LICHFIELDS

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NYMNPA
21/03/2019

Date: 21 March 2019
Our ref: 50303/04/HS/JCx/16877357v2
Your ref: NYM/2017/0505/MEIA

Dear Rob

North York Moors: Woodsmith Mine - Application to Partially Discharge Conditions 4, 18, 34, 45, 46, 47, 52, 57, 60, 68, 70, 71, 73, 76, 79, 81, 87, 91, 92, 93, 94, 95 & 97 of Planning Permission NYM/2017/0505/MEIA

On behalf of our client, Sirius Minerals plc ("Sirius Minerals"), we are pleased to submit this application for limited and partial approval of Planning Conditions 4, 18, 34, 45, 46, 47, 52, 57, 60, 68, 70, 71, 73, 76, 79, 81, 87, 91, 92, 93, 94, 95 & 97 of Planning Permission NYM/2017/0505/MEIA.

The Project will be delivered in a series of Phases. This application relates solely to the Phase 10 works at the Woodsmith Mine.

Background

On 19 October 2015, the NYMNPA granted planning permission for the "Winning and working of polyhalite by underground methods including the construction of a minehead at Dove's Nest Farm involving access, maintenance and ventilation shafts, the landforming of associated spoil, the construction of buildings, access roads, car parking and helicopter landing site, attenuation ponds, landscaping, restoration and aftercare and associated works. In addition, the construction of an underground tunnel between Doves Nest Farm and land at Wilton that links to the mine below ground, comprising 1 no. shaft at Doves Nest Farm, 3 no. intermediate access shaft sites, each with associated landforming of associated spoil, the construction of buildings, access roads and car parking, landscaping, restoration and aftercare, and the construction of a tunnel portal at Wilton comprising buildings, landforming of spoil and associated works" (Council Reference NYM/2014/0676/MEIA).

NYM/2014/0676/MEIA was approved subject to 95 planning conditions and a Section 106 Agreement.

On 6 February 2017, the NYMNPA granted planning permission for the *"Variation of Condition 5 of planning permission NYM/2014/0676/MEIA to allow minor material amendments relating to that part of the development at the Woodsmith Mine site (formerly known as Doves Nest Farm and Haxby Plantation), including; re-design of foreshafts and shaft construction methodology, changes to building layout and shaft access arrangements, revisions to construction and operational shaft platform levels, revisions to location and layout of surface water attenuation ponds, revisions to groundwater management*

arrangements and amendments to internal access arrangements" (Council Reference NYM/2017/0505/MEIA).

The amended scheme (NYM/2017/0505/MEIA) was approved subject to 98 planning conditions and a deed of variation to the originally approved Section 106 Agreement.

Phase 10 Works

Phase 10 covers off the following proposed works at the Woodsmith Mine:

- Excavation of Service Shaft via a mechanical extraction method;
- Installation of grout shed and air compressor shed;
- Installation of drying rooms adjacent to the existing welfare facility;
- Erection of temporary storage unit for winder equipment; and
- Installation of oxygen tank and cabin.

Planning Conditions 52, 57, 70, 73 and 95

Sirius Minerals is committed to implementing the mitigation, monitoring and reporting measures developed in previous phases, throughout Phase 10 for the following conditions:

- NYM-52 Protected Species Management Plans;
- NYM-57 Landscape and Ecological Management Plan;
- NYM-70 Arboricultural Method Statement;
- NYM-73 Woodland Management Plan; and
- NYM-95 Archaeological Written Scheme of Investigation;

Sirius Minerals is not intending to re-submit the documentation for the above conditions as they have already been approved and implemented in full for the duration of previous phases and will continue to be implemented insofar as they relate to Phase 10.

Partial Discharge

Sirius Minerals acknowledges that limited and partial approval of Planning Conditions 4, 18, 34, 45, 46, 47, 52, 57, 60, 68, 70, 71, 73, 76, 79, 81, 87, 91, 92, 93, 94, 95 & 97 when given, does not constitute permission to undertake works other than those described, including any works at Lady Cross Plantation, and that such works remain subject to the approval of other conditions.

This approach has been discussed and agreed with your Planning Team and is consistent with the approach taken on previous phases of the Project.

Application Submission

The application was submitted via the planning portal on 20 March 2019 (reference PP-07719856) and comprises the following documentation:

- Completed application form;
- Application drawings – Please see Appendix 1;
- Supporting Documents – Please see Appendix 1.

The requisite planning application fee of £116 has been paid online by credit card.

Conclusion

We trust that this application provides you with the necessary information to be able to partially discharge the above conditions to cover Phase 10 works at Woodsmith Mine. However, should you require any further information, please do not hesitate to contact me.

Yours sincerely

James Cox
Associate Director

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Appendix 1 : Supporting Documents

Table 1: List of Supporting Documents

Condition No	Description	Document Name / Number	Further Details
N/A	N/A	Listed Plans	40-ARI-WS-7100-CI-18-01038 - Woodsmith Mine Construction Phase 10 Masterplan 40-ARI-WS-7100-CI-18-01039 - Woodsmith Mine Construction Phase 10 Planning Phases Comparison General Arrangement 40-ARI-WS-7100-CI-18-01040 – Woodsmith Mine Construction Phase 10 Drainage General Arrangement
4	Phasing Plan	40-ARI-WS-7100-CI-18-01039 - Woodsmith Mine Construction Phase 10 Planning Phases Comparison General Arrangement	40-ARI-WS-7100-CI-18-01038 - Woodsmith Mine Construction Phase 10 Masterplan
18	Noise & Vibration	Phase 5 Woodsmith Mine Noise and Vibration Management Plan – 40-RHD-WS-70-EN-PL-0027	Predictions of noise due to mechanical excavation of the Service Shaft were undertaken for the Phase 5 Noise & Vibration Management Plan. The predictions included for the use of excavator mounted rock breakers, excavators, cranes and associated movement of excavated material. These activities were undertaken within the early stages of the Service Shaft sinking and were therefore close to the surface. The methodology for Phase 10 includes the use of an excavator in place of the previously approved Vertical Shaft Sinking Machine ("VSM") methodology. The excavation will generate noise levels no higher than those described within the Phase 5 NVMP. Whilst the controls and mitigation measures described within the Phase 5 NVMP would continue to apply to Phase 10, the acoustic barrier described at para. 5.3.4 would no longer be required due to the increased depth at which the excavation activities would occur.

			It is considered that the activities within Phase 10 will, therefore, not give rise to breaches of the planning condition limits.
34	Construction Traffic Management Plan	Phase 7 Woodsmith Mine Construction Traffic Management Plan 40-RHD-WS-70-CI-PL-0011	To manage the potential impacts of construction traffic associated with the Phase 7 works at Woodsmith Mine, a Construction Traffic Management Plan was submitted to North York Moors National Park Authority and North Yorkshire County Council (local highway authority). The Phase 10 works will not require additional numbers of employee above those levels previous forecast for Phase 7 and demand for deliveries will continue to be accommodated within the daily targets set out in the Phase 7 CTMP. The mobilisation of the Phase 10 Contractor will result in additional abnormal indivisible load (AIL) deliveries, but these are expected to be fewer than 5 over the duration of the phase of work. The routing and timing of these AIL deliveries will be subject to separate agreement with the local highway authorities and police through the established Electronic Service Delivery for Abnormal Loads system (ESDAL) process. The routing, restrictions, targets, measures and monitoring processes contained within the Phase 7 CTMP continue to apply to Phase 10 and no update to the Phase 7 CTMP is considered necessary.
45	Recharge Trench	Phase 10 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0010	N/A
46	GW / SW Monitoring Scheme	Phase 10 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-	Refer to Section 8 of the Phase 6 Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0007 Phase 4a Works at Woodsmith Mine, North Yorkshire Construction and Operation

		WM-RA-0010	Phase Ground and Surface Water Monitoring Scheme – 40-FWS-WS-70-CI-PL-0005 Phase 4 Works at Woodsmith Mine, North Yorkshire Construction and Operation Phase Ground and Surface Water Monitoring Scheme – 40-FWS-WS-70-WM-PL-0008
46	Hydrogeological Risk Assessment	Phase 10 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0010	N/A
46	Remedial Action Plan	Phase 10 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0010	Phase 9 Remedial Action Plan (reference 40-FWS-WS-70-WM-PL-0021) Phase 4a Remedial Action Plan (reference 40-FWS-WS-70-PL-0013) Phase 4 Remedial Action Plan (reference 40-FWS-70-PL-009)
47	Groundwater Management Scheme	Phase 7 Works at Woodsmith Mine, North Yorkshire – Groundwater Management Scheme – 40-FWS-WS-70-WM-PL-0018	Grouting for the Phase 10 works will be undertaken using the same principles set out in Section 2.5 of the Phase 7 Groundwater Management Scheme (Ref. 20); please refer to sections relating to Grout Injection Management, Management of Drilling Arisings, Validation of Grouting, Specification of Grout Mix and Operational Management During Grouting. During excavation, groundwater management, including pumping from the sump and monitoring of water levels within the vibrating wire piezometers will be undertaken as detailed in section 2.3.2 of the Phase 7 Groundwater Management Scheme. In accordance with Section 2.3.3 of the Phase 7 Groundwater Management Scheme, the Contractor will be responsible for maintaining daily records of the groundwater levels and flow rates discharged from the sump pumping,

52	Protected Species Management Plan	Refer to CEMP (Condition 93)	Whilst the previously approved Protected Species Management Plans remain applicable to Phase 10, Sirius Minerals is in the process of producing an updated Protected Species Management Plan in respect of badgers that will be submitted under separate cover.
57	Landscape & Ecological Management Plan	Refer to CEMP (Condition 93)	Phase 3 Landscape and Ecological Management Plan (40-RHD-WS-70-EN-PL-0008)
60	Surface Water Drainage	Woodsmith Mine – Phase 7 Works – NYMNPA 60 and 79 Surface Water Drainage Scheme – 40-ARI-WS-7100-CI-RP-01001	There are no changes to the surface water drainage strategy for Phase 10, therefore the Surface Water Drainage Scheme report submitted for Phase 7 continues to apply.
68	Temporary Structures	Refer to Construction Method Statement (Condition 94)	Listed plans.
70	Arboricultural Method Statement	Refer to CEMP (Condition 93)	N/A
71	Hard & Soft Landscaping	40-ARI-WS-7100-CI-18-01041 - Woodsmith Mine Construction Phase 10 Hard and Soft Landscaping Plan	N/A
73	Woodland Management Plan	N/A	No tree removal is proposed as part of Phase 10 and therefore no specific management measures are included within this phase.
76	Soil Management Plan	Refer to CEMP (Condition 93)	N/A
79	Surface Water Drainage	Woodsmith Mine – Phase 7 Works – NYMNPA 60 and 79 Surface Water Drainage Scheme – 40-ARI-WS-7100-CI-RP-01001	There are no changes to surface water drainage strategy for Phase 10, therefore the Surface Water Drainage Scheme report submitted for Phase 7 continues to apply.
81	Waste Water Management Scheme	Woodsmith Mine – Phase 7 Works – NYMNPA 81 Non-	Groundwater ingress via the sides of the excavation will be limited through the use of a temporary concrete liner and through

		Domestic Wastewater Management Scheme – 40-ARI-WS-7100-CI-RP-01002	grouting of the Saltwick formation. Any ingress of groundwater will be pumped to the surface and infiltrated in the lagoon constructed, but not currently used, for the reinjection borehole. The lagoon will not be lined at this stage to allow the water to re-infiltrate.
87	Reinjection Borehole	Woodsmith Mine – Phase 5 Works – NYMNPA 45 and 87 Deep Reinjection Borehole, Recharge Trench and Groundwater Programmes – 40-ARI-WS-71-PA-RP-1060	The programme that was approved at Phase 5 remains applicable for Phase 10.
91	Emissions	Phase 7 – Woodsmith Mine Emissions to Atmosphere – NYMNPA - 91: 40-RHD-WS-70-EN-RP-0005	The activities associated with Phase 10 will not require any additional power generation above that considered in the Phase 7 Emissions to Atmosphere report. The conclusions of the Phase 7 emissions to atmosphere report are therefore applicable to Phase 10.
92	CVPMP	Phase 7 – Woodsmith Mine Construction Vehicle and Plant Management Plan – 40-RHD-WS-70-CI-PL-0012	A Construction Vehicle and Plant Management Plan (CVPMP) was submitted to discharge condition NYMNPA-92 as part of the Phase 7 Works at Woodsmith Mine. The plant required for the Phase 10 Works will be similar in both number and nature to that considered during Phase 7, therefore particulate emissions from plant used during Phase 10 are expected to be of a similar magnitude to that presented in the Phase 7 CVPMP. Emissions from vehicle movements were considered in the Phase 7 CVPMP, and were based on the maximum permissible light and heavy goods vehicle movements that can travel to and from Woodsmith Mine. Traffic movements associated with the Phase 10 Works will be accommodated within these limits and therefore consideration of additional traffic movements is not required.

			The Phase 7 CVPMP is therefore considered to be applicable for Phase 10.
93	CEMP	Phase 7 – Woodsmith Mine Construction Environmental Management Plan – 40-RHD-WS-70-EN-PL-0029 Phase 5 – Woodsmith Mine Construction Environmental Management Plan – 40-CAR-WS-8300-PA-MS-00001	The excavation of the Service Shaft in Phase 10 will utilise similar methodologies to the grouting procedure and Service Shaft foreshaft excavation as specified in the Phase 5 CEMP. Any relevant control methods for additional chemicals and the management of the excavated material will be carried out in accordance with the procedures detailed in the Phase 5 CEMP. Any water pumped from the excavations will be managed as detailed in the Phase 7 CEMP. There are not anticipated to be any additional control methods required for the installation and erection of structures on site above those previously considered in earlier Phases of Works. The impact of any internal lighting associated with the upper floors of the proposed drying rooms will be mitigated by the provision of shutters at the windows which will be used during the hours of darkness. Any impact of Works to be carried out in Phase 10 will therefore be appropriately prevented or controlled to acceptable levels.
94	Construction Method Statement	Phase 10 Construction Method Statement – NYMNPA 94 – 40-SMP-WS-7100-PA-AD-00008	Phase 7 Construction Method Statement - 40-SMP-WS-7100-PA-MS-00003
95	Written Scheme of Investigation	Refer to CEMP (Condition 93)	N/A
97	Internal Diameters	N/A	Refer to Phase 7 Construction Method Statement - 40-SMP-WS-7100-PA-MS-00003

* As agreed, documents from previous phases (where they remain unchanged in relation to Phase 10) have not been resubmitted with this application

NYMNPA

21/03/2019

Project Title / Facility Name:

North Yorkshire Polyhalite Project

Document Title:

CONTRUCTION METHOD STATEMENT (NYMNPA 94 - PHASE 10) (CMS)

Document Review Status

- ☐ 1. Reviewed – Accepted – Work May Proceed
- ☐ 2. Reviewed – Accepted As Noted, Work May Proceed, Revise & Resubmit
- ☐ 3. Reviewed – Work May Not Proceed, Revise & Resubmit
- ☐ 4. For information only

Rev.	Revision Date (dd mmm yyyy)	Reason For Issue		Prepared by	Verified by	Approved by
0	21-Mar-2019	Information	IFI	HillVict	HickStev	CoxJam
C	21-Mar-2019	Review	IFR	HillVict		
B	20-Mar-2019	Review	IFR	HillVict		
A	18-Mar-2019	Review	IFR	HillVict		

Document ID:

40-SMP-WS-7100-PA-MS-00008

Sustaining the future.

SIRIUS MINERALS PLC

Woodsmith Mine Phase 10 Construction Method Statement (CMS)

Document Number: 40-SMP-WS-7100-PA-MS-00008

Document Verification				
Revision	**Date Created**	**Checked by**	**Approved by**	**Reason for Issue**
0	21/03/2019	S. Hickey	J. Cox	Issued for Information

Woodsmith Mine Phase 10 Construction Method Statement (CMS)

Contents

Woodsmith Mine Phase 10 Construction Method Statement (CMS)

1 Introduction

1.1 The Purpose of this document

This document details the Construction Method Statement (CMS) for Phase 10 Site Works at Woodsmith Mine. This CMS is required to partially discharge condition 94 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA (as subsequently varied by NYM/2017/0505/MEIA), and has been prepared in accordance with good practice.

This CMS details the works to be undertaken during the Phase 10 Site Works at Woodsmith Mine only. Further construction methods statements will be submitted to discharge condition NYMNPA 94 for subsequent phases. The CMS will remain a live document, being reviewed, and updated as required.

1.2 Compliance with Condition NYMNPA 94

The wording of planning condition 94, and where the necessary material has been provided within the report, is set out in Table 1.1.

Table 1.1 : Details of NYMNPA Planning Condition 94

NYMNPA Condition 94	Compliance with Condition 94
Prior to the commencement of each phase of the development at Dove's Nest Farm or Lady Cross Plantation in accordance with the approved Phasing Plan, a Construction Method Statement will be submitted for that phase, and approved in writing by the MPA, in consultation with the appropriate Highways Authority. Each approved Statement will be adhered to throughout the construction period. The Statements will provide for:	This CMS is provided for Phase 10 Works at Woodsmith Mine only. Other phases will have bespoke CMS documents.
(i) The parking of vehicles of site operatives and visitors clear of the highways;	Section 2.5
(ii) Loading and unloading of plant and materials;	Section 2.7
(iii) Storage of plant and materials used in constructing the development;	Section 2.8
(iv) Erection and maintenance of security fencing;	This type of work is not required in Phase 10.
(v) Wheel washing facilities;	Section 2.9
(vi) An outline construction method for sub-surface works including adherence to the 'rack and pillar' method of mining described in the SEI (14th February 2015) and the SRK Subsidence Memorandum (15th May 2013);	This type of work is not required in Phase 10.
(vii) Buildings and structures associated with the mine and tunnel shafts;	Section 3
(viii) Welfare/office building and security gatehouse;	This type of work is not required in Phase 10.
(ix) Screening bunds;	This type of work is not required in Phase 10.

NYMNPA Condition 94	Compliance with Condition 94
(x) Hardstandings;	Section 3
(xi) Shuttle Bus terminal;	Section 2.5
(xii) Park-and-Ride layby;	Section 2.5
(xiii) Emergency helipad;	This type of work is not required in Phase 10.
(xiv) Lighting columns;	Section 2.11
(xv) Internal access and haul roads;	This type of work is not required in Phase 10.
(xvi) Domestic wastewater (foul sewage) treatment plant;	This type of work is not required in Phase 10.
(xvii) Non-domestic wastewater treatment plant and settlement tanks;	This type of work is not required in Phase 10.
(xviii) Surface water attenuation ponds, settlement ponds, swales and wetland areas;	This type of work is not required in Phase 10.
(xix) Temporary spoil and Polyhalite storage areas;	Refer to Sections 3.7 of the Phase 7 Construction Method Statement, Ref: 40-SMP-WS-7100-PA-MS-00003
(xx) Road widening and provision of right hand turn areas;	This type of work is not required in Phase 10.
(xxi) Removal of any temporary structures; and	This type of work is not required in Phase 10.
(xxii) Formation spoil mounds and the establishment of vegetation on them	Refer to Sections 3.7 of the Phase 7 Construction Method Statement, Ref: 40-SMP-WS-7100-PA-MS-00003
The CMS will contain a construction timetable and order of works noting any construction dependencies, refer to any inherent mitigation measures required to address adverse impacts identified in the EIA and cross refer to the CEMP in relation to any additional avoidance or mitigation measures	The CMS relates to the Phase 10 Works at Woodsmith Mine only and all required mitigation has been included in a Construction Environmental Management Plan (CEMP), which is required to discharge condition 93.

Table 2.2 : Details of NYMNPA Planning Condition 97

NYMNPA Condition 97	Compliance with Condition 97
Prior to the commencement of shaft sinking, details of final expected internal diameters for the Production Shaft, Service Shaft and Mineral Transport System Shaft shall be submitted to the MPA for written approval. Such details shall be accompanied by information demonstrating the expected total volume and tonnage of spoil and a breakdown of the volume and tonnage of the principle types of spoil expected to be generated during the sinking of each shaft and include updated information on the intended arrangements for the management of the spoil in accordance with the requirements of this permission.	Refer to Sections 3.2 and 3.4 of the Phase 7 Construction Method Statement, Ref: 40-SMP-WS-7100-PA-MS-00003

2 Project Overview and Description of the Works

2.1 Project overview

Sirius Minerals Plc is developing a new mine surface development south of Whitby in North Yorkshire to extract polyhalite and transfer it to a processing and port facility on Teesside (the port facility is covered by a separate consenting regime). A full and detailed description of the project can be found in the Environmental Statement. This CMS relates to the Phase 10 Works at Woodsmith Mine only. This document builds on the CMS documents produced for Phases 1-9 and further versions of this live CMS will be produced for subsequent phases as outlined in Section 1.1.

2.2 CMS overview

The CMS provides an overview of the resource requirements and the plant and materials that are anticipated to be used during the Phase 10 Works. It includes the measures to be taken to ensure that the works are carried out in accordance with the requirements of both the planning permission and of Sirius Minerals Plc and, above all, are carried out safely and in compliance with all statutory obligations.

2.3 Description of the works

The Phase 10 works comprise:

- Excavation of Service Shaft via a mechanical extraction method;
- Installation of grout shed and air compressor;
- Erection of temporary storage unit for winder equipment;
- Installation of drying rooms adjacent to the existing welfare facility; and
- Installation of oxygen tank and cabin.

These works are further detailed in section 3.

2.4 Contractor's offices/compounds

All contractors will continue to use the facilities already established in earlier phases, namely the main site welfare facility established in Phase 3 and extended in Phase 6. Some smaller self-contained facilities may need to be established closer to certain work areas as the site develops in order to provide facilities at a suitable distance of work areas.

2.5 Parking of cars

There are 187 spaces at Cross Butts Park and Ride that came into use in October 2018 and will continue to be used, as agreed with the NYMNPA and the North Yorkshire County Council Highways department.

There will be no parking on site with the exception of limited designated spaces for exceptional permitted use.

As part of the parking management strategy, a shuttle bus is now operational and runs between the Cross Butts P&R facility to a drop-off point adjacent to the welfare facility.

2.6 Mobilisation

All equipment, plant and materials will be delivered to site using the approved traffic routes as per the Phase 7 Construction Traffic Management Plan (Ref: 40-RHD-WS-70-CI-PL-0011).

All HGVs and abnormal loads will drive directly to site and will not stop / wait on the public highway. All storage units will be painted RAL6008 (brown/green) prior to arrival on site.

2.7 Unloading and loading of materials

The areas for storage have been planned to prevent excessive handling of material and to facilitate loading and unloading;

- Careys will manage all activities regarding '*Excavation of Service Shaft via Mechanical Extraction Method*' with laydown & storage in the base of the service shaft head chamber, lifting all plant, equipment and materials into position as outlined in the Phase 7 works.
- DMC will manage the Grout Shed, Compressor and Winder Equipment unit delivery, laydown, storage and installation at the specific locations designated for each structure, as defined on the Construction Phase Plan General Arrangement drawing (Ref: 40-ARI-WS-7100-CI-18-01039).
- Sirius will manage the Drying Room, Oxygen and Cabin unit delivery and installation directly onto the prepared designated area behind the existing main welfare facility.

2.8 Storage of plant and materials

Materials will be stored in accordance with the approach established for Phase 2 and implemented throughout all subsequent phases.

Plant and materials will be stored in designated areas as close to the works as possible. All storage areas will be on hardstanding appropriate to the plant and materials and away from sensitive receptors. COSHH and fuel storage will be as per Pollution Prevention Best Practice measures and the Construction Environmental Management Plan (CEMP) submitted for Phase 7 (Ref: 40-RHD-WS-70-EN-PL-0029).

2.9 Wheel wash

Vehicles entering site will stay on hardstanding already installed in previous phases. No plant will travel off site other than by specialised plant moving transport.

Vehicles exiting the site and on-site plant will use the wheel wash as described in the approved documents for Phase 3.

2.10 Internal access routes

Haul roads and internal access routes within the Phase 10 working area will be demarcated and separated from pedestrians as per previous phases. Speed limits will be enforced as per the site limits.

2.11 Lighting columns

No permanent lighting columns will be installed in this Phase of Works. Only temporary task lighting will be used, as described in the Phase 7 CEMP (Ref: 40-RHD-WS-70-EN-PL-0029).

3 Construction Method Statements

3.1 Excavation of Service Shaft via Mechanical Extraction Method

Whilst approval for the completion of the Service Shaft via Vertical Shaft-Sinking Machine ("VSM") method was secured as part of the Phase 7 works (Phase 7 CMS, Ref: 40-SMP-WS-7100-PA-MS-00003), it is now proposed to commence excavation of the Service Shaft via traditional mechanical means.

3.1.1 Principal Changes

There are three principal changes to the previously approved VSM method. These are stated below.

3.1.1.1 Use of mechanical excavation as opposed to VSM for commencement

This change involves using traditional mechanical excavation techniques in the base of the Service Shaft main shaft, working within a dry environment to commence the excavation. The technique will be largely in line with the methodology outlined for excavation within the D wall on the Production Shaft, comprising use of a small excavator or robotic breaker and removal of the arisings via a skips as detailed within the previously approved Phase 7 CMS (Ref: 40-SMP-WS-7100-PA-MS-00003).

Mechanical Excavation Within the Shaft

3.1.1.2 Use of a temporary concrete liner

In order to prevent groundwater ingress from the sides of the excavation and for safety reasons, the sides of excavation will be covered with a temporary concrete liner as excavation progresses. The inside diameter of the temporary liner will be 8.2m to allow a secondary, more permanent, liner to be placed post completion. The outside diameter will be 8.7m and the excavation size will be as close to this as possible (<50mm anulus).

The temporary liner design will be constructed from precast concrete segments and built using the underpinning method described in **Appendix A**. The precast units will be back grouted as the excavation progresses in order to minimise the inflow of water from the sides of the excavation.

Precast Concrete Liner

3.1.1.3 Use of grouting to reduce groundwater inflow

In order to manage the ingress of water, grouting of the Saltwick formation may be undertaken; specifically at the higher ingress areas identified from ground investigations. However, probe holes will be drilled ahead of the excavation to confirm areas that are likely to require grouting. Probe holes are planned to extend 10m ahead of the excavation and excavation will then progress up to 5m before re-drilling probe holes to 10m. From ground investigation, the principal areas that may require grouting are 137- 116m AOD and 110 – 103m AOD.

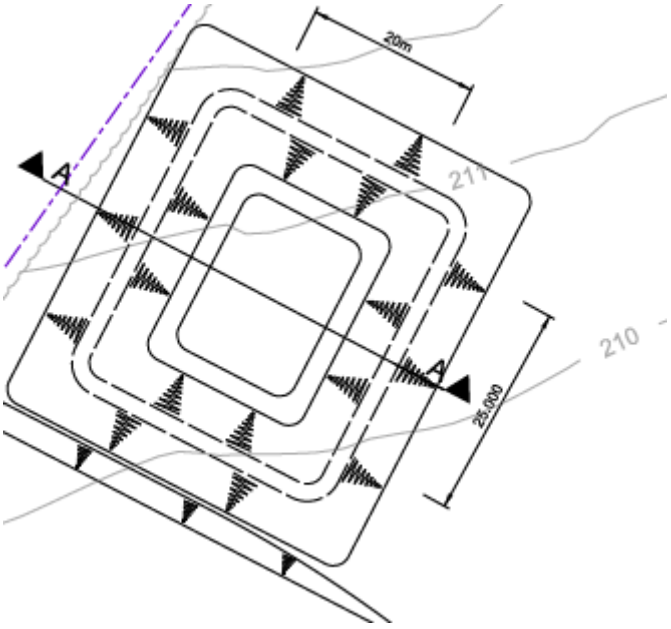
All grouting materials will be in accordance with those discharged under Phase 7 (Phase 7 CMS, Ref: 40-SMP-WS-7100-PA-MS-00003) for the MTS shaft and the grout will be targeted at fractures or discontinuities in the rock.

The groundwater will be immediately discharged to a soakaway, located adjacent to the re-injection pad on site which will be excavated (as previously discharged under Phase 3) with the omission of the base liner, to allow soakaway into the Ravenscar group of secondary A aquifers. Whilst, as result of the proposed grouting, water ingress is not expected to a reach a level that would require permitting

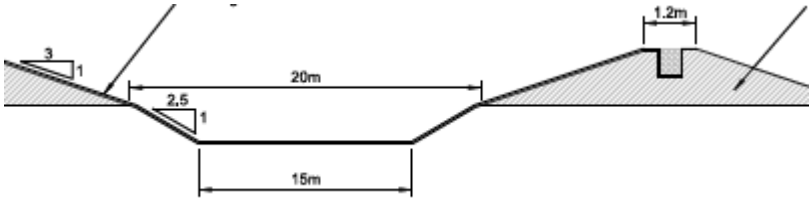
(under 'The Water Abstraction and Impounding (Exemptions) Regulations 2017, Section 5), the volume of water pumped from the base of the shaft will be monitored at all times. Should the water ingress reach a level that would otherwise be permittable, works will stop and the VSM machine will be installed as per the previous, Phase 7 (Phase 7 CMS, Ref: 40-SMP-WS-7100-PA-MS-00003), strategy. Further details are provided in the Phase 10 HRA (Ref: 40-FWS-WS-70-WM-RA-0010).

3.1.2 Groundwater Management

Groundwater inflow will be pumped from a sump at the base of the excavation to be immediately discharged through the soakaway. Should the infiltration rate not be achieved in the base of the soakaway, excess water will be tankered off site to prevent exceedances of lagoon capacity. This will be assessed on an observational approach. The soakaway's base drainage area is 15m x 25m;



Soak away plan view



Soak away section view

It should be noted, a HB50 settlement tank will be placed in the pipework chain to the lagoon to settle solids. A 'silt sock' will also be placed on the pipeline to capture suspended solids prior to entering the soakaway. Finer particles will settle out in the base of the lagoon prior to infiltrating the rock.

Should a hydraulic (oil) leak occur in the excavation, as a result of any damage or breakages to the machinery, contaminated water will be captured in the settlement tank and tankered offsite for disposal. A structured maintenance and monitoring regime will be incorporated to the construction operations to ensure there is no significant risk of leaks or spillages occurring.

An observational monitoring approach of groundwater levels and groundwater ingress impacting on the Service Shaft excavation will be undertaken during the Phase 10 works. This will include monitoring of the existing Vibrating Wire Piezometers (VWPs) placed with the Cloughton and Saltwick Formations around the shaft, monitoring of the groundwater ingress into the shaft excavation and monitoring of the pumping rate necessary to maintain the excavation dry.

For further details, refer to the Phase 10 Hydrogeological Risk Assessment (Ref: 40-FWS-WS-70-WM-RA-00010).

3.2 Installation of Air Compressor Shed

To provide weather protection for the air compressor equipment, a steel frame, steel cladded, coverall structure will be erected onto a concrete base slab cast into the existing MTS platform (See **Appendix B**). This will include 6m x 6m high roller shutter door and side access door. Summary detail;

- Footprint area; 9m x 18m
- Section area; 5.12m eaves height, 5.29m total height
- Roof Cladding - Sheet Metal
- Wall Cladding - Uninsulated Sheet Metal
- Exterior Colour - RAL 6008 brown green

The coverall structure will be a temporary structure that will be in place for the duration of the shaft-sinking works.

3.3 Installation of Grout Plant

A shelter to provide weather protection for the grout mixing equipment, complete with a 2.9m x 3.5m roller shutter door at the front and access hatch and door in the rear end, will be erected (See **Appendix C**). The structure will be steel framed and based on a concrete pad, cast into the platform, with a covering membrane fabricated from high tenacity PVC polyester fabric, which is flame retardant. The roof material will match the walls, all to be provided in RAL 7013.

Dimensions are designed to ensure cover up of grout plant which is about 2.2 meters cubed in size and have additional room inside to store various grouting ingredients and equipment. Two horizontal silos will be located outside this building, based on concrete pads, with screw feeds entering through the upper hatch. The feed will be lined up with and sealed on to the mixer to prevent dust. Summary;

- Footprint area; 8m x 9m
- Section area; 3.35m eaves height, 5.32m total height
- Roof & Wall Cladding; high tenacity PVC polyester fabric
- Exterior Colour - RAL 7013 brown grey

The coverall structure will be a temporary structure that will be in place for the duration of the shaft-sinking works.

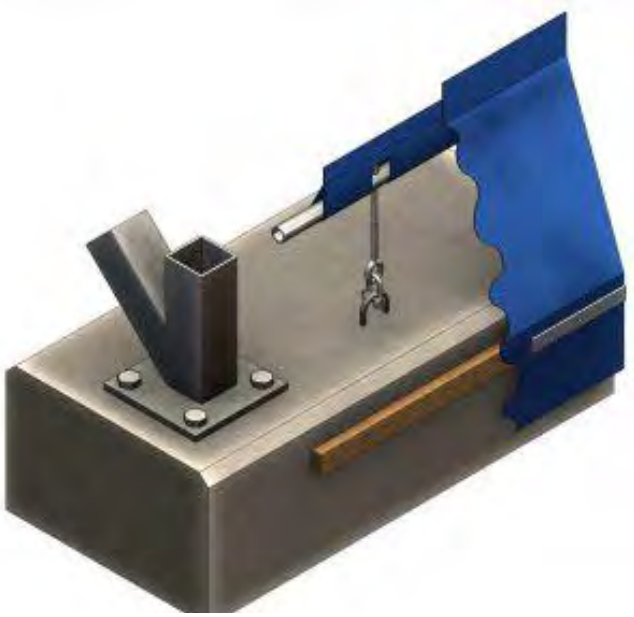
3.4 Erection of Temporary Storage Unit for Winder Equipment

A coverall structure is to be installed to the south of the Service for protection of the winding equipment during commissioning / greasing on site. Foundation secured to concrete base slab. Structure type features rectangular leg and roof box sections of steel with PVC polyester fabric cladding, in RAL 7013 brown grey (See **Appendix D**). Summary;

- Footprint area; 20m x 40m
- Section area; 5m eaves height, 8.06m total height
- Roof & Wall Cladding; high tenacity PVC polyester fabric
- Exterior Colour - RAL 7013 brown grey

The coverall structure will be a temporary structure that will be in place for the duration of the construction of Service Shaft and Production Shaft buildings.

Unit, full colour to be RAL 7013



Unit foundation

3.5 Installation of Drying Rooms

Eight drying room units are to be installed behind the existing welfare facility (six to be double stacked and two to be single stacked). The units will be screened by existing fencing, with shutters installed on windows to prevent light emission in hours of darkness. Units to be supplied as standard, dark green (See **Appendix E**).

3.6 Installation of Oxygen Tank and Cabin

As part of the Mine Rescue requirements under the HSE, there is a requirement for a rescue set oxygen tank re-charge unit on site. This will comprise of a 10ft stores unit and series of oxygen bottles to be stored in a secure cage adjacent to the existing welfare facility. This will be a single storey unit placed on the east side of the welfare and screened by both the welfare and the boundary fence.

Oxygen cylinders secured in cage

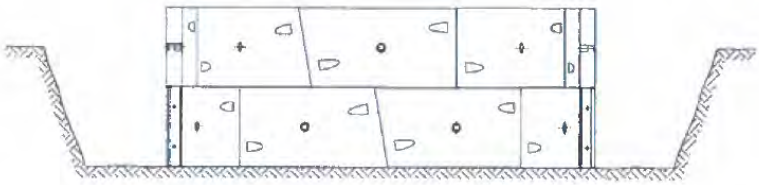
10ft Unit – Standard RAL6005

Appendix A – Underpinning Methodology

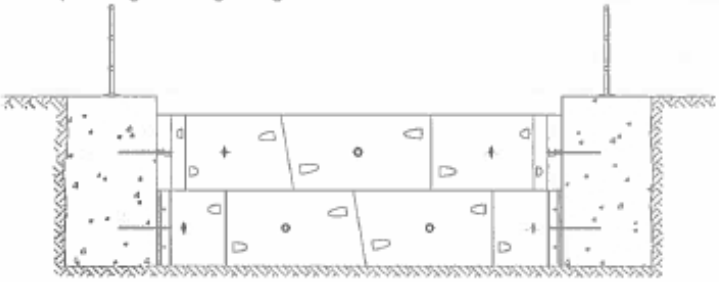
Building Sequence – Underpinning Method

The installation should proceed as follows: -

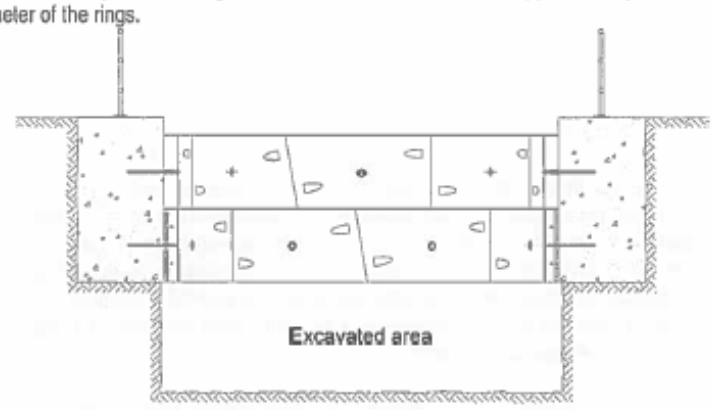
- Excavate a circular hole, typically to accommodate one or two rings and the concrete collar.
- Build the rings to correct line and level to the surface – see `Building sequence – Chimney fashion'.



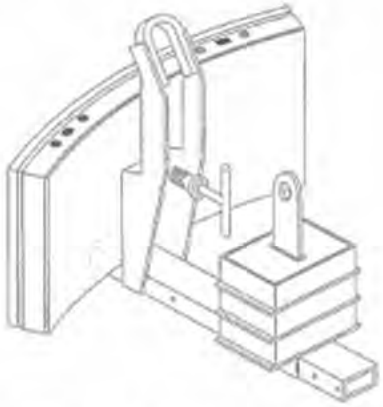
- Locate reinforcing bars through the wall. Pour the concrete collar. Note: The reinforcing bars and collar should be of sufficient strength and size to be capable of anchoring the rings, thereby supporting the weight of subsequent rings before grouting.



- Excavate the depth of 1.5 rings. The excavation should extend approximately 50mm beyond the outside diameter of the rings.



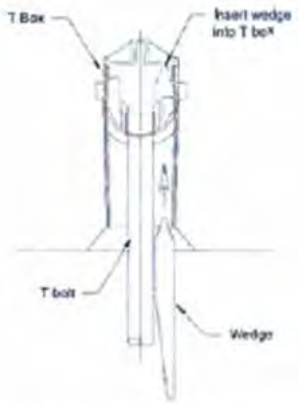
- Offer up the first ordinary segment to the ring above using an underpinning frame with all T bolts hanging in the through holes.



Place the segment approximately 300mm below its intended position, with the centre of the segment directly underneath a joint on the ring above. Supports should be placed on top of the segment to avoid trapped hands should the segment be lifted unexpectedly.

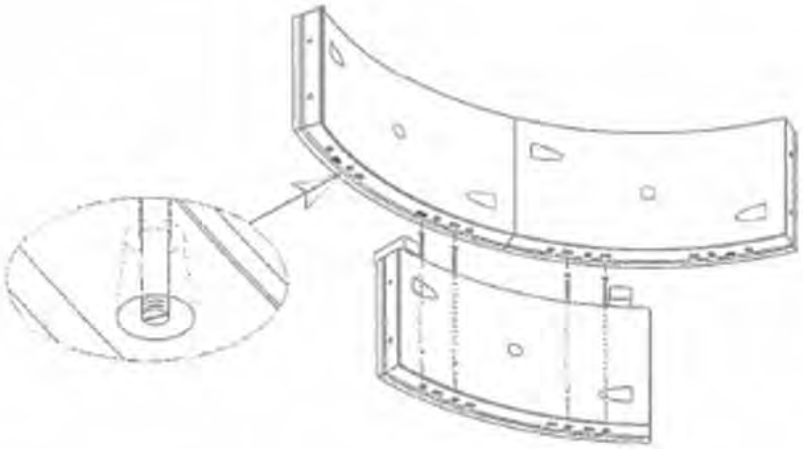
Lift and locate the 'T' bolts into the segments above, turning each clockwise through 90° and pulling downwards to lock them in position. A slot is located at the end of the thread. The slot should be in the correct orientation in the locked position i.e. radial.

Optional: Insert one number locking wedge into the each T box.



- Check that the slot on the threaded end of each bolt points towards the centre of the shaft. Evenly tighten the 'T' bolts. Repeat the sequence until the gasket is compressed taking care not to overtorque any bolt as this may result in stripping of the threads. * Typical torques required range between 100Nm and 150Nm. 200Nm should not be exceeded without discussion with FM Technical Department. The degree of gasket compression required is dependent on the water pressure to be resisted. It should be noted that the circle joint has a flatness tolerance therefore full closure of the joint cannot be expected. Contact FPM Technical Department for further assistance if required.

- The relative position of the bolts and the gasket may result in some 'birds mouthing. The use of timber shims or wedges at the intrados of the joint, which should be removed as the joint is closed, can correct this. Check the segment for plumb.



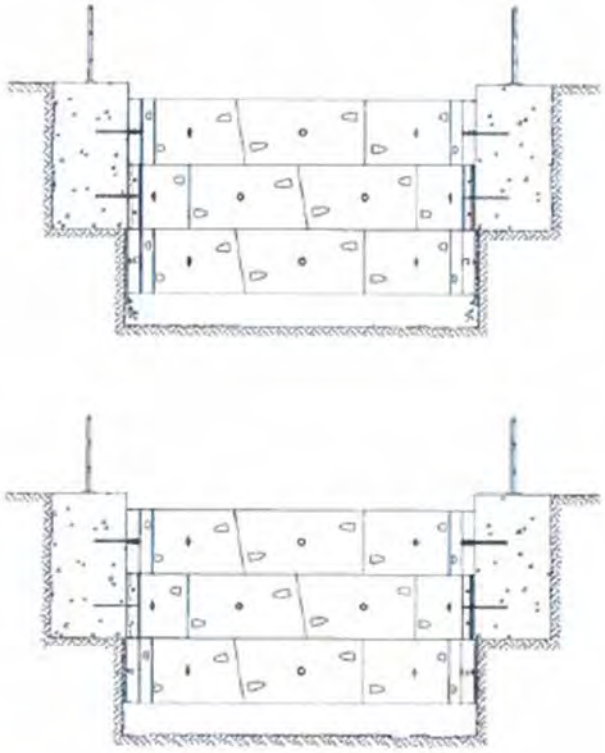
- When building the next and subsequent ordinary segments, follow the sequence as described below:

- Lubricate the gaskets on the mating surfaces of the segment.
- Offer the unit up using an underpinning frame and engage the 'T' bolts and locking wedge as described previously.
- Lift the segments and tighten the 'T' bolts to close the circle joint sufficient to position spear bolts into sockets on cross joint.
- The cross joint bolts may now be located and tightened to achieve a cross joint width of approximately 5mm.
- Evenly tighten all bolts within the circle and cross joints to compress the gasket. *Typical torques required range between 100Nm and 150Nm. 200Nm (T bolt) and 150Nm (cross joint bolts) should not be exceeded without discussion with FPM Technical Department. The degree of gasket compression required is dependent on the water pressure to be resisted. It should be noted that the circle joint faces have a flatness tolerance therefore full closure of the joint cannot be expected. Contact FPM Technical Department for further assistance if required.

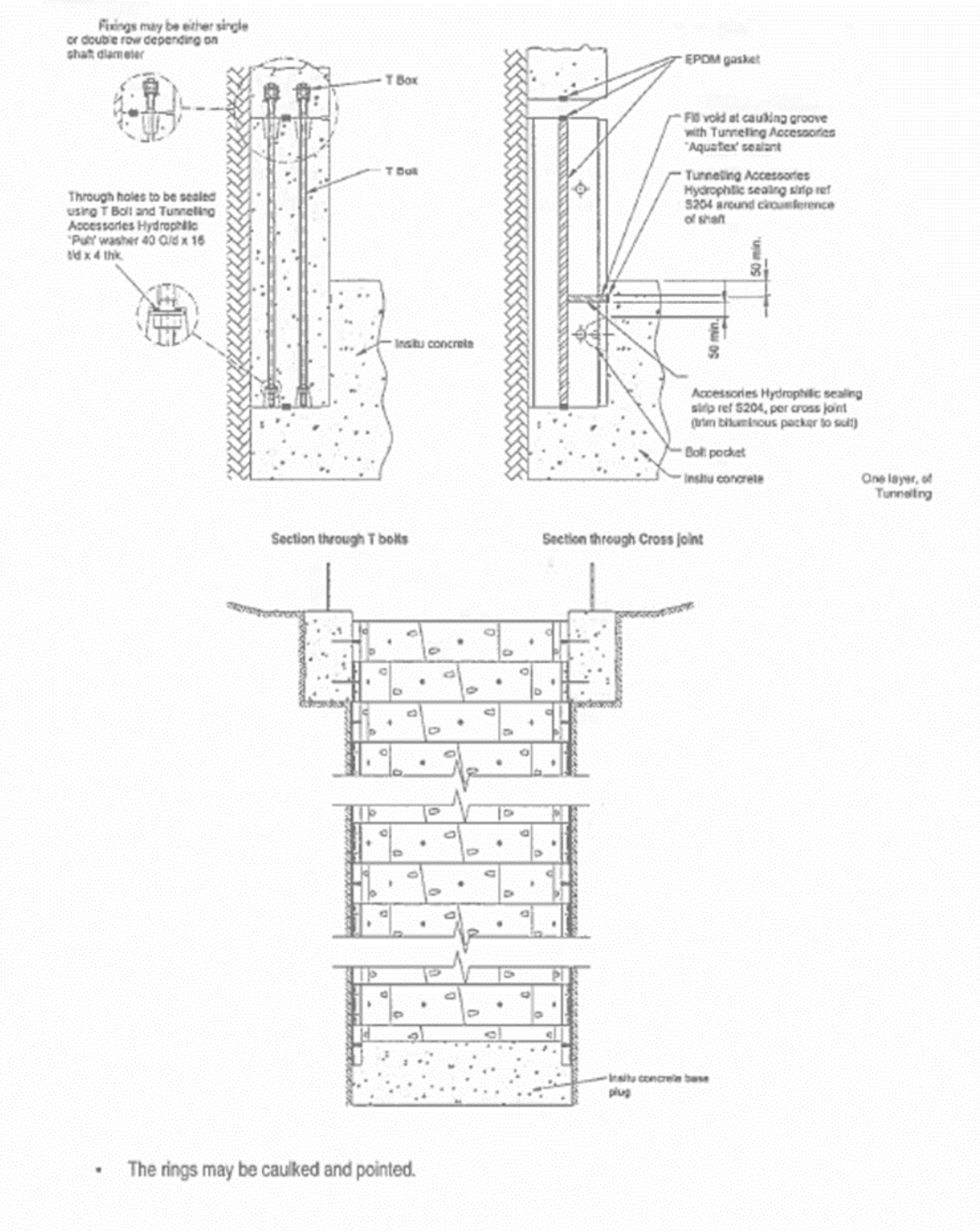
- When building the top segments follow the sequence as described below:

- Install the first top segment as described above with the wide side uppermost.
- Offer up the second top segment. It may be necessary to excavate the ground locally to an additional depth in order to insert the last unit. Tighten the bolts as described for the ordinary segments.

- Close the gap between the excavation and the rings and grout the shaft through the grout sockets / non return valves cast into the segments. Fit the grout plugs on completion. **Important note- no more than one ring should be erected before grouting.**

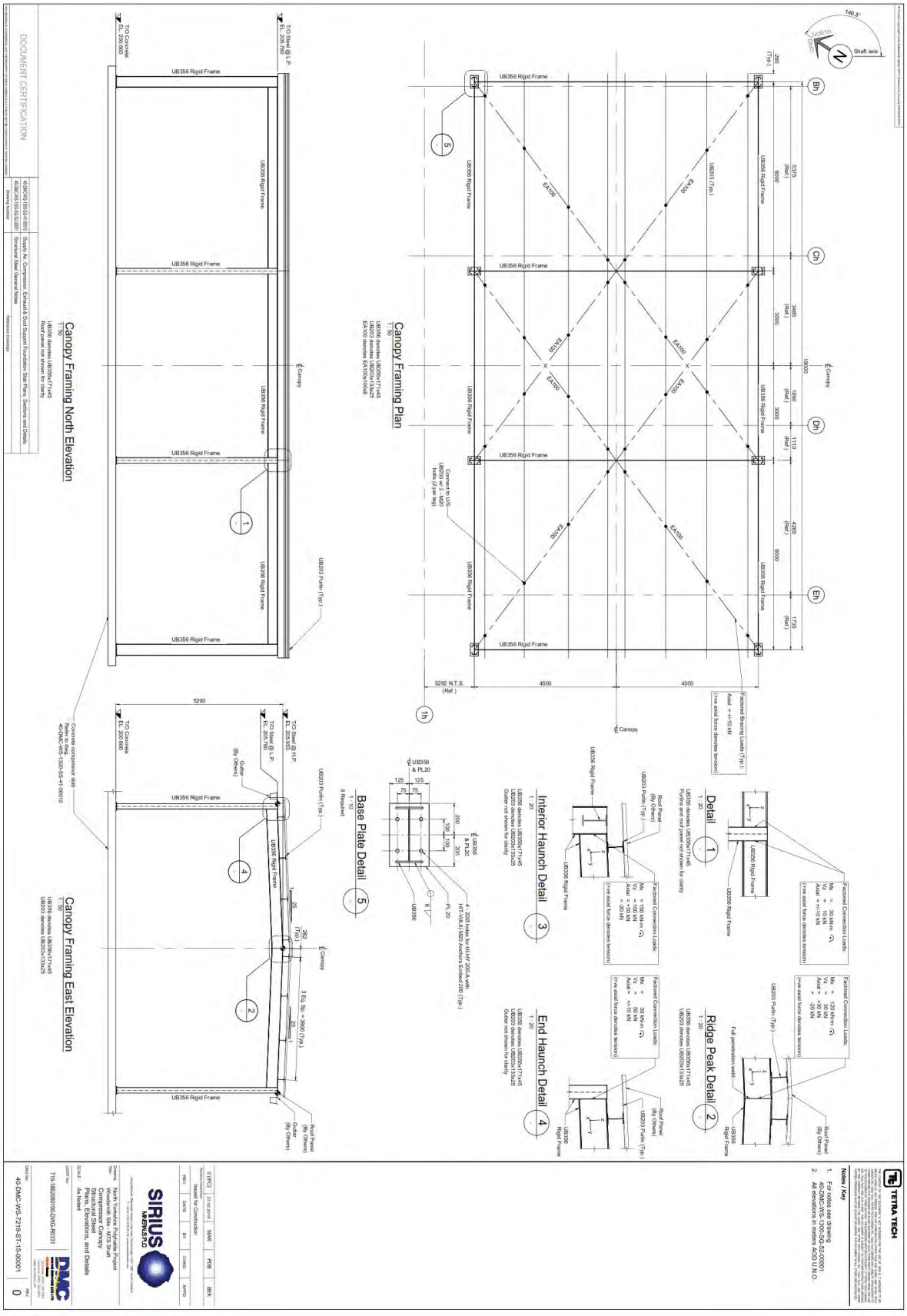


- Repeat the process for all subsequent rings.
- A base slab may then be cast under or within the bottom of the shaft. The installation of seals will be required to avoid tracking of water through vertical holes, segment joints and between the base slab and the rings. For advice contact F P McCann Technical Department. The details below are typical and do not apply to all shafts.

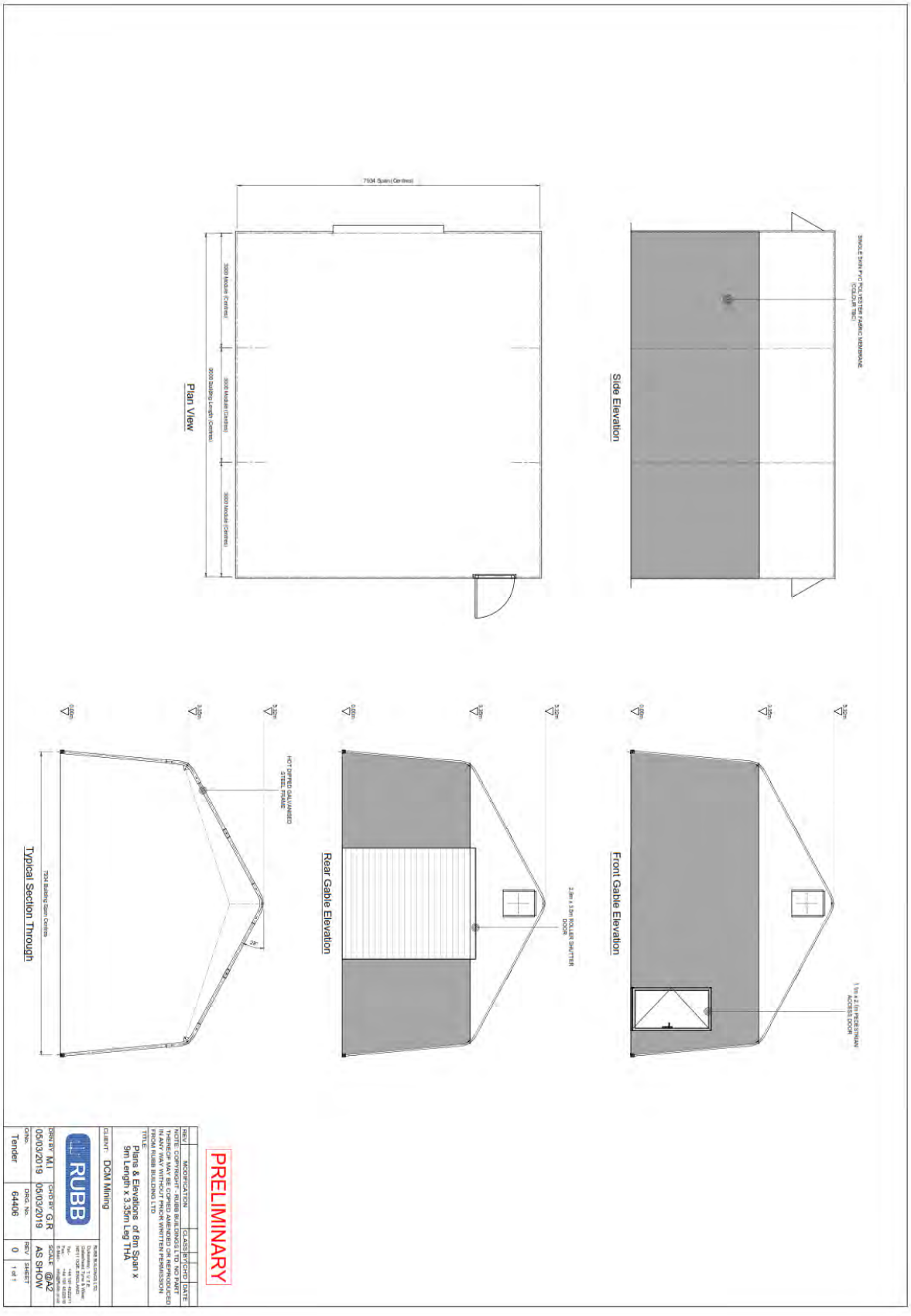


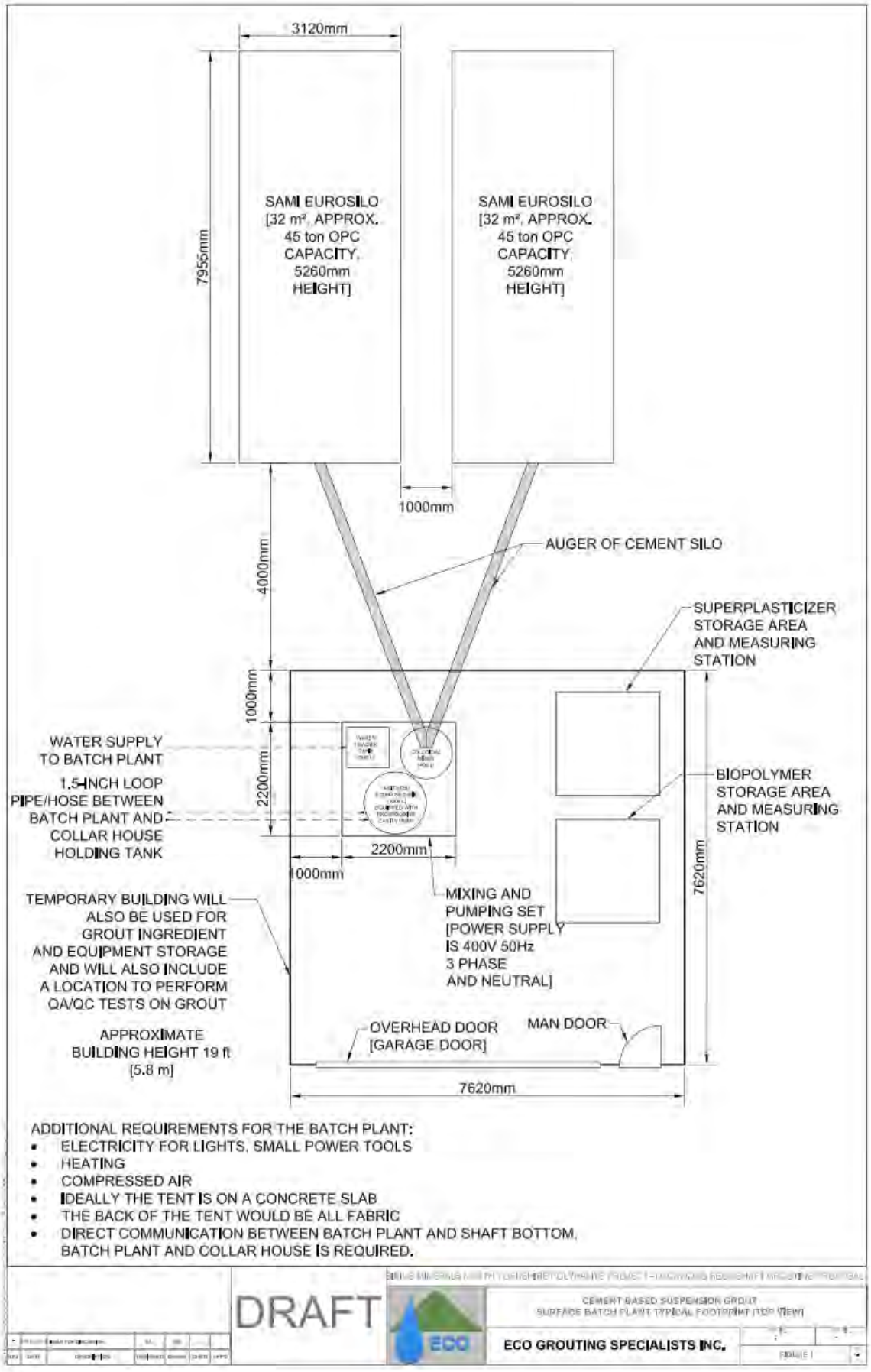
- The rings may be caulked and pointed.

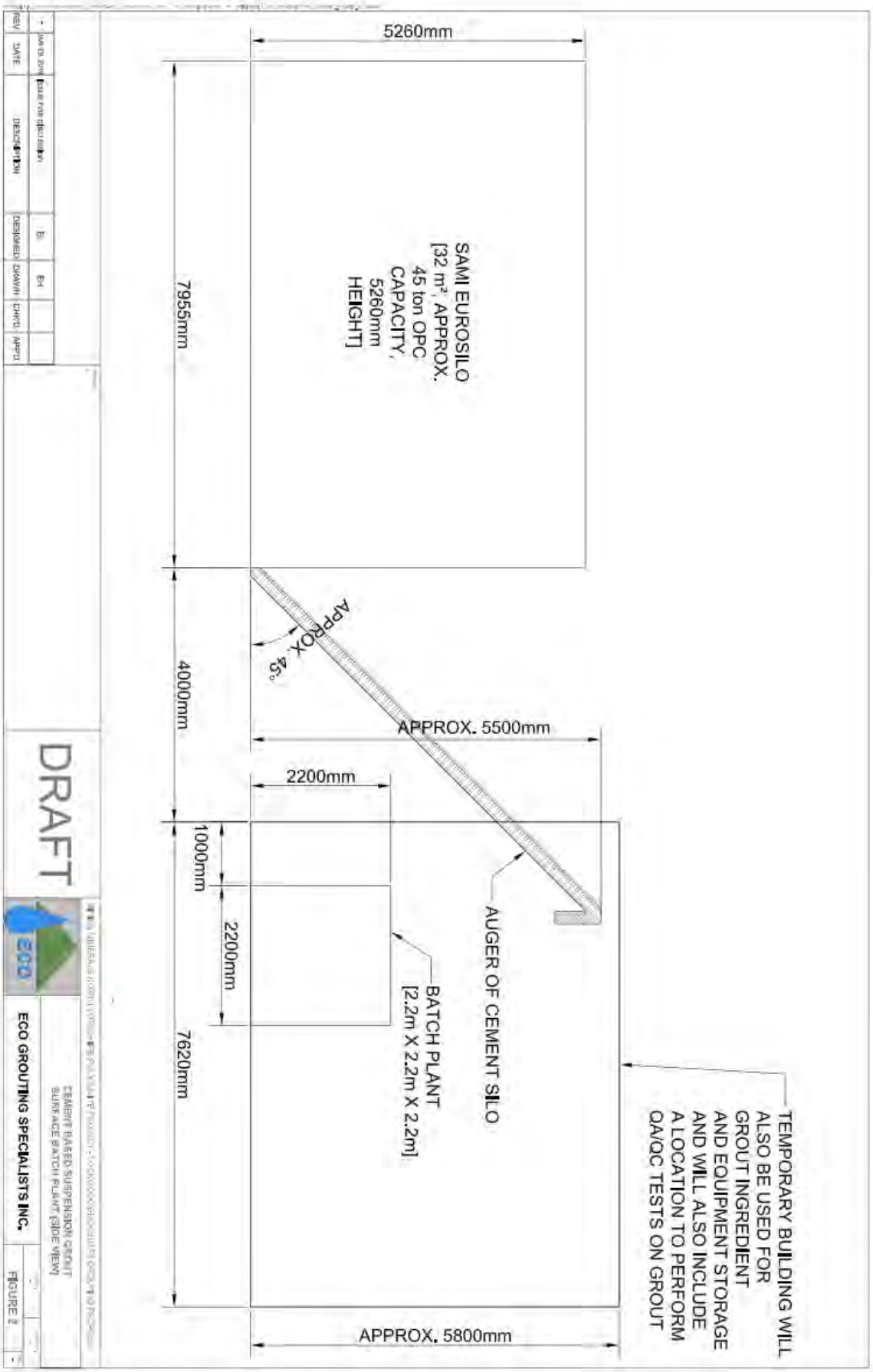
Appendix B – Air Compressor Shed

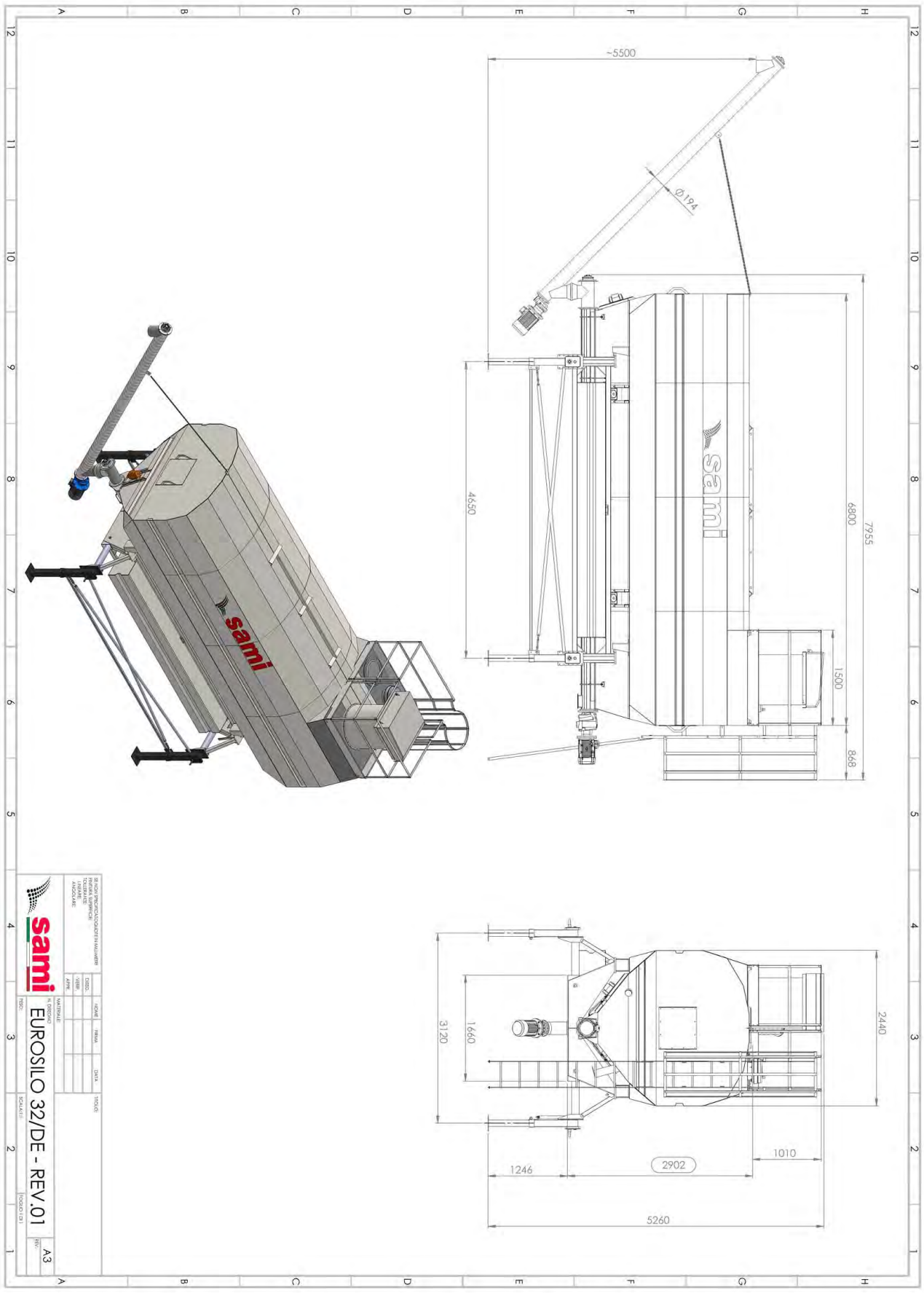


Appendix C - Grout Plant Layout & Sections




3120mm
7955mm
SAMI EUROSILO
[32 m³, APPROX.
45 ton OPC
CAPACITY,
5260mm
HEIGHT]
SAMI EUROSILO
[32 m³, APPROX.
45 ton OPC
CAPACITY,
5260mm
HEIGHT]
1000mm
AUGER OF CEMENT SILO
4000mm
SUPERPLASTICIZER
STORAGE AREA
AND MEASURING
STATION
1000mm
2200mm
WATER SUPPLY
TO BATCH PLANT
1.5-INCH LOOP
PIPE/HOSE BETWEEN
BATCH PLANT AND
COLLAR HOUSE
HOLDING TANK
BIOPOLYMER
STORAGE AREA
AND MEASURING
STATION
2200mm
1000mm
7620mm
TEMPORARY BUILDING WILL
ALSO BE USED FOR
GROUT INGREDIENT
AND EQUIPMENT STORAGE
AND WILL ALSO INCLUDE
A LOCATION TO PERFORM
QA/QC TESTS ON GROUT
MIXING AND
PUMPING SET
[POWER SUPPLY
IS 400V 50Hz
3 PHASE
AND NEUTRAL]
APPROXIMATE
BUILDING HEIGHT 19 ft
[5.8 m]
OVERHEAD DOOR
[GARAGE DOOR]
MAN DOOR
7620mm
ADDITIONAL REQUIREMENTS FOR THE BATCH PLANT:
• ELECTRICITY FOR LIGHTS, SMALL POWER TOOLS
• HEATING
• COMPRESSED AIR
• IDEALLY THE TENT IS ON A CONCRETE SLAB
• THE BACK OF THE TENT WOULD BE ALL FABRIC
• DIRECT COMMUNICATION BETWEEN BATCH PLANT AND SHAFT BOTTOM.
BATCH PLANT AND COLLAR HOUSE IS REQUIRED.
DRAFT
CEMENT BASED SUSPENSION GROUT
SURFACE BATCH PLANT TYPICAL FOOTPRINT (TOP VIEW)
ECO GROUTING SPECIALISTS INC.


5260mm
SAMI EUROSILO
[32 m³, APPROX.
45 ton OPC
CAPACITY,
5260mm
HEIGHT]
7955mm
4000mm
APPROX. 45°
APPROX. 5500mm
2200mm
1000mm
2200mm
7620mm
AUGER OF CEMENT SILO
BATCH PLANT
[2.2m X 2.2m X 2.2m]
TEMPORARY BUILDING WILL
ALSO BE USED FOR
GROUT INGREDIENT
AND EQUIPMENT STORAGE
AND WILL ALSO INCLUDE
A LOCATION TO PERFORM
QA/QC TESTS ON GROUT
APPROX. 5800mm
DRAFT
ECO GROUTING SPECIALISTS INC.
CEMENT BASED SUSPENSION GROUT
SURFACE BATCH PLANT (SIDE VIEW)
FIGURE 2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7955
1500
868
3120
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1246
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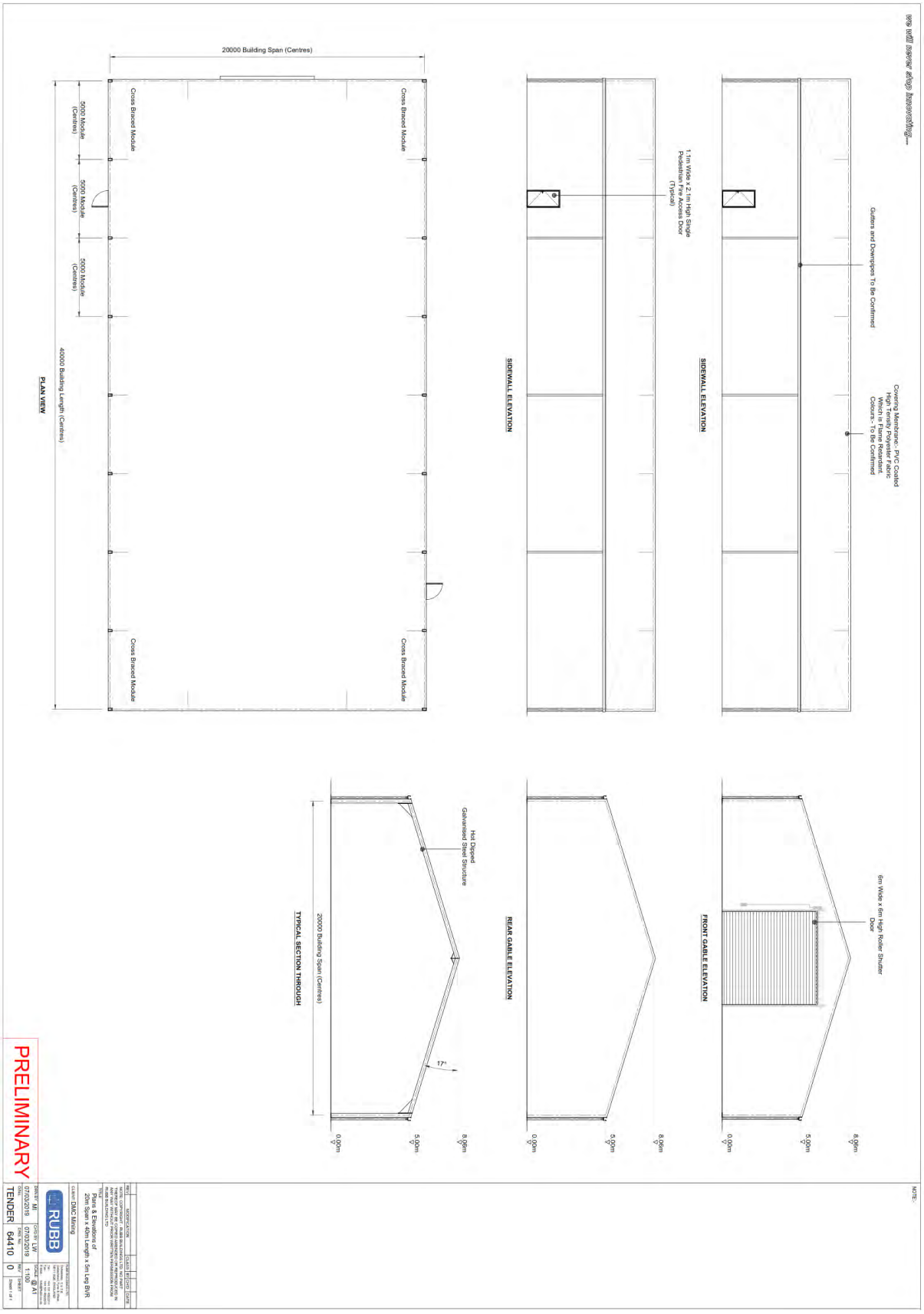
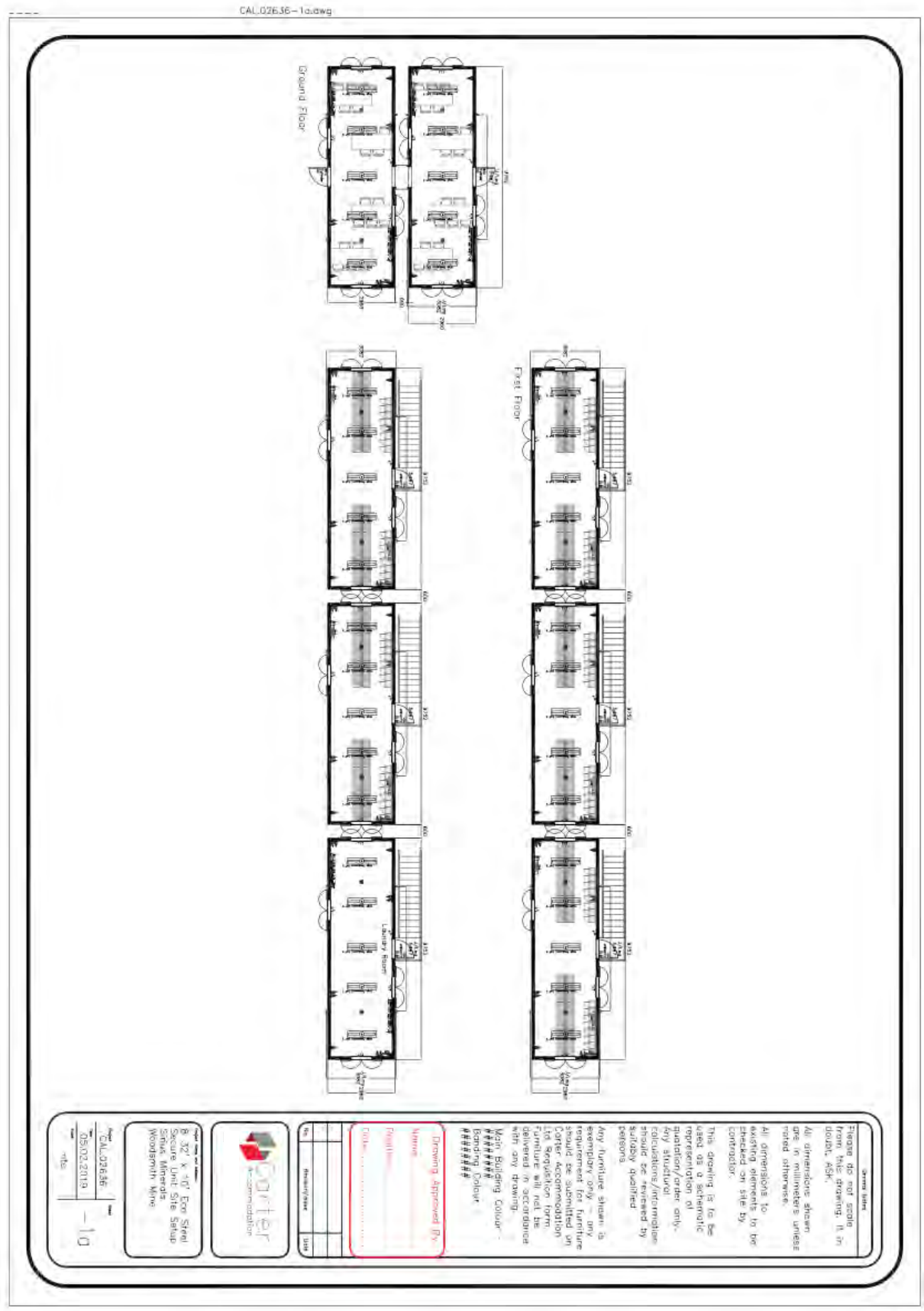
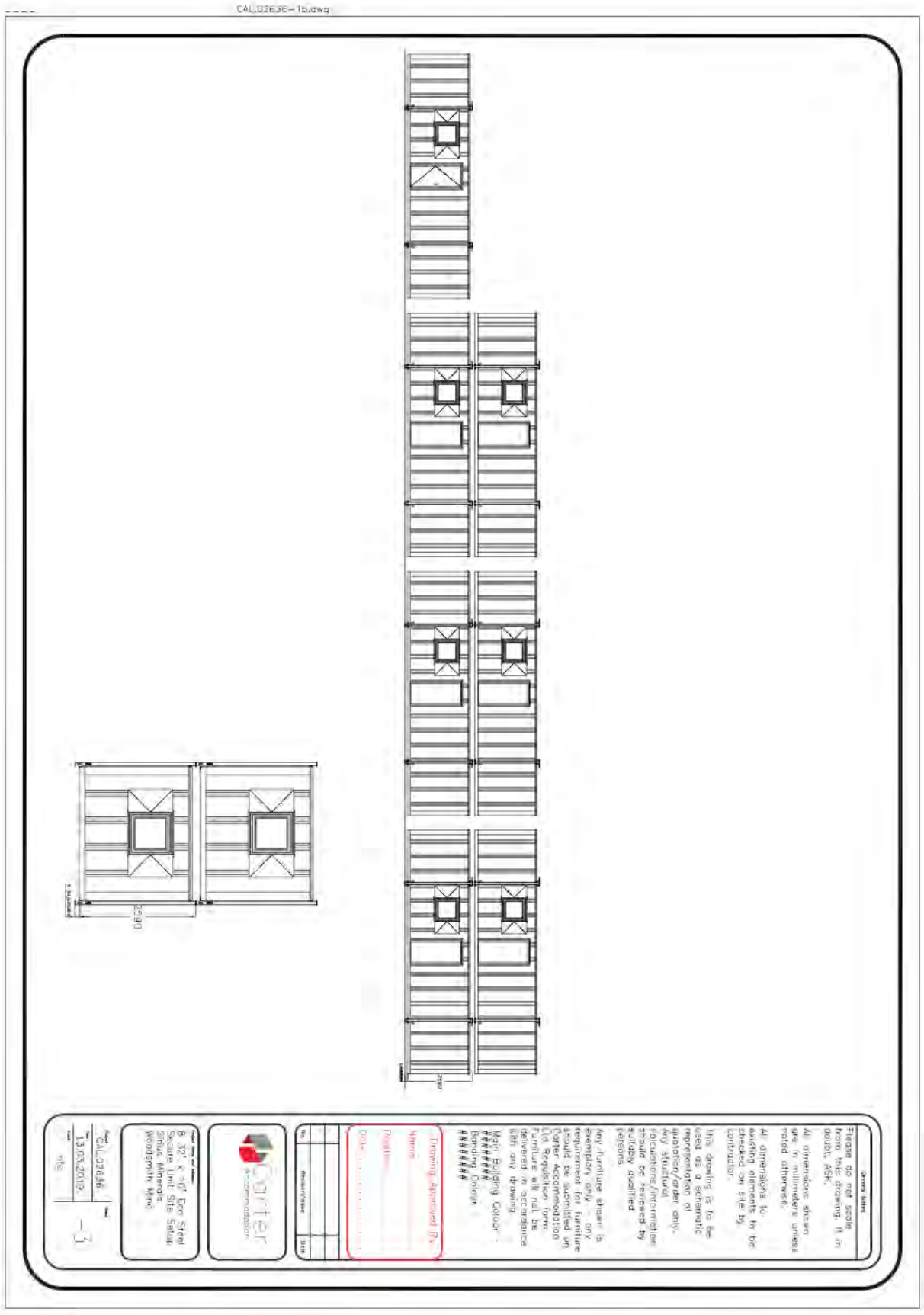
sami
EUROSILO 32/DE - REV.01
A3

Appendix D - Temporary Storage Unit for Winder Equipment



Appendix E - Drying Rooms




CAL_026356-1b.dwg
2591
2590
General Notes
Please do not scale from this drawing. If in doubt, ASK.
All dimensions shown are in millimeters unless noted otherwise.
All dimensions to existing elements to be checked on site by contractor.
This drawing is to be used as a schematic representation of quotation/order only. Any structural calculations/information should be reviewed by suitably qualified persons.
Any furniture shown is exemplary only - any requirement for furniture should be submitted on Porter Accommodation Ltd Requisition form. Furniture will not be delivered in accordance with any drawing.
Drawing Approved By:
Name
Position
Date
Main Building Colour - ########
Bonding Colour - ########
Porter accommodation
8.32' X 40' Eco Steel Secure Unit Site Setup
Sirius Minerals
Woodsmith Mine
CAL_026356
13.03.2019
-3

FWS Geological & Geo-Environmental Consultants

NYMNPA

21/03/2019

SIRIUS MINERALS PLC - DISCHARGE OF PLANNING CONDITIONS FOR PLANNING PERMISSION NYM/2014/0676/MEIA (AS VARIED BY NYM/2017/0505/MEIA), NORTH YORKSHIRE POLYHALITE PROJECT

CONDITION	NYMNPA 45 & 46
REPORT	HYDROGEOLOGICAL RISK ASSESSMENT (NYMNPA 45 & 46 – PHASE 10)
SITE	PHASE 10 WORKS AT WOODSMITH MINE, NORTH YORKSHIRE
DOCUMENT NUMBER	40-FWS-WS-70-WM-RA-00010

1433DevOR423 Rev02/March 2019

FWS Consultants Ltd
Merrington House
Merrington Lane Ind Est
Spennymoor
County Durham
DL16 7UT
Company Registration No. 3944252

PROJECT NUMBER	1433Dev			
PROJECT TITLE	North Yorkshire Polyhalite Project			
CLIENT	Sirius Minerals Plc Resolution House Lake View Scarborough YO11 3ZB			
REPORT TITLE	Hydrogeological Risk Assessment (NYMNPA 45 & 46 – PHASE 10)			
REPORT REFERENCE	1433DevOR423			
DOCUMENT NUMBER	40-FWS-WS-70-WM-RA-0010			
REVISION	**DATE**	**AUTHOR**	**CHECKED**	**APPROVED**
REV 02	20/03/2019	CM	RIL	RIL

CONTENTS

APPENDICES

HYDROGEOLOGICAL RISK ASSESSMENT (NYMNPA 45 & 46 – PHASE 10)

1 INTRODUCTION

1.1 General Background

This document has been prepared on behalf of Sirius Minerals Plc and provides the Hydrogeological Risk Assessment (HRA) for the Phase 10 Works at Woodsmith Mine. This is required to satisfy Condition 46 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA (as varied by NYM/2017/0505/MEIA).

Previous documents prepared by FWS on the hydrogeology of the site and the phased construction works have included a revised Hydrogeological Baseline Report (Ref. 1), Hydrogeological Risk Assessments for the Phase 2, 3, 4, 4a, 5, 6, 6a, 7, 8 and 9 Works (Refs. 2 to 10) and an assessment of the long term cumulative hydrogeological impacts, in support of the s73 application (Ref. 11).

As part of the approved 'Phase 7 Works', construction of the Service Shaft from 162.17 m AOD to 83.17 m AOD was to be undertaken using a Vertical Shaft Sinking Machine (VSM) (Ref. 8). As excavation of the headframe chamber has now completed in advance of the Vertical Shaft Sinking Machine completing its work at the Materials Transport System shaft, commencing the Service Shaft using conventional mechanical excavation available offers significant construction programme benefits while not exceeding the environmental parameters that were established at Phase 7. This report provides the Hydrogeological Risk Assessment for this amended construction process for the upper section of the Service Shaft , as required to satisfy Condition 46 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA (as varied by NYM/2017/0505/MEIA).

1.2 Compliance with Conditions

Table 1 sets out the wording of Planning Conditions 45 and 46 to Planning Permission Ref. No. NYM/2014/0676/MEIA (as varied by NYM/2017/0505/MEIA) that relates to the Hydrogeological Risk Assessment and details where the relevant material, to comply with this condition, has been provided within this report:-

Table 1 - Summary of Planning Conditions 45 and 46 and Where Relevant Details Are Provided In This Report

PLANNING CONDITIONS RELATING TO IMPLEMENTATION OF THE RECHARGE TRENCH AND GROUNDWATER DRAINAGE	
NYMNP Condition 45	**Compliance with Condition 45**
Prior to the commencement of shaft sinking or chamber formation beneath ground at Doves Nest Farm site and in accordance with the details in the document "York Potash Project: Habitats Regulation Assessment" prepared by Amec Foster Wheeler dated June 2015 with document reference 35190CGos064R, and as updated by the HRA prepared by Royal Haskoning DHV dated November 2017 with document reference 40-RHD-WS-83-WM-RP-001 Rev 4, a programme for the implementation of the following shall be submitted to and agreed in writing with the MPA:-	Comment on the requirement for implementation of the recharge trench and groundwater drainage beneath bunds E and F is presented in Section 7.

a. A recharge trench to promote re-infiltration of surface runoff to recharge the Moor Grit up hydraulic gradient of the source area to Moorside Farm Spring. b. Provision of groundwater drainage areas beneath bunds E and F to collect spring waters issues from the Scarborough and Cloughton Formations for discharge via the mine site surface water drainage system.	
PLANNING CONDITIONS RELATING TO THE HYDROGEOLOGICAL RISK ASSESSMENT	
NYMNP Condition 46	**Compliance with Condition 46**
Prior to the Commencement of Development at the Doves Nest Farm Minesite a revised Hydrogeological Risk Assessment based on the most up to date monitoring data shall be undertaken in accordance with the details in the document "York Potash Project: Habitats Regulations Assessment" prepared by Amec Foster Wheeler dated June 2015, with document reference 35190CGos064R and as updated by the HRA prepared by Royal Haskoning dated November 2017 with document reference 40-RHD-WS-83-WM-RP-0001 Rev 4; and submitted for approval in writing by the MPA in consultation with Natural England and the Environment Agency.	1. Details of the Works are presented in Section 3. 2. Up to date monitoring is presented in FWS Consultants Ltd 2016 Hydrogeological Baseline Report for the Doves Nest Farm Minesite, 2012 to 2016 (1975OR01 Ref. 1). 3. Details of the Hydrogeological Risk Assessment are presented in Section 6.
PLANNING CONDITIONS RELATING TO THE CONSTRUCTION AND OPERATIONAL PHASE GROUND AND SURFACE WATER MONITORING	
NYMNP 46	**Compliance with Condition 46**
The scheme shall include: -	
Details of the number, type and location of monitoring points.	Section 8 and Phase 4 and 4a GW&SWMS (Refs. 12 and 15) and Section 8 of the Phase 6 HRA (Ref. 7).
A protocol for the removal and replacement of any existing monitoring points.	
Details of the frequency of monitoring during construction and operation.	
A list of the ground and surface water determinands to be tested for.	
Monitoring of ground water levels and spring flows.	
Monitoring of surface water quality including sediment, BOD, ammonia, pH.	
Geomorphology in Sneaton Thorpe Beck.	
A list of SAC/SSSI habitat measures to be tested for.	
Groundwater quality and level triggers.	
Surface water quality triggers.	
Surface water geomorphology triggers.	
SAC/SSSI habitat triggers.	
Monitoring of groundwater quality against groundwater triggers.	
A scheme for periodic review and refinement of the monitoring regime to take account of any approved changes to site layout/design, construction methods and monitoring data.	
A protocol for notifying the MPA of any breach of the Trigger Values, including the timing of any such notification.	
Details of the method and frequency with which monitoring results will be shared with the MPA, Natural England and the Environment Agency.	
The approved scheme shall thereafter be implemented in full, with monitoring continuing in accordance with the approved scheme until such time that it is agreed in writing by the MPA in consultation with Natural England and the Environment Agency that monitoring may cease.	

PLANNING CONDITIONS RELATING TO THE REMEDIAL ACTION PLAN	
NYMNP 46	**Compliance with Condition 46**
The scheme shall include: -	
Prior to commencement of each Phase of Construction at Doves Nest Farm a Remedial Action Plan, setting out the remedial actions to be taken in the event that any monitoring triggers of the approved Construction and operation Phase Ground and Surface Water Monitoring Scheme are exceeded, shall be submitted to and approved in writing by the MPA in consultation with the Environment Agency.	Section 9 and Phase 4, 4a and 9 Remedial Action Plan (Refs. 13, 16 and 25).
Should any monitoring results exceed those triggers set out in the approved Construction and Operation Phase Ground and Surface Water Monitoring Scheme, the MPA, the Environment Agency and Natural England shall be informed as soon as possible, and the approved Remedial Action Plan shall thereafter be implemented as soon as possible and within one month of the relevant monitoring trigger having been exceeded. Following remedial action, monitoring in accordance with the Construction and Operation Phase Ground and Surface Water Monitoring Scheme will be undertaken in accordance with the timescale to be submitted to and approved by the MPA in consultation with the Environment Agency, the results of which shall be reported to the MPA within four weeks of the monitoring date.	

1.3 Objectives

The purpose of this document is to:-

- Provide details of the hydrogeology of the site and adjacent areas.
- Provide details of the Works and the groundwater control measures that will be implemented.
- Provide a qualitative assessment of the magnitude of risks to hydrogeological receptors from the Works undertaken concurrently with Phases 4a, 5, 6, 7, 8 and 9 Works.

All details relating to the “as built” conditions, long term impacts and associated qualitative and quantitative modelling of the completed Service, Production and MTS shafts remain unchanged and are as addressed in detail in the Section 73 Works Hydrogeological Risk Assessments (Ref. 11).

2 DATA SOURCES

The data considered within this report are from the following sources:-

Hydrogeological Data

- Hydrogeological Baseline Report for the Woodsmith Mine, North Yorkshire 2012 to 2016 (1975OR01; Ref. 1).

Development Details of Phase 10 Works

- Sirius NYMNPA 94 –Phase 10 Construction Method Statement (Phase 10) Document No. 40-SMP-WS-7100-PA-MS-00008.

3 DETAILS OF THE PHASE 10 WORKS

3.1 General Description

Construction of the Phase 4a, 5, 6, 7 and 8 works, as detailed in the Hydrogeological Risk Assessments (Refs. 6 to 10), are ongoing. Provided below are details of the proposed Phase 10 Works that will be undertaken concurrently with ongoing works.

There are four principal changes to the Phase 7 sequence or construction, introduced by the Phase 10 works, that require an update to the hydrogeological risk assessment:-

- Piling to the floor slab in the head frame chamber will be undertaken after completion of installing the hydrostatic liner to the Service Shaft to an elevation of 83.17 m AOD.
- Grouting may be undertaken to minimise water ingress into the shaft excavation.
- Mechanical excavation equipment will be utilised instead of VSM system.
- A temporary precast concrete segmental liner with back grouting will be adopted during excavation with the permanent secondary cast insitu concrete liner installed from bottom up on completion of excavation to 83.17 m AOD.

The following works that are to be placed on the site platform area will also be included within the Phase 10 works:-

- Installation of grout shed and air compressor shed;
- Installation of drying rooms adjacent to the existing welfare facility;
- Erection of temporary storage unit for winder equipment; and
- Installation of oxygen tank and cabin.

These surface works, placed on the shaft platform area, will have no additional hydrogeological impacts above that previously addressed for the shaft platform and no site specific hydrogeological risk assessment is required for these aspects of the works.

The following sections present details of the design levels and construction methodology for the Phase 10 Works.

3.2 Construction Methodology

3.2.1 Proof Drilling to Determine Targeted Grouting Requirements

As diaphragm walling has been installed for the Headframe Chamber around the Service Shaft to an elevation of 140 m AOD, this structure provides a cut off to ground water inflow to the shaft excavation from the overlying Cloughton and Ellerbeck Formations. Below the diaphragm walling, due to the presence of permeable strata within the Saltwick Formation, groundwater control by grouting may be necessary to mitigate groundwater ingress during shaft construction below the Headframe Chamber Floor Slab. Table 2 summarises potential water bearing zones identified within this section of the shaft construction, based on ground conditions determined in the Shaft Pilot Hole, adjacent boreholes and from mud losses observed during diaphragm walling at the production Shaft location.

Table 2 Potential Water Bearing Horizons Within the Service Shaft Excavation

Potentially Permeable Horizons Based on the South Shaft Pilot Hole	Metres below Shaft Platform level (m BSPL)	Elevation (m AOD)
Saltwick (Fractured Sandstone Unit)	65.42 m to 67.52 m	137.75 m to 135.65 m
Saltwick (Fractured Sandstone Unit)	69.52 m to 72.52 m	133.65 m to 130.65 m
Saltwick (Sandstone with interbedded Mudstone)	75.02 m to 86.72 m	128.15 m to 116.45 m
Saltwick (Fractured Sandstone Unit)	94.22 m to 99.19 m	108.95 m to 103.98 m
Saltwick (Fractured Sandstone Unit)	104.57 m to 105.39 m	98.60 m to 97.78 m
Dogger Formation (Sandstone Conglomerate Unit)	107.07 m to 110.82 m	96.10 m to 92.35 m

Although historical groundwater levels in the Saltwick aquifer have been monitored at a maximum elevation of 153 m AOD, water levels monitored between June 2018 and February 2019 indicate that a lower groundwater level now exists at an elevation of around 138.8 m AOD in this aquifer. The strategy to be adopted for ground water control during shaft excavation is for proof drilling to be undertaken in 10 m sections in advance of excavation and for grouting to be undertaken within two principal sections (116 to 137 m AOD and 103 to 110 m AOD), if deemed necessary or as required during the excavation to minimise water ingress. This will be determined by the observational method.

The proof drilling will be undertaken to determine the magnitude of water flow from ungrouted sections. Probe holes will extend 10 m ahead of the excavation and the excavation will then progress up to 5 m before re-drilling probe holes a further 10 m. Subject to the magnitude of water flows determined from the probe holes, targeted grouting will be undertaken, as necessary.

3.2.2 Construction Sequencing

As summarised below, a staged excavation, grouting, as required, and temporary lining sequence is proposed either until the VSM becomes available to complete this section of shaft excavation or until the temporary liner is installed to an elevation of 83.17 m AOD enabling installation of the secondary liner. To facilitate this construction sequence, grouting may be undertaken of the water bearing strata within the Saltwick Formation and, if necessary, the Dogger Formation, to limit groundwater ingress during shaft excavation. The objective of the grouting is to achieve a maximum permeability for the shaft annulus of 1 x 10^{-7} m/s and, as such, horizons of higher permeability will be treated to this level and strata with a permeability below this value will remain ungrouted.

- Following completion of the Phase 7 headframe chamber excavation, to the base of the floor slab at 158 m AOD, a 6 m deep by 20 m diameter circular sub cellar will be excavated and lined using either a precast segmental lining or a Sprayed Concrete Lining. The floor of the sub cellar will comprise a 300 mm thick concrete temporary working platform with a finished surface at 152.3 m AOD.

- A reinforced concrete collar will be constructed securing two segmental concrete rings, with an internal diameter of 8.2 m, into the rock below the slab, to form the upper collar for the temporary segmental concrete liner.

- Stage 1 Pre-Grout Excavation and Temporary Lining; Probe drilling at 10 m intervals will be undertaken from the base of the sub cellar at 152.3 m AOD to the toe of the diaphragm wall

at an elevation of 140 m AOD. This will be carried out to confirm that the diaphragm walling has cut off ground water inflow from the overlying Cloughton and Ellerbeck Formations. Excavation of the Service Shaft, using a 5T excavator and a robotic breaker, will progress to form an 8.7 m diameter excavation to a depth of 1.5 times the height of the segmental rings (segments are 1 m) and a maximum depth of 2 m. This excavation will progress to a maximum depth of 5 m above the depth of probe drilling.

The extractive materials will be lifted to surface using a crawler crane and skip mounted at the surface level. A ring of segmental liners will then be underpinned by bolting to the overlying section. On completion of installing a full segmental ring, the 50 mm gap between the excavation and the external face of the segmental liner will be grouted through the grout sockets. Following grouting, excavation for installation of the subsequent segment can proceed with the sequence repeated.

- Stage 2 Excavation and Temporary Lining; Prior to commencement of excavation below 140 m AOD, probe drilling will be undertaken in 10 m sections, groundwater can be managed to a limit that prevents the need for permitting. This excavation and temporary lining sequence will be carried out, as detailed in stage 1 or by grouting (Stage 3) and then continuing as detailed in Stage 1.

- Stage 3 Grouting; Prior to commencement of shaft excavation below 140 m AOD, drilling will be undertaken through the base of the temporary lined shaft to install a grout curtain to control the groundwater, to prevent permitting being required, if deemed necessary by assessing the probe drilling.

- Stage 4; This excavation and temporary lining sequence will be carried out, as detailed for Stage 1 to place the final segmental ring at around 83.17 m AOD. Beneath this ring will be cast a concrete base slab to provide protection prior to secondary lining.

- Stage 5 Secondary Lining; On completion of shaft excavation and installation of the segmental temporary liner, a permanent cast insitu hydrostatic liner will be installed from the bottom.

- If the VSM becomes available in advance of completion of this section of the Service Shaft by mechanical excavation methods, then excavation and lining may proceed as approved for the Phase 7 works.

- Following completion of permanent shaft lining to 83.17 m AOD, the sub cellar will be reinstated to enable the headframe chamber floor to be constructed up to the shaft and the floor slab piling completed.

3.2.3 Grouting Process

Grouting Layout and Drilling Process

The Stage 3 grouting, and any additional targeted grouting determined necessary by the probe drilling, will comprise a single ring of 150 mm diameter holes to create a 1.5 m thick grout curtain. This grouting process will be undertaken in descending 5 m stages to mitigate water/grout loss and bore collapse. These stage lengths will be shortened if persistent water loss or no flush return conditions arise, to enable grouting through highly permeable sections before further drilling.

Grouting Materials

A standard or microfine cement-based grout will be used together with fresh water, superplasticizer and anti-washout additives, in accordance with those approved under the Phase 5 Works, to achieve a target permeability of 1 x 10^{-7} m/s within a grout zone of 1.5 m radius around the shaft. When grouting commences from the upper level, there will be an overlap of grouting holes to ensure full coverage of grout.

The grout injection pressure will be determined by a pressure test. Grout will be injected at a pressure of up to 0.5 bar per metre depth. Following grouting, a post-treatment permeability test will be undertaken for each stage. This process will be repeated if further treatment is needed in zones of high permeability. On completion of treatment, the holes will be backfilled with the same grout mix as used for the curtain grouting.

Drilling Water

Water used in drilling will be passed through settlement tanks, silt busters and a sand filter and re-used as far as practicable, however when water quality deteriorates beyond that required by the grouting contractor the "used" water will be bled-off and tankered off-site for disposal.

3.3 Groundwater Management Measures

During shaft excavation to 83.17 m AOD, groundwater ingress will be managed by pumping from a sump at the base of the excavation immediately to a soakaway lagoon in the south of the site (as shown on Drawing 40-ARI-WS-71-CI-DR-1057 Rev0) for discharge; in accordance with Section 5 of the Water Abstraction and Impounding (Exemptions) Regulations 2017.

An observational monitoring approach will be adopted throughout the works including evaluation of the following:-

- Groundwater levels within the Saltwick Formation.
- Groundwater ingress from exposed rock face during excavation.
- Impacts of rock breaking on groundwater ingress.

Subject to the assessment of this data, amendments will be made to the grouting programme, which may include revision to the radius of grout curtain employed.

3.4 Construction Programme

The construction programme for the Phase 10 works is expected to be around 3 months from Mid-March to the end of June 2019.

4 MINESITE HYDROGEOLOGICAL CONDITIONS

The stratigraphic units that will be encountered within the depth of the shaft construction works extend from the base of the Cloughton Formation in the Ravenscar Group down to the upper part of the Whitby Mudstone Formation, as illustrated in Drawings 1433DevOD397 Appendix 1. Detailed descriptions of the geology, geotechnical properties and hydrogeological conditions across these strata are presented in the Hydrogeological Baseline Report (Ref. 1). For the purpose of this report, a summary of the aquifer units, the interpreted groundwater surface,

design permeability characteristics and water quality conditions within the depth profile of the proposed shaft construction works are provided in Table 3.

The Ravenscar Group, and upper section of the Lias Group, aquifers down to the Whitby Mudstone, are all classed as Secondary A Aquifers. At the minesite the Moor Grit Member (Scalby Formation), Scarborough Formation, Cloughton Formation and Saltwick Formation are the four main, near surface, Secondary A Aquifer units which are interconnected.

There are two principal groundwater bodies within the depth of the Phase 10 shaft construction works, one in the Cloughton aquifer and one in the Saltwick aquifer (Drawing 1433DevOD397).

The chemical quality of the groundwaters to be encountered in the Ravenscar Group aquifers may be characterised as freshwater of good quality. Due to the non-aquifer characteristics of the Whitby Mudstone, groundwater samples have not been recoverable from these strata. Based on the rock chemistry however, should groundwater be encountered within fissures in this stratum, this would be expected to be slightly alkaline with slightly elevated concentrations of sulphates.

Table 3 – Shaft Aquifer Conditions

			Service Shaft
Platform Level		m AOD	203.17
Head Chamber Diameter		m	37.4
Base of Headframe Chamber		m AOD	157
Base of Diaphragm Wall		m AOD	143
Headframe floor Piles		m AOD	154 - 117
Shaft Diameter		m	8.25
Base of Shaft		m AOD	83
Moor Grit Member	**Top & Base Level of Aquifer**	m AOD	~200.4 to 193.0
	Inferred Groundwater Surface (Winter, Mean levels)	m AOD	Winter average 197.6
	Aquifer Design Permeability	m/s	Most Likely 1.3 x10^{-5} m/s
	Water Quality		Good
Scarborough Formation	**Top and Base Level of Upper Aquitard Unit**	m AOD	~194.5 to 190.0
	Upper Aquitard Design Permeability	m AOD	Most Likely 4.0 x 10^{-6} m/s
	Elevation of Mid-Section Permeable Aquifer	m AOD	~190.0 to 188.0
	Inferred Groundwater Surface	m AOD	191.1 to 193.1
	Aquifer Design Permeability	m/s	Most Likely 1.3 x 10^{-5} m/s (Fractures 5.2 x 10^{-4} m/s)
	Water Quality		Good
	Elevation of lower Aquitard Unit	m AOD	~188.0 to 184.5
	Lower Aquitard Design Permeability	m/s	Most Likely K_h 2 x 10^{-6} m/s, K_v 1 x 10^{-8} m/s
Cloughton Formation	**Top & Base Level of Upper Aquifer**	m AOD	184.5 to 163.1
	Inferred Groundwater Surface	m AOD	181.6
	Aquifer Design Permeability	m/s	K_h 2 x 10^{-4} m/s,
	Water Quality		Good
	Top & Base Level of Lower Aquitard	m AOD	163.1 to 155.0
	Aquitard Design Permeability	m/s	K_h 1 x 10^{-7} m/s, K_v 1 x 10^{-9} m/s
Eller Beck Formation	**Top & Base Level of Formation**	m AOD	155.0 to 149.6
	Inferred Groundwater Surface	m AOD	157.3
	Water Quality		Good
	Aquitard Design Permeability	m/s	1 x 10^{-7} m/s
Saltwick Formation	**Top & Base Level of Formation**	m AOD	149.6 to 96.1
	Inferred Groundwater Surface	m AOD	138.8
	Aquifer Design Permeability	m/s	Most Likely K_h 2 x 10^{-4} m/s
	Water Quality		Good
	Aquitard Design Permeability	m/s	K_h 1 x 10^{-7} m/s, K_v 1 x 10^{-9} m/s

			Service Shaft
Dogger Formation	**Top & Base Level of Upper Aquifer**	m AOD	96.1 to 92.4
	Inferred Groundwater Surface	m AOD	Assumed 138.8
	Aquifer Design Permeability	m/s	K_h 2.3 x 10^{-8} m/s
	Water Quality		Good
Whitby Mudstone	**Top & Base Level of Formation**	m AOD	92.4 to 16.2
	Inferred Groundwater Surface	m AOD	Phreatic surface determined
	Water Quality		Expected slightly sulphatic
	Aquiclude Design Permeability	m/s	< 1 x 10^{-9} m/s

5 RECEPTORS

The hydrogeological receptors and the ecologically sensitive habitats on Ugglebarnby Moor that may be impacted upon by the Works are shown in Drawing 1433DevOR381 Appendix 1 and summarised in Table 4.

Table 4 - Receptors

Type	Receptor	Sensitivity
Sensitive Aquifers	Moor Grit Member	Medium
	Scarborough Formation	Medium
	Cloughton Formation	Medium
	Saltwick Formation	Medium
Base Flow Springs	Doves Nest Farm Spring (DNS1)	Very Low
	Ugglebarnby Moor Spring (SP01)	Very Low
	Springs Northwest of Ugglebarnby Moor (SP02, SP03)	Very Low
	Springs North of Woodsmith Mine (SP04)	Very Low
	Springs North of Woodsmith Mine (KHF)	Very Low
Spring Water Supplies	Moorside Farm Spring (MF2)	High
	Soulsgrave Farm Spring (SF2)	High
	Newton House Farm Spring (NHF1)	High
Groundwater Abstractions	Sneaton Low Moor Caravan Park	High
Ecological Receptors	Ugglebarnby Moor Northern Dry Heath Area	Low
	Ugglebarnby Moor Central Wet Heath Area	Low
	Ugglebarnby Moor Southern Dry Heath Area	Low
	Ugglebarnby Moor Southern Spring Flush (Soligenous Habitat Area)*	High (Low)*
	Sneaton Low Moor Dry Heath Area	Low
Surface Waters	Sneaton Thorpe Beck	Low
	Little Beck	Medium

Note: *Recent ecological surveys (Ref. 23) have confirmed that there are no hydrogeologically supported ecosystems within this moorland area adjacent to the minesite and that this study has now reclassified an area of flora previously designated to be a Spring Flush habitat as now identified to be a Soligenous habitat. As a precautionary measure, until discussed further, this receptor will be classified as High sensitivity.

6 QUALITATIVE HYDROGEOLOGICAL RISK ASSESSMENT

6.1 Conceptual Model

The principal hydrogeological units underlying the Headframe Chamber and Shaft construction works comprise Secondary A aquifers of local importance (Cloughton and Saltwick) to depths of around 100 m AOD. Due to the presence of leaky argillaceous aquitard units between these aquifers, there is limited vertical connectivity. Groundwater levels in these aquifers have been determined to show seasonal variability. In general, the direction of groundwater flow in these

aquifers occurs to the north/northeast, with a significant westerly and easterly flow from the hydrogeological divide aligned along the B1416, to the west of the Woodsmith Mine.

Within the minesite area, there are no hydrogeologically-supported terrestrial ecosystems or groundwater abstractions. The shallow Secondary A Aquifers beneath the minesite area are determined as being of local importance providing base flow to surface waters, in particular to Sneaton Thorpe Beck.

Offsite, bordering and within close proximity to the minesite, there is flora in the shallow valley feature (which has a precautionary classification as a Spring Flush habitat), in the southern area of Ugglebarnby Moor (Drawing 1433DevOD381 Appendix 1), which is fed by surface runoff and infiltration held in the superficial deposits, with only a minor and intermittent contribution to the general soil dampness by groundwater within the Moor Grit aquifer. The dry heath ecosystems in the northern and southern areas of Ugglebarnby Moor, and on Sneaton Low Moor and the wet heath ecosystems in the central area of Ugglebarnby Moor, are not hydrogeologically supported by shallow groundwaters in the bedrock aquifers. There are four groundwater abstractions in close proximity to the minesite (Drawing 1433DevOD382 Appendix 1); one from a well drilled into the Cloughton Formation at Sneaton Low Moor Caravan Park, and three from spring issues; one associated with Thornhill Farm (and the adjacent property) Moorside Farm Spring (MF2), Soulsgrave Farm Spring (SF2) and Newton House Farm Spring (NHF1). There are three spring discharges that have been determined to contribute low and intermittent volumes to surface water flows to the west of Ugglebarnby Moor (SP01, SP02 and SP03), and two to the north of the Woodsmith Mine (SP04 and KHF), as shown on Drawing 1433DevOD382.

6.2 Groundwater Effects

The physical and chemical groundwater effects that may arise as a result of the Phase 10 Works are summarised in Tables 5 and 6:-

Table 5 – Physical Effects

Effect	Discussion	Magnitude of Effect at Source
During excavation within the existing diaphragm walling for; the sub cellar from 158 m AOD to around 152 m AOD (51 m bgl) and for the shaft from 152 to 140 m AOD (63 m bgl), localised groundwater ingress could occur through imperfections in the panel jointing and base of the excavation. Such ingress could present a risk to construction operations.	The diaphragm walling construction penetrates into the Eller Beck Formation and should cut off vertical hydraulic continuity between the Moor Grit, Scarborough and Cloughton aquifers promoting groundwater ingress around the toe of the wall into the chamber excavation. Due to low transmissivity through the Eller Beck and basal Cloughton argillaceous strata, only low groundwater ingress is anticipated into the base of the excavation to 142 m AOD, which is to be accommodated for by sump pumping. This will be confirmed by probe drilling in advance of excavation to confirm only low water flows through ungrouted sections. Where high flows are encountered additional targeted grouting will be undertaken, as necessary, to limit inflows.	Very Low Magnitude of Effect at Source.

Effect	Discussion	Magnitude of Effect at Source
During excavation of the shaft from 140 m AOD to 113 m AOD (90 m bgl) and then 113 to 103 m AOD (100 m AOD), if grouting is required, groundwater ingress could occur through the base of the excavation and through the grout wall which is designed to a maximum permeability of around 1 x 10^{-7} m/s. Such ingress could present a risk to construction operations.	The 1.5 m radius grout wall with a design permeability of 1x10^{-7} m/s will penetrate down through the identified permeable horizons within the Saltwick Formation locally, which could locally promote groundwater ingress into open sections of the shaft excavation prior to lining. The grouting will reduce horizontal and vertical hydraulic gradient around the shaft annulus and will limit groundwater ingress through the unlined open 2 m high excavation, prior to installation of the back grouted temporary segmental liner. Only low groundwater ingress is anticipated through the sides and base of the excavation through the grouted sections, which will to be accommodated for by pumping directly to a soakaway for discharge. Prior to excavation through both the ungrouted and grouted sections, probe drilling will be undertaken to confirm only low water flows are to be managed through the open excavation. Where high flows are encountered additional targeted grouting will be undertaken, as necessary, to limit inflows.	Very Low Magnitude of Effect at Source.
During excavation of the shaft from 103 to 82.17 m AOD groundwater ingress could occur through the base of the excavation and through the ungrouted shaft wall. Such ingress could present a risk to construction operations.	Shaft excavation below 103 m AOD to 82.17 m AOD will be within the lower permeability Saltwick and Dogger aquitard units. As such, only limited groundwater ingress is expected to occur in this section of the shaft excavation below the grouted annulus. Only low groundwater ingress is anticipated through the sides and base of the excavation through this section, which will to be accommodated for by pumping directly to a soakaway for discharge. Prior to excavation through the grouted sections, probe drilling will be undertaken to confirm only low water flows are to be managed through the open excavation. Where high flows are encountered additional targeted grouting will be undertaken, as necessary, to limit inflows.	Very Low Magnitude of Effect at Source.
During temporary lining, groundwater ingress could occur into the excavation via seepage down the back of the installed temporary liner from above completed sections.	To limit vertical hydraulic continuity developing down the back of the temporary liner, back grouting will be undertaken of each completed temporary liner segment, prior to commencement of excavation for the subsequent section.	Very Low Magnitude of Effect at Source
Temporary alteration of groundwater levels in the Cloughton and Saltwick aquifers may arise during intermittent dewatering from sumps in the shaft excavation and shaft wall construction.	The process of excavation and construction of the shaft wall will entail a temporary localised dewatering from sumps to remove groundwater ingress through the unlined excavation surface. This sump pumping will have only a very localised effect on groundwater flows and levels immediately adjacent to the construction works.	Very Low Magnitude of Effect at Source.

Effect	Discussion	Magnitude of Effect at Source
Temporary alteration of the groundwater levels in the Moor Grit aquifer may arise during intermittent infiltration of groundwater from the shaft excavation and construction into the soakaway lagoon constructed in the south of the site adjacent to the reinjection pad.	Water from the shaft excavation and construction will be pumped to a soakaway lagoon that will recharge the Moor Grit Aquifer causing a localised rise in groundwater levels and flows. The base of the soakaway pond will be excavated to rockhead at the surface of the Moor Grit aquifer. Subject to the infiltration rate achieved in the base of the pond, it may necessary for excess construction water to be tankered off site to prevent exceedances of water infiltration capacity in the soakaway lagoon.	Very Low Magnitude of Effect at Source.

6.2.1 Chemical Effects

Table 6 – Chemical Effects

Effect	Discussion	Magnitude of Effect at Source
Groundwater pollution from grout losses during installation of the 1.5 m grout wall, targeted grouting and during back grouting to the temporary segmental lining.	Grouting pressures and volumes will be computer controlled to limit the risk of hydrofracturing and grout injection beyond the designed 1.5 m radius of the grout wall and during targeted grouting, where necessary. The annulus between the shaft temporary lining and rock is targeted at <50 mm wide. The back wall grouting will not be injected under pressure and inert additives will be utilised to achieve rapid setting of the grout limiting egress beyond the annulus.	Very Low Magnitude of Effect at Source
Temporary and localised groundwater pollution arising from leakage / spillage of hydraulic fluids and fuel oils from the excavation plant.	A structured maintenance and monitoring regime will be adopted for the construction operations and plant to ensure that there are no significant leaks or spillages of hydraulic fluids or lubricants that may enter the excavation or become adhered to the excavation arisings. A settlement tank will be placed in the pipework chain to the soakaway lagoon. If hydrocarbons are observed within the construction water, it will be captured and collected from the settlement tank prior to entering the soakaway for disposal off site.	Low Magnitude of Effect at Source.
Groundwater pollution of the Moor Grit aquifer from infiltration of construction water through the soakaway pond constructed in the south of the site.	Construction water will contain rock flour suspended solids and very slightly elevated pH if grouting activities are required. A settlement tank and silt sock will be placed in the pipework chain to capture suspended solids within the construction water prior to it entering the soakaway lagoon. Suspended solids will settle out in the base of the lagoon prior to infiltrating the groundwater. Marginally elevated pH, associated with the cementitious grout, will dilute and disperse within the soakaway lagoon through infiltration of the base.	Very Low Magnitude of Effect at Source.

6.3 Hydrogeological Risk Assessment

A qualitative hydrogeological risk assessment has been carried out in accordance with the methodology presented in Appendix 2 to evaluate the potential physical and chemical impacts of the Works on the site specific hydrogeological receptors, detailed in Section 5, and the results are presented in Appendix 3.2 and discussed in Section 6.4.

Evaluation of the Likelihood of Occurrence of an impact has been undertaken by consideration of the Proximity and Connectivity between an activity and the receptor. Appendix 3.1, evaluates the proximity of each activity to each receptor taking account of both horizontal and vertical proximity. To determine the Likelihood of Occurrence of an impact on a receptor, the physical and chemical impacts have been evaluated by consideration of the activity with the worst case proximity (i.e. highest values detailed in Appendix 3.2) to each receptor in conjunction with the worst case connectivity (between an activity and the receptor). The magnitude of the worst case proximity adopted for each receptor and the Likelihood of Occurrence determined are presented in Appendix 3.2.

The Magnitude of Effect at the Receptor has been evaluated by consideration of the qualitative assessment of the Magnitude of Effect at Source, as presented in Section 6.2 and the Likelihood of Occurrence as presented in Appendix 3.2.

Assessment of the Significance of Impact of the physical and chemical effects on the specific hydrogeological receptors have been evaluated by consideration of the Magnitude of Effect at Receptor and the Receptor Sensitivity and the results are presented in Appendix 3.2 and evaluated in Section 6.4.

6.4 Results of the Hydrogeological Risk Assessment

For all hydrogeological receptors, including Moorside Farm Spring, Soulsgrave Farm Spring and the habitat within the shallow valley feature (precautionary referred to as the Spring Flush), as well as the surface waters and springs, the qualitative risk assessment demonstrates that the Phase 10 Works will have a Negligible Physical and Chemical Impact. As detailed in the Section 73 Hydrogeological Risk Assessment (Ref. 11), this development will have a negligible cumulative long term hydrogeological impact on all hydrogeological receptors.

7 CONSIDERATION OF MITIGATION MEASURES

This risk assessment has demonstrated that no additional measures are required as part of the Works to mitigate hydrogeological impacts on the environment. To ensure that the hydrogeological conditions are managed effectively during the construction works testing and monitoring procedures for specific construction activities are detailed in the Groundwater Management Schemes (Ref. 17 to 20).

As part of this assessment, consideration has been given as to whether the recharge trench to the west of Bund C and groundwater drainage beneath Bunds E and F are necessary mitigation measures to be initiated as part of these Phase 10 Works. Taking account of the previously submitted quantitative modelling outputs and field monitoring data (Ref 22), this hydrogeological risk assessment has demonstrated that these measures are not warranted at this stage of the construction process.

8 CONSTRUCTION OPERATION GROUND AND SURFACE WATER MONITORING SCHEME

As determined from the hydrogeological risk assessment presented in Section 6, the Works present negligible physical and chemical impacts on groundwater levels and spring flow rates at Moorside and Soulsgrave Farm springs and a negligible physical and chemical impact on the Spring Flush terrestrial ecosystem.

Over the Phase 10 construction period, construction phase ground and surface water monitoring will be undertaken in accordance with the procedures detailed in the Construction and Operation Groundwater and Surface Water Monitoring Scheme for the Phase 4 and 4a Works (Refs. 15 and 17) and with the supplementary requirements of the additional monitoring detailed in the Phase 6, 7, 8 and 9 Hydrogeological Risk Assessments (Refs. 7 and 10).

The scope of monitoring and the Trigger Values proposed for the Phase 4 and 4a Works and amended in the Phase 7 Hydrogeological Risk Assessment (Ref. 8) are also considered appropriate for the Phase 10 Works and, as such, no amendment or addition is considered necessary to the trigger values implemented through the Phase 4 and 4a agreed procedures.

An observational monitoring approach of groundwater levels and groundwater ingress impacting on the Service Shaft excavation will be undertaken during the Phase 10 works. This will include monitoring of the existing Vibrating Wire Piezometers (VWPs) placed with the Cloughton and Saltwick Formations around the shaft, monitoring of the groundwater ingress into the shaft excavation and monitoring of the pumping rate necessary to maintain the excavation dry.

9 REMEDIAL ACTION PLAN

During the Phase 10 construction period, the procedures for evaluating breaches in Trigger Values for groundwater quality, spring water quality, surface water quality and geomorphology and ecology, the reporting strategy, and the responsibilities and contacts of parties who will manage the remedial actions, will all be as detailed in the approved Remedial Action Plan for the Phase 4, 4a, 5 and 9 Works (Refs. 13, 16, 6 and 25 respectively).

C MILLER
ASSOCIATE DIRECTOR

R IZATT-LOWRY
DIRECTOR

10 REFERENCES

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2 FWS Consultants Ltd, 2017 Hydrogeological Risk Assessment for the Phase 2 Works at Doves Nest Farm Minesite, North Yorkshire (1433OR27).

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20 FWS Consultants Ltd, 2017 Groundwater Management Scheme for the Phase 7 Works at Woodsmith Mine, North Yorkshire (1433OR401).

21 Sirius NYMNPA 94 - Construction Method Statement (Phase 7) Document No. 40-SMP-WS-7100-PA-MS-0007.

22 Sirius Minerals Plc, 2018 Review of Dewatering During Diaphragm Walling at the Service Shaft. Doc. Ref. No. 40-SMP-WS-1200-WM-RP-00001.

23 PAC Ltd, Ugglebarnby Moor Vegetation Survey (2018). 40-PCA-WS-8300-EN-SV-00001/V3.

24 Sirius NYMNPA 94 - Construction Method Statement (Phase 10) Document No. 40-SMP-WS-7100-PA-MS-0008.

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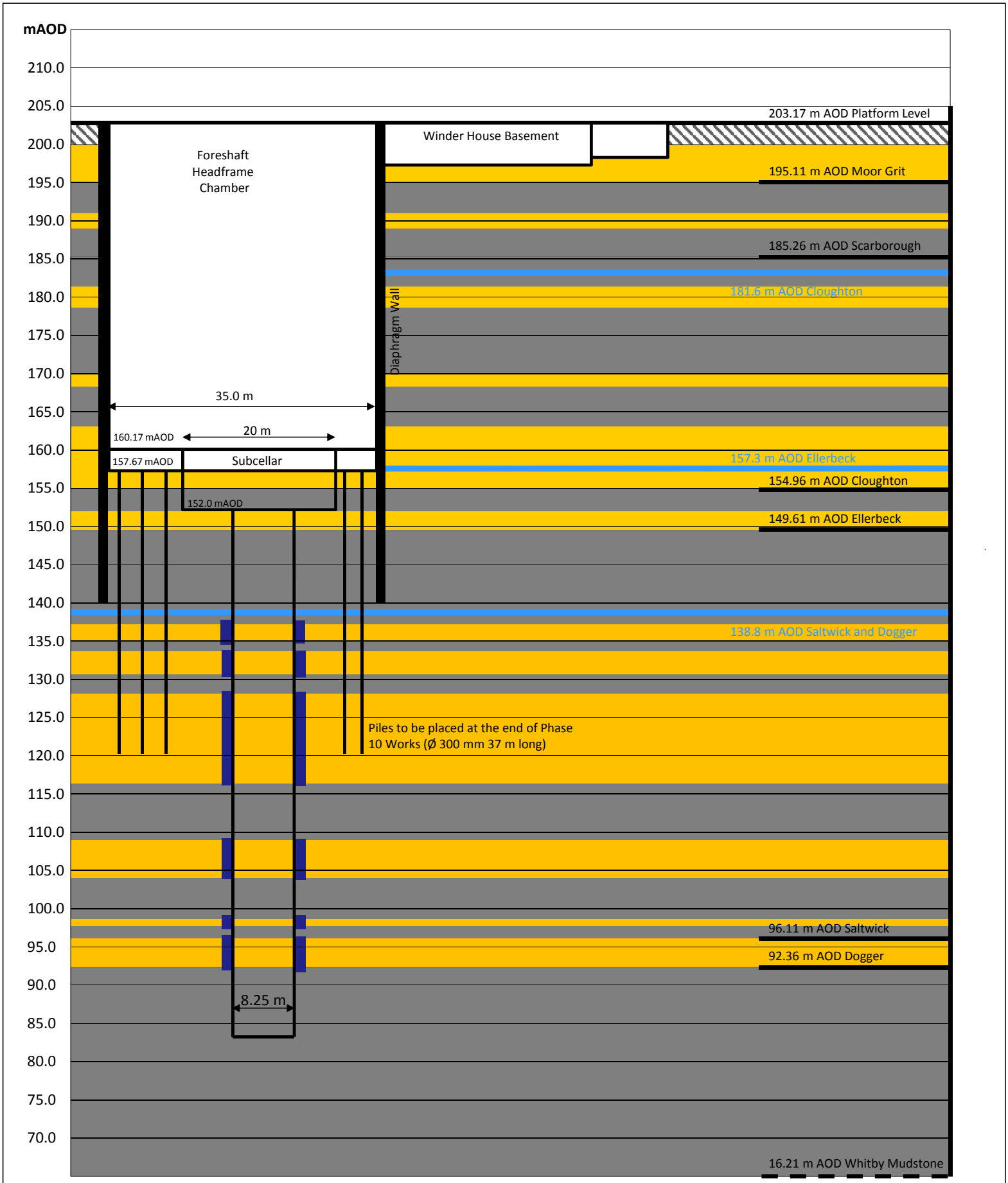
APPENDIX 1

DRAWINGS

1433DevOD397	HYDROGEOLOGICAL SCHEMATIC SECTION THROUGH PHASE 10 WORKS AS SERVICE SHAFT
1433DevOD380	GEOLOGICAL PLAN FOR PHASE 10 WORKS
1433DevOD381	PHASE 10 HYDROGEOLOGICAL RECEPTORS AND ECOLOGICALLY SENSITIVE HABITATS ON UGGLEBARNBY MOOR
1433DevOD382	WOODSMITH MINE HYDROGEOLOGICAL RECEPTORS - PHASE 10



NOTES / KEY

- GRANULAR PLATFORM AND SUPERFICIALS
- SANDSTONE AQUIFERS
- MUDSTONE AND SILTSTONE AQUITARDS
- GROUT ZONES
- CURRENT GROUNDWATER HEAD LEVELS (FEBRUARY 2019)
- STRATA BOUNDARY WITH BASE ELEVATION

DRAWING TITLE

HYDROGEOLOGICAL SCHEMATIC THROUGH THE PHASE 10 WORKS AT THE SERVICE SHAFT

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT

SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
FINAL	1433
DRAWN BY	DATE
CM	March 2019
SCALE	DRG. No.
AS SHOWN	1433DevOD397

FWS Geological & Geo-Environmental Consultants

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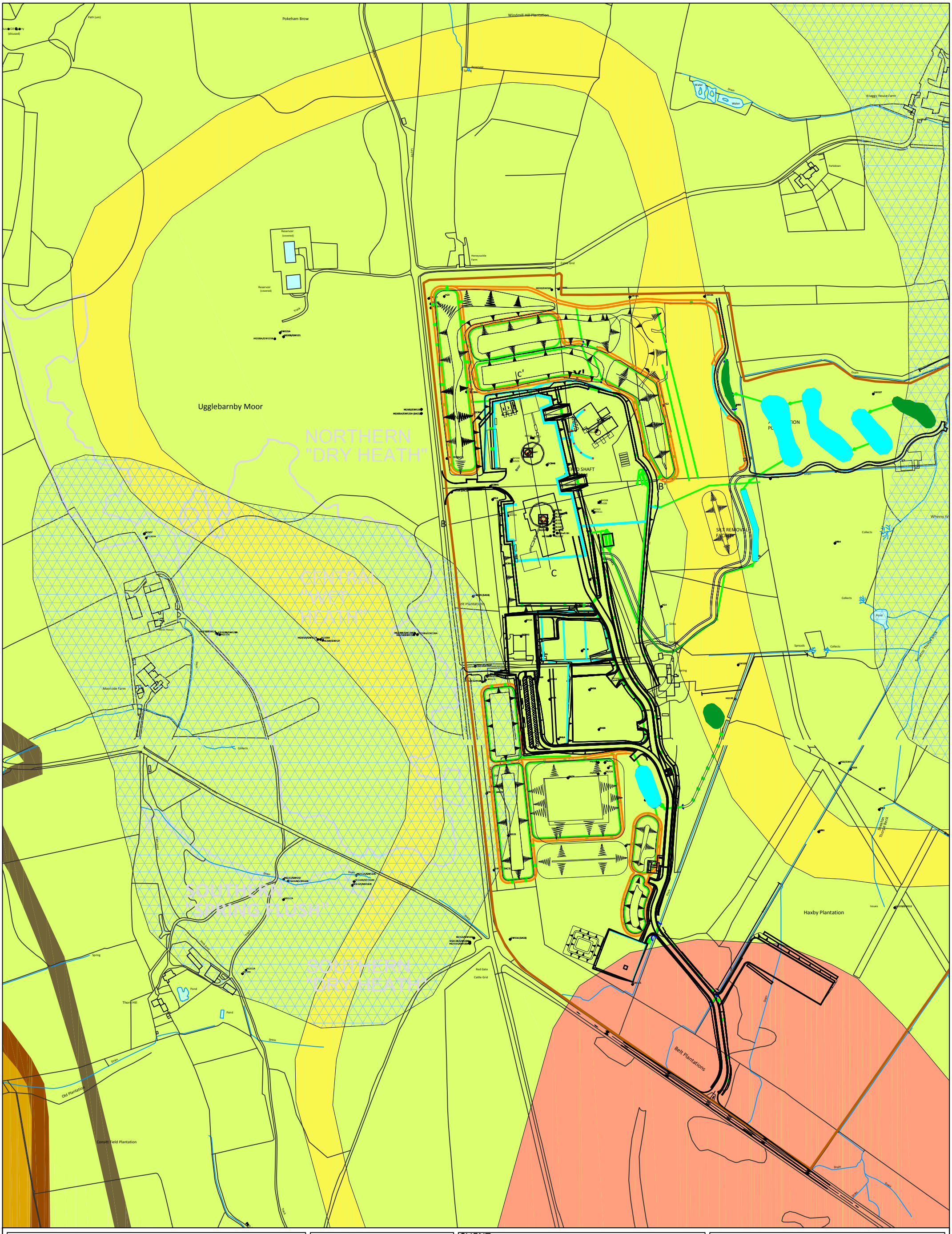

NOTES / KEY

SITE OWNERSHIP BOUNDARY

NYM SAC

SURFACE WATER

BOREHOLES GCBH01

HYDROGEOLOGICAL RECPTORS MF2

LINE OF CROSS SECTION
CROSS SECTION A-A' and B-B' DRAWING 1433DevOD244
CROSS SECTION A-A' DIAPHRAGM WALL DRAWING1433DevOD268
CROSS SECTION C-C' DRAWING 1433DevOD266
CROSS SECTION D-D' DRAWING 1433DevOD267

GEOLOGY
GLACIAL TILL
LONG NAB
MOOR GRIT
SCARBOROUGH FORMATION
CLOUGHTON & SALTWICK FORMATION
ELLER BECK FORMATION
DOGGER FORMATION
WHITBY MUDSTONE

DRAWING TITLE

GEOLOGICAL MAP AND LINE OF CROSS SECTIONS

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433Dev

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1433DevOD380

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NORTHERN "DRY HEATH"

CENTRAL "WET HEATH"

SOUTHERN "SPRING FLUSH"

SOUTHERN "DRY HEATH"

Ugglebarnby Moor

Knaggy House Farm

SP04

SP01

Discharge 108/10

HG2 Discharge

MF1

MF2

Windmill Hill Plantation

Whinny Wood

Haxby Plantation

Belt Plantations

NOTES / KEY

- NYM SAC
- SURFACE WATER
- BOREHOLES GCBH01
- HYDROGEOLOGICAL RECEPTORS MF2

DRAWING TITLE
HYDROGEOLOGICAL RECEPTORS AND ECOLOGICALLY SENSITIVE HABITATS ON UGGLEBARNBY MOOR - PHASE 10

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433Dev

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MARCH 2019

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1:5,000@A3/1:2,500@A1

DRG. No.
1433DevOD381

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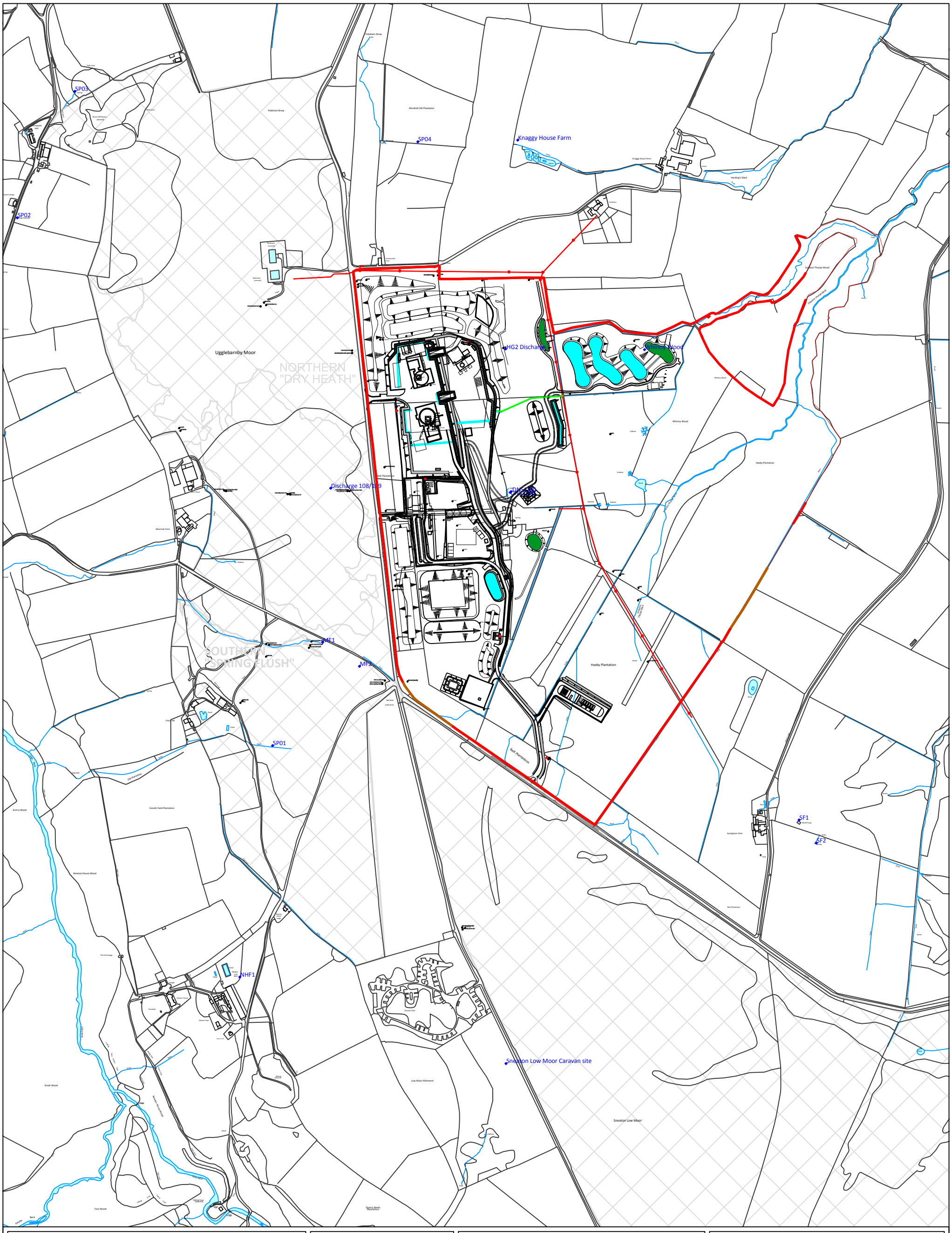

NOTES / KEY

SITE OWNERSHIP BOUNDARY

NYM SAC

SURFACE WATER

BOREHOLES GCBH01

HYDROGEOLOGICAL RECEPTORS MF2

DRAWING TITLE

HYDROGEOLOGICAL RECEPTORS - PHASE 10

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433Dev

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CM

DATE
MARCH 2019

SCALE
1:8,000@A3/1:4,000@A1

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1433DevOD382

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APPENDIX 2

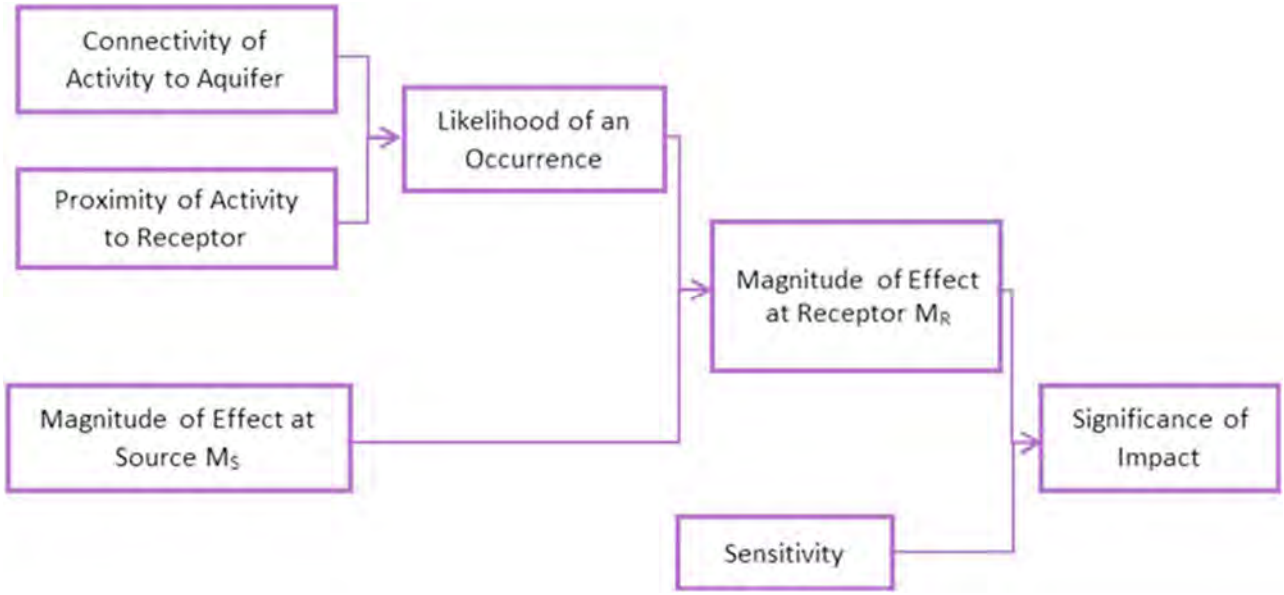
RISK ASSESSMENT METHODOLOGY

APPENDIX 2

1 RISK ASSESSMENT METHODOLOGY

The revised qualitative hydrogeological risk assessment presented in this report evaluates the "Significance of Impact" of the Phase 10 Works on hydrogeologically sensitive receptors, and follows a source-pathway-receptor approach to meet regulatory requirements.

In order to evaluate the physical and chemical hydrogeological impacts, the following criteria, and the linkages between them, have been considered:-



Two criteria have been used to assess the "Likelihood" of an effect propagating through the hydrogeological system to a receptor. These are the Connectivity and Proximity of an activity to a receptor. Therefore, the closer and more directly connected an activity is to a receptor, the more likely it is that a pathway will exist between an activity and that receptor.

The Magnitude of Effect at Source (MS) has been considered in terms of the worst-case physical and chemical changes to baseline conditions that might occur.

Combining the Likelihood of an Occurrence with the Magnitude of Effect at Source provides a qualitative evaluation for the Magnitude of Effect at Receptor (MR), which is the effect that a particular activity will have on a specific receptor.

The Magnitude of Effect at Receptor is then combined with the Sensitivity of the Receptor to provide an estimate of the Significance of Impact.

Five categories are used to describe the Connectivity, the Proximity, the Likelihood of an Occurrence, the Magnitude of Effect at Source (MS), the Magnitude of Effect at Receptor (MR); and the Sensitivity of a Receptor:-

- Very High
- High
- Medium
- Low
- Very Low

Four categories are then used to describe the overall "Significance of Impact":-

- Major
- Moderate
- Minor
- Negligible

The results of the revised qualitative assessment are given in risk matrices presented in Appendix 3 that identify which of the five categories above apply to specific activities and receptors during the Phase 10 Works and, from this, it has been assessed which of the four categories of "Significance of Impact" they belong.

The following sections provide descriptions and definitions for each of these categories as they apply to each of the components of the qualitative risk assessment.

1.1 Likelihood of Occurrence

The Likelihood of Occurrence of a physical or chemical effect is evaluated by combining Connectivity and Proximity of an activity to a receptor, as detailed below.

Likelihood	**Connectivity between Activity and Receptor**					
		Very Low	**Low**	**Medium**	**High**	**Very High**
Receptor Proximity to Activity	**Very Low**	Very Low	Low	Low	Medium	Medium
	Low	Low	Low	Medium	Medium	High
	Medium	Low	Medium	Medium	High	High
	High	Medium	Medium	High	High	Very High
	Very High	Medium	High	High	Very High	Very High

1.1.1 Connectivity

Very High Connectivity	Activity and receptor occur in the same aquifer unit, with a direct or known pathway between them. For chemical impacts, the receptor is also down hydraulic gradient from the activity and on the same flow path (determined as being a line of flow between the source and the receptor that is perpendicular to groundwater contours).
High Connectivity	Activity and receptor occur in the same aquifer unit but the pathway is indirect as a result of the presence of a very thin (<1 m) or discontinuous aquitard. For chemical impacts, the receptor is down hydraulic gradient from the activity and is slightly oblique to the flow path.
Medium Connectivity	Activity and receptor occur in adjacent aquifer units that are in hydraulic continuity but are separated by a thin (>1 m), fractured or leaky aquitard. For chemical impacts the receptor is down hydraulic gradient from the activity and is strongly oblique to a flow path.
Low Connectivity	Activity and receptor are in adjacent aquifer units with no or very limited hydraulic continuity between them due to the presence of a natural or man-made aquitard. For chemical impacts the receptor is down hydraulic gradient from the activity and is on a different flow path.
Very Low Connectivity	There is no hydraulic continuity between the activity and the receptor due to the presence of a laterally and vertically continuous, or multiple thin (>1 m) aquitard units, an aquiclude unit or an engineered barrier unit. For chemical impacts, the receptor is up hydraulic gradient from the activity.

1.1.2 Proximity

In accordance with Environment Agency guidance on groundwater protection (Ref. 12), the minimum permitted distance for the proximity of a potentially polluting activity to a water abstraction is 50 m (equivalent to Source Protection Zone I). As such, for the purpose of this qualitative risk assessment a distance of <50 m has been used to define the condition of Very High Proximity. By consideration of Environment Agency guidance for the minimum distance of 250 m to a Source Protection Zone II this distance has been used to define the condition of High Proximity. Moderate and a Low Proximity limits have been set equally spaced from the 250 m zone, at 500 and 750 m respectively, and a Very Low Proximity has been defined as >750 m. The following absolute values have, therefore, been used to evaluate the Proximity of an activity to a receptor.

Very high proximity	< 50 m
High proximity	51 – 250 m
Medium proximity	251 – 500 m
Low proximity	501 – 750 m
Very low proximity	>750 m

A multi-layered aquifer system also requires consideration of vertical proximity. In order to take this into account, the proximity between aquifers moving down vertically through a sequence is reduced by one category for each aquifer to be consistent with the concept of connectivity.

1.2 Magnitude of Effect at Source (M_S)

The Magnitude of Effect at Source of a physical or chemical impact is categorised, as detailed below:-

Very High Magnitude of Effect at Source	A very high degree of physical change is a change in groundwater level that is >150% of the regional natural annual groundwater level variation for an aquifer, or >150% of the natural variation in flowrate from a spring. A very high degree of chemical change is a change of >150% of the natural baseline chemical quality variation that could cause a risk of harm or give rise to a pollution risk.
High Magnitude of Effect at Source	A high degree of physical change is a change in groundwater level that is between 100 and 150% of the regional natural annual groundwater level variation for an aquifer, or between 100 and 150% of the natural variation in flowrate from a spring. A high degree of chemical change is a change of between 100 and 150% of the natural baseline chemical quality variation that could cause a risk of harm or give rise to a pollution risk.
Medium Magnitude of Effect at Source	A moderate degree of physical change is a change in groundwater level that is between 50 and 100% of the local natural annual groundwater level variation for an aquifer, or between 50 and 100% of the natural variation in flowrate from a spring. A high degree of chemical change is a local change of between 50 and 100% of the natural baseline chemical quality variation that could cause a risk of harm or give rise to a pollution risk.
Low Magnitude of Effect at Source	A low degree of physical change is a change in groundwater level that is between 20 and 50% of the local natural annual groundwater level variation for an aquifer, or between 20 and 50% of the natural variation in flowrate from a spring. A low degree of chemical change is a local change of between 20 and 50% of the natural baseline chemical quality variation.
Very Low Magnitude of Effect at Source.	A very low degree of physical change is a change in groundwater level that is <20% of the local natural annual groundwater level variation for an aquifer, or <20% of the flow from a spring. A very low degree of chemical change is a local change of <20% of the local natural baseline chemical variation.

1.3 Magnitude of Effect at Receptor (MR)

The Magnitude of Effect at any Receptor is estimated by combining the Magnitude of Effect at Source and the Likelihood of a hydrogeological "effect" occurring, as detailed in the matrix below:-

Magnitude of Effect at the Receptor		**Likelihood**				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Magnitude of Effect at Source	**Very Low**	Very Low	Very Low	Very Low	Very Low	Very Low
	Low	Very Low	Very Low	Low	Low	Low
	Medium	Very Low	Low	Low	Medium	Medium
	High	Very Low	Low	Medium	High	High
	Very High	Very Low	Low	Medium	High	Very High

A description of the five categories of hydrogeological "Magnitude of Effect at the Receptor" that have been used in this report are presented below:-

Magnitude of Effect at Receptor	**Description**
Very High	Loss of resource and/or integrity of the resource; severe damage to key characteristics or features and permanent/ irreplaceable change is certain to occur.
High	Loss of resource, but not affecting the overall integrity of the resource; partial loss of or damage to key characteristics or features and permanent/irreplaceable change is likely to occur.
Medium	Minor loss of, or alteration to, key characteristics of a resource; measurable change in attributes, quality or vulnerability. Long term, though reversible change, is likely to occur.
Low	Very minor loss of, or alteration to, key characteristics of a resource; noticeable change in attributes, quality or vulnerability. Short to medium term, though reversible, change could possibly occur.
Very Low	Temporary or intermittent very minor loss of, or alteration to, key characteristics of a resource; noticeable change in attributes, quality or vulnerability. Short to medium term change is unlikely to occur, and when does is likely to be intermittent and reversible.

1.4 Receptor Sensitivity

The sensitivity of groundwater receptors in the qualitative risk assessment has been assessed in terms of their ability to accommodate physical or chemical change and on the impact any change may have on a regional or local ecological or other environmental system. By adopting this approach to the qualitative assessment, the most sensitive receptors are determined to be those with very limited or no capacity to accommodate physical and/or chemical change that are of very high importance as a groundwater resource. Conversely very low sensitivity receptors are those that can generally tolerate physical and/or chemical changes and are of low importance as a groundwater resource. Groundwater receptor characteristics and receptor examples are detailed in the table overleaf:-

Sensitivity	Groundwater Receptor Characteristics	Receptor Examples
Very High	• Has very limited or no capacity to accommodate physical or chemical changes. • Supports internationally important ecological, amenity or landscape features.	• Licensed public water supply or major industrial abstractions (e.g. SPZ 1/2). • Licensed/unlicensed abstractions and springs providing potable water supply, for which there is no alternative source (e.g. mains water). • Designated SAC, SPA, or Ramsar site with fauna or flora that are hydrogeologically supported from groundwaters within rock aquifers. • Surface water bodies supporting the above.
High	• Has limited capacity to accommodate physical or chemical changes. • Supports nationally important ecological amenity or landscape features.	• Designated 'Principal Aquifer'. • Licensed/unlicensed abstractions and springs providing potable water supply, for which an alternative source (e.g. mains water) is available. • Designated SAC, SPA, or Ramsar site with fauna or flora that are intermittently but not primarily hydrogeologically supported from groundwaters. • SSSI, NNR with fauna or flora that are hydrogeologically supported from groundwaters within rock aquifers. • Surface water bodies supporting the above.
Medium	• Has limited capacity to accommodate physical or chemical changes. • Supports regionally important ecological, amenity or landscape features.	• Designated 'Secondary A (or Undifferentiated) Aquifer'. • Regionally important wildlife sites with fauna or flora that are hydrogeologically supported from groundwaters within rock aquifers. • Non-potable licensed abstractions. • Surface water bodies supporting the above or classified as Good under Water Framework Directive.
Low	• Has moderate capacity to accommodate physical or chemical changes. • Supports locally important ecological, amenity or landscape features.	• Non-potable unlicensed abstractions. • Local wildlife sites (LNR, SNCI, RIGS), country parks with flora hydrogeologically supported from groundwaters within rock aquifers. • Designated SAC, SPA, or Ramsar site with fauna or flora that are not hydrogeologically supported from groundwaters within rock aquifers. • Surface water bodies supporting the above or classified as Moderate under Water Framework Directive.
Very Low	• Generally tolerant of and can accommodate physical or chemical changes. • Supports no features of significant ecological, amenity or landscape value.	• Designated 'Secondary B Aquifer' or 'Unproductive Strata'. • Surface waters with no important, dependent receptors. • SSSI, NNR with fauna or flora that are not hydrogeologically supported from groundwaters within rock aquifers.

1.5 Significance of Impact

The significance of the impact that changes will have on a hydrogeological receptor is assessed by comparing the Magnitude of Effect at Receptor with the receptor Sensitivity. This is assessed using the following matrix.

Receptor Sensitivity	Magnitude Of Effect At Receptor				
	Very Low	**Low**	**Medium**	**High**	**Very High**
Very Low	Negligible	Negligible	Negligible	Negligible	Minor
Low	Negligible	Negligible	Minor	Minor	Minor
Medium	Negligible	Minor	Minor	Moderate	Moderate
High	Negligible	Minor	Moderate	Moderate	Major
Very High	Negligible	Minor	Moderate	Major	Major

The four categories assigned to the Significance of Impact above relate to a Major, Moderate, Minor or negligible (as identified below) against which the necessity to implement mitigation measures is evaluated.

Significance of Impact	Description	Necessity Of Mitigation Measures
Major	Major risk of unacceptable change to a sensitive hydrogeological receptor.	Mitigation measures required.
Moderate	Moderate risk with measurable change to a sensitive hydrogeological receptor.	Mitigation measures required.
Minor	Minor risk with local minor change to a sensitive hydrogeological receptor.	Mitigation measures may be required.
Negligible	No risk and no discernible change to a sensitive hydrogeological receptor.	No mitigation measures required.

APPENDIX 3

QUALITATIVE RISK ASSESSMENT

APPENDIX 3.1

EVALUATION OF PROXIMITY OF RECEPTOR TO THE PHYSICAL AND CHEMICAL EFFECTS OF CONSTRUCTION WORKS ASSOCIATED WITH SPECIFIC PHASE 10 WORKS ACTIVITIES

Receptor and Associated Geology		() = overlying	Phase 10 Works Activities and Associated Geology	
			Service Shaft	Soakaway Lagoon
			Moor Grit, Scarborough, Cloughton, Saltwick	Moor Grit
Ugglebarnby Moor Northern Dry Heath Area	**Dry Heath Ecology**	Distance (m) Horizontal Proximity **Calculated Proximity**	185 High **Medium**	675 Low **Very Low**
Ugglebarnby Moor Central Wet Heath Area	**Wetland Ecology**	Distance (m) Horizontal Proximity **Calculated Proximity**	160 High **Medium**	280 Medium **Low**
Ugglebarnby Moor Southern Dry Heath Area	**Dry Heath Ecology**	Distance (m) Horizontal Proximity **Calculated Proximity**	540 Low **Very Low**	170 High **High**
Ugglebarnby Moor Southern Spring Flush	**Wetland Ecology**	Distance (m) Horizontal Proximity **Calculated Proximity**	515 Low **Low**	415 Medium **Medium**
Sneaton Low Moor Dry Heath Area	**Dry Heath Ecology**	Distance (m) Horizontal Proximity **Calculated Proximity**	800 Very Low **Very Low**	115 High **High**
Sneaton Thorpe Beck	**Surface Water**	Distance (m) Horizontal Proximity **Calculated Proximity**	585 Low **Low**	135 High **High**
Little Beck	**Surface Water**	Distance (m) Horizontal Proximity **Calculated Proximity**	1215 Very Low **Very Low**	1020 Very Low **Very Low**
Sneaton Low Moor Caravan Park Cloughton Fm	**Drinking Water**	Distance (m) Horizontal Proximity **Calculated Proximity**	1405 Very Low **Very Low**	600 Low **Very Low**
MF2 Moor Grit	**Drinking Water**	Distance (m) Horizontal Proximity **Calculated Proximity**	570 Low **Low**	260 Medium **Medium**
SF2 Scarborough Fm	**Drinking Water**	Distance (m) Horizontal Proximity **Calculated Proximity**	1350 Very Low **Very Low**	850 Very Low **Very Low**
NHF Cloughton Fm	**Drinking Water**	Distance (m) Horizontal Proximity **Calculated Proximity**	1390 Very Low **Very Low**	860 Very Low **Very Low**
SP01 Moor Grit	**Baseflow**	Distance (m) Horizontal Proximity **Calculated Proximity**	850 Very Low **Very Low**	470 Medium **Medium**
SP02, SP03 Cloughton Fm	**Baseflow**	Distance (m) Horizontal Proximity **Calculated Proximity**	1070 Very Low **Very Low**	1530 Very Low **Very Low**
SP04 Moor Grit	**Baseflow**	Distance (m) Horizontal Proximity **Calculated Proximity**	635 Very Low **Very Low**	1280 Very Low **Very Low**
DNS1 Moor Grit	**Baseflow**	Distance (m) Horizontal Proximity **Calculated Proximity**	250 High **High**	445 Medium **Medium**
Knaggy House Farm Spring Scarborough Fm	**Baseflow**	Distance (m) Horizontal Proximity **Calculated Proximity**	670 Low **Low**	1275 Very Low **Very Low**
Moor Grit Secondary A Aquifer	**"Shallow aquifer/ Drinking water/ Baseflow"**	Distance (m) Horizontal Proximity **Calculated Proximity**	0 Very High **Very High**	0 Very High **Very High**
Scarborough Fm Secondary A Aquifer	**"Shallow aquifer/ Drinking water/ Baseflow"**	Distance (m) Horizontal Proximity **Calculated Proximity**	0 Very High **Very High**	0 Very High **High**
Cloughton Fm Secondary A Aquifer	**"Moderate depth aquifer/ Drinking water/ Baseflow"**	Distance (m) Horizontal Proximity **Calculated Proximity**	0 Very High **Very High**	0 Very High **Medium**
Saltwick Fm Secondary A Aquifer	**Moderate depth aquifer**	Distance (m) Horizontal Proximity **Calculated Proximity**	0 Very High **Very High**	0 Very High **Low**

Note: Calculated Proximity is determined from the Horizontal Proximity and the Vertical Proximity as detailed in Appendix 2.

APPENDIX 3.2 - Qualitative Hydrogeological Risk Assessment - Phase 10 Works

			Ugglebarnby Moor Northern Dry Heath Area	Ugglebarnby Moor Central Wet Heath Area	Ugglebarnby Moor Southern Dry Heath Area	Ugglebarnby Moor Southern Spring Flush Area	Sneaton Low Moor Dry Heath Area	Sneaton Thorpe Beck	Little Beck	Sneaton Low Moor Caravan Park	MF2	SF2	NHF	SP01	SP02, SP03	SP04	Knaggy House Farm Spring	Moor Grit Secondary A Aquifer	Scarborough Fm Secondary A Aquifer	Cloughton Fm Secondary A Aquifer	Saltwick Fm Secondary A Aquifer
			Dry Heath Ecology	Wetland Ecology	Dry Heath Ecology	Wetland Ecology	Dry Heath Ecology	Surface Water	Surface Water	Drinking Water	Drinking Water	Drinking Water	Drinking Water	Baseflow	Baseflow	Baseflow	Baseflow	Shallow aquifer/ Drinking water/ Baseflow	Shallow aquifer/ Drinking water/ Baseflow	Medium depth aquifer/ Drinking water/ Baseflow	Medium depth aquifer
PHYSICAL IMPACTS	During excavation within the existing diaphragm walling for; the sub cellar from 158 m AOD to around 152 m AOD (51 m bgl) and for the shaft from 152 to 140 m AOD (63 m bgl), localised groundwater ingress could occur through imperfections in the panel jointing and base of the excavation. Such ingress could present a risk to construction operations.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Low	High	Very Low	Low	Low	Low	Very High	Very High
		Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very High	Very High
		Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Low	Medium	Very Low	Low	Low	Low	Very High	Very High
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
	During excavation of the shaft from 140 m AOD to 113 m AOD (90 m bgl) and then 113 to 103 m AOD (100 m AOD) within the grout wall, groundwater ingress could occur through the base of the excavation and through the grout wall which is designed to a maximum permeability of around 1x10-7 m/s. Such ingress could present a risk to construction operations.	Connectivity between Activity and Receptor	Low	Low	Low	Low	Low	Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	High	Very Low	Very Low	Low	Low	Very High	Very High
		Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very High	Very High
		Likelihood	Low	Low	Low	Low	Low	Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Medium	Very Low	Low	Low	Low	Very High	Very High
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
	During excavation of the shaft from 103 to 82.17 m AOD groundwater ingress could occur through the base of the excavation and through the ungrouted shaft wall. Such ingress could present a risk to construction operations.	Connectivity between Activity and Receptor	Low	Low	Low	Low	Low	Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Medium	Very Low	Very Low	Very Low	Very Low	Very High	Very High
		Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very High	Very High
		Likelihood	Low	Low	Low	Low	Low	Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very High	Very High
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
	During temporary lining, groundwater ingress could occur into the excavation via seepage down the back of the installed temporary liner from above completed sections.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	High	Very Low	Low	Low	Very Low	High	Very Low	Low	Very Low	Very Low	Very High	Very High
		Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very High	Very High
		Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Medium	Very Low	Low	Low	Very Low	Medium	Very Low	Low	Very Low	Very Low	Very High	Very High
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
	Temporary alteration of the groundwater levels in the Moor Grit aquifer may arise during intermittent infiltration of groundwater from the shaft excavation and construction into the soakaway lagoon constructed in the south of the site adjacent to the reinjection pad.	Connectivity between Activity and Receptor	High	High	High	High	High	High	Medium	Low	Medium	Medium	Low	High	Low	High	Medium	Very High	Medium	Medium	Low
		Receptor Proximity to Activity	Very Low	Low	Very High	Medium	Very High	Very High	Very Low	Very Low	Medium	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very High	High	Medium	Low
		Likelihood	Medium	Medium	Very High	High	Very High	Very High	Low	Low	Medium	Low	Low	Medium	Low	Medium	Low	Very High	High	Medium	Low
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
CHEMICAL IMPACTS	Groundwater pollution from grout losses during installation of the 1.5 m grout wall, targeted grouting and during back grouting to the temporary segmental lining.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Medium	Very Low	Very Low	Low	Low	Very High	Very High
		Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very High	Very High
		Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very High	Very High
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
	Temporary and localised groundwater pollution arising from leakage / spillage of hydraulic fluids and fuel oils from the excavation plant.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Medium	Very Low	Very Low	Very High	Medium	Very High	Very High
		Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very High	High	Very High	Very High
		Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Low	Very Low	Low	Very High	High	Very High	Very High
		Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Low**	**Low**	**Low**	**Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Minor**	**Minor**	**Minor**	**Minor**
	Groundwater pollution of the Moor Grit aquifer from infiltration of construction water through the soakaway pond constructed in the south of the site.	Connectivity between Activity and Receptor	High	High	High	High	High	High	Medium	Low	Medium	Medium	Low	High	Low	High	Medium	Very High	Medium	Medium	Low
		Receptor Proximity to Activity	Very Low	Low	Very High	Medium	Very High	Very High	Very Low	Very Low	Medium	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very High	High	Medium	Low
		Likelihood	Medium	Medium	Very High	High	Very High	Very High	Low	Low	Medium	Low	Low	Medium	Low	Medium	Low	Very High	High	Medium	Low
		Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
		Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
		Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Medium**	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Medium**	**Medium**	**Medium**	**Medium**
		Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**