

TECHNICAL MEMORANDUM

DATE May 21, 2020 923-1000-006.2020

TO Mr. Jerome Cruz
Washington State Department of Ecology

CC Landsburg PLP Group

FROM Gary L. Zimmerman **EMAIL** gzimmerman@golder.com

APRIL 2020 GROUNDWATER MONITORING RESAMPLING RESULTS, LANDSBURG MINE SITE

Golder Associates Inc. (Golder) notified the Washington State Department of Ecology, in an email dated April 17, 2020, that specific wells at the Landsburg Mine Site were going to be resampled to evaluate the following detections that occurred during the March 2020 quarterly sampling round:

- An initial detection of bis(2-ethylhexyl)phthalate at 34.2 µg/L was reported in the sample collected from well LMW-8. Bis(2-ethylhexyl)phthalate is a known common laboratory contaminant, so Golder requested that the laboratory re-run the analysis using the remaining sample volume. The re-analysis did not detect bis(2-ethylhexyl)phthalate, which confirmed that the initial detection was the result of a laboratory contaminant. The re-analysis occurred past the recommended hold time for the bis(2-ethylhexyl)phthalate analysis, so to further confirm that the initial detection was a false-positive, well LMW-8 was resampled in April 2020 for bis(2-ethylhexyl)phthalate.
- The concentrations of a calcium, cobalt, iron, magnesium, manganese, and nickel detected in the sample from well LMW-14 (dual-purpose south sentinel /cap effectiveness well) were higher during the March 2020 sampling round than detected in LMW-14 during the May 2019 sampling round. Of these metals only iron, manganese and cobalt were detected above their cleanup levels. As you are aware, iron and manganese concentrations are naturally elevated in several of the Site wells in association with the coal mine water and are not designated as contaminants with trigger levels for contingent measures (see Note to Table A-4: *Contingent Groundwater Extraction and Treatment System Plan Triggers*, in the Compliance Monitoring Plan). Cobalt was detected in LMW-14 during the March 2020 sampling round at a concentration of 0.052 mg/L. Cobalt is also a metal that is naturally found in coal. Cobalt was not detected in any of the other wells and has not historically been detected in Site groundwater wells. Cobalt was also not detected in LMW-14 during the May 2019 monitoring round. In January 2020, Ecology added cobalt to the CLARC list of compounds and assigned a groundwater cleanup level of 0.0048 mg/L. Well LMW-14 was resampled in April 2020 for cobalt. Iron and manganese were also analyzed in the resample to evaluate if concentrations of some metals naturally fluctuate in LMW-14. LMW-14 was installed in 2019, and analysis for the priority metals is only required on an annual basis, as such, priority metals analyses for this well are limited to May 2019 and March 2020.

The resampling occurred April 20, 2020. Laboratory data have been received and validated. Complete results of the March 2020 sampling round, including results from the resampling, will be provided to Ecology in the First Quarter 2020 groundwater monitoring report. Below is a discussion of the resampling results.

Bis(2-ethylhexyl)phthalate was not reported above the laboratory detection limit of 0.5 µg/L in LMW-8, which confirms the initial detection was a false-positive, related to laboratory contamination.


Cobalt, iron, and manganese detected during the April resampling of LMW-14 were slightly lower than then concentrations reported in the March sample results. The attached Table 1 present the March 2020 results and the April 2020 resampling results for cobalt, iron, and manganese in LMW-14. For comparison, the LMW-14 May 2019 analytical results for these metals are also included in Table 1. Most pronounced in comparing the May 2019 results to the March/April 2020 results is the increase in iron from 11.1 mg/L to 53.4/24.2 mg/L, respectively. This increase in iron was accompanied by an increase in cobalt from non-detect in May 2019 to detections of 0.052/0.04 mg/L in March/April 2020 sampling. This association between increased dissolved iron and increased detection of cobalt from a coal bedrock groundwater system is expected given of the following geogenic processes:

- Colloidal iron in groundwater: Particles of colloidal iron (hydr)oxides (collectively often referred to as ferrihydrite - $[\text{Fe}(\text{OH})_3]$), when present in a groundwater sample, would be accompanied by other metals that are co-precipitated with or adsorbed onto the (hydr)oxide matrix. The relationship between iron and co-precipitated or adsorbed cobalt in the natural environment has been well established (e.g., Butt et al. 2000; Hem 1985; Nordstrom and Alpers 1999). As such, cobalt in the presence of elevated iron would be expected in groundwater, especially in coal bearing strata. LMW-14 is screened within coal of the Rogers Coal seam.
- Localized variability in groundwater oxidation-reduction (redox) conditions: The presence of cobalt in coal is well known, with an average concentration of 4.5 mg/kg across all U.S. coal sources (Lin et al. 2018). In coal, cobalt typically occurs in association with sulfide minerals such as pyrite $[\text{FeS}_2]$ (e.g., Rose et al. 1979). Cobalt in the coal matrix, when associated with iron (hydr)oxides, is highly sensitive to groundwater redox conditions, with increasing co-precipitation of iron and cobalt with reducing redox conditions. At LMW-14, reducing conditions are evident by the field-measured redox potential (ORP) of groundwater, historically ranging from -38.1 to -86.8 millivolts (mV) and low dissolved oxygen (DO) ranging from 1.4 to 0.08 mg/L at LMW-14. This reducing groundwater, when in contact with natural soils and coal bedrock, would cause the reductive dissolution of iron (hydr)oxides and associated cobalt.


During 2019, trench areas 9, 8, 7, and 6 were backfilled in association with the Site Cleanup Action Plan (CAP) (Ecology 2017). Field parameters including temperature, pH, conductivity, DO, ORP, and turbidity were measured before, during, and subsequent to backfilling of these trench areas. LMW-14 is located at the south end of trench area 6, which is hydrologically upgradient of the former waste disposal area. The average DO measured in LMW-14 prior to completion of trench backfilling was 0.94 mg/L and the average DO measured since completing backfilling of the trench is 0.22 mg/L. The average ORP measured in LMW-14 prior to completion of trench backfilling was -59 mV and the average ORP measured since completing backfilling of the trench is -68 mV. These data indicate that the groundwater in the area of LMW-14 is slightly more reducing following completion of the trench backfilling. As mentioned above, these slight changes in redox conditions can result in increased dissolution of natural iron and cobalt present in the coal bedrock.

Based on these multiple lines of evidence, it is apparent that the cobalt detected in LMW-14 at concentrations exceeding the recently assigned MTCA cleanup level is associated with dissolution of naturally occurring metals present in coal. Similar to arsenic, iron, and manganese at the Site, the cobalt detection in LMW-14 is naturally occurring in association with the coal mine water and is not designated as a contaminant with a trigger level for contingent measures.

Golder Associates Inc.



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Attachment:

Table 1: Analytical Results for Cobalt, Iron, and Manganese detected in LMW-14

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Table 1

Table 1 - Analytical Results for Cobalt, Iron, and Manganese detected in LMW-14

Parameter	2019-05 Result	2020-03 Result	2020-04 Resample Result	MTCA Cleanup Level	Units
Cobalt	0.01 U	0.052	0.04	0.0048	mg/L
Iron	11.1	53.6	24.2	11	mg/L
Manganese	0.79	1.16	0.7	0.75	mg/L

Notes:

U - The analyte was not detected above the level of the method detection limit.

mg/L = milligrams per liter