APPENDIX A

METHODS

STANDARD OPERATING PROCEDURES

Water Quality Assessment and Response Plan

Operating Procedure: PR8.0.0.01	Revision: 2011.01	Page 1 of 10
	Replaces: 2007.01	
Approved: February 18, 2011	Valid Until: February 18, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the timely development and implementation of investigative and mitigative measures in response to confirmed water quality trends identified through the Performance Monitoring Programs;
- Establish methods of data evaluation and trend confirmation that are consistent with regulatory requirements and corporate objectives;
- Assign responsibility for trend confirmation and response plan development and implementation.

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;

Final treated effluent action levels and response plans are documented in Section 7.4 of site-specific Operating, Care and Maintenance (OCM) Plans. Generic response plans for effluent treatment plant failure, poor effluent quality and high rates of seepage are documented in PL10.2.0.01 Emergency Response Plan with site-specific details provided in Section 10.2 of site-specific OCM Plans.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure;
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure;
- Regular review of "flagged data" points and confirmation of implementation and response to data validation procedures
- Review of annual program data assessment reports and directing the development and implementation of investigative and mitigative measures in response to confirmed water quality trends

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including water quality response plan implementation. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel participating in water quality response plan review, development and implementation are adequately trained and competent to perform assigned task;
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure
- Initiating review of annual program data assessment reports and managing the development and implementation of investigative and mitigative measures in response to confirmed water quality trends

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the data validation, data assessment and trend confirmation components of the Water Quality Response Plan. Responsibilities specific to this procedure include

- Confirming data quality assessment is conducted in accordance with PR8.5.4.01 Water Quality Data Quality Assessment;
- Confirming data validation is conducted in accordance with PR8.7.3.02 Data Validation Procedures;
- Reviewing data quality assessment and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;

- Reviewing monthly water quality reports and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager
- Reviewing annual and five year data summaries for annual water quality reports and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager
- Incorporating response plan progress reports as required in the Monthly Care and Maintenance Reports, Monthly Water Quality Reports, and the Annual SRWMP and OCM Reports;
- Assigning responsibility for completion of data quality assessment and data validation in accordance with relevant procedures;
- Assigning responsibility and confirming completion of response monitoring activities
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Completing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Water Quality Response Plan Procedure. Responsibilities specific to this procedure include:

- Conducting data quality assessment in accordance with PR8.5.4.01 Water Quality Data Quality Assessment including preparation and maintenance of data assessment records and reports
- Conducting data validation in accordance with PR8.7.3.02 Data Validation including preparation and maintenance of data validation records and reports
- Compiling data for monthly water quality reports and visually reviewing data for emerging trends or outliers not captured in data validation; informing Environmental Coordinator of findings
- Compiling annual and five year data summaries for annual water quality reports and visually reviewing data for emerging trends or outliers not captured in data validation; informing Environmental Coordinator of findings
- Maintaining response plan records and reports
- Scheduling response monitoring field parameters, samples and analytes in the environmental database as directed by the Environmental Coordinator and in accordance with PR8.7.2.01 Scheduling.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned performance or response monitoring responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Participating in and completing the training requirements including working knowledge of RG8.7.2.02 Control Limit Registry and PL10.2.0.01 Emergency Response Plan
- Completing response monitoring and associated activities as assigned
- Informing the Compliance Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4 PROCEDURES

4.1 Water Quality Assessment

Water quality is routinely assessed in accordance with the following processes

- Data validation in accordance with PR8.7.3.02 Data Validation including preparation and maintenance of data validation records and reports. All data entered into the environmental database is validated with monthly "flagged data" compiled by the Compliance Coordinator and reviewed by the Environmental Coordinator who is responsible for initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;
- Monthly compilation of year to date water quality results including visual review of data and identification of potential outliers or emerging trends. Data is compiled by the Compliance Coordinator and reviewed by the Environmental Coordinator who is responsible for initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;
- Annual compilation of year to date water quality results and five year summary including visual review of data and identification of emerging trends. Data is compiled by the Compliance Coordinator and reviewed by the Environmental Coordinator who is responsible for initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;
- Periodic statistical trend evaluation of data as part of the State of the Environment Report based on methodology presented in the associated Design Report.

4.2 Trend Identification

Identification of a water quality trend may result from:

- Trend evaluation conducted as part of the "Decision Path for Data Validation" as documented in PR8.7.3.02 Data Validation; or

- Trend identification conducted in accordance with Section 4.1 above.

4.2.1 Water quality trends identified by the Compliance Coordinator are to be reviewed by the Environmental Coordinator. The Environmental Coordinator is responsible for evaluating trends and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager

4.3 Trend Confirmation

4.3.1 The Compliance Coordinator under the direction of the Environmental Coordinator and in consultation with the Rio RA and Den RA is responsible for confirming the water quality trend using the following weight-of-evidence approach as shown in Figure 4.1:

- Is the trend isolated to one chemical parameter? If more than one related parameter is showing a similar trend at the same location, then the trend is not likely the result of an analysis error.
- Is there a similar trend at upstream or downstream stations? Involvement of related stations may indicate an upset rather than an analysis or sampling error.
- Are there similar trends at non-related stations? If trends are only evident at related stations, trends under investigation are corroborated, if trends are evident at unrelated stations then sampling or analysis error is likely.
- Is the trend consistent with changes detected in upstream tailings management or source area water quality monitoring? If yes, the trend is corroborated.
- Is the trend consistent with forecast changes resulting from geochemical evolution of upstream sources? A positive answer supports the evidence of a confirmed trend.

4.3.2 The Environmental Coordinator is responsible for ensuring that confirmed trends are reported in the Monthly Water Quality Report.

4.4 Trend Evaluation

4.4.1 The Reclamation Manger and/or Environmental Manager are responsible for reviewing data compiled for the “weight of evidence” review of the trend and identifying requirements for additional investigation to evaluate the significance of any potential impact and possible remedial or mitigative measures as required.

4.4.2 Where additional investigation is required, the Reclamation Manager or Denison Environmental Services Manager are responsible for providing the required resources to conduct the investigation and notifying the Canadian Nuclear Safety Commission that the Response Plan as identified in Figure 4.2 has been triggered.

4.4.3 Where the trend is not mining related, or the “weight of evidence” approach confirms negligible impact, the Environmental Coordinator is responsible for incorporating the findings in the monthly and annual water quality reports.

Figure 4.1. Trend Evaluation

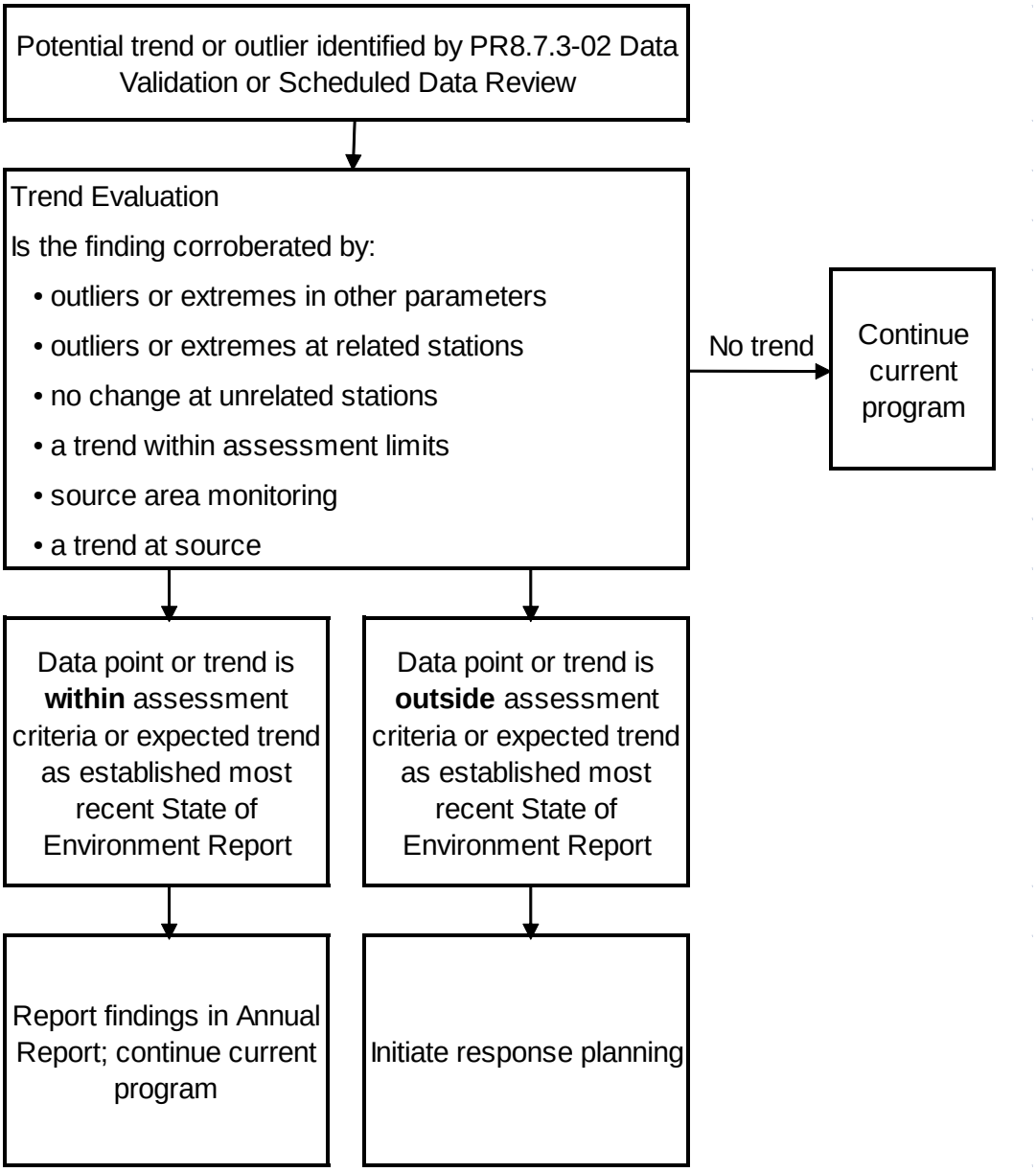
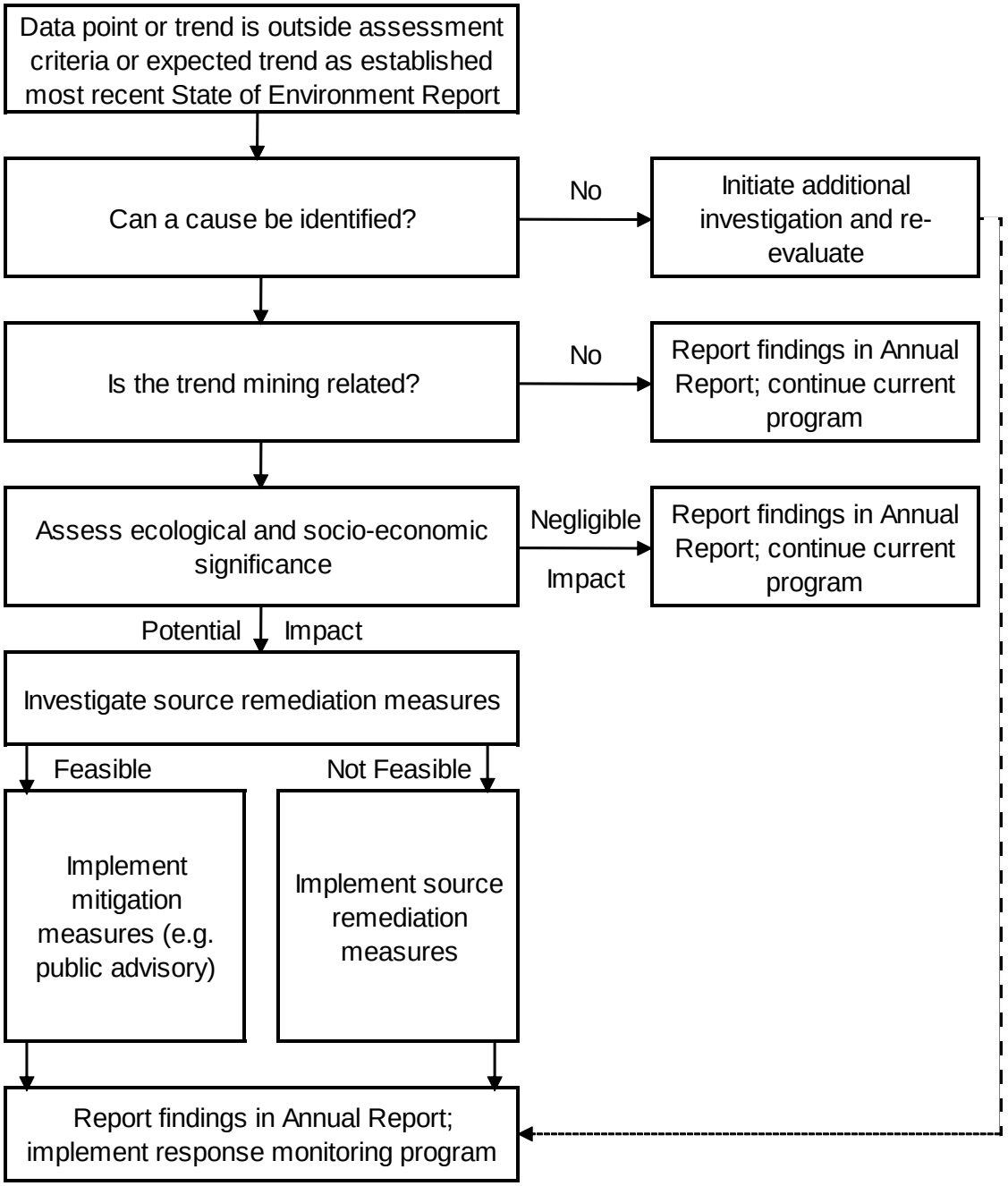


Figure 4.2. Environmental Response Plan Process



4.5 Response Implementation

4.5.1 Where the additional investigation confirms an increased contribution from an identifiable source that is having a significant impact on the downstream environment, the owner's Responsible Authority (Rio Algom Reclamation Manager or Denison Environmental Services Manager) is responsible for submitting to the CNSC an investigation summary that provides the following information:

- Summary of additional investigation findings;
- Recommended remedial and mitigative measures;
- Proposed implementation schedule; and
- Confirmation monitoring plan.

4.5.2 Where significant remedial and/or mitigative measures are implemented, the relevant Responsible Authority is responsible for ensuring the inclusion of a response plan within the relevant annual report that contains the following information:

- Summary of remedial and mitigative measures implemented;
- Results of confirmation monitoring;
- Continued confirmation monitoring program (if required); and
- Changes in operating procedures (if applicable).

4.5.3 The Environmental Coordinator is responsible for ensuring that updates on Response Plan implementation are included in monthly and annual water quality reports.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation
- Completion of documented review of RG8.7.2.02 Control Limit Registry and PL10.2.0.01 Emergency Response Plan

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
	Site-specific Operating, Care and Maintenance Plans
RG1.0.0.02	Operating Document Registry
PR8.5.4.1	Water Quality Data Quality Assessment
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
RG8.7.2.02	Control Limit Registry
PR8.7.3.02	Data Validation Procedure
PL10.2.0.01	Emergency Response Plan
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007.01	Aug 15, 2007	Update roles and responsibilities as well as procedure references, include all monitoring programs not just SRWMP, update formatting
2011.01	Feb. 18, 2011	Update roles and responsibilities, include data assessment section, separate trend evaluation from environmental response plan process in figures, revise number from 8.1.0.01 to 8.0.0.01 to reflect application to all monitoring programs

Field Sampling Quality Control

Operating Procedure: PR8.5.3.01	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011	Valid Until: February 25, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the quality of the performance monitoring data while tracking and minimizing the effects of bias and imprecision in field sampling effort;
- Establish field sampling quality control (QC) measures that are consistent with regulatory requirements and corporate objectives; and
- Assign responsibility to ensure that field sampling quality control is conducted in accordance with license and performance monitoring program requirements.

2 APPLICATION

This procedure applies to field sampling at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

Assessment of field sampling quality control results and performance is incorporated in PR8.5.4.01 Water Quality Data Quality Assessment.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited

(RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field sampling quality control. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting performance monitoring sampling are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field Sampling Quality Control Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of field sampling quality control in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing field sampling quality control modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field Sampling Quality Control Procedure. Responsibilities specific to this procedure include:

- Scheduling field blank and field duplicates in the environmental database in accordance with PR8.7.2.01: Scheduling;
- Generating data quality assessment reports for field quality control sampling in accordance with PR8.5.4.01 Water Quality Data Quality Assessment and reviewing results to identify appropriate field blank and field duplicate locations
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned field sampling quality control sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting field sampling quality control sampling in accordance with this procedure and relevant sampling procedure: PR8.6.1.01 Surface Water Grab Sampling or PR8.6.2.01 Groundwater Sampling;
- Participating in and completing the training requirements

4 PROCEDURES

4.1 Quality Control Sample Types

Two types of field sampling quality control samples are collected:

- **Field Blanks**: A field blank is a sample of distilled/deionized water that is processed in the field in a manner identical to that used for the randomly selected sample location (eg. Through sampler/pump for groundwater and through depth sampler for depth samples). The field blank allows assessment for potential contamination of the sample by the bottle itself, preservatives, dust and sample handling.
- **Field Duplicates**: A field duplicate is a sample that is taken at the same time and location as a regular field sample (ie; side by side), where possible; at times low flows restrict the ability to sample using larger bottles. If a smaller container is required to decant, the smaller container volumes are divided between the original and the duplicate. The samples are prepared and analysed in an identical manner. The data from field duplicates reflect the natural spatial and/or temporal variability, as well as the variability associated with sample collection and handling methods.

4.2 Location Selection

4.2.1 Field blank and field duplicate samples are collected at pre-established stations. Stations have been selected to meet the criteria outlined below and are changed infrequently in order to establish high-low flag data set. Current and historic station designations for field blanks and field duplicates are documented in RG8.5.3.01 QA/QC Requirements Registry.

- Representative of the full performance monitoring parameter suite for designated QC purpose (SRWMP, SAMP, TOMP)
- Sampled at frequency that will generate data to meet 10% of total number of sample requirements; and
- Representative of field conditions and sampling protocols (e.g. use of sample collection devices)
- Representative of concentration range of analytes in the performance monitoring program

4.3 Scheduling

4.3.1 Quality Control (QC) samples will be applied to a minimum of 10% of the total number of samples required for each of SRWMP, SAMP and TOMP, as compiled in RG8.7.2.01 Performance Monitoring Registry.

4.3.2 The Compliance Coordinator is responsible for scheduling QC samples such that:

- Objectives are incorporated into the electronic schedule in accordance with PR8.7.2.01 Scheduling Procedure;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01 Water Quality Monitoring Data Quality Objectives
- Field blank and field duplicate sample names and designations will be maintained in RG8.5.3.01 QA/QC Requirements Registry.

4.3.3 The Compliance Coordinator is responsible for ensuring any changes to QC sampling are incorporated into the schedule as per PR8.7.2.01 Scheduling Procedure.

4.4 Sampling

4.4.1 The Field Technician or other adequately trained personnel are responsible for collecting field QC samples in accordance with PR8.6.0.01 Surface Water Grab Sampling or 8.6.2.01 Groundwater Sampling Procedures.

4.4.2 Field blanks and field duplicates are collected in accordance with the sample collection method as scheduled in the Database.

4.5 Data Validation, Review and Reporting

4.5.1 The Compliance Coordinator is responsible for data validation and review of quality control samples in accordance with PR8.7.3.02 Data Validation Procedure.

4.5.2 The Compliance Coordinator is responsible for evaluating, reviewing and reporting field quality control sampling results in accordance with PR8.5.4.01 Water Quality Data Quality Assessment Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing field sampling quality control meet the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RG8.5.3.01	QA/QC Requirements Registry
PR8.5.4.01	Water Quality Data Quality Assessment
PR8.6.1.01	Surface Water Grab Sampling
PR8.6.2.01	Groundwater Sampling
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2005.02	Dec. 21, 2005	Update roles and responsibilities; reference groundwater procedures, remove Envista references
2006.01	Aug. 22, 2006	Include addition groundwater QA/QC locations
2007.01	Aug 30, 2007	Update roles and responsibilities as well as procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Water Quality Data Quality Assessment

Operating Procedure: PR8.5.4.01	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 16, 2011	Valid Until: February 16, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the quality of the monitoring programs while tracking and minimizing the effects of bias and imprecision in sampling effort;
- Control measurement errors to acceptable levels and to ensure that the data are useful and of known quality;
- Establish data quality assessment standards that are consistent with regulatory requirements and corporate objectives; and
- Assign responsibility to ensure that data quality assessment is conducted in accordance with license requirements.

2 APPLICATION

This procedure applies to data quality assessment of quality control (QC) sampling as per RG8.5.3-01 *Quality Control and Quality Assurance Registry* for each of the sampling programs including:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program; and
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including water quality data quality assessment. Responsibilities specific to this procedure include:

- Reviewing data quality assessment reports (e.g. RF8.5.4 series report forms Table 7.1, monthly reports, annual reports) and programs and managing modifications as required.
- Confirming care and maintenance contractor, data management supplier and analytical supplier conformance with this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Water Quality Data Quality Assessment Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of data quality assessment in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to data quality assessment procedures;
- Directing training of care and maintenance contractor staff involved in data quality assessment;
- Initiating and directing data management and analytical services modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure and associated registries and report forms;
- Developing and supervising responses to data that does not conform to the data quality objectives and communicating progress to Environmental Manager and Reclamation Manager; and
- Reviewing data quality assessment reports (e.g. RF8.5.4 series report forms Table 7.1, monthly reports, annual reports) and programs and initiating and supervising modifications as required.

3.4 Compliance Coordinator

The Environmental Coordinator is responsible for implementing the Water Quality Data Quality Assessment Procedure. Responsibilities specific to this procedure include:

- Conducting data quality assessment in accordance with this procedure;
- Reviewing and confirming that field and analytical results generated through the data quality assessment program are valid and entered into the data management system within 60 days of the sample date;
- Generating and reviewing data quality assessment reports using the report forms associated with this procedure (RF8.5.4 series indentified in Table 7.1) and initiating responses to data that does not conform to the data quality objectives;
- Reviewing laboratory quality control reports and initiating responses to data that does not conform to the data quality objectives;
- Implementing responses to data that does not conform to the data quality objectives as directed by the Environmental Coordinator;
- Preparing data quality assessment (field and laboratory) components of internal and annual water quality reports including reporting on the status of responses to data that does not conform to the data quality objectives; and
- Implementing modifications to this procedure and associated registries and report forms including updates triggered by changes to data quality objectives (DQO).

4 PROCEDURES

4.1 Scheduling

4.1.1 The Compliance Coordinator is responsible for ensuring that the minimum requirement of 10% is met for QA/QC on all Performance Monitoring Program requirements.

4.1.2 Quality control samples will be scheduled in accordance with RG8.7.2-01 *Performance Monitoring Registry*.

4.2 Supporting Reports/Forms

4.2.1 The Compliance Coordinator is responsible for ensuring that changes in Data Quality Objectives (DQO, RG8.5.3-01) are incorporated into the data quality assessment process and onto the appropriate forms and reports (RF8.5.4 series in Table 7.1).

4.2.2 The Compliance Coordinator is responsible for ensuring all emLine data quality assessment report forms are working correctly and initiating modifications with the data management service provider as required. EmLine report forms are maintained in the emLine data management system under the appropriate application (Rio/SRWMP/Denison) and can be accessed by the Reports/Report Manager when logged on to the emLine database. EmLine-generated data quality assessment reports are maintained for each of the RF8.5.4 series field DQA reports identified in Table 7.1 (e.g SRWMP, SAMP/TOMP and groundwater).

4.3 Data Validation and Review

4.3.1 The Compliance Coordinator is responsible for ensuring that all analyses on relevant field QC samples have been reported by the Laboratory within 60 days of sample date.

4.3.2 The Compliance Coordinator is responsible for ensuring the QA/QC data is validated and reviewed as per PR8.7.3-02 *Data Validation Procedures*, prior to issuing data quality assessment reports.

4.4 Report Preparation, Assessment and Reporting

4.4.1 The Compliance Coordinator is responsible for monthly and annual preparation of data quality assessment reports. Reports are accessed and data imported from the database using the following steps:

1. Log-on to emline;
2. Choose the Appropriate APPLICATION, Rio/SRWMP/Denison
3. Click on the REPORTS Tab at the top of the Page;
4. Click on REPORT MANAGER;
5. On this page you will select the appropriate DQA Report;
6. Select a date range (Year to Date);
7. Select VIEW REPORT at top of page;
8. Select SAVE report (rather than open) and save to the Annual Archive/Operating Program Records; Section 8 (enable macros)

4.4.2 The Compliance Coordinator will evaluate any field precision exceedances by evaluating trends, investigating sample conditions and possible sources of contamination or variability and requesting repeat analysis when it is deemed necessary. Repeat exceedances and trends are to be reviewed with the Environmental Coordinator for development and implementation of an appropriate response plan.

4.4.3 The Compliance Coordinator will evaluate any field blank exceedances by evaluating trends, investigating sample conditions and possible sources of contamination and requesting repeat analysis when it is deemed necessary. Repeat exceedances and trends are to be reviewed with the Environmental Coordinator for development and implementation of an appropriate response plan.

4.4.4 The Compliance Coordinator will evaluate any laboratory data quality objective exceedances by evaluating trends, requesting investigation of laboratory conditions and possible sources of contamination, or sample mixup and requesting repeat analysis and or follow-up when it is deemed necessary. Repeat exceedances and trends are to be reviewed with the Environmental Coordinator for development and implementation of an appropriate response plan.

4.4.5 On a monthly basis, the Compliance Coordinator will generate year to date data quality assessment report forms for inclusion as an attachment to the RAL Monthly Care and Maintenance Report. The Compliance Coordinator will also prepare the data quality assessment (field and laboratory) components of the monthly report including reporting on the status of responses to data that does not conform to the data quality objectives.

4.4.6 On an annual basis, the Compliance Coordinator will generate annual data quality assessment report forms for inclusion in the Annual SRWMP Water Quality Report or Annual Rio Algom or Denison Operating Care and Maintenance Reports as appropriate. The Compliance Coordinator will also prepare the data quality assessment (field and laboratory) components of these annual reports including reporting on the status of responses to data that does not conform to the data quality objectives and their potential impact on the interpretation of performance monitoring data.

5 TRAINING

The Environmental Coordinator is responsible for confirming that care and maintenance staff performing data quality assessments meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation.

6 ADMINISTRATION

6.1 Procedure Review

Data quality assessment documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 *Operating Document Registry*.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 *Rio Algom Limited General Operating Document Review and Revision Procedures*.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
RG8.5.3-01	Quality Control and Quality Assurance Registry
RF8.5.4-01a	SRWMP DQA Field Precision
RF8.5.4-01b	SRWMP DQA Field Blank
RF8.5.4-02a	SAMP/TOMP DQA Field Precision
RF8.5.4-02b	SAMP/TOMP DQA Field Blank
RF8.5.4.03a	Groundwater DQA Field Precision
RF8.5.4.03b	Groundwater DQA Field Blank
RG8.7.2-01	Performance Monitoring Registry
PR8.7.3-02	Data Validation Procedures
	Rio Algom Limited Monthly Care and Maintenance Report
	SRWMP Annual Water Quality Report
	Rio Algom Limited Annual Operating Care and Maintenance Report
	Denison Mines Inc. Annual Operating Care and Maintenance Report
RG1.0.0.02	Operating Document Registry
PR11.1.0-01	Operating Document Review and Revision Procedure

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2005-01	Sept. 5, 2005	Update references to revised report form format based on consolidation of SAMP and TOMP DQA report forms
2007-01	Aug. 30, 2007	Update to reflect transition from Envista to emLine; include laboratory data quality assessment reviews, update roles and responsibilities
2011-01	Feb. 10, 2011	Update roles and responsibilities, include Denison Mines Reporting Requirements to reflect standardized data quality assessment programs; update associated report forms and data quality objectives based on Cycle 3 Design and 2011 draft State of Environment Report

Surface Water Grab Sampling

Operating Procedure: PR8.6.1.01	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011	Valid Until: February 25, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a surface water grab sampling standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to surface water grab sampling at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including surface water grab sampling. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting surface water grab sampling are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Surface Water Grab Sampling Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of surface water grab sampling in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing surface water grab sampling modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Surface Water Grab Sampling Procedure. Responsibilities specific to this procedure include:

- Scheduling surface water grab samples in the environmental database in accordance with PR8.7.2.01: Scheduling.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned surface water grab sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting surface water grab sampling in accordance with PR8.6.1.01 Surface Water Grab Sampling;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

4 PROCEDURES

4.1 Location Selection

4.1.1 Samples are collected at pre-established stations. Stations were established to meet the following criteria and should only be collected as long as these conditions are satisfied:

- Safe access;
- Sample can be obtained without disturbing bottom sediments;
- Flow and/or mixing to ensure that the sample location is representative of the waterbody being sampled;
- The surface is free and clear of floating debris.

4.2 Scheduling

4.2.1 Surface water grab samples will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

4.2.2 The Compliance Coordinator is responsible for scheduling surface water grab samples such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

4.2.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.3 Sampling and Sample Delivery

4.3.1 The Field Technician, Operator or other adequately trained personnel shall conduct surface water grab samples in accordance with the following protocol:

- Obtain pre-washed High Density Polyethylene (HDPE) bottles in the appropriate volumetric sizes (2L, 4L);
- Prior to filling, the sampler shall triple rinse all sample containers using sample water, affix the lid and shake vigorously;
- If sample must be collected using a device other than the laboratory container the sampler shall triple rinse both the device and the sample container in the above fashion;
- Samples will be collected by immersing the sample container upside down to a depth of 20 cm (where possible) and returning bottle to the upright position until full;

- Laboratory containers will be filled completely where possible, and capped under water to ensure no residual airspace in the sample container and limit surface contamination;
- All reasonable efforts shall be taken to ensure samples are maintained at a consistent temperature, avoiding heating or freezing;
- When temperature change may be a factor due to sample delivery delays coolers will be used.

4.3.2 The sampler shall record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling.

4.3.3 Upon arrival to the sample preparation room with the samples, the technician must prepare the samples for shipment in the following manner:

- Obtain the necessary bottles provided by the lab for the appropriate analysis to be performed on the sample;
- Ensure each bottle is labeled properly with the appropriate information (ie. Date, location of sample, analysis requested and person who collected the sample);
- Prior to separating the sample into the appropriate bottles, mix the sample by inverting the bottle upside down and back several times to ensure the sample is uniform throughout the bottle;
- Depending on the analysis required, the small bottles provided by the lab may contain preservative in them thus requiring the technician to take the appropriate safety precaution (ie. Safety glasses, rubber gloves) when decanting the sample;
- Carefully decant the sample into the small bottles leaving as little air space as possible without overflowing the sample container. Overflowing the containers that contain preservative can result in the sample not being preserved properly and may have impacts on the analysis being performed;
- Once the appropriate bottles have been filled, carefully place them into a cooler for shipment. Package the samples tightly together and add space filler if required to ensure there is no movement and possible damage to the samples. Place an appropriate amount of ice into the cooler to prevent the samples from overheating during the summer months and hot water bottles to prevent from freezing during the winter months;
- Prepare a chain of custody form in the data management system. Save the form in the public drive and email it to the laboratory as well as provide the chain of custody to the lab by printing a copy and inserting it into the cooler prior to shipment;
- Once all material is in the cooler, secure the lid and have the sample shipped to the appropriate lab.

4.4 Data Validation and Review

4.4.1 Data validation and review of surface water grab samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that care and maintenance staff performing surface water grab sampling meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2006-01	Dec. 21, 2006	Update roles and responsibilities; include sample preparation for shipment requirements
2007-01	Aug 31, 2007	Update roles and responsibilities as well as procedure references
2011-01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Toxicity Sampling

Operating Procedure: PR8.6.1.03	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011	Valid Until: February 25, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a toxicity sampling standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to toxicity sampling for the purpose of determining lethality or growth inhibition, at the following Elliot Lake monitoring locations:

- PR-01: Effluent Creek at Hwy 17
- N-12: Buckles Creek at Hwy 108
- MPE: Milliken Park Effluent
- P-14: Panel Final Discharge
- Q-28: Quirke Final Discharge
- CL-06: Stanleigh Final Discharge
- D-2: Stollery Lake Outlet
- DS-4: Orient Lake Outlet

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited

(RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including toxicity sampling. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting toxicity sampling are adequately trained and competent to perform assigned task; and
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Toxicity Sampling Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of toxicity sampling in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing toxicity sampling modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Toxicity Sampling Procedure. Responsibilities specific to this procedure include:

- Scheduling toxicity samples in the environmental database in accordance with PR8.7.2.01: Scheduling;
- Ensuring sample containers and liners are available in sufficient supply at any given time; and
- Communicating with toxicity laboratory and confirming sample dates.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned toxicity sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting toxicity sampling in accordance with PR8.6.1.03 Toxicity Sampling;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry; and
- Informing the Compliance Coordinator when pails and/or liner supplies are low.

4 PROCEDURES

4.1 Equipment

4.1.1 The following equipment is required for toxicity sampling:

- Toxicity pails, with lids (provided by toxicity laboratory);
- 3X collapsible containers provided by laboratory (various volumes have been supplied);
- 1 cooler;
- Toxicity pail liners (provided by toxicity laboratory);
- Nylon tie wraps;
- Labels;
- Chain of Custody Form (provided by toxicity laboratory);
- Secondary Container (if required to fill pails);
- Ice packs.

4.2 Scheduling

4.2.1 Toxicity samples will be scheduled in the environmental database as required for SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

4.2.2 The Compliance Coordinator is responsible for scheduling toxicity samples such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- The toxicity sample is scheduled to coincide with the monthly water quality sample;
- Individual analytes are scheduled using the following naming conventions:
  - ToxRT: Rainbow Trout
  - ToxDM: Daphnia magna
  - ToxCD: *Ceriodaphnia dubia*.

4.2.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.3 Sampling and Sample Delivery

4.3.1 The Compliance Coordinator shall ensure the following items are carried out in support of toxicity sampling:

- Check with laboratory that will be doing the toxicity testing to ensure that they are in a position to accept the samples. Optimally samples will be collected before Wednesday if possible;
- Ensure that sufficient sample containers are available to collect adequate sample as required:
  - ToxRT & ToxDM require one 25L pail;
  - ToxCD requires 3X collapsible containers (various volumes have been supplied)

4.3.2 The Field Technician, Operator or other adequately trained personnel shall collect toxicity samples in accordance with the following protocol:

- Confirm with Operator that the effluent to be sampled is representative of normal operating conditions;
- Sampling should not be conducted by persons having been in contact with lime dust, barium chloride, or other potentially toxic contaminants;
- Complete shipping labels, and affix to pails prior to sampling while pails are clean, dry and warm;
- During summer months insert a frozen ice pack in the cooler containing the collapsible containers to keep the sample cool during shipping;
- Install liner in pail without touching or reaching inside the liner. All manipulation shall be done by pulling on the exterior of the liner;
- Use a small volume of sample to rinse out the liner/collapsible containers and the container used for pouring;
- Collect sample to within 10 cm of the brim by either placing container directly in the stream flow or by using a second triple rinsed container to fill the pail;
- Before the liner is sealed, the sample should be visually inspected to ensure there is no visible contamination. If contamination is noted sample should be repeated in its entirety;
- Seal the liner by lifting the top and;
  - Twisting the liner beginning at the water surface, until all the excess is tightly twisted, to ensure no air enters the sample;
  - Fold twisted liner and tie shut with nylon tie-wrap;
  - Liner/collapsible container should be securely closed in this manner such that no water escapes and no air is present in the sample;

- Apply the lid securely onto the sample pail.

- All efforts shall be taken to ensure samples are maintained at a consistent temperature, avoiding heating or freezing during transportation.

4.3.3 The sampler shall record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling.

4.3.4 The sampler, prior to shipment of the sample, shall verify that the container is properly labelled.

4.4 Data Validation and Review

Data validation and review of toxicity samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that care and maintenance staff performing toxicity sampling meet the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.02	July 23, 2003	Remove toxicity fat head minnows, add responsibility to Field Technician and update number formatting
2003.03	Oct. 16, 2003	Add use of ice pack and rinsing requirements
2004.01	Oct. 14, 2004	Update equipment; correct to Ceriodaphnia dubia
2005.01	Sept. 5, 2005	Update formatting to current standard
2007.01	Sept. 26, 2007	Update roles and responsibilities, remove reference to Envista as well as procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Groundwater Sampling

Operating Procedure: PR8.6.2.01	Revision: 2011.01	Page 1 of 8
	Replaces: 2007-01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Michael Lachance
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a groundwater sampling standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to groundwater sampling at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in the Tailings Management Area (TMA) Operational Monitoring Program (TOMP).

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including groundwater sampling. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting groundwater sampling are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Groundwater Sampling Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of groundwater sampling in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing groundwater sampling modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Groundwater Sampling Procedure. Responsibilities specific to this procedure include:

- Scheduling groundwater samples in the environmental database in accordance with PR8.7.2.01: Scheduling.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned groundwater sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting groundwater sampling in accordance with PR8.6.2.01 Groundwater Sampling;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

4 PROCEDURES

4.1 Equipment

4.1.1 The following equipment is required for groundwater sampling:

1. Waterra Inertia Lift Pump (foot valve), generally for flushing well diameters greater than 1 inch with a head differential of greater than 30 feet;

2. Peristaltic Pump, generally for well diameters smaller than 1 inch and a head differential of ≈30 feet;
3. Tubing of various lengths and diameters as per section *Protocol: Sample Collection*;
4. 0.45µ pore, 700cm^2 In-line water filters for sample collection from peristaltic pump;
5. C-FLEX®TUBING L/S ®24 for use with peristaltic pump (reorder#06424-24);
6. Nitrogen gas cylinder, regulator, well cap adapter and tubing for wells greater than 100 feet or where necessary;
7. pH meter;
8. Minimum 200' Water level indicator tape;
9. 4L of 10% nitric acid (to flush tubing between wells);
10. 10L of distilled water (to flush tubing, rinse & wash down sampling equipment between wells);
11. 500ml squirt bottle w/ distilled water;
12. Graduated purge containers (various volumes: 2L, 4L, 10L, 20L)
13. Cooler and ice packs;
14. Pre-labeled volumetric sample bottles;
15. Paper towels/disposable wipes;
16. Field book;
17. Groundwater tool box w/ appropriate spare assorted connectors, Waterra foot valves and electrical tape (4 rolls minimum);
18. White paint marker, extra locks and oil for maintaining Piezometer I.D., proper security and lid function.

4.2 Scheduling

4.2.1 Groundwater samples will be scheduled in the environmental database as required for TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

4.2.2 The Compliance Coordinator is responsible for scheduling groundwater samples such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

4.2.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.3 Sampling

4.3.1 The Field Technician or other adequately trained personnel shall collect groundwater grab samples and prepare samples for shipping in accordance with the following protocols:

Protocol: Static Water Level Determination & Field Measurements

- Prior to disturbing the standing water in the well, the water level and borehole total depth must be measured and recorded;
- The reading is taken using the Solinst water level indicator or other similar device;
- Before placing the level indicator in the piezometer, first visually inspect the piezometer casing for damage and the probe tip for defects such as kinks or damage to the black protective coating or weighted assembly near the probe tip. The probe tip and line must be straight as possible to prevent snagging on the piezometer casing as it descends;
- Water level is indicated by a sharp but definite beep that can be verified by slowly moving the cable up and down the well or adjusting the instruments sensitivity. This will greatly reduce false readings. As the Solinst cable is being rewound care should be taken to gently wipe the cable and probe tip clean without damaging the marked intervals from the cable. The probe tip may need to be rinsed with distilled water to dislodge sediments;
- Record water level and total depth readings and calculate piezometer specific parameters on the Groundwater Instrumentation Field Inspection Form (RF8.6.2.01). There is a logical progression of data entry and calculations to be completed at time of sampling. These measurements provide a record of parameters to be entered into the Environmental Data Management System and calculations will determine the volume to be purged. The Field Technician will bring the previous year's completed field form binder to roughly verify results and proper piezometer function.

Protocol: Bottle Preparation

- Obtain analysis specific bottles in the appropriate volumetric size. Bottles are provided by the analytical lab and are sterile and precharged therefore, rinsing is not required.
- Prior to filling the sampler shall mark the piezometer identification number, date and sampler ID on each bottle and verify no defects to bottle or cap and liner.

Protocol: Well Flushing/Purging

- Standing water within the well casing must be removed prior to sampling;
- Three well volumes, the volume of water contained between the bottom of the well screen and the static water level within the well, should be removed where possible prior to sampling. Graduated purge containers of various sizes are available to ensure that the actual purged volume can be accurately recorded in the dedicated field binder;

- Wells that are slow to recharge and therefore preclude the flushing in the above manner, should be pumped dry and sampled when a sufficient amount of water has re-entered the well;
- Time elapsed should be noted if sufficient sample cannot be obtained in 8hrs. If the well does not recharge within 24hrs the instrument is considered dry and will be recorded as such in the Data Management System.

Protocol: Sample Collection

Current well diameters at the Elliot Lake sites include 2¼ inch, 1½ inch, ¾ inch, ½ inch and ⅜ inch:

- The 1½ and 2¼ inch monitoring wells are **purged** using a Waterra Inertia pumping system (foot valve) and **sampled** using the peristaltic pumping system with an in-line filter.
- In the cases where the head differential is >30^{ft} after purging, the Waterra (provided 3 times the volume has been removed from the well through it) can be used to fill a clean 2L container and the Peristaltic system with clean tubing may be used for filtering the sample from that container into the appropriate volumetric bottles for analysis at the lab;
- The ¾ and ½ inch diameter are flushed and sampled using a peristaltic pump;
- The ⅜ inch monitoring wells are purged and sampled by connecting the peristaltic pump directly to the ⅜ inch well casing with the appropriate connector from the GW tool box;
- Monitoring wells greater than 100 feet will be purged and sampled using the Nitrogen gas method. Samples are recovered by placing a small diameter polyethylene hose into the piezometer lead pipe down to the bottom of the water zone. As gas is released from the supply bottle, pressure in the piezometer builds and displaces water through the well cap adapter that the gas line is passed through. The sample water is collected in a clean 2L bottle and filtered from that bottle with the peristaltic pump and in-line filter into the appropriate volumetric bottles for analysis at the lab. This is done in the same way as bullet point 1 of this sub-section;
- ALL samples will be filtered through an in-line, 0.45µ pore size, high flow GW filter (at least 700cm^2 filter area) directly to the pre-labelled, precharged, volumetric sample bottles in the field using the peristaltic pumping system;
- As per the electronic schedule, pHf will be measured in the field using calibrated meters and recorded on the Groundwater Instrumentation Field Inspection Form (RF8.6.2.01) under the appropriate heading;
- Field parameters will be measured during sample collection by placing the probe into the 500ml sample container while the sample water is being pumped out. This will be the last of the 3 bottles to be filled for analysis;
- Water should be continuously pumped to the sample container while field measurements are being determined.

Protocol: In Field Sample Integrity

- Sample containers are filled completely leaving little to no residual air at the top of the container, where possible;
- The caps should be inspected to ensure the liners are in place. While sampling ensure the cap is stored in a clean and secure location to avoid contamination;
- All pumps and tubing used in groundwater sampling shall be flushed with 10% Nitric acid solution (4L) and distilled water (10L) between wells and wiped using paper towels or disposable wipes, to avoid sample contamination;
- Lines using Waterra foot valves cannot be flushed in this manner. However, if the piezometer is flushed and recharges instantly, the tubing is considered clean and sampling to a clean 2L intermediate sample container immediately following purging without removing the Waterra is permitted. This should only be done without removing the tubing from the piezometer casing as it may become contaminated upon removal. Once the sample water has been collected the peristaltic pump and in-line filter are used to fill the appropriate volumetric bottles for analysis at the lab;
- If the well does not recharge instantly, leave the Waterra line in and return at a later time to sample. Another option would be to use the peristaltic pump system with clean tubing upon return to collect the sample provided the head differential is $\approx 30^{ft}$;
- Once the sample has been properly collected store in a cooler with ice packs for transportation to the Sample Preparation Room to prepare for shipment;
- All reasonable efforts shall be taken to ensure samples are maintained at a consistent temperature, avoiding heating or freezing;
- When temperature change may be a factor due to sample delivery delays, coolers and ice packs will be used.

Protocol: Sample Preparation for Shipment

- Samples will be bottled in predetermined, pre-labelled and precharged sample bottles in the field for shipment.
- A corresponding chain of custody (C of C) can now be generated through the completion of the “Request for Lab Analysis” module in the Environmental Data Management System. Two “.PDF” format copies of the C of C file will be printed off; one for archiving at the office and one to be included in the sample cooler for shipment;
- An alternate C of C in “Tab Delimited” format will be e-mailed to the analytical lab for tracking purposes within their electronic system;
- Once the C of C form, samples, packing medium and ice packs have been placed in the cooler it is now ready to be sealed and delivered to the Office Administrator for final shipping preparation and notification to the courier;

- Field measurements can now be entered through the data entry process in the "Rapid Entry of Events and Measurements" modules in the Environmental Data Management System (see PR8.7.3.01 Data Entry Procedure).

4.3.2 The sampler shall record any unusual sample collection and filtration conditions or observations on the corresponding Groundwater Instrumentation Field Inspection Form (RF8.6.2.01) and incorporate it into the dedicated field binder.

4.4 Data Validation and Review

4.4.1 Data validation and review of groundwater samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing groundwater sampling meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RF8.6.2.01	Groundwater Instrumentation Field Inspection Form
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.01	Data Entry Procedure
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.01	Jan. 22, 2003	Procedure revisions to reflect current protocols
2005.01	Sept. 7, 2005	Incorporate use of report form; additional detail added to procedure for clarification
2006.01	Dec. 19, 2006	Procedure revisions to filtration and sample shipping resulting from change in analytical supplier
2007.01	Aug. 7, 2007	Include in-line filtration of samples; revise sample bottles and labelling
2011.01	Feb. 19, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Field pH Determination

Operating Procedure: PR8.6.3.01	Revision: 2011.01	Page 1 of 5
	Replaces: 2007.01	
Approved: February 18, 2011	Valid Until: February 18, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a field pH determination standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to field pH determination at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field pH determination. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting field pH determination are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field pH Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of field pH determination in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing field pH determination modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field pH Determination Procedure. Responsibilities specific to this procedure include:

- Scheduling field pH determinations in the environmental database in accordance with PR8.7.2.01: Scheduling.

Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned field pH determination responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting field pH determination in accordance with PR8.6.3.01 Field pH Determination;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry
- Maintaining calibration records and field logs.

4 PROCEDURES

Equipment

The following equipment is required for field pH determination:

- pH meter and carrying case;
- Manufacturers Instruction Manual;
- Calibration log;
- pH buffer solutions (at least two) in small sample containers;
- Distilled water;
- Batteries.

Scheduling

Field pH determination will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

The Compliance Coordinator is responsible for scheduling field pH determinations such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Calibration

The Field Technician or other adequately trained personnel shall refer to manufacturer's instructions in the operation manual of the pH meter for specific calibration, storage and maintenance instructions.

A wide variety of pH meters and multimeters with pH probes are currently in use. The following are some general instructions to follow:

- Prior to use the Field Technician shall calibrate the meter using a minimum of two pH calibration standards;
- Calibration of the meter should be verified once every five samples;
- If meter readings do not meet precision and accuracy objectives specified in RG8.5.2.01 Data Quality Objectives, the meter must be re-calibrated

The Field Technician or other adequately trained personnel shall record the calibration record on RF 8.6.3.01 Field Instrument Calibration Records.

Field Instructions

The Field Technician or other adequately trained personnel shall obtain field pH measurements in accordance with the meter-specific operation manual in addition to following these general guidelines:

- Place the probe in the water and turn the meter on (depending on the meter minimal stirring of the probe may be required);
- Allow the meter reading to reach equilibrium;
- Record the reading in the dedicated waterproof field notebook;
- Record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling;
- When the meter is not in use the probe should be stored according to manufacturer specifications.

Data Validation and Review

Data validation and review of surface water samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing surface field pH determinations meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RF8.6.3.01	Field Instrument Calibration Records
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.01	Jan 16, 2003	Correct typo to replace “toxicity” with field pH
2007.01	Sept. 7, 2007	Update roles and responsibilities, remove references to Envista and update procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Field Conductivity Determination

Operating Procedure: PR8.6.3.03	Revision: 2011.01	Page 1 of 5
	Replaces: 2007.01	
Approved: February 25, 2011	Valid Until: February 25, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a field conductivity determination standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to field conductivity determinations at the following Elliot Lake monitoring locations:

- P-15: Panel Settling Pond Underflow Drainage

The procedure may also be applied to other field applications.

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field conductivity determination. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting field conductivity determinations are adequately trained and competent to perform assigned task; and
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field Conductivity Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of field conductivity determination in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing field conductivity determinaiton modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field Conductivity Determination Procedure. Responsibilities specific to this procedure include:

- Scheduling field conductivity determinations in the environmental database in accordance with PR8.7.2.01: Scheduling.

Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned field conductivity determination responsibilities are responsible for:

- Conducting field conductivity determinations in accordance with PR8.6.3.03 Field Conductivity Determination;
- Maintaining calibration records and field logs;
- Participating in and completing the training requirements; and

- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry.

4 PROCEDURES

Equipment

The following equipment is required for conductivity determination:

- Conductivity meter and carrying case;
- Manufacturers instruction manual;
- Calibration log;
- Distilled water;
- Spare batteries.

Scheduling

Field conductivity determinations will be scheduled in the environmental database as required for TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

The Compliance Coordinator is responsible for scheduling field conductivity determinations such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling.

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Calibration

The Field Technician or other adequately trained personnel shall refer to manufacturer's instructions in the operation manual of the conductivity meter for specific calibration, storage and maintenance instructions.

A variety of conductivity meters and multi-meters are currently in use. The following are some general instructions to follow:

- System calibration is rarely required because conductivity meters are factory calibrated;
- On occasion it is prudent to check system calibration and make adjustments when necessary;
- Calibration and verification should be conducted as per manufacturer's instructions;
- If meter readings do not meet precision and accuracy objectives specified in RG8.5.2.01 Data Quality Objectives, the meter must be factory calibrated;
- Cleaning should be conducted in accordance with manufacturer's specifications.

The Field Technician or other adequately trained personnel shall record the calibration record on RF 8.6.3.01 Field Instrument Calibration Records.

Field Instructions

The Field Technician or other adequately trained personnel shall obtain conductivity measurements in accordance with the meter-specific operation manual in addition to following these general guidelines:

- Place the probe in the water and turn the meter on (depending on the meter minimal stirring or agitation of the probe may be required);
- Allow the meter reading to reach equilibrium;
- Record the reading in the dedicated waterproof field notebook;
- Record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling;
- When the meter is not in use the probe should be stored according to manufacturer specifications.

Data Validation and Review

Data validation and review of field conductivity determinations shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing field conductivity determinations meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RF8.6.3.01	Field Instrument Calibration Records
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.01	Jan 15, 2003	Correct typo to replace “temperature” with conductivity
2005.01	Dec. 15, 2005	Correct additional typo to replace “temperature” with conductivity
2006.01	Nov 27, 2006	Update roles and responsibilities, remove reference to Envista as well as procedure references
2007.01	Sept. 11, 2007	Update roles and responsibilities; update companion document listing
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Flow Determination

Operating Procedure: PR8.6.4.02	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 18, 2011	Valid Until: February 18, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish weir, staff gauge and instrumentation driven flow determination protocols that are consistent with regulatory requirements and standard industry practices;
- Assign responsibility to ensure that flow monitoring is conducted in accordance with license requirements and ISCO Open Channel Flow Measurement Handbook.

2 APPLICATION

This procedure applies to flow determination at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

Location-specific flow monitoring requirements are documented in RG8.6.4.02 Flow Determination Registry. Flow determination at the Elliot Lake sites include:

- V-notch and flat rectangular weirs;
- Parshall flumes
- Staff gauge;
- Environment Canada flow station;
- MAG-X;
- Multi-ranger Plus (sonic level element).

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including flow determinations. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting flow determinations are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Flow Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of flow determination in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing flow determination modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Flow Determination Procedure. Responsibilities specific to this procedure include:

- Scheduling flow determination in the environmental database in accordance with PR8.7.2.01: Scheduling.

Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned flow determination responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting flow determinations in accordance with PR8.6.4.02 Flow Determination;
- Participating in and completing the training requirements;
- Reporting any items requiring action to the Environmental Coordinator and entering into the Action Item Database
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

4 PROCEDURES

Equipment and Preparation

The following equipment is required to determine flow measurements in open channels with existing flow measurement structures:

- Engineer's ruler;
- Waterproof Field notebook or daily ETP operation sheets.

Scheduling

Flow determinations will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

The Compliance Coordinator is responsible for scheduling flow determinations such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- The parameter code for flow is indicative of the specific parameter used to obtain the flow value as per RG8.6.4.02 Flow Determination Registry.
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Field Measurements

The Field Technician, Operator or person designated to determine flow shall obtain flow in the appropriate manner as indicated in RG8.6.4.02 Flow Determination Registry and record the measurement in the designated waterproof field notebook or on the appropriate Workday or Weekly Shut-Down inspections sheets (RF7.3.0.01 and RF7.3.0.02 series report forms).

The person designated to determine flow is responsible for:

- Inspecting the flow measurement structures (weirs) for damage, leakage, etc.;
- Removing obstructions prior to flow determination whereupon sufficient time must be allowed for flow to reach equilibrium (dependent on size of pondage immediately upstream);
- Ensuring Instrumentation is consistent with expected flows as observed on SCADA trends in conjunction with weather patterns (where applicable);
- Reporting any items requiring action to the Environmental Coordinator and entering into the Action Item Database.

The person designated to determine flow shall record any unusual conditions or observations, weather conditions and time designated waterproof field notebook or on the appropriate Workday or Weekly Shut-Down inspections sheets (RF7.3.0.01 and RF7.3.0.02 series report forms) at the time of monitoring. Record all raw field measurements and calculations.

Data Entry & Calculations

The Field Inspector, Operator or person designated to determine flow is responsible for entering data into environmental database as per PR8.7.3.01 Data Entry Procedure.

Data Validation and Review

Data validation and review of flow determinations shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing flow monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
	ISCO Open Channel Flow Measurement Handbook
RG1.0.0.02	Operating Document Registry
RF7.3.0.01	Site-specific Workday Inspection Record
RF7.3.0.02	Site-specific Weekly Shut-down Inspection Record
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RG8.6.4.02	Flow Determination Registry
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.01	Data Entry Procedure
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007.01	Sept. 20, 2007	Update roles and responsibilities as well as procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison to reflect common use of procedure; revise schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Control Limit Maintenance

Operating Procedure: PR8.7.2.02	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011	Valid Until: February 25, 2016	
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish control limits in the environmental database that are consistent with license and permit requirements, internal operating limits, environmental quality assessment criteria and data validation protocols;
- Establish on line notification and protocols for initial response to control limit exceedances; and
- Assign responsibility for control limit maintenance in the environmental database and supporting registry

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;

Field parameters, samples and analytes subject to control limits are scheduled in the environmental database in accordance with RG8.7.2.01 Performance Monitoring Registry.

Table 2.1 provides a summary of control limit designations, source documents, objective and data sets to which the control limits apply.

Final treated effluent control limit exceedance response plans are documented in Section 7.4 of site-specific Operating, Care and Maintenance (OCM) Plans. Generic response plans for effluent treatment plant failure, poor effluent quality and high rates of seepage are documented

in PL10.2.0.01 Emergency Response Plan with site-specific details provided in Section 10.2 of site-specific OCM Plans.

Water quality assessment and response protocols are documented in PR8.0.0.01 Water Quality Assessment and Response Plans.

Table 2.1. Control Limit Designations

Control Limit Type	Source Documents	Objective	Applies to
Compliance Limits	Site-specficic OCM Plans, Certificate of Approvals Sewage	to provide immediate notification of compliance issue	Final point of control (CL-06, N-19, P14, PR-04, Q-28)
Action Levels	Site-specficic OCM Plans	to provide early warning of potential compliance issue	
Internal Investigation		to provide identification of upset or unusual operating conditions	
Data Validation	Performance monitoring current design documents	to provide automated approach to identification of outliers and potential data quality issues	All data entered into database
Evaluation Criteria	Performance monitoring current State of Environment Report		SRWMP water quality data; SAMP and TOMP surface water quality data at 10x criteria

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure (e.g. changes to license or permit documents or other regulatory requirements).

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including control limit maintenance. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel participating in control limit maintenance and response initiations are adequately trained and competent to perform assigned tasks;
- Confirming care and maintenance contractor conformance with this procedure
- Confirming data management modifications required in response to changes to this procedure are completed and managing relationship (commercial and working) with database service provider.

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Control Limit Procedure. Responsibilities specific to this procedure include

- Assigning responsibility for completion of control limit maintenance in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to control limits and response initiation requirements;
- Directing training of care and maintenance contractor staff involved in control limit maintenance and response initiation;
- Initiating and directing data management modifications required in response to changes to this procedure including changes requiring database service provider support;
- Initiating and reviewing modifications to this procedure and associated registries and report forms;
- Developing and initiating responses to control limits as identified in RG8.7.2.01 Control Limit Registry and communicating progress to Environmental Manager and Reclamation Manager;
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and data management service provider conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for control limit maintenance. Responsibilities specific to this procedure include:

- Conducting data validation in accordance with PR8.7.3-02 Data Validation including confirmation that data validation control limits are functioning as designed

- Implementing modifications to this procedure and associated registries in accordance with RG1.0.0.01 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other individuals assigned performance monitoring responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Participating in and completing the training requirements
- Responding to control limit excedances and associated activities as assigned
- Informing the Compliance Coordinator of data validation flags during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator of control limit exceedances during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4 PROCEDURES

4.1 Control Limit Registry Maintenance

RG8.7.2-02 Control Limit Registry includes the following information required to maintain control limits in the environmental database:

- Control Limit Designations: documents the locations, message and response initiation requirements for each control limit type
- Compliance Limits: documents location and analyte specific compliance limits, action levels and internal investigation levels
- Data Validation: documents the number of rolling counts to be used in calculating data validation assessment limits for each sampling frequency
- Evaluation Criteria: documents the parameter-specific water quality environmental assessment criteria and associated references

4.1.1 The Rio Algom Reclamation Manager or Denison Environmental Services Manager as appropriate are responsible for notifying the Environmental Manager and Environmental Coordinator of changes to licenses and/or permits that would impact compliance limits, action limits and/or internal investigation levels

4.1.2 The Environmental Coordinator is responsible for reviewing performance monitoring design documents and periodic State of the Environment Reports to identify changes in evaluation criteria

4.1.3 The Environmental Coordinator is responsible for directing Compliance Coordinator modifications to RG8.7.2-02 Control Limit Registry originating from changes in source documents or regulatory requirements

4.2 Database Control Limit Maintenance

The Compliance Coordinator is responsible for configuring control limits in the environmental database in accordance with requirements documented in RG8.7.2-02 Control Limit Registry.

4.2.1 Station and parameter specific compliance limits, action levels and internal investigation level control limits are configured using the "Limit Group" function. To configure a station and parameter specific control limit:

- Log into em-Line and select the appropriate application in which the data will be validated (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project)
    - Select the Compliance Module: Limit Group;
    - Update and modify limits as necessary;
    - Click the Save button.

4.2.2 Data Validation Limits are station, parameter specific hi low limits which are configured under Station Limits. These limits are automatically calculated based on the statistical trends of historical data, to provide early notification of outliers or emerging trends during data entry/import and data quality assessment.

- A Control Limit Script provides the vehicle to flag any value outside +/- 3 Standard deviations of a given mean and is run on a nightly basis;
- In the Station Limits module, the station and parameter specific period is specified (ie daily, weekly monthly etc.) followed by the period be used in calculating the assessment limit (e.g. daily is 251);
- The Compliance Coordinator is responsible for conducting periodic checks to confirm that data validation control limits are functioning as designed.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of documented review of RG8.7.2.02 Control Limit Registry

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2011	Serpent River Watershed State of the Environment Report
	Site-specific OCM Plans
	Certificate of Approval Sewage: Stanleigh, Nordic and Pronto
RG1.0.0.02	Operating Document Registry
PR8.0.0.01	Water Quality Assessment and Response Plans
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
PR8.7.2.02	Control Limit Maintenance
RG8.7.2.02	Control Limit Registry
PR8.7.3-02	Data Validation
RF8.7.3.02	Flagged Data Report
PL10.2.0.01	Emergency Response Plan
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007-01	Sept 27, 2007	Update roles and responsibilities as well as procedure references, update based on transition from Envista to emLine; include internal investigation limits
2011-01	Feb. 18, 2011	Update roles and responsibilities, add Table 2.1 to define control limit designations; eliminate reporting as this is addressed elsewhere

Data Entry

Operating Procedure: PR8.7.3.01	Revision: 2011.01	Page 1 of 8
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout
	Compliance Coordinator	Valerie Kilp

1 PURPOSE

The purpose of this procedure is to:

- Assure that all data is entered into the Environmental Database in accordance with license requirements, PR8.7.2-01 Scheduling as well as any non-routine and internal samples;
- Assign responsibility to ensure that data entry will comply with license requirements.

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;
- Response monitoring

This procedure does not apply to data generated by outside consultants in support of the above programs.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including performance monitoring data entry. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting performance monitoring data entry are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Performance Monitoring Data Entry Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of performance monitoring data entry in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing performance monitoring data entry modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Performance Monitoring Data Entry Procedure. Responsibilities specific to this procedure include:

- Scheduling performance monitoring field parameters, samples and analytes in the environmental database in accordance with PR8.7.2.01: Scheduling.
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned performance monitoring data entry responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting performance monitoring data entry in accordance with PR8.7.3.01 Performance Monitoring Data Entry;
- Participating in and completing the training requirements;
- Informing the Compliance Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Saving all importing data excel and pdf files Annual Archive/Analytical Results.

4 PROCEDURES

4.1 Scheduling

4.1.1 Field parameters, samples and analytes will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009. Additional performance monitoring requirements may arise from response monitoring programs and internal monitoring initiatives as identified by the Reclamation Manager and/or Environmental Manager.

4.1.2 The Compliance Coordinator is responsible for scheduling field parameters, samples and analytes such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

4.1.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.2 Data Entry Requirements

4.2.1 Field Technicians, Operators, and/or other designated personnel are responsible for entering/importing all data into the emLine database in accordance with requirements registered in RG8.7.2.01 Performance Monitoring Registry.

4.2.2 All data will be entered via import templates where possible, or manual entry for field parameters and unusual samples/analytes.

4.2.3 It is important to adhere to the following standards during unscheduled data entry to ensure consistency and accuracy of the data:

- Log on to the emLine database under Network I.D and password;
- Select the appropriate application in which the data will be entered (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project);
- Select the Rapid Entry of Events module;
- Use the drop down list to select the event type (water sample, field event) appropriate for the task performed;
- Enter the desired date range in which data will be entered and refresh the table;
- Under the default settings, select the magnifying glass located beside the station default, enter a code for the station required and refresh the screen;
- Select the desired station by clicking on the corresponding select button;
- Ensure the performed on date is the same date the event took place;
- Select “new” at the bottom of the screen to create the new event;
- Select “save” at the bottom of the screen to save the event into the database and record the generated Field # which will be required to create the measurement;
- Select “home” at the top of the screen to return to the home page;
- Select Rapid Entry of Measurements;
- Enter an appropriate date range for the data to be entered and refresh the screen;
- Under the defaults heading use the drop down list to select the parameter to be created;
- Ensure the “measured on” date corresponds with the date the parameter was measured on;
- Type in the previously recorded Field # which was generated when the event was created and saved in the Field # section;
- Select “new” at the bottom of the screen to create the measurement;
- Enter the data into the appropriate blank spaces and ensure the performed on date is the correct date in which the measurements took place;
- If qualifiers are required due to unusual circumstances observed, select the text or details symbol at the left side of the screen associated with the same location. There will be a drop down list in which to select the appropriate qualifier

- On this page you also assign a purpose and enter any comments if necessary;
- Select Return to Grid to continue entering data;
- Alterations must be made only as necessary and an audit trail provides a means of tracking altered data;
- Inform the Compliance Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
- Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4.2.4 It is important to adhere to the following standards during scheduled data entry to ensure consistency and accuracy of the data:

- Log on to the emLine database under Network I.D and password;
- Select the appropriate application in which the data will be entered (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project);
- Select the Rapid Entry of Events module;
- Use the drop down list to select the event type (water sample, field event) appropriate for the task performed;
- Enter the desired date range in which data will be entered and refresh the table;
- Change the status for each location that is viewed as “pending” to “completed”. This can be done by using the drop down arrow provided. Ensure the date shown is the correct date that the event was completed;
- Save the completed events by selecting the “save” button at the bottom of the screen. Ensure that a field number is generated for each event that was marked as completed;
- Select the “home” icon at the top of the page. This will return the user to the main screen;
- Select Rapid Entry of Measurements;
- Use the drop down list to select the event type (water sample, field event) appropriate for the task performed
- Enter the desired date range in which data will be entered and refresh the table;
- Enter the data into the appropriate blank spaces and ensure the performed on date is the correct date in which the measurements took place;
- If qualifiers are required due to unusual circumstances observed, select the text or details symbol at the left side of the screen associated with the same location. There will be a drop down list in which to select the appropriate qualifier;
- On this page you also assign a purpose and enter any comments if necessary;
- Select the save button at the bottom of the screen;

- Select Return to Grid to continue entering data;
- Alterations must be made only as necessary and an audit trail provides a means of tracking altered data;
- Inform the Compliance Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
- Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4.2.5 It is important to adhere to the following standards during importing of data to ensure consistency and accuracy of the data:

- Once the results have been received from the laboratory, save the excel and pdf files Annual Archive/Analytical Results for future reference and retrieval during the importing process;
- Log on to the emLine database under Network I.D and password;
- Select the Denison Environmental Services Application;
- Select importing;
- Under the tasks heading select “start a new import”;
- Under file format use the drop down arrow to select excel spreadsheet
- Under worksheet name in the filename of the data to be imported (EM LINE is the file name currently used for all files);
- Select the Upload File button associated with the filename and navigate through the system and select the file to be imported;
- Select the magnifying glass associated with the import class and select the measurement button;
- Select next at the bottom of the page, this will load all data on the file to the screen
- Select “import data” once file has been loaded successfully;
- Select “view warning” at the bottom of the page;
    - Inform the Compliance Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
    - Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Select “finish” to save the data into the database.

4.3 Data Validation and Review

Data validation and review of performance monitoring data shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring data entry meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
RG8.7.2.02	Control Limit Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007-01	Aug 15, 2007	Update roles and responsibilities as well as procedure references and remove references to Envista
2011-01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Data Validation

Operating Procedure: PR8.7.3.02	Revision: 2011.01	Page 1 of 8
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the quality and accuracy of data entered in the environmental monitoring database by ensuring no major identifiable sampling, analysis or entry errors have occurred;
- Establish data validation standards that are consistent with program requirements and procedures; and
- Assign responsibility to ensure that data is validated in accordance program requirements and procedures and optimal environmental database functionality

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;

Field parameters, samples and analytes subject to data validation are scheduled in the environmental database in accordance with RG8.7.2.01 Performance Monitoring Registry.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited

(RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure;

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including data validation. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel participating in data validation are adequately trained and competent to perform assigned task;
- Reviewing data validation reports and trends and managing modifications of associated procedures and training programs as required;
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Data Validation Procedure. Responsibilities specific to this procedure include

- Assigning responsibility for completion of data validation in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to data quality assessment procedures;
- Directing training of care and maintenance contractor staff involved in data validation;
- Initiating and directing data management and analytical services modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure and associated registries and report forms;
- Developing and supervising responses to data that does not conform to the data validation criteria and communicating progress to Environmental Manager and Reclamation Manager; and
- Reviewing data validation reports and programs and initiating and supervising modifications as required.
- Informing care and maintenance contractor staff of changes to this procedure;
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for implementation of the Data Validation Procedure. Responsibilities specific to this procedure include:

- Conducting data validation in accordance with PR8.7.3-02 Data Validation including preparation and maintenance of data validation records and reports
- Reviewing and posting data;
- Reviewing and confirming that field and analytical results are valid and entered into the data management system within 60 days of the sample date;
- Generating and reviewing data validation reports using the report forms associated with this procedure and initiating responses to data that does not conform to the data validation protocols
- Implementing responses to data that does not conform to the data quality objectives as directed by the Environmental Coordinator
- Preparing data validation components of internal and regulatory monthly and annual water quality reports including reporting on the status of responses to data that does not conform to the data validation protocols;
- Implementing modifications to this procedure and associated report forms in accordance with RG1.0.0.01 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other individuals assigned performance monitoring responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Participating in and completing the training requirements
- Responding to data validation inquiries and associated activities as assigned
- Posting field data within one week of data collection
- Informing the Compliance Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4 PROCEDURES

4.1 Supporting Reports

4.1.1 The Compliance Coordinator is responsible for ensuring that changes in data validation procedures are incorporated into RF8.7.3.02 Flagged Data Report

4.1.2 The Compliance Coordinator is responsible for ensuring all environmental database data validation report forms are working correctly and initiating modifications with the data management service provider as required. Environmental data management report forms are maintained in the data management system under the appropriate application (Rio/SRWMP/Denison) and can be accessed by the Reports/Report Manager when logged on to the database.

Assessments limit calculations are documented in PR8.7.2.02 Control Limit Maintenance.

4.2 Data Validation Requirements

4.2.1 Any person entering data into the database, in accordance with PR8.7.3-01 Data Entry Procedures, is responsible for informing the Compliance Coordinator of flags during import and data entry, to ensure timely resolution of import and data validation issues.

4.2.2 All field data shall be reviewed and posted on at least a weekly basis by relevant field staff.

- Log into em-Line and select the appropriate application in which the data will be validated (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project)
- Select the Compliance Module: Review Measurements;
- Sort as desired (parameter, location etc.), to facilitate review of individual data;
- Review, trend data and either post or report any unusual flags to the Compliance Coordinator;
- Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Click the Save button/

4.2.3 In order to ensure all data has been entered in compliance with the schedule requirements the data will first be reviewed and posted, by the Compliance Coordinator (or designate):

- Log into em-Line and select the appropriate application in which the data will be validated (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project)
- Select the Compliance Module: Review Measurements;
- Group by Limit types (go back about 2 months) and hit Refresh;
- Review and post limit groups with no exeedences; save after each one ;
- Report any Action, Compliance, High/Low Flags or Internal limit exeedences to Environmental Coordinator first before posting;
- As a check refresh by selecting the Status.

4.2.4 In order to ensure that all scheduled analytes have been completed, prior to the validation process:

- Select the Reports Module; Under Monitoring & Compliance select Schedule Compliance:
- Under Measurement Status, filter on Pending and Entered samples;
- View the Schedule Compliance Report; Print if desired;

- Contact the laboratory as required to address any outstanding issues.

4.2.5 The Compliance Coordinator is responsible for conducting data validation in the environmental monitoring database in accordance with this procedure.

- Log onto the environmental monitoring database and select Detailed Measurements under the Environmental Performance Module;
- Type in Station and Analyte (Parameter) and select date criteria (go back at least 5 years); View Report and review trend individually for each analyte.

4.2.6 The Compliance Coordinator is responsible for running RF8.7.3.02 Flagged Data Report on a monthly basis. This includes:

- Click on the Reports Tab along the top of the environmental database tool bar;
- Select the Report Manager under Other Reports;
- Select the Hi/Low Flag and set date criteria for the previous month only; View Report;
- Save the file to operating program records Section 8.7 when prompted; Open & Print.

4.2.7 Figure 4.1 Decision Path for Data Validation includes a detailed flow path for guidance/reference in decision making with respect to data validation of the data points generated in 4.2.6:

1. Flagged data points will be evaluated through trending in Detailed Measurements Reports to determine:
   - Whether they are in error; or
   - At the beginning of a gradual trend or shift in the system; or
   - The result of a system upset; or
   - Result of a lab or sampling error.
2. Where there is no readily identifiable factor causing a data point to be flagged, re-analysis or re-sampling will be conducted;
3. If the resulting second data point does not corroborate the first (ie: it is within the acceptable range of variability), the new data point will be accepted and the old one rejected from the database. Comments will be made in the comments section of the individual analytes;
4. If the second data point corroborates the first, the data will be accepted or rejected on the basis of trend evaluation as outlined in Figure 4.1;
   - If a trend is identified the data point will be accepted and a new assessment limit will automatically calculated in the database Limits as per PR8.7.2.02 Control Limit Maintenance Procedure.
   - If no trend is identified, (pending the database update) the data point will be isolated from the main database into a separate location where it will be stored but will not affect valid data and trends.

5. Include comments on the decision path, validation process on RF8.7.3-02 Flagged Data Report, included in the monthly Care and Maintenance Report
6. A summary of all rejected data will be provided with the data quality reporting in the Annual Water Quality Report.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented on the job training for emLine database access and report generation
- Completion of documented review of RG8.7.2.02 Control Limit Registry

6 ADMINISTRATION

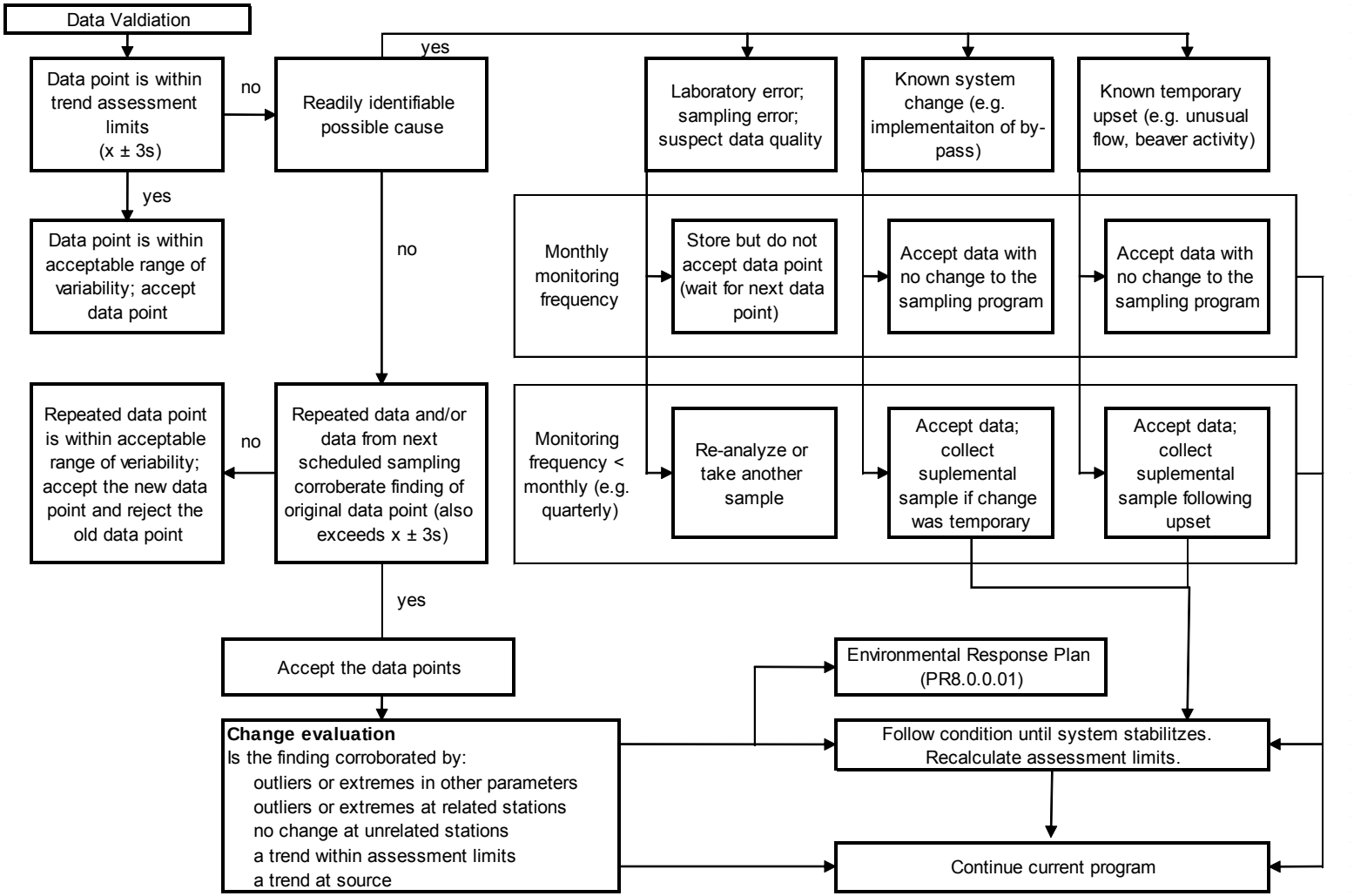
6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

Figure 4.1. Decision Path for Data Validation



7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
PR8.7.2.02	Control Limit Maintenance
RG8.7.2.02	Control Limit Registry
RF8.7.3.02	Flagged Data Report
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007-01	Aug 15, 2007	Update roles and responsibilities as well as procedure references, update based on transition from Envista to emLine
2011-01	Feb. 18, 2011	Update roles and responsibilities, add supporting reports section; revise Fig 4.1 to align with Cycle 3 design

DATA RETRIEVAL PROTOCOL

Serpent River Watershed State of the Environment Report
Data Retrieval Summary

Data Retrieval General:

The State of the Environment (SOE) Report data files were extracted from the emLine database using a number of different methods and rationale to satisfy each individual point outlined in various data requests from Minnow Environmental Inc. (Minnow). Retrieval methods and rationale employed by DES to satisfy the various data requests are described below. It should be noted that annual means calculated from data provided for the SOE report may not equal annual means presented in the Annual Operating, Care and Maintenance (OCM) Reports. Annual OCM reported averages are calculated using data collected for "regulated" sample results only; whereas the data extracted for the SOE report reflects all available data including "Internal" & "Special Project" data for averaging purposes. Data from 2005 to 2006 had already been downloaded for use in the SOE (Minnow 2008) and so retrieval of data was limited to data collected since the last SOE (i.e., 2007 to 2009)

Reagent Use & Treated Effluent Volume:

ETP Operating Summaries, running from January 1 2007 to December 31 2009, were pulled using the report form set up in emLine for the completion of the Annual Reports. It should be noted that 2009 was the first year that barium chloride was not used during treatment at the Pronto ETP.

Total flow data from these reports should not be used in the calculation of loadings as they are based on average monthly flows and not actual daily flows reported.

File: Minnow Request – Reagent Use07-09rev

Surface Water:

SAMP results were pulled from emLine using Cycle 3 locations and parameters, running from January 1 2007 to December 31 2009, using the SAMP purpose. In addition, TSS, Cu, Pb, Ni, Zn were requested to assess license discharge criteria. Any "<" symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each SAMP location was assigned to a separate worksheet.

File: Minnow Request – SAMP07-09rev

TOMP results were pulled from emLine using Cycle 3 locations and parameters, running from January 1 2007 to December 31 2009. Any "<" symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each TOMP location was assigned to a separate worksheet, with locations for each site segregated into individual files due to the large amounts of data.

File: TOMP_Denison07-09rev

TOMP_Milliken07-09rev

TOMP_Nordic07-09rev

TOMP_Panel07-09rev

TOMP_Pronto07-09rev

TOMP_Quirke07-09rev

TOMP_SpanAmerican07-09rev

TOMP_Stanleigh07-09rev

TOMP_Stanrock07-09rev

Groundwater:

Groundwater results were pulled from emLine using the Cycle3 locations and parameters, running from January 1 2007 to December 31 2009. Any "<" symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Groundwater locations were grouped by site, with each site assigned to a separate worksheet.

File: Minnow Request – Groundwater07-09rev

SRWMP Data:

Water quality results for the SRWMP were pulled using the Cycle3 locations and parameters, running from January 1 2007 to December 31 2009, using the SWRMP purpose. All "<" symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each sample location was assigned to a separate worksheet.

File: Minnow Request – SRWMP07-09rev

Toxicity for SAMP Stations:

Toxicity results were pulled from emLine, running from January 1 2007 to December 31 2009, using the SAMP purpose. Each sample location was assigned to a separate worksheet.

File: Minnow Request – Toxicity07-09rev

Water Elevations for TMA's:

For flooded basins water elevation data was pulled from emLine, running from January 1 2007 to December 31 2009. Each sample location was assigned to a separate worksheet.

File: Minnow Request – Basin Elevations07-09rev

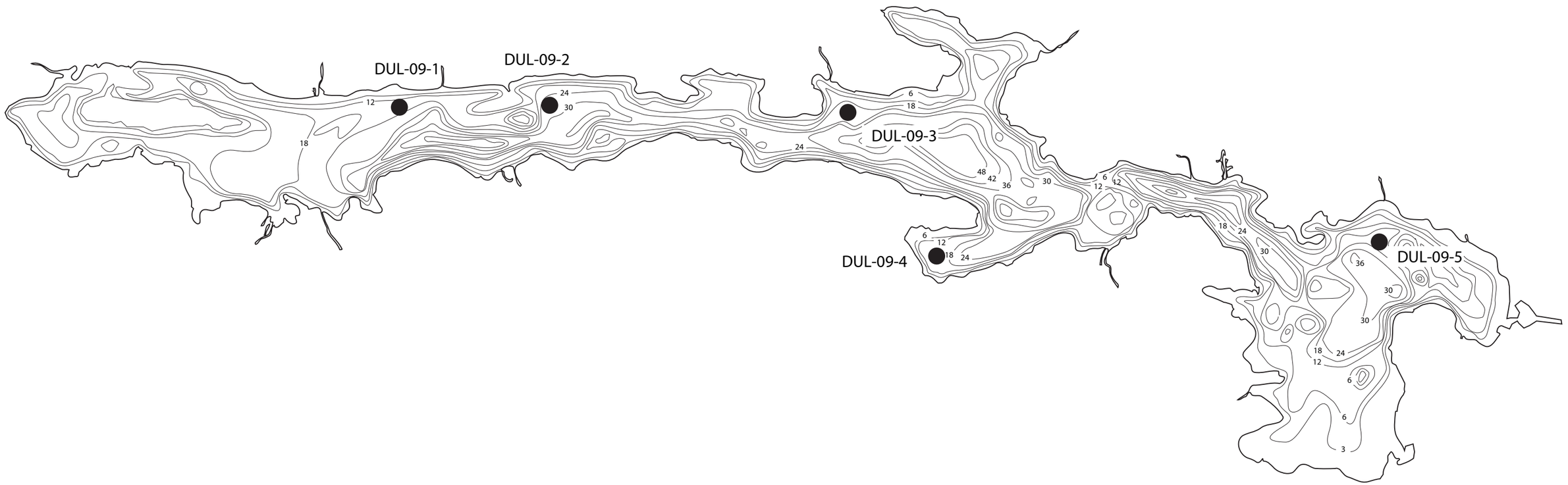
SAMPLING DEPTH AND UTM COORDINATES FOR SAMPLING STATIONS

Appendix Table A.1: Benthic and sediment monitoring station locations and depths sampled, SRWMP 2009.

Station	Station ID	Depth (m)	UTM (north)	UTM (east)
Dunlop Lake	DUL-09-1	15.1	5150897	364300
	DUL-09-2	15.3	5150867	365441
	DUL-09-3	15.0	5150805	367859
	DUL-09-4	15.0	5149613	368751
	DUL-09-5	15.1	5149642	372231
Elliot Lake	EL-09-1	15.2	5138606	367871
	EL-09-2	15.1	5138800	369733
	EL-09-3	15.5	5138518	371395
	EL-09-4	15.8	5138602	367248
	EL-09-5	15.3	5139414	367878
Hough Lake	HOL-09-1	14.8	5140440	384644
	HOL-09-2	15.0	5140550	385311
	HOL-09-3	16.0	5139975	385655
	HOL-09-4	15.8	5140037	385229
	HOL-09-5	14.7	5140470	384984
May Lake	MAL-09-1	15.0	5144773	384891
	MAL-09-2	14.8	5143310	384357
	MAL-09-3	15.1	5142843	386545
	MAL-09-4	14.8	5143297	385820
	MAL-09-5	14.8	5142155	386430
McCarthy Lake	MCL-09-1	15.4	5131182	389407
	MCL-09-2	15.3	5131187	388173
	MCL-09-3	15.0	5129043	388055
	MCL-09-4	14.9	5132124	388673
	MCL-09-5	15.1	5129917	387994
McCabe Lake	ML-09-1	15.1	5141695	378663
	ML-09-2	15.2	5142144	379486
	ML-09-3	14.6	5142813	380020
	ML-09-4	15.6	5142083	379158
	ML-09-5	15.1	5142095	379502
Nordic Lake	NL-09-1	13.0	5135447	376090
	NL-09-2	15.3	5135457	376825
	NL-09-3	14.7	5135080	377788
	NL-09-4	14.8	5135118	377372
	NL-09-5	15.3	5135284	377634
Pecors Lake	PL-09-1	14.2	5137281	388301
	PL-09-2	15.3	5138102	387594
	PL-09-3	14.8	5138969	386817
	PL-09-4	14.9	5137853	387251
	PL-09-5	15.0	5137064	389585
Quirke Lake	QL-09-1	21.0	5151261	378184
	QL-09-2	18.2	5150983	381098
	QL-09-3	20.6	5194960	384089
	QL-09-4	21.0	5148792	378194
	QL-09-5	23.2	5148765	380595
Rochester Lake	RL-09-1	15.2	5153617	383274
	RL-09-2	15.0	5153559	383590
	RL-09-3	14.7	5153407	385182
	RL-09-4	14.9	5153405	385386
	RL-09-5	15.1	5153495	383900
Semiwite Lake	SL-09-1	15.0	5159958	371505
	SL-09-2	15.0	5158814	371659
	SL-09-3	14.7	5159540	370832
	SL-09-4	15.2	5159406	372503
	SL-09-5	15.0	5159377	371917
Summers Lake	SUL-09-1	15.4	5146194	365726
	SUL-09-2	15.5	5146614	365068
	SUL-09-3	15.2	5147241	365543
	SUL-09-4	15.4	5147338	364872
	SUL-09-5	15.1	5146975	365065
Ten Mile Lake	TML-09-1	17.0	5152822	364205
	TML-09-2	18.3	5151602	363615
	TML-09-3	17.6	5152432	364966
	TML-09-4	17.6	5153825	360651
	TML-09-5	18.2	5152979	365447

All stations were sampled using a petite ponar. Benthic and sediment sampling consisted of 5 composites with an additional two composites for T.O.C. and grain size.

MAPS OF SRWMP LAKE SAMPLING LOCATIONS



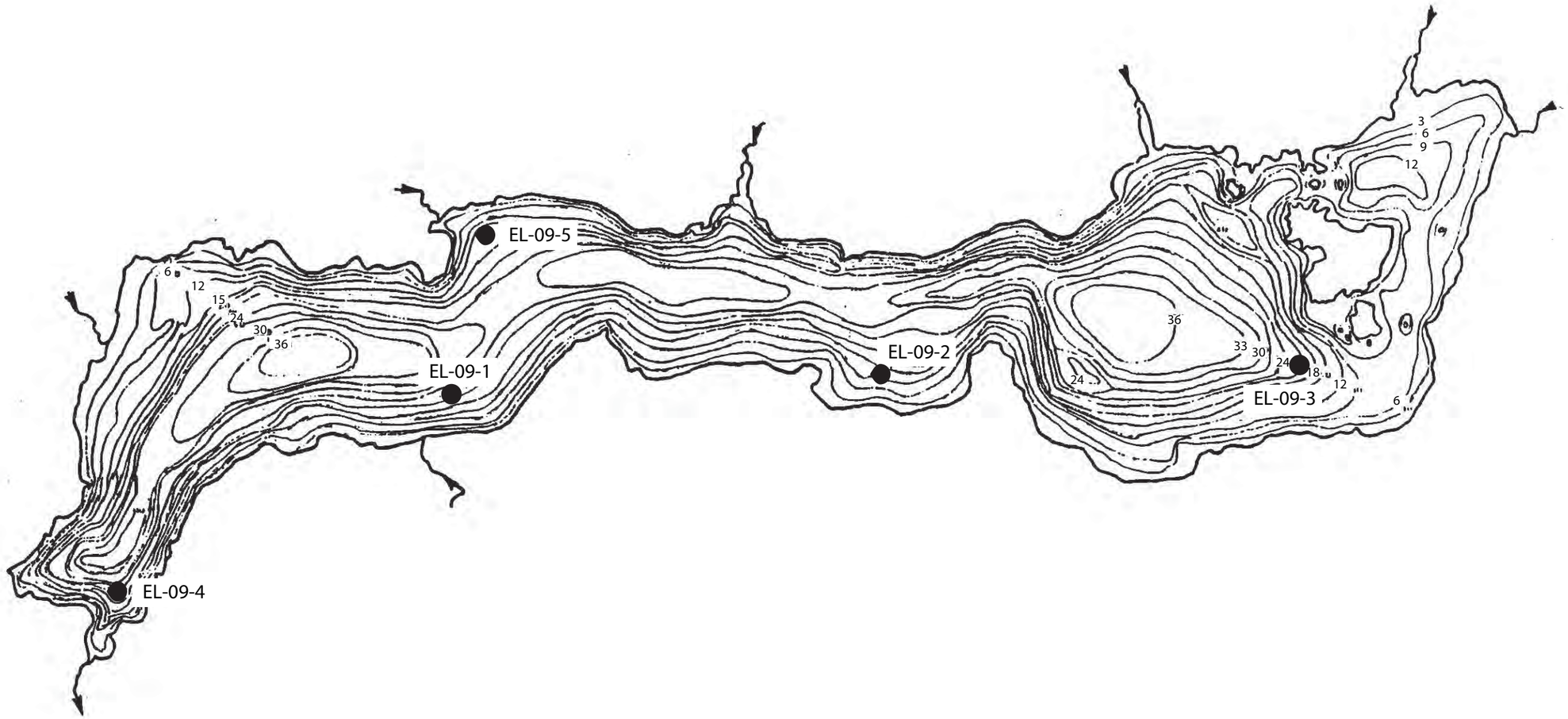
0 400 1000km

depth contours in metres

Figure A.1

Dunlop Lake sample locations, September 2009.

Ref: 2295
Date: November 2010



0 2 kilometers

depth contours in metres

Figure A.2

Elliot Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

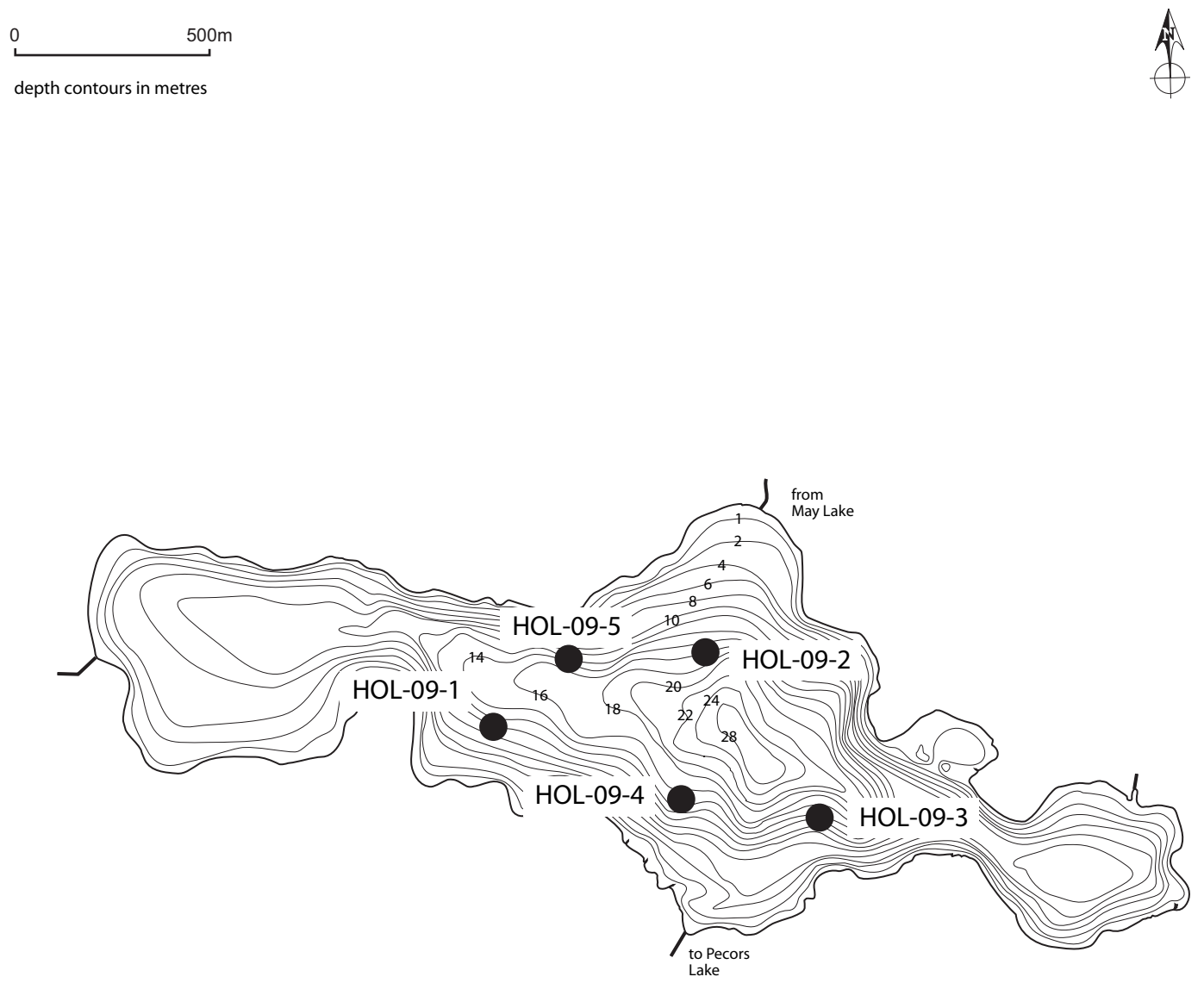


Figure A.3

Hough Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

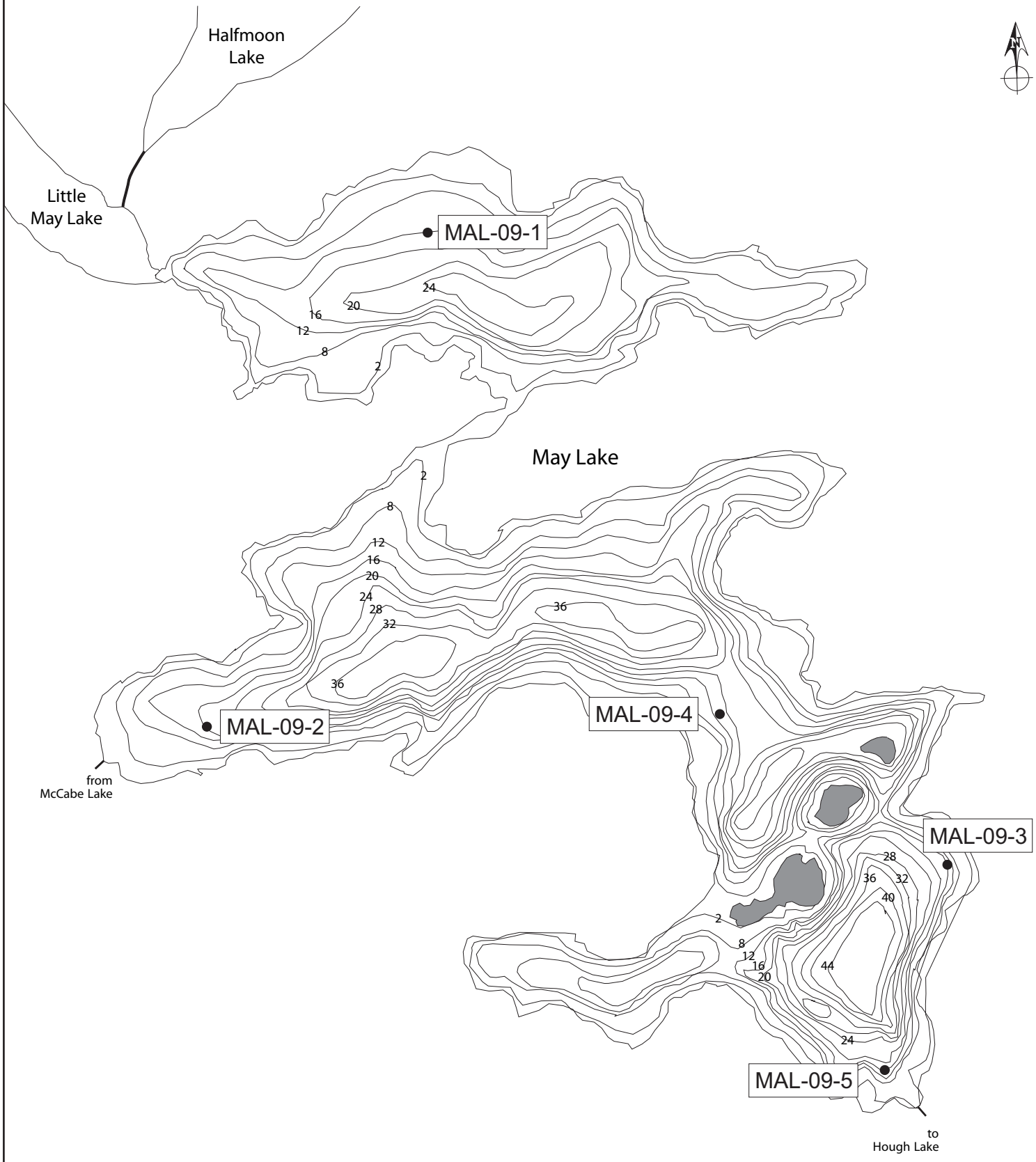


Figure A.4

May Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

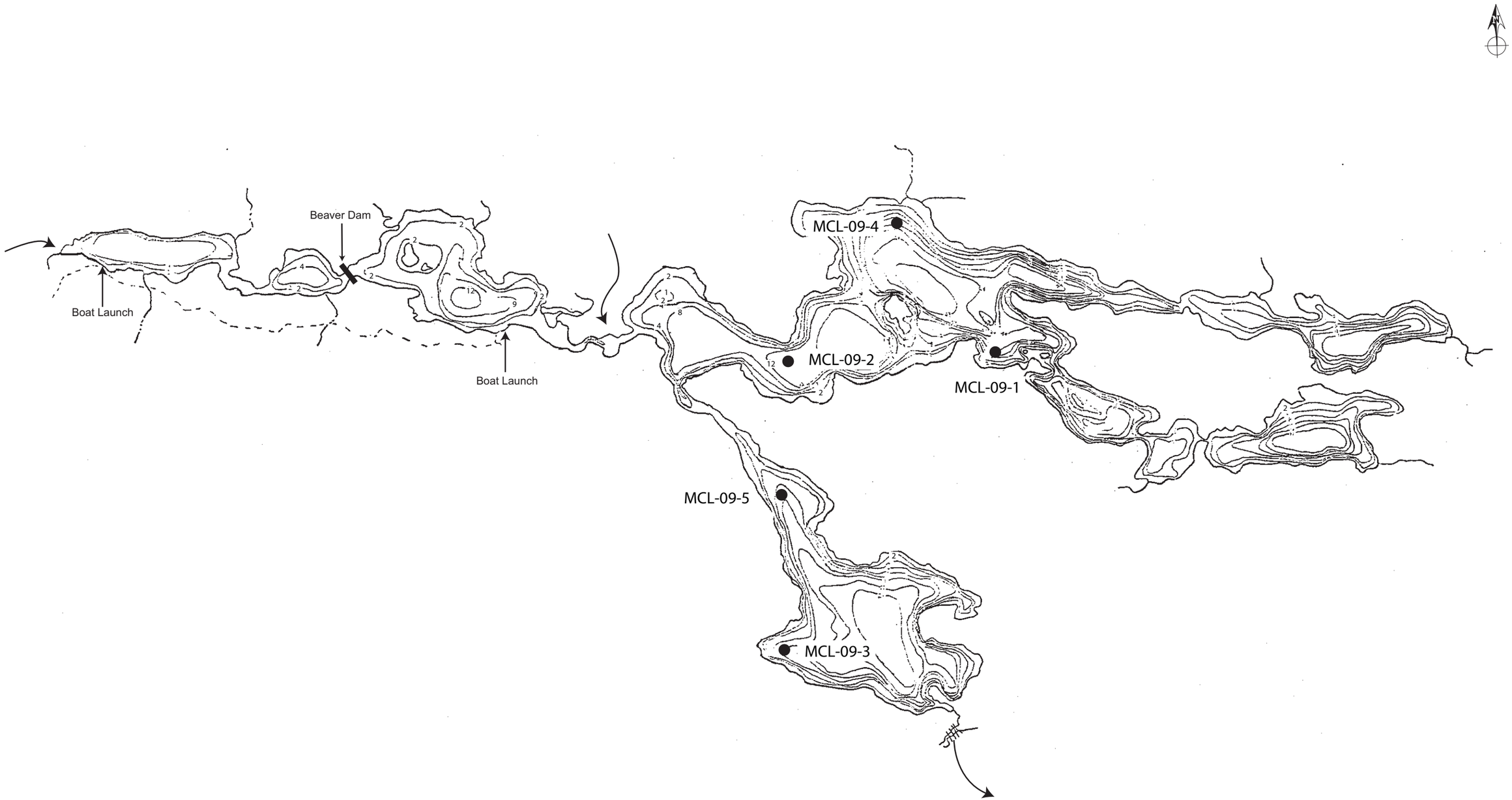


Figure A.5

McCarthy Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

Figure A.6

McCabe Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

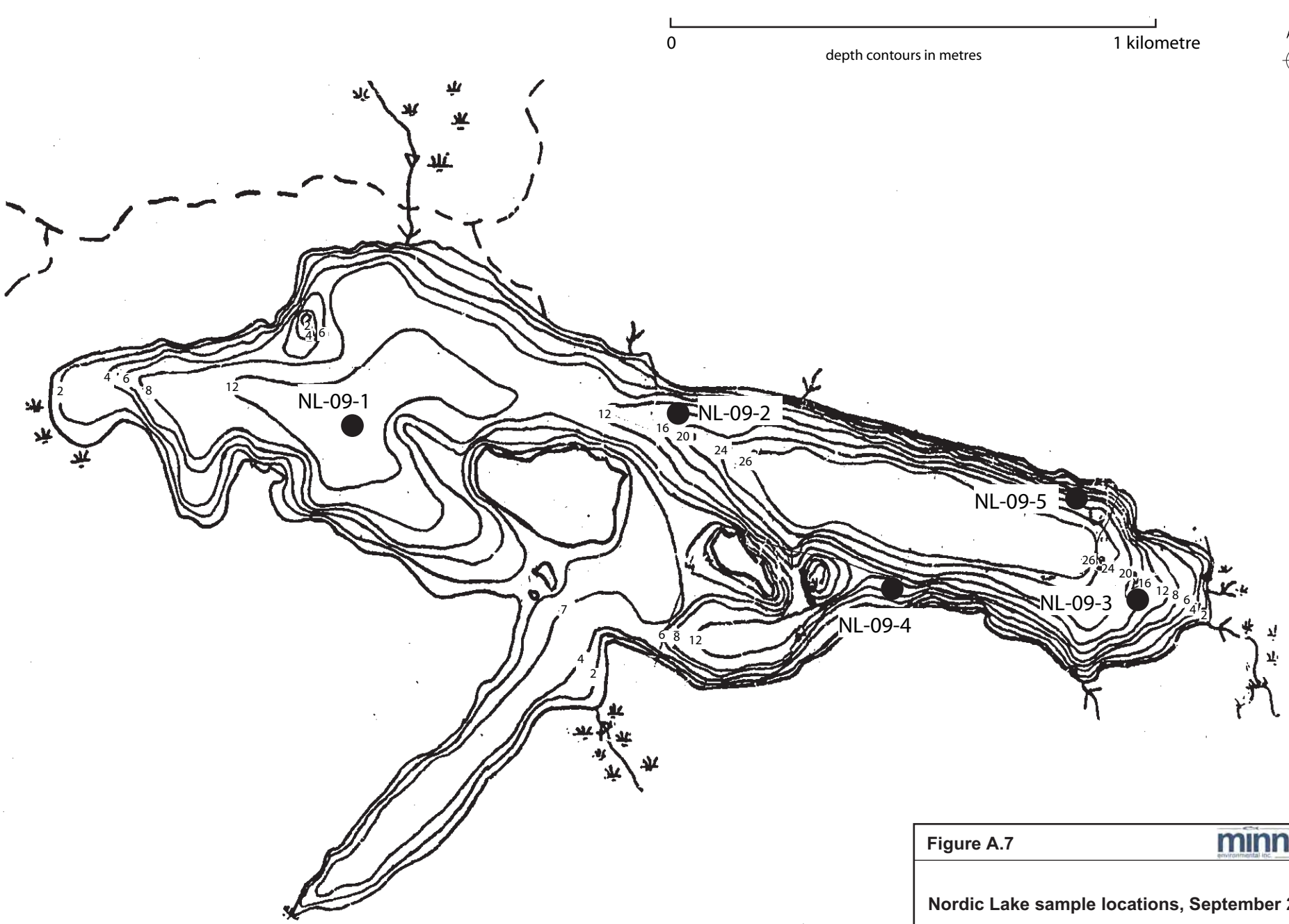
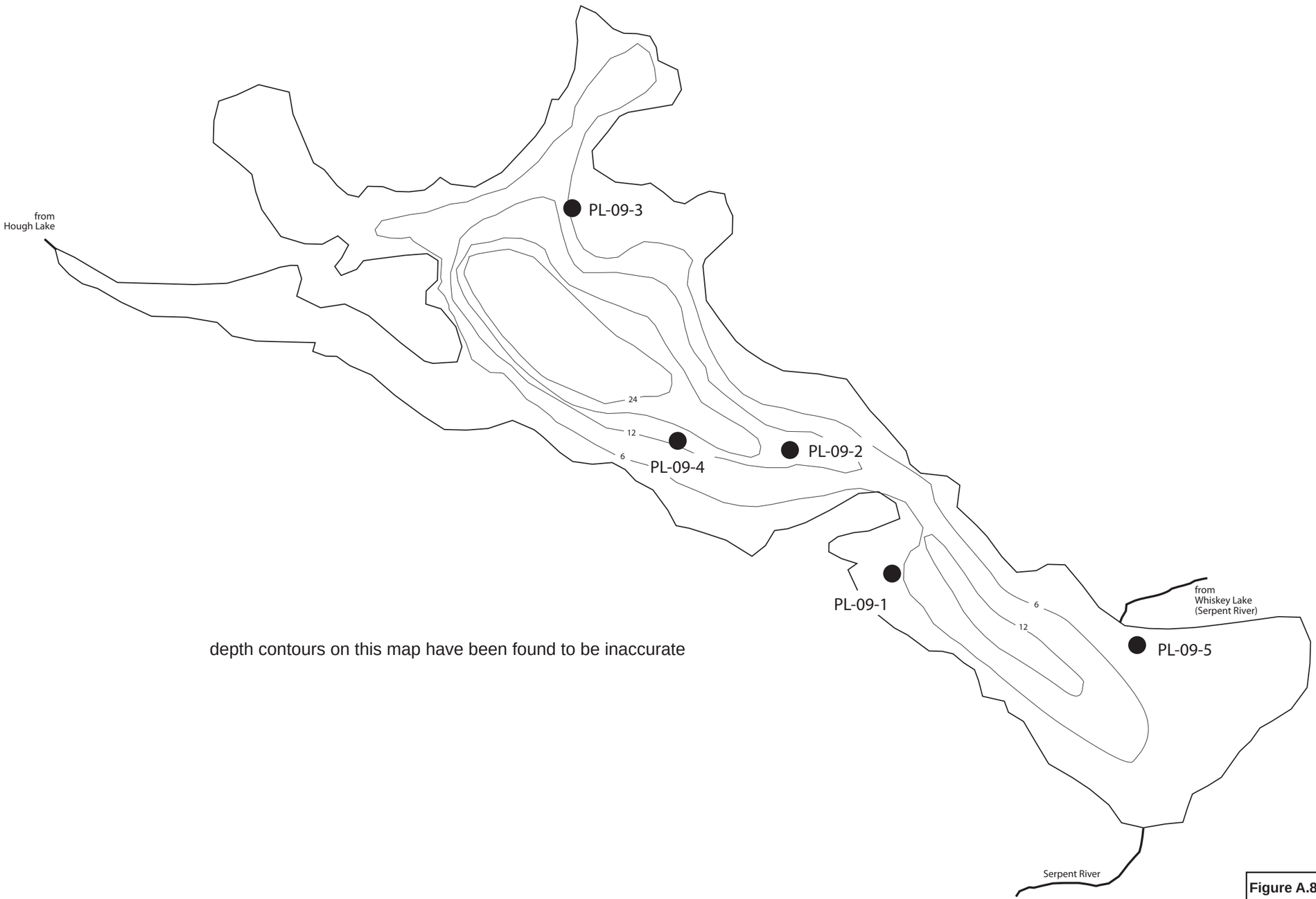


Figure A.7

Nordic Lake sample locations, September 2009.

Ref: 2295
Date: November 2010



depth contours on this map have been found to be inaccurate

0 500 metres

depth contours in metres

Figure A.8

Pecors Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

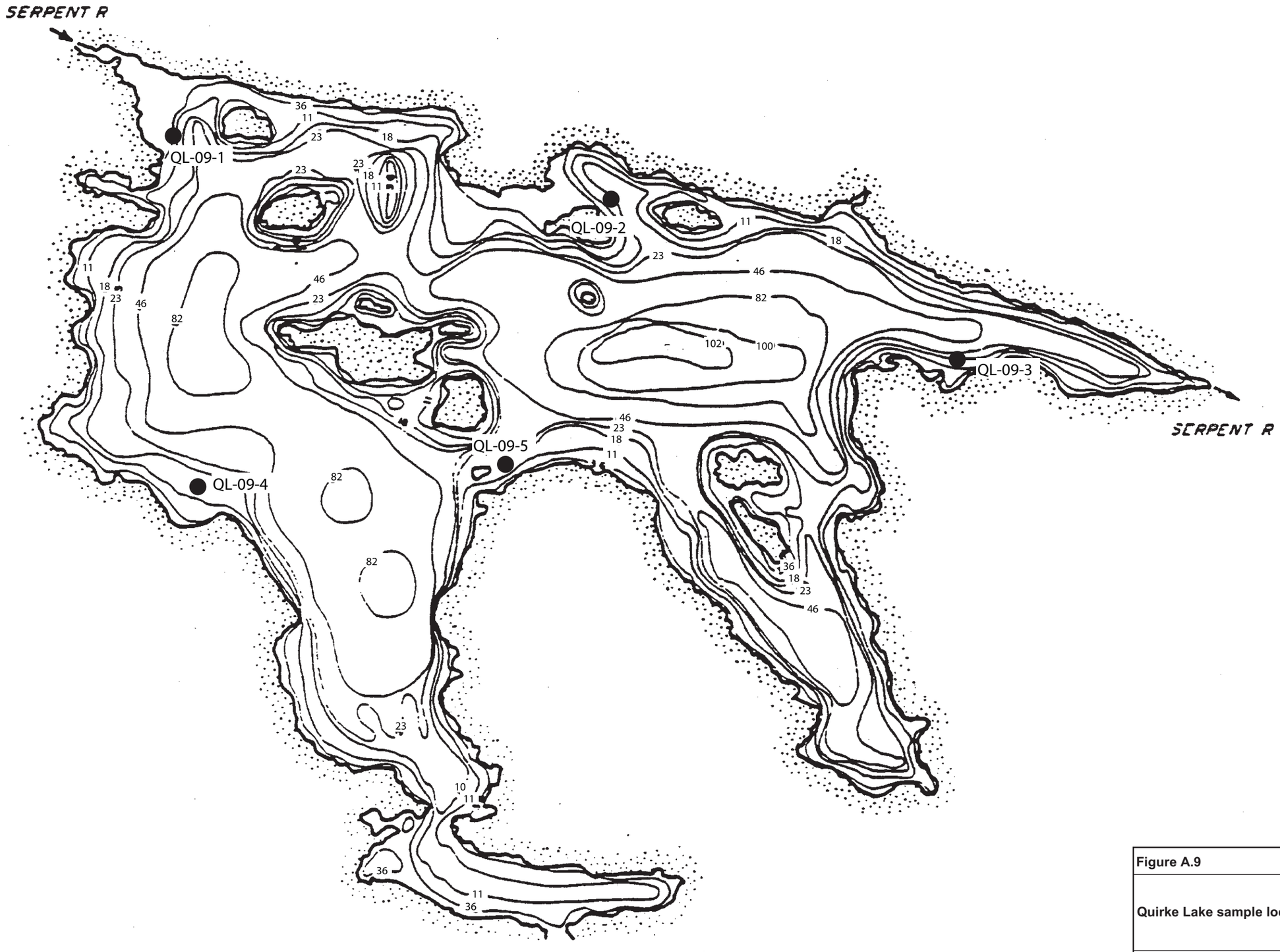


Figure A.9

Quirke Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

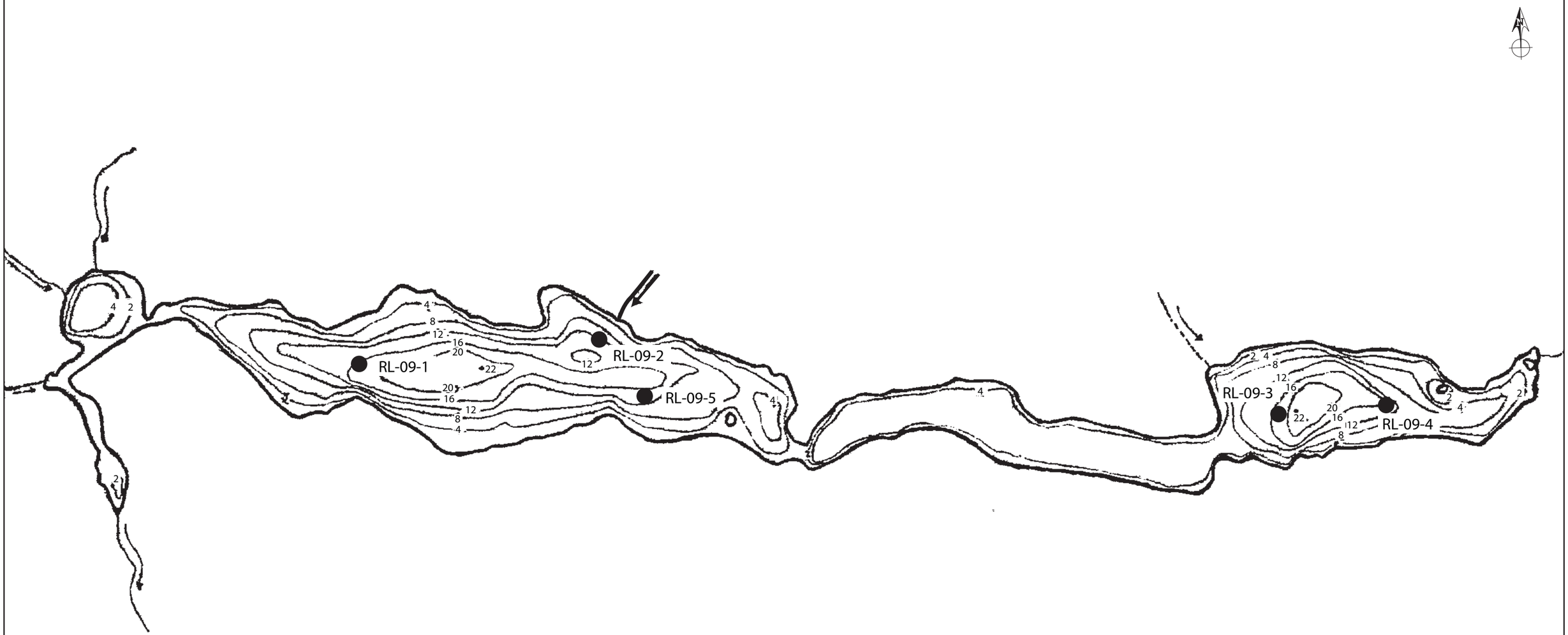


Figure A.10

Rochester Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

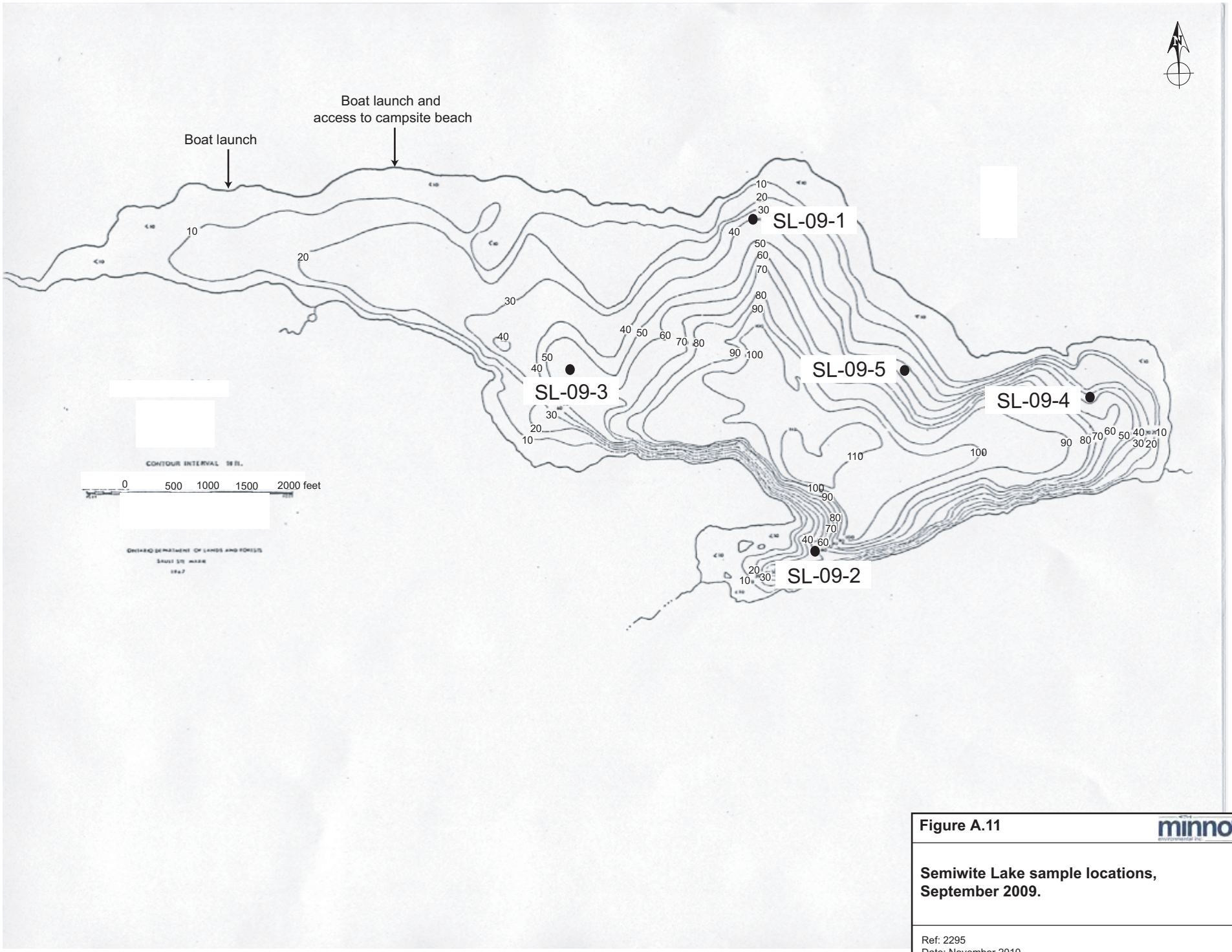


Figure A.11

Semiwite Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

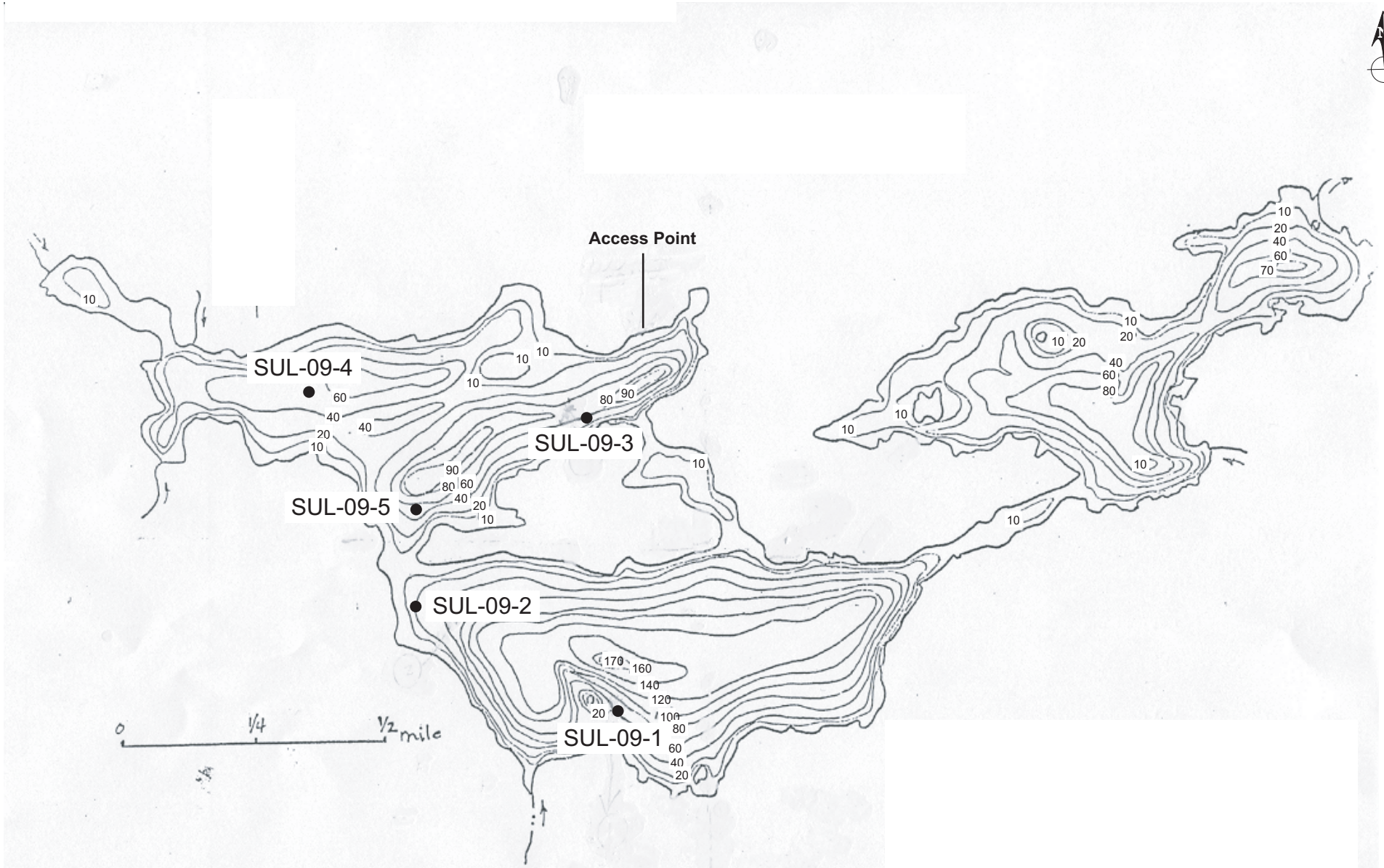
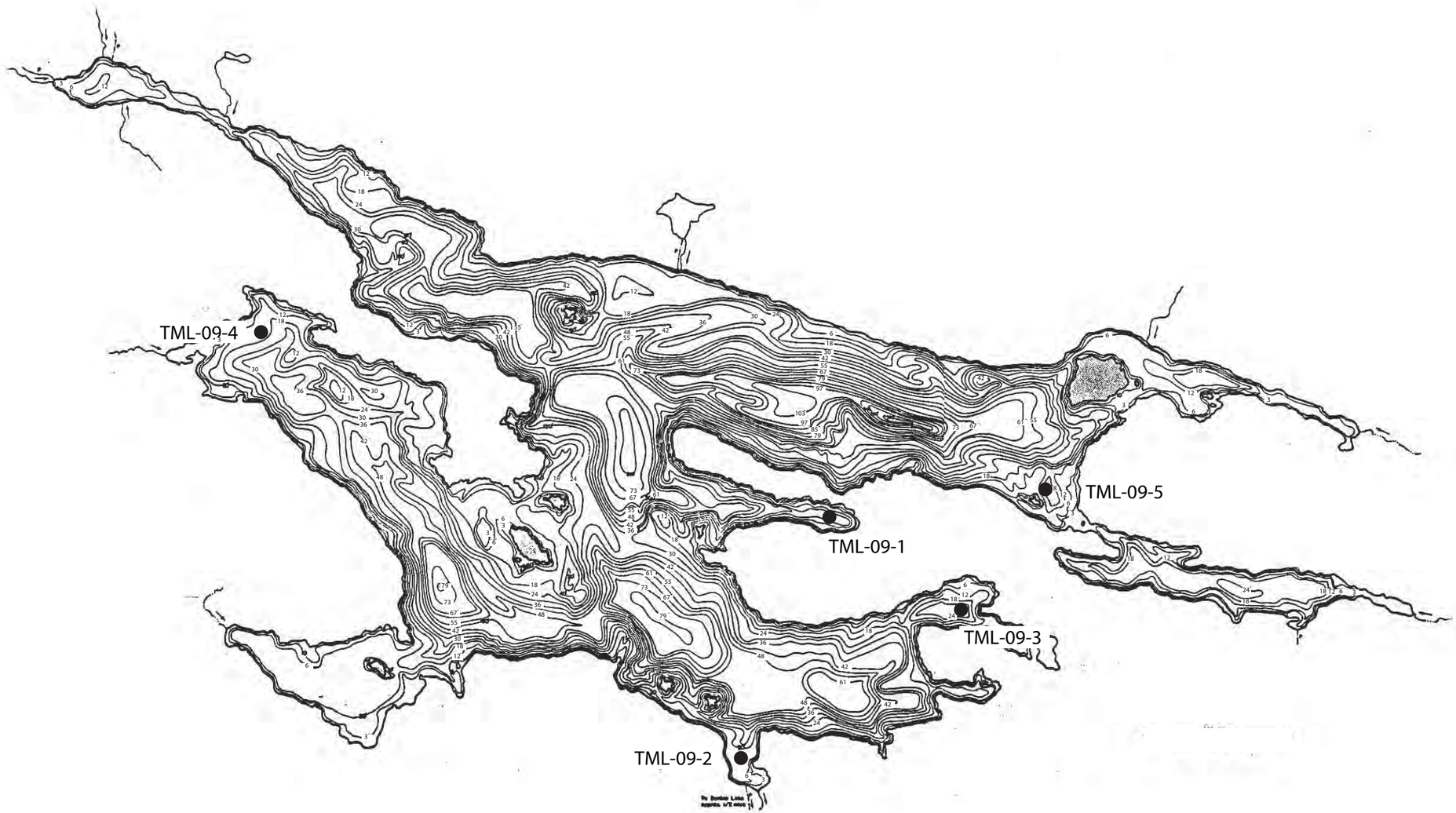


Figure A.12

Summers Lake sample locations, September 2009.

Ref: 2295
Date: November 2010



0 2 km

depth contours in metres

Figure A.13

minnow environmental inc.

Ten Mile Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

APPENDIX B

DATA QUALITY ASSESSMENT

APPENDIX B: DATA QUALITY ASSESSMENT

B1.0 INTRODUCTION

Data Quality Assessment (DQA) was conducted on data collected under the TOMP, SAMP and SRWMP between January 2005 and December 2009. The objective of DQA is to define the overall quality of the data presented in the report, and, by extension, the confidence with which the data can be used to derive conclusions.

B1.1 Background

A variety of factors can influence the chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. Therefore, a quality management program was previously established for the TOMP, SAMP and SRWMP to ensure that the data produced would satisfy the objectives of the program.

The data quality assessment and validation processes for the SRWMP were prescribed in detail in the Serpent River Watershed and In-Basin “Implementation Document” (BEAK 1999). The data quality assessment and validation process was revised in 2002 following recommendations from the Cycle 1 SRWMP (Minnow and Beak 2001b). Standard Operating Procedures (SOPs) providing additional clarification and detail with respect to data quality evaluation procedures were then prepared (Minnow 2005). Similarly, data quality management plans were developed as part of the initial TOMP and SAMP programs (Minnow 2002 a, b) which were updated as part of the revised study designs (Minnow 2009 a, b). Data quality for data collected during Cycle 3 of the TOMP, SAMP and SRWMP (2005 to 2009) was assessed in accordance with the

requirements outlined in the study designs and the results are presented in the following sections.

In brief, data quality assessment involved comparison of actual field and laboratory measurement performance to the data quality objectives (DQOs) established for the SRWMP, SAMP and TOMP (Appendix Tables B.1 and B.2). This included evaluation of analytical method detection limits, blank sample concentrations (field and laboratory), data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spikes and certified reference material analyses). Data quality protocols and sampling were incorporated into all components of the SRWMP, SAMP and TOMP including water, sediment, and benthos and represented a minimum of 10 percent of the total samples submitted for analysis.

Programs involving a large amount of samples and analytes usually result in some results that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP scans for metals) since the analytical conditions are not necessarily optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

B1.2 Water Sampling Program Administration

Water quality sampling is administered by Denison Environmental Services (DES) under contract to Rio Algom Limited and Denison Mines Inc. DES personnel are responsible for the scheduling of water sampling and quality assurance (QA) samples (field blanks and duplicates), the collection of samples, submission to the laboratory, data validation and water quality report preparation (monthly and annual reporting).

DES is also responsible for ensuring that all staff participating in the collection and handling of samples and data management for the SRWMP, SAMP and TOMP are adequately trained. In addition to the provision of standard operating procedures (SOPs) for each aspect of the program, DES maintains a training module on their database which tracks the completion of training for each employee by equipment or task.

Rio Algom Limited and Denison Mines Inc. have an Operating Document Registry which provides procedures and protocols to address all aspects of decommissioning operations and monitoring (Minnow 2005). DES staff use these protocols to implement

the water quality monitoring component of the TOMP, SAMP and SRWMP. Standard Operating Procedures that provide further clarification and detail with respect to data quality evaluation procedures are provided (Appendix A –PR8.5.3-01, PR8.5.4-01 and PR8.7.3-02)

The water samples were analyzed by the Elliot Lake Research Field Station (ELRFS; Laurentian University, Sudbury, Ontario) until the end of 2005 and since January 2006 SGS Laboratories (Lakefield, Ontario) have conducted the water analysis. Both laboratories are accredited by the Canadian Association of Environmental and Analytical Laboratories (CAEAL). Since 2006, Becquerel Laboratories (Mississauga, Ontario) has been commissioned to analyze for radium-226 in water and sediment samples.

Prior to 2006, ELRFS laboratory entered laboratory results into a central database program (Envista) following internal QA review. As of January 2006, the data management software was changed to emLine and since that time SGS laboratories has entered the data into their laboratory information management system (LIMS) data management program and DES imports the data from LIMS into emLine. This minimizes data entry errors.

As per the TOMP, SAMP and SRWMP the laboratories were responsible for conducting QA analysis including laboratory blanks and duplicates, as well as Certified Reference Material (CRM) and spike sample recoveries. Each laboratory provided annual data quality reports in which they compare the performance of QA samples to the established data quality objectives (2005-2009 annual reports can be found at the end of this appendix). Due to a re-issue of results in 2006 and 2007, Becquerel Laboratories quality assurance reports are provided as separate files at the end of this appendix, while the reports from 2008 and 2009 from Becquerel Laboratories are summarized at the end of the 2008 and 2009 SGS reports, respectively. Detailed quality assurance reports are kept on file as part of the monitoring archives with DES and Rio Algom Ltd.

B1.3 Types of Quality Control Samples Collected

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples, and a description of each, include the following:

- **Field Duplicates** are replicate samples collected from a selected field station using identical collection and handling methods that are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field duplicate samples reflect natural

variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.

- **Laboratory Duplicates** are replicate sub-samples created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.

- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks are created using laboratory control materials whereas matrix spikes are created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials and QC Standards** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

Two types of QC were applied to benthic invertebrate community samples as follows:

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

- **Sub-Sampling Error** is assessed for studies in which benthic invertebrate community samples require sub-sampling (due to excessive sample volume and/or invertebrate density). By comparing the numbers of benthic invertebrates

recovered between at least two sub-samples, this measure provides an evaluation of how effective the sub-sampling method was in evenly dividing the original sample. Therefore, sub-sampling error provides a measure of analytical accuracy and precision. The processing of entire benthic invertebrate community samples in representative sample fractions also allows an evaluation of sub-sampling accuracy.

B2.0 WATER SAMPLES

B2.1 Method Detection Limits

In general, the requested method detection limits (MDLs) were achieved for SRWMP, SAMP and TOMP for most parameters assessed during the 2005 to 2009 period (Tables B.3 and B.4). There were a few exceptions for cobalt, sulphate, TSS and uranium at only one or two stations within each program (Table B.5). In instances where requested MDLs were not achieved, the difference was generally minimal (i.e., sulphate, TSS), there was a suspected typographical error (i.e., cobalt), and/or the achieved MDL was at or below receiving environment water quality criteria (i.e., sulphate, TSS, uranium; Table B.5). Specifically, at SRWMP station P-01 and TOMP station DK16-2B, the sulphate MDL was five- and two-fold higher than requested, respectively; however, the achieved MDL was substantially lower than the receiving environment criteria. In SAMP, the achieved uranium MDL at station N-12 (2005) was an order of magnitude higher than the requested MDL; however, it was still equal to the receiving environment criteria. Achieved MDL for TSS at SAMP station D-2 (2006) and TOMP station Q-28 (2006) was two-fold higher than the requested MDL. However, given that the effluent discharge criteria is between 20 and 50 mg/L, the higher MDL did not affect the ability of the mine to determine compliance with effluent limits. The achieved MDL for cobalt at SAMP station D-2 (2005) was higher than both the requested MDL and the receiving environment criteria. This was likely a typographical error as the MDL in May and November 2005 was 0.0003 mg/L for all 2005 sampling at Station P-01. Therefore, despite some DQO exceedences for MDL, overall sample data for this project could be reliably interpreted relative to the objectives of each program.

B2.2 Field and Laboratory Blank Sample Analysis

Field Blanks

Analytical results for blank samples are considered acceptable when concentrations are below two times the requested MDL. However, in cases where the MDL exceeded acceptability criteria (e.g., sulphate in 2006 at SRWMP station P-01, Table B.6; uranium in 2005 at SAMP station N-12, Table B.7), blank results were not considered to exceed criteria because the true concentration is not known (i.e., the results were not detectable). There was one case where a detected concentration was >2 times the MDL in SAMP (e.g., sulphate; Table B.7), and numerous cases in TOMP (e.g., radium-226 in

Table B.8; acidity, iron, sulphate in Table B.9). In none of these cases would the field blank concentrations have any potential to confound the interpretation of results, as measured sample concentrations for these specific parameters were substantially higher.

Laboratory Blanks

Laboratory blank data were summarized as part of the annual quality control reports for 2005 (ELRFS) and 2006 to 2009 (SGS); however, data were not provided for individual laboratory blank samples (Table B.10). In addition, acidity and TSS were not analyzed in 2005. As a result, assessment and interpretation is limited to summarized data.

There were no mean laboratory blank concentrations that exceeded the program criteria. However, there were a few cases where individual concentrations of some parameters exceeded the program and lab criteria, including radium-226 in 2005, 2006 and 2007, as well as sulphate in 2005 (Table B.10). However, exceedences of radium-226 and sulphate in the laboratory blanks will not confound the interpretation of results, as measured concentrations from the programs are substantially higher. Overall, the laboratory blank data is acceptable for the objectives of these programs.

B2.3 Data Precision

Precision is based on the relative percent difference (RPD) between analytical results for samples collected side by side in the field, or samples split in the laboratory. The RPD is calculated by Minnow by taking the absolute difference between samples divided by the average of the samples, multiplied by 100. This method always produces a positive value even if the duplicate has a concentration less than the original (e.g. the value represents the percent difference between samples). Conversely, the laboratories produce values that can be positive or negative depending on the whether the concentration in the duplicate is greater than or less than the original. The problem with this latter approach is that when the results are averaged, extremely positive and extremely negative RPDs will cancel each other out to produce a mean RPD near 0%. An RPD near 0% suggests that duplicate samples are generally not different from the original sample, which may or may not actually be the case. Therefore, when the labs summarize the laboratory duplicate data (individual RPDs are not provided), it is difficult to interpret the mean RPDs.

Field Precision

Many duplicate water samples were collected in the field from 2005 to 2009 from SRWMP, SAMP, TOMP, and they generally showed fairly good agreement in analyte concentrations (Tables B.11 to B.15). These RPDs are calculated using Minnow's approach (absolute difference between samples). Most parameters with DQO exceedences could be considered isolated cases due to the low number of exceedences over the five-year sampling period: acidity (3 exceedences), barium (4), cobalt (2), iron (6), manganese (1 – probable typographical error), sulphate (2), and uranium (1; exceedences summarized in Table B.16). There were more DQO exceedences observed for radium-226 (30) and TSS (31; Table B.16). Despite RPD exceedences ranging from 22.2% to 100% for TSS, in all cases the high RPD was a result of concentrations being close to the detection limit. Conversely, only 5 exceedences for radium-226 can be explained by concentrations nearing the detection limit (28.6% to 50% RPD range) and all occurred in the SRWMP. The other 25 exceedences for radium-226 mainly occurred in SAMP (22.2% to 42.4% RPD range) and TOMP (20.4% to 32.9% RPD range) stations at concentrations orders of magnitude higher than the MDL. Three exceedences of radium-226 in SRWMP (27.7% to 57.1% RPD range) could also not be explained by concentrations near MDL. While most exceedences were between 20% and 30% for radium-226, and RPDs >30% were isolated cases, it would still be worth examining the field water sampling program to see if the sampling techniques can be augmented to reduce any field variability. It may also be possible that some of the "field variability" for radium-226 may be caused by analytical difficulties, as radium-226 was the only parameter to have any CRM DQO exceedences (Section B2.4), and the only parameter to have laboratory duplicate DQO exceedences not explained by concentrations near the MDL (next section). Overall, since most DQO exceedences in the field were isolated, the data suggest that reported sample data were reasonably precise representations of conditions at the time of sampling with some possible environmental variability or analytical difficulty for radium-226.

Laboratory Duplicate Samples

Overall, there is close agreement between original and duplicate water analysis in the laboratory for all parameters (Table B.17). Out of 6192 laboratory duplicate analyses, only 214 (3.5%) exceeded the program DQO of 10%. Of these, all parameter exceedences (except radium-226) are explained by detectable concentrations nearing the MDL. For radium-226, specifically, a total of 456 duplicate analyses were conducted by Becquerel Laboratories with a total of 42 DQO exceedences (9.2%). Of these, only 7

can be explained by concentrations nearing the MDL. This result in combination with the high occurrence of DQO exceedences for field duplicate samples for radium-226 suggest analytical difficulties are likely responsible for variability within results. In the 2006 and 2007 reports, Becquerel states that "the main challenge is in maintaining precision without incurring unreasonable expenditures of resources". In the 2008 and 2009 reports, they state "rush analyses present challenges in maintaining accuracy and precision" despite concluding that the QA data is satisfactory. It was 2008 and 2009 that contained the most DQO exceedences for radium-226 (15 exceedences each year). It is recommended that any analytical difficulties with radium-226 be discussed with Becquerel Laboratories, in order to identify opportunities to increase precision.

B2.4 Laboratory Data Accuracy

For the most part, analyte recoveries for spiked blank samples met the laboratory DQO of 70 - 130%; however, since laboratory results are summarized rather than presented individually, it is not possible to ascertain if the spiked blank samples met the program DQO of 80 - 120% (Table B.18). Barium recovery could be considered poor in 2006, where 44.5% of samples showed <70% recovery (lab DQO). That number would be expected to increase when using the program criteria (80 – 120% recovery). Again in the 2007 to 2009 reports, barium was the only parameter to have recoveries <70% (on average). The laboratory suggested these poor recoveries were a result of very low concentrations of barium being spiked into the blank. The concentrations of barium introduced into the blank samples were below the program method detection limit resulting in the reporting of "less than" results which in turn produced very low (or zero) percent recovery numbers. In the future spiked concentrations of all analytes should be at a level greater than the method detection limit in order to facilitate the calculation of meaningful percent recovery numbers. Recovery of certified reference material (CRM) met the DQO of 80 – 120% for all parameters except radium-226 (4,663 analyses). There were a few instances in 2006 and 2007 where recovery of radium-226 was outside of the program DQO for some individual samples. Originally, 8 of 95 samples (8.4%) in 2006 for radium-226 fell outside the DQO, but two were re-analyzed (considered non-conformances by the laboratory) and new results were within DQO.

These results in combination with the high RPDs in field and laboratory duplicates for radium-226 suggest that there may some challenges associated with the analysis of this particular parameter. Thus, opportunities should be identified either in the field or within the analytical technique so that more results achieve the program objectives.

B3.0 SEDIMENT SAMPLES

B3.1 Method Detection Limits

Target laboratory method detection limits (MDLs) for sediment sample analyses were established at levels below all potentially applicable sediment quality guidelines (Table B.20). Not all analyses achieved the target MDL (i.e., iron, manganese and radium-226). Each of these analytes were detectable in sediment samples (iron >8,200 mg/kg; manganese >290 mg/kg; radium-226 >40 Bq/kg) at concentrations much greater than the achieved MDLs, therefore these elevated MDLs did not compromise the intended use of the data.

B3.2 Laboratory Blank

No analytes were detected in the laboratory blanks (Table B.21), although as mentioned in Section B3.1, the MDLs for iron, manganese, and radium-226 were higher than the target MDL (Table B.20). However, since concentrations of these substances were so much higher in all lake samples, this does not affect the utility of the results. The laboratory blanks are considered acceptable.

B3.3 Data Precision

Field Duplicate Samples

There were some very minor exceedences of RPD of 40% in the particle size analysis, but only by 1 or 2% (Table B.22). Two duplicates had RPDs >40% for manganese at Stations SL-09-05 and SUL-09-03 and this may suggest somewhat higher environmental variability for this particular parameter. No other parameter exceeded the DQO, and overall, field precision is considered acceptable for the program objectives.

Laboratory Duplicate Samples

Most laboratory duplicate sediment analyses met the DQO of 20% (Tables B.23 and B.24). However, one radium-226 duplicate analysis returned a RPD of 33%, although concentrations are nearing the detection limit (Table B.23). As well, the QC batch number 1965516 of report MA9C6993 (McCarthy Lake) experienced a few laboratory duplicates where the relative percent difference was greater than 20% (barium, cobalt, iron, and manganese; Table B.24). However, considering all other quality control measures (e.g. laboratory blank, laboratory accuracy for this particular QC analysis), the overall data quality was considered acceptable and possibly the large RPD values

associated with this one sample may suggest that these sediments were not sufficiently homogenized prior to sub-sampling.

B3.4 Data Accuracy

Recoveries of all analytes in spiked blank samples and QC standards met the respective data quality objectives with exception of one iron sample, but this was only 4% outside the DQO range and was an isolated case (Table B.25). Recoveries of all matrix spikes were within the DQO range of 70 - 130% (Table B.26). These data indicated acceptable analytical accuracy associated with the analysis of sediment samples.

B3.5 Toxicity

All toxicity test validity criteria specified in the test method cited in the Aquatox toxicity report were satisfied (see test reports provided in Appendix E).

B4.0 BENTHIC MACROINVERTEBRATE SAMPLES

B4.1 Organism Recovery

The objective for percent organism recovery was 95%, and there were four out of seven instances where this DQO was not met (i.e., HOL-09-01, PL-09-2, RL-09-3 and TML-09-5), but in all cases percent recovery was >90% and in most cases, the difference in number of organisms was only 12 (Table B.27). The overall percent recovery was 94.2%, which is only slightly less than the DQO. Therefore, percent recovery is considered acceptable.

B4.2 Sub-sampling Precision and Accuracy

Fractions sorted for each sample ranged from 1/8 to whole samples, with five samples chosen for sub-sampling (Table B.28). Precision and accuracy of the sub-sampled benthic invertebrate community samples met the DQO of 20% in all cases (Table B.29). Therefore, precision and accuracy are considered acceptable for the program objectives.

B5.0 DATA QUALITY STATEMENT

While there were some field blanks for the groundwater and porewater samples did not achieve the established DQO, the concentrations detected in actual field samples were substantially high enough that the low concentrations detected in the blank samples would not influence the interpretation of results. Most DQOs for surface water duplicate samples were considered acceptable, since in the few instances when concentrations exceeded the DQO they were near MDLs. There appeared to be some analytical difficulties with radium-226 that affected field precision results, laboratory precision results and recovery of CRM. This should be examined and discussed with the laboratory to identify opportunities to reduce variability and meet the program DQO for this parameter. The major problem with the laboratory QA reports, in general, is in their reporting and data summarization. For barium, the actual MDL is much lower than the target MDL and the spike concentration is also lower than the target MDL. Thus, reporting of this parameter is inaccurate, at present. As well, the laboratory's method of calculation for average RPD is misleading, as poor recovery can be masked by extreme positive and negative recovery values.

For sediment samples, high RPDs in field duplicates for manganese suggest some environmental variability. There were some issues with barium, cobalt, iron and manganese exceeding laboratory DQOs in laboratory duplicates of one sediment sample, but these are considered acceptable based on all other QA/QC data.

Benthic data quality was considered acceptable, although the percent organism recovery was a bit lower than the target DQO.

Overall, the majority of data quality analysis (with the exception of barium and radium-226 laboratory concerns, as mentioned above) was considered adequate to serve the project objectives.

Appendix Table B.1: Data quality objectives for the SRWMP.

Measurements	Units	Detection Limit	Field & Lab Blank Criterion	Analytical Precision (Duplicates)	Analytical Accuracy		Field Precision (Duplicates)
					Spike	CRM[b]	
Field Measurements							
pH	pH units	0.1	-	0.1[a]	-	-	10%
Conductivity	mS/cm	0.01	-	0.05[a]	-	-	10%
Dissolved oxygen	mg/L	0.01	-	0.05[a]	-	-	20%
Temperature	^{o}C	varies w method	-	0.1[a]	-	-	20%
Flow	L/s	varies w method	-	0.1[a]	-	-	30%
Laboratory Water Chemistry							
Barium	mg/L	0.005	0.01	10%	80 - 120%	80 - 120%	20%
Cobalt	mg/L	0.0005	0.001	10%	80 - 120%	80 - 120%	20%
Iron	mg/L	0.02	0.04	10%	80 - 120%	80 - 120%	20%
Manganese	mg/L	0.002	0.004	10%	80 - 120%	80 - 120%	20%
Radium-226	Bq/L	0.005	0.01	20%	80 - 120%	-	20%
Sulphate	mg/L	0.1	0.2	10%	80 - 120%	80 - 120%	20%
Uranium	mg/L	0.0005	0.001	10%	80 - 120%	80 - 120%	20%
Laboratory Sediment Chemistry							
Barium	mg/kg	0.5	-	20%	70 - 130%	70 - 130%	40%
Cobalt	mg/kg	0.2	-	20%	70 - 130%	70 - 130%	40%
Iron	mg/kg	20	-	20%	70 - 130%	70 - 130%	40%
Manganese	mg/kg	0.5	-	20%	70 - 130%	70 - 130%	40%
Nickel	mg/kg	0.5	-	20%	70 - 130%	70 - 130%	40%
Radium-226	Bq/kg	5	-	20%	70 - 130%	70 - 130%	40%
Uranium	mg/kg	0.1	-	20%	70 - 130%	70 - 130%	40%
Grain size	%	0.1	-	20%	70 - 130%	70 - 130%	40%
TOC	%	0.05	-	20%	70 - 130%	70 - 130%	40%
Benthos							
Organism Recovery		-	-	90%	-	-	-
Subsampling Precision		-	-	20%	-	-	-
Subsampling Accuracy				20%			
Sediment Toxicity							
Chironomus dilutus		-	70% control surv.	20% control CV	-	± 3 SD in ref tox	-
Hyalella azteca		-	70% control surv.	20% control CV	-	± 3 SD in ref tox	-

[a] Minimum Detectable Difference as identified in instrument manual rather than measurement of analytical precision using replicate samples.
[b] CRM (Certified Reference Material).

Appendix Table B.2: Field and laboratory data quality objectives for SAMP/TOMP stations.

Parameter	Units	Targeted Detection Limit	Minimum Detectable Difference	Field Blank Criteria	Laboratory Blank Criteria	Field Precision	Laboratory Precision	Laboratory Spikes	Laboratory Accuracy (CRM)
Field Parameters									
Flow	L/s	method	0.1	-	-	-	-	-	-
pH	pH units	0.1	0.01	-	-	20%	-	-	-
Laboratory Parameters									
Acidity	mg/L	2.0	-	2	2	20%	10%	-	80 - 120%
Barium	mg/L	0.005	-	0.01	0.01	20%	10%	80 - 120%	80 - 120%
Cobalt	mg/L	0.0005	-	0.001	0.001	20%	10%	80 - 120%	80 - 120%
Iron	mg/L	0.02	-	0.04	0.04	20%	10%	80 - 120%	80 - 120%
Manganese	mg/L	0.002	-	0.004	0.004	20%	10%	80 - 120%	80 - 120%
Radium-226	Bq/L	0.005	-	0.01	0.01	20%	10%	80 - 120%	80 - 120%
Sulphate	mg/L	0.1	-	0.2	0.2	20%	10%	80 - 120%	80 - 120%
TSS	mg/L	1	-	2	2	20%	-	-	-
Uranium	mg/L	0.0005	-	0.001	0.001	20%	10%	80 - 120%	80 - 120%

Appendix Table B.3: Field and laboratory method detection limits (MDLs) for SRWMP water quality analysis.

Parameter	Units	MDL Requested (DQO)	MDL Achieved
Field Instruments			
pH	pH units	0.1	0.1
Conductivity	uS/cm	0	0
Dissolved Oxygen	mg/L	0	0
Laboratory			
Barium	mg/L	0.005	0.001 - 0.005
Cobalt	mg/L	0.0005	0.0003 - 0.0005
Iron	mg/L	0.02	0.02
Manganese	mg/L	0.002	0.002
Radium-226	Bq/L	0.005	0.005
Sulphate	mg/L	0.1	0.1 - 0.5
Uranium	mg/L	0.0005	0.0005

MDL does not meet DQO

Appendix Table B.4: Field and laboratory method detection limits (MDLs) for SAMP and TOMP water quality analysis.

Parameter	Units	MDL Requested (DQO)	MDL Achieved
Field Instruments			
pH	pH units	0.1	0.1
Conductivity	uS/cm	0	0
Laboratory			
Acidity	mg/L	2	1
Barium	mg/L	0.005	0.001 - 0.005
Cobalt	mg/L	0.0005	0.0003 - 0.003
Iron	mg/L	0.02	0.02
Manganese	mg/L	0.002	0.002
Radium-226	Bq/L	0.005	0.005
Sulphate	mg/L	0.1	0.1 - 0.2
TSS	mg/L	1	1 - 2
Uranium	mg/L	0.0005	0.0005 - 0.005

MDL does not meet DQO

Appendix Table B.5: Specific method detection limits that did not meet data quality objectives, 2005 to 2009.

Program	Station	Date	Parameter	Units	MDL Requested (DQO)	MDL Achieved	Receiving Environment Criteria	Range in Discharge Criteria (Grab)
SRWMP	P-01	Jan-06	Sulphate	mg/L	0.1	0.5	100[a]	-
SAMP	N-12	Feb-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		May-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		Jul-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		Aug-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		Nov-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
	D-2	Aug-05	Cobalt	mg/L	0.0005	0.003	0.0009[b]	-
		Feb-06	TSS	mg/L	1	2	-	20-50
		Mar-06	TSS	mg/L	1	2	-	20-50
TOMP	Q-28	Jan-06	TSS	mg/L	1	2	-	20-50
		Feb-06	TSS	mg/L	1	2	-	20-50
		Mar-06	TSS	mg/L	1	2	-	20-50
	DK16-2B	Aug-07	Sulphate	mg/L	0.1	0.2	100[a]	-

[a] British Columbia Water Quality Guidelines (BCMOE 2006)

[b] Provincial Water Quality Objectives

"-" denotes that no criteria has been set

Appendix Table B.6: Field blanks for SRWMP 2005-2009.

Date	Units	Field Blank Criterion	P-01													
			Jan-05	Apr-05	Jul-05	Oct-05	Jan-06	Apr-06	May-06	Jul-06	Oct-06	Nov-06	Feb-07	Apr-07	May-07	Jul-07
Barium	mg/L	0.01	0.002	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0003	<0.0003	<0.0003	<0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04					<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004					<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	pH units	-	5	5.5	5.1	5.4										
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	<0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Date	Units	Field Blank Criterion	P-01													
			Oct-07	Nov-07	Jan-08	Apr-08	May-08	Aug-08	Oct-08	Jan-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Oct-09
Barium	mg/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	pH units	-														
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	<0.1	0.2	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Date	Units	Field Blank Criterion	D-5										
			May-05	Nov-05	May-06	Nov-06	May-07	Nov-07	May-08	Nov-08	Feb-09	Jun-09	Nov-09
Barium	mg/L	0.01	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0003	<0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	pH units	-	5.6	5									
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.7: Field blanks in SAMP water samples from 2005-2009.

Date	Units	Field Blank Criterion	N-12											
			Feb-05	May-05	Aug-05	Nov-05	Feb-06	May-06	Aug-06	Nov-06	Feb-07	May-07	Aug-07	Nov-07
Barium	mg/L	0.01	0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0003	<0.0003	<0.0003	<0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003
pH	-	-	4.7	5.6	5.6	5.5	5.6	5.4	5.6	5.3	5.3	5.3	5.3	5.3
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Date	Units	Field Blank Criterion	N-12							
			Feb-08	May-08	Aug-08	Nov-08	Feb-09	May-09	Aug-09	Nov-09
Barium	mg/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002
pH	-	-	5.3	5.4	5.5	6	5.6	5.5	5.5	5.7
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.8: Field blanks for TOMP water samples from 2005-2009.

Date	Units	Field Blank Criterion	Q-28											
			Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05
Acidity	mg/L	2												
Barium	mg/L	0.01												
Cobalt	mg/L	0.001												
Iron	mg/L	0.04												
Manganese	mg/L	0.004												
pH	-	-	5.5	5.6	5.6	5.6	5.5	5.5	5.7	5.6	5.7	5.7	5.7	5.7
Radium-226	Bq/L	0.01	<0.005	0.006	0.011	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Sulphate	mg/L	0.2												
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001												

Date	Units	Field Blank Criterion	Q-28											
			Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						0.04	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.6	5.5	5.5	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<2	<2	<2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Date	Units	Field Blank Criterion	Q-28											
			Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						<0.02	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Date	Units	Field Blank Criterion	Q-28											
			Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						<0.02	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.1	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Date	Units	Field Blank Criterion	Q-28											
			Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						<0.02	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.4	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<1	1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.9: Field blanks in TOMP porewater (PW) and groundwater (GW) from 2006-2009.

Date	Units	Field Blank Criterion	BH96-D10-13A (PW)				DK16-2B (PW)				P-34A (PW)			UW9-1 (PW)		
			Jul-06	Sep-07	Aug-08	Sep-09	Jun-06	Aug-07	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09
Acidity	mg/L as CaCO3	4	1	4		3	3	2	5	6	3	3	3	2	9	5
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.04	0.18	0.08	<0.02	<0.02	0.79	0.05	0.26
pH	pH units	-	5	5.7	5.7											
Sulphate	mg/L	0.2						<0.2	1.9	12		0.2	0.3		0.4	4.2

Date	Units	Field Blank Criterion	P-31 (GW)			SGW3 (GW)			95N-4A (GW)			95QW-5A (GW)			98-15A (GW)			
			Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jul-06	Sep-07	Aug-08	Sep-09
Acidity	mg/L as CaCO3	4	2	4	3	4	3	35	1	3	11	2	3	6	5	3		27
Iron	mg/L	0.04	<0.02	0.03	0.14	0.14	<0.02	0.18	0.06	0.52	0.03	0.02	<0.02	0.27	0.23	0.09	<0.02	0.72
pH	pH units	-													5	6	5.5	
Sulphate	mg/L	0.2		0.5	2.8		1.5	7.7		0.1	4.8		0.5	8.9				

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.10: Laboratory blank quality control results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L
	Program Criteria	4	0.01	0.001	0.04	0.004	0.01	0.2	2	0.001
	Lab Criteria	4	0.01	0.001	0.04	0.004	0.01	0.2	2	0.001
2005	Mean	-	0.00016	0.00006	0.00093	0.00005	0.0049	0.022	-	0.0005
	# above criteria	-	0	0	0	0	1	1	-	0
	% above criteria	-	0	0	0	0	0.95	5.26	-	0
	# samples	-	34	32	45	35	105	19	-	20
2006	Mean	2.07	0.00082	0.00008	0.00162	0.0003	<0.005	0.019	0.12	0.0001
	# above criteria	0	0	0	0	0	1	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0
	# samples	36	131	134	129	129	95	135	156	133
2007	Mean	2.06	0.0023	0.00023	0.00909	0.0009	<0.005	0.045	0.44	0.0002
	# above criteria	0	0	0	0	0	2	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
	# samples	115	202	204	239	202	100	242	273	207
2008	Mean	1.71	0.00247	0.00025	0.00963	0.001	<0.005	0.050	0.50	0.0003
	# above criteria	0	0	0	0	0	0	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	# samples	96	212	210	241	221	117	223	276	207
2009	Mean	1.87	0.00245	0.00025	0.01013	0.001	<0.005	0.012	0.509	0.00029
	# above criteria	0	0	0	0	0	0	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	# samples	95	208	199	252	209	96	203	195	240

Mean blank concentration greater than Program criteria

Actual MDL does not meet target MDL

Appendix Table B.11: Field duplicates for SRWMP from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-05			Apr-05			Jul-05			Oct-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.024	0.023	4.3	0.024	0.013	59.5	0.019	0.019	0	0.01	0.01	0
Cobalt	mg/L	20	<0.0003	<0.0003	NC	<0.0003	<0.0003	NC	0.0003	0.0004	28.6	<0.0003	<0.0003	NC
Iron	mg/L	20	0.24	0.24	0	0.14	0.14	0	0.16	0.16	0	0.05	0.05	0
Managanese	mg/L	20	0.021	0.021	0	0.024	0.024	0	0.103	0.101	2	0.009	0.009	0
pH	-	10	6.8	6.8	0	6.4	6.4	0	6.6	6.6	0	6.9	6.9	0
Radium-226	Bq/L	20	0.038	0.033	14.1	0.008	0.006	28.6	0.01	0.018	57.1	0.01	0.01	0
Sulphate	mg/L	20	7.2	7.3	1.4	4.9	4.8	2.1	7.2	6.9	4.3	9	9	0
Uranium	mg/L	20	<0.0005	0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-06			Apr-06			Jul-06			Oct-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.018	0.018	0	0.015	0.0149	0.7	0.017	0.016	6.1	0.015	0.014	6.9
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.14	0.14	0	0.12	0.12	0	0.08	0.07	13.3	0.13	0.12	8
Managanese	mg/L	20	0.0095	0.0095	0	0.012	0.0119	0.8	0.0294	0.0289	1.7	0.019	0.018	5.4
pH	-	10	7.1	7.1	0	6.7	6.7	0	6.8	6.8	0	6.7	6.7	0
Radium-226	Bq/L	20	<0.005	0.006	NC	0.005	<0.005	NC	0.01	0.007	35.3	0.011	0.008	31.6
Sulphate	mg/L	20	9.1	9	1.1	5.1	5.1	0	6.3	6.3	0	9	9	0
Uranium	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	P-01											
			Feb-07			Apr-07			Jul-07			Oct-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.017	0	0.016	0.015	6.5	0.015	0.015	0	0.015	0.015	0
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.14	0.13	7.4	0.13	0.12	8	0.06	0.07	15.4	0.14	0.14	0
Managanese	mg/L	20	0.005	0.005	0	0.017	0.015	12.5	0.022	0.023	4.4	0.027	0.026	3.8
pH	-	10	6.5	6.6	1.5	6.8	6.8	0	7.2	7.2	0	6.5	6.5	0
Radium-226	Bq/L	20	<0.007	0.008	NC	0.006	<0.005	NC	0.011	0.009	20	0.013	0.013	0
Sulphate	mg/L	20	7.1	7.1	0	5.3	5.5	3.7	6.4	6.5	1.6	8.3	8.3	0
Uranium	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Field Precision Criteria not met

NC = not calculated because the concentration from one or both samples was below detection

Appendix Table B.11: Field duplicates for SRWMP from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-08			Apr-08			Aug-08			Oct-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.017	0	0.014	0.014	0	0.014	0.014	0	0.016	0.016	0
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.17	0.17	0	0.15	0.15	0	0.2	0.16	22.2	0.12	0.13	8
Managanese	mg/L	20	0.016	0.016	0	0.023	0.024	4.3	0.025	0.025	0	0.019	0.018	5.4
pH	-	10	6.8	6.8	0	6.9	6.9	0	6.8	6.8	0	7.3	7.3	0
Radium-226	Bq/L	20	0.01	0.006	50	<0.005	<0.005	NC	0.008	0.006	28.6	0.008	<0.005	NC
Sulphate	mg/L	20	6	5.7	5.1	4.5	4.6	2.2	4	3.9	2.5	5.3	5.3	0
Uranium	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-09			Apr-09			Jul-09			Oct-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.015	0.015	0	0.014	0.014	0	0.014	0.014	0	0.0132	0.0132	0
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.24	0.22	8.7	0.18	0.18	0	0.11	0.11	0	0.33	0.32	3.1
Managanese	mg/L	20	0.016	0.014	13.3	0.023	0.025	8.3	0.025	0.025	0	0.0334	0.0322	3.7
pH	-	10	7.1	7.1	0	6.4	6.4	0	7.2	7.2	0	6.9	6.9	0
Radium-226	Bq/L	20	0.005	<0.005	NC	<0.005	<0.005	NC	0.005	<0.005	NC	<0.005	0.006	NC
Sulphate	mg/L	20	6.8	5	30.5	4.2	4.2	0	4.6	4.6	0	5.2	5.2	0
Uranium	mg/L	20	0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	D-5											
			May-05			Nov-05			May-06			Nov-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.044	0.045	2.2	0.107	0.106	0.9	0.0408	0.03894	4.7	0.039	0.04	2.5
Cobalt	mg/L	20	<0.0003	<0.0003	NC	<0.0003	<0.0003	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.08	0.08	0	0.09	0.09	0.0	0.05	0.05	0.0	0.05	0.04	22.2
Manganese	mg/L	20	0.041	0.042	2.4	0.019	0.019	0.0	0.0272	0.0248	9.2	0.032	0.032	0.0
pH	-	10	7.2	7.2	0	7	7	0	6.9	6.9	0	6.9	6.9	0
Radium-226	Bq/L	20	0.055	0.065	16.7	0.15	0.15	0	0.03	0.043	35.6	0.041	0.036	13
Sulphate	mg/L	20	25.9	26.1	0.8	88	87.9	0.1	15	15	0	23	23	0
Uranium	mg/L	20	0.0022	0.0025	12.8	0.0057	0.0057	0	0.00167	0.00153	8.8	0.002	0.002	0

Field Precision Criteria not met

NC = not calculated because the concentration from one or both samples was below detection

Appendix Table B.11: Field duplicates for SRWMP from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	D-5											
			May-07			Nov-07			May-08			Nov-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.043	0.042	2.4	0.055	0.058	5.3	0.031	0.031	0	0.081	0.083	2.4
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.05	0.06	18.2	0.05	0.06	18.2	0.06	0.06	0.0	0.07	0.07	0.0
Manganese	mg/L	20	0.032	0.031	3.2	0.031	0.034	9.2	0.026	0.026	0.0	0.034	0.035	2.9
pH	-	10	7.1	7.1	0	6.4	6.4	0	6.5	6.5	0	6.7	6.7	0
Radium-226	Bq/L	20	0.048	0.049	2.1	0.071	0.078	9.4	0.027	0.029	7.1	0.089	0.088	1.1
Sulphate	mg/L	20	19	19	0	28	27	3.6	14	14	0	34	34	0
Uranium	mg/L	20	0.002	0.0019	5.1	0.0021	0.0021	0	0.0013	0.0013	0	0.0021	0.0022	4.7

Date	Units	Field Precision Criteria (%)	D-5								
			May-09			Jun-09			Nov-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.035	0.034	2.9	0.047	0.048	2.1	0.04547	0.03801	17.9
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.06	0.06	0.0	0.04	0.04	0.0	0.07	0.06	15.4
Manganese	mg/L	20	0.025	0.022	12.8	0.023	0.022	4.4	0.031	0.027	13.8
pH	-	10	7.4	7.3	1.4	7.3	7.2	1.4	7.2	7.2	0
Radium-226	Bq/L	20	0.037	0.028	27.7	0.051	0.053	3.8	0.035	0.034	2.9
Sulphate	mg/L	20	11	11	0	8.8	8.6	2.3	26	19	31.1
Uranium	mg/L	20	0.0012	0.0011	8.7	0.001	0.0009	10.5	0.0021	0.0014	40

Field Precision Criteria not met

NC = not calculated because the concentration from one or both samples was below detection

Appendix Table B.12: Field duplicates for SAMP (Station N-12) from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	N-12																
			Jan-05			Feb-05			May-05			Jul-05			Aug-05			Nov-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.046	0.049	6.3	0.051	0.045	12.5	0.033	0.032	3.1	0.027	0.027	0	0.094	0.088	6.6	0.018	0.023	24.4
Cobalt	mg/L	20	0.0035	0.0029	18.8	0.004	0.0038	5.1	0.0021	0.0022	4.7	0.0008	0.0007	13.3	0.0026	0.0024	8	0.0021	0.002	4.9
Iron	mg/L	20	2.17	2.11	2.8	1.68	1.61	4.3	0.75	0.75	0	0.76	0.75	1.3	2.46	2.44	0.8	1.09	1.11	1.8
Manganese	mg/L	20	0.181	0.0182	163	0.241	0.217	10.5	0.175	0.175	0	0.2	0.198	1	0.336	0.328	2.4.	0.184	0.182	1.1
pH	-	20	6.2	6.2	0	6.3	6.3	0	6.9	6.9	0	6.8	6.8	0	6.8	6.8	0	6.4	6.4	0
Radium-226	Bq/L	20	0.24	0.24	0	0.24	0.25	4.1	0.2	0.21	4.9	0.37	0.43	15	0.37	0.36	2.7	0.065	0.065	0
Sulphate	mg/L	20	387	388	0.3	403	420	4.1	672	661	1.7	1021	999	2.2	815	812	0.4	638	629	1.4
Uranium	mg/L	20	0.006	0.006	0	0.009	0.008	11.8	<0.005	<0.005	NC	<0.005	0.005	NC	0.005	0.006	18.2	<0.005	<0.005	NC

Date	Units	Field Precision Criteria (%)	N-12														
			May-06			Jun-06			Aug-06			Sep-06			Nov-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.0216	0.0218	0.9	0.0257	0.0262	1.9	0.03	0.033	9.5	0.026	0.025	3.9	0.017	0.017	0
Cobalt	mg/L	20	0.00235	0.0022	6.6	0.00344	0.00344	0	0.0063	0.0052	19.1	0.0034	0.0036	5.7	0.0015	0.0015	0
Iron	mg/L	20	2.76	2.81	1.8	2.25	2.31	2.6	0.68	0.59	14.2	0.62	0.58	6.7	2.18	2.14	1.9
Manganese	mg/L	20	0.185	0.202	8.8	0.286	0.287	0.3	0.403	0.388	3.8	0.293	0.293	0	0.137	0.135	1.5
pH	-	20	6.7	6.8	1.5	6.6	6.6	0	7	7	0	6.9	6.9	0	6.5	6.6	1.5
Radium-226	Bq/L	20	0.069	0.067	2.9	0.094	0.09	4.3	0.12	0.11	8.7	0.065	0.088	30.1	0.053	0.052	1.9
Sulphate	mg/L	20	490	490	0	670	670	0	870	830	4.7	990	970	2	450	450	0
Uranium	mg/L	20	0.00256	0.00279	8.6	0.00296	0.00322	8.4	0.0037	0.0038	2.7	0.004	0.0041	2.5	0.0021	0.0022	4.7

Date	Units	Field Precision Criteria (%)	N-12																
			Feb-07			May-07			Jun-07			Aug-07			Sep-07			Nov-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.021	0.022	4.7	0.021	0.02	4.9	0.031	0.032	3.2	0.016	0.016	0	0.017	0.017	0	0.028	0.027	3.6
Cobalt	mg/L	20	0.0021	0.0021	0	0.0031	0.0021	38.5	0.003	0.003	0	0.0015	0.0015	0	0.0037	0.0038	2.7	0.0044	0.0046	4.4
Iron	mg/L	20	2.15	2.09	2.8	1.79	1.73	3.4	1.3	1.31	0.8	0.2	0.21	4.9	0.32	0.32	0	0.67	0.66	1.5
Manganese	mg/L	20	0.179	0.173	3.4	0.169	0.16	5.5	0.219	0.22	0.5	0.122	0.121	0.8	0.148	0.15	1.3	0.31	0.312	0.6
pH	-	20	6.7	6.7	0	7	7	0	7.1	7.1	0	7.5	7.5	0	7.5	7.5	0	6.7	6.7	0
Radium-226	Bq/L	20	0.072	0.065	10.2	0.076	0.07	8.2	0.12	0.12	0	0.067	0.06	11	0.06	0.061	1.7	0.084	0.088	4.7
Sulphate	mg/L	20	510	510	0	590	560	5.2	670	700	4.4	1000	1000	0	1000	1000	0	930	780	17.5
Uranium	mg/L	20	0.003	0.003	0	0.0024	0.0024	0	0.0033	0.0032	3.1	0.0032	0.0029	9.8	0.0051	0.0051	0	0.0041	0.0043	4.8

Field precision criteria not met

Actual MDL does not meet target MDL

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.12: Field duplicates for SAMP (Station N-12) from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	N-12																
			Feb-08			May-08			Jun-08			Aug-08			Sep-08			Nov-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.015	12.5	0.019	0.02	5.1	0.021	0.021	0	0.02	0.02	0	0.02	0.021	4.9	0.029	0.029	0
Cobalt	mg/L	20	0.0042	0.0038	10	0.0018	0.0018	0	0.0019	0.002	5.1	0.0012	0.0013	8	0.0012	0.0012	0	0.0025	0.0025	0
Iron	mg/L	20	2.31	2.26	2.2	0.67	0.66	1.5	0.61	0.67	9.4	0.33	0.33	0	0.44	0.45	2.2	0.46	0.46	0
Manganese	mg/L	20	0.169	0.149	12.6	0.106	0.108	1.9	0.167	0.178	6.4	0.165	0.17	3	0.149	0.153	2.6	0.258	0.255	1.2
pH	-	20	6.6	6.6	0	6.7	6.7	0	7.2	7.2	0	7.1	7.1	0	7	7	0	6.9	6.9	0
Radium-226	Bq/L	20	0.1	0.09	10.5	0.066	0.064	3.1	0.068	0.072	5.7	0.063	0.067	6.2	0.078	0.071	9.4	0.073	0.089	19.8
Sulphate	mg/L	20	290	290	0	330	370	11.4	490	490	0	870	830	4.7	880	860	2.3	850	860	1.2
Uranium	mg/L	20	0.0045	0.004	11.8	0.0028	0.0028	0	0.003	0.0031	3.3	0.0023	0.0025	8.3	0.0031	0.0032	3.2	0.0023	0.0025	8.3

Date	Units	Field Precision Criteria (%)	N-12																
			Feb-09			May-09			Jun-09			Aug-09			Sep-09			Nov-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.026	0.027	3.8	0.023	0.022	4.3	0.024	0.023	4.2	0.026	0.026	0.0	0.024	0.024	0.0	0.02	0.02	0
Cobalt	mg/L	20	0.002	0.0021	4.9	0.0011	0.0011	0.0	0.0013	0.0012	7.7	0.0011	0.0011	0.0	0.0015	0.0015	0.0	0.0013	0.0013	0
Iron	mg/L	20	1.85	1.88	1.6	0.82	0.74	9.8	0.85	0.78	8.2	0.51	0.51	0.0	0.29	0.28	3.4	0.48	0.47	2.1
Manganese	mg/L	20	0.202	0.228	12.1	0.106	0.102	3.8	0.132	0.128	3.0	0.117	0.116	0.9	0.147	0.152	3.4	0.094	0.096	2.1
pH	-	20	6.6	6.6	0	6.9	6.9	0.0	6.5	6.5	0.0	6.5	6.5	0.0	6.9	6.9	0.0	6.9	6.9	0
Radium-226	Bq/L	20	0.098	0.11	11.5	0.085	0.087	2.3	0.1	0.099	1.0	0.1	0.1	0.0	0.091	0.079	14.1	0.056	0.068	19.4
Sulphate	mg/L	20	660	660	0	330	330	0.0	470	460	2.2	640	650	1.6	820	810	1.2	360	360	0
Uranium	mg/L	20	0.0037	0.0038	2.7	0.0025	0.0025	0.0	0.0029	0.0028	3.4	0.0024	0.0025	4.2	0.0025	0.0024	4.0	0.0022	0.0022	0

Field precision criteria not met

Actual MDL does not meet target MDL

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.13: Field duplicates for SAMP (Station D-2) from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	D-2																					
			Feb-05			Mar-05			May-05			Aug-05			Oct-05			Nov-05			Dec-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.072			0.034			0.111	0.121	8.6	0.039	0.041	5	0.046			0.084	0.089	5.8	0.03		
Cobalt	mg/L	20	0.0017			0.0016			0.0018	0.0021	15.4	<0.003	<0.003	NC	0.0005			0.0015	0.0016	6.5	0.0017		
Iron	mg/L	20	0.47			0.14			0.23	0.26	12.2	0.03	0.03	0	0.03			0.12	0.12	0	0.12		
Manganese	mg/L	20	0.392			0.43			0.402	0.43	6.7	0.035	0.037	5.6	0.164			0.318	0.328	3.1	0.359		
pH	-	20	7.1			7.2			7.3			7.5			7.3			7.2			7.4		
Radium (total)	Bq/L	20	0.064	0.077	18.4	0.03	0.035	15.4	0.23	0.24	4.3	0.051	0.054	5.7	0.069	0.083	18.4	0.17	0.17	0	0.056	0.042	28.6
TSS	mg/L	20	<1	<1	NC	<1	<1	NC	1	1	0	1	1	0	<1	<1	NC	<1	<1	NC	<1	<1	NC
Uranium	mg/L	20	0.064			0.087			0.085	0.087	2.3	0.08	0.08	0	0.104			0.115	0.112	2.6	0.115		

Date	Units	Field Precision Criteria (%)	D-2																					
			Feb-06			Mar-06			May-06			Jul-06			Aug-06			Sep-06			Oct-06			Nov-06			Dec-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20							0.151	0.11	31.4				0.041	0.046	11.5							0.086	0.092	6.7			
Cobalt	mg/L	20							0.00194	0.00198	2				0.0005	0.0005	0							0.0022	0.002	9.5			
Iron	mg/L	20							0.32	0.31	3.2				0.06	0.05	18.2							0.15	0.15	0			
Manganese	mg/L	20							0.397	0.419	5.4				0.094	0.096	2.1							0.425	0.418	1.7			
pH	-	20	7.3	7.3	0	7.3	7.3	0	7.5	7.5	0	7.6	7.6	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0
Radium (total)	Bq/L	20	0.025	0.029	14.8	0.031	0.036	14.9	0.11	0.12	8.7	0.083	0.068	19.9	0.047	0.055	15.7	0.046	0.047	2.2	0.057	0.075	27.3	0.1	0.1	0	0.072	0.091	23.3
TSS	mg/L	20	<2	<2	NC	<2	<2	NC	2	2	0	<1	<1	0	1	1	0	1	1	0	1	1	0	<1	1	0	1	1	0
Uranium	mg/L	20							0.0697	0.0691	0.9				0.0852	0.0827	3							0.0979	0.0953	2.7			

Date	Units	Field Precision Criteria (%)	D-2																															
			Jan-07			Feb-07			Mar-07			Apr-07			May-07			Jun-07			Jul-07			Aug-07			Sep-07			Oct-07			Nov-07			Dec-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.069	0.071	2.9							0.117	0.122	4.2							0.065	0.055	16.7							0.161	0.118	30.8			
Cobalt	mg/L	20				0.0024	0.0026	8							0.0022	0.0022	0							0.001	0.001	0							0.002	0.0019	5.1			
Iron	mg/L	20				1	0.98	2							0.61	0.54	12.2							0.06	0.07	15.4							0.19	0.18	5.4			
Manganese	mg/L	20				0.396	0.415	4.7							0.481	0.467	3							0.313	0.316	1							0.479	0.459	4.3			
pH	-	20	7.4	7.4	0	7	7	0	7.1	7.1	0	7.4	7.4	0	7.4	7.4	0	7.7	7.7	0	7.3	7.3	0	7.3	7.3	0	7.7	7.7	0	7.1	7.1	0	7.2	7.2	0	7.1	7.1	0
Radium (total)	Bq/L	20	0.12	0.13	8	0.082	0.069	17.2	0.061	0.047	25.9	0.12	0.1	18.2	0.16	0.16	0	0.091	0.1	9.4	0.088	0.11	22.2	0.082	0.097	16.8	0.085	0.079	7.3	0.11	0.1	9.5	0.12	0.15	22.2	0.045	0.038	16.9
TSS	mg/L	20	2	2	0	3	3	0	2	2	0	2	2	0	3	1	100	1	<1	NC	1	1	0	1	1	0	1	<1	NC	<1	<1	NC	2	1	66.7	1	<1	NC
Uranium	mg/L	20				0.0508	0.0525	3.3							0.0613	0.0595	3							0.0859	0.0855	0.5							0.106	0.104	1.9			

Date	Units	Field Precision Criteria (%)	D-2																															
			Jan-08			Feb-08			Mar-08			Apr-08			May-08			Jun-08			Jul-08			Aug-08			Sep-08			Oct-08			Nov-08			Dec-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.032	0.032								0.126	0.117	7.4							0.1	0.1	0							0.111	0.111	0			
Cobalt	mg/L	20				0.0032	0.0031								0.0018	0.0018	0							0.0008	0.0008	0							0.0015	0.0015	0			
Iron	mg/L	20				1.35	1.35								0.34	0.33	3							0.07	0.07	0							0.14	0.15	6.9			
Manganese	mg/L	20				0.573	0.558								0.463	0.443	4.4							0.205	0.203	1							0.341	0.34	0.3			
pH	-	20	6.8	6.8	0	6.6	6.6	0	6.8	6.8	0	6.8	6.8	0	7.2	7.2	0	7.5	7.5	0	7.6	7.6	0	7.4	7.4	0	7.5	7.5	0	7.2	7.2	0	7.2	7.2	0	7.1	7.1	0
Radium (total)	Bq/L	20	0.031	0.021	38.5	0.021	0.025	17.4	0.21	0.19	10	0.29	0.25	14.8	0.22	0.25	12.8	0.11	0.12	8.7	0.2	0.2	0	0.12	0.078	42.4	0.062	0.069	10.7	0.078	0.082	5	0.11	0.11	0	0.05	0.038	27.3
TSS	mg/L	20	<1	1	NC	2	2	0	2	2	0	2	2	0	1	2	66.7	1	1	0	<1	<1	NC	1	1	0	1	1	0	1	1	0	2	2	0	<1	1	0
Uranium	mg/L	20				0.0605	0.059								0.0594	0.0584	1.7							0.0777	0.0762	1.9							0.103	0.102	1			

Date	Units	Field Precision Criteria (%)	D-2																															
			Jan-09			Feb-09			Mar-09			Apr-09			May-09			Jun-09			Jul-09			Aug-09			Sep-09			Oct-09			Nov-09			Dec-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.091	0.085	6.8							0.159	0.149	6.5							0.067	0.072	7.2							0.158	0.158	0			
Cobalt	mg/L	20				0.0018	0.0018	0							0.0015	0.0015	0							0.0008	0.0008	0							0.0015	0.0015	0			
Iron	mg/L	20				0.73	0.72	1.4							0.36	0.35	2.8							0.07	0.06	15.4							0.16	0.16	0			
Manganese	mg/L	20				0.394	0.376	4.7							0.375	0.367	2.2							0.191	0.188	1.6							0.298	0.298	0			
pH	-	20	6.8	6.8	0	6.9	6.9	0	7.1	7.1	0	6.9	6.9	0	7	7	0	7.2	7.2	0	7.3	7.3	0	7.2	7.2	0	7.1	7.1	0	6.9	6.9	0	7	7	0	6.7	6.7	0
Radium (total)	Bq/L	20	0.24	0.25	4.1	0.14	0.13	7.4	0.28	0.23	19.6	0.27	0.26	3.8	0.27	0.24	11.8	0.15	0.14	6.9	0.19	0.17	11.1	0.1	0.086	15.1	0.1	0.096	4.1	0.18	0.17	5.7	0.18	0.16	11.8	0.12	0.12	0
TSS	mg/L	20	1	1	0	2	2	0	1	1	0	2	2	0	1	2	66.7	2	1	66.7	1	1	0	<1	<1	NC	<1	<1	NC	2	2	0	1	1	0	1	1	0
Uranium	mg/L	20				0.0535	0.052	2.8							0.0529	0.0544	2.8							0.0854	0.0849	0.6							0.104	0.104	0			

Field precision criteria not met

Actual MDL does not meet target MDL

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.14: Field duplicates for TOMP stations 2005 to 2009.

Date	Units	Field Precision Criteria (%)	Q-28																																	
			Jan-05			Feb-05			Mar-05			Apr-05			May-05			Jun-05			Jul-05			Aug-05			Sep-05			Oct-05			Nov-05			Dec-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.065			0.069			0.074			0.067			0.077			0.073			0.066			0.061			0.052			0.053			0.065			0.074		
Cobalt	mg/L	20	0.02			0.021			0.0193			0.0155			0.0135			0.0065			0.0033			0.0029			0.0023			0.0022			0.008			0.0174		
Iron	mg/L	20	1.24			1.14			0.71			0.74			0.22			0.23			0.15			0.19			0.26			0.24			0.23			0.87		
Manganese	mg/L	20	2.32			2.24			3.17			1.81			1.69			1.16			0.722			0.661			0.538			0.449			1.47			2.49		
pH	-	20	7.3	7.3	0	7.9	7.9	0	8.1	8.1	0	7.3	7.3	0	7.4	7.4	0	7.5	7.5	0	7.7	7.7	0	7.6	7.6	0	7.7	7.7	0	7.7	7.7	0	7.5	7.2	4.1	7.3	7.3	0
Radium (total)	Bq/L	20	0.22	0.27	20.4	0.19	0.18	5.4	0.11	0.12	8.7	0.05	0.045	10.5	0.019	0.017	11.1	0.069	0.078	12.2	0.091	0.083	9.2	0.06	0.051	16.2	0.035	0.029	18.8	0.031	0.03	3.3	0.072	0.094	26.5	0.24		
Sulphate	mg/L	20	1279			1227			1321			1253			832			1009			1214			1258			1438			1596			1273			1329		
TSS	mg/L	20	3	3	0	3	3	0	2	1	66.7	3	2	40	<1	<1	NC	<1	<1	NC	1	1	0	1	1	0	<1	1	NC	1	1	0	1	1	0	3		
Uranium	mg/L	20	0.021			0.025			0.027			0.024			0.022			0.022			0.021			0.032			0.049			0.036			0.032			0.025		

Date	Units	Field Precision Criteria (%)	Q-28																																	
			Jan-06			Feb-06			Mar-06			Apr-06			May-06			Jun-06			Jul-06			Aug-06			Sep-06			Oct-06			Nov-06			Dec-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.0886	0.0861	2.9																	0.035	0.036	2.8			
Cobalt	mg/L	20													0.0194	0.0196	1																	0.0092	0.0091	1.1			
Iron	mg/L	20													0.24	0.24	0																	0.29	0.29	0			
Manganese	mg/L	20													1.81	1.82	0.6																	1.57	1.29	19.6			
pH	-	20	8.2	8.2	0	8.2	8.2	0	8.2	8.2	0	7.4	7.4	0	7.5	7.5	0	7.8	7.8	0	7.5	7.5	0	7.7	7.7	0	7.5	7.5	0	7.6	7.6	0	7.4	7.4	0	7.7	7.7	0
Radium (total)	Bq/L	20	0.11	0.11	0	0.085	0.07	19.4	0.067	0.064	4.6	0.047	0.061	25.9	0.046	0.033	32.9	0.12	0.12	0	0.043	0.036	17.7	0.089	0.1	11.6	0.06	0.063	4.9	0.044	0.034	25.6	0.032	0.026	20.7	0.086	0.092	6.7
Sulphate	mg/L	20													740	800	7.8																	1100	1100	0			
TSS	mg/L	20	4	5	22.2	3	5	50	2	3	40	5	4	22.2	1	2	66.7	1	1	0	<1	<1	NC	<1	1	NC	1	1	0	1	1	0	1	1	0	<1	1	NC
Uranium	mg/L	20													0.0154	0.0147	4.7																	0.0486	0.0475	2.3			

Date	Units	Field Precision Criteria (%)	Q-28																																	
			Jan-07			Feb-07			Mar-07			Apr-07			May-07			Jun-07			Jul-07			Aug-07			Sep-07			Oct-07			Nov-07			Dec-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.084	0.083	1.2																	0.068	0.069	1.5			
Cobalt	mg/L	20													0.0063	0.0063	0																	0.0119	0.0123	3.3			
Iron	mg/L	20													0.17	0.17	0																	0.36	0.36	0			
Manganese	mg/L	20													1.11	1.11	0																	1.91	1.92	0.5			
pH	-	20	7.1	7.1	0	8.3	8.3	0	8.3	8.3	0	7.3	7.3	0	7.3	7.3	0	7.5	7.5	0	7.5	7.5	0	7.8	7.8	0	7.7	7.7	0	7.4	7.4	0	7.4	7.4	0	8	8	0
Radium (total)	Bq/L	20	0.18	0.19	5.4	0.13	0.13	0	0.066	0.064	3.1	0.087	0.11	23.4	0.075	0.078	3.9	0.061	0.06	1.7	0.09	0.091	1.1	0.088	0.095	7.7	0.1	0.1	0	0.13	0.12	8	0.18	0.19	5.4	0.14	0.17	19.4
Sulphate	mg/L	20													780	760	2.6																	1200	1200	0			
TSS	mg/L	20	2	2	0	2	2	0	1	2	66.7	4	3	28.6	1	1	0	<1	1	NC	1	1	0	1	1	0	1	2	66.7	2	1	66.7	1	2	66.7	3	3	0
Uranium	mg/L	20													0.0208	0.0202	2.9																	0.0242	0.0246	1.6			

Date	Units	Field Precision Criteria (%)	Q-28																																	
			Jan-08			Feb-08			Mar-08			Apr-08			May-08			Jun-08			Jul-08			Aug-08			Sep-08			Oct-08			Nov-08			Dec-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.154	0.15	2.6																	0.072	0.073	1.4			
Cobalt	mg/L	20													0.0071	0.0072	1.4																	0.0069	0.0069	0			
Iron	mg/L	20													0.22	0.23	4.4																	0.31	0.31	0			
Manganese	mg/L	20													1.09	1.08	0.9																	1.22	1.21	0.8			
pH	-	20	7.4	7.4	0	7.6	7.6	0	8.2	8.2	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0	7.6	7.6	0	7.3	7.3	0	7.5	7.5	0	7.8	7.8	0	7.5	7.5	0	8.4	8.4	0
Radium (total)	Bq/L	20	0.18	0.14	25	0.14	0.16	13.3	0.11	0.089	21.1	0.078	0.073	6.6	0.053	0.042	23.2	0.06	0.05	18.2	0.094	0.092	2.2	0.084	0.087	3.5	0.11	0.11	0	0.13	0.12	8	0.08	0.096	18.2	0.12	0.15	22.2
Sulphate	mg/L	20													560	660	16.4																	1000	1100	9.5			
TSS	mg/L	20	2	3	40	5	4	22.2	4	2	66.7	3	2	40	1	1	0	1	<1	0	3	1	100	2	2	0	1	1	0	3	2	40	1	2	66.7	2	2	0
Uranium	mg/L	20													0.0114	0.0111	2.7																	0.022	0.0219	0.5			

Date	Units	Field Precision Criteria (%)	Q-28																																	
			Jan-09			Feb-09			Mar-09			Apr-09			May-09			Jun-09			Jul-09			Aug-09			Sep-09			Oct-09			Nov-09			Dec-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.135	0.137	1.5																	0.09	0.091	1.1			
Cobalt	mg/L	20													0.0083	0.0081	2.4																	0.0112	0.0114	1.8			
Iron	mg/L	20													0.25	0.25	0																	0.66	0.65	1.5			
Manganese	mg/L	20													1.14	1.1	3.6																	1.73	1.76	1.7			
pH	-	20	8.2	8.2	0	8.2	8.2	0	7.9	7.9	0	8.4	8.4	0	7.5	7.5	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0	7.5	7.5	0	7.6	6.8	11.1	7.4	7.4	0	7.7	7.7	0
Radium (total)	Bq/L	20	0.15	0.13	14.3	0.095	0.088	7.7	0.12	0.13	8	0.081	0.096	16.9	0.091	0.094	3.2	0.14	0.16	13.3	0.088	0.11	22.2	0.1	0.11	9.5	0.13	0.15	14.3	0.12	0.11	8.7	0.075	0.077	2.6	0.22	0.19	14.6
Sulphate	mg/L	20													630	620	1.6																	890	940	5.5			
TSS	mg/L	20	3	5	50	3	4	28.6	1	2	66.7	2	3	40	<1	<1	NC	<1	1	NC	1	2	66.7	2	1	66.7	1	1	0	1	1	0	2	2	0	4	3	28.6
Uranium	mg/L	20													0.0133	0.0132	0.8																	0.0195	0.0201	3			

Field precision criteria not met

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.15: Field duplicates for RioAlgom TOMP porewater and groundwater from 2006 to 2009.

Date	Units	Field Precision Criteria (%)	UW9-1												95N-4A											
			Jun-06			Jul-07			Jul-08			Sep-09			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	3090	3050	1.3	3790	3750	1.1	3520	3540	0.6	2960	2900	2	2390	2400	0.4	2450	2440	0.4	2550	2650	3.8	2530	2530	0
iron	mg/L	20	1220	1150	5.9	1390	1350	2.9	1320	1270	3.9	953	973	2.1	1408	1494	5.9	1410	1440	2.1	1570	1570	0	1400	1340	4.4
pHf for blind[a]	-	20				3.89	3.91	0.5	3.97	4.01	1							5.6	5.57	0.2	4.3	4.34	1.4			
pHf for blank[a]	-	20				4.1	4.1	0	4.14	4.1	1	4.2	4.22	0.5				6.22	6.28	1	6.02	6.03	0.2	6.21	5.85	6
Sulphate	mg/L	20				4800	4800	0	5000	4300	15.1	4000	4200	4.9				4200	4200	0	4400	4200	4.7	4600	4600	0

Date	Units	Field Precision Criteria (%)	SGW3												95QW-5A											
			Jun-06			Jul-07			Jul-08			Sep-09			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	1860	1850	0.5	1630	1650	1.2	1470	1440	2.1	1300	1170	10.5	22	21	4.7	7	8.5	19.4	29	20	36.7	39	22	55.7
iron	mg/L	20	1030	1020	1	831	826	0.6	847	819	3.4	682	589	14.6	14.4	14.4	0	15.9	15.9	0	24	21.8	9.6	12.5	15.2	19.5
pHf for blind[a]	-	20				4.47	4.44	0.7	4.63	4.64	0.2							5.88	5.85	0.5	6.23	6.33	1.6			
pHf for blank[a]	-	20				4.84	4.85	0.2	4.92	4.93	0.2	4.89	5.14	5				5.7	5.7	0	5.85	5.76	1.6	4.97	4.97	0
Sulphate	mg/L	20				2800	2900	3.5	2600	3000	14.3	2400	2300	4.3				770	760	1.3	670	720	7.2	640	670	4.6

Date	Units	Field Precision Criteria (%)	P-31												DK16-2B											
			Jun-06			Jul-07			Jul-08			Sep-09			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	<1	<1	NC	<1	<1	NC	<1	<1	NC	2	<1	NC	<1	<1	NC	<1	<1	NC	<1	<1	NC	2	<1	NC
iron	mg/L	20	0.13	0.13	0	<0.02	0.03	NC	0.05	0.04	22.2	0.1	0.13	26.1	0.1	0.09	10.5	0.03	0.04	28.6	0.02	<0.02	NC	<0.02	0.03	NC
pHf for blind[a]	-	20				6.97	6.94	0.4	6.97	6.91	0.9							8.3	8.51	2.1	8.2	8.33	1.8			
pHf for blank[a]	-	20				6.7	6.7	0	6.5	6.53	0.5	6.47	6.47	0				8.8	8.8	0	8.65	8.67	0.2	8.12	8.12	0
Sulphate	mg/L	20				1100	1100	0	990	980	1	930	1100	16.7				1600	1600	0	1500	1500	0	1500	1600	6.5

Date	Units	Field Precision Criteria (%)	P-34A												BH96 D10 13A											
			Jun-06			Jul-07			Jul-08			Sep-09			Jul-06			Sep-07			Aug-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	208	204	1.9	153	142	7.5	120	174	36.7	96	95	1												
iron	mg/L	20	155	143	8.1	126	130	3.1	87.9	88	0.1	164	80.2	68.6	0.13	0.11	16.7	3.19	3.09	3.2	3.54	3.55	0.3	3.75	3.9	3.9
pHf for blind[a]	-	20				6.0	6.01	0.7	5.8	5.69	1.9							7.7	7.7	0	7.71	7.74	0.4			
pHf for blank[a]	-	20				6.6	6.6	0	6.55	6.57	0.3	6.49	6.49	0												
Sulphate	mg/L	20				2800	2800	0	2700	2800	3.6	2700	2500	7.7	<1	<1	NC	<1	<1	NC	<1	<1	NC	<1	<1	NC

Date	Units	Field Precision Criteria (%)	98 15A								
			Jul-06			Sep-07			Aug-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)
acidity	mg/L	20	2510	2360	6.2	2460	2174	12.3	2200	2190	0.5
iron	mg/L	20	1260	1410	11.2	1560	1290	18.9	1360	1350	0.7
pH	-	20				5.9	5.9	0	6.1	6.11	0.2
Sulphate	mg/L	20									

Field precision criteria not met

NC= not calculated because the concentration of one or both samples was below detection

[a] one pH measure was for the blind sample (duplicate) and one was taken for the blank sample

Appendix Table B.16: Summary of field duplicate results that exceeded the DQO.

Program	Station	Date	Parameter	Units	MDL	RPD (%)	Original Conc.	Duplicate Conc.
SRWMP	P-01	Apr-05	Barium	mg/L	0.005	59.5	0.024	0.013
		Apr-05	Radium-226	Bq/L	0.005	28.6	0.008	0.006
		Jul-05	Cobalt	mg/L	0.0005	28.6	0.003	0.0004
		Jul-05	Radium-226	Bq/L	0.005	57.1	0.01	0.018
		Jul-06	Radium-226	Bq/L	0.005	35.3	0.01	0.007
		Oct-06	Radium-226	Bq/L	0.005	31.6	0.011	0.008
		Jan-08	Radium-226	Bq/L	0.005	50	0.01	0.006
		Aug-08	Iron	mg/L	0.02	22.2	0.2	0.16
		Aug-08	Radium-226	Bq/L	0.005	28.6	0.008	0.006
		Jan-09	Sulphate	mg/L	0.1	30.5	6.8	5
	D-5	May-06	Radium-226	Bq/L	0.005	35.6	0.03	0.043
		Nov-06	Iron	mg/L	0.02	22.2	0.05	0.04
		May-09	Radium-226	Bq/L	0.005	27.7	0.037	0.028
		Nov-09	Sulphate	mg/L	0.1	31.1	26	19
		Nov-09	Uranium	mg/L	0.0005	40	0.0021	0.0014
SAMP	N-12	Jan-05	Manganese	mg/L	0.002	163	0.181	0.018
		Nov-05	Barium	mg/L	0.005	24.4	0.018	0.023
		Sep-06	Radium-226	Bq/L	0.005	30.1	0.065	0.088
		May-07	Cobalt	mg/L	0.0005	38.5	0.0031	0.0021
	D-2	Dec-05	Radium-226	Bq/L	0.005	28.6	0.056	0.042
		May-06	Barium	mg/L	0.005	31.4	0.151	0.11
		Oct-06	Radium-226	Bq/L	0.005	27.3	0.057	0.075
		Dec-06	Radium-226	Bq/L	0.005	23.3	0.072	0.091
		Mar-07	Radium-226	Bq/L	0.005	25.9	0.061	0.047
		May-07	TSS	mg/L	1	100	3	1
		Jul-07	Radium-226	Bq/L	0.005	22.2	0.088	0.11
		Nov-07	Barium	mg/L	0.005	30.8	0.161	0.118
		Nov-07	Radium-226	Bq/L	0.005	22.2	0.12	0.15
		Nov-07	TSS	mg/L	1	66.7	2	1
		Jan-08	Radium-226	Bq/L	0.005	38.5	0.031	0.021
		May-08	TSS	mg/L	1	66.7	1	2
		Aug-08	Radium-226	Bq/L	0.005	42.4	0.12	0.078
		Dec-08	Radium-226	Bq/L	0.005	27.3	0.05	0.038
		May-09	TSS	mg/L	1	66.7	1	2
		Jun-09	TSS	mg/L	1	66.7	2	1

Appendix Table B.16: Summary of field duplicate results that exceeded the DQO.

Program	Station	Date	Parameter	Units	MDL	RPD (%)	Original Conc.	Duplicate Conc.
TOMP	Q-28	Jan-05	Radium-226	Bq/L	0.005	20.4	0.22	0.27
		Mar-05	TSS	mg/L	1	66.7	2	1
		Apr-05	TSS	mg/L	1	40	3	2
		Nov-05	Radium-226	Bq/L	0.005	26.5	0.072	0.094
		Jan-06	TSS	mg/L	1	22.2	4	5
		Feb-06	TSS	mg/L	1	50	3	5
		Mar-06	TSS	mg/L	1	40	2	3
		Apr-06	Radium-226	Bq/L	0.005	25.9	0.047	0.061
		Apr-06	TSS	mg/L	1	22.2	5	4
		May-06	Radium-226	Bq/L	0.005	32.9	0.046	0.033
		May-06	TSS	mg/L	1	66.7	1	2
		Oct-06	Radium-226	Bq/L	0.005	25.6	0.044	0.034
		Nov-06	Radium-226	Bq/L	0.005	20.7	0.032	0.026
		Mar-07	TSS	mg/L	1	66.7	1	2
		Apr-07	Radium-226	Bq/L	0.005	23.4	0.087	0.11
		Apr-07	TSS	mg/L	1	28.6	4	3
		Sep-07	TSS	mg/L	1	66.7	1	2
		Oct-07	TSS	mg/L	1	66.7	2	1
		Nov-07	TSS	mg/L	1	66.7	1	2
		Jan-08	Radium-226	Bq/L	0.005	25	0.18	0.14
		Jan-08	TSS	mg/L	1	40	2	3
		Feb-08	TSS	mg/L	1	22.2	5	4
		Mar-08	Radium-226	Bq/L	0.005	21.1	0.11	0.089
		Mar-08	TSS	mg/L	1	66.7	4	2
		Apr-08	TSS	mg/L	1	40	3	2
		May-08	Radium-226	Bq/L	0.005	23.2	0.053	0.042
		Jul-08	TSS	mg/L	1	100	3	1
		Oct-08	TSS	mg/L	1	40	3	2
		Nov-08	TSS	mg/L	1	66.7	1	2
		Dec-08	Radium-226	Bq/L	0.005	22.2	0.12	0.15
		Jan-09	TSS	mg/L	1	50	3	5
		Feb-09	TSS	mg/L	1	28.6	3	4
		Mar-09	TSS	mg/L	1	66.7	1	2
		Apr-09	TSS	mg/L	1	40	2	3
		Jul-09	Radium-226	Bq/L	0.005	22.2	0.088	0.11
		Jul-09	TSS	mg/L	1	66.7	1	2
		Aug-09	TSS	mg/L	1	66.7	2	1
		Dec-09	TSS	mg/L	1	28.6	4	3
	95QW-5A	Jul-08	Acidity	mg/L	1	36.7	29	20
		Sep-09	Acidity	mg/L	1	55.7	39	22
	P-31	Jul-08	Iron	mg/L	0.02	22.2	0.05	0.04
		Sep-09	Iron	mg/L	0.02	26.1	0.1	0.13
	DK16-2B	Jul-07	Iron	mg/L	0.02	28.6	0.03	0.04
	P-34A	Jul-08	Acidity	mg/L	1	36.7	120	174
		Sep-09	Iron	mg/L	0.02	68.6	164	80.2

Exceedence of DQO (20%) not explained by concentrations near MDL

Appendix Table B.17: Summary of laboratory duplicate results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	
	Program Criteria	10%	10%	10%	10%	10%	10%	10%	10%	10%	
	Lab Criteria	10%	10%	10%	10%	10%	10%	10%	10%	10%	
2005	Mean	-	2.57	4.05	2.28	1.87	5.33	0.78	-	3.93	-
	# above criteria	-	0	4	0	0	2	0	-	0	6
	% above criteria	-	0.0	18.2	0.0	0.0	4.1	0.0	-	0.0	3.1
	# samples	-	23	22	36	23	49	20	-	19	192
2006	Mean	2.125	-1.603	1.145	1.785	0.524	9.6	-0.282	-0.916	0.302	-
	# above criteria	1	7	8	16	3	7	1	8	2	53
	% above criteria	4.2	6.2	6.8	14.5	2.6	7.4	1.4	7.5	1.7	6.1
	# samples	24	113	117	110	116	95	73	107	116	871
2007	Mean	0.884	0.1	0.19	1.416	0.129	4.7	1.071	3.044	0.776	-
	# above criteria	5	0	0	4	4	3	6	28	0	50
	% above criteria	5.6	0.0	0.0	2.1	2.1	3.0	3.3	10.2	0.0	3.1
	# samples	89	202	191	188	195	99	180	274	207	1625
2008	Mean	0.975	-0.137	0.141	-0.195	0.181	1.8	-0.387	1.295	0.061	-
	# above criteria	0	4	3	10	3	15[a]	2	20	5	62
	% above criteria	0.0	1.9	1.5	4.2	1.3	12.8	1.0	8.2	0.0	3.6
	# samples	82	208	197	239	225	117	200	245	199	1712
2009	Mean	0.974	0.843	0.588	1.05	0.727	-1.2	-0.058	1.356	0.816	-
	# above criteria	1	1	1	11	1	15	0	0	13	43
	% above criteria	1.3	0.5	0.5	3.8	0.4	15.6	0.0	0.0	4.9	2.4
	# samples	77	221	215	287	224	96	213	193	266	1792
Total	# above criteria	7	12	16	41	11	42	9	56	20	214
	% above criteria	2.6	1.6	2.2	4.8	1.4	9.2	1.3	6.8	2.5	3.5
	# samples	272	767	742	860	783	456	686	819	807	6192

Samples above lab and program criteria

[a] 5 is the number of cases >20% criteria used by the lab in 2008; however, based on Minnow calculation of RPD using 10% criteria, there were 15 above criteria (12.8%), with the highest RPD at 40%. With exception of this parameter in 2008, all other lab criteria was set at 10%.

Appendix Table B.18: Summary of laboratory matrix spike blank quality control results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	
	Program Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	-	80 - 120%	
	Lab Criteria	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	-	70 - 130%	
2005	Mean	-	87.7	84.6	96.6	87.0	99.5	99.7	-	105.7	-
	# above criteria	-	0	0	0	0	0	0	-	0	0
	% above criteria	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	-	17	18	27	17	73	23	-	17	192
2006	Mean	107.2	90.6	101.6	109.2	101.9	99.2	100.7[a]	-	101.9	-
	# above criteria	0	65	0	1	0	0	0	-	0	66
	% above criteria	0.0	44.5	0.0	0.8	0.0	0.0	0.0	-	0.0	6.8
	# samples	35	146	147	129	134	95	138	-	147	971
2007	Mean	109.7	66.0	102.3	109.9	104.5	102.1	100.1[a]	-	101.8	-
	# above criteria	0	13	0	0	0	0	0	-	0	13
	% above criteria	0.0	7.5	0.0	0.0	0.0	0.0	0.0	-	0.0	1.0
	# samples	92	173	175	210	154	99	345	-	54	1302
2008	Mean	112.0	67.3	101.2	107.8	99.4	97.7	100.1	-	100.9	-
	# above criteria	0	0	0	0	0	0[b]	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	74	234	208	235	238	117	253	-	225	1584
2009	Mean	110.9	67.3	100.8	105.7	99.7	101.5	94.7	-	100.9	-
	# above criteria	0	0	0	0	0	0[b]	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	48	229	206	286	217	96	333	-	227	1642
Total	# above criteria	0	78	0	1	0	0	0	-	0	79
	% above criteria	0	9.8	0	0.1	0	0	0	-	0	1.4
	# samples	249	799	754	887	760	480	1092	-	670	5691

Mean spike recovery does not meet program DQO

Samples above lab criteria, but not necessarily above program criteria

[a] mean is calculated using the weighted means of SO_4 recovery with certified value of 4 and 100 mg/L

[b] this lab criteria was 80 - 120%, so met with program criteria as well

Appendix Table B.19: Summary of laboratory certified reference material (CRM) quality control results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	
	Program Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	-	80 - 120%	-	80 - 120%	
	Lab Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	-	80 - 120%	
2005	Mean	-	103.0	106.6	108.1	108.3	97.8	104.4	-	104.2	-
	# above criteria	-	0	0	0	0	0	0	-	0	0
	% above criteria	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	-	34	31	45	35	76	20	-	24	265
2006	Mean	102.1[a]	100	100	103.9	100	98.2[b]	100	-	100	-
	# above criteria	0	0	0	0	0	6	0	-	0	6
	% above criteria	0.0	0.0	0.0	0.0	0.0	6.3	0.0	-	0.0	1.6
	# samples	19	32	33	30	33	95	91	-	32	365
2007	Mean	102.0	100	100	102	100	95.5[b]	100.2	-	100	-
	# above criteria	0	0	0	0	0	8	0	-	0	8
	% above criteria	0.0	0.0	0.0	0.0	0.0	8.0	0.0	-	0.0	0.6
	# samples	99	185	185	112	192	100	194	-	189	1256
2008	Mean	102.1	100	100	100.7	100	102.4	101	-	100	-
	# above criteria	0	0	0	0	0	0	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	117	223	216	264	239	117	207	-	214	1597
2009	Mean	102.9	100	100	100.1	100	102.4	101.4	-	100	-
	# above criteria	0	0	0	0	0	0	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	106	229	222	294	228	96	263	-	226	1664
Total	# above criteria	0	0	0	0	0	14	0	-	0	14
	% above criteria	0	0	0	0	0	3	0	-	0	0.3
	# samples	341	703	687	745	727	484	775	-	685	5147

Samples above lab criteria, but not necessarily above program criteria

[a] mean is calculated using the weighted means of CRM recovery

[b] this lab criteria was 90 - 110%

Appendix Table B.20: Target and achieved method detection limits (MDLs) for SRWMP sediment quality analysis.

Parameter	Units	Target MDL	Achieved MDL	LEL	SEL
Barium	mg/kg	0.5	0.5	-	-
Cobalt	mg/kg	0.2	0.1	-	-
Grain size	%	0.1	0.1	-	-
Iron	mg/kg	20	50	20000[a]	40000[a]
Manganese	mg/kg	0.5	1	460[a]	1100[a]
Nickel	mg/kg	0.5	0.5	23.4[b]	484[b]
Radium-226	Bq/kg	5	10	0.6[b]	14.4[b]
TOC	mg/kg	500	500	-	-
Uranium	mg/kg	0.1	0.05	104.4[b]	5874[b]

LEL - Lowest Effects Level

SEL - Severe Effects Level

[a] Provincial Sediment Quality Guidelines, MOE 1993

[b] Values used to screen lakes, based on Thompson et al. 2005

Target MDL not achieved

Appendix Table B.21: Laboratory blank results associated with analyses of SRWMP sediment samples.

Parameter	Units	MDL	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
Maxxam Analytics												
	QC Batch Number		1961646			1962983	1959556		1960614		1962311	1961821
Total Organic Carbon	mg/kg	500	ND			ND	ND		ND		ND	ND
	QC Batch Number		1962399	1966318	1965774	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Barium (Ba)	ug/g	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	ug/g	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron (Fe)	ug/g	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese (Mn)	ug/g	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	ug/g	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (U)	ug/g	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Becquerel Laboratories						
Parameter	**QC Batch Numbers**		T09-01418	T09-01415	T09-01412	T09-01413
			T09-01416	T09-01414	T09-01417	
Radium-226 (Ra-226)	Bq/g	0.01	ND	ND	ND	ND

MDL - Method Detection Limit
ND - Not detected
Actual MDL does not meet target MDL

Appendix Table B.22: Field duplicate results for analysis of SRWMP sediment samples.

Parameter	Units	RDL	EL-09-03			NL-09-03			HOL-09-02			SL-09-01		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Total Organic Carbon	mg/kg	500	50000	51000	2	62000	59000	5	67000	66000	2	66000	65000	2
Gravel	%	0.1	ND	ND	NC	ND	ND	NC	ND	ND	NC	ND	ND	NC
Sand	%	0.1	28	41	38	45	41	9	31	30	3	24	22	9
Silt	%	0.1	50	44	13	43	47	9	55	58	5	62	60	3
Clay	%	0.1	22	15	38	12	12	0	14	12	15	13	17	27

Parameter	Units	MDL	SUL-09-03			QL-09-02			MAL-09-02			MCL-09-03		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Total Organic Carbon	mg/kg	500	110000	100000	10	72000	74000	3	94000	86000	9	38000	40000	5
Gravel	%	0.1							ND	ND	NC	ND	ND	NC
Sand	%	0.1							45	58	25	24	33	32
Silt	%	0.1							43	34	23	53	52	2
Clay	%	0.1							12	7.9	41	23	15	42

Parameter	Units	MDL	ML-09-02			NL-09-01			HOL-09-02			SL-09-05		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Barium (Ba)	ug/g	0.5	1400	1000	33	130	120	8	72	72	0	540	720	29
Cobalt (Co)	ug/g	0.1	220	170	26	25	24	4	25	22	13	14	13	7
Iron (Fe)	ug/g	50	75000	65000	14	33000	42000	24	46000	49000	6	49000	53000	8
Manganese (Mn)	ug/g	1	35000	25000	33	300	350	15	2500	1800	33	8400	15000	56
Nickel (Ni)	ug/g	0.5	110	98	12	37	37	0	39	39	0	24	23	4
Radium-226	Ba/L	0.005	13	14	7	2.3	2.0	14	1.6	1.3	21	0.18	0.17	6
Uranium (U)	ug/g	0.05	280	270	4	110	99	11	91	96	5	4.1	4.1	0

Parameter	Units	MDL	SUL-09-03			QL-09-02		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Barium (Ba)	ug/g	0.5	100	91	9	530	400	28
Cobalt (Co)	ug/g	0.1	30	29	3	26	28	7
Iron (Fe)	ug/g	50	46000	54000	16	49000	53000	8
Manganese (Mn)	ug/g	1	1100	1700	43	3100	3700	18
Nickel (Ni)	ug/g	0.5	20	17	16	24	23	4
Radium-226	Bq/L	0.005	0.28	0.19	38	2.2	2.8	24
Uranium (U)	ug/g	0.05	2.9	2.5	15	300	280	7

RPD - Relative Percent Difference
Rep - Replicate
ND - Not detected
NC - Not calculable as one or both concentrations are below MDL
Field precision criteria (<40%) not met
Actual MDL does not meet target MDL

Appendix Table B.23: Laboratory duplicate results for analysis of SRWMP sediment samples.

Parameter	Units	MDL	Maxxam Job	QC Batch	Sample	Original Sample	Laboratory Duplicate	RPD (%)
Total Organic Carbon	mg/kg	500	A9C7001	1962311	EL-09-01	37000	37000	0
			A9C6972	1962983	ML-09-01	86000	86000	0
			A9C6911	1959556	RL-09-01	98000	97000	1
			A9C6996	1961646	QL-09-03	22000	23000	4
				1961821	QL-09-02Z	74000	74000	0

Parameter	Units	MDL	Maxxam Job A9C7001			Maxxam Job A9C6924					
			QC Batch 1965399			QC Batch 1962399			QC Batch 1965774		
			Sample EL-09-05			Sample PL-09-04			Sample HOL-09-02Z		
			Original Sample	Laboratory Duplicate	RPD (%)	Original Sample	Laboratory Duplicate	RPD (%)	Original Sample	Laboratory Duplicate	RPD (%)
Acid Extractable Barium (Ba)	ug/g	0.5	200	220	10	110	110	0	72	74	3
Acid Extractable Cobalt (Co)	ug/g	0.1	89	97	9	39	41	5	22	22	0
Acid Extractable Iron (Fe)	ug/g	50	60000	64000	6	37000	38000	3	49000	48000	2
Acid Extractable Manganese (Mn)	ug/g	1	9000	9900	10	1500	1600	6	1800	1800	0
Acid Extractable Nickel (Ni)	ug/g	0.5	59	64	8	40	44	10	39	38	3
Acid Extractable Uranium (U)	ug/g	0.05	220	240	9	110	120	9	96	99	3

Parameter	Units	MDL	Becquerel Laboratories											
			QC Batch T09-01418 and T09-01416			QC Batch T09-01415 and T09-01414			QC Batch T09-01418 and T09-01416			QC Batch T09-01418 and T09-01416		
			Sample ID not provided			Sample ID not provided			Sample ID not provided			Sample ID not provided		
Radium-226 (Ra-226)	Bq/g	0.01	0.05	0.06	18	15	17	13	0.17	0.18	6	0.07	0.05	33

Field precision criteria (<20%) not met

Appendix Table B.24: Laboratory duplicate results (relative percent difference, RPD) for analysis of SRWMP sediment samples.

Parameter	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
QC Batch Number	1961646			1962983	1959556		1960614		1962311	1961821
Total Organic Carbon	3.1			0.5	1.2		0.3		1.3	0.5
QC Batch Number	1962399	1965774	1966318	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Barium (Ba)	2	2	12	6	1	6	0	7	37	0
Cobalt (Co)	6	2	12	4	4	9	4	1	48	14
Iron (Fe)	2	2				5			82	
Manganese (Mn)	5	2				10			43	
Nickel (Ni)	9	2	NC	6	12	8	5	4	15	0
Uranium (U)	2	3				8				

NC - Not calculated

Laboratory precision criteria (<20%) not met

Appendix Table B.25: Recoveries (%) of quality control (QC) standards associated with SRWMP sediment analyses.

Parameter	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
QC Batch Number	1961646			1962983	1959556		1960614		1962311	1961821
Total Organic Carbon	99			93	92		96		96	91
QC Batch Number	1962399	1965774	1966318	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Barium (Ba)	101	100	102	103	99	95	94	100	99	98
Cobalt (Co)	101	106	105	107	105	100	97	101	105	102
Iron (Fe)	80	134	83	111	109	88	107	91	94	110
Manganese (Mn)	99	106	106	109	107	101	96	100	105	101
Nickel (Ni)	103	107	103	108	107	99	96	102	106	102
Uranium (U)	95	104	110	106	103	101	95	102	101	99

Parameter	Becquerel Laboratories			
QC Batch Number	T09-01418	T09-01415	T09-01412	T09-01413
	T09-01416	T09-01414	T09-01417	
Standard	DL1-A	DL1-A	CLV-1	DL1-A
Radium-226 (Ra-226)	88	89	100	94

Analytical accuracy criteria (70 - 130%) not met

Appendix Table B.26: Recoveries (%) of matrix spikes for SRWMP sediment sample analyses.

Parameter	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
	1962399	1965774	1966318	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Maxxam Analytics										
Barium (Ba)	NC	NC	94	99	NC	NC	NC	NC	NC	92
Cobalt (Co)	NC	98	99	102	96	NC	102	86	97	92
Iron (Fe)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Manganese (Mn)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Nickel (Ni)	NC	NC	97	104	94	NC	102	NC	NC	93
Uranium (U)	NC	NC	103	98	96	NC	104	98	99	97

NC - Not calculated

Analytical accuracy criteria (70 - 130%) not met

Appendix Table B.27: Percent recovery of benthic macroinvertebrates from samples collected from Serpent River (2009).

Station	Number of Organisms Recovered in initial sort	Number of Organisms in Re-sort	Percent Recovery
DUL-09-5	223	232	96.1%
HOL-09-1	222	234	94.9%
MAL-09-4	227	239	95.0%
PL-09-2	326	348	93.7%
RL-09-3	88	96	91.7%
SL-09-5	171	178	96.1%
TML-09-5	143	155	92.3%
		Average % Recovery	94.2%

QA/QC Notes

Pupae were not counted toward total number of taxa unless they were the sole representative of their taxa group. Immatures were not counted toward total number of taxa unless they were the sole representative of their taxa group.

Appendix Table B.28: Sample fractions sorted from Serpent River (2009).

Station	Fraction Sorted (500 um)	Station	Fraction Sorted (500 um)	Station	Fraction Sorted (500 um)
DUL-09-1	1/4	MCL-09-3	1/2	QL-09-5	1/2
DUL-09-2	1/4	MCL-09-4	Whole	RL-09-1	Whole
DUL-09-3	1/4	MCL-09-5	1/2	RL-09-2	Whole
DUL-09-4	1/4	ML-09-1	1/4	RL-09-3	Whole
DUL-09-5	1/4	ML-09-2	1/8	RL-09-4	Whole
EL-09-1	Whole	ML-09-3	1/4	RL-09-5	1/2
EL-09-2	Whole	ML-09-4	1/8	SL-09-1	1/2
EL-09-3	Whole[a]	ML-09-5	1/16	SL-09-2	1/8
EL-09-4	1/2	NL-05-1	Whole	SL-09-3	1/4
EL-09-5	Whole	NL-05-2	Whole[a]	SL-09-4	1/8
HOL-09-1	Whole	NL-05-3	Whole	SL-09-5	1/4
HOL-09-2	1/4	NL-05-4	1/2	SUL-09-1	Whole
HOL-09-3	Whole[a]	NL-05-5	1/2	SUL-09-2	1/2
HOL-09-4	Whole	PL-09-1	1/4	SUL-09-3	1/4
HOL-09-5	1/2	PL-09-2	Whole[a]	SUL-09-4	1/2
MAL-09-1	Whole[a]	PL-09-3	1/2	SUL-09-5	1/2
MAL-09-2	Whole	PL-09-4	1/2	TML-09-1	1/8
MAL-09-3	1/2	PL-09-5	1/16	TML-09-2	1/8
MAL-09-4	Whole	QL-09-1	Whole	TML-09-3	1/2
MAL-09-5	1/2	QL-09-2	1/4	TML-09-4	1/2
MCL-09-1	1/2	QL-09-3	1/2	TML-09-5	1/8
MCL-09-2	1/2	QL-09-4	1/2		

[a] two halves sorted for subsampling error calculations.

Appendix Table B.29: Calculation of subsampling error for benthic macroinvertebrate samples from Serpent River (2009).

Station	Number of Whole Large Organisms *	Number of Organisms in Fraction 1	Number of Organisms in Fraction 2	Actual Density*	Precision	Accuracy
					%	%
EL-09-3	0	201	249	450	19.3	10.7
HOL-09-3	0	366	433	799	15.5	8.4
MAL-09-1	0	187	189	376	1.1	0.5
NL-05-2	0	131	153	284	14.4	7.7
PL-09-2	0	172	176	348	2.3	1.1

* whole large organisms excluded in calculations.

min = minimum absolute % error

max = maximum absolute % error

TITLE: **2005 SRWMP ANNUAL DATA QUALITY ASSESSMENT REPORT**	File No: **ERL.QR 05-14**
	Date Issued: Jan. 30, 2006
	Number of Pages: 33
WRITTEN BY: ZHENG Z. WANG	Catalogue: Quality Report

Revision:	Page	Paragraph	Date

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1. INTRODUCTION

This report provides all QC sample results analyzed in this laboratory during the year of 2005 for Serpent River Watershed and In-basin Monitoring Program (SRWMP). Based on the Serpent River Watershed and In-basin Monitoring Program-Implementation Section 14, this assessment covers all 4 data quality indicators for each of 10 monitoring parameters.

1.1 Data Quality Indicators: There are 4 QC data quality indicators**:**

- **Laboratory Reagent Blank**;
- **Duplicate precision**;
- **Spike accuracy**;
- **Certified reference material (CRM) accuracy**.

1.2 Mine Monitoring Parameters: There are **10** monitoring parameters:

- **Mine Indicators, 4**: Radium-226, uranium, sulfate and iron.
- **Potential Mine Indicators, 5**: Barium, cobalt, manganese, selenium and silver.
- **Ancillary, 1:** Dissolved organic carbon (DOC).

1.3 References: To prepare this report, the following data sources were used:

- 12 Analytical Data Quality Monthly Reports;
- Envista QC database;
- ELRFS Analytical Raw Data Worksheets;
- CAEAL Proficiency Test for 2005.

2. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

2.1 In 2005, ELRFS had achieved CAEAL accreditation again including:

- Updated the Quality Manual and Standard Operating Procedures;
- Successfully completed the CAEAL site assessment and received approval of accreditation by CAEAL for the year of 2005;
- Acidity had received a new QC standard material and achieved a good CRM recovery;
- Updated Instrument Preventive Maintenance including:
    - Two Balances by accredited balance service, Mettler;
    - Replace IC column for DX-120;
    - Re-calibrate all micro-pipettes, digital pipettes and digital burets;
    - Updated all calibration standards and certified reference materials (CRM).

2.2 ELRFS has passed all PT tests for soil/sediment samples. For water samples, arsenic was failed in the October 2005 program due to a human mistake. The following parameters are awarded the PT recognition:

In water and wastewater: pH, Alkalinity, TSS, DOC;
Ag, Ba, Cd, Co, Cu, Fe, Mn, Ni, Pb, Se, U & Zn;
SO_4^{2-} & Cl.
In soils: As, Cd, Cu, Pb, Zn, Co and Ni

Note: Radium-226, acidity and TDS were awarded the accreditation but not the PT recognition since CAEAL does not have PT test programs for these parameters. From March 2006, the lab will participate PT test for TDS.

2.3 PT scores in 2005 for above 19 parameters in water and 7 elements in soil/sediments are provided as follows:

Test Parameter	Program	Method	Jan-2005 Soil	Mar-2005 Water	Jun-2005 Soil	Oct-2005 Water
PH	Water	Potontiometric		100		93
Alkalinity	Water	Potontiometric		100		81
Cd	Water	ICP-USN		95		84
Cu	Water	ICP-USN		80		88
Ni	Water	ICP-USN		100		88
Pb	Water	ICP-USN		100		87
Zn	Water	ICP-USN		95		84
Ag	Water	ICP-USN		75		83
Ba	Water	ICP-USN		95		90
Co	Water	ICP-USN		85		89
Fe	Water	ICP-USN		85		95
Mn	Water	ICP-USN		95		93
As	Water	Hydride AA		85		***68***
Se	Water	Hydride AA		80		93
U	Water	Fluorimetry		100		87
Chloride	Water	IC		100		78
Sulfate	Water	IC		100		74
DOC	Water	TOC Analyzer		100		87
TSS	Water	Gravimetric		100		98
As	Soil	Acid Extraction & Hydride AAS	100		100	
Cd	Soil	Acid Extraction & ICP-AES	100		100	
Co	Soil	Acid Extraction & ICP-AES	100		100	
Cu	Soil	Acid Extraction	90		85	

		& ICP-AES				
Pb	Soil	Acid Extraction & ICP-AES	85		95	
Ni	Soil	Acid Extraction & ICP-AES	95		100	
Zn	Soil	Acid Extraction & ICP-AES	95		100	

2.4 During the year of 2005, ELRFS has performed a total of **1,230** QA/QC analyses for the 10 monitoring parameters for SRWMP and In-Basis monitoring program, about **21.5%** of the Rio Algom/Denison total samples and analytes (Denison – 1,630 analytes; Rio Algom – 4,101 analytes). Details are provided below.

3 QC DATA QUALITY SUMMARY - ANNUAL AVERAGE

This report collected **1,230** analytical results for **40** quality control parameters (multiplication of quality indicators by monitoring parameters), calculated the annual average for reagent blank, duplicate precision, spike accuracy and CRM accuracy according to the project #2095 formulas (See **Ref.1**). The annual average results are then compared with the Target Data Quality Objectives (TDQO, see **Ref. 2**).

The explanations are made for any parameter in which the annual average results did not meet the TDQO requirements. If the individual result is over the target objective, it is called exceeding. The percentage of exceeding is counted as one of the quality performance indicators. The corrective actions and suggestions are also made after the explanations.

The annual average results for blanks, duplicate precision, spike accuracy and CRM accuracy are provided in Table 1-1, 1-2 and 1-3 below.

The detailed QC results for 40 individual QC parameters are provided in Table 2-1 to 2-10 in the Appendix.

Table 1-1 **MINE INDICATORS**
Annual Average of Data Quality Results - 2005

QC Parameter	Description	**Ra (T)** Bq/L	**Uranium** mg/L	**Sulfate** mg/L	**Iron** mg/L	Total
Reagent Blank	Criteria	**0.01**	**0.001**	**0.2**	**0.04**	-
	Average Result	0.0049	0.00045	0.022	0.00093	-
	Exceeding	1	0	1	0	*2*
	% Exceeding	0.95%	0%	5.26%	0%	*1.1%*
	Total Analyses	105	20	19	45	*189*
CRM Accuracy	Criteria	**±20%**	**±20%**	**±20%**	**±20%**	-
	Average Result	-2.20%	4.17%	4.44%	8.10%	-
	Exceeding	0	0	0	0	*0*
	% Exceeding	0%	0%	0%	0%	*0.6%*
	Total Analyses	76	24	20	45	*165*
Spike Accuracy	Criteria	**±30%**	**±30%**	**±30%**	**±30%**	-
	Average Result	-0.49%	5.65%	0.34%	-3.40%	-
	Exceeding	0	0	0	0	*0*
	% Exceeding	0%	0%	0%	0%	*0%*
	Total Analyses	73	17	23	27	*140*
Duplicate Precision	Criteria	**10%**	**10%**	**10%**	**10%**	-
	Average Result	5.33%	3.93%	0.78%	2.28%	-
	Exceeding	2	0	0	0	*2*
	% Exceeding	4.1%	0%	0%	0%	*1.6%*
	Total Analyses	49	19	20	36	*124*
Total Analyses		***303***	***80***	***82***	***153***	***618***
Total Exceeding		***3***	***0***	***1***	***0***	***4***
% Exceeding		***1.0%***	***0%***	***1.2%***	***0%***	***0.6%***

Table 1-2 **POTENTIAL MINE INDICATORS**
Annual Average of Data Quality Results - 2005

QC Parameter	Description	**Barium** mg/L	**Cobalt** mg/L	**Manganese** mg/L	**Selenium** mg/L	**Silver** mg/L	*Total*
Reagent Blank	Criteria	**0.01**	**0.001**	**0.004**	**0.001**	**0.0001**	-
	Average Result	0.00016	0.00006	0.00005	0.00078	0.00003	-
	Exceeding	0	0	0	2	1	*3*
	% Exceeding	0%	0%	0%	9.5%	6.3%	*2.2%*
	Total Analyses	34	32	35	21	16	*138*
CRM Accuracy	Criteria	**±20%**	**±20%**	**±20%**	**±20%**	**±20%**	-
	Average Result	2.95%	6.61%	8.25%	6.03%	4.63%	-
	Exceeding	0	0	0	0	0	*0*
	% Exceeding	0%	0%	0%	0%	0%	*0%*
	Total Analyses	34	31	35	21	21	*142*
Spike Accuracy	Criteria	**±30%**	**±30%**	**±30%**	**±30%**	**±30%**	-
	Average Result	-12.3%	-15.38%	-13.04%	0.0%	-3.11%	-
	Exceeding	0	0	0	0	0	*0*
	% Exceeding	0%	0%	0%	0%	0%	*0%*
	Total Analyses	17	18	17	17	18	*87*
Duplicate Precision	Criteria	**10%**	**10%**	**10%**	**10%**	**10%**	-
	Average Result	2.57%	4.05%	1.87%	5.06%	5.74%	-
	Exceeding	0	4	0	3	4	*11*
	% Exceeding	0%	18.2%	0%	16.7%	22.2%	*10.6%*
	Total Analyses	23	22	23	18	18	*104*
Total Analyses		***108***	***103***	***110***	*77*	***73***	***471***
Total Exceeding		***0***	***4***	***0***	***5***	***5***	***14***
% Exceeding		***0%***	***3.9%***	***0%***	***6.5%***	***6.8%***	***3.0%***

Table 1-3 **ANCILLARY**
Annual Average of Data Quality Results - 2005

QC Parameter	Description	**DOC** mg/L
Reagent Blank	Criteria Average Result Exceeding % Exceeding Total Analyses	**1** 0.17 0 0% 26
CRM Accuracy	Criteria Average Result Exceeding % Exceeding Total Analyses	**±20%** -4.44% 0 0% 26
Spike Accuracy	Criteria Average Result Exceeding % Exceeding Total Analyses	**±30%** -4.64% 0 0% 40
Duplicate Precision	Criteria Average Result Exceeding % Exceeding Total Analyses	**10%** 5.70% 6 12.2% 49
Total Analyses		***141***
Total Exceeding		***6***
% Exceeding		***4.3%***

4. CONCLUSION AND SIGNIFICANT FINDINGS

4.1 It is concluded from the above tables that **the annual 2005 average QC results in all of 10 monitoring parameters for all of 4 required QC indicators have met the target data quality objectives (TDQO).**

4.2 **Significant findings:**

4.2.1 Overall performance of QC analyses is summarized in Table 3.

Table 3 Overall Quality Control Performance Summary

Item	QC Parameter	Total Analysis	Individual Exceeding	Blank Analysis	CRM Analysis	Spike Analysis	Duplicate Analysis
Mine Indicator	16	618	4	189	165	140	124
Potential Mine Indicator	20	471	14	138	142	87	104
Ancillary	4	141	6	26	26	40	49
Total	**40**	**1,230**	**24**	**353**	**333**	**267**	**277**
Total Analytes		5731					
Percentage		**21.5%**	**2.0%**	**28.7%**	**27.1%**	**21.7%**	**22.5%**

In this table, there are **1,230** QC samples analyzed for SRWMP in 2005, about **21.5%** of total effluent analyses for both companies (Rio: 4,101; Denison: 1,630). **24** individual QC samples exceeded the TDQO, about **2.0%** of total QC analyses.

In the four quality indicators, blank analysis has the highest percentage, 28.7%, of total QC analyses. CRM analysis has 27.1%; duplicate analysis 22.5%; and spike analyses 21.7%.

4.2.2 **Radium-226** was the mostly frequent analyzed monitoring parameters in the QC analysis. **Iron and DOC** are 12.4% and 11.5% respectively. See Table 4.

Table 4 The Most Frequently Analyzed Monitoring Parameters

No.	Monitoring Parameter	Total QC Samples Analyzed	Percentage
1	Radium-226	303	24.6%
2	Iron	153	12.4%
3	DOC	141	11.5%

4.2.3 The highest exceeding rates occurred in 3 monitoring parameters, i.e. **silver, selenium and DOC**, and in 4 QA/QC parameters, i.e. duplicates for silver, cobalt, selenium and DOC. Details are provided in Table 5.

Table 5 Individual Parameters with Highest Exceeding Rate

Item	Exceeding Number	Exceeding Percentage
Silver	5	6.8%
Selenium	5	6.5%
DOC	6	4.3%
Duplicate Analysis for Silver	4	22.2%
Duplicate Analysis for Cobalt	4	18.2%
Duplicate Analysis for Selenium	3	16.7%
Duplicate Analysis for DOC	6	12.2%

4.2.4 **Uranium, Iron, Barium, Manganese and Sulfate** have achieved the best QC performance with only 1 exceeding in the sulfate analysis. Uranium and sulfate have average accuracy of 0.34 to 5.65%; the average duplicate precision is 0.78 to 3.93%.

5. DETAILS OF EXCEEDING RESULTS IN DUPLICATE ANALYSIS

5.1 Radium-226

No.	Date	Sample ID	Code	1st Result, Bq/L	2nd Result , Bq/L	Average, Bq/L	Difference
1	2005.04.25	N-20	N05-50	0.0052	0.007	0.0061	**29.7%**
2	2005.09.22	Cell 14	Q05-127	0.437	0.395	0.416	**10.1%**

5.2 Cobalt

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.02.07	DS-4	DS05-1	0.00074	0.00082	0.00078	**10.3%**
2	2005.06.23	D-2	D05-62	0.00062	0.00054	0.00058	**13.8%**
3	2005.11.10	D-2	D05-114	0.00048	0.00043	0.000455	**11.0%**
4	2005.12.12	Q-09	Rio05-95	0.00062	0.00070	0.00066	**12.1%**

5.3 Selenium

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.08.12	SR-08	Rio05-53	0.00019	0.00023	0.00021	**19.1%**
2	2005.09.13	D-5	Den05-25	0.00007	0.00009	0.00008	**25.0%**
3	2005.11.23	PR-01	PR05-32	0.00048	0.00043	0.000455	**11.0%**

5.5 Silver

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.03.02	DS-4	DS05-10	0.00323	0.00286	0.003045	**12.2%**
2	2005.05.03	DS-18	Den05-22	0.00027	0.00031	0.00029	**13.8%**
3	2005.06.14	P-14	P05-22	0.00041	0.00036	0.000385	**13.0%**
4	2005.06.24	SR-08	Rio05-50	0.00019	0.00022	0.000205	**14.6%**

5.6 DOC

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.01.14	SR-19	Rio04-109	5.04	5.67	5.36	**11.7%**
2	2005.02.25	D-6	Den05-5	3.93	3.54	3.73	**10.5%**
3	2005.02.25	DS-18	Den05-6	2.166	1.941	2.054	**10.9%**
4	2005.04.30	DS-18	Den05-13	1.75	2.04	1.89	**15.3%**
4	2005.06.07	SR-06	Rio05-39	2.08	1.767	1.92	**16.3%**
4	2005.08.26	P-01	Rio05-66	3.133	2.827	2.98	**10.3%**

6. IMPLEMANTATION OF 2004 CORRECTIVE ACTIONS

6.1 Blank Sample Analysis for Silver

In 2005, the silver blank sample was pre-concentrated. This is the same procedure for samples to achieve lowest method detection limit, 0.00006 mg/L. The results are shown in Table 2-9. In the 16 blank samples, average result is 0.00003 mg/L. There was only 1 sample result, 0.00012 mg/L, exceeded the target value of 0.0001 mg/L. Compared to 2004 results, the average blank dropped almost 7 times. The percentage of exceeding dropped 6 times from 38.9% to 6.2% (see Table 6).

Table 6 Comparison of Blank Results for Silver

Description	2004	2005
Criteria, mg/L	0.0001	0.0001
Average Result, mg/L	0.00020	0.00003
Exceeding Number	14	1
% Exceeding	38.9%	6.2%
Total Analysis	36	16

6.2 Duplicate Analysis for Radium-226 and DOC

According to 2004 recommendations, all of low radioactivity samples and duplicate samples for radium-226 were counted twice or three times. The average precision is slightly higher than 2004. The exceeding percentage drops 5 times from 20.3% to 4.1% (see Table 7).

For DOC analysis, the numbers of duplicate samples did not increase. The QC performance for 2005 has not improved yet. The exceeding percentage is almost the same as 2004 (see Table 7).

Table 7 Comparison of Duplicate Analysis for Radium-226 and DOC

Description	Ra-226 for 2004	Ra-226 for 2005	DOC for 2004	DOC for 2005
Criteria	10%	10%	10%	10%
Average Result	6.51%	5.33%	4.55%	5.70%
Exceeding Number	13	2	7	6
% Exceeding	20.3%	4.1%	11.9%	12.2%
Total Analysis	64	49	59	49

7. CORRECTIVE ACTIONS

7.1 The highest exceeding frequency of duplicate analysis occurred in silver, cobalt, selenium and DOC. The reason is the lower concentrations in the SRWMP samples as seen in the Section 5.

To improve the duplicate performance, **the following corrective actions** should be taken:

- Repeat the analysis if the sample concentrations are too low.
- Perform more duplicate samples.
- Choose the duplicate samples that contain higher concentrations of the analyte.

8. REFERENCES

8.1 Minnow Proposal: **QA/QC Information, Serpent River Watershed Monitoring Program (Project No. 2095),** September 20 – October 3, 2004

8.2 **Data Quality Objective Table 2.1** 1999 SRWMP and In-basin document for Rio Algom Mines Ltd. and Denison Mines Ltd.

8.3 **Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater,** Ontario, July 1999.

8.4 **Reference Methods for Sampling and Analysis of Metal Mining Effluents** Draft 3. Prepared by Peter Fowlie. January 1999.

8.5 Data **Quality Assessment and Reporting Procedure, QAP-6**. ELRFS Quality Manual

APPENDIX: SUMMARY OF DETAILED SRWMP QC DATA QUALITY RESULTS FOR THE YEAR OF 2005

See **Table 2-1 to Table 2-10 in the following pages**

Environmental Services

REPORT CODE: *DEN-ANN06*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.2*

ISSUED BY:

Quality Control Coordinator,
SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *23 March 2007*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Please find below a summary of the laboratory quality management system, key actions taken by the laboratory for samples analysed during 2006, as well as a summary the significant findings and corrective actions taken.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited by the Standards Council of Canada (SCC) and by the Canadian Association for Environmental Analytical Laboratories (CAEAL), for specific environmental tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Control Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL ANALYSIS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2006 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 9809 analyses with 7028 QC checks, which represents 72% QC for sample analysis. This level of QC analysis exceeds the lab standard for QC insertion, which is generally at 20% insertion.
- Blank data values for acidity and DOC that exceeded the data quality objective represent data at or near the detection limit where the limit is +/- the detection limit. The supporting QC data within all runs was within data quality objective limits. **Corrective Action**: No further action required.
- All Certified Reference Material data values for samples processed in 2006 were within the data quality objective of +/- 20%. **Corrective Action**: N/A
- There were duplicate sample values outside of the data quality objective of +/- 10% observed. However, the duplicate values represent data at or near the detection limit where the repeatability is +/- the detection limit. The supporting QC data within all runs was within data quality objective limits. **Corrective Action**: No actual non-conformances occurred; the data is evaluated against current SGS Environmental Services limits, which are at or below DES limits and no further action is required; the LIMS data management program cannot be changed to accommodate a modified reporting limit.
- Spike blanks for Ba, Se, and Fe exceeded the data quality objectives. However, reporting limits for these elements for Denison Environmental Services exceed the standard reporting limits for SGS Environmental Services. Therefore, spike blanks are reported as 'less than' (<) detection limit and flagged as outliers/failures by our LIMS data management program. Results remain within data quality objectives for the method. **Corrective Action**: No actual non-conformances occurred; the data is evaluated against current SGS Environmental Services limits, which are at or below DES limits and no further action is required; the LIMS data management program cannot be changed to accommodate a modified reporting limit.
- Several spike duplicate results exceeded the data quality objectives for a number of elements. The Se results that were biased high had a (suspected) positive chloride interference in the matrix and a suspected contamination in the spike solution. A positive bias in the spike solutions in conjunction with non-detect values of Se in unknown samples does not have a significant impact on the final concentration, as opposed to a low bias, which would indicate incomplete recovery. This data set, along with all other spike duplicate results outside of the data quality objectives had supporting QC in the run that was within the limits required, therefore, data was accepted. **Corrective Action:** When the concerns with Se were first identified, SGS Environmental Services confirmed all positive results by ICP-MS and AA Hydride Generation, (which eliminated the interference). A new (higher concentration) spiking solution was ordered and a new ICP-MS CRI was commissioned for use in January 2007. As a result, interference effects for Se at these detection limits will be eliminated.

5. QC DATA QUALITY SUMMARY

Blank Data:

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Detection Limit
Acidity	mg/L as CaCO3	2	2.07356	36	6	0
Ag	mg/L	0.0001	0.00001	133	0	0
Alkalinity	mg/L as CaCO3	2	0.28000	5	0	0
As	mg/L	0.0005	0.00005	55	0	0
Ba	mg/L	0.005	0.00082	131	0	0
Co	mg/L	0.0005	0.00008	134	0	0
Cu	mg/L	0.0001	0.00014	79	0	0
DOC	mg/L	0.5	0.12788	32	1	0
Fe	mg/L	0.02	0.00162	129	0	0
Mn	µg/L	0.002	0.00033	129	0	0
Ni	µg/L	0.002	0.00032	78	0	0
Pb	µg/L	0.00002	0.00007	75	0	0
Se	µg/L	0.0005	0.00003	131	0	0
SO4	mg/L	0.1	0.01852	135	0	0
Total Suspended Solids	mg/L	1	0.11502	156	0	0
U	µg/L	0.0005	0.00007	133	0	0
Zn	µg/L	0.001	0.00015	79	0	0

CRM Data:

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
DOC	mg/L	25	20	30	24	25.98	3.74	-3.93	0
pH	units	4	3.2	4.8	7	4.00	0.40	-0.04	0
Acidity	mg/L as CaCO3	50	40	60	12	48.95	1.41	2.10	0
Acidity	mg/L as CaCO3	10	8	12	7	10.94	2.94	-9.37	0
Ag	mg/L	0.1	0.08	0.12	31	0.10	3.42	-0.83	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	8	48.53	1.42	-2.82	0
As	mg/L	0.1	0.08	0.12	31	0.10	5.90	1.21	0
Ba	mg/L	0.1	0.08	0.12	32	0.10	4.00	-3.21	0
Co	mg/L	0.1	0.08	0.12	33	0.10	4.40	-1.85	0
Cu	mg/L	0.1	0.08	0.12	35	0.10	3.64	-0.45	0
DOC	mg/L	10	8	12	16	10.49	4.05	-4.92	0
Fe	mg/L	500	400	600	30	519.46	2.41	-3.89	0
Mn	µg/L	0.1	0.08	0.12	33	0.10	4.06	-1.91	0
Ni	µg/L	0.1	0.08	0.12	32	0.10	3.22	1.22	0
Pb	µg/L	0.1	0.08	0.12	32	0.10	2.97	-0.52	0
Se	µg/L	0.1	0.08	0.12	32	0.10	5.76	0.75	0
SO4	mg/L	5	4	6	91	5.00	2.01	0.08	0
U	µg/L	0.1	0.08	0.12	32	0.10	4.14	-1.02	0
Zn	µg/L	0.1	0.08	0.12	33	0.10	3.68	-0.95	0

Duplicate Data:

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	24	2.125	1	0
Ag	% Rec.	100	90	110	112	2.045	4	0
Alkalinity	% Rec.	100	90	110	7	0.667	1	0
As	% Rec.	100	90	110	40	5.256	16	0
Ba	% Rec.	100	90	110	113	-1.603	7	0
Co	% Rec.	100	90	110	117	1.145	8	0
Cu	% Rec.	100	90	110	58	6.902	22	0
DOC	% Rec.	100	90	110	23	1.540	8	0
Fe	% Rec.	100	90	110	110	1.785	16	0
Mn	% Rec.	100	90	110	116	0.524	3	0
Ni	% Rec.	100	90	110	55	-1.159	18	0
Pb	% Rec.	100	90	110	60	1.144	21	0
pH	% Rec.	100	90	110	4	94.238	4	0
Se	% Rec.	100	90	110	89	2.047	18	0
S	% Rec.	100	90	110	73	-0.282	1	0
Tot Suspended Solids	% Rec.	100	90	110	107	-0.916	8	0
U	% Rec.	100	90	110	116	0.302	2	0
Zn	% Rec.	100	90	110	58	-1.345	15	0

Spike Blank Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO	Number Spike Blank outside of SGS QC protocols and below Denison MDL
Acidity	mg/L as CaCO3	10	7	13	35	107.22	0.517	0	0
Ag	mg/L	0.00016	0.000112	0.00021	139	102.01	0.000	0	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	7	102.29	0.281	0	0
As	mg/L	0.0064	0.00448	0.00832	69	99.91	0.000	0	0
Ba	mg/L	0.004	0.0028	0.0052	146	90.59	0.000	65	0
Co	mg/L	0.002	0.0014	0.0026	147	101.63	0.000	0	0
Cu	mg/L	0.0016	0.00112	0.00208	92	112.22	0.000	0	0
DOC	mg/L	20	14	26	56	99.16	0.722	0	0
Fe	mg/L	0.1	0.07	0.13	129	109.21	0.006	1	0
Mn	µg/L	0.0032	0.00224	0.00416	134	101.85	0.000	0	0
Ni	µg/L	0.0048	0.00336	0.00624	89	102.96	0.000	0	0
Pb	µg/L	0.0032	0.00224	0.00416	68	109.13	0.000	0	0
Se	µg/L	0.0008	0.00056	0.00104	115	104.76	0.000	3	3
SO4	mg/L	4	2.8	5.2	108	100.64	0.103	0	0
SO4	mg/L	100	70	130	30	101.05	9.863	0	0
U	µg/L	0.0008	0.00056	0.00104	147	101.85	0.000	0	0
Zn	µg/L	0.0056	0.00392	0.00728	62	114.94	0.000	0	0

Spike Duplicate Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO	Number Spike Dup. outside of SGS QC protocols and below Denison MDL
Ag	µg/L	0.16	0.112	0.208	116	94.58	0.02	6	0
As	µg/L	6.4	4.48	8.32	53	104.11	0.64	0	0
Ba	µg/L	4	2.8	5.2	98	93.15	1.05	20	0
Co	µg/L	2	1.4	2.6	133	101.08	0.21	1	0
Cu	µg/L	1.6	1.12	2.08	74	106.64	0.18	5	0
DOC	mg/L	100	70	130	44	99.01	6.55	0	0
Fe	mg/L	0.1	0.07	0.13	112	110.13	0.01	3	1
Mn	µg/L	3.2	2.24	4.16	74	99.30	0.94	14	0
Ni	µg/L	4.8	3.36	6.24	71	96.42	1.16	3	0
Pb	µg/L	3.2	2.24	4.16	79	111.61	0.30	6	0
Se	µg/L	0.8	0.56	1.04	87	110.50	0.29	36	18
SO4	mg/L	100	70	130	92	99.92	6.47	0	0
U	µg/L	0.8	0.56	1.04	111	104.53	0.11	7	2
Zn	µg/L	5.6	3.92	7.28	63	114.46	1.15	15	5

QC Frequency:

Total Number of Blanks	1783
Total Number of CRM	919
Total Number of Duplicates	1400
Total Number of Spike Blank	1573
Total Number of Spike Duplicates:	1353
Sum of QC Insertion	**7028**
Total Analysis:	**9809**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. While some of the data points exceeded the data quality objectives, the additional QC samples analyzed supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2007.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- Discrepancies in Ag analysis in solution were noted between SGS Environmental Services and the previous laboratory used by Denison Environmental Services. SGS Environmental Services Ag data was consistently lower than previous reports. Upon discussion with Denison Environmental Services it became apparent that there were differences in the analytical instrumentation previously in use. SGS Environmental Services uses a quadruple inductively coupled plasma mass spectrometer (ICP-MS) whereas previous data was generated by inductively coupled plasma optical emission spectrometer (ICP-OES) with ultrasonic nebulization (USN). While both techniques are good there are certain advantages of ICP-MS when compared to ICP-OES with USN. ICP-MS is a more sensitive technique, having a much lower analytical sensitivity, which is relatively interference free for silver, while ICP-OES with USN is not as sensitive, and can exhibit more background interferences which may have lead to higher analytical results (possibly due to sulphate concentrations). **Corrective Action:** Based on the above technical information, it was determined that the analysis for silver would be done by ICP-MS.
- Several spike duplicate results exceeded the data quality objectives for a number of elements. The Se results that were biased high had a (suspected) positive chloride interference in the matrix and a suspected contamination in the spike solution. A positive bias in the spike solutions in conjunction with non-detect values of Se in unknown samples does not have a significant impact on the final concentration, as opposed to a low bias, which would indicate incomplete recovery. This data set, along with all other spike duplicate results outside of the data quality objectives had supporting QC in the run that was within the limits required, therefore, data was accepted. **Corrective Action:** When the concerns with Se were first identified, SGS Environmental Services confirmed all positive results by ICP-MS and AA Hydride Generation, (which eliminated the interference). A new (higher concentration) spiking solution was ordered and a

new ICP-MS CRI was commissioned for use in January 2007. As a result, interference effects for Se at these detection limits will be eliminated.

- The required limit for lead was previously listed as 0.00002 mg/L, with a mean data blank value of 0.00008 mg/L. Therefore, at least one of the blank results did not meet the data quality objectives **Corrective Action**: The required reporting limit has been updated to the Denison Environmental Services limit of 0.0005 mg/L with the mean data blank value of 0.00008 mg/L falling well below the required limit.
- Denison Environmental Services report CA11555-SEP06 was issued with incorrect values for SO4. The samples were run with a 100X dilution but the factor was omitted when entered into the sequence. The error was not noticed during the calculation stage and was reported 100X lower than the actual results. **Corrective Action:** The error was documented as per the requirements of our Quality Management System, which the technician signed. The data for SO4 was re-issued under report CA10079-NOV06.
- During the review of Denison Environmental Services QC files, it was noted that the limits for acidity reflected the standard lab data quality objectives of +/- 20%. **Corrective Action:** No values for acidity exceeded +/- 10%. The limits in the LIMS program have been updated to +/- 10%.
- Denison Environmental Services notified SGS Environmental Services of a deviation from required MDL values. It was noted by SGS Environmental Services that chain of custody forms for the October submissions came in for SRWMP requiring the 0.00006 mg/L MDL while in November the submission was for NORDIC requiring the 0.0001 mg/L MDL. **Corrective Action:** SGS Environmental Services logs in samples as per the charge code on the submission forms. Unfortunately this is a required process prior to the import of the EMLINE file. No further action required.
- Based on correspondence received from Denison Environmental Services, an in-house study was done that compared acidity data from reports generated at SGS with those from another laboratory previously used by Denison Environmental Services. There was a notable difference in analytical values between historical values analyzed in 2005 and results generated from the same sampling sites in 2006 (see Addendum 2). **Corrective Action**: SGS performed a series of re-assays to ascertain the reasons for the discrepancies. Three different circumstances were identified as contributing factors to the discrepancy in data.
    - Data provided to SGS by Denison Environmental Services did not match data originally reported by SGS. A review of the original Certificate's analysis identified transcription errors. However, the errors occurred after the data had been released to the company managing the information for Denison Environmental Services, and as such no corrective action taken.
    - Data provided to Denison Environmental Services was reported low due to a software issue with the Mantec™ auto-titration system used by SGS Environmental Services. Specifically, samples that reach the maximum

amount of titrant (set at 50 mL to prevent the over-titration of samples resulting in a spill of material on the instrument) are not flagged as incomplete and are reported as <1 mg/L. Results of <1 mg/L, however, require laboratory technicians to identify and re-assay the samples that were incomplete and which require a smaller aliquot. **Corrective actions:** Quality action Forms 1297, 1308, and 1309 were created within the quality system, where possible all of the effected samples were re-assayed, all technicians involved with the determination were instructed, and re-trained on how to avoid the problem.

- Data provided from Denison Environmental Services generally showed an overall bias when compared to the SGS Environmental Services data. It was determined that SGS and the original testing laboratory used two (slightly) different methods for the determination of acidity. It is believed that this difference in methodology resulted in the higher bias of the original 2005 results. SGS follows the standard methods procedure 2310B (APHA, 2005). The primary difference between the two methodologies is that SGS performs an "oxidation step" as per 2310B (the samples are titrated to a pH of 3.9 with 0.02 N sulfuric acid, add 5 drops of hydrogen peroxide and boiled before titrating to a pH of 8.3 with 0.02 N sodium hydroxide), whereas the methodology used by the original laboratory did not carry out the oxidation step. Further research suggests that the differences in the amount of H2CO3, Fe+2, and Fe+3 resulted in the bias of the data. The Statement: *"For samples containing hydrolyzable metals, the addition of H2SO4 acid serves to convert HCO3 into H2CO3 which allows CO2 to degass rapidly upon boiling so CO2-derived acidity is intentionally not measured. The addition of H2O2 causes oxidation of Fe +2 and Mn +2 so that they can be precipitated as oxides or hydroxides during the titration"* (C.S. Kirby, C.A. Cravotta III, applied geochemistry, 2005) helps explain the complexity of the analysis and the distinct bias between the two data sets. **Corrective actions:** SGS performed a number of re-assays to determine if the above changes in methodology contributed to the bias in data. (Addendum 3). The results demonstrated the bias when samples that were titrated "oxidized" and not "oxidized" supporting the above arguments. No further action is necessary. SGS will continue to run acidities according to the established method.

8. SUBCONTRACT LAB INFORMATION

A full report will be provided by the subcontract lab for all analyses performed. A summary of the information included in the subcontract lab reports is below.

Analytical Parameter	Blank Result Bq/L	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO	-	-	+- 10	-

Ra-226	< 0.005	89	2.9	91

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+/- 30		10	
Ra-226	+0.8	89	8.6	89

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Date: 08-Mar-2007

Annual Quality Assessment Report for 2006

Introduction

The following samples were used for quality control in 2006. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

While samples from Dennison Mines were limited to a 500 mL volume, some duplicates were from samples submitted by other clients.

Analyte Spikes

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

While samples from Dennison Mines were limited to a 500 mL volume, some spiked samples were prepared from samples submitted by other clients.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards

Several check standards were using during 2006.

RA226.012
: A portion of Canmet CRM DH1-A was dissolved and diluted with dilute nitric acid.

R63
: This was a solution obtained from Environmental Research Associates in a performance evaluation trial. It was used as a temporary check standard until a standard solution was received.

R59
: This was a solution obtained from Environmental Research Associates in a performance evaluation trial. It was used as a temporary check standard until a standard solution was received.

RA226.013
: This was a solution prepared from the spike solution. It was used as a temporary check standard until a standard solution was received.

RA226.015
: A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare this check standard. The standard was checked against Canmet CRM DL1-A.

Major Achievements in Quality Control

Sample identification was placed under stricter control, with all containers and prepared sources labelled.

Ongoing improvements in precision were obtained through mechanical sample changing during yield determination and adjustment of counting times. Sample aliquot size was increased for the same reason.

QC Data Quality Summary

Analytical Parameter	Blank Result Bq/l	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO			+- 10	
Ra-226	< 0.005	95	-1.8	95

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+- 30		10	
Ra-226	-0.8	95	9.6	95

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 4.6% and that for the spike becomes 4.7%.

The precision value is the mean of the absolute percent differences for duplicate results above 10 times the detection limit. If all duplicates involving positive original results are included, this mean becomes 19%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: One positive blank result was obtained.

CRM: 6 CRM results differed from the expected value by more than 10 percent. The maximum deviation was +16 percent.

Spike: The maximum deviation was –28 %.

Duplicate: Of the 95 duplicate sets run, 37 gave positive results. 27 duplicates gave results greater than 10 times the detection limit: of these, 7 duplicates differed by more than 10 percent. The maximum deviation was +53%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. The main challenge is in maintaining precision without incurring unreasonable expenditures of resources.

Corrective Actions

Two samples were interchanged during analysis**.** They were re-analyzed and the new results reported.

Erratic results were found for the first and last few aliquots of check standards. Arrangements have been made to prepare and characterize check standards in advance of previous ones running out.

Appendix Raw QC Data negative values signify upper limits

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.012	0.94	0.86	0.011	0.007	104
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.98	0.009	0.007	102
-0.005	RA226.012	0.94	0.90	0.023	0.019	94
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	91
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	105
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	104
-0.005	RA226.012	0.94	0.89	0.011	0.016	102
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	101
-0.005	RA226.012	0.94	0.93	-0.005	-0.005	103
-0.005	RA226.012	0.94	0.86	0.005	-0.005	97
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	94
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	98
-0.005	RA226.012	0.94	0.92	-0.005	-0.005	106
-0.005	RA226.012	0.94	0.87	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.91	0.026	0.022	95
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	116
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.88	0.026	0.031	113
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.92	0.016	0.014	108
-0.005	RA226.012	0.94	0.90	0.13	0.14	110
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	101
-0.005	RA226.012	0.94	1.05	-0.005	-0.005	101
-0.005	RA226.012	0.94	0.98	-0.005	-0.005	103
-0.005	RA226.012	0.94	0.93	0.11	0.11	96
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.97	-0.005	-0.005	95
-0.005	RA226.012	0.92	0.97	-0.005	-0.005	95
-0.005	RA226.012	0.94	0.93	1.2	1.0	95
-0.005	RA226.012	0.94	0.91	-0.005	-0.005	95
-0.005	RA226.012	0.94	0.87	-0.005	-0.005	97
-0.005	RA226.012	0.94	0.92	-0.005	-0.005	93
-0.005	RA226.012	0.94	0.83	-0.005	-0.005	97
-0.005	RA226.012	0.94	0.90	-0.005	-0.005	102
-0.005	RA226.012	0.94	0.96	0.71	0.72	97
-0.005	RA226.012	0.94	0.86	0.011	0.007	104
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.98	0.009	0.007	102
-0.005	RA226.012	0.94	0.90	0.023	0.019	94
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	91
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	105
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	104
-0.005	RA226.012	0.94	0.89	0.011	0.016	102
-0.005	RA226.012	0.94	0.90	0.94	0.90	104
-0.005	RA226.012	0.94	0.87	0.39	0.37	101
-0.005	RA226.012	0.94	0.90	0.13	0.14	110
-0.004	RA226.012	0.94	1.00	0.14	0.15	102
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	100

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.93	-0.005	-0.005	108
-0.005	RA226.012	0.94	0.98	-0.005	-0.005	104
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	94
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.86	-0.005	-0.005	103
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	102
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	94
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	109
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	101
-0.005	RA226.012	0.94	0.85	-0.005	-0.005	97
-0.005	RA226.012	0.94	1.00	0.14	0.15	102
-0.005	RA226.012	0.94	0.90	-0.005	-0.005	88
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	101
-0.005	RA226.012	0.94	1.04	-0.005	-0.005	98
-0.005	RA226.012	0.94	0.97	-0.005	-0.005	91
-0.005	RA226.012	0.94	0.85	0.068	0.062	93
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	102
-0.005	RA226.012	0.94	0.92	0.22	0.27	102
-0.005	RA226.012	0.94	0.84	1.4	1.3	97
-0.005	RA226.012	0.94	0.95	0.055	0.059	104
-0.005	R63	0.31	0.28	-0.005	-0.005	97
-0.005	R63	0.31	0.29	0.18	0.18	103
-0.005	R63	0.31	0.28	-0.005	-0.005	97
-0.005	R63	0.31	0.32	-0.005	-0.005	98
-0.005	R63	0.31	0.31	-0.005	-0.005	103
-0.005	R63	0.31	0.31	-0.005	-0.005	97
-0.005	R59	0.36	0.37	-0.005	-0.005	94
-0.005	R59	0.36	0.37	0.071	0.065	106
-0.005	R59	0.36	0.34	-0.005	-0.005	101
-0.005	R59	0.36	0.37	0.34	0.31	72
-0.005	R59	0.36	0.32	0.008	0.007	87
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	102
0.006	R59	0.34	0.29	0.072	0.11	98
-0.005	R59	0.34	0.33	-0.006	0.009	89
-0.005	RA226.013	1.00	1.02	0.44	0.47	110
-0.005	RA226.013	1.00	1.10	0.028	0.035	108
-0.005	RA226.013	1.00	1.03	0.51	0.45	115
-0.005	RA226.013	1.00	0.94	0.03	0.031	99
-0.005	RA226.013	1.00	1.16	1.20	1.3	88
-0.005	RA226.015	0.96	1.00	-0.005	-0.005	99
-0.005	RA226.015	0.96	0.98	0.096	0.094	90
-0.005	RA226.015	0.96	0.93	0.13	0.13	86
-0.005	RA226.015	0.96	0.97	0.039	0.035	92
-0.005	RA226.015	0.96	1.02	0.34	0.36	91
-0.005	RA226.015	0.96	0.98	0.096	0.107	98
-0.005	RA226.015	0.96	0.97	0.15	0.13	101
-0.005	RA226.015	0.96	0.88	0.029	0.057	96
-0.005	RA226.015	0.96	0.95	0.019	0.021	100
-0.005	RA226.015	0.96	0.95	0.13	0.14	97
-0.005	RA226.015	0.96	0.88	-0.005	0.007	99

SGS Environmental Services

REPORT CODE: *DEN-ANN07*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.1*

ISSUED BY:

Quality Control Coordinator,
SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *26 February 2008*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Please find below a summary of the laboratory quality management system, key actions taken by the laboratory for samples analysed during 2007, as well as a summary the significant findings and corrective actions taken.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited by the Standards Council of Canada (SCC) and by the Canadian Association for Environmental Analytical Laboratories (CAEAL), for specific environmental tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Control Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL ANALYSIS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2007 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 18054 analyses with 11221 QC checks, which represents 62% QC for sample analysis. This level of QC analysis exceeds the lab standard for QC insertion, which is generally 20%.
- All blank data results were within the data quality objectives, with the exception of 2 elevated results for copper, (as noted in the September report). **Corrective Action**: the Cu results were reported in LIMS numbers CA10235-SEP07, and CA10234-SEP07. While 2 results were reported as elevated, only one was analyzed but reported twice. The samples are disposed of, making a re-assay impossible. All other QC in the report was acceptable; therefore, the results were accepted and no further action was taken.
- All Certified Reference Material data values in the SGS system for samples processed in 2007 were within the data quality objectives. **Corrective Action**: N/A
- All data for Ra226 has been excluded from this report pending clarification from the subcontract lab. **Corrective Action**: N/A
- Thirteen spike blanks for Ba exceeded the data quality objectives. However, reporting limits for this element for Denison Environmental Services exceeds the standard reporting limit for SGS Environmental Services. Therefore, spike blanks are reported as 'less than' (<) detection limit and flagged as outliers/failures by our LIMS data management program. Results remain within data quality objectives for the method. **Corrective Action**: No actual non-conformances occurred; the data is evaluated against current SGS Environmental Services limits, which are at or below DES limits and no further action is required; the LIMS data management program cannot be changed to accommodate a modified reporting limit.
- No spike duplicate results exceeded the data quality objectives. **Corrective Action:** N/A

5. QC DATA QUALITY SUMMARY

Blank Data:

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Limit
Acidity	mg/L as CaCO3	2	2.06128	115	34	0
Ag	mg/L	0.0001	0.08337	204	0	0
Alkalinity	mg/L as CaCO3	2	7.00000	7	0	0
As	mg/L	0.0005	---	0	0	0
Ba	mg/L	0.005	0.00230	202	0	0
Co	mg/L	0.0005	0.00023	204	0	0
Cu	mg/L	0.0001	0.00039	54	2	2
DOC	mg/L	0.5	0.22608	120	0	0
Fe	mg/L	0.02	0.00909	239	0	0
Mn	mg/L	0.002	0.00088	202	0	0
Ni	mg/L	0.002	0.00093	55	0	0
Pb	mg/L	0.00002	0.00023	55	0	0
Se	mg/L	0.0005	0.00019	214	1	0
SO4	mg/L	0.1	0.04502	242	1	0
Total Suspended Solids	mg/L	1	0.43913	273	0	0
U	mg/L	0.0005	0.00023	207	0	0
Zn	mg/L	0.001	0.00046	55	0	0

CRM Data:

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	40	60	99	50.98	2.31	-1.95	0
Acidity	mg/L as CaCO3	10	8	12	0	---	---	---	0
Ag	mg/L	0.1	0.08	0.12	186	0.10	2.45	-1.94	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	6	48.63	4.37	-2.75	0
As	mg/L	0.1	0.08	0.12	4	0.10	6.34	1.14	0
Ba	mg/L	0.1	0.08	0.12	185	0.10	3.18	-0.94	0
Co	mg/L	0.1	0.08	0.12	185	0.10	3.31	-2.10	0
Cu	mg/L	0.1	0.08	0.12	51	0.10	2.62	-2.08	0
DOC	mg/L	10	8	12	125	9.74	4.43	2.55	0
Fe	mg/L	500	400	600	112	509.83	10.84	1.72	0
Mn	mg/L	0.1	0.08	0.12	192	0.10	3.89	-0.90	0
Ni	mg/L	0.1	0.08	0.12	51	0.10	3.14	-1.14	0
Pb	mg/L	0.1	0.08	0.12	50	0.10	2.25	-0.58	0
Se	mg/L	0.1	0.08	0.12	188	0.10	4.67	1.37	0
SO4	mg/L	5	4	6	194	5.01	2.60	-0.24	0
U	mg/L	0.1	0.08	0.12	189	0.10	3.83	-1.05	0
Zn	mg/L	0.1	0.08	0.12	186	0.10	3.40	-2.04	0

Duplicate Data:

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	89	0.884	5	0
Ag	% Rec.	100	90	110	184	0.072	0	0
Alkalinity	% Rec.	100	90	110	6	0.000	0	0
As	% Rec.	100	90	110	17	1.235	1	0
Ba	% Rec.	100	90	110	202	0.100	0	0
Co	% Rec.	100	90	110	191	0.190	0	0
Cu	% Rec.	100	90	110	52	3.090	14	0
DOC	% Rec.	100	90	110	113	2.528	11	0
Fe	% Rec.	100	90	110	188	1.416	4	0
Mn	% Rec.	100	90	110	195	0.129	4	0
Ni	% Rec.	100	90	110	54	-0.678	11	0
Pb	% Rec.	100	90	110	47	0.597	4	0
pH	% Rec.	100	90	110	26	0.077	0	0
Se	% Rec.	100	90	110	191	-0.264	7	0
S	% Rec.	100	90	110	180	1.071	6	0
Tot Suspended Solids	% Rec.	100	90	110	274	3.044	28	0
U	% Rec.	100	90	110	207	0.776	0	0
Zn	% Rec.	100	90	110	46	2.742	10	0

Spike Blank Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	62	109.68	0.34	0
Ag	mg/L	0.00016	0.000112	0.00021	171	109.04	0.00	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	4	101.06	---	0
As	mg/L	0.0064	0.00448	0.00832	4	102.14	0.00	0
Ba	mg/L	0.004	0.0028	0.0052	173	65.95	0.00	13
Co	mg/L	0.002	0.0014	0.0026	175	102.25	0.00	0
Cu	mg/L	0.0016	0.00112	0.00208	42	112.05	0.00	0
DOC	mg/L	20	14	26	141	98.30	1.39	0
Fe	mg/L	0.1	0.07	0.13	210	412.84	0.05	0
Mn	mg/L	0.0032	0.00224	0.00416	154	104.50	0.00	0
Ni	mg/L	0.0048	0.00336	0.00624	48	104.10	0.00	0
Pb	mg/L	0.0032	0.00224	0.00416	39	109.25	0.00	0
Se	mg/L	0.0008	0.00056	0.00104	166	101.78	0.00	0
SO4	mg/L	4	2.8	5.2	206	99.67	0.14	0
SO4	mg/L	100	70	130	139	100.64	0.00	0
U	mg/L	0.0008	0.00056	0.00104	54	101.76	0.00	0
Zn	mg/L	0.0056	0.00392	0.00728	5	119.94	0.00	0

Spike Duplicate Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Ag	µg/L	0.16	0.112	0.208	209	96.42	0.01	0
As	µg/L	6.4	4.48	8.32	0	---	---	0
Ba	µg/L	4	2.8	5.2	189	99.96	0.14	0
Co	µg/L	2	1.4	2.6	204	101.09	0.07	0
Cu	µg/L	1.6	1.12	2.08	48	101.97	0.11	0
DOC	mg/L	100	70	130	117	94.98	7.39	0
Fe	mg/L	0.1	0.07	0.13	187	106.71	0.01	0
Mn	mg/L	3.2	2.24	4.16	169	102.22	0.15	0
Ni	mg/L	4.8	3.36	6.24	51	99.04	0.16	0
Pb	mg/L	3.2	2.24	4.16	44	106.99	0.16	0
Se	mg/L	0.8	0.56	1.04	197	98.94	0.56	0
SO4	mg/L	100	70	130	190	99.69	5.13	0
U	mg/L	0.8	0.56	1.04	86	101.43	0.07	0
Zn	mg/L	5.6	3.92	7.28	11	96.22	1.06	0

QC Frequency:

Total Number of Blanks	2283
Total Number of CRM	2151
Total Number of Duplicates	2495
Total Number of Spike Blank	1874
Total Number of Spike Duplicates:	2418
Sum of QC Insertion	**11221**
Total Analysis:	**18054**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2008.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- None

8. SUBCONTRACT LAB INFORMATION

A full report has been provided by the subcontract lab and is included as Addendum A of this report.

9. HISTORY OF REVISIONS

1. *26 February 2008*: removed Ra226 data pending review of data by the subcontract lab; the annual report submitted to SGS was inconsistent with the monthly data and non-conformance information contained in the monthly reports; all other amendments are identified by highlighting throughout the document. *Note: as per the request of the client, all highlighting has been removed.*

10. ADDENDUM A - SUBCONTRACT LAB INFORMATION

This section has been intentionally removed from the report pending revision of the QC data.

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Date: 09-Jan-2008

Annual Quality Assessment Report for 2007

Introduction

The number of samples analyzed was 794.

The following samples were used for quality control in 2007. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

Analyte Spikes

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards

Several check standards were using during 2007.

RA226.15, RA226.16, RA226.19, RA226.20

A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare these check standards.

Major Achievements in Quality Control

Precision, as measured by duplicate analyses, improved over that found in 2006.

Eight new alpha-particle spectrometers were purchased and installed.

Expermental trials were initiated with the object of reducing processing times, reducing mtrix effects and improving the quality of alpha-particle spectra. These trials are ongoing.

QC Data Quality Summary

Analytical Parameter	Blank Result Bq/l	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO			+- 10	
Ra-226	< 0.005	100	-0.5	100

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+- 30		10	
Ra-226	+2.1	99	4.7	99

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 4.8% and that for the spike becomes 4.8%.

The precision value is the mean of the absolute percent differences for duplicate results above 10 times the detection limit. If all duplicates involving positive original results are included, this mean becomes 9.1%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: Two positive blank results, of 0.008 and 0.015 Bq/l, were obtained.

CRM: 8 CRM results differed from the expected value by more than 10 percent. The maximum deviation was -33 %.

Two of these were treated as non-conformances, were investigated by reanalyses, and were superseded by new results within limits.

Spike: The maximum deviation was +21 %.

Duplicate: Of the 99 duplicate sets run, 95 gave positive results. 72 duplicates gave results greater than 10 times the detection limit: of these, 3 duplicates differed by more than 10 percent. The maximum deviation was +14%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. The main challenge is in maintaining precision without incurring unreasonable expenditures of resources.

Corrective Actions

A sample originally reported as < 0.006 Bq/l was recounted and reported as < 0.005 Bq/l.

In one run, the duplicate failed to agree. The run was repeated and gave a satisfactory duplicate result.

A positive blank result of 0.008 Bq/l was found in one run. A second blank and samples giving results less than 0.1 Bq/l were reanalyzed.

A positive blank was obtained. The blank and samples giving values of 0.1 Bq/l or less were rerun.

On two occasions, a low CRM result was obtained. The CRM and a sample giving a positive result were rerun to demonstrate that the problem with the standard was not general.

For batch T07-00827.0, a duplicate was drawn from the second of the two bottles submitted for a sample. That duplicate result was in poor agreement with the original result. A second duplicate was drawn from the first bottle and gave much better agreement.

Appendix Raw QC Data negative values signify upper limits

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.15	0.96	0.90	0.64	0.65	96
-0.005	RA226.15	0.96	0.90	0.32	0.33	89
-0.005	RA226.15	0.96	0.90	0.029	0.025	101
-0.005	RA226.15	0.96	0.96	0.11	0.11	106
-0.005	RA226.15	0.96	0.90	0.55	0.50	104
-0.005	RA226.15	0.96	0.91	0.79	0.79	99
-0.005	RA226.15	0.96	0.93	0.53	0.58	106
-0.005	RA226.15	0.96	0.87	0.038	0.030	102
-0.005	RA226.15	0.96	0.95	0.11	0.10	96
-0.005	RA226.15	0.96	1.05	0.023	0.026	105
-0.005	RA226.15	0.96	0.97	0.11	0.10	91
-0.005	RA226.15	0.96	0.97	-0.005	-0.005	109
-0.005	RA226.15	0.96	1.00	0.073	0.079	103
-0.005	RA226.15	0.96	0.90	0.55	0.54	108
-0.005	RA226.15	0.96	0.94	0.087	0.078	100
-0.005	RA226.15	0.96	0.94	0.94	0.98	106
-0.005	RA226.15	0.96	1.00	0.073	0.079	103
-0.005	RA226.15	0.96	0.95	0.30	0.27	96
-0.005	RA226.15	0.96	0.89	0.081	0.076	92
-0.005	RA226.15	0.96	0.90	0.066	0.063	96
-0.005	RA226.16	0.90	0.89	-0.005	-0.005	96
-0.005	RA226.16	0.90	0.91	0.58	0.57	105
-0.005	RA226.16	0.90	0.95	0.041	0.042	96
-0.005	RA226.16	0.90	0.95	0.019	0.020	102
-0.005	RA226.16	0.90	0.93	0.28	0.28	98
-0.005	RA226.16	0.90	0.93	0.029	0.029	98
-0.005	RA226.16	0.90	0.87	0.67	0.067	98
-0.005	RA226.16	0.90	0.93	0.088	0.087	106
-0.005	RA226.16	0.90	0.96	0.21	0.21	101
-0.005	RA226.16	0.90	0.99	0.079	0.078	102
-0.005	RA226.16	0.90	0.86	0.42	0.38	107
-0.005	RA226.16	0.90	0.94	0.20	0.18	93
-0.005	RA226.16	0.90	0.95	0.15	0.16	99
-0.005	RA226.16	0.90	0.94	-0.005	-0.005	99
-0.005	RA226.16	0.90	1.00	0.008	0.008	97
-0.005	RA226.16	0.90	0.99	0.035	0.030	106
-0.005	RA226.16	0.90	1.00	0.79	0.79	107
-0.005	RA226.16	0.90	0.92	0.021	0.029	101
-0.005	RA226.16	0.90	0.96	0.12	0.12	105
-0.005	RA226.16	0.90	0.93	0.75	0.75	104
-0.005	RA226.16	0.90	0.97	0.60	0.60	105
-0.005	RA226.16	0.90	0.92	0.21	0.21	99
-0.005	RA226.16	0.90	0.93	0.75	0.75	104
-0.005	RA226.16	0.90	0.97	1.14	1.14	108
-0.005	RA226.16	0.90	0.95	0.73	0.69	108
-0.005	RA226.16	0.90	0.99	0.20	0.21	100
-0.005	RA226.16	0.90	0.95	0.062	0.060	104
-0.005	RA226.16	0.90	1.00	0.037	0.034	106
-0.005	RA226.16	0.90	0.98	0.25	0.25	103

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.18	1.00	0.99	0.70	0.69	107
-0.005	RA226.18	1.00	0.94	-0.005	-0.005	102
-0.005	RA226.18	1.00	1.00	0.10	0.11	110
-0.005	RA226.18	1.00	0.90	0.048	0.043	100
-0.005	RA226.18	1.00	0.96	0.60	0.60	97
-0.005	RA226.18	1.00	0.94	0.076	0.076	100
-0.005	RA226.18	1.00	0.90	0.051	0.053	112
-0.005	RA226.18	1.00	0.97	1.05	0.95	114
-0.005	RA226.18	1.00	1.00	0.28	0.25	105
-0.005	RA226.18	1.00	0.95	0.046	0.040	99
-0.005	RA226.18	1.00	0.95	0.12	0.12	103
-0.005	RA226.18	1.00	0.90	0.056	0.061	100
-0.005	RA226.18	1.00	0.97	0.16	0.15	101
-0.005	RA226.18	1.00	1.01	0.099	0.098	104
-0.005	RA226.18	1.00	0.98	0.12	0.13	105
-0.005	RA226.18	1.00	0.99	0.087	0.080	102
-0.005	RA226.18	1.00	0.97	0.61	0.59	100
-0.005	RA226.18	1.00	1.00	1.19	1.12	107
-0.005	RA226.18	1.00	0.98	0.038	0.038	104
-0.005	RA226.18	1.00	1.01	0.073	0.073	109
-0.005	RA226.18	1.00	1.06	0.031	0.030	83
-0.005	RA226.19	1.00	0.98	0.12	0.11	98
-0.005	RA226.19	1.00	1.01	0.49	0.45	105
-0.005	RA226.19	1.00	0.93	1.2	1.2	117
-0.005	RA226.19	1.00	0.96	0.089	0.094	102
-0.005	RA226.19	1.00	0.93	0.065	0.071	114
-0.005	RA226.19	1.00	0.98	0.047	0.049	102
-0.005	RA226.19	1.00	0.95	0.14	0.14	102
-0.005	RA226.19	1.00	0.98	0.54	0.50	103
-0.005	RA226.19	1.00	0.95	0.010	-0.010	104
-0.005	RA226.19	1.00	1.02	0.013	0.006	90
-0.005	RA226.19	1.00	0.95	0.087	0.081	94
-0.005	RA226.19	1.00	0.96	0.007	0.010	111
-0.005	RA226.19	1.00	1.00	0.16	0.17	108
0.006	RA226.19	1.00	0.96	0.036	0.038	102
-0.005	RA226.19	1.00	0.96	0.071	0.071	97
-0.005	RA226.19	1.00	0.93	0.054	0.053	103
-0.005	RA226.19	1.00	0.92	0.097	0.090	99
-0.005	RA226.19	1.00	0.93	0.51	0.47	100
-0.005	RA226.19	1.00	1.01	0.35	0.033	98
-0.005	RA226.19	1.00	0.94	0.046	0.046	113
-0.005	RA226.19	1.00	0.93	0.12	0.11	109
-0.005	RA226.19	1.00	0.99	1.05	1.06	102
-0.005	RA226.19	1.00	1.04	0.032	0.039	121
-0.005	RA226.19	1.00	0.90	0.47	0.48	96
-0.005	RA226.20	0.90	0.97	0.13	0.12	100
-0.005	RA226.20	0.90	0.95	0.80	0.76	97
-0.005	RA226.20	0.90	0.96	0.26	0.24	99
-0.005	RA226.20	0.90	0.84	0.010	0.006	98
-0.005	RA226.20	0.90	0.84	0.022	0.026	90
0.008						
0.015						

SGS Environmental Services

REPORT CODE: *DEN-ANN08*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.1*

ISSUED BY:

Quality Coordinator, Canadian Operations - SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *18 Mar. 2009*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Below is a summary of the laboratory quality management system, key actions taken by the laboratory for samples analyzed during 2008, as well as a summary of the significant findings and the corrective actions implemented.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2008 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 10505 analyses with 11191 QC checks, which represents 107% QC for sample analysis. This level of QC is significantly higher than the lab standard, which is generally 20%.
- All blank data results were within the data quality objectives. **Corrective Action**: N/A
- All CRM data results were within the data quality objectives. **Corrective Action**: N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A
- No spike blanks exceeded the data quality objectives. **Corrective Action**: N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action**: N/A

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Limit
Acidity	mg/L as CaCO3	2	1.71276	96	10	0
Ag	mg/L	0.0001	0.00004	207	0	0
Alkalinity	mg/L as CaCO3	2	1.00000	5	0	0
As	mg/L	0.0005	---	0	0	0
Ba	mg/L	0.005	0.00247	212	0	0
Co	mg/L	0.0005	0.00025	210	0	0
Cu	mg/L	0.0001	0.00025	65	0	0
DOC	mg/L	0.5	0.00025	85	0	0
Fe	mg/L	0.02	0.00963	241	0	0
Mn	mg/L	0.002	0.00100	221	0	0
Ni	mg/L	0.002	0.00100	60	0	0
Pb	mg/L	0.00002	0.00004	59	0	0
Se	mg/L	0.0005	0.00022	220	1	0
SO4	mg/L	0.1	0.05041	223	0	0
Total Suspended Solids	mg/L	1	0.50403	276	0	0
U	mg/L	0.0005	0.00025	207	0	0
Zn	mg/L	0.001	0.00050	69	0	0

5.2. CRM Data

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	40	60	117	51.07	1.98	-2.13	0
Acidity	mg/L as CaCO3	10	8	12	0	---	---	---	0
Ag	mg/L	0.1	0.08	0.12	212	0.10	2.62	0.02	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	4	47.50	2.11	-1.69	0
As	mg/L	0.1	0.08	0.12	0	---	---	---	0
Ba	mg/L	0.1	0.08	0.12	223	0.10	3.00	-0.27	0
Co	mg/L	0.1	0.08	0.12	216	0.10	2.73	-1.54	0
Cu	mg/L	0.1	0.08	0.12	69	0.10	2.39	-0.49	0
DOC	mg/L	10	8	12	93	9.58	4.85	4.19	0
Fe	mg/L	500	400	600	264	503.40	1.97	-0.68	0
Mn	mg/L	0.1	0.08	0.12	239	0.10	2.38	-0.50	0
Ni	mg/L	0.1	0.08	0.12	66	0.10	2.54	-0.94	0
Pb	mg/L	0.1	0.08	0.12	68	0.10	2.64	0.62	0
Se	mg/L	0.1	0.08	0.12	234	0.10	3.73	0.42	0
SO4	mg/L	5	4	6	207	5.05	2.80	-0.95	0
U	mg/L	0.1	0.08	0.12	214	0.10	2.93	-0.07	0
Zn	mg/L	0.1	0.08	0.12	79	0.10	1.94	-0.90	0

5.3. Duplicate Data

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	82	0.975	0.000	0
Ag	% Rec.	100	90	110	192	0.000	0.000	0
Alkalinity	% Rec.	100	90	110	5	2.500	0.000	0
As	% Rec.	100	90	110	0	---	0.000	0
Ba	% Rec.	100	90	110	208	-0.137	0.333	0
Co	% Rec.	100	90	110	197	0.141	0.250	0
Cu	% Rec.	100	90	110	65	-0.274	0.000	0
DOC	% Rec.	100	90	110	75	1.659	0.500	0
Fe	% Rec.	100	90	110	239	-0.195	0.833	0
Mn	% Rec.	100	90	110	225	0.181	0.250	0
Ni	% Rec.	100	90	110	63	-0.028	0.000	0
Pb	% Rec.	100	90	110	61	0.518	0.250	0
pH	% Rec.	100	90	110	27	3.762	0.000	0
Se	% Rec.	100	90	110	207	-0.220	0.083	0
S	% Rec.	100	90	110	200	-0.387	0.167	0
Total Suspended Solids	% Rec.	100	90	110	245	1.295	1.667	0
U	% Rec.	100	90	110	199	0.061	0.417	0
Zn	% Rec.	100	90	110	68	2.490	0.167	0

5.4. Spike Blank Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	74	112.03	0.37	0
Ag	mg/L	0.00016	0.000112	0.00021	207	104.60	0.00	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	2	101.06	---	0
As	mg/L	0.0064	0.00448	0.00832	0	---	0.00	0
Ba	mg/L	0.004	0.0028	0.0052	234	67.39	0.00	0
Co	mg/L	0.002	0.0014	0.0026	208	101.24	0.00	0
Cu	mg/L	0.0016	0.00112	0.00208	61	111.39	0.00	0
DOC	mg/L	20	14	26	108	96.84	0.74	0
Fe	mg/L	0.1	0.07	0.13	235	107.82	0.00	0
Mn	mg/L	0.0032	0.00224	0.00416	238	99.38	0.07	0
Ni	mg/L	0.0048	0.00336	0.00624	67	102.91	0.00	0
Pb	mg/L	0.0032	0.00224	0.00416	75	106.85	0.00	0
Se	mg/L	0.0008	0.00056	0.00104	232	100.40	0.05	0
SO4	mg/L	4	2.8	5.2	248	99.98	0.05	0
SO4	mg/L	100	70	130	5	107.50	0.07	0
U	mg/L	0.0008	0.00056	0.00104	225	100.89	0.01	0
Zn	mg/L	0.0056	0.00392	0.00728	44	106.46	0.001	0

5.5. Spike Duplicate Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spiked Duplicates	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Ag	µg/L	0.16	0.112	0.208	202	96.11	0.01	0
As	µg/L	6.4	4.48	8.32	0	---	---	0
Ba	µg/L	4	2.8	5.2	171	99.40	0.08	0
Co	µg/L	2	1.4	2.6	198	100.45	0.05	0
Cu	µg/L	1.6	1.12	2.08	67	101.61	0.07	0
DOC	mg/L	100	70	130	97	92.90	6.42	0
Fe	mg/L	0.1	0.07	0.13	205	103.20	0.01	0
Mn	mg/L	3.2	2.24	4.16	135	99.89	0.12	0
Ni	mg/L	4.8	3.36	6.24	63	97.76	0.10	0
Pb	mg/L	3.2	2.24	4.16	62	101.54	0.15	0
Se	mg/L	0.8	0.56	1.04	161	100.87	0.05	0
SO4	mg/L	100	70	130	211	99.72	5.41	0
U	mg/L	0.8	0.56	1.04	189	100.64	0.03	0
Zn	mg/L	5.6	3.92	7.28	38	105.71	0.33	0

5.6. QC Frequency

Total Number of Blanks:	2456
Total Number of CRM:	2305
Total Number of Duplicates:	2358
Total Number of Spike Blank:	2263
Total Number of Spike Duplicates:	1799
Sum of QC Insertion:	11181
Total Analysis:	10505

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2009.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- As a result of a sampling error, two TSS values were switched in report CA10256-APR08. **Corrective Action**: Lab staff confirmed that a labeling error occurred; the results in the report were revised and the report was re-issued.
- There was a transcription error in the dilution column for SO4 in report CA10381-JUL08. **Corrective Action**: Lab staff confirmed that a transcription error was made; the results in the report were revised and the report was re-issued.
- The required detection limit for reporting TSS results is 1 mg/L; however, in reports, CA10482-JUL08, CA10484-JUL08 and CA10485-JUL08, results were (incorrectly) reported as <2 mg/L. **Corrective Action:** All affected reports have been revised and reissued with the appropriate reporting levels.
- In report, CA10549-AUG08 results were reported as <2 mg/L due to insufficient volume of sample being processed. **Corrective Action:** For clean samples, 600mL is required to achieve a 1mg/L reporting limit. Only 500mL of sample was provided, therefore, the lab was unable to filter the required 600mL to achieve a < 1mg/L result.
- A number of selenium (Se) results (by ICP-MS) were flagged for re-analysis and the results of the re-analysis were below detection and inconsistent with the original data in some of the September reports. Specifically, CA10305-SEP08, CA10137-SEP08,

CA10377-SEP08 and CA10139-SEP08. Those reports indicated Se was present in the sample, (which was not expected). Re-analysis of the samples for Se was performed under the following certificates of analysis; CA10188-NOV08, CA10187-NOV08 and CA10186-NOV08 and the re-assay values were all below the reporting detection limit. An investigation into the discrepancies was done. **Corrective Action**: Chloride is a direct positive interference for Se when analyzed by ICP-MS due to the formation of an Argon/Chloride complex. While the samples likely did not contain a significant amount of chloride, chloride may have been present within the sample introduction system prior to analysis. The re-analysis was performed using on the same instrument (ICP-MS with the CRI matrix elimination system) after confirming that no chloride was present in the system.

8. SUBCONTRACT LAB INFORMATION

A full report has been provided by the subcontract lab and is included as Addendum A of this report.

Addendum A

Becquerel LABORATORIES

Becquerel Laboratories Inc. Phone: (905) 826-3080
6790 Kitimat Rd., Unit 4 FAX: (905) 826-4151
Mississauga, Ontario
Canada, L5N 5L9

Date: 11-Mar-2009

Annual Quality Assessment Report for 2008

Introduction

The number of samples analyzed was 894.

The following samples were used for quality control in 2008. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

Analyte Spikes

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards

Several check standards were using during 2008.

RA226.20, RA226.21, RA226.22, RA226.23,RA226.24 and RA226.25.

A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare these check standards.

Major Achievements in Quality Control

Equipment changes now permit chemical yields to be determined more quickly and with lower uncertainty.

The format used for QC reports was changed to meet requirements.

A trial of precision showed that precision is stable and mainly controlled by counting statistics.

QC Data Quality Summary

Analytical Parameter	Blank Result (Bq/l)	Number of Blanks	CRM Accuracy (%)	Numbers of CRMs
DQO			+- 20	
Ra-226	< 0.005	117	+2.4	117

Analytical Parameter	Spike accuracy (%)	Number of Spikes	Precision (%)	Number of Duplicates
DQO	+- 20		+-20	
Ra-226	-0.3	117	+1.8	117

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 3.5% and that for the spike becomes 5.8%.

The precision value is the mean of the percent differences for duplicate results. If absolute differences are used, this mean becomes 7.7%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: No positive blank results were obtained.

CRM: No CRM results differed from the expected value by more than 20 percent. The maximum deviation was +19.8 %.

Spike: No spike recovery deviated from 100% by more than 20%. The maximum deviation was -19 %.

Duplicate: Of the 117 duplicate sets run, 110 gave positive results. Of these, 5 duplicates differed by more than 20%. The maximum deviation was +50% for an original value of 0.006 Bq/l.

98 duplicates gave results greater than 10 times the detection limit: of these, 1 duplicate differed by more than 20 percent. The maximum deviation was +22%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. Rush analyses present challenges in maintaining accuracy and precision.

Corrective Actions

Sample 3 of batch T08-00088.0 was retested at the client's request, and found to give a lower result than that originally reported.

Investigation revealed an instrument malfunction that had been remedied shortly after the original measurement. No other samples of this or other submissions were affected.

Raw QC Data (Note: negative values signify upper limits)

Blank	Standard	Standard Result	Standard Value	Original	Duplicate	Spike % Recovery
-0.005	RA226.20	0.87	0.90	0.77	0.75	82
-0.005	RA226.20	0.92	0.90	0.18	0.18	95
-0.005	RA226.20	0.93	0.90	0.009	0.01	105
-0.005	RA226.20	0.98	0.90	0.023	0.018	101
-0.005	RA226.20	0.98	0.90	1.01	0.903	101
-0.005	RA226.20	0.90	0.90	0.25	0.23	106
-0.005	RA226.20	0.99	0.90	0.023	0.023	92
-0.005	RA226.20	0.90	0.90	0.56	0.55	105
-0.005	RA226.20	0.96	0.90	0.036	0.029	89
-0.005	RA226.20	0.92	0.90	0.21	0.19	81
-0.005	RA226.20	0.92	0.90	0.17	0.16	92
-0.005	RA226.20	0.95	0.90	0.79	0.77	87
-0.005	RA226.20	0.97	0.90	0.70	0.73	87
-0.005	RA226.20	0.91	0.90	0.11	0.11	93
-0.005	RA226.21	0.91	0.91	0.078	0.071	84
-0.005	RA226.21	0.91	0.91	0.016	0.011	95
-0.005	RA226.21	0.89	0.91	0.057	0.062	89
-0.005	RA226.21	0.87	0.91	0.11	0.11	94
-0.005	RA226.21	0.95	0.91	0.74	0.66	98
-0.005	RA226.21	0.89	0.91	0.031	0.039	89
-0.005	RA226.21	0.97	0.91	0.017	0.019	95
-0.005	RA226.21	0.90	0.91	0.39	0.32	81
-0.005	RA226.21	0.94	0.91	0.079	0.085	100
-0.005	RA226.21	0.92	0.91	0.13	0.12	106
-0.005	RA226.21	0.93	0.91	0.1	0.11	90
-0.005	RA226.21	0.86	0.91	0.43	0.43	96
-0.005	RA226.21	0.89	0.91	0.77	0.74	100
-0.005	RA226.21	0.96	0.91	0.073	0.074	92
-0.005	RA226.21	0.89	0.91	0.74	0.7	91
-0.005	RA226.21	0.99	0.91	0.086	0.085	92
-0.005	RA226.21	0.93	0.91	0.068	0.069	109

-0.005	RA226.21	0.94	0.91	0.011	0.012	104
-0.005	RA226.21	1.04	0.91	-0.005	-0.006	95
-0.005	RA226.21	0.88	0.91	0.06	0.065	95
-0.005	RA226.21	0.86	0.91	0.42	0.44	97
-0.005	RA226.22	0.93	0.91	0.52	0.53	110
-0.005	RA226.22	0.92	0.91	0.072	0.071	97
-0.005	RA226.22	0.94	0.91	0.47	0.47	101
-0.005	RA226.22	0.90	0.91	0.88	0.91	99
-0.005	RA226.22	0.91	0.91	0.086	0.085	97
-0.005	RA226.22	0.92	0.91	0.94	1.01	98
-0.005	RA226.22	0.91	0.91	0.48	0.44	100
-0.005	RA226.22	0.93	0.91	0.13	0.12	104
-0.005	RA226.22	0.92	0.91	0.072	0.076	95
-0.005	RA226.22	0.94	0.91	0.78	0.74	110
-0.005	RA226.22	0.91	0.91	0.05	0.05	100
-0.01	RA226.22	0.98	0.91	0.31	0.27	118
-0.005	RA226.22	0.92	0.91	0.29	0.3	103
-0.005	RA226.22	0.97	0.91	0.45	0.48	107
-0.005	RA226.22	0.96	0.91	0.35	0.35	105
-0.005	RA226.22	0.90	0.91	0.2	0.2	91
-0.005	RA226.22	0.90	0.91	0.25	0.25	103
-0.005	RA226.22	0.92	0.91	0.74	0.72	101
-0.005	RA226.23	0.94	0.91	0.75	0.69	102
-0.005	RA226.23	0.91	0.91	0.15	0.16	97
-0.005	RA226.23	0.95	0.91	0.092	0.088	105
-0.01	RA226.23	0.97	0.91	0.09	0.11	93
-0.005	RA226.23	0.91	0.91	0.3	0.32	103
-0.005	RA226.23	0.96	0.91	0.096	0.096	105
-0.005	RA226.23	0.93	0.91	0.054	0.057	104
-0.005	RA226.23	0.87	0.91	0.14	0.12	88
-0.005	RA226.23	0.90	0.91	0.106	0.091	115
-0.01	RA226.23	0.93	0.91	-0.01	-0.01	102
-0.005	RA226.23	0.90	0.91	0.67	0.68	93
-0.005	RA226.23	0.96	0.91	0.28	0.29	101
-0.005	RA226.23	0.87	0.91	0.23	0.24	95

-0.005	RA226.23	0.97	0.91	0.29	0.28	104
-0.005	RA226.23	1.00	0.91	0.34	0.32	105
-0.005	RA226.23	0.95	0.91	0.59	0.62	103
-0.01	RA226.23	0.90	0.91	0.24	0.24	98
-0.005	RA226.23	1.00	0.91	0.066	0.069	98
-0.005	RA226.23	0.95	0.91	0.006	0.009	104
-0.005	RA226.23	0.92	0.91	0.052	0.052	90
-0.005	RA226.23	0.93	0.91	0.15	0.16	106
-0.005	RA226.23	0.89	0.91	-0.01	-0.01	97
-0.005	RA226.23	0.92	0.91	-0.005	-0.005	96
-0.005	RA225.24	0.88	0.91	0.35	0.33	104
-0.005	RA225.24	0.91	0.91	0.79	0.77	90
-0.005	RA225.24	0.93	0.91	0.16	0.16	104
-0.005	RA225.24	0.91	0.91	0.1	0.098	117
-0.005	RA225.24	0.92	0.91	0.027	0.028	110
-0.005	RA225.24	0.98	0.91	0.037	0.036	99
-0.005	RA225.24	0.94	0.91	0.46	0.44	111
-0.005	RA225.24	0.92	0.91	0.007	-0.005	112
-0.005	RA225.24	0.95	0.91	0.18	0.18	104
-0.005	RA225.24	0.99	0.91	0.96	0.94	94
-0.005	RA225.24	0.96	0.91	0.047	0.046	100
-0.005	RA225.24	0.91	0.91	0.19	0.21	100
-0.005	RA225.24	0.91	0.91	0.8	0.83	104
-0.005	RA225.24	0.92	0.91	0.51	0.47	100
-0.005	RA225.24	1.09	0.91	0.12	0.13	105
-0.005	RA225.24	0.91	0.91	0.4	0.41	99
-0.005	RA225.24	0.93	0.91	1	0.94	93
-0.005	RA225.24	0.91	0.91	0.42	0.43	99
-0.005	RA225.24	0.90	0.91	0.076	0.078	90
-0.005	RA225.24	0.92	0.91	0.64	0.59	108
-0.005	RA225.24	0.94	0.91	0.15	0.14	100
-0.005	RA225.24	0.93	0.91	0.066	0.064	105
-0.005	RA225.24	0.97	0.91	0.52	0.59	95
-0.005	RA225.24	0.90	0.91	0.059	0.056	98
-0.005	RA225.24	0.97	0.91	0.073	0.077	104

-0.005	RA225.24	0.86	0.91	0.089	0.081	100
-0.005	RA225.24	0.91	0.91	0.95	0.87	101
-0.005	RA225.24	0.91	0.91	0.08	0.085	101
-0.007	RA226.25	0.92	0.91	0.14	0.13	98
-0.005	RA226.25	0.93	0.91	0.13	0.14	106
-0.005	RA226.25	0.99	0.91	1.24	1.24	101
-0.005	RA226.25	0.97	0.91	0.99	0.9	93
-0.005	RA226.25	0.90	0.91	-0.005	-0.005	109
-0.005	RA226.25	0.90	0.91	0.17	0.16	100
-0.005	RA226.25	0.96	0.91	0.11	0.11	107
-0.005	RA226.25	0.93	0.91	0.18	0.18	113
-0.005	RA226.25	0.97	0.91	0.45	0.46	104
-0.005	RA226.25	0.99	0.91	0.84	0.82	106
-0.005	RA226.25	0.94	0.91	0.16	0.17	107
-0.005	RA226.25	0.93	0.91	0.33	0.35	111
-0.005	RA226.25	0.97	0.91	0.17	0.16	110

SGS Environmental Services

REPORT CODE: *DEN-ANN09*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.2*

ISSUED BY:

Quality Coordinator, Canadian Operations - SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *10 Mar. 2010*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Below is a summary of the laboratory quality management system, key actions taken by the laboratory for samples analyzed during 2009, as well as a summary of the significant findings and the corrective actions implemented.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2009 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 10505 analyses with 11748 QC checks, which represents 112% QC for sample analysis. This level of QC is significantly higher than the lab standard, which is generally 20%.
- All blank data results were within the data quality objectives. **Corrective Action:** N/A
- **A**ll CRM data results were within the data quality objectives. **Corrective Action:** N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A
- No spike blanks exceeded the data quality objectives. **Corrective Action**: N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action:** N/A

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Detection Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside SGS Quality Limit (+/- Detection Limit)
Acidity	mg/L as CaCO3	2	1.87329	95	27	0
Ag	mg/L	0.0001	0.00004	200	0	0
Alkalinity	mg/L as CaCO3	2	1.00000	3	0	0
As	mg/L	0.0005	xxx	0	0	0
Ba	mg/L	0.005	0.00245	208	0	0
Co	mg/L	0.0005	0.00025	199	0	0
Cu	mg/L	0.0001	0.00025	72	0	0
DOC	mg/L	0.5	0.19198	172	1	0
Fe	mg/L	0.02	0.01013	252	2	0
Mn	mg/L	0.002	0.00100	209	0	0
Ni	mg/L	0.002	0.00100	70	0	0
Pb	mg/L	0.00002	0.00020	69	0	0
Se	mg/L	0.0005	0.00195	123	58	0
SO4	mg/L	0.1	0.01239	203	0	0
Total Suspended Solids	mg/L	1	0.50860	193	1	0
U	mg/L	0.0005	0.00029	240	91	0
Zn	mg/L	0.001	0.00047	106	2	0

5.2. CRM Data

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	40	60	106	51.47	2.27	-2.93	0
Ag	mg/L	0.1	0.08	0.12	220	0.10	2.82	0.02	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	1	49.00	2.11	---	0
As	mg/L	0.1	0.08	0.12	0	---	---	---	0
Ba	mg/L	0.1	0.08	0.12	229	0.10	2.45	-1.88	0
Co	mg/L	0.1	0.08	0.12	222	0.10	2.46	-1.60	0
Cu	mg/L	0.1	0.08	0.12	77	0.10	1.73	-1.68	0
DOC	mg/L	10	8	12	213	9.78	4.49	2.18	0
Fe	mg/L	500	400	600	294	500.72	2.33	-0.14	0
Mn	mg/L	0.1	0.08	0.12	228	0.10	2.62	-1.63	0
Ni	mg/L	0.1	0.08	0.12	74	0.10	1.90	-2.14	0
Pb	mg/L	0.1	0.08	0.12	76	0.10	2.02	-0.70	0
Se	mg/L	0.1	0.08	0.12	193	0.10	4.07	-1.17	0
SO4	mg/L	5	4	6	263	5.07	3.23	-1.50	0
U	mg/L	0.1	0.08	0.12	226	0.10	2.67	-1.64	0
Zn	mg/L	0.1	0.08	0.12	76	0.10	1.98	-1.77	0

5.3. Duplicate Data

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	77	0.974	0
Ag	% Rec.	100	90	110	200	-0.025	0
Alkalinity	% Rec.	100	90	110	4	-0.333	0
As	% Rec.	100	90	110	0	---	0
Ba	% Rec.	100	90	110	221	0.843	0
Co	% Rec.	100	90	110	215	0.588	0
Cu	% Rec.	100	90	110	74	0.383	0
DOC	% Rec.	100	90	110	193	2.096	0
Fe	% Rec.	100	90	110	287	1.050	0
Mn	% Rec.	100	90	110	224	0.727	0
Ni	% Rec.	100	90	110	71	-0.030	0
Pb	% Rec.	100	90	110	72	0.416	0
pH	% Rec.	100	90	110	28	0.129	0
Se	% Rec.	100	90	110	150	0.098	0
S	% Rec.	100	90	110	213	-0.058	0
Total Suspended Solids	% Rec.	100	90	110	193	1.356	0
U	% Rec.	100	90	110	266	0.816	0
Zn	% Rec.	100	90	110	121	0.879	0

5.4. Spike Blank Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	48	110.93	109.79	0
Ag	mg/L	0.00016	0.000112	0.00021	202	101.98	0.00	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	2	97.98	---	0
As	mg/L	0.0064	0.00448	0.00832	2	105.00	0.00	0
Ba	mg/L	0.004	0.0028	0.0052	229	67.34	0.00	0
Co	mg/L	0.002	0.0014	0.0026	206	100.81	0.00	0
Cu	mg/L	0.0016	0.00112	0.00208	67	109.96	0.00	0
DOC	mg/L	20	14	26	227	96.86	0.96	0
Fe	mg/L	0.1	0.07	0.13	286	105.68	0.01	0
Mn	mg/L	0.0032	0.00224	0.00416	217	99.66	0.06	0
Ni	mg/L	0.0048	0.00336	0.00624	72	102.86	0.00	0
Pb	mg/L	0.0032	0.00224	0.00416	81	104.65	0.00	0
Se	mg/L	0.0008	0.00056	0.00104	123	109.48	0.07	0
SO4	mg/L	4	2.8	5.2	272	92.25	0.07	0
SO4	mg/L	100	70	130	61	105.55	4.44	0
U	mg/L	0.0008	0.00056	0.00104	227	100.85	0.00	0
Zn	mg/L	0.0056	0.00392	0.00728	71	108.24	0.000	0

5.5. Spike Duplicate Data

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spiked Duplicates	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Ag	µg/L	0.16	0.112	0.208	200	97.32	0.01	0
As	µg/L	6.4	4.48	8.32	0	---	---	0
Ba	µg/L	4	2.8	5.2	170	99.36	0.18	0
Co	µg/L	2	1.4	2.6	194	99.62	0.10	0
Cu	µg/L	1.6	1.12	2.08	58	100.86	0.08	0
DOC	mg/L	100	70	130	208	90.53	6.85	0
Fe	mg/L	0.1	0.07	0.13	196	101.11	0.01	0
Mn	mg/L	3.2	2.24	4.16	116	100.49	0.13	0
Ni	mg/L	4.8	3.36	6.24	60	98.61	0.15	0
Pb	mg/L	3.2	2.24	4.16	65	102.15	0.13	0
Se	mg/L	0.8	0.56	1.04	91	88.19	0.05	0
SO4	mg/L	100	70	130	201	93.27	5.56	0
U	mg/L	0.8	0.56	1.04	193	1140.84	0.03	0
Zn	mg/L	5.6	3.92	7.28	71	96.15	0.38	0

5.6. QC Frequency

Total Number of Blanks	2425
Total Number of CRM	2498
Total Number of Duplicates	2609
Total Number of Spike Blank	2393
Total Number of Spike Duplicates	1823
Sum of QC Insertion:	**11748**
Total Analysis:	**10505**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2009.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- SGS was contacted by Denison Environmental Services regarding report, CA10225-JAN09. The metal results appeared to be lower than expected values, when compared to the historical values over the last five years. **Corrective Action:** The lab was unable to identify a root cause for this incident; however, the re-assay data showed the SO4 and metals back in line with expected results.
- During the dilution process in analyzing for SO4 on sample D-14 (August 11) there was an instrument failure that resulted in a backwash of dilution water into the sample bottle. As this was the only unpreserved sample portion for this set of bottles another sample was requested. **Corrective Action**: An additional sample was submitted and processed.

8. SUBCONTRACT LAB INFORMATION

A full report has been provided by the subcontract lab and is included as Addendum A of this report.

Addendum A

Becquerel Laboratories Inc. Phone: (905) 826-3080
6790 Kitimat Rd., Unit 4 FAX: (905) 826-4151
Mississauga, Ontario
Canada, L5N 5L9

Date: 05-Jan-2010

Annual Quality Assessment Report for 2009

Introduction

The number of samples analyzed was 798.

The following samples were used for quality control in 2009. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks:

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates:

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

Analyte Spikes:

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards:

Several check standards were using during 2009.

RA226.25, RA226.26, RA226.27, RA226.28,RA226.29 and RA226.30.

A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare these check standards.

Major Achievements in Quality Control

Steps were taken to improve the resolution of alpha spectra by reducing the mass of prepared samples. If too much material is present on prepared sources, alpha spectra become smeared. This is particularly problematic for the complex spectra due to the presence of Ra-224 in some samples.

Procedures were modified to guard against sample mix-ups.

QC Data Quality Summary

Analytical Parameter	Blank Result Bq/l	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO			+- 20	
Ra-226	< 0.005	96	+2.4	96

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+- 20		+-10	
Ra-226	+1.5	96	-1.2	96

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 4.7% and that for the spike becomes 5.2%.

The precision value is the mean of the percent differences for duplicate results. If absolute differences are used, this mean becomes 5.8%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: One positive blank result of 0.006 Bq/l was obtained.

CRM: No CRM results differed from the expected value by more than 20 percent. The maximum deviation was +12 %.

Spike: No spike recovery deviated from 100% by more than 20%. The maximum deviation was -16 %.

Duplicate: Of the 96 duplicate sets run, 94 gave positive results. Of these, 15 duplicates differed by more than 10%. The maximum deviation was -16% for an original value of 0.12 Bq/l.

91 duplicates gave results greater than 10 times the detection limit: of these, 14 duplicates differed by more than 10 percent. The maximum deviation was -16%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. Rush analyses present challenges in maintaining accuracy and precision.

Corrective Actions

Results were reissued for batches T09-00653.1 and T0900671.0 after an error in computation was corrected.

Samples were reanalyzed and results were reissued for batch T09-00925.0 after requested re-analyses revealed a sample mix-up.

Results were reissued for batch T09-01720.0 after one sample was reanalyzed when a sample mix-up was detected.

Appendix: Raw QC Data (Negative Values Signify Upper Limits)

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.25	0.91	1.00	2.1	2.2	105
-0.005	RA226.25	0.91	0.96	0.1	0.11	99
-0.005	RA226.25	0.91	0.91	0.038	0.036	111
-0.005	RA226.25	0.91	0.98	0.34	0.33	110
-0.005	RA226.25	0.91	0.92	0.86	0.75	100
-0.005	RA226.25	0.91	0.92	0.32	0.32	92
-0.005	RA226.26	0.91	0.98	0.2	0.2	104
-0.005	RA226.26	0.91	0.92	0.16	0.16	101
-0.005	RA226.26	0.91	1.02	0.12	0.12	107
-0.005	RA226.26	0.91	1.01	0.78	0.82	95
-0.005	RA226.26	0.91	0.86	0.11	0.094	97
-0.005	RA226.26	0.91	0.95	0.79	0.83	104
-0.005	RA226.26	0.91	0.99	0.48	0.47	102
-0.005	RA226.26	0.91	0.93	0.086	0.087	104

-0.005	RA226.26	0.91	0.92	0.15	0.15	99
-0.005	RA226.26	0.91	0.92	0.26	0.26	108
-0.006	RA226.26	0.91	0.93	-0.008	0.005	84
-0.005	RA226.26	0.92	0.95	0.14	0.13	102
-0.005	RA226.26	0.92	0.88	0.12	0.1	100
-0.005	RA26.26	0.92	1.00	0.99	0.93	103
-0.005	RA226.26	0.92	0.99	0.1	0.1	108
-0.005	RA226.26	0.92	0.91	0.11	0.1	95
-0.005	RA226.26	0.92	0.91	0.14	0.14	104
-0.005	RA226.26	0.92	0.92	0.09	0.092	98
-0.005	RA226.26	0.92	0.87	0.51	0.52	100
-0.005	RA226.26	0.92	0.94	0.14	0.15	108
-0.005	RA226.26	0.92	0.93	0.081	0.083	100
-0.005	RA226.26	0.92	0.94	0.53	0.5	111
-0.005	RA226.26	0.92	0.95	0.79	0.83	99
-0.005	RA226.26	0.92	0.84	0.073	0.082	112
-0.005	RA226.26	0.92	0.95	0.099	0.094	111
-0.005	RA226.26	0.92	0.93	0.055	0.055	99
-0.005	RA226.27	0.92	0.91	0.06	0.067	110
-0.005	RA226.27	0.92	0.92	0.29	0.27	95
-0.005	RA226.27	0.92	0.95	0.085	0.085	95
-0.005	RA226.27	0.92	0.92	0.091	0.080	90
-0.005	RA226.27	0.92	0.82	0.71	0.68	105
-0.005	RA226.27	0.92	0.97	0.41	0.39	108
-0.007	RA226.27	0.92	0.89	0.063	0.059	103
-0.005	RA226.27	0.92	0.98	0.11	0.11	106
-0.007	RA226.27	0.92	0.94	0.11	0.099	106
-0.005	RA226.27	0.92	0.89	0.61	0.61	88
-0.005	RA226.27	0.92	0.97	0.12	0.13	94
-0.005	RA226.27	0.92	0.98	0.12	0.1	111
-0.005	RA226.27	0.92	0.96	0.72	0.65	95
-0.005	RA226.27	0.92	0.90	0.1	0.092	103
-0.005	RA226.27	0.92	0.96	0.83	0.86	101
-0.006	RA226.27	0.92	0.99	0.095	0.097	112
-0.005	RA226.27	0.92	0.95	0.096	0.088	105

-0.006	RA226.27	0.92	0.99	0.095	0.097	112
-0.005	RA226.27	0.92	0.96	0.085	0.079	105
-0.005	RA226.28	0.92	0.98	0.084	0.084	98
-0.005	RA226.28	0.92	1.03	0.16	0.17	105
-0.005	RA226.28	0.92	0.98	0.097	0.105	95
-0.005	RA226.28	0.92	0.97	0.18	0.17	111
-0.005	RA226.28	0.92	0.94	0.95	0.84	104
-0.005	RA226.28	0.92	0.92	1.6	1.8	105
-0.005	RA226.28	0.92	0.94	0.027	0.029	98
-0.005	RA226.28	0.92	0.95	0.056	0.053	106
-0.005	RA226.28	0.92	0.90	0.073	0.061	106
-0.005	RA226.28	0.92	0.90	0.11	0.1	107
-0.005	RA226.28	0.92	1.00	0.1	0.11	104
-0.005	RA226.28	0.92	0.90	1.3	1.2	96
-0.005	RA226.28	0.92	0.87	0.71	0.63	106
-0.005	RA226.28	0.92	0.97	1.93	1.86	96
-0.005	RA226.28	0.92	0.83	0.12	0.13	104
-0.005	RA226.28	0.92	0.87	0.26	0.25	110
-0.005	RA226.28	0.92	0.92	0.12	0.14	97
-0.005	RA226.28	0.92	0.86	0.186	0.18	94
-0.007	RA226.28	0.92	0.99	0.013	0.011	99
-0.005	RA226.28	0.92	0.95	0.169	0.163	114
-0.005	RA226.29	0.92	0.86	0.12	0.11	101
-0.005	RA226.29	0.92	0.91	0.053	0.054	97
-0.005	RA226.29	0.92	0.96	2.79	2.78	103
-0.005	RA226.29	0.92	0.89	0.15	0.16	107
-0.005	RA226.29	0.92	0.93	0.38	0.35	109
-0.005	RA226.29	0.92	0.95	0.15	0.16	103
-0.005	RA226.29	0.92	0.96	0.17	0.18	105
-0.005	RA226.29	0.92	1.03	0.15	0.16	99
-0.005	RA226.29	0.92	0.93	-0.005	-0.005	100
-0.005	RA226.29	0.92	0.95	0.12	0.12	93
-0.005	RA226.29	0.92	0.97	0.35	0.34	102
-0.005	RA226.29	0.92	0.97	0.16	0.15	104

-0.006	RA226.29	0.92	0.88	0.12	0.12	89
-0.005	RA226.29	0.92	1.01	0.14	0.14	97
-0.005	RA226.29	0.92	0.92	0.089	0.09	94
-0.005	RA226.29	0.92	0.93	0.83	0.78	101
0.006	RA226.30	0.92	0.95	0.74	0.73	104
-0.007	RA226.30	0.92	0.82	0.055	0.063	93
-0.005	RA226.30	0.92	0.96	0.2	0.21	98
-0.005	RA226.30	0.92	0.90	0.86	0.83	97
-0.006	RA226.30	0.92	1.01	0.15	0.14	90
-0.005	RA226.30	0.92	0.97	0.12	0.11	101
-0.005	RA226.30	0.92	1.02	0.81	0.9	91
-0.005	RA226.30	0.92	1.03	0.21	0.21	100
-0.005	RA226.30	0.92	1.01	0.22	0.23	94