

APPENDIX F

Monitoring Programme for D-Wall Slurry Losses

This document outlines a telemetrically connected monitoring program to be installed prior to diaphragm wall construction, and monitored in real-time during the proposed construction activities through the Ravenscar Group formation.

The monitoring wells are proposed to reach a depth of 60m, commensurate with the depth of the Phase 4 diaphragm walls and the depth of the local groundwater abstraction wells screened in the Cloughton Formation. Based on the Hydrogeological Baseline Report, all of the noted springs of concern at the site are within the Moor Grit, Scarborough and Cloughton Formations within the surface 60 m.

- The proposed program will be comprised of two nests of three, 2-inch diameter PVC standpipe piezometers installed with three screened intervals of up to 10 m in length per nest, within each proposed, 8-inch diameter borehole. The individual monitoring response zones will be separated from one another by a bentonite plug. The length and vertical alignment of the six screened response zones, will be designed specifically for that location and targeted on the Moor Grit, Scarborough and Cloughton aquifer units to provide designed response zones across the full 60 m depth of diaphragm walling
 - The figures showing the wells location and construction are attached in Appendices 1 and 2. The actual locations at which the network of monitoring wells surrounding the diaphragm walls will be installed, will be determined based on available access, so as to not interfere with other construction activities planned to be carried out on site.
- The groundwater monitoring, for the potential migration of bentonite based support slurries (with limited polymer additives), will be carried out using AquaTROLL400 or AquaTROLL600 Multiparameter Probe. It may be possible to use those probes to monitor pH in real time (AquaTROLL 400 or AquaTROLL 600) but this would need to be confirmed, via the proposed testing program, with the cooperation of Bauer previously to the on-site works. The specifications of these two instruments are attached in Appendices 3 and 4.
 - The AquaTROLL400 probe contains six water quality sensors housed in a 1.85-inch OD unit, measuring actual and specific conductivity, salinity, total dissolved solids, resistivity, density, dissolved oxygen, ORP, pH, temperature, water level and water pressure at high frequency intervals.
 - The AquaTROLL600 probe, also housed in a 1.85-inch OD unit, can be configured to measure temperature, conductivity, turbidity, optical RDO, pH/ORP, vented or non-vented level water level.

The proposed configuration, including near-field and far-field (sentinel) monitoring locations, at approximately 50m distance from the diaphragm wall and in proximity to the property line, respectively, will allow for continuous monitoring during construction activities. However, to prove the adequacy of the proposed system, some preliminary confirmatory testing will be necessary. The proposed testing approach involves the following:

- Rental of an AquaTROLL400/600 Multiparameter Probe from In-Solution and shipment of the probe and associated software to a facility to perform the testing.
- Batching of the full suite of proposed support slurries, and measuring (and videoing) the increase in multiple parameters by:
 - a. Filling a minimum of 20 L container with clean water.
 - b. Starting the video recorder
 - c. Immersing the AquaTROLL400/600 into the water.

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- d. Slowly pouring batched mud into the pail of clean water, and monitoring parameter increases with time and increasing “concentration” of support slurry
 - e. Stopping the video recorder
 - f. Removing, cleaning and re-calibrating the probes (as necessary)
 - g. Repeating Steps (a) to (f) for each, alternative mix design incorporating various, proposed admixtures/additives
- In examining the TDS and MSDS information provided by Bauer, and based on the water chemistry information presented in Sections 7.5.3 (Moor Grit), 7.6.3 (Scarborough), 7.7.3 (Cloughton) and 7.8.3 (Saltwick) of the FWS Consultants Ltd., Doc. No. 1433MineOC15C/September 2014, “Hydrogeological Baseline Report for the Dove’s Nest Site, North Yorkshire, we believe that it should be possible to detect increases in:
 - pH and electrical conductivity; and possibly
 - total dissolved solids, density, resistivity and/or salinity.
 - The most sensitive parameter to each mix design will be identified. The entire suite of mix testing repeated, on-site, using sampled groundwater from the developed monitoring wells, prior to commencing diaphragm wall cutting activities.
 - Additionally, while carrying out the above mix testing program, it would also be possible to determine dynamic viscosity and yield stress values using a coaxial viscometer for calculations of potential penetration distances in various aperture sizes away from the diaphragm wall.

Appendices:

Appendix 1: 40-AMC-WS-CI-DR-0001 Monitoring Programme

Appendix 2: 40-AMC-WS-CI-DR-0002 Detail of Monitoring Wells

Appendix 3: Aqua TROLL® 400 Multiparameter Probe Specifications

Appendix 4: Aqua TROLL® 600 Multiparameter Sonde Specifications

Appendix 5: Flowchart – Emergency Preparedness Plan for Monitoring Bentonite Losses