.4
Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Magnesium (Mg)-Total (mg/L)	23.9	36.5	0.33	7.63	11.1
Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)-Total (mg/L)	9.6	14.0	<2.0	3.1	4.5
Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon (Si)-Total (mg/L)	1.72	1.68	1.83	1.72	1.73
Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium (Na)-Total (mg/L)	112	165	2.6	38.5	52.5
Strontium (Sr)-Total (mg/L)	0.0767	0.107	0.0152	0.0344	0.0434
Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L1276405-16 Description: Water Sampled Date: 06-MAR-13 Sampled Time: 10:00 Client ID: 667 - WET OLD	Sample ID: L1276405-17 Description: Water Sampled Date: 06-MAR-13 Sampled Time: 10:00 Client ID: 1000 - WET OLD	Sample ID: L1276405-18 Description: Water Sampled Date: 06-MAR-13 Sampled Time: 10:00 Client ID: 1500 - WET OLD		
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	845	1220	1910		
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	67.0	90.3	126		
	Chloride (Cl) (mg/L)	331	496	755		
	Sulfate (SO4) (mg/L)	57.5	84	129		
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20		
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20		
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20		
	Barium (Ba)-Total (mg/L)	<0.010	<0.010	<0.010		
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050		
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20		
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10		
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010		
	Calcium (Ca)-Total (mg/L)	140	207	304		
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010		
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010		
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010		
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030		
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050		
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010		
	Magnesium (Mg)-Total (mg/L)	16.3	24.5	37.0		
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050		
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030		
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050		
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30		
	Potassium (K)-Total (mg/L)	6.5	9.9	14.3		
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20		
	Silicon (Si)-Total (mg/L)	1.74	1.72	1.70		
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010		
	Sodium (Na)-Total (mg/L)	76.7	115	169		
	Strontium (Sr)-Total (mg/L)	0.0569	0.0789	0.109		
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20		
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030		
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010		
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030		
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 2 3

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

L1276405

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washing
5009 Pacif
Tacoma, W
Phone 253
Fax 253.92

L1276405-COFC

4N3

Chain of Custody

Date Mar 6/13 Page 1 of 3

Sample Collection By: JBF

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	Same as report
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphides	Total Chlorides	Total Dissolved Solids (TDS)			Receipt Temperature (°C)
1	Control - New	March 6/13	1000	Water	1000 mL	1	TDS-Dry/Wet New	x	x	x	x	x	x	x	x			
2	296 - New	March 6/13	1000	Water	1000 mL	1	TDS-Dry/Wet New	x	x	x	x	x	x	x	x			
3	444 - New	March 6/13	1000	Water	1000 mL	1	TDS-Dry/Wet New	x	x	x	x	x	x	x	x			
4	667 - New	March 6/13	1000	Water	1000 mL	1	TDS-Dry/Wet New	x	x	x	x	x	x	x	x			
5	1000 - New	March 6/13	1000	Water	1000 mL	1	TDS-Dry/Wet New	x	x	x	x	x	x	x	x			
6	1500 - New	March 6/13	1000	Water	1000 mL	1	TDS-Dry/Wet New	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION

Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature) JBaker (Time) 1600h

(Printed Name) Josh Baker (Date) Mar 6/13

(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (COURIER)

(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (LABORATORY)

(Signature) Walt Mar 6 (Time)

(Printed Name) (Date) 18:30

(Company) S.G.S.

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Nautilus Environmental

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washington
5009 Pacific H
Tacoma, WA
Phone 253.92
Fax 253.922.5

L1276405-COFC

Chain of Custody

Date Mar 6/13 Page 2 of 3

Sample Collection By: JBF

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	Same as report
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphides	Total Chlorides	Total Dissolved Solids (TDS)			Receipt Temperature (°C)
1	Control - Dry Old	March 6/13	1000	Water	1000 mL	1	TDS-Dry Old	x	x	x	x	x	x	x	x			
2	296 - Dry Old	March 6/13	1000	Water	1000 mL	1	TDS-Dry Old	x	x	x	x	x	x	x	x			
3	444 - Dry Old	March 6/13	1000	Water	1000 mL	1	TDS-Dry Old	x	x	x	x	x	x	x	x			
4	667 - Dry Old	March 6/13	1000	Water	1000 mL	1	TDS-Dry Old	x	x	x	x	x	x	x	x			
5	1000 - Dry Old	March 6/13	1000	Water	1000 mL	1	TDS-Dry Old	x	x	x	x	x	x	x	x			
6	1500 - Dry Old	March 6/13	1000	Water	1000 mL	1	TDS-Dry Old	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION

Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature) J Baker (Time) 1600 h
(Printed Name) Josh Baker (Date) Mar 6/13
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)

(Signature) Walt Mar 6 (Time) 15:30
(Printed Name)
(Company) ESG

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Nautilus Environmental

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washington
5009 Pacific Highwa
Tacoma, WA 98424
Phone 253.922.42
Fax 253.922.5814

L1276405-COFC

Chain of Custody

Date Mar6/13 Page 3 of 3

Sample Collection By: JBF

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	Same as report
Address	—
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphides	Total Chlorides	Total Dissolved Solids (TDS)			Receipt Temperature (°C)
1	Control - Wet Old	March 6/13	1000	Water	1000 mL	1	TDS-Wet Old	x	x	x	x	x	x	x	x			
2	296- Wet Old	March 6/13	1000	Water	1000 mL	1	TDS-Wet Old	x	x	x	x	x	x	x	x			
3	444- Wet Old	March 6/13	1000	Water	1000 mL	1	TDS-Wet Old	x	x	x	x	x	x	x	x			
4	667- Wet Old	March 6/13	1000	Water	1000 mL	1	TDS-Wet Old	x	x	x	x	x	x	x	x			
5	1000- Wet Old	March 6/13	1000	Water	1000 mL	1	TDS-Wet Old	x	x	x	x	x	x	x	x			
6	1500- Wet Old	March 6/13	1000	Water	1000 mL	1	TDS-Wet Old	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

ANALYSES REQUIRED

PROJECT INFORMATION

Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature) (Time): 1600h
(Printed Name) (Date): Josh Baker Mar6/13
(Company): Nautilus Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time):
(Printed Name) (Date):
(Company):

RECEIVED BY (COURIER)

(Signature) (Time):
(Printed Name) (Date):
(Company):

RECEIVED BY (LABORATORY)

(Signature) (Time): Mar 8 18:30
(Printed Name) (Date):
(Company): 8.9 C

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 05-APR-13
Report Date: 11-APR-13 17:25 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1286798
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

TDS
Dry Fert
Final

Lake trout test

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1286798-1 water 05-APR-13 09:45 CONTROL	L1286798-2 water 05-APR-13 09:45 296	L1286798-3 water 05-APR-13 09:45 444	L1286798-4 water 05-APR-13 09:45 667	L1286798-5 water 05-APR-13 09:45 1000
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	29	432	567	808	1090
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	14.0	32.4	43.3	59.4	83.8
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	14.0	32.4	43.3	59.4	83.8
	Chloride (Cl) (mg/L)	3.78	152	222	336	496
	Sulfate (SO4) (mg/L)	2.99	27.8	38.7	57.5	83
Total Metals	Calcium (Ca)-Total (mg/L)	4.76	68.2	96.4	145	211
	Magnesium (Mg)-Total (mg/L)	0.34	7.95	11.3	17.2	25.4
	Potassium (K)-Total (mg/L)	<2.0	3.5	4.8	7.1	10.3
	Sodium (Na)-Total (mg/L)	2.2	34.9	50.4	77.1	114

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1286798-6				
	Description	water				
	Sampled Date	05-APR-13				
	Sampled Time	09:45				
	Client ID	1500				
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1800				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	120				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	120				
	Chloride (Cl) (mg/L)	767				
	Sulfate (SO4) (mg/L)	129				
Total Metals	Calcium (Ca)-Total (mg/L)	304				
	Magnesium (Mg)-Total (mg/L)	27.6				
	Potassium (K)-Total (mg/L)	14.7				
	Sodium (Na)-Total (mg/L)	165				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-1
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Bicarbonate (as CaCO3)	B	L1286798-2, -3, -4, -5, -6
Method Blank	Alkalinity, Total (as CaCO3)	B	L1286798-2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

Reference Information

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washington
5009 Pacific Highway East, Suite 2
Tacoma, WA 98424
Phone 253.922.4296
Fax 253.922.5814

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

Date Apr 5/13 Page 1 of 1

Sample Collection By: JBF

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	
Address	
City/State/Zip	
Contact	
Phone	
Email	

L1286798-COFC

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	Total Dissolved Solids			Receipt Temperature (°C)
1	Control	April 5/13	0945h	Water	1000 mL	1	Old Solution (Final) - Dry	x	x	x	x	x	x	x	x			
2	296	April 5/13	0945h	Water	1000 mL	1	Old Solution (Final)	x	x	x	x	x	x	x	x			
3	444	April 5/13	0945h	Water	1000 mL	1	Old Solution (Final)	x	x	x	x	x	x	x	x			
4	667	April 5/13	0945h	Water	1000 mL	1	Old Solution (Final)	x	x	x	x	x	x	x	x			
5	1000	April 5/13	0945h	Water	1000 mL	1	Old Solution (Final)	x	x	x	x	x	x	x	x			
6	1500	April 5/13	0945h	Water	1000 mL	1	Old Solution (Final)	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

PROJECT INFORMATION

Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature)	(Time) 1600h
(Printed Name) Josh Baker	(Date) Apr 5/13
(Company) Nautilus Env.	

RECEIVED BY (COURIER)

(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RELINQUISHED BY (COURIER)

(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RECEIVED BY (LABORATORY)

(Signature) TN Apr 5	(Time) 18:00
(Printed Name)	(Date)
(Company)	13°

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-APR-13
Report Date: 18-APR-13 16:42 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1289142
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

TDS
Wet Fert
Final
Lake trout test

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID Description Sampled Date Sampled Time Client ID	L1289142-1 Water 10-APR-13 09:45 CONTROL	L1289142-2 Water 10-APR-13 09:45 296	L1289142-3 Water 10-APR-13 09:45 444	L1289142-4 Water 10-APR-13 09:45 667	L1289142-5 Water 10-APR-13 09:45 1000
WATER							
Physical Tests	Total Dissolved Solids (mg/L)		26	430	646	990	1390
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)		11.0	30.0	39.9	49.3	81.1
	Chloride (Cl) (mg/L)		4.68	146	229	339	495
	Sulfate (SO4) (mg/L)		3.22	28.3	40.5	59.3	86
Total Metals	Calcium (Ca)-Total (mg/L)		5.12	62.6	94.6	136	200
	Magnesium (Mg)-Total (mg/L)		0.38	7.22	11.1	16.3	24.1
	Potassium (K)-Total (mg/L)		<2.0	3.0	4.5	6.5	9.6
	Sodium (Na)-Total (mg/L)		2.4	35.2	51.9	75.7	112

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1289142-6
	Description	Water
	Sampled Date	10-APR-13
	Sampled Time	09:45
	Client ID	1500
Grouping	Analyte	
WATER		
Physical Tests	Total Dissolved Solids (mg/L)	2180
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	112
	Chloride (Cl) (mg/L)	745
	Sulfate (SO4) (mg/L)	128
Total Metals	Calcium (Ca)-Total (mg/L)	285
	Magnesium (Mg)-Total (mg/L)	36.0
	Potassium (K)-Total (mg/L)	13.7
	Sodium (Na)-Total (mg/L)	161

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washington
5009 Pacific Highway East, Suite 2
Tacoma, WA 98424
Phone 253.922.4296
Fax 253.922.5814

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

Date Apr 11/13 Page 1 of 1

Sample Collection By: JBF

Report to: L1289142

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	Same as report
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	Total Dissolved Solids			Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	Control	April 10/13	0945h	Water	1000 mL	1	Old Solution (Final) - Wet Fert Lake Trout	x	x	x	x	x	x	x	x			
2	296	April 10/13	0945h	Water	1000 mL	1	Old Solution (Final) - Wet Fert Lake Trout	x	x	x	x	x	x	x	x			
3	444	April 10/13	0945h	Water	1000 mL	1	Old Solution (Final) - Wet Fert Lake Trout	x	x	x	x	x	x	x	x			
4	667	April 10/13	0945h	Water	1000 mL	1	Old Solution (Final) - Wet Fert Lake Trout	x	x	x	x	x	x	x	x			
5	1000	April 10/13	0945h	Water	1000 mL	1	Old Solution (Final) - Wet Fert Lake Trout	x	x	x	x	x	x	x	x			
6	1500	April 10/13	0945h	Water	1000 mL	1	Old Solution (Final) - Wet Fert Lake Trout	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		**Total No. of Containers**	
PO No.:		**Received Good Condition?**	
Shipped Via:		**Matches Test Schedule?**	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (COURIER)	
(Signature)	(Time) 1700h
(Printed Name) Josh Baker	(Date) Apr 11/13
(Company) Nautilus	

RECEIVED BY (COURIER)	
(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RELINQUISHED BY (COURIER)	
(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RECEIVED BY (LABORATORY)	
(Signature) Walt	(Time) Apr 11 16
(Printed Name)	(Date) 18:30
(Company) KT	

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Measured TDS Values (calculated as sum of major ions)

Lake Trout tests

Dry Fertilization	Initial	Corrected Values Inter #1 New	Inter #1 Old	Inter #2 New	Inter #2 Old	Final	Average	
Control	17.7	18.8	21.1	19.4	25.7	24.6	21.2	
296	309.5	309.2	324.1	306.3	317.7	314.1	313.5	105.9
444	457.1	440.9	464.9	444.3	454.8	450	452.0	101.8
667	692.4	661.4	682.6	654.5	674.6	676.1	673.6	101.0
1000	1013.1	986.1	999.3	990.6	990.4	990.8	995.1	99.5
1500	1507.3	1494.3	1473.5	1481.4	1502.1	1480.5	1489.9	99.3

Wet Fertilization	Initial	Inter #1 New	Inter #1 Old	Inter #2 New	Inter #2 Old	Final	Average	
Control	17.7	18.8	24.3	19.4	26.4	24.5	21.9	
296	309.5	309.2	323.3	306.3	319.9	300.6	311.5	105.2
444	457.1	440.9	456.7	444.3	450.7	455.94	450.9	101.6
667	692.4	661.4	684.6	654.5	668.9	662.87	670.8	100.6
1000	1013.1	986.1	1003.4	990.6	991.5	976.17	993.5	99.3
1500	1507.3	1494.3	1498.1	1481.4	1485.2	1437.02	1483.9	98.9

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 23-MAY-13
Report Date: 31-MAY-13 10:01 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1306419

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Test initiation

Wet and dry fertilization

Arctic Grayling tests

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1306419-1 Water 23-MAY-13 12:00 CONTROL-INITIAL	L1306419-2 Water 23-MAY-13 12:00 296-INITIAL	L1306419-3 Water 23-MAY-13 12:00 444-INITIAL	L1306419-4 Water 23-MAY-13 12:00 667-INITIAL	L1306419-5 Water 23-MAY-13 12:00 1000-INITIAL
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	31	495	681	937	1310
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	8.7	29.1	38.3	58.8	83.6
	Chloride (Cl) (mg/L)	1.65	150	219	319	482
	Sulfate (SO4) (mg/L)	2.87	29.3	39.0	57.0	80
Total Metals	Calcium (Ca)-Total (mg/L)	3.92	63.2	96.1	140	205
	Magnesium (Mg)-Total (mg/L)	0.16	6.98	10.9	16.1	23.9
	Potassium (K)-Total (mg/L)	<2.0	2.9	4.4	6.5	9.5
	Sodium (Na)-Total (mg/L)	<2.0	34.1	52.9	70.9	105

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1306419-6				
	Description	Water				
	Sampled Date	23-MAY-13				
	Sampled Time	12:00				
	Client ID	1500-INITIAL				
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	2090				
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	113				
	Chloride (Cl) (mg/L)	712				
	Sulfate (SO4) (mg/L)	124				
Total Metals	Calcium (Ca)-Total (mg/L)	303				
	Magnesium (Mg)-Total (mg/L)	37.2				
	Potassium (K)-Total (mg/L)	14.1				
	Sodium (Na)-Total (mg/L)	156				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1306419-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

TESTING LOCATION (Please Circle)

California
5550 Morehouse Drive, Suite 150
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

Washington
5009 Pacific Highway East, Suite 2
Tacoma, WA 98424
Phone 253.922.4296
Fax 253.922.5814

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

L1306419

Date May 23/13 Page 1 of 1

Sample Collection By: JAB

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	Same as report
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	Total Dissolved Solids (TDS)			Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	Control -Initial	May 23/13	1200h	Water	1000 mL	1	TDS-Dry/Wet Initial- Grayling	x	x	x	x	x	x	x	x			
2	296 - Initial	May 23/13	1200h	Water	1000 mL	1	TDS-Dry/Wet Initial- Grayling	x	x	x	x	x	x	x	x			
3	444 - Initial	May 23/13	1200h	Water	1000 mL	1	TDS-Dry/Wet Initial- Grayling	x	x	x	x	x	x	x	x			
4	667 - Initial	May 23/13	1200h	Water	1000 mL	1	TDS-Dry/Wet Initial- Grayling	x	x	x	x	x	x	x	x			
5	1000 - Initial	May 23/13	1200h	Water	1000 mL	1	TDS-Dry/Wet Initial- Grayling	x	x	x	x	x	x	x	x			
6	1500 - Initial	May 23/13	1200h	Water	1000 mL	1	TDS-Dry/Wet Initial- Grayling	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

L1306419-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		**Total No. of Containers**	
PO No.:		**Received Good Condition?**	
Shipped Via:		**Matches Test Schedule?**	

SPECIAL INSTRUCTIONS/COMMENTS:

Short Holding Time

Rush Processing

RELINQUISHED BY (CLIENT)		RELINQUISHED BY (COURIER)	
(Signature)	(Time) 1400 h	(Signature)	(Time)
(Printed Name) Josh Baker	(Date) May 23/13	(Printed Name)	(Date)
(Company) Nautilus Env		(Company)	

RECEIVED BY (COURIER)		RECEIVED BY (LABORATORY)	
(Signature) TN May 23 18:25	(Time)	(Signature)	(Time)
(Printed Name) 12°	(Date)	(Printed Name)	(Date)
(Company)		(Company)	

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 22-JUL-13
Report Date: 26-JUL-13 15:10 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1336090

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 1, 2, 3
Legal Site Desc:

Interim measurements

Wet and dry fertilization

Arctic Grayling test

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1336090-1	L1336090-2	L1336090-3	L1336090-4	L1336090-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-JUL-13	18-JUL-13	18-JUL-13	18-JUL-13	18-JUL-13
	Sampled Time	14:45	14:45	14:45	14:45	14:45
	Client ID	CONTROL	296	444	667	1000
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	24	538	772	1010	1520
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	9.9	28.6	36.8	45.8	68.6
	Chloride (Cl) (mg/L)	2.91	155	206	292	394
	Sulfate (SO4) (mg/L)	2.79	29.7	36.1	52.6	69
Total Metals	Calcium (Ca)-Total (mg/L)	4.46	66.2	94.0	128	196
	Magnesium (Mg)-Total (mg/L)	0.29	8.10	11.5	15.8	24.4
	Potassium (K)-Total (mg/L)	<2.0	3.4	4.6	6.4	9.8
	Sodium (Na)-Total (mg/L)	2.0	39.4	51.0	73.1	114

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1336090-6 Water 18-JUL-13 14:45 1500	L1336090-7 Water 18-JUL-13 14:45 CONTROL	L1336090-8 Water 18-JUL-13 14:45 296	L1336090-9 Water 18-JUL-13 14:45 444	L1336090-10 Water 18-JUL-13 14:45 667
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	2520	24	528	797	1090
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	98.9	9.6	28.8	36.9	45.8
	Chloride (Cl) (mg/L)	697	2.43	155	211	276
	Sulfate (SO4) (mg/L)	118	2.70	29.7	38.4	49.4
Total Metals	Calcium (Ca)-Total (mg/L)	286	4.56	65.8	90.6	131
	Magnesium (Mg)-Total (mg/L)	36.5	0.27	7.93	11.1	16.0
	Potassium (K)-Total (mg/L)	14.1	<2.0	3.3	4.5	6.5
	Sodium (Na)-Total (mg/L)	165	<2.0	35.5	49.5	73.9

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1336090-11	L1336090-12	L1336090-13	L1336090-14	L1336090-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-JUL-13	18-JUL-13	18-JUL-13	18-JUL-13	18-JUL-13
	Sampled Time	14:45	14:45	14:45	14:45	14:45
	Client ID	1000	1500	CONTROL	296	444
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1570	2570	32	501	748
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	70.5	100	9.2	26.1	34.4
	Chloride (Cl) (mg/L)	411	708	1.64	148	202
	Sulfate (SO4) (mg/L)	72	120	2.51	28.4	35.1
Total Metals	Calcium (Ca)-Total (mg/L)	193	287	4.37	62.1	91.2
	Magnesium (Mg)-Total (mg/L)	23.9	36.6	0.20	7.44	11.0
	Potassium (K)-Total (mg/L)	9.5	14.3	<2.0	3.0	4.4
	Sodium (Na)-Total (mg/L)	110	166	<2.0	35.0	48.0

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1336090-16	L1336090-17	L1336090-18		
	Description	Water	Water	Water		
	Sampled Date	18-JUL-13	18-JUL-13	18-JUL-13		
	Sampled Time	14:45	14:45	14:45		
	Client ID	667	1000	1500		
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1020	1530	2530		
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	43.9	67.0	92.2		
	Chloride (Cl) (mg/L)	309	464	611		
	Sulfate (SO4) (mg/L)	55.2	81	106		
Total Metals	Calcium (Ca)-Total (mg/L)	130	188	274		
	Magnesium (Mg)-Total (mg/L)	16.2	23.4	35.0		
	Potassium (K)-Total (mg/L)	6.5	9.3	13.7		
	Sodium (Na)-Total (mg/L)	74.2	107	158		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 2 3

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

L1336090

TESTING

California
5550 Morehouse Dri
San Diego, CA 9212
Phone 858.587.733
Fax 858.587.3961

L1336090-COFC

Columbia
mmerce Court
, British Columbia, Canada V5A 4N3
04.420.8773
04.357.1361

Chain of Custody

Date July 22/13 Page 1 of 3

Sample Collection By: JAB

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	Total Dissolved Solids			Receipt Temperature (°C)
	ANALYSES REQUIRED																	
1	Control	July 18/13	1445h	Water	1000 mL	1	Old Solution - Wet Fert Arctic Grayling	x	x	x	x	x	x	x	x			
2	296	July 18/13	1445h	Water	1000 mL	1	Old Solution - Wet Fert Arctic Grayling	x	x	x	x	x	x	x	x			
3	444	July 18/13	1445h	Water	1000 mL	1	Old Solution - Wet Fert Arctic Grayling	x	x	x	x	x	x	x	x			
4	667	July 18/13	1445h	Water	1000 mL	1	Old Solution - Wet Fert Arctic Grayling	x	x	x	x	x	x	x	x			
5	1000	July 18/13	1445h	Water	1000 mL	1	Old Solution - Wet Fert Arctic Grayling	x	x	x	x	x	x	x	x			
6	1500	July 18/13	1445h	Water	1000 mL	1	Old Solution - Wet Fert Arctic Grayling	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

PROJECT INFORMATION		**SAMPLE RECEIPT**	
Client:		**Total No. of Containers**	
PO No.:		**Received Good Condition?**	
Shipped Via:		**Matches Test Schedule?**	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature)	(Time) 1700h
(Printed Name) Josh Baker	(Date) July 22/13
(Company) Nautilus Environmental	

RELINQUISHED BY (COURIER)

(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

RECEIVED BY (COURIER)

(Signature) Y.C	(Time) 17:00
(Printed Name) 9.4°C	(Date) July 22
(Company)	

RECEIVED BY (LABORATORY)

(Signature)	(Time)
(Printed Name)	(Date)
(Company)	

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Nautilus Environmental

TESTING LOCAT

California
5550 Morehouse Drive, Suite
San Diego, CA 92121
Phone 858.587.7333
Fax 858.587.3961

L1336090-COFC

bia
Court
olumbia, Canada V5A 4N3
73
Fax 604.357.1361

Chain of Custody

Date July 22/13 Page 2 of 3

Sample Collection By: JAB

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

Company	
Address	
City/State/Zip	
Contact	
Phone	
Email	

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	Total Dissolved Solids			Receipt Temperature (°C)
1	Control	July 18/13	1445h	Water	1000 mL	1	Old Solution - Dry Fert Arctic Grayling	x	x	x	x	x	x	x	x			
2	296	July 18/13	1445h	Water	1000 mL	1	Old Solution - Dry Fert Arctic Grayling	x	x	x	x	x	x	x	x			
3	444	July 18/13	1445h	Water	1000 mL	1	Old Solution - Dry Fert Arctic Grayling	x	x	x	x	x	x	x	x			
4	667	July 18/13	1445h	Water	1000 mL	1	Old Solution - Dry Fert Arctic Grayling	x	x	x	x	x	x	x	x			
5	1000	July 18/13	1445h	Water	1000 mL	1	Old Solution - Dry Fert Arctic Grayling	x	x	x	x	x	x	x	x			
6	1500	July 18/13	1445h	Water	1000 mL	1	Old Solution - Dry Fert Arctic Grayling	x	x	x	x	x	x	x	x			
7																		
8																		
9																		
10																		

PROJECT INFORMATION

Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RELINQUISHED BY (COURIER)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)

(Signature) Y.C (Time) 17:ee
(Printed Name) 9.4°C (Date) July 22
(Company)

RECEIVED BY (LABORATORY)

(Signature) (Time)
(Printed Name) (Date)
(Company)

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Nautilus Environmental

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San Diego, CA 9
Phone 858.587.7
Fax 858.587.3961

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Commerce Court
aby, British Columbia, Canada V5A 4N3
e 604.420.8773
x 604.357.1361

Chain of Custody

Date July 22/13 Page 3 of 3

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Address	8664 Commerce Court
City/State/Zip	Burnaby, BC V5A 4N3
Contact	Josh Baker, James Elphick
Phone	604 420 8773
Email	josh@nautilusenvironmental.com

Invoice To:

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	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Na	Total K	Total Ca	Total Mg	Total Alkalinity	Total Sulphates	Total Chlorides	Total Dissolved Solids			Receipt Temperature (°C)
								ANALYSES REQUIRED										
1	Control	July 18/13	1445h	Water	1000 mL	1	New Solution - Dry/Wet Arctic Grayling	x	x	x	x	x	x	x	x			
2	296	July 18/13	1445h	Water	1000 mL	1	New Solution - Dry/Wet Arctic Grayling	x	x	x	x	x	x	x	x			
3	444	July 18/13	1445h	Water	1000 mL	1	New Solution - Dry/Wet Arctic Grayling	x	x	x	x	x	x	x	x			
4	667	July 18/13	1445h	Water	1000 mL	1	New Solution - Dry/Wet Arctic Grayling	x	x	x	x	x	x	x	x			
5	1000	July 18/13	1445h	Water	1000 mL	1	New Solution - Dry/Wet Arctic Grayling	x	x	x	x	x	x	x	x			
6	1500	July 18/13	1445h	Water	1000 mL	1	New Solution - Dry/Wet Arctic Grayling	x	x	x	x	x	x	x	x			
7																		
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9																		
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PROJECT INFORMATION	
Client:	
PO No.:	
Shipped Via:	

SAMPLE RECEIPT	
Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

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(Printed Name) (Date)

(Company)

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(Signature) (Time)

(Printed Name) (Date)

(Company)

RECEIVED BY (COURIER)

(Signature) Y.C (Time) 17:00

(Printed Name) 9.4°C (Date) July 22

(Company)

RECEIVED BY (LABORATORY)

(Signature) (Time)

(Printed Name) (Date)

(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Josh Baker
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 29-JUL-13
Report Date: 07-AUG-13 17:13 (MT)
Version: FINAL REV. 2

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1339737

Project P.O. #: NOT SUBMITTED
Job Reference: FINAL SOLUTION - ARCTIC GRAYLING
C of C Numbers: 1 of 2, 2 of 2
Legal Site Desc:

Comments:

07-AUG-13: Revision 2: This revision replaces and supersedes previous revision of this report. This revision includes Sodium data for the sample ALS identify as L1339737-9.

Arctic Grayling test
Test termination

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1339737-1 water 29-JUL-13 08:30 CONTROL - DRY	L1339737-2 water 29-JUL-13 08:30 296 - DRY	L1339737-3 water 29-JUL-13 08:30 444 - DRY	L1339737-4 water 29-JUL-13 08:30 667 - DRY	L1339737-5 water 29-JUL-13 08:30 1000 - DRY
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	27	492	770	1170	1720
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	9.8	30.0	38.9	49.3	77.9
	Chloride (Cl) (mg/L)	3.09	157	227	329	485
	Sulfate (SO4) (mg/L)	2.88	30.3	41.3	59.4	84
Total Metals	Calcium (Ca)-Total (mg/L)	3.88	68.2	96.8	135	198
	Magnesium (Mg)-Total (mg/L)	0.30	8.10	11.6	16.6	24.4
	Potassium (K)-Total (mg/L)	<2.0	3.3	4.6	6.5	9.5
	Sodium (Na)-Total (mg/L)	2.2	41.5	52.4	74.0	108

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1339737-6 water 29-JUL-13 08:30 1500 - DRY	L1339737-7 water 29-JUL-13 08:30 CONTROL - WET	L1339737-8 water 29-JUL-13 08:30 296 - WET	L1339737-9 water 29-JUL-13 08:30 444 - WET	L1339737-10 water 29-JUL-13 08:30 667 - WET
Sample ID						
Description						
Sampled Date						
Sampled Time						
Client ID						
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	2610	28	592	840	1200
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	106	9.6	29.2	38.4	49.2
	Chloride (Cl) (mg/L)	724	3.52	157	228	330
	Sulfate (SO4) (mg/L)	127	2.93	30.3	41.4	59.4
Total Metals	Calcium (Ca)-Total (mg/L)	294	4.17	68.4	93.6	136
	Magnesium (Mg)-Total (mg/L)	36.9	0.34	8.12	10.3	16.5
	Potassium (K)-Total (mg/L)	14.2	<2.0	3.3	3.9	6.5
	Sodium (Na)-Total (mg/L)	162	2.3	41.0	56.5	72.5

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1339737-11	L1339737-12			
	Description	water	water			
	Sampled Date	29-JUL-13	29-JUL-13			
	Sampled Time	08:30	08:30			
	Client ID	1000 - WET	1500 - WET			
Grouping	**Analyte**					
WATER						
Physical Tests	Total Dissolved Solids (mg/L)	1670	2690			
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	79.1	109			
	Chloride (Cl) (mg/L)	484	725			
	Sulfate (SO4) (mg/L)	85	128			
Total Metals	Calcium (Ca)-Total (mg/L)	202	291			
	Magnesium (Mg)-Total (mg/L)	24.9	36.3			
	Potassium (K)-Total (mg/L)	9.7	14.0			
	Sodium (Na)-Total (mg/L)	109	159			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 of 2 2 of 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
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< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
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Measured TDS values (calculated as the sum of major ions). Arctic Grayling tests

Dry Fertilization	Initial	Inter #1		Final	
		New	Old		Average
Control	17.91	23.532	25.416	20.33	21.8
296	304.23	325.961	343.598	326.7	325.1
444	445.66	447.084	464.509	457.43	453.7
667	645.37	661.779	626.538	650.57	646.1
1000	956.4	980.57	932.905	956.42	956.6
1500	1415.23	1346.142	1492.9	1422.76	1419.3

Wet Fertilization	Initial	Inter #1		Final	
		New	Old		Average
Control	17.91	23.532	30.389	21.12	23.2
296	304.23	325.961	347.846	325.93	326.0
444	445.66	447.084	462.448	457.12	453.1
667	645.37	661.779	641.638	650.91	649.9
1000	956.4	980.57	917.646	962.85	954.4
1500	1415.23	1346.142	1475.829	1419.79	1414.2