Attachment 7

# 2016 Faro Mine Water Monitoring Investigation Data Quality Evaluation Report

Water samples were collected and analyzed during the 2016 Site-Wide Water Monitoring Investigation in support of the Faro Mine Remediation Project (FMRP). This included the waste rock dump groundwater monitoring in February and June 2016, Faro Pit Lake profiling in March 2016, and seep monitoring in spring 2016. All analytical data were evaluated in compliance with the *Quality Assurance Project Plan, Faro Mine Remediation Project* (QAPP) (CH2M HILL Canada Limited [CH2M], 2015a). This data quality evaluation (DQE) report summarizes the results of the quality assurance and quality control activities prescribed in the QAPP and assesses data usability. The QAPP identifies method-specific quality control (QC) requirements for each analytical parameter and matrix and defines a plan to test that the correct sampling, analytical, and data reduction procedures are followed by using audits and data validation.

This DQE report is a general data quality assessment designed to summarize data issues.

## Analytical Data

Between February 17 and June 7, 2016, 14 groundwater, 60 seep water, 7 pit lake profile samples, 3 groundwater field duplicates (FD), 8 seep water FDs, 1 pit lake profile FD, and 6 equipment blanks (EB) were collected. Samples were analyzed by ALS Canada, Ltd. (ALS) in Burnaby, British Columbia. The laboratory placed the samples into 10 sample delivery groups (SDG). Summaries of the samples collected are presented in Tables 1 and 2. Seventeen methods were used to analyze the environmental samples. The samples were collected and couriered to ALS in Whitehorse, where they were shipped by overnight carrier to ALS in Burnaby for analysis. Selected samples were analyzed for one or more of the following analytes/methods:

Free cyanide — Method ASTM D7237

Lime demand/solids formed — Method CH1987LIME

pH — Method CSSS/APHA 4500H

Mercury, dissolved — Method E1631E

Mercury, total — Method E245.7

Ferrous iron — Method Ferrozine

Ammonia — Method JEM/SM4500N

Acidity, hot peroxide — Method SM2310\_HP

Alkalinity, bicarbonate, carbonate, hydroxide, and total — Method SM2320B

Hardness — Method SM2340B\_CALC

Total dissolved solids (TDS) — Method SM2540C

Total suspended solids — Method SM2540D

Anions (chloride, fluoride, nitrate, nitrite, sulfate) — Method SM4110B

Phosphorus — Method SM4500P

Dissolved organic carbon (DOC) — Method SM5310

Metals, total and dissolved — Method SW6010B

Metals, dissolved — Method SW6020A

The SDGs were evaluated by CH2M chemists for data quality. Analytical performance was initially assessed on an SDG basis or an analytical batch basis. The association of laboratory QC samples and environmental samples from the same analytical batch is determined by the laboratory lot control number. Data were assessed by using the following Level II validation:

1. Review data set narrative to identify issues that the laboratory reported in the data deliverable
2. Check sample integrity (e.g., sample collection, preservation, and holding times)
3. Evaluate basic QC measurements used to assess the accuracy, precision, and representativeness of data, including QC blanks, laboratory control samples, matrix spike samples and field or laboratory duplicate results
4. Review sample results, target compound lists, and detection limits to verify that project analytical requirements are met
5. Initiate corrective actions, as necessary, based on the data review findings
6. Verify that hardcopy results match electronic deliverable results
7. Qualify data by using appropriate qualifier flags, as necessary, to indicate data usability limitations

Field samples were also reviewed to ascertain field compliance and data quality issues. This included a review of EBs and FDs.

Data flags were assigned in accordance with the QC acceptance limits defined in the QAPP. Data validation flags for the SDG are summarized in each data quality validation report. The data flags and the reason for each flag are recorded in the electronic validation database. Multiple data flags can be applied to specific sample method/matrix/analyte combinations, but there is only one final data flag. The final data flag is applied on the basis of the data flags entered into the database and is the most conservative of the applied data flags. The final data flag also includes matrix and blank sample impacts.

Data flags can be separated into two categories to be used in estimating both contractor and analytical completeness:

1. Flags applied because of laboratory deviations from requirements in the QAPP
2. Flags applied because of the nature of the sample matrix or method limitations

The database tracks the type of protocol violation and the contractual and analytical completeness during data validation.

The data flags are defined in the QAPP as follows:

J = Analyte was present but the reported value may not be accurate or precise.

UJ = Analyte was not detected above the detection limit objective. However, the reported detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R = Result has been rejected for use.

U = Analyte was analyzed for but not detected at the specified detection limit.

None = A database flag with no QC implications. A flag is not applied. This is a placeholder for calculating QC criteria issues that do not require flagging.

Exclude = A database flag with no QC implications. When multiple data points have been reported, such as dilutions or re-extractions, the data that best match QAPP QC requirements are presented to the data users and the remainders are marked with this flag.

= = A database flag with no QC implications. A place holder for the DQE reporting purposes noting that the reported result is a detected concentration greater than the reporting limit.

## Findings

The overall summaries of the data validation findings are contained in Tables 1 through 8 and summarized in the method sections that follow:

* **Table 1: Sample Summary by COC – Data Summary**. Presents the sample identifiers, sampling dates, and SDG sorted by chain-of-custody (COC) number.
* **Table 2: Sample Chronology – Data Summary**. Presents the sample identifiers, methods, sampling dates, received dates, extraction dates, and analysis dates sorted by SDG number.
* **Table 3: Overall Flagging Summary**. Presents the number of occurrences for each data validation reason by method.
* **Table 4: Field Duplicate Precision – Qualified Data**. Presents the results that are qualified because of FD precision exceedances.
* **Table 5: Holding Time – Qualified Data**. Presents the data qualified because of holding time criteria exceedances.
* **Table 6: Laboratory Duplicate Precision – Qualified Data**. Presents the results that are qualified because of laboratory duplicate precision exceedances.
* **Table 7: Blank Contamination – Qualified Data**. Presents the data qualified because of blank contamination.
* **Table 8: Site Completeness by Analyte – Qualified Data**. Presents the percent completeness by method, analyte, and matrix.

## Overall Flagging Summary

The frequency of field and laboratory QC samples and the associated control criteria are specified in the QAPP. The control criteria were used to evaluate laboratory data. In the following method-specific discussions, only the criteria exceedances that affect data qualification are discussed.

### Method Ferrozine (FERROUS IRON, DISSOLVED)

#### Field Duplicate

Table 4 lists the specific field samples and their associated FD criteria exceedances. There were criteria exceedances in two FD pairs. The associated detected concentrations were flagged “J.” The associated non-detected concentration was flagged “UJ.”

### Method SM2320B (Alkalinity)

#### Holding Time

Table 5 lists the specific field sample and its associated holding time criteria exceedances. The 14-day holding time for water samples was exceeded by 4 days for one sample. The associated non-detect concentrations were flagged “UJ.”

### Method SM2340B\_CALC (Hardness)

#### Field Duplicate

Table 4 lists the specific field sample and the associated FD that exceeded criteria. There was a criteria exceedance in one FD pair. The associated detected concentrations were flagged “J.”

### Method SM2540C (Total Dissolved Solids)

#### Field Duplicate

Table 4 lists the specific field sample and the associated FD that exceeded criteria. There was a criteria exceedance in one FD pair. The associated detected concentrations were flagged “J.”

### Method SM2540D (Total Suspended Solids)

#### Field Duplicate

Table 4 lists the specific field samples and their associated FD that exceeded criteria. There were criteria exceedances in three FD pairs. The associated detected concentrations were flagged “J.”

#### Laboratory Duplicate

Table 6 lists the specific field sample and its associated laboratory duplicate relative percent difference criteria exceedance. There was a criteria exceedance in one sample. The associated detected concentration was flagged “J.”

### Method SM4110B (Chloride, Nitrate, Nitrite, and Sulfate)

#### Field Duplicate

Table 4 lists the specific field samples and their associated FD that exceeded criteria. There was a criteria exceedance in one FD pair. The associated detected concentrations were flagged “J.”

#### Holding Time

Table 5 lists the specific field samples and their associated holding time criteria exceedances. The 3-day nitrate and nitrite holding time for water samples was exceeded by 1 or 2 days for 60 samples. The associated detected concentrations were flagged “J.” The associated non-detect concentrations were flagged “UJ.”

### Method SW6010B (Metals)

#### Field Duplicate

Table 4 lists the specific field samples and their associated FD that exceeded criteria. There was a criteria exceedance in one FD pair. The associated detected concentrations were flagged “J.”

### Method SW6020A (Metals)

#### Field Duplicate

Table 6 lists the specific field samples and their associated FD that exceeded criteria. There was a criteria exceedance in four FD pairs. The associated detected concentrations were flagged “J.”

#### Equipment Blank

Table 7 lists the specific field samples and their associated EB criteria exceedances. Aluminum was detected in three EBs associated with seven sample results, and lead was detected in one EB associated with two sample results. The associated detected concentrations were flagged “U.”

## Overall Assessment

Completeness is calculated and reported for each method, matrix, and analyte combination as outlined in the QAPP. The number of valid (i.e., not qualified with an “R” flag) results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. A summary of the completeness percentages is provided in Table 8.

The QAPP completeness goal is 90 percent, and the overall data completeness is 100 percent.

Of 4,629 normal and FD data points, 54 detected results and 41 non-detected results (approximately 2.1 percent) were qualified as estimated concentrations because of QC exceedances. Blank contamination resulted in nine detected results being flagged as non-detects (approximately 0.2 percent). Evaluation of 100 percent of the chemical data was performed in compliance with the QAPP.

## Data Management

The FMRP sampling activity logs and laboratory analytical data are maintained in a project database or in project files, where appropriate. Data were collected and stored in compliance with the QAPP requirements.

All raw data will be maintained on file in the laboratory and will be available upon request. Complete documentation of sample preparation and analysis and associated QC information will be maintained in a manner that allows easy retrieval if that information is needed. The following minimum documentation was kept for this project:

Original work order, COC forms, and other pertinent documents received with the samples

Records of communications between the laboratory, field personnel, and the client

Corrective action reports

Laboratory data reports

Laboratory logbooks and all raw sample preparation and analytical data

Electronic data and all pertinent standard operating procedures

The minimum field records retained for this project included correspondence, COC forms, field notes, field equipment performance records, maintenance logs, field procedures, corrective action reports, field personnel files, and project‐related reports.

The receipt of electronic and portable document format (PDF) laboratory data were logged into the sample tracking program to determine completeness and contractor turnaround time compliance.

CH2M chemists uploaded these data into the validation program. All data validation was performed by a semi-automated data validation program that uses laboratory PDF report and electronic data simultaneously. All validation flags and discoveries were entered into the validation database and linked directly to each individual data point.

All DQE reports were generated from the validation database. Final validation flags and data points were uploaded to the FMRP EQuIS site.

The data management system is designed to maintain the usability and integrity of the data through a series of procedures and QC checks that began at the field site and carried through to the generation of data for the user. These data include chemical data and field operation information. Both the chemical data and the field operations information were handled in accordance with the guidelines established in the QAPP and the Faro Mine Complex Data Management Plan (CH2M, 2015b).

The laboratory PDF reports are stored in the project files and project local area network hard drive areas in the CH2M office in Redding, California. The original field data forms are stored on the FMRP SharePoint site. Laboratories are required to archive the analytical data, in compliance with the QAPP.

## Works Cited

CH2M Canada Limited (CH2M). 2015a. *Quality Assurance Project Plan.* Final. Prepared for Government of Yukon and Government of Canada as represented by Aboriginal Affairs and Northern Development Canada. September 10.

CH2M Canada Limited (CH2M). 2015b. *Faro Mine Complex Data Management Plan.* Final. Prepared for Government of Yukon and Government of Canada as represented by Aboriginal Affairs and Northern Development Canada. December 1.

DQE Summaries

Tables