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Technical Report Overview

Report: Third-Party Audit 2017 Report

Overview: This report provides the results of the first third-party audit of Teck's data quality and completeness and Teck's standard operating procedures for managing environment data.

This report was prepared for Teck by Matrix Solutions Inc.

For More Information

If you have questions regarding this report, please:

- Phone toll-free to 1.855.806.6854
- Email **feedbackteckcoal@teck.com**

Future studies will be made available at **teck.com/elkvalley**

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

THIRD-PARTY AUDIT - PERMIT 107517

ELK VALLEY MINES
SPARWOOD, BRITISH COLUMBIA

Report Prepared for:
TECK COAL LIMITED

Prepared by:
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October 2017
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Report prepared for Teck Coal Limited, October 2017

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DISCLAIMER

We certify that this report is accurate and complete and accords with the information available during the audit. Information obtained during the audit is believed to be accurate but is not guaranteed. We have exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

As described in CSA Standard Z773-17, Environmental Compliance Auditing, there are inherent limitations to every audit. These risks were reduced by following standard audit procedures, including verification of audit evidence by more than one means, wherever possible. Audits provide a snapshot in time of the auditee's activities within the scope and objectives of the audit. Auditees can fall in and out of compliance or management system conformance at any point in time. The conclusions of the audit team are therefore limited by many variables, including sample size of audit evidence and even audit criteria.

This report was prepared for Teck Coal Ltd. The report may not be relied upon by any other person or entity without our written consent and that of Teck Coal Ltd. Any uses of this report by a third party, or any reliance on decisions made based on it, are the responsibility of that party. We are not responsible for damages or injuries incurred by any third party, as a result of decisions made or actions taken based on this report.

EXECUTIVE SUMMARY

Teck Coal Limited retained Matrix Solutions Inc. to conduct a third-party audit, as required by Permit 107517, Condition 12.3, under the British Columbia (BC) *Environmental Management Act*. This was the first audit conducted in accordance with Permit requirements. Findings and results of the audit are outlined in this report.

The Environmental Monitoring Committee (EMC) prescribed the objectives, scope, and criteria for this audit.

The objective of the audit was to assess monitoring data and its analysis, as required by Permit 107517, Condition 12.3, and as prescribed by the EMC.

The scope of the audit was Elk Valley Mine Permit 107517 activities related to the following:

- two topic areas:
  1. data quality and completeness
  2. standard operating procedures (SOPs) and data handling protocols in place for Teck

- four monitoring subject areas:
  1. surface water quality
  2. acute toxicity
  3. chronic toxicity
  4. benthic community structure

The EMC provided 55 questions that formed the audit criteria for each of the four monitoring subject areas (Appendix A). This audit did not assess compliance with any Act, Regulation, or Elk Valley Mine Permit requirements. The audit was strictly based on the questions provided by the EMC. Each question was evaluated based on audit evidence obtained through records review and interviews. The questions posed a mixture of audit requirements related to compliance (i.e., conformance with specified provincial requirements) and management system (i.e., best management practices).

The audit was conducted between June and August 2017 with interviews at the Teck office in Sparwood, BC. No field visit was conducted. Extensive records review was completed, including planning documents such as study plans, Teck's Standards, Practices, and Procedures (SP&P), field forms and sampling results, laboratory data (raw and within EQuIS™ database), and reports.

Positive observations were noted throughout the audit, including the following:

- Teck personnel and contractors were supportive of the audit process, helpful and forthcoming with information.

- Teck has ten applicable SP&Ps in place and was developing several data quality-related procedures during the audit.

- During the audit, personnel in Teck's Sparwood office were implementing several new modules and improvements within the EQuIS™ water quality database, which will support sampling and data quality processes in the future.

- Contractors working on sampling programs demonstrated engagement with their programs and with the EMC.

This audit resulted in 30 audit findings (where an EMC question was answered as a "no") as summarized in Table A. Details of the findings are contained within the report.

TABLE A Summary of Audit Findings

Finding	Topic	Monitoring Subject Area
Study Design		
1	Sample collection methods in study design	Chronic toxicity
2	Study plan authors	Chronic toxicity
Documentation of Sampling Design		
3	Sample collection methods in SOP	Chronic toxicity
4	Data quality objectives and field crews	Acute toxicity
5	Sample collection methods – sample collection	Water quality Acute toxicity Chronic toxicity
6	Sample collection methods - handling, storage, shipping	Chronic toxicity
7	Waste management	Water quality
8	Field sampling plan procedures	Water quality Acute toxicity Chronic toxicity
9	Sampling procedures - Quality assurance/quality control (QA/QC) Samples	Acute toxicity
10	Field sampling plan variances	Water quality Acute toxicity Chronic toxicity
Documentation of Laboratory Program		
11	Project management	Water quality Acute toxicity Chronic toxicity
12	Data quality objectives	Water quality Acute quality
13	QA/QC program design	Water quality
14	Training requirements	Water quality Acute toxicity Chronic toxicity
15	Sample collection methods	Chronic toxicity
16	Quality control (QC) methods and procedures	Water quality Acute toxicity
17	Field equipment - calibration and maintenance	Water quality

Finding	Topic	Monitoring Subject Area
18	Field equipment - calibration and frequency	Water quality
19	Inspection procedure for supplies and consumables	Water quality Acute toxicity Chronic toxicity Benthos
20	Data management procedures	Water quality Acute toxicity Chronic toxicity Benthos
21	Response actions	Water quality Acute toxicity
22	Data evaluation and usability	Water quality Acute toxicity
23	Test acceptability criteria	Water quality Acute toxicity
Data Quality		
24	Chain-of-custody documentation and field records retention	Water quality Acute toxicity Chronic toxicity
25	Dissolved metals	Water quality
26	Laboratory QC validation - accuracy checks	Water quality
27	Laboratory QC validation - precision checks	Water quality
28	Laboratory QC validation - test acceptability criteria checks	Water quality
29	Data entry and translation	Water quality Acute toxicity Chronic toxicity
30	Metadata	Water quality Acute toxicity

Recommendations are provided regarding the 30 findings. Most of the recommendations relate to the further development of data QA/QC processes including the following:

- further defining and documenting water quality and acute toxicity data quality objectives (including acceptance criteria for laboratory QC evaluations)
- implementing a routine evaluation of data quality objectives, including accountabilities and timing
- documenting and implementing relevant response actions when test acceptance criteria have not been met
- clarifying, documenting, and communicating key responsibilities and expectations related to the water quality, and acute and chronic toxicity programs (from planning, sample collection, laboratory sample submission, data review/results verification for acceptability and reporting)
- defining and implementing improved field sampling practices, including calibration and record maintenance, and appropriate field filtration and preservation

- defining data delivery, translation calculations, and database maintenance processes as they pertain to regulatory reports

- documenting and implementing consistent training requirements for all Elk Valley operations (e.g., sampling competency, laboratory data quality evaluations, EQuIS™ usage, health and safety)

- creating chronic toxicity sampling documentation

- updating procedure(s) to include EQuIS™ field sampling plan processes (e.g., Sample Planning Module [SPM])

- updating documentation to align with *British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (B.C. WLAP 2013) and *British Columbia Environmental Laboratory Manual* (Austin 2015) to support compliance with Permit 107517, Condition 9.1.2.1

The audit found that the complex surface water quality, and acute and chronic toxicity program requirements are generally well-managed by Teck. The benthos program has been well-documented by Minnow Environmental Inc. Overall, the audit team found that the monitoring subject area programs could be improved by implementing robust and timely data quality objective evaluations and updating SOPs.

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APPENDICES

1 INTRODUCTION

Teck Coal Limited retained Matrix Solutions Inc. to conduct a third-party audit, as required to be completed every 2 years by Condition 12.3 of Permit 107517, under the British Columbia (BC) *Environmental Management Act* (EMA). This was the first audit conducted in accordance with permit requirements. Findings and results of the audit are outlined in this report.

The Permit 107517 Environmental Monitoring Committee (EMC) prescribed the objectives, scope, and criteria for this audit.

The audit was conducted between June and September 2017.

1.1 Objectives

The objective of the audit was to assess monitoring data and its analysis, as required by Permit 107517, Condition 12.3, and as prescribed by the EMC.

1.2 Scope

The scope of the audit was Elk Valley Mine Permit 107517 activities related to the following:

- two topic areas:
  1. data quality and completeness
  2. standard operating procedures (SOPs) and data handling protocols in place for Teck

- four monitoring subject areas:
  1. surface water quality
  2. acute toxicity
  3. chronic toxicity
  4. benthic community structure

The two topic areas and four monitoring subject areas were audited by responding to questions provided by EMC that fell under the following five categories:

- study design
- document of sampling design
- documentation of laboratory program design
- health and safety requirements
- data quality

The time frame for the audit record review was November 2014 (when the original Permit was issued) to October 31, 2016. Reports published up to May 31, 2017, were reviewed where they contained data from the audit time frame.

The audit scope did not include the following:

- Selenium speciation because these requirements were added to Permit 107517 in 2017; therefore, they are not included within the surface water quality scope.
- Calcite supporting studies because benthic invertebrates are no longer assessed as part of these studies; therefore, they are not included within the benthic community structure scope.
- Toxicity identification evaluation (TIE) studies because they are not part of Permit 107517; therefore, they are not included within the toxicity scope.

1.3 Criteria

The EMC provided 55 questions, each to be answered by a yes/no response. The questions are provided in Appendix A. These questions provided the audit criteria for each of the four monitoring subject areas: surface water quality, acute toxicity, chronic toxicity, and benthic community structure. These questions were copied into a protocol and were answered for each subject area. Possible responses were as follows:

- Yes, where sufficient evidence was provided to fully answer the question(s).
- No, where insufficient evidence was provided to fully answer the question (this response constitutes a “finding” within this report).
- Not applicable, where the question does not apply to a monitoring subject area.

This audit did not assess compliance with any Act, Regulation, or Elk Valley Mine Permit requirements. The audit was strictly based on the questions provided by the EMC.

1.4 Previous Audits

This is the first audit under Permit 107517, Condition 12.3. This report must be submitted to the British Columbia Ministry of Environment and Climate Change (B.C. ENV; formerly British Columbia Ministry of Environment [B.C. MoE]) Director by October 31, 2017, and future reports will be required by October 31 every 2 years.

2 METHODS

The audit was conducted in accordance with Canadian Standards Association *CSA Standard Z773-17: Environmental Compliance Auditing* (CSA 2017). The Auditing Association of Canada *Code of Ethics* (AAC 2014) was observed at all times.

Auditors were independent of the auditee and used an evidence-based approach throughout the audit.

2.1 Preparation

An audit plan was developed to document and confirm audit objectives, scope, and criteria. An audit protocol for each subject monitoring area was then compiled based on the list of questions provided by the EMC.

Teck provided a number of records in advance of the audit, including study design documents, reports and data, and procedures.

2.2 Audit

The audit team comprised the following:

- Beth Michener, M.Sc., P. Biol., EP(CEA), EP(EMSLA), Lead Auditor
- Scott Kolochuk, M.Sc., P. Biol., R.P.Bio., Auditor, aquatic biology
- Elisabeth Henson, B.Sc., Auditor, surface water quality, toxicity and data management
- Betsy Evans, M.E.Sc., P.Eng., EP(CEA), EP(EMSLA) Senior Technical Reviewer

An opening meeting was held at the start of the audit to review the objectives, scope, and approach of the audit. Attendees were the audit team and Teck's Manager Regional Water Monitoring and Environmental Clerk.

In addition to providing documents, Teck provided the audit team access to Teck's EQuIS™ database and the EMC SharePoint site. Teck uses the environmental database EQuIS™ to store water quality and acute toxicity data. The EMC SharePoint site contains study plans and reports; these were also provided to Matrix through a Matrix-hosted SharePoint site. Teck also provided the audit team with access to personnel on an as-needed basis to provide information required to answer EMC questions. Teck personnel supported the audit team with setting up interviews, finding records, and explaining the various monitoring programs.

During the audit, information was sampled and recorded, and the EMC questions were answered based on audit evidence. Methods for collecting information included document review and interviews with a sample of personnel and consultants. The audit did not include onsite activities, such as inspection of sampling activities. Audit evidence was based on samples of available and relevant information.

While at Teck's Sparwood office on June 7, 2017, the audit team met with the following Teck personnel:

- Manager Regional Water Monitoring
- Environmental Clerk
- Environmental Coordinator and/or Environmental Technician representatives from each of the five mines
- Regional Monitoring Lead
- Regional Monitoring Technician
- Senior Lead Data Management
- Lead Environmental Data Management
- Lead Adaptive Water Management
- Lead Environment

The audit team also spoke with the following representatives' office environmental contractors working on various components of the monitoring associated with Permit 107517:

- Nautilus Environmental Company, Inc. (President, Environmental Toxicologist)
- Golder Associates Limited (Environmental Scientist, Associate)
- VAST Resource Solutions Inc. (Fish Biologist)
- Minnow Environmental Inc. (Principal and Senior Scientist)
- ZEAS Incorporated (Principal)

As they arose, observations indicating potential findings were discussed with Teck personnel, recorded, and later reviewed during the closing meeting and report writing process.

The results of the audit were reviewed during the closing meeting on July 27, 2017. Findings were discussed with Teck personnel, who were provided an opportunity to provide context and ask for clarification. Attendees at the closing meeting were the following:

- Beth Michener, Lead Auditor
- Elisabeth Henson, Auditor, surface water quality, toxicity and data management
- Betsy Evans, Senior Technical Reviewer
- Manager Regional Water Monitoring
- Environmental Clerk

2.3 Reporting

The following types of observations are noted within this report (Section 4):

- positive observations, which include observations where Teck has demonstrated due diligence beyond the requirements of the criteria questions
- findings, where the response to the criteria question was "no"
- opportunities for improvement, where observations do not directly relate to a criteria question, but where practices may be improved
    - The identification of opportunities for improvement was requested by Teck.

Conformant observations where criteria questions are answered with "yes" are not documented in the results section of this report.

2.4 Terminology

Some of the terminology used within the criteria questions is based on those defined by the United States Environmental Protection Agency (U.S. EPA 2002, 2001). Under Permit 107517, Condition 9.1.2.1, Teck is required to sample according to the most recent *British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (BC Field Sampling Manual; B.C. WLAP 2013). Also, laboratory analyses must be performed in accordance with the *British Columbia Environmental Laboratory Manual* (BC Laboratory Manual; Austin 2015). While U.S. EPA and BC terminology are similar, this report adopts the following terms referenced within the BC manuals to aid in the discussion of findings and recommendations:

- **Quality Assurance (QA)** includes a range of management and technical practices designed to guarantee that the delivered end product is commensurate with the intended use. For environmental or discharge-related studies, QA ensures that the data are of adequate scientific credibility to permit statistical interpretations, which lead to resource use management decisions (BC Field Sampling Manual, Part A Quality Control and Quality Assurance).

- **Quality Control (QC)** is one of the most important aspects of QA, including specific formal goals (called data quality objectives [DQOs]), collection of data to assess data quality, the statistical assessment of the data quality, and the remedial measurements taken whenever the DQOs are not realized (BC Field Sampling Manual, Part A Quality Control and Quality Assurance). Samplers and analysts should be involved jointly in all aspects of QC from program design to data interpretation. It is particularly important that there is timely identification of problems, with effective feedback between samplers and analysis (BC Field Sampling Manual, Section 2.16).

    - **Field QC Samples**: for samples collected and forwarded to laboratories for analysis, QC samples shall include the following:

- field and trip blanks to monitor possible contamination before receipt at the laboratory
- duplicate or replicate samples to measure both field sampling error plus local environmental variance (named field duplicates)
- in-house reference samples to monitor accuracy (named field calibration standards; BC Field Sampling Manual, Section 2.17)

- **Laboratory QC Samples**: QC samples include the following:

  - method blanks to monitor possible contamination
  - duplicates to monitor precision (both inter- and intra-laboratory)
  - certified reference samples to monitor accuracy
  - internal reference samples to monitor accuracy
  - analyte spikes to monitor recoveries
  - surrogate spikes to monitor recoveries (BC Laboratory Manual, Section 2.16)

- **DQOs** are formal data quality specifications. These objectives determine the maximum amount of uncertainty (or error) that can be tolerated in the data if it is to be satisfactory for the intended use. Once DQOs have been established and sampling has commenced, there must be regular performance checks to determine whether or not DQOs are met. Corrective action must be taken when DQOs fail to be met (BC Field Sampling Manual, Section 2.18).

- **Acceptability Criteria (or Acceptance Criteria)** are DQOs that are quantitative guidelines for determining the acceptability of the blank, precision, and accuracy data collected (BC Field Sampling Manual, Appendix 3).

3 BACKGROUND

3.1 Permitting

Teck owns and operates five coal mines within the Elk River Valley in southeastern BC. Each coal mine operates under a BC *Mines Act* Permit, a mine-specific EMA discharge effluent Permit, and an over-arching EMA discharge effluent Permit, as summarized in Table 1. This audit looked only at the subject monitoring areas discussed within Permit 107517.

TABLE 1 Elk Valley Mine Permit List

Mine	*Mines Act* Permit	*Environmental Management Act* Permit
All five Elk Valley mines and Koocanusa Reservoir		107517
Coal Mountain Operations (CMO)	C-84	4750
Elkview Operations (EVO)	C-2	425
Fording River Operations (FRO)	C-3	424
Greenhills Operations (GHO)	C-137	6248
Line Creek Operations (LCO)	C-129	5353

Permit 107517 was issued by the B.C. ENV under the provisions of the EMA in November 2014 and updated and reissued on March 1, 2017. It authorizes the discharge of effluent to the land and water from five coal mine sites within the Elk River Valley near Elkford and Sparwood, BC, subject to terms and conditions noted within the Permit. The Permit includes monitoring requirements for the five coal mines and the Koocanusa Reservoir. These terms and conditions are intended to supplement the *Elk Valley Water Quality Plan* (Teck 2014), which Teck was required to prepare. The *Elk Valley Water Quality Plan* was approved by the B.C. MoE on November 18, 2014.

The EMC and its role are prescribed by Permit 107517, Condition 12.2. The Committee is to consist of representatives from the B.C. ENV, the Ministry of Energy and Mines, Environment and Climate Change Canada (ECCC), the Ktunaxa Nation, Interior Health Authority, and Teck. The EMC's purpose is to review submissions and provide technical advice to Teck and the B.C. ENV regarding monitoring submissions and this audit. The EMC provided this audit's objectives, scope, and criteria.

3.2 Monitoring Subject Areas

Each monitoring subject area is described below to provide context for the audit results.

A summary of each organization responsible and the documentation (e.g., procedures and records) related to each subject monitoring area is provided in Appendix B. They are grouped by the five criteria or protocol headings: study design, documentation of sampling design, documentation of laboratory program design, health and safety requirements, and data quality.

3.2.1 Surface Water Quality

Since 2014, Permit 107517, Condition 9.1 (less Condition 9.1.2.2, flow monitoring) and Appendix 2, has prescribed surface water quality monitoring requirements. Each mine-specific EMA permit has additional water quality monitoring requirements; these were not assessed as part of this audit. Authorized discharges and Site Performance Objectives (Permit 107517, Sections 2 and 3) were also not a focus of this audit. Koocanusa Reservoir monitoring requirements are prescribed within Permit 107517 and within the *Surface Water Monitoring Plan, Lake Koocanusa, BC* (Surface Water Monitoring Plan; Teck 2015).

Surface water quality sampling is managed by personnel at each mine; sampling is performed by Teck personnel or Nupqu Development Corporation contractors. Regional sampling (i.e., sampling beyond the mines) is performed by Teck personnel (rivers and creeks), and VAST Resource Solutions Inc. (Koocanusa Reservoir). Surface water quality sampling is performed in conjunction with acute and chronic toxicity sampling.

Water quality samples are submitted to ALS Environmental laboratories in Burnaby, BC, and Calgary, Alberta. The destination laboratory depends on analyses requested, with a goal of minimizing hold time exceedance issues and to meet detection limits.

Laboratory water quality results are loaded directly into Teck's EQuIS™ database by ALS. Field water quality analysis results are loaded into EQuIS™ by Teck personnel. If there are any data load issues, an automated email notification is sent back to the laboratory and to Teck personnel. Once the data have been successfully loaded into the EQuIS™ database, there are automated email notifications generated to Teck personnel if any of the results exceed a site-specific limit and/or *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (BCWQG; B.C. MoE 2017), or if a hold time exceedance occurred. At each mine, Teck personnel compile quarterly and annual water quality reports, which are reviewed and combined within the Sparwood office. Quarterly and annual reports are submitted to the B.C. ENV.

Teck personnel from each mine are responsible for QC, even when the sampling is conducted by a subcontractor.

Teck has developed the following Standard Practices and Procedures (SP&P) documentation for water quality procedures:

- TC-GEN-01 Chain-of-Custody
- TC-GEN-02 Field Documentation and Record Keeping
- TC-GEN-03 Field Housekeeping and Prevention of Contamination
- TC-GEN-04 Sampler Competency and Performance Audits
- TC-GEN-05 Sample Storage and Shipment
- TC-SW-01 Measurement of Surface Water Field Parameters Procedure
- TC-SW-02 Surface Water Sampling Procedure
- TC-SW-03 Field Filtration
- TC-SW-04 Preparation of Field Quality Control Samples for Surface Water

Some mines have developed their own work procedures, such as the GHO Environmental Monitoring Contractor Requirements. Field sampling plans are created via the EQuIS™ SPM or manually within Excel.

The SPM design is created in an Electronic Data Deliverable (EDD) format and transferred into EQuIS™ (i.e., the sample point location, planned sampling date, and analytical parameters). From these data, an electronic field data input file is produced, as well as electronic chain-of-custodies (COCs) and bottle labels. During the audit, Teck was working toward implementing the SPM for all operations and on generating completeness reports (including flags by email) to ensure no compliance results data were missed.

During this audit, Teck was developing a data management plan and had three reporting documents that include details on quality assurance/quality control (QA/QC) processes:

- TC-DATA-02, Reviewing Quality Control Samples
- Teck Quarterly Reporting - EQuIS™ User Guide (draft)
- Teck Annual Reporting - EQuIS™ User Guide (draft)

3.2.2 Acute Toxicity

Acute toxicity requirements are prescribed within Permit 107517; Conditions 7.2, 9.1, and 10.2.2; and Appendix 2.

Acute toxicity water sampling is coordinated by each mine and samples are withdrawn by Teck or Nupqu personnel. Acute water sample shipments are coordinated by site personnel with the toxicity laboratories to ensure hold times are met.

Teck has various SP&P documents that support the acute toxicity sampling program:

- TC-GEN-01 Chain-of-Custody
- TC-GEN-02 Field Documentation and Record Keeping
- TC-GEN-03 Field Housekeeping and Prevention of Contamination
- TC-GEN-04 Sample Competency and Performance Audits
- TC-GEN-05 Sample Storage and Shipment
- TC-SW-01 Measurement of Surface Water Field Parameters Procedure
- TC-SW-02 Surface Water Sampling Procedure
- TC-SW-05 Sampling For Bioassays and Toxicity Testing

Water samples are shipped to Nautilus Environmental (Burnaby or Calgary) for acute toxicity analysis. In some circumstances, Nautilus Environmental will subcontract acute toxicity samples to alternate accredited facilities (e.g., if capacity issues are encountered). Maxxam Analytics has also been used for some acute toxicity analyses.

All compliance-based acute toxicity data are stored in EQuIS™. Teck is responsible for evaluating acute toxicity results on an ongoing basis, reporting missed samples and toxic laboratory results to B.C. ENV, and compiling the acute toxicity data into the quarterly and annual water quality reports.

3.2.3 Chronic Toxicity

Chronic toxicity study design is provided within the following:

- Permit 107517, Condition 9.8, which requires that Teck develop and implement a chronic toxicity testing program for receiving environments affected by the mining operations
    - Various requirements of the program are prescribed in Condition 9.8, including types of bioassays, frequency of testing, and an annual review of the toxicity tests by the EMC.
- *Final Study Design to Address Section 9.8.2 of EMA Permit 107517* (Sublethal Toxicity Study Design; Golder 2015a)
    - This study was developed with input from the EMC, to confirm that surface waters meeting the Site Performance Objectives for the order stations are not toxic to sensitive aquatic receptors. The study design was submitted to the B.C. MoE in April 2015.
- *Chronic Toxicity Testing of Nitrate and Sulphate to Support Permit Requirements* (Integrated Nitrate-Sulphate Toxicity Testing Study Design; Golder 2015b)

The chronic toxicity program is coordinated through the Sparwood office by the Lead Adaptive Water Management and the Lead Regional Water Monitoring. Water sampling is performed by mine site personnel from either Teck or Nupqu. Chronic water sample shipments are coordinated by site personnel with the toxicity laboratories to ensure hold times are met.

The following procedures that cover chronic toxicity water sampling methods were provided:

- Teck SP&P documents:
    - TC-GEN-01 Chain-of-Custody
    - TC-GEN-02 Field Documentation and Record Keeping
    - TC-GEN-03 Field Housekeeping and Prevention of Contamination
    - TC-GEN-04 Sample Competency and Performance Audits
    - TC-GEN-05 Sample Storage and Shipment
    - TC-SW-01 Measurement of Surface Water Field Parameters Procedure
    - TC-SW-02 Surface Water Sampling Procedure
    - TC-SW-05 Sampling For Bioassays and Toxicity Testing
- Field Procedure for Amphibian Sampling (unreferenced)

- *2015 Westslope Cutthroat Trout and Spawning - Scope of Work* (LOTIC Environmental 2015)

Chronic toxicity analyses are performed by Nautilus Environmental (Burnaby and Calgary laboratories) and data is not uploaded into EQuIS™.

Quarterly chronic toxicity reports are prepared by Nautilus Environmental and interpretive annual chronic toxicity reports are prepared by Golder.

3.2.4 Benthic Community Structure

The entire benthic community structure monitoring program is designed and implemented by Minnow.

Benthic study design is provided within the following:

- Regional Aquatic Effects Monitoring Program (RAEMP) Study Design 2015 to 2017 (Minnow 2015a)
- Koocanusa Biological Monitoring Design 2015 and 2016 (Minnow 2015b, 2016a, respectively)
- LCO Local Aquatic Effects Monitoring Program (LAEMP) 2015 and 2016 Study Design (Minnow 2015c, 2016b, respectively)
- FRO LAEMP 2016 to 2019 Study Design (Minnow 2016c)

Benthic data from these programs are retained by Minnow within Excel spreadsheets and are provided to Teck in data packages and within reports.

The benthos programs in the LAEMP and RAEMP (Permit 107517, Sections 9.3 and 9.4) rely on water quality data obtained by both Teck and Minnow. The water quality data management processes in place for Minnow as part of the LAEMP and RAEMP (Permit 107517, Sections 9.3 and 9.4) were partially assessed as part of the benthos program.

Teck is required to implement the RAEMP approved by the B.C. MoE on November 14, 2014, and must submit a final study design for each subsequent 3-year cycle; the next study design is due to B.C. ENV by December 15, 2017 (Permit 10715, Condition 9.4).

Minnow's activities are governed by their SOPs.

4 AUDIT RESULTS

The following audit results are provided below:

- positive observations (Section 4.1)
- findings, where the response to the criteria question was "no" (Section 4.2)
- opportunities for improvement (Section 4.3)

4.1 Positive Observations

Positive observations include findings where a particular practice stands out as providing a substantial level of regulatory due diligence or where Teck has shown a commitment to continual improvement with the management of the subject monitoring areas. Positive observations noted during the audit included the following:

- All Teck personnel and contractors were helpful and forthcoming with information to support the audit.

- During the audit, Teck was working on implementing several modules and improvements within EQuIS™; examples of initiatives include the following:

  - Automated notifications are used when laboratory EDD could not be loaded successfully into EQuIS™. Once the data have been successfully loaded into the EQuIS™ software, automated email notifications are generated if any of the results exceed a limit and/or BC *Water Quality Guideline*, or if a hold time exceedance occurred. This automated notification supports timely responses in the event that these exceedance issues are encountered.

  - The SPM has been implemented for several mines, in which Teck pre-populates sampling events in the SPM so that each sample collected is assigned a unique identifier that is automatically propagated through to field EDDs, COCs, and bottle labels. This ensures that field-screening and laboratory results are aligned in the EQuIS™ database improving traceability of the samples.

  - Data capture has been piloted directly from iPads for processing field-screening data. The system provides automated notifications when potential errors are flagged during field data entry (e.g., data outside a specified range).

  - An automated EQuIS™ report and supporting documentation (i.e., TC-DATA-02 Reviewing Quality Control Samples) have been created to support the evaluation of field duplicates (using calculations of relative percent difference) and field blanks to determine if field QC results were acceptable or not.

  - A draft data management plan is being developed to clarify minimum data management and QC processes.

- EQuIS™ permissions are managed by a senior lead according to individual monitoring programs and data management requirements.

- The Sparwood office provides EQuIS™ training for new personnel:

  - field data capture and uploading
  - how to run reports and address select data issues from laboratories

- A quarterly meeting for the water working group is in place.

- There are clear expectations for subcontractors related to health and safety as well as technical requirements. For example, VAST performs water quality sampling on Koocanusa Reservoir. They are currently updating a health, safety, and environment plan. All employees will have to sign off on the plan.

- The GHO sampling guidance document is reviewed and updated annually before freshet.

- Acute and chronic toxicity samples are taken in conjunction with field-screening data and full water quality analyses, which is helpful for the interpretation of results. Multiple reference sites are also assessed as part of the chronic toxicity program, in addition to downstream to help assess organism response variability that may not be discharge-related.

- Surface water quality quarterly and annual report reviews are performed at the site level and from Sparwood. Quarterly and annual water quality reporting process has been standardized over the past few years.

- Mine safety practices were described as rigorous. Examples include depth × velocity calculations to determine whether to go into a watercourse; throw ropes and personal floatation devices on site; buddy system for working alone; use of SPOT personal tracker devices; Take 5 Program (a personal safety planning tool); and risk matrices for sites with high water.

- The following positive observations were identified in the benthos program were identified:

    - QA/QC requirements exceed industry standards. Through Teck's program, Minnow has contributed to improving QA/QC standards for benthic analysis by recommending a minimum of 5% of a sample to be sorted, rather than relying on the standard of 300 individuals per sample.

    - Minnow field documentation was reviewed internally, and errors or omissions were highlighted.

    - Minnow was able to quickly provide comprehensive documentation related to planning, sampling, laboratory submission, QA/QC, and laboratory results.

- Long-term subcontractors (e.g., Minnow, Golder, and VAST) and accredited laboratories (Nautilus Environmental) are involved in EMC meetings on an ongoing basis. They are involved through all aspects of these programs (from planning, through data analysis and reporting), provide historical context, and are well aware of site-specific challenges and opportunities.

4.2 Findings

As summarized in Table 2, the audit team identified 30 findings related to the 55 audit criteria provided by the EMC.

The audit criteria provided by the EMC do not necessarily reflect regulatory compliance requirements, nor do they represent criteria typical of a comprehensive environmental management system. The audit criteria do not reflect all the requirements of Permit 107517 or other applicable environmental legislation.

Therefore, the findings provided in Table 2 represent the auditors observations relating to “no” answers to EMC criteria questions, rather than representing concerns relating to regulatory compliance.

TABLE 2 Audit Findings

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
Study Design				
1	Sample Collection Methods in Study Design • Chronic toxicity	1(e) Did the study design describe the methods that would be used to collect the identified representative environmental samples?	There is no chronic toxicity sampling procedure. Chronic toxicity sampling methods were not included in study design documentation (i.e., Sublethal Toxicity Study Design [Golder 2015a] and Integrated Nitrate-Sulphate Toxicity Testing Study Design [Golder 2015b]). Teck's SP&P TC-SW-05 Sampling For Bioassays and Toxicity Testing provides details related to acute toxicity sampling and is not appropriate for routine chronic toxicity sampling.	Document detailed descriptions of chronic toxicity sampling methods, including sample handling, storage, sample custody, and shipping procedures. Ensure methods are consistent with the BC Field Sampling Manual (B.C. WLAP 2013) to support compliance with Permit 107517, Condition 9.1.2.1.
2	Study Plan Authors • Chronic toxicity	1(h) Were the authors of the study design clearly identified and was the study design signed by an appropriate qualified professional?	Of approximately 12 study design documents reviewed, one document did not include the author - Field Procedure for Amphibian Sampling. The author and qualifications of the author were unknown.	Ensure all future study design documents include authors and their qualifications.
Documentation of Sampling Design				
3	Sample Collection Methods in SOP • Chronic toxicity	2(a) Was a Field Sampling Plan (FSP) prepared to document the design of the sampling plan or was the study design and Standard Operating Procedures (SOPs) used to define the sampling plan?	No chronic toxicity sampling information is included in the Sublethal Toxicity Study Design (Golder 2015a) or Integrated Nitrate-Sulphate Toxicity Testing Study Design (Golder 2015b) as the field sample collection is completed by Teck. Teck's SP&P TC-SW-05 Sampling For Bioassays and Toxicity Testing provides details related to acute toxicity sampling only; it is not appropriate for chronic toxicity sampling.	Document the design of the sampling plan within a FSP or SP&P (Finding 1).

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
4	Data Quality Objectives and Field Crews • Acute toxicity	2(c) Did the FSP or other supporting documents: • present the purpose of the study and project data quality objectives to ensure that all participants in the field program understood why the data were being collected? Were these reviewed with field crews prior to starting field sampling program?	There are no documented acute toxicity DQOs (acceptance criteria) beyond logistical requirements (e.g., hold times, shipping, and sample volumes). High-level objectives for acute toxicity data are outlined in Permit 107517, Condition 7.2 effluent non-toxicity <50% mortality.	Document acute toxicity DQOs, especially those that trigger resampling events, such as invalid test results and toxic results. Consider applying chronic toxicity data quality objectives to the acute program (Section 4.3.9). Review data quality objectives with field samplers, as appropriate (Finding 5).

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
5	Sample Collection Methods – Sample Collection • Water quality • Acute toxicity • Chronic toxicity	2(f) Did the FSP or other supporting documents: • provide detailed descriptions of the methods and procedures that were to be used to collect environmental samples (e.g., required field equipment, sampling methods, decontamination procedures, etc.)? Were the sampling methods consistent with the BC Field Sampling Manual (BC 2013) or suitable alternative procedures as authorized by the Director, MoE?	Not all documented water quality sampling methods were consistent with the BC Field Sampling Manual (B.C. WLAP 2013). Inconsistencies between SP&Ps and the BC Field Sampling Manual include the following: • calibration record retention (Quality Control and Quality Assurance Sections 2.7 and 2.15) • field sampler awareness of QC requirements (Section 2.16) • sampler performance audit requirements (Section 2.20) For example, the Manual requires that problems be identified in a timely manner and with effective feedback between samplers and analysts. Samplers should also be aware of the potential impacts of improper sample collection on the quality of the laboratory results (e.g., improper field filtration/preservation, using expired calibration solutions, and sample containers filled with headspace). For acute toxicity, there was inconsistency between the BC Field Sampling Manual (B.C. WLAP 2013) and implementation regarding field sampler awareness of QC requirements (Section 2.16) and sampler performance audit requirements (Section 2.20). There is no sample collection methods description for chronic toxicity (i.e., within TC-SW-05, or study design documentation; Golder 2015a, 2015b).	Align water quality, and acute and chronic toxicity SP&P sampling methods with the BC Field Sampling Manual (B.C. WLAP 2013) to support compliance with Permit 107517, Condition 9.1.2.1. Clarify the relevant QC requirements for samplers to ensure that potential quality problems are identified in a timely manner. Consider if samplers should be involved in addressing sample integrity issues flagged in the laboratory's sample receipt confirmations on a routine basis. See Finding 1 for chronic toxicity.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
6	Sample Collection Methods – Handling, Storage, Shipping • Chronic toxicity	2(g) Did the FSP or other supporting documents: • provide detailed descriptions of sample handling, storage, and shipping procedures (e.g., type of container for each sample type/analysis, sample handling methods, sample preservation methods, sample packaging methods, sample shipping methods, and laboratory information)? Were the sample-handling methods consistent with "British Columbia Field Sampling Manual…"?	There is no FSP or other supporting documents that provide detailed descriptions of chronic toxicity sampling methods, including sample handling, storage, and shipping procedures. TC-SW-05 Sampling For Bioassays and Toxicity Testing provides details related to acute toxicity sampling, and the details are not appropriate for chronic toxicity sampling. No chronic sampling information is included in the Sublethal Toxicity Study Design (Golder 2015a) or Integrated Nitrate-Sulphate Toxicity Testing Study Design (Golder 2015b) as the field sample collection is completed by Teck.	See Finding 1.
7	Waste Management • Water quality	2(h) Did the FSP or other supporting documents: • describe the procedures for disposal of residual materials?	TC-GEN-03, Section 2.0 discusses discarding instruments, equipment, and supplies that are not usable in accordance with any applicable waste management policies; however, it does not specify what to do with the waste and residual materials, such as chemical waste.	Clarify waste management procedures within existing SP&Ps (i.e., for field calibration solutions and preservatives).
8	FSP Procedures • Water quality • Acute toxicity • Chronic toxicity	2(i) Did the FSP or other supporting documents: • describe sample documentation procedures (e.g., field data collection forms, chain-of-custody forms, sample labeling methods, sample/site photo documentation)?	Existing SP&Ps do not include sample documentation procedures related to EQuIS™. Several mines had recently implemented field sampling processes with the support of EQuIS™ modules SPM (to create COCs, labels, etc.) and EDD (to enable electronic field data collection).	Update SP&Ps to include new sampling processes that utilize EQuIS™ modules SPM and EDD.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
9	Sampling Procedures – QA/QC Samples • Acute toxicity	2(k) Did the FSP or other supporting documents: • describe the requirements for preparing and/or collecting quality assurance/quality control (QA/QC) samples (e.g., replicate samples, duplicate samples, field blanks, trip blanks, equipment blanks, temperature blanks, certified reference material samples, laboratory QA/QC samples, data entry/translation checks)?	TC-SW-05 Sampling For Bioassays and Toxicity Testing, Section 4.4 does not accurately describe the requirements for preparing and/or collecting QA/QC samples. It states that samples will be collected in duplicates and sent to separate laboratories for analysis. Based on interviews, this is not common practice. There are also mandatory requirements for resampling if any lethal results are obtained. These requirements are not documented within this procedure.	Update TC-SW-05 Sampling For Bioassays and Toxicity Testing, including the following: • Remove bullet 4 (collect two sets of samples at each location). • To avoid confusion between minimum requirements for sampling acute and chronic toxicity samples, consider updating the title of TC-SW-05 to include the word "acute." Add details about resampling procedure when there is a "lethal result" and the process for resampling and analyzing multiple-concentration tests (as outlined in Permit 107517) in relevant documentation.
10	FSP Variances • Water quality • Acute toxicity • Chronic toxicity	2(l) Did the FSP or other supporting documents: • describe the requirements for documenting variances from the methods described in the FSP?	Deviations from sampling procedure requirements are noted within several SP&Ps, including TC-GEN-01, TC-GEN-02, TC-GEN-03, TC-GEN-05, TC-SW-01, TC-SW-02, and TC-SW-05 Section 5.0; however, details are not specific about what to do in the event of a variance. Koocanusa Reservoir study designs (Minnow 2015b, 2016a), and Surface Water Monitoring Plan (Teck 2015) do not discuss how to handle variances. Interviews indicated that personnel have been documenting variances within field forms and these notes have been transcribed into EQuIS™.	In relevant SP&Ps, document what to do in the event of a sampling variance. Document how sampling deviations are translated into field EDDs and are entered in EQuIS™.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
Documentation of Laboratory Program				
11	Project Management • Water quality • Acute toxicity • Chronic toxicity	3(c) Did the QAPP or other supporting documents: • describe the management of the project (e.g., project organization, approval form, distribution list)?	There is limited formal documentation describing the project management of the water quality and acute toxicity programs. SP&P TC-SW-03, Section 2.0 provides roles and responsibilities related to sampling. Teck Quarterly Reporting - EQuIS™ User Guide, Section 2.0; and Site Permit Annual Reporting - EQuIS™ User Guide, Section 2.0 provide roles and responsibilities related to quarterly and annual reporting, respectively. TC-DATA-02 notes roles related to operation, data validation and management activities. Project management is not discussed within regional water quality monitoring documentation (Minnow 2015b, 2016a; Teck 2015). There is no formal documentation describing the project management of the chronic toxicity program. Interviews with Teck and Golder clarified that sample design, data analysis, and reporting are Golder's responsibility (in consultation with Nautilus Environmental); whereas executing the sampling is Teck's responsibility.	During this audit, Teck was working on documentation of roles and responsibilities for data collection and data quality evaluations. It is recommended that Teck document key responsibilities and expectations related to the water quality, and acute and chronic toxicity programs (including planning, sample collection, laboratory sample submission, data review, results verification for acceptability, and reporting).

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
12	Data quality objectives • Water quality • Acute toxicity	3(f) Did the QAPP or other supporting documents: • include a description of the data quality objectives?	Water quality DQOs are not fully described within the program documentation. QC of water quality laboratory data, including the evaluation of surrogate spikes, laboratory method blanks, laboratory duplicates, laboratory analyte spikes, and laboratory-certified reference samples, is not prescribed in documentation. Teck personnel indicated that the acceptability of laboratory results is delegated to the laboratory. It is possible for accredited laboratories to generate results that do not meet all QC criteria. Teck has assessed some water quality DQOs (e.g., hold time exceedances, missed samples, field duplicate issues, field blank issues, and method detection limit issues), as documented within the 2015 and 2016 annual and quarterly Elk Valley water quality reports. Processes related to these water quality data quality checks are outlined in TC-DATA-02, Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide. Acute toxicity DQOs are not defined in program documentation beyond Permit requirements and logistical requirements (e.g., hold times, shipping, and sample volumes). Data evaluations must be made to address invalid test results (triggers resampling), toxic results (triggers resampling), and reliability of results.	Document a description of water quality toxicity DQOs. Teck has recently documented water quality DQOs within a data management procedure. It is recommended that they be aligned with those within the BC Field Sampling Manual (B.C. WLAP 2013), Part A: Appendix 3. Include a detailed description of the performance criteria for measurement data (e.g., accuracy, precision, sensitivity, representativeness, and completeness). See Finding 4 for acute DQOs.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
13	QA/QC Program Design • Water quality	3(g) Did the QAPP or other supporting documents: • include a detailed description of the performance criteria for measurement data (e.g., accuracy, precision, sensitivity, representativeness, completeness)?	There is no documentation that describes the acceptance criteria for laboratory measurement data (e.g., accuracy, precision, sensitivity, representativeness, and completeness). Personnel indicated that the acceptability of laboratory results is delegated to the laboratory. Although accredited, it is possible for laboratories to generate results that do not meet all QC criteria. There is documentation that describes the acceptance criteria for field measurement data (e.g., field duplicate and field blank requirements are described in TC-DATA-02, Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide.)	See Finding 12.
14	Training Requirements • Water quality • Acute toxicity • Chronic toxicity	3(h) Did the QAPP or other supporting documents: • describe any special training needs and/or certification needed to successfully complete the project?	TC-GEN-04, Section 4.1 includes general requirements for sampler competency; however, special training needs and/or certification are not prescribed. Mine training requirements are not consistent. For example, during interviews, several inconsistencies related to water sampling and data analysis training were noted, including the following: • Cheat sheets, procedure sign-off, and mentorship requirements were noted for some mines and not others. • One new employee had not received EQuIS™ training. Although documented within SP&Ps, performance audits have not been implemented.	Consider whether special training needs and/or certifications are required for various program roles. Determine and document minimum training and competency requirements for sampling. Consider providing general environmental data quality training, including EQuIS™ training from the Sparwood office, with site-specific training and mentorship. Implement performance audits as required in by BC Field Sampling Manual (B.C. WLAP 2013), Section 2.20 and TC-GEN-04.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
15	Sample Collection Methods • Chronic toxicity	3(l) Did the QAPP or other supporting documents: • describe sampling, sample handling, and sample custody methods?	There is no documentation that describes chronic toxicity sampling, sample handling, and sample custody methods. TC-SW-05 Sampling For Bioassays and Toxicity Testing includes details related to acute toxicity sampling; these details are not appropriate for chronic toxicity sampling. No chronic sampling information is included in the Sublethal Toxicity Study Design (Golder 2015a) or Integrated Nitrate-Sulphate Toxicity Testing Study Design (Golder 2015b) as the field sample collection is completed by Teck.	See Finding 1.
16	Quality Control Methods and Procedures • Water quality • Acute toxicity	3(n) Did the QAPP or other supporting documents: • describe quality control methods and procedures?	There is no documentation that describes water laboratory QC methods and procedures (including evaluation of surrogate spikes, laboratory method blanks, laboratory duplicates, laboratory analyte spikes, and laboratory-certified reference samples). Field QC methods and procedures are described in the following documents: TC-SW-04, TC-DATA-02, Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide. TC-DATA-02 notes that QC data should be evaluated within 30 days of receiving results. Interviews indicated that the evaluations were being completing less frequently (quarterly or annually). There is not documentation that prescribes acute toxicity data QC methods and procedures.	Describe laboratory QC methods and procedures, such as acceptance criteria checks for water quality and acute toxicity at a frequency appropriate to allow for data quality rechecks to be requested (within 30 days as currently prescribed in SP&P TC-DATA-02). Align these QA/QC methods with the BC Field Sampling Manual (B.C. WLAP 2013). See Finding 12 for water quality and Finding 4 for acute toxicity.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
17	Field Equipment – Calibration and Maintenance • Water quality	3(o) Did the QAPP or other supporting documents: • describe instrument/equipment testing, inspection, and maintenance procedures?	TC-SW-01 Measurement of Surface Water Field Parameters Procedure does not define instrument testing, inspection, and specific maintenance requirements. The BC Field Sampling Manual prescribes that "a log should be kept for each item of equipment to document calibration, exposure, maintenance, and service." Field meter testing, inspection, and maintenance are not conducted consistently by Teck and contractor personnel. TC-SW-01 includes high-level instrument maintenance procedures and that equipment should be serviced annually. Interviews indicated that equipment service frequency is not well understood and that records are not readily available.	Within relevant SP&Ps, define requirements for instrument testing, inspection, and maintenance. Include manufacturer's specifications and consider using a work order system to track manufacturer maintenance (e.g., reminder to send meter to manufacturer annually for calibration). Ensure SP&Ps meet the requirements of the BC Field Sampling Manual (B.C. WLAP 2013). Implement consistent field meter testing, inspection, and maintenance processes across the mines.
18	Field Equipment – Calibration and Frequency • Water quality	3(p) Did the QAPP or other supporting documents: • describe the required instrument/equipment calibration and frequency?	TC-SW-01 Measurement of Surface Water Field Parameters Procedure does not define instrument calibration frequency requirements. The EVO mine has a YSI Calibration Procedure. The Koocanusa Reservoir water quality sampling plan contains minimum calibration requirements.	Define calibration requirements within all applicable procedures, including frequency. Ensure SP&Ps meet the requirements of the BC Field Sampling Manual (B.C. WLAP 2013). Implement consistent field meter calibration and record retention processes across the mines and retain records.
19	Inspection Procedure for Supplies and Consumables • Water quality • Acute toxicity • Chronic toxicity • Benthos	3(q) Did the QAPP or other supporting documents: • describe the procedures for inspection/acceptance of supplies and consumables?	No documents describe procedures for the inspection/ acceptance of supplies and consumables. For the surface water quality, and acute and chronic toxicity programs, TC-GEN-03 Field Housekeeping and Prevention of Contamination outlines general requirements for maintaining supplies and consumables but does not include a procedure for inspection or acceptance criteria. Minnow RAEMP SOPs do not include requirements for inspection/acceptance of supplies and consumables.	Consider adding documentation about procedures for inspection and acceptance of supplies and consumables within SOPs (e.g., checking expiry dates of calibration solutions).

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
20	Data Management Procedures • Water quality • Acute toxicity • Chronic toxicity • Benthos	3(s) Did the QAPP or other supporting documents: • describe data management procedures (including format for delivery of raw data, data translation, data storage, etc.)?	There was no documented data management procedure in place for surface water quality, acute and chronic toxicity, or benthos during the audit, except for the Koocanusa Reservoir monitoring program. The delivery of raw data and data translation is not prescribed in Teck, Golder, or Minnow documents. Surface water quality results are provided directly to Teck in detailed PDF reports and EDD format from ALS Environmental. These data are directly uploaded into EQuIS™ for all compliance samples. Currently no one is accountable for reviewing discrepancies between the EDD and PDF results. Acute toxicity results are provided directly to Teck in detailed PDF reports and EDD format from Nautilus Environmental. These data are translated into EQuIS™ for compliance samples. Interviews indicated there had been instances of discrepancies between EDD and PDF results. Chronic toxicity results are provided directly to Teck in detailed PDF reports and summarized quarterly reports from Nautilus Environmental. These data are not translated into EQuIS™. Teck passes chronic toxicity data on an annual basis to Golder for compliance chronic sampling and on a more frequent basis for other chronic toxicity testing programs (e.g., westslope cutthroat trout, SPO mixtures, and amphibian toxicity programs). Relevant water quality data are downloaded from Teck's database and provided to Golder to integrate with the chronic toxicity data analysis. Benthic data are provided directly from the laboratories in Excel tables to Minnow for data analysis and reporting. Water quality data are provided from either accredited laboratories or from Teck database downloads to Minnow to incorporate into their benthic analysis.	Document data management procedures for processing surface water quality, acute and chronic toxicity, and benthic results. Include the delivery of raw data, data translation, and data storage.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
21	Response Actions • Water quality • Acute toxicity	3(t) Did the QAPP or other supporting documents: • describe the methods that would be used to evaluate compliance with the QAPP, relevant response actions, and reports to management?	No documentation fully describes the methods that are used to evaluate compliance with program requirements, relevant response actions, and reports to management. Roles and responsibilities are described in relevant SP&Ps, quarterly/annual reporting guides, and the missed sample protocol. Criteria for rechecks if field/laboratory QC criteria that are not met are not prescribed. Criteria for resampling are not prescribed if toxic acute results are obtained, or of laboratory QC criteria are not met.	Document methods to evaluate compliance with program requirements, including field/laboratory QC checks, data review, data verification, data validation, relevant response actions (including resampling and rechecks), and reports to management. Include laboratory QA/QC data quality evaluation frequencies that allow for data quality rechecks to be requested from laboratories. Align these response actions with those outlined in the BC Field Sampling Manual (B.C. WLAP 2013), Part A: Appendix 3, and Permit 107517 for acute toxicity.
22	Data Evaluation and Usability • Water quality • Acute toxicity	3(u) Did the QAPP or other supporting documents: • describe the methods for data evaluation and evaluation of data usability (e.g., data review, data verification, data validation, reconciliation with data user requirements, etc.)?	Methods related to water quality data evaluations are described in TC-DATA-02, Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide; however, no document fully describes QC, including data review, data verification, data validation, and reconciliation with data user requirements. Teck partially assesses and reports on data quality and usability (e.g., hold time exceedances, missed samples, field duplicate issues, field blank issues, and method detection limit issues) within the 2015 and 2016 annual and quarterly Elk Valley water quality reports for acute and water quality data. There is not documentation that describes methods for acute toxicity data evaluation and evaluation of data usability.	See Finding 21.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
23	Test Acceptability Criteria • Water quality • Acute toxicity	3(v) Were test acceptability criteria documented for all tests?	Teck partially documented test acceptability criteria (e.g., hold time exceedances, missed samples, field duplicate issues, field blank issues, and method detection limit issues) within the 2015 and 2016 annual and quarterly water quality reports for water quality and acute toxicity data. The water quality data evaluation process is outlined in TC-DATA-02, Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide. No assessment of laboratory QC data is prescribed in any of these documents including evaluation of surrogate spikes, laboratory method blanks, laboratory duplicates, laboratory analyte spikes, and laboratory-certified reference samples. There are not Teck documents that prescribe acute toxicity data acceptability criteria.	See Finding 12 for Water Quality. See Finding 4 for Acute Toxicity
Data Quality				
24	Chain-of-Custody Documentation and Field Records Retention • Water quality • Acute toxicity • Chronic toxicity	5(a) Were the environmental samples collected in accordance with the approved FSP or other supporting documents? Were field data collection forms, chain-of-custody forms, and other forms of sample documentation available and correctly completed?	Some requested records for GHO, LCO, and the regional water quality program were not provided for review: • COCs for surface water quality, and acute or chronic toxicity from LCO, GHO, and the regional water quality program • field notes and calibration records for LCO and GHO Surface water quality COCs included identification of blank and duplicate information.	Implement field record retention practices that are aligned with those set out in the approved SP&P documents. During the audit, Teck indicated that they had recently implemented a new process, where sample naming conventions for COC forms keep the type of sample (i.e., field duplicates and blanks) unknown to the laboratory.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
25	Dissolved Metals • Water quality	5(c) Were the environmental samples handled, shipped, transported, and stored in accordance with the methods described in the FSP, QAPP or other relevant documents? Were the steps of the sampling process adequately documented?	The sampling SP&P requires field filtration for dissolved parameters; however, personnel indicated that samples are not filtered in the field. On COCs where dissolved metals and dissolved organic parameters were requested, it was not clear whether field filtration or preservation had been completed.	Review and update TC-SW-03 to describe field methods and implement appropriate field filtration and preservation procedures. Provide updated procedure training to all water samplers. On COCs, samplers should document whether samples with dissolved parameters were field filtered or field preserved so that sample integrity is maintained.
26	Laboratory QC Validation - accuracy checks • Water quality	5(f) Were the requirements for data accuracy met for all batches of samples? If not, were deviations for the requirements documented in the performance criteria for measurement data.	Teck has not been evaluating surrogate spikes, laboratory analyte spikes, and laboratory certified reference samples. Interviews confirmed that laboratory QC data are not assessed by Teck.	Implement laboratory QA/QC water quality data evaluations to ensure data accuracy, precision, and acceptability criteria requirements are met, including evaluations of the following: • surrogate spikes • laboratory analyte spikes • laboratory certified reference samples • laboratory duplicates • laboratory method blanks Within SP&Ps, include DQOs from the BC Field Sampling Manual (B.C. WLAP 2013), Part A: Appendix 3. Implement laboratory test acceptability evaluations at a frequency appropriate to allow for data quality rechecks to be requested.
27	Laboratory QC Validation - precision checks • Water quality	5(g) Were the requirements for data precision met for all batches of samples? If not, were deviations from the requirements documented in the performance criteria for measurement data?	Teck has not been evaluating laboratory duplicate data. Interviews confirmed that laboratory duplicate data are not assessed by Teck. Field duplicates were evaluated in accordance with TC-DATA-02 and any results that did not meet defined criteria were reported in annual and quarterly reports.	See Finding 26.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
28	Laboratory QC Validation - test acceptability criteria checks • Water quality	5(i) Were test acceptability criteria met for all tests? If not, were these deviations from test acceptability criteria documented.	Teck partially assessed and reported on test acceptability criteria (e.g., hold time exceedances, missed samples, field duplicate issues, field blank issues, and method detection limit issues) within the 2015 and 2016 annual and quarterly Elk Valley water quality reports. Water quality test acceptability was not fully defined and documented; no assessment of laboratory QC data was completed including surrogate spikes, laboratory method blanks, laboratory duplicates, laboratory analyte spikes, and laboratory-certified reference samples. Interviews confirmed that laboratory QC data is not assessed by Teck. Assessments against DQOs are not consistently documented and are not performed within a time frame that allows for data quality rechecks to be placed. Data quality issues were observed in the laboratory reports from September 1 to 10, 2017. Examples include method blanks failing criteria, analyte spikes recovery not accurately calculated or failed criteria, detection limits were raised, interferences were noted, and dissolved concentrations exceeded total. These deficiencies may have biased Teck's reportable results that were processed concurrent with these laboratory QC samples.	See Finding 26.

#	Topic Monitoring Subject Area	EMC Question	Finding	Recommendation
29	Data Entry and Translation • Water quality • Acute toxicity • Chronic toxicity	5(k) Was data entry and translation checks completed as per study design to confirm data accuracy used in evaluation and reporting (i.e., laboratory data obtained in electronic format, independent data validation completed, etc.)? Evaluate and report on the accuracy of such data entry and translations.	Data entry and translation checks are not prescribed in Teck or Golder documents except for the Koocanusa study design documents ((Minnow 2015b, 2016a; Teck 2015). The SP&Ps do not specify who is accountable for verifying EDD and PDF results for acute toxicity and water quality data. Data entry and translation checks are therefore not implemented on a routine basis. No surface water quality, acute toxicity, or chronic toxicity data evaluation records were available for review. Within quarterly and annual water quality reports, data translation checks cannot be completed because reports do not include discrete values (e.g., for receiving environment samples). Reports include applied BCWQG (B.C. MoE 2017) averages, but did not indicate the period or volume of data included in the averages.	Data delivery and translation processes are well understood by Teck, Nupqu, VAST, Minnow, and Golder. Consider whether documenting raw data delivery and translation is required, as described within the EMC question. If necessary, clarify which roles/individuals are responsible for which part of the surface water quality, and acute and chronic toxicity projects including the verification that laboratory results in PDF and EDD or Excel format are consistent. Include discrete water quality data within quarterly and annual water quality reports, and clarify which values are averages. This way, data translation checks may be completed by regulators, as needed.
30	Metadata • Water quality • Acute toxicity	5(l) Is sufficient metadata included in the project database(s) to fully document the generation and reliability of the underlying data? If not, please document deficiencies in the documentation provided in the project database(s).	Laboratory QC data that accompanies water quality data was not being evaluated by Teck before the audit. Once QC checks are implemented using this data in in EQuIS™, the reliability of the underlying data can be fully assessed. There was no documented recheck process in place for the data stored during the audit. It is unclear if all data stored in EQuIS™ (original and recheck values) are used for regulatory reporting. There is no process to assess reliability of the acute toxicity results (laboratory QC issues) except for results that are considered invalid by Nautilus Environmental or if hold times have been exceeded. Nautilus Environmental laboratory submissions EDD and PDF results were provided.	For acute toxicity data, evaluate toxicity laboratory data for protocol deviations, and add appropriate qualifiers into EQuIS™ as needed. Consider aligning the acute toxicity DQOs with those already established for the chronic toxicity program (Golder 2015a, 2015b). For surface water quality and acute toxicity results, clarify data quality recheck workflow, whether original or recheck results are "reportable" and how that is reflected within EQuIS™.

4.3 Opportunities for Improvement

The following opportunities for improvement were noted throughout this audit. Opportunities for improvement are observations that are not directly related to a criteria question, but where practices may be improved. The identification of opportunities for improvement was requested by Teck.

4.3.1 Laboratory Accreditation

It is common practice for industry to rely on laboratory accreditation to the *ISO/IEC 17025:2005: General requirements for the competence of testing and calibration laboratories* (ISO 2005) for each parameter to ensure laboratory internal QA/QC processes are implemented. There is also a *Directory of Qualified Laboratories,* which is maintained by the B.C. ENV (2017), which can be checked to verify current laboratory accreditation status and specific scopes of accreditation. Teck could not confirm whether a laboratory accreditation check is performed periodically. Teck may consider verifying accreditation status of primary laboratories and parameters on a routine basis.

4.3.2 Treatment of Data Within Water Quality Reports

Within EQuIS™, results below the detection limit are assigned the detection limit value; this detection limit value is included in mean calculations. This treatment of non-detect water quality data is not mentioned within quarterly reports. Within all water quality reports, describe how non-detect data are treated within monthly average calculations.

Also, Teck should consider clarifying how the BCWQG is applied in the quarterly and annual water quality reports, specifically with respect to the following:

- explaining Environment Guideline Exceedances tables in the quarterly Elk Valley Water Quality Report (i.e., are the guideline exceedances based on discrete values or 30-day average values?)
- defining how data is treated within Summary of Water Quality Guideline Exceedances tables in Permit 107517 annual water quality monitoring reports
    - It is unclear whether each value in the result column represents either a discrete value for that analyte on that specific date and location (for BCWQG-approved max) or a 30-day averaged value (for BCWQG-approved or working averages).
        - where averages are applied, clarify the sample count associated with each average (similar to what is shown on the Compliance Station summary tables)
        - consider updating the date column to represent all dates included in the averaged data set or clarify what the date column represents on these tables

Treatment of data (e.g., non-detect data and averages) and how the BCWQG is applied within water quality reports should be clarified.

As per Finding 29, currently there are no discrete surface water quality data for receiving environment samples in quarterly or annual water quality reports (e.g., full laboratory reports or data summary tables). Consider including raw data results to provide context for exceedance data (e.g., to show if results are consistently above average or there was one anomalously high result skewing the average).

4.3.3 Health and Safety

Health and safety requirements appear to be rigorous, but are not consistent across the mines. For example, FRO has identified sampling and health and safety concerns at each water quality monitoring site (i.e., hazard registry), have minimum personal protective equipment (PPE) requirements, and working alone procedures. Other mines encourage water samplers to Take 5. Spot tracking devices are used by at least one mine.

Teck may consider whether health and safety requirements should be standardized across the mines for surface water sampling. Requirements could include many existing best practices that have already been identified by the mines.

4.3.4 Minnow Field Sheets

Within field sheets, Teck may consider providing documentation about follow-ups when issues are noted (i.e., add additional notes within field sheets). This will provide insight on whether the issues were addressed and help identify and address the root cause of the issue.

4.3.5 Chain-of-custody Documentation

The following issues or opportunities for improvement were noted with respect to COC documentation:

- Sample locations are noted on all COC documentation (benthos, acute and chronic toxicity, and water quality). This introduces a potential bias for the laboratory to compare results to previous results at the same location.

- Some COC documentation provided were not filled out fully and correctly (e.g., missing time of sampling and providing incorrect laboratory contact information).

- For acute and chronic toxicity COC documentation, multiple-concentration or single-concentration analysis may be required for each test species; COC documentation should specify which test option is required.

- Where dissolved metals or dissolved organics are collected, COC documentation should be clear regarding whether the sample has been field filtered or preserved (see Finding 25).

4.3.6 EQuIS™ User Guides

A number of personnel indicated that EQuIS™ user guides are difficult to understand and use. These pertain to surface water quality and acute toxicity data.

Consider simplifying EQuIS™ instructional information within Teck procedures.

4.3.7 Toxicity Data Review

There is an opportunity to implement more frequent chronic toxicity data quality checks aligned with those conducted annually by Golder to ensure that invalid results and/or suspect data can be resampled in a timely manner. Criteria could be similar to those documented by Golder in the Elk Valley Chronic Toxicity Annual Report and include an assessment of the following:

- Health histories of the test organisms used in the exposures were acceptable and met requirements of the ECCC protocols.
- Tests meet all control acceptability criteria.
- Water quality parameters remain within ranges specified in the protocol throughout the tests.
- Deviations occur from the test methods.
- Results of the reference toxicant tests fall within the acceptable range for organism performance of mean and two standard deviations, based on historical results obtained by the laboratory (i.e., sensitivity of organisms used in the tests was acceptable).

4.3.8 Water Quality Sampling Procedures

GHO Environmental Monitoring Contractor Requirements (January 2017) includes discussion about conductivity. Permit 107517 requires in situ-specific conductance measurements.

Review procedural documents and apply the correct terminology (i.e., specific conductance vs. conductivity).

4.3.9 Acute Toxicity Procedure

Update wording in TC-SW-05, Section 5.0 from “sampling potable water for bacteriological analysis” to “sampling for bioassays.”

5 CONCLUSION

This audit assessed monitoring data and its analysis, as required by BC EMA Permit 107517, Condition 12.3, and as prescribed by the EMC. The scope of the audit was Permit 107517 activities related to the following:

- two topic areas:
  1. data quality and completeness
  2. SOP and data handling protocols in place for Teck

- four monitoring subject areas:
  1. surface water quality
  2. acute toxicity
  3. chronic toxicity
  4. benthic community structure

Each of the 55 audit criteria questions were evaluated for each of the four monitoring subject areas.

A number of positive observations were noted throughout the audit, including the following:

- Teck personnel and contractors were helpful and forthcoming with information to support the audit process.

- Teck has a number of SOPs (SP&Ps) in place and was developing several data quality-related procedures during the audit.

- During the audit, the Sparwood office was working on implementing several new modules and improvements within EQuIS™ in support of sampling and data quality process improvements.

- Contractors demonstrated engagement with their programs and with the EMC.

This audit resulted in 30 audit findings (where an EMC question was answered as a “no”), as summarized in Table 2. Recommendations are provided regarding the 30 findings. Most of the recommendations relate to the further development of data QA/QC processes, including the following:

- further defining and documenting water quality and acute toxicity DQOs (including acceptance criteria for laboratory QC evaluations)

- implementing a routine evaluation of DQOs, including accountabilities and timing

- documenting and implementing relevant response actions when test acceptance criteria have not been met

- clarifying, documenting, and communicating key responsibilities and expectations related to the water quality, and acute and chronic toxicity programs (from planning, sample collection, laboratory sample submission, data review/results verification for acceptability, and reporting)

- defining and implementing improved field sampling practices, including calibration and record maintenance, and proper field filtration and preservation

- defining data delivery, translation calculations, and database maintenance processes as they pertain to regulatory reports

- documenting and implementing consistent training requirements for all Elk Valley operations (e.g., sampling competency, laboratory data quality evaluations, EQuIS™ usage, and health and safety)

- creating chronic toxicity sampling documentation

- updating procedure(s) to include EQuIS™ field sampling plan processes (e.g., SPM)

- updating documentation to align with BC Field Sampling Manual (B.C. WLAP 2013) and BC Laboratory Methods Manual (Austin 2015) to support compliance with Permit 107517, Condition 9.1.2.1

The audit found that the complex surface water quality, and acute and chronic toxicity program requirements are generally well-managed by Teck. The benthos program has been well-documented by Minnow. Overall, the audit team found that the monitoring subject area programs could be enhanced by several recommended data quality management improvements and also SOP updates.

6 AUDIT PROGRAM RECOMMENDATIONS

The design of the 2017 audit program presented challenges. The following recommendations are provided for consideration during planning of future audits, which are required on a 2-year cycle, as per Permit 107517, Condition 12.3.

1. Audit criteria: Permit 107517, Condition 12.3 prescribes some requirements for audits, including the consideration of topic areas, which are a mixture of compliance and management system topics (e.g., compliance with Permit requirements vs. assessing protocols and procedures). For future audits, Teck may consider whether the specific audit criteria are compliance- or management system-based. For protocol elements that are compliance-based, legal requirements (e.g., Act, Regulation, and Permit Conditions) or closed-ended (yes/no) questions are appropriate. However, if the audit protocol element is a management system requirement, questions should be open-ended to allow for a full evaluation.

2. Audit scope: Defining audit scope was a challenge as the breadth of each subject monitoring area is complex in terms of both programs and timing. Additional definition of the audit objectives, scope, and criteria could be helpful to future auditors. ISO 19011:11 *Guidelines for Auditing Management Systems* (ISO 2011) provides some guidance on developing objectives and scope for management system audit items, and *CSA Standard Z773-17: Environmental Compliance Auditing* (CSA 2017) provides guidance for compliance-based audit planning.

3. No sampling assessment: Several of the audit protocol questions were difficult to answer without an assessment of field activities. Teck may consider whether future audits should include a field component.

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APPENDIX A
Audit Criteria

APPENDIX A

AUDIT CRITERIA

		Criteria Heading	Criteria
1	a	Study Design	Was a study design prepared to document the plan of the study?
1	b	Study Design	Did the study design document the purpose/objectives of the study?
1	c	Study Design	Did the study design document the project data quality objectives?
1	d	Study Design	Did that study design present or reference the results of power analyses to estimate the minimum data requirements for the study (i.e., how many samples needed to be collected from each location)?
1	e	Study Design	Did the study design describe the methods that would be used to collect the identified representative environmental samples?
1	f	Study Design	Did the study design include a description of the statistical design that would be used to generate the burden of evidence effects occurred at the site; e.g., before: after-control: impact, gradient, control-impact, reference-condition-approach, etc.
1	g	Study Design	Did the study design include a description of the methods that would be used to analyze the data? (e.g., analysis of variance, non-parametric, multi-variate tools);
1	h	Study Design	Were the authors of the study design clearly identified and was the study design signed by an appropriate qualified professional?
1	i	Study Design	Was the study design peer-reviewed by the EMC prior to implementation of the study?
2	a	Documentation of Sampling Design	Was a Field Sampling Plan (FSP) prepared to document the design of the sampling plan or was the study design and Standard Operating Procedures (SOPs) used to define the sampling plan?
2	b	Documentation of Sampling Design	Did the FSP or other supporting documents: provide relevant information on the sampling locations (e.g., narrative descriptions, maps, relevant background information on environmental conditions)?
2	c	Documentation of Sampling Design	Did the FSP or other supporting documents:present the purpose of the study and project data quality objectives to ensure that all participants in the field program understood why the data were being collected? Were these reviewed with field crews prior to starting field sampling program?
2	d	Documentation of Sampling Design	Did the FSP or other supporting documents: Include a description of the analytical support that was required to facilitate the analysis of environmental samples (i.e., chemicals of potential concern [COPCs], analyses requested, turnaround time, selected laboratories, etc.)?
2	e	Documentation of Sampling Design	Did the FSP or other supporting documents: provide details on the sampling frequency and any specific timing constraints or limitations for sampling?
2	f	Documentation of Sampling Design	Did the FSP or other supporting documents: provide detailed descriptions of the methods and procedures that were to be used to collect environmental samples (e.g., required field equipment, sampling methods, decontamination procedures, etc.)? Were the sampling methods consistent with the “British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples” or suitable alternative procedures as authorized by the Director, Ministry of Environment (MOE)?

		Criteria Heading	Criteria
2	g	Documentation of Sampling Design	Did the FSP or other supporting documents:provide detailed descriptions of sample handling, storage, and shipping procedures (e.g., type of container for each sample type/analysis, sample handling methods, sample preservation methods, sample packaging methods, sample shipping methods, and laboratory information)? Were the sample-handling methods consistent with "British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples"?
2	h	Documentation of Sampling Design	Did the FSP or other supporting documents: describe the procedures for disposal of residual materials?
2	i	Documentation of Sampling Design	Did the FSP or other supporting documents: describe sample documentation procedures (e.g., field data collection forms, chain-of-custody forms, sample labeling methods, sample/site photo documentation)?
2	k	Documentation of Sampling Design	Did the FSP or other supporting documents: describe the requirements for preparing and/or collecting quality assurance/quality control (QA/QC) samples (e.g., replicate samples, duplicate samples, field blanks, trip blanks, equipment blanks, temperature blanks, certified reference material samples, laboratory QA/QC samples, data entry/translation checks)?
2	l	Documentation of Sampling Design	Did the FSP or other supporting documents: describe the requirements for documenting variances from the methods described in the FSP?
3	a	Documentation of Laboratory Program Design	Was a Quality Assurance Project Plan (QAPP) or other supporting documents prepared to document the design of the sampling program?
3	b	Documentation of Laboratory Program Design	Was the QAPP or other supporting documents implemented in accordance with the Environmental Data Quality Assurance Regulation and guidance provided in "British Columbia Laboratory Methods Manual for the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air".
3	c	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents:describe the management of the project (e.g., project organization, approval form, distribution list)?
3	d	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: provide a description of the project background and definition of the purpose/objective that the data will be used to evaluate?
3	e	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: provide a detailed description of the study plan design? and associated tasks?
3	f	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: include a description of the data quality objectives?
3	g	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents:include a detailed description of the performance criteria for measurement data (e.g., accuracy, precision, sensitivity, representativeness, completeness)?
3	h	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe any special training needs and/or certification needed to successfully complete the project?
3	i	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the requirements for documentation of data generation and record keeping?

		Criteria Heading	Criteria
3	k	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the experimental design for the study?
3	l	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe sampling, sample handling, and sample custody methods?
3	m	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the analytical methods that would be used to generate chemistry, toxicity, and/or benthic invertebrate community structure data?
3	n	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe quality control methods and procedures?
3	o	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe instrument/equipment testing, inspection, and maintenance procedures?
3	p	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents:describe the required instrument/equipment calibration and frequency?
3	q	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the procedures for inspection/acceptance of supplies and consumables?
3	r	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the methods for making non-direct measurements?
3	s	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe data management procedures (including format for delivery of raw data, data translation, data storage, etc.)?
3	t	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the methods that would be used to evaluate compliance with the QAPP, relevant response actions, and reports to management?
3	u	Documentation of Laboratory Program Design	Did the QAPP or other supporting documents: describe the methods for data evaluation and evaluation of data usability (e.g., data review, data verification, data validation, reconciliation with data user requirements, etc.)?
3	v	Documentation of Laboratory Program Design	Were test acceptability criteria documented for all tests?
3	w	Documentation of Laboratory Program Design	Were criteria for evaluating the accuracy of benthic invertebrate identification documented and consistent with industry standards?
4	a	Health and Safety	Was an Environmental, Health, Safety and Communities Plan (EHSC) prepared to ensure worker safety during the environmental sample collection and data generation processes?
5	a	Data Quality	Were the environmental samples collected in accordance with the approved FSP or other supporting documents? Were field data collection forms, chain-of-custody forms, and other forms of sample documentation available and correctly completed?
5	b	Data Quality	Were all of the environmental samples identified in the FSP or other supporting documents collected during the sampling program? If not, were the changes documented with rational for change captured? What was the sampling completeness for each sample type that was collected?

		Criteria Heading	Criteria
5	c	Data Quality	Were the environmental samples handled, shipped, transported, and stored in accordance with the methods described in the FSP, QAPP or other relevant documents? Were the steps of the sampling process adequately documented?
5	d	Data Quality	Were all environmental samples characterized by certified laboratories? Did the laboratories follow the QA/QC requirements documented in the study design, FSP, QAPP, and/or other relevant documents? Did the laboratory have established standard operating procedures (SOPs) for conducting each analysis and/or procedure? If not, document any deficiencies.
5	e	Data Quality	Were the environmental samples characterized in accordance with the approved QAPP or other relevant documents (i.e., were all of the required analyses conducted on each environmental sample? i.e., chemical analyses, toxicity testing, benthic invertebrate identification)?
5	f	Data Quality	Were the requirements for data accuracy met for all batches of samples? If not, were deviations for the requirements documented in the performance criteria for measurement data.
5	g	Data Quality	Were the requirements for data precision met for all batches of samples? If not, were deviations from the requirements documented in the performance criteria for measurement data.
5	h	Data Quality	Were the requirements for sensitivity (i.e., analytical detection limits) met for all batches of samples? If not, were deviations from the requirements documented in the performance criteria for measurement data.
5	i	Data Quality	Were test acceptability criteria met for all tests? If not, were these deviations from test acceptability criteria documented.
5	j	Data Quality	Were identified QA/QC procedures followed to confirm data acceptability (i.e., 10% of the samples for analysis of the benthic invertebrate community structure randomly selected and resorted, were invertebrates identified to the lowest possible taxonomic level, etc.) as per approved study design? Document the results of the evaluations of the quality of the benthic invertebrate community structure data.
5	k	Data Quality	Was data entry and translation checks completed as per study design to confirm data accuracy used in evaluation and reporting (i.e., lab data obtained in electronic format, independent data validation completed, etc.)? Evaluate and report on the accuracy of such data entry and translations.
5	l	Data Quality	Is sufficient metadata included in the project database(s) to fully document the generation and reliability of the underlying data? If not, please document deficiencies in the documentation provided in the project database(s).

APPENDIX B
Summary of Subject Monitoring Area Responsibilities and Documentation

APPENDIX B

SUMMARY OF SUBJECT MONITORING AREA RESPONSIBILITIES AND DOCUMENTATION

	Surface Water Quality	Acute Toxicity	Chronic Toxicity	Benthic Community Structure
Study Design				
Responsible	• British Columbia Ministry of Environment and Climate Change Strategy (B.C. ENV; formerly British Columbia Ministry of Environment [MoE]) • Koocanusa Reservoir Working Group	• B.C. ENV	• Teck Coal Limited (Sparwood) • Golder Associates Ltd.	• Minnow Environmental Inc.
Documentation	• Permit 107517, Section 9.2 • Koocanusa Biological Monitoring Design 2015 and 2016 (Minnow 2015a, 2016a) • Surface Water Monitoring Plan, Lake Koocanusa, BC (Teck 2015; Koocanusa Reservoir Working Group) • Teck Coal Field Sampling Manual 2013 (Standards, Practices and Procedures [SP&P])	• Permit 107517 Teck Coal Field Sampling Manual 2013 (SP&P Documents)	• Permit 107517 • Sublethal Toxicity Study Design (Golder 2015) • Chronic Toxicity Testing of Nitrate and Sulphate to Support Permit Requirements (Golder 2015) • Field Procedure for Amphibian Sampling (Teck) • 2015 westslope cutthroat trout and spawning - Scope of Work (LOTIC Environmental) • Teck Coal Field Sampling Manual 2013 (SP&P Documents)	• Regional Aquatic Effects Monitoring Program (RAEMP) Study Design 2015 – 2017 (Minnow 2015b) • Koocanusa Biological Monitoring Design 2015 and 2016 (Minnow 2015a, 2016a) • LCO Local Aquatic Effects Monitoring Program (LAEMP) 2015 and 2016 Study Design (Minnow 2015c, 2016b) • FRO LAEMP 2016-2019 Study Design (Minnow 2016c) • Minnow Standard Operating Procedures

	Surface Water Quality	Acute Toxicity	Chronic Toxicity	Benthic Community Structure
Documentation of the Sampling Design				
Responsible	• Teck (each mine and Sparwood) or Nupqu • VAST Resource Solutions	• Teck (each mine and Sparwood) or Nupqu	• Teck (each mine and Sparwood) or Nupqu • LOTIC Environmental	• Minnow
Documentation	• Permit, EQuIS™ Sample Planning Module (SPM), or spreadsheets • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Koocanusa 2015 Biological Monitoring Program Design (Minnow 2015) • Koocanusa 2016 Biological Monitoring Program Design (Minnow 2016a) • Surface Water Monitoring Plan, Lake Koocanusa, BC (Teck 2015; LKMRWG) • BC Field Sampling Manual (B.C. WLAP 2013)	• Permit, EQuIS™ SPM or spreadsheets • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • BC Field Sampling Manual (B.C. WLAP 2013)	• Permit, EQuIS™ SPM or Spreadsheets • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • 2015 Westslope Cutthroat Trout and Spawning – Scope of Work • Field Procedure for Amphibian Sampling • BC Field Sampling Manual (B.C. WLAP 2013)	• Study design documents for RAEMP, LAEMP and Koocanusa programs • Minnow Field Checklists • Minnow Standard Operating Procedures

	Surface Water Quality	Acute Toxicity	Chronic Toxicity	Benthic Community Structure
Documentation of the Laboratory Program Design				
Responsible	• ALS Environmental (Burnaby and Calgary)	• Nautilus Environmental (Burnaby and Calgary)	• Nautilus Environmental (Burnaby and Calgary)	• Cordillera Consulting (Summerland, BC) • ZEAS Incorporated (Nobleton, Ontario)
Documentation	• Permit • BC Laboratory Methods Manual (Austin 2015) • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Koocanusa 2015 Biological Monitoring Program Design (Minnow 2015) • Koocanusa 2016 Biological Monitoring Program Design (Minnow 2016a) • Surface Water Monitoring Plan, Lake Koocanusa, BC (Teck 2015; Koocanusa Reservoir Working Group) • TC-DATA-02, Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuiS User Guide • Missed Sample Protocol (Teck 2015)	• Permit • BC Laboratory Methods Manual (Austin 2015) • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide	• Permit and British Columbia Laboratory Methods Manual for the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Sublethal Toxicity Study Design (Golder 2015) • Chronic Toxicity Testing of Nitrate and Sulphate to Support Permit Requirements (Golder 2015)	• Study design documents for RAEMP, LAEMP, and Koocanusa programs • Minnow Standard Operating Procedures
Health and Safety				
Responsible	• Teck (each mine and Sparwood)	• Teck (each mine and Sparwood)	• Teck (each mine)	• Teck and Minnow
Documentation	• Environmental Health and Safety Plan (EHSP)	• EHSP	• EHSP	• EHSP

	Surface Water Quality	Acute Toxicity	Chronic Toxicity	Benthic Community Structure
Data Quality				
Responsible	• Teck (each mine and Sparwood)	• Teck (each mine and Sparwood)	• Nautilus Environmental (quarterly reports) • Golder (annual reports)	• Minnow • Cordillera Consulting • ZEAS Incorporated
Documentation	• Teck Quarterly Reporting - EQuIS™ User Guide, and Site Permit Annual Reporting - EQuIS™ User Guide • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Elk Valley Water Quality Reports (Quarterly and Annual) • Teck COCs, Field Notes, Calibration Records, Laboratory Results, EQuIS™ View	• Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Elk Valley Water Quality Reports (Quarterly and Annual) • Teck COCs, Field Notes, Calibration Records, Laboratory Results, EQuIS™ View	• Nautilus Quarterly Reports, Section 4.0 and Golder Annual Reports, Sections 2.3 to 3.2 • Teck Coal Field Sampling Manual 2013 (SP&P Documents) • Elk Valley Chronic Toxicity Reports (Quarterly and Annual) • Teck COCs, Field Notes, Calibration Records, Laboratory Results	• Minnow Field sheets and COCs (both for water quality and benthic results) • QA/QC results from ALS and Cordillera laboratories • LCO LAEMP, 2015 (Minnow 2016a)

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