FWS Environmental & Geological Consultants

SIRIUS MINERALS PLC
NORTH YORKSHIRE POLYHALITE PROJECT

REPORT	HYDROGEOLOGICAL ASSESSMENT OF CHANGES TO THE VENTILATION STRUCTURE
SITE	VENTILATION SYSTEM WORKS AT WOODSMITH MINE, NORTH YORKSHIRE
DOCUMENT NUMBER	40-FWS-WS-70-PA-AS-0001

1433DevOR389Rev4/August 2018

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REPORT TITLE	HYDROGEOLOGICAL ASSESSMENT OF CHANGES TO THE VENTILATION STRUCTURE	
REPORT REFERENCE	1433DevOR389	
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HYDROGEOLOGICAL ASSESSMENT OF CHANGES TO THE VENTILATION STRUCTURE

1 INTRODUCTION

1.1 General Background

Hydrogeological Risk Assessment for the mine site's original Planning Application included evaluation of; a ventilation shaft with a fan building, housing fans within 10m deep basement structures and a 50m deep ventilation shaft with a horizontal development at 92m AOD to link the Service Shaft (Ref 1 & 2). Subsequent modifications in 2017 to the Service Shaft's headframe chamber enabled the ventilation shaft to be designed out, for which the changes to the Hydrogeological Risk Assessment were documented in the Section 73 submission (Ref 3).

This document summarises the modifications that are proposed to the substructures and earthworks elements associated with the ventilation system and identifies the impact these design changes have had on the hydrogeological assessment and mitigation measures proposed.

1.2 Objectives

The purpose of this document is to:-

- Identify the design changes to the substructures, construction methodology and earthworks that have now been incorporated into the proposed mine site development.
- Identify which hydrogeological effects and impacts have the potential to be affected by the design changes.
- Assess the magnitude of risk to hydrogeological receptors from the proposed design changes to the development.
- To identify, where appropriate, any additional hydrogeological mitigation measures that may be warranted as part of the proposed design changes to the development.

2 DESIGN CHANGES TO THE VENTILATION STRUCTURE

2.1 Construction

The design change options to the surface layout and earthworks that have been incorporated into the mine surface development and the design changes to the substructures are illustrated in the schematic geological sections, presented in Drawing 1433OD342 and 343 Appendix 1.

A summary of the principal modifications to the subsurface ventilation structures that impact on the hydrogeological assessment are summarised in Table 1.

TABLE 1 SUMMARY OF DESIGN CHANGES

September 2014 Design (Ref 1)		February 2015 (Ref. 2)		July 2017 (Ref. 3)		Current Design April 2018	
Dimensions	**Groundwater Mitigation Measures**	**Dimensions**	**Groundwater Mitigation Measures**	**Dimensions**	**Groundwater Mitigation Measures**	**Dimensions**	**Groundwater Mitigation Measures**
Fan House Substructure Chamber 200.7 to 190.2 m AOD Dimensions 62m x 28m.	Pre-grout wall 5 to 10m wide to ~192m AOD Scarborough.	No change		The requirement for a fan house basement, an independent ventilation shaft and a horizontal development was designed out by adopting a wider and deeper fore shaft arrangement to the Service Shaft	None	Fan House Substructure Chamber 203.2 to between 193.2 and 188 m AOD. Dimensions between 52 and 73 m x 56m.	Secant piled wall with a pre-grout 5m deep low permeable zone at the basement floor level.
Intake Shaft 190.2 to 140.1m AOD with an external diameter of 10m.	Pre-grout wall 5 to 10m wide.	Intake Shaft 190.2 to 100.1m AOD with an external diameter of 11m.	Pre-grout wall 5 to 10m wide down to the Whitby Mudstone.			Intake Shaft 188m AOD to 78m AOD with an external diameter of 9m.	Shaft construction is expected to utilise Vertical Shaft Sinking Machine (VSM).
Intake Ventilation Horizontal Development 149.6 to 140.1m AOD length 100m width 10m.	Pre-grout wall 5 to 10m wide.	Intake Ventilation Horizontal Development 100.2 to 92.3m AOD length 110m width 9.5m.	No design change proposed.			Intake Ventilation Horizontal Development 78m AOD length 100 - 135m width 7m.	Development within the Whitby Mudstone. Pre-grout only where necessary.

2.2 Operation

As part of the design amendments to the ventilation structures, no changes to the operation of the minesite groundwater management measures, included for in the Section 73 submission (Ref 3), are proposed.

2.3 Decommissioning

As part of the design amendments to the scheme, no changes to decommissioning of the minesite groundwater management measures, included for at the time of the Planning Application and the Section 73 submission (Ref 1 and 3), are proposed.

3 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 Changes to Conceptual Model and Groundwater Hazards

The proposed changes to the mine surface development include amendments to the mine substructures and earthworks that will penetrate the superficial deposits into the bedrock strata and will interact with the groundwater system. The principal changes to the hydrogeological conceptual model submitted with the Planning Application (Ref 1) and with the subsequent Section 73 submission (Ref 3) are summarised below:-

Ventilation Substructures

The basement fan house, to a depth of between 10m to 15m (193 to 188 mAOD) below shaft platform level (bspl) (Drawing 1433DevOR343), is to be constructed with a secant piled wall and pre-grouting of a ~5m vertical zone below the basement floor to restrict groundwater ingress through the base of the excavation from the Scarborough aquifer. This piled wall and pre-grouting will negate the requirement for dewatering and, as such, groundwater lowering around the excavation will not be required during basement construction. As only minor groundwater ingress should arise during excavation, water control during construction of the basement walls and floor will be maintained by pumping from sumps, where necessary. Such localised sump pumping will have no significant effect on groundwater levels in the Moor Grit or Scarborough aquifers outside of the pilled wall. The effects on groundwater conditions of such excavations within piled wall and grouted floor solutions was previously assessed, in terms of its potential hydrogeological impacts, within the original planning application (Ref 1). This confirmed that this construction process will have no significant physical or chemical impacts on groundwater in the near surface aquifers in this area of the site.

Following completion of the basement structure, the majority of the ventilation shaft is to be constructed using a VSM system from the Scarborough Formation down to the Whitby Mudstone (Drawing 1433DevOR342). The shaft bottom and horizontal development is to be constructed by drill and blast methods. As detailed in the Hydrogeological Risk Assessment for the Phase 4a MTS Shaft (Ref 5), this form of shaft construction will have no significant physical or chemical impacts on groundwater in the near surface aquifers.

On completion of the shaft to approximately 78m AOD (i.e. approximately 15m below the top of the Whitby Mudstone aquiclude) a horizontal connection is to be constructed through the mudstone between the ventilation and service shafts (Drawing 1433DevOR342). As detailed in the Hydrogeological Risk Assessment for the original planning application (Ref 2) construction of this horizontal development through the Whitby Mudstone will have no significant physical or chemical impacts on groundwater in the near surface aquifers in this area of the site.

Earthworks

The proposed design amendment to the ventilation shaft will generate an additional 50,000m^3 of rock arisings to be placed within the extractive materials management facilities onsite. This volume of material will be accommodated for within the existing footprint to the landscape mounds and, as such, will present no additional physical impact on groundwater recharge or chemical impact on water quality to the Moor Grit and Scarborough aquifers, above the conditions detailed in the Section 73 submission (Ref 3).

3.2 Hydrogeological Receptors

As detailed in the Hydrogeological Risk Assessments for the construction conditions (Ref 4 and 5) and cumulative long term impacts of the minesite development (Ref 3), the principal sensitive hydrogeological receptors in close proximity to the ventilation structure comprise the high sensitivity Spring Flush ecological system, the high sensitivity Moorside and Soulsgrave Farm springs and the medium sensitivity Moor Grit and Scarborough aquifers.

3.3 Hydrogeological Risk Assessment

The proposed construction methodology for the fan basement incorporates secant piled walls and pre-grouting. As determined previously by the Hydrogeological Risk Assessment of the Minesite Development at Dove's Nest Site, North Yorkshire (Ref 1), this form of fan basement construction will have only a negligible physical and chemical impact on groundwater in the near surface aquifers.

The proposed ventilation shaft is to be constructed utilising VSM technology. As determined previously by the Hydrogeological Risk Assessment (NYMNPAn 46- Phase 4a) (Ref 5) this form of shaft construction will have only a negligible physical and chemical impact on groundwater in the near surface aquifers.

The proposed horizontal development is to be constructed within the Whitby Mudstone between the Service Shaft and the Ventilation Shaft. As determined previously by the Hydrogeological Assessment of Changes to the York Potash Planning Submission for the Mine Surface Development Site and Mineral Transport System (Ref 2), this form of construction below the Ravenscar Aquifers will have a negligible physical and chemical impact on groundwater in the near surface aquifers.

4 REQUIREMENT FOR ADDITIONAL MITIGATION MEASURES

As determined from the above hydrogeological risk assessment, the two options for the proposed amended design to the fan house development and ventilation shaft are both expected to present no significant adverse hydrogeological impacts on the environment. As such, the mitigation measures currently allowed for in the development design, as detailed in Section 4 of the Hydrogeological Risk Assessment Report for the Section 73 Works (Ref 3), are considered appropriate and no additional mitigation measures will be warranted.

Subject to the final design of the construction methodology, detailed qualitative and, where necessary, quantitative modelling will be undertaken for this Phase of construction prior to commencement, to confirm the groundwater management systems to be employed to facilitate these works.

R IZATT-LOWRY
DIRECTOR

5 REFERENCES

1 FWS Consultants Ltd, September 2014. Hydrogeological Risk Assessment of the Minesite Development at Dove's Nest Site, North Yorkshire. Report 1433MineOR24E.

2 FWS Consultants Ltd, Hydrogeological Risk Assessment of the Changes to the York Potash Planning Submission for the Mine Surface Development Site and Mineral Transport System. Report 1433MineOR44Rev 3 February 2015.

3 FWS Consultants Ltd, 2017 Hydrogeological Risk Assessment Section 73 Works At Woodsmith Mine, North Yorkshire (1433OR226).

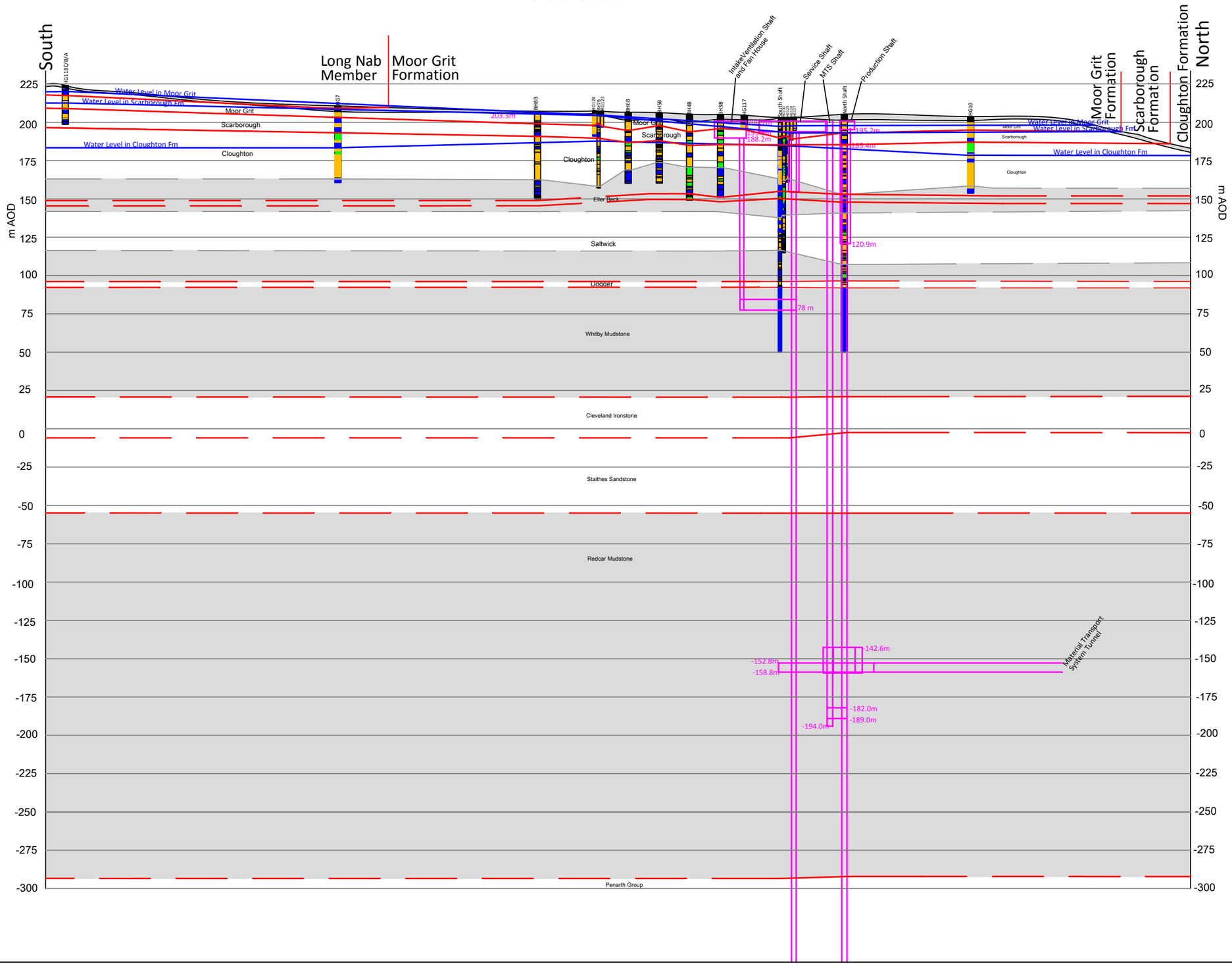
4 FWS Consultants Ltd, 2017 Hydrogeological Risk Assessment for the Phase 4 Works at Doves Nest Farm Minesite, North Yorkshire (1433OR205).

5 Sirius Minerals Plc NYMNPA 94 - Construction Method Statement (Phase 4a) Document No. 40-SMP-WS-1000-CN-MS-00001.

APPENDIX 1

FWS DRAWINGS

Mine Site N-S Cross Section



Vertical scale 3x Horizontal

Key

- Topsoil
- Sand
- Clay
- Mudstone
- Sandstone
- Siltstone
- Interbedded Sandstone and Siltstone
- Interbedded Mudstone and Siltstone
- Interbedded Mudstone and Sandstone
- Core loss

DRAWING NUMBER 1433DevOD342	**JOB TITLE** NORTH YORKSHIRE POLYHALITE PROJECT HYDROGEOLOGICAL STUDY	**CLIENT** SIIRUS MINERALS	
DRAWING TITLE SCHEMATIC GEOLOGICAL SECTION THROUGH VENTILATION SHAFT		**SCALE** Horizontal 1: 8000@A3 Horizontal 1: 4000@A1 Vertical =3x Horizontal	**DRAWN BY** J DANN **DATE** April 2018

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A

A'

215.0

210.0

205.0

200.0

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180.0

175.0

170.0

165.0

160.0

155.0

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140.0

135.0

130.0

BUND A

55.00 m

9.00 m

VENTILATION SHAFT

SUPERFICIAL DEPOSITS (PREDOMINANTLY CLAY)

MAXIMUM GROUNDWATER LEVEL MOOR GRIT

AVERAGE GROUNDWATER LEVEL SCARBOROUGH

MOOR GRIT

FAN BASEMENT STRUCTURE

188.20 mAOD

SCARBOROUGH FORMATION

AVERAGE GROUNDWATER LEVEL CLOUGHTON

CLOUGHTON FORMATION

ELLER BECK FORMATION

AVERAGE GROUNDWATER LEVEL SALTWICK

NOTES / KEY

PHASE 2&3 WORKS

GEOMEMBRANE

LINED DRAINAGE DITCH

GEOLOGY

EXISTING GRANULAR PLATFORM CONSTRUCTION

NEW GRANULAR PLATFORM CONSTRUCTION

COHESIVE SUPERFICIAL DEPOSITS

MOOR GRIT

SCARBOROUGH FORMATION

CLOUGHTON FORMATION

ELLER BECK

SALTWICK FORMATION

DOGGER FORMATION

WHITBY MUDSTONE FORMATION

DRAWING TITLE
SCHEMATIC SECTION OF THE FAN BASEMENT AND VENTILATION SHAFT

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433Dev

DRAWN BY
JD

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