



COLORADO

Division of Reclamation,
Mining and Safety

Department of Natural Resources

1313 Sherman Street, Room 215
Denver, CO 80203

MEMO

Date: May 30, 2014

From: Tom Kaldenbach, Senior Environmental Protection Specialist *Tom Kaldenbach*

To: File
Boettcher Limestone Quarry, M-1977-348
Summary of meeting held May 28, 2014 regarding groundwater quality

A meeting was held on May 28, 2014 in the Denver office of DRMS for the main purpose of discussing the possibility that the Golder Associates report "Groundwater Characterization Report", dated April 28, 2014, would support a DRMS decision to approve a final bond release of the site, or whether additional investigations are needed prior to DRMS making such a decision. Representing the mine operator were Joel Bolduc of Holcim(US) Inc. and Randy March and Sara Harkins of Golder Associates. Eric Scott and Tom Kaldenbach represented DRMS. The mine operator representatives summarized key findings in the report, including:

- Due to the low hydraulic conductivity of the Niobrara Formation and Codell Sandstone, the calculated traveltime of groundwater flowing from the mine's cement kiln dust (CKD) disposal areas to monitoring wells MW-4 and MW-7 is too large for CKD leachate to have reached the monitoring wells, yet.
- Groundwater in all monitoring wells has near neutral pH with only one metal species (barium) having anomalously high concentrations in two wells, rather than what would be expected for CKD leachate (highly alkaline with high concentrations of multiple metal species).
- In some cases, groundwater samples from wells collected soon after well completion may not be representative of actual groundwater quality because the groundwater near the wellbore has not yet reached equilibrium with groundwater in the surrounding formation.
- Naturally high barium concentrations have been reported in water produced from a Niobrara Formation hydrocarbon well in Wyoming.

DRMS representatives summarized the results of their review of the Golder report as follows:

- Pre-2001 barium concentrations in samples from MW-4 were not elevated, but barium concentrations in that well since 2010 are elevated.
- A gap in monitoring data from 2001 to 2010 for MW-4 hinders interpretation of long-term trends in groundwater quality.
- The near neutral pH and absence of multiple elevated metals in groundwater from MW-4 and MW-7 probably is not consistent with the characteristics expected for CKD leachate.



May 30, 2014

- Additional investigation is needed before the weight of evidence could be considered sufficient to conclude a natural source (for example, barium in the Niobrara Formation) causes the anomalously high barium levels in MW-4 and MW-7, and CKD leachate is not the source.
- USGS Professional Paper 594-L reports barite-rich nodules in the lower Niobrara Formation in South Dakota.
- The Dry CKD disposal area, south of CKD area A2-A, should be included in any future evaluation of groundwater contaminant transport.
- Calculations of Darcy groundwater flow velocity would be improved by excluding impermeable beds from the calculation of transmissivity and hydraulic conductivity.
- Geophysical logs from a nearby oil well, combined with detailed lithologic descriptions of the Codell Sandstone in the Boettcher Limestone Quarry indicate the only significant groundwater flow unit for CKD leachate if it migrated from the quarry probably is an approximate 20-foot thick sandstone interval at the top of the Codell Sandstone. (References: oil well - Rocky Knoll #1, Sec. 2-8N-69W, lithologic descriptions - Master's thesis by Donna Caraway, CSU, 1990, "Depositional System, Facies Relations & Reservoir Characteristics of Codell Sandstone, Colorado")
- The long-term trend of low concentrations of certain constituents warrant their elimination from the Boettcher Limestone Quarry monitoring plan, resulting in the following analyte list for continued quarterly monitoring: alkalinity, chloride, pH, TDS, sulfate, and dissolved barium, boron, calcium, iron, magnesium, manganese, potassium, and sodium. (Although it was not discussed during the meeting, the revised analyte list will require submittal of a Technical Revision to incorporate the change into the mining permit.)

The following investigations were discussed as possible options for helping demonstrate the high barium concentrations in MW-4 and MW-7 have a natural source:

- Groundwater dating with tritium or other methods.
- Determining naturally occurring barium concentrations at the top of the Codell Sandstone in a well that is immediately outside the groundwater flow path of the Boettcher Quarry.
- Compiling characteristics of CKD leachate and groundwater quality at other CKD disposal sites.
- Researching reported occurrences of barium-rich nodules in the lower Niobrara Formation.

cc(via email):

Joel Bolduc, Holcim

Eric Scott, DRMS

Tony Waldron, DRMS