LICHFIELDS

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Date: 9 April 2020
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, 64, 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, 64, 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 12 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 12 Works

Phase 12 covers off the following proposed works at the Woodsmith Mine:

- Assembly and operation of Shaft Boring Roadheaders (SBR) at both Service Shaft and Production Shaft;
- Installation of additional welfare cabins;
- Installation of segregated materials bunker;
- Creation of laydown area for segment and tubbing storage;
- Installation of lightning protection and canopy to SSUs; and
- Installation of access control measures.

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 12 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 12.

Partial Discharge

Sirius Minerals acknowledges that limited and partial approval of Planning Conditions 4, 18, 34, 45, 46, 47, 52, 57, 60, 64, 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 9 April 2020 (reference PP-08641806) 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 12 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

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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-22-01067 - Woodsmith Mine Construction Phase 12 Masterplan 40-ARI-WS-7100-CI-22-01068 - Woodsmith Mine Construction Phase 12 Planning Phases Comparison General Arrangement 40-ARI-WS-7100-CI-22-01069 – Woodsmith Mine Construction Phase 12 Drainage General Arrangement 40-ARI-WS-7100-CI-22-01071 - Woodsmith Mine Construction Phase 12 Additional Laydown Area 40-ARI-WS-7100-CI-22-01072 – Woodsmith Mine Construction Phase 12 Bund F Surface Water Drainage 40-ARI-WS-7100-CI-22-01073 – Woodsmith Mine Construction Phase 12 Bund F Basal Drainage 40-ARI-WS-7100-CI-18-01072 Woodsmith Mine Construction Phase 12 Earthworks
4	Phasing Plan	40-ARI-WS-7100-CI-22-01068 - Woodsmith Mine Construction Phase 12 Planning Phases Comparison General Arrangement	40-ARI-WS-7100-CI-22-01067 - Woodsmith Mine Construction Phase 12 Masterplan
18	Noise & Vibration	Phase 12 Woodsmith Mine Noise and Vibration Management Plan – 40-RHD-WS-EN-PL-0044	Phase 12 – Woodsmith Mine Construction Environmental Management Plan – 40-RHD-WS-70-EN-PL-0045 Phase 12 Construction Method Statement – NYMNPA 94 – 40-SMP-WS-7100-PA-MS-00011
34	Construction Traffic	Phase 12 Woodsmith Mine Construction	Phase 4 CTMP (reference 40-RHD-WS-70-CI-PL-0004)

	Management Plan	Traffic Management Plan 40-RHD-WS-70-CI-PL-0016	
45	Recharge Trench	Phase 12 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0014	N/A
46	GW / SW Monitoring Scheme	Phase 12 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0014	Phase 11 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0013 Phase 11 Works at Woodsmith Mine, North Yorkshire Construction and Operation Phase Ground & Surface Water Monitoring Scheme – 40-FWS-WS-70-WM-PL-0023
46	Hydrogeological Risk Assessment	Phase 12 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0014	N/A
46	Remedial Action Plan	Phase 12 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0014	Phase 11 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0013 Phase 11 Works at Woodsmith Mine, North Yorkshire Construction and Operation Phase Ground & Surface Water Monitoring Scheme – 40-FWS-WS-70-WM-PL-0023
47	Groundwater Management Scheme	Phase 12 Works at Woodsmith Mine, North Yorkshire Hydrogeological Risk Assessment – 40-FWS-WS-70-WM-RA-0014	Phase 11 Works at Woodsmith Mine, North Yorkshire – Groundwater Management Scheme – 40-FWS-WS-70-WM-PL-0022
52	Protected Species	Refer to CEMP (Condition 93)	Phase 11 – Woodsmith Mine Protected Species Management Plan – Bats – 40-

	Management Plan		RHD-WS-70-EN-PL-0043
57	Landscape & Ecological Management Plan	Refer to CEMP (Condition 93)	N/A
60	Surface Water Drainage	Woodsmith Mine – Phase 12 Works – NYMNPA 60 and 79 Surface Water Drainage Scheme – 40-ARI-WS-7100-CI-RP-01008	Woodsmith Mine – Phase 11 Works – NYMNPA 60 and 79 Surface Water Drainage Scheme – 40-ARI-WS-7100-CI-RP-01007 Woodsmith Mine – Phase 11 Works – NYMNPA 76 Soil Management Plan - 40-ARI-WS-7100-CI-PL-01000 40-ARI-WS-7100-CI-22-01069 – Woodsmith Mine Construction Phase 12 Drainage General Arrangement 40-ARI-WS-7100-CI-22-01072 – Woodsmith Mine Construction Phase 12 Bund F Surface Water Drainage 40-ARI-WS-7100-CI-22-01703 – Woodsmith Mine Construction Phase 12 Bund F Basal Drainage
64	Temporary Fencing	Refer to Construction Method Statement (Condition 94) for details of the proposed fencing associated with the access control arrangements	40-ARI-WS-7100-CI-22-01067 - Woodsmith Mine Construction Phase 12 Masterplan
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-22-01070 - Woodsmith Mine Construction Phase 12 Hard and Soft Landscaping Plan	N/A

73	Woodland Management Plan	N/A	No trees are to be removed as part of this phase.
76	Soil Management Plan	Refer to CEMP (Condition 93)	Woodsmith Mine – Phase 11 Works – NYMNPA 76 Soil Management Plan - 40-ARI-WS-7100-CI-PL-01000
79	Surface Water Drainage	Woodsmith Mine – Phase 12 Works – NYMNPA 60 and 79 Surface Water Drainage Scheme – 40-ARI-WS-7100-CI-RP-01008	Woodsmith Mine – Phase 11 Works – NYMNPA 60 and 79 Surface Water Drainage Scheme – 40-ARI-WS-7100-CI-RP-01007 Woodsmith Mine – Phase 11 Works – NYMNPA 76 Soil Management Plan - 40-ARI-WS-7100-CI-PL-01000 40-ARI-WS-7100-CI-22-01069 – Woodsmith Mine Construction Phase 12 Drainage General Arrangement 40-ARI-WS-7100-CI-22-01072 – Woodsmith Mine Construction Phase 12 Bund F Surface Water Drainage 40-ARI-WS-7100-CI-22-01703 – Woodsmith Mine Construction Phase 12 Bund F Basal Drainage
81	Waste Water Management Scheme	Woodsmith Mine – Phase 7 Works – NYMNPA 81 Non-Domestic Wastewater Management Scheme – 40-ARI-WS-7100-CI-RP-01002	N/A
87	Reinjection Borehole	N/A	Sirius Minerals propose to discharge saline water off-site, subject to any necessary third-party agreements being established. Accordingly, no programme for the development of the reinjection borehole is submitted as part of this phase.
91	Emissions	N/A	Condition NYMNPA-91 states that emissions associated with construction works at Woodsmith Mine must lead to nutrient nitrogen and acid deposition no greater than that reported in the Environmental Statement and

			Supplementary Environmental Information (SEI) Report on which the planning permission was based (reference NYM/2017/0505/MEIA). The levels of deposition detailed in the SEI were based upon emissions from 18MW of diesel power generation fitted with Selective Catalytic Reduction (SCR) technology, the blasting of three shafts (one blast per shaft, per day) and emissions from onsite mobile plant. Sirius Minerals obtained planning permission to provide onsite power via an 11kV electrical supply (reference NYM/2018/0181/NM) and Liquefied Natural Gas (LNG) generators (reference NYM/2018/0662/NM), removing the requirement for diesel generation. The nutrient nitrogen and acid deposition associated with the LNG generators was significantly lower than that predicted using the diesel generators. In Phase 12, the LNG generators and 11kV supply will be in use. Blasting operations, approved under Phase 11, will continue to occur on only the MTS shaft, using the same type and quantity of explosives per blast as considered in the SEI Report. Total emissions from blasting would therefore be reduced by approximately one third compared with the scenario modelling in the SEI. Emissions from onsite mobile plant are not expected to be of any greater magnitude than previously considered. Given the above, emissions associated with the LNG generators, blasting, and plant which will occur concurrently during Phase 12 would result in nutrient nitrogen and acid deposition of a lower magnitude than reported in the SEI, due to the improved generator technology, the reduction in shafts to be blasted and the use of an 11kV electrical supply.

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) (reference 40-RHD-WS-70-CI-PL-0012) was submitted to discharge condition NYMNPA-92 as part of the Phase 7 Works at Woodsmith Mine. The plant required for the Phase 12 Works will be similar in nature to that considered during Phase 7 and in no greater number. Therefore particulate emissions from plant used during Phase 12 are expected to be of no greater magnitude than that presented in the Phase 7 CVPMP. Dust and particulate matter generated during the ongoing blasting will be filtered and captured via the ventilation system which will be operated for a period of approximately 30 minutes following each blast. This will ensure minimal release of particulate matter to the atmosphere. Emissions from vehicle movements were considered in the Phase 7 CVPMP, and were based on the maximum permissible light and heavy goods vehicle movements to and from Woodsmith Mine. Traffic movements associated with the Phase 12 Works will be accommodated within these limits and therefore no consideration of additional traffic movements is required. The Phase 7 CVPMP is therefore considered to be applicable for Phase 12.
93	CEMP	Phase 12 – Woodsmith Mine Construction Environmental Management Plan – 40-RHD-WS-70-EN-PL-0045	Phase 12 Construction Method Statement – NYMNPA 94 – 40-SMP-WS-7100-PA-MS-00011 Phase 3 Surface Water Drainage Scheme (reference 40-ARI-WS-71-PA-RP-1050) Phase 3 CEMP (reference 40-RHD-WS-70-EN-PL-0014) Protected Species Management Plans:

			40-RHD-WS-70-EN-PL-0010 Ph3 PSMP for Reptiles; 40-RHD-WS-70-EN-PL-0042 Ph11 PSMP for Badgers; 40-RHD-WS-70-EN-PL-0012 Ph3 PSMP for Birds; and 40-RHD-WS-70-EN-PL-0043 Ph11 PSMP for Bats. 40-ESW-WS-5810-EN-31-00004 – Woodsmith Mine Landscape – Planting Plan, Bunds A, F & Water Treatment Area
94	Construction Method Statement	Phase 12 Construction Method Statement – NYMNPA 94 – 40-SMP-WS-7100-PA-MS-00011	Listed plans. Phase 12 - Woodsmith Mine Construction Traffic Management Plan 40-RHD-WS-70-CI-PL-0016 Phase 12 – Woodsmith Mine Construction Environmental Management Plan – 40-RHD-WS-70-EN-PL-0045 Phase 11 – Woodsmith Mine Construction Method Statement – 40-SMP-WS-7100-PA-MS-00009 Phase 10 – Woodsmith Mine Construction Method Statement – 40-SMP-WS-7100-PA-MS-00008
95	Written Scheme of Investigation	Refer to CEMP (Condition 93)	N/A
97	Internal Diameters	Refer to CMS (Condition 94)	N/A

*** As agreed, documents from previous phases (where they remain unchanged in relation to Phase 12) have not been resubmitted with this application**

NYMNPA
14/04/2020

SIRIUS MINERALS PLC

Project Title / Facility Name:

North Yorkshire Polyhalite Project

Document Title:

Woodsmith Mine Construction Phase 12 Bund F Surface Water Drainage

Document Review Status

- [x] 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
- [ ] 5. On Hold – Pending Project Restart & Ramp Up

By: Robert Staniland
On: 09 Apr 2020 17:51

1	09-Apr-2020	Planning	PLA			
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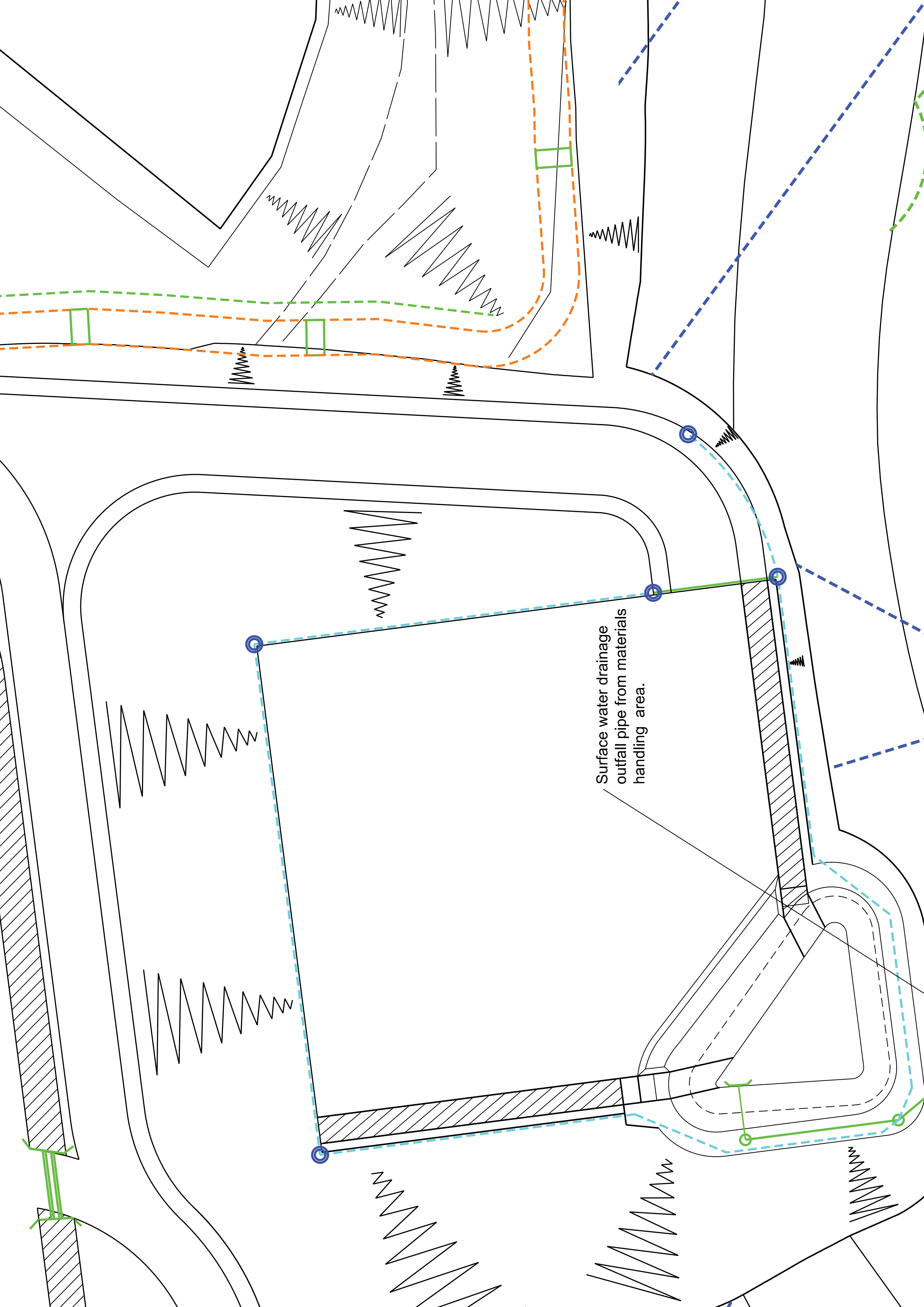
A	19-Mar-2020	Review	IFR			
Rev.	Revision Date (dd mmm yyyy)	Reason For Issue		Prepared by	Verified by	Approved by

Document ID:

40-ARI-WS-7100-CI-22-01072


Surface water drainage
outfall pipe from materials
handling area.

NYMNPA
14/04/2020

Project Title / Facility Name:

North Yorkshire Polyhalite Project

Document Title:

NYMNPA 60 and 79 Surface Water Drainage Schemes

Document Review Status

- [x] 1. Reviewed – Accepted – Work May Proceed
- [ ] 2. Reviewed – Accepted As Noted, Work May Proceed, Revise & Resubmit
- [ ] 3. Reviewed – Work May Not Proceed, Revise & Resubmit
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40-ARI-WS-7100-CI-RP-01008

Sirius Minerals Plc

Woodsmith Mine - Phase 12 Works

NYMNPA 60 and 79 Surface Water Drainage Schemes

40-ARI-WS-7100-CI-RP-01008

Rev 0 | 9 April 2020

Job number 253285

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ARUP

Document Verification

ARUP

Job title	Woodsmith Mine - Phase 12 Works	**Job number** 253285
Document title	NYMNPA 60 and 79 Surface Water Drainage Schemes	**File reference**
Document ref	40-ARI-WS-7100-CI-RP-01008	

Revision	**Date**	**Filename**	40-ARI-WS-7100-CI-RP-01008_A_PLA_20200403_Ph 12 NYM 60 79 SWD Strategy.docx		
Rev A	03 April 2020	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Julia Beaumont	Chris Williams	Andrew Hornung
		Signature			
Rev B	9 Apr 2020	**Filename**	40-ARI-WS-7100-CI-RP-01008_B_PLA_2020409_Ph 12 NYM 60 79 SWD Strategy.docx		
		Description	Sirius comments incorporated.		
			Prepared by	Checked by	Approved by
		Name	Julia Beaumont	Chris Williams	Andrew Hornung
		Signature			
Rev 0	9 Apr 2020	**Filename**	40-ARI-WS-7100-CI-RP-01008_0_PLA_2020409_Ph 12 NYM 60 79 SWD Strategy.docx		
		Description	Issue		
			Prepared by	Checked by	Approved by
		Name	Julia Beaumont	Chris Williams	Andrew Hornung
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

1 Introduction

1.1 Overview

This document has been prepared on behalf of Sirius Minerals PLC and details the surface water drainage scheme for the Phase 12 construction activity at Woodsmith Mine (Phase 12 Works). This is required to discharge conditions 60 and 79 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA, as subsequently varied by NYM/2017/0505/MEIA [1].

This report only details the works required at the Woodsmith Mine site.

The Phase 12 Works comprise:

- Assembly and operation of Shaft Boring Roadheaders (SBRs) at both Service Shaft and Production Shaft for shaft excavation to the base of the Lias Group at approximately 493m below ground level;
- Installation of additional welfare cabins;
- Installation of segregated materials bunker;
- Creation of laydown area for segment and tubbing storage;
- Installation of lightning protection and canopy to SSUs; and
- Installation of access control measures.

1.2 Surface water drainage strategy - compliance with conditions

The drainage strategy, calculations and surface water management plan described in the Phase 11 Surface Water Drainage Scheme [2] are still applicable during the Phase 12 works. The surface water system that will be in use during Phase 12 is shown on the general arrangement drawing 40-ARI-WS-7100-CI-22-01067 in Appendix A. The changes between Phases 11 and 12 and their potential to impact on the surface water drainage design are outlined below.

- **Assembly and operation of Shaft Boring Roadheaders (SBRs) at both Service Shaft and Production Shaft**

  Extractive material arisings from the operation of the SBR's will require placement within the site landscape screening bunds.

  <u>SW Drainage Impact Assessment:</u> *The works described above have an interaction with the surface water drainage scheme in relation to the placement of extractive material in landscape screening bunds. Refer to Section 2.1 of this report for further details.*

- **Installation of segregated materials bunker**

  This consists of a covered concrete hardstanding area for the storage of segregated materials prior to being removal off-site. All storage of segregated materials and vehicle loading from the area will be undertaken within the covered area. All water collected from the concrete slab will be retained and treated via the non-domestic wastewater treatment plant prior to either being discharged or tankered off-site.

  The covered materials bunker will have approximate dimensions of 25m x 50m and roof drainage will outfall into the existing swale system which runs adjacent to the bunker.

  SW Drainage Impact Assessment: The works described above have an interaction with the surface water drainage scheme. Refer to Section 2.2 of this report for further details.

- **Creation of laydown area for segment and tubbing storage**

  The creation of an additional granular platform for the laydown of segment and tubbing storage of approximate area 1.7ha.

  SW Drainage Impact Assessment: The works described above have an impact on the surface water drainage strategy, refer to Section 2.3 of this report for further details.

- **Installation of additional welfare cabins**

  The installation of additional welfare cabins on areas of the existing construction platform which was constructed as part of previous planning phases. Three separate cabin clusters are to be provided each with approximate dimensions of 29m by 6m. All roof drainage will outfall into the existing platform perimeter drainage system.

  SW Drainage Impact Assessment: The works described above have no impact on the surface water drainage strategy. Any surface water drainage from the additional welfare cabins will be directed/piped to the existing platform drainage system. The offices are to be installed on areas of the existing construction platform and therefore their installation will not increase the overall drained area of the site.

- **Installation of access control measures**

  The installation of access control measures on the existing construction platforms.

  SW Drainage Impact Assessment: The works described above have no impact on the surface water drainage strategy.

- **Amendment to the design of the Secure Storage Unit (SSU)**

  The installation of a small canopy outside the door of each of the SSU's. The canopies are to be provided on areas of existing drained surfacing and therefore they do not result in an increase in the overall drained site area.

SW Drainage Impact Assessment: The works described above have no impact on the surface water drainage strategy.

No other changes between Phases 11 and 12 impact on compliance with the conditions that were described in the Phase 11 report.

2 Phase 12 works

The following works have an impact on the surface water drainage strategy.

2.1 Assembly and operation of Shaft Boring Roadheaders (SBRs)

The works include the assembly of the SBR's within an area of the existing construction platform and therefore this has no impact on the existing surface water drainage strategy with all surface water run-off passing through the platform oil interceptors prior to discharging through the main site attenuation ponds.

During shaft sinking operations any non-domestic wastewater collected within the shafts will be treated within the non-domestic wastewater treatment plant prior to either being discharged or tankered off-site.

The Phase 12 works result in the generation of additional extractive material and this therefore requires the Bund F landscape screening mound as submitted as part of the Phase 11 works to be extended to incorporate the additional arisings from the shafts. This will be completed in accordance with the Environmental Permit for "Run-off and basal drainage of bunds' permit number EPR/MB/3399VR and accompanying documents submitted in support of the application for an Environmental Permit.

The Phase 12 earthworks (as described on drawing 40-ARI-WS-7100-CI-22-01072) will involve the exposure of unfinished ground in preparation for deposition of materials extracted from the shafts and reforming of some of the permanent and temporary storage bunds on site. To accommodate the collection and attenuation of surface water run-off from these new earthworks, the existing drainage network will be extended, as set out in this document.

The silt mitigation strategy for the surface water run-off approved as part of previous phases, will be applied for the new earthwork areas. The main principle is to minimise the sediment entrainment with measures applied at source. Additional silt fences will be installed around newly disturbed earthworks; check dams will be placed in the new/extended swales and ditches; all run-off from the screening mounds will be attenuated, and sediment particles will be allowed to settle.

Extractive material generated from sinking the shafts will be placed within Bund F as shown on the accompanying drawings. Prior to placing the material, a basal drainage system will be provided as defined in the Phase 11 submission. Basal drainage will be collected and conveyed to the bund perimeter swale which outfalls into Wetland C. The basal drainage system is designed such that, if through on-site testing, the quality of the outfall water is resulting in water quality triggers being breached, the basal drainage system can be isolated prior to outfalling into the bund perimeter swale. Basal drainage can then be collected at defined catchpits for treatment prior to outfall or tankering off-site. Refer to drawing 40-ARI-WS-7100-CI-22-01073 for the location of the catchpits.

On completion of the placement of extractive material within the bund, and prior to the placement of restoration soils (topsoil and subsoil), a surface drainage network will be provided in accordance with Drawing 40-ARI-WS-7100-CI-22-01072. This will be collected and conveyed to the perimeter swale which outfalls in to Wetland C.

The restoration soils will be placed in accordance with the Phase 11 Soil Management Plan (40-ARI-WS-7100-CI-PL-01000).

2.2 Installation of segregated materials bunker

The creation of a segregated materials bunker includes the provision of an additional 0.08ha concrete paved hardstanding area as shown on drawing 40-ARI-WS-7100-CI-22-01067.

The bunker will be covered to enable rainwater to be collected separately and conveyed to the site surface water drainage network and eventual outfall via the surface water attenuation ponds. All water collected on the concrete slab within the covered bunker will be collected in a sump and either tankered off-site or treated within the non-domestic wastewater treatment plant prior to discharge.

2.3 Creation of laydown area for segment and tubbing storage

The works will consist of a 1.7Ha granular platform located adjacent to the existing laydown area to the southern end of the site.

The existing laydown area will be retained, including the retention of the existing platform surface water drainage system, perimeter filter drains, oil interceptor and outfall into the adjacent drainage ditch.

The additional laydown area will consist of a granular platform with a separate surface water drainage system and outfall being provided to that of the retained laydown area. This will consist of a series of filter drains/swales as detailed on drawing 40-ARI-WS-7100-CI-22-01071 that outfall into Pond D, prior to discharging into the main site attenuation ponds and eventual treatment in the surface water treatment plant (removal of silt) and outfall into Sneaton Thorpe Beck.

The additional laydown area results in an overall increase in the positive drained area of the site, however Pond D includes a flow control on its outfall which enables the overall site drainage strategy to be balanced without increasing the overall site discharge rate, flood risk and maintains the surface water drainage design basis. It should also be noted that this pond was not fully utilised in previous phases. Refer to Section 3 for further details.

No oil interceptors are incorporated in the southern catchment drainage network prior to discharging off-site. This is mitigated in the proposed operation of the area with the area being predominantly used for the storage of segments and tubbing requiring infrequent vehicle movements across the platform. The only vehicle movements will be in relation to either deliveries onto the platform or transporting segments from the platform for use during the works. All vehicle laydown will be undertaken on the existing laydown area (which incorporates a petrol interceptor) with vehicles only entering the additional laydown area for loading/unloading. No refuelling or routine plant maintenance will be undertaken on the additional laydown area. Should any plant breakdown within the new laydown area necessitate unplanned plant maintenance, drip trays/plant nappies will be used. Any spillages during these activities will be contained with spill kits and the area of the spillage being appropriately remediated. Pond D also incorporates a penstock as part of its outfall structure enabling the pond to be isolated if required and any spillages cleaned up.

3 Drainage calculations

Refer to the Phase 11 surface water drainage scheme, report 40-ARI-7100-CI-RP-01007 in relation to the wider drainage strategy. The section below sets out changes to the surface water drainage catchment areas and presents the revised drainage modelling results as a consequence of the Phase 12 works.

3.1 Drainage catchment areas

The drainage catchment areas that are affected by the Phase 12 works are as follows:

- Western bund catchment – the overall drained catchment area has increased due to the additional laydown area and segregated materials bunker (refer to Sections 2.2 and 2.3). This catchment is predominantly drained through Pond D (which has a flow control on the outfall) and outfalls through the main site attenuation ponds;
- Northern bund catchment – The drained catchment area stays approximately the same during this phase. Therefore, the overall run-off rate from the northern bund catchment stays the same.

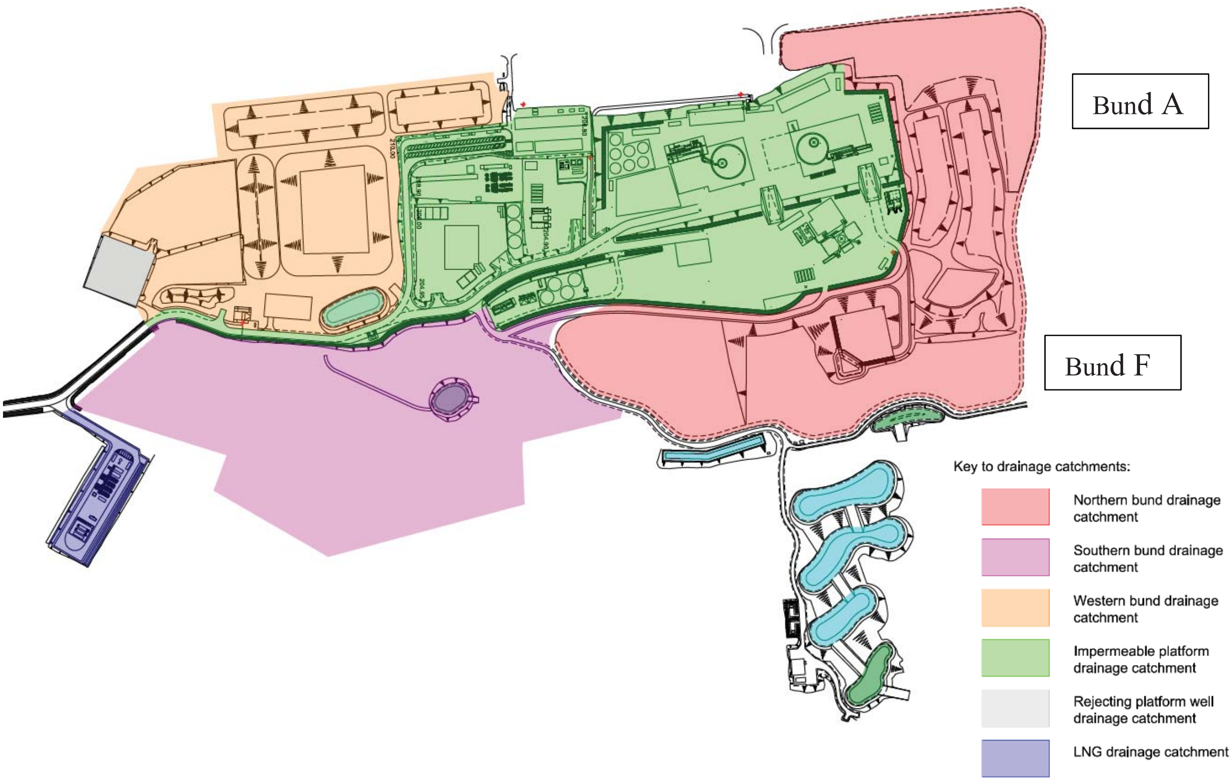


Figure 1: Woodsmith catchment areas

3.2 Calculation methodology

The Phase 12 Works layout for the Woodsmith Mine has been assessed and the required attenuation volumes calculated. The results are shown in Section 3.3.2.

The allowable rates of discharge from the ponds have been calculated for the Phase 12 Works based on the Q_{Bar} greenfield run-off rate for the total contributing area.

For the Phase 12 Works, a 1-in-20-year return period design storm with no climate change allowance has been applied to a MicroDrainage model of the proposed network. Simulations have been undertaken using a range of durations from 15 minutes to seven days to determine the critical duration for each part of the network to ensure no flooding occurs and the attenuation is sufficient.

3.3 Calculation results

The MicroDrainage model outputs in Appendix C demonstrate that the design described in this report meets the requirements set out in the planning conditions. In particular, the discharge rate from the developed areas has been limited to the Q_{Bar} greenfield run-off rate and the volume of attenuation provided is sufficient to attenuate flows up to the 1-in-20-year return period event. This includes the expected overflow from Pond C when the total capacity of the surface water treatment facility is exceeded.

3.3.1 Run-off rates

The allowable QBar greenfield run-off rate is 6.5 l/s/ha, based on the Baseline Surface Hydrology report [3].

The flow rate is controlled by flow control devices at the outlets of the attenuation ponds. Table 3.1 summarises the modelling outputs in Appendix D.

Table 3.1 Summary of modelled Run-off Rates

Catchments	**Northern drainage catchment**	**Southern drainage catchment**	**Combined northern and southern drainage catchments**	**LNG Platform catchment**	**Refer to:**
	Impermeable platforms Northern landscape bunds	Western landscape bunds			
Gross area drained	26.2 hectares	6.5 hectares	32.7 hectares	0.5 hectares	
Greenfield Run-off Rate (allowable rate of discharge)	6.5 x 26.2 = 170.3 l/s	6.5 x 6.5 = 42.3 l/s	6.5 x 32.7 = 212.6 l/s	6.5 x 0.5 = 3.25 l/s (min 5 l/s)	Baseline Surface Hydrology report
Maximum modelled rate of discharge	N/A See combined discharge rate.	N/A See combined discharge rate.	132.3 l/s	5 l/s**	Appendix D, critical results by maximum level for Pipes PH3-N-1.039 (Wetland A outfall)

* Where catchments are small and limits of discharge are less than 5l/s (risk of throttle blockage), a minimum of 5l/s is allowed, Reference: DEFRA, Rainfall run-off management for developments.

** This has not changed since the previous phase and therefore the previous calculations remain applicable.

3.3.2 Attenuation pond and wetland sizing

To ensure sufficient surface water attenuation is available to meet the requirement to restrict flows from the site to the green field run-off rate and to ensure sufficient capacity is retained in the ponds to provide sufficient dilution of basal drainage (in accordance the Environmental Permit for “Run-off and basal drainage of bunds” permit number EPR/MB/3399VR and accompanying submission documents) with surface water run-off, the following pond capacities are proposed across the site during the Phase 12 works.

Table 3.2 Pond and Wetland Capacities

Pond	Construction Phase			Operational Phase (post 1.5 years following construction)		
	Total Capacity (m^3)	SW Flood Attenuation Capacity (m^3)	Permanent Dilution Volume (m^3)	Total Capacity (m^3)	SW Flood Attenuation Capacity (m^3)	Permanent Dilution Volume (m^3)
A	3,700	3,700	0	3,700	3,700	0
B	3,700	3,700	0	3,700	3,700	0
C	2,400	2,070	330	2,400	2,400	0
WA	975	0	975	975	0	975
WC	800	800	0	430	0	430
D	1,300	1,000	N/A	N/A		

3.3.3 Volume of attenuation

A summary of the MicroDrainage modelling results are shown in Table 3.3 and the modelling outputs are shown in Appendix D.

Table 3.3 Summary of modelled attenuation volume requirements

	Northern Drainage Catchment	Southern Drainage Catchment	Northern and Southern Catchments Combined	The LNG Platform Catchment	Refer to:
Volume used in MicroDrainage model	10,270 m^3 (*see note below)	985 m^3	11,255 m^3	99 m^3 **	Appendix C, graphs for pipes: • PH3-N-1.036 to 1.038 and PH3-N-24.029 (Ponds A, B, C and WC), • Pipe PH3-N-18.006 (Pond D).
Volume provided by proposed construction phase design	10,270 m^3	1,000 m^3	11,270 m^3	180 m^3	Appendix B: Drawing 40-ARI-WS-7100-CI-22-01069 and Table 3.2 above

* In the Microdrainage model the volume stored in the ponds slightly exceeds the volume given in the above table. This is because the ponds utilise some of the additional volume provided in the ponds freeboard above the spillway levels.

** This has not changed since the previous phase and therefore the previous calculations remain applicable.

In all catchments the attenuation ponds provided in the earthworks design have sufficient storage volumes to attenuate surface water run-off to the allowable rate of discharge.

The storage provided at the main attenuation ponds has been maximised to minimise the risk of sediment discharging into the watercourse. Providing additional storage means that the rate of discharge can be significantly reduced to approximately 60% of the allowable greenfield run-off rate.

There is a very low risk that the surface water treatment facility capacity might be exceeded in the higher storm events. A small volume of excess water would be discharged through the Pond C emergency overflow into the final Wetland A in the critical rainfall duration 1-in-6 year storm event and above (most 1 in 6 year storm events will not cause flow down the emergency overflow).

The treatment facility will remove silt from the water from Pond C and discharge clean water to the wetland prior to outfall. This clean water will dilute any water that discharges over the emergency overflow. The combined discharge rate from Wetland A, which includes the flow from the surface water treatment facility and the emergency overflow from Pond C, is a total of 132.3 l/s (Refer to Table 3.1 and Appendix C), which remains below the permitted discharge rate of 211.9 l/s.

4 Conclusions

4.1 Surface water management scheme

There are no changes between Phases 11 and 12 that adversely impact the surface water drainage design. The Phase 11 Surface Water Drainage Scheme [2] is still applicable during Phase 12.

The additions of the assembly and operation of the SBR's, the installation of the segregated materials bunker and creation of additional laydown area in Phase 12 do have an interaction with the surface water drainage, but the mitigation proposed minimises the risk to an acceptable level.

This report demonstrates that the Surface Water Drainage design and management during the Phase 12 Works meets the requirements of conditions 60 and 79 of the North York Moors National Park Authority (NYMNPA) planning permission NYM/2014/0676/MEIA, as subsequently varied by NYM/2017/0505/MEIA.

As a result of the Phase 12 works, no new additional Land Drainage Consents will be required.

References

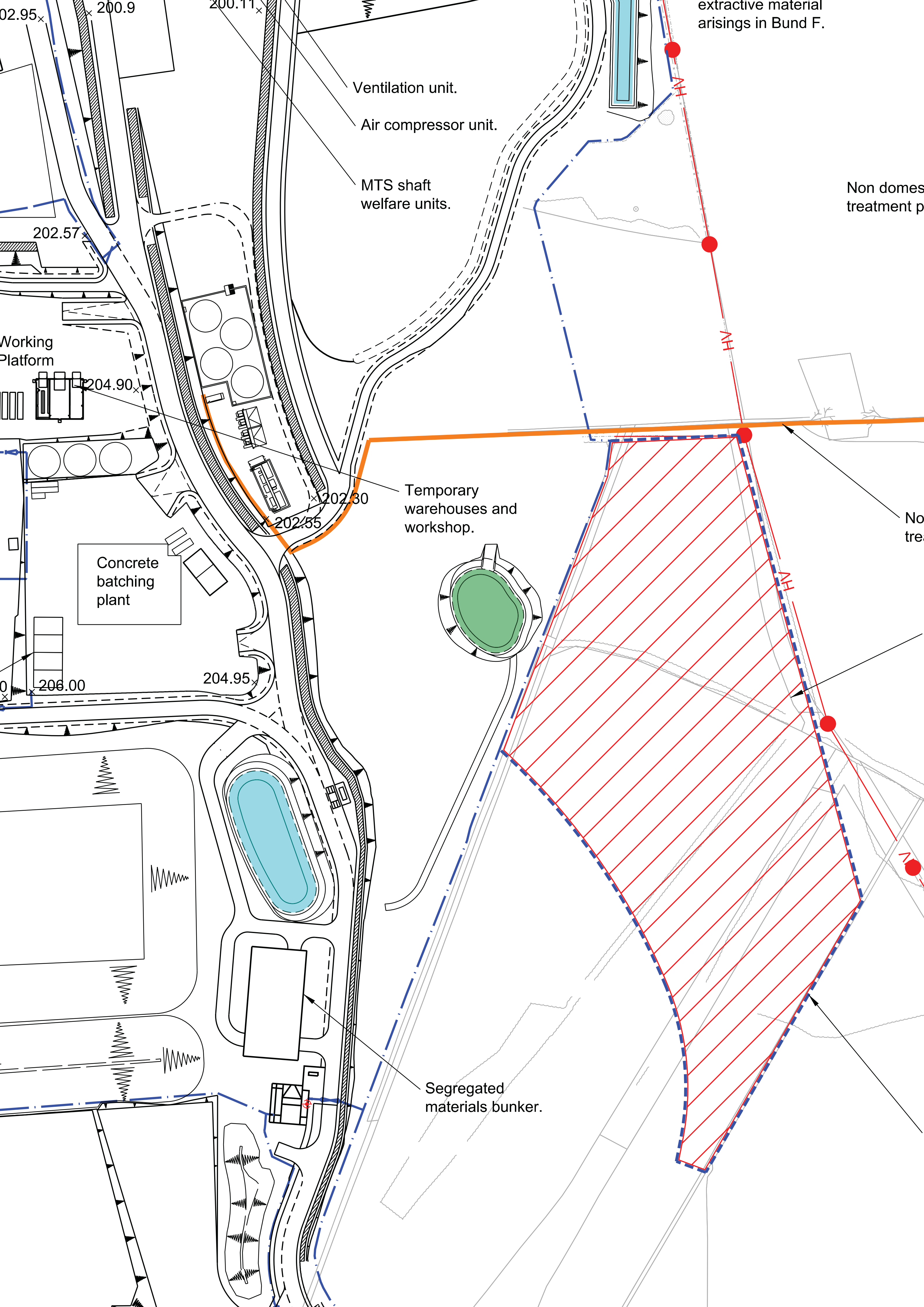
[1] North York Moors National Park Authority planning permission NYM/2014/0676/MEIA and as subsequently varied by NYM/2017/0505/MEIA.

[2] NYMNPA 60 and 79 Surface Water Drainage Scheme, 40-ARI-WS-7100-CI-RP-01007, Rev 0, Arup, July 2019.

[3] Baseline Surface Hydrology, Ref LDT/2021/BSH, Revision F, BWB, 11/0/2014.

Appendix A

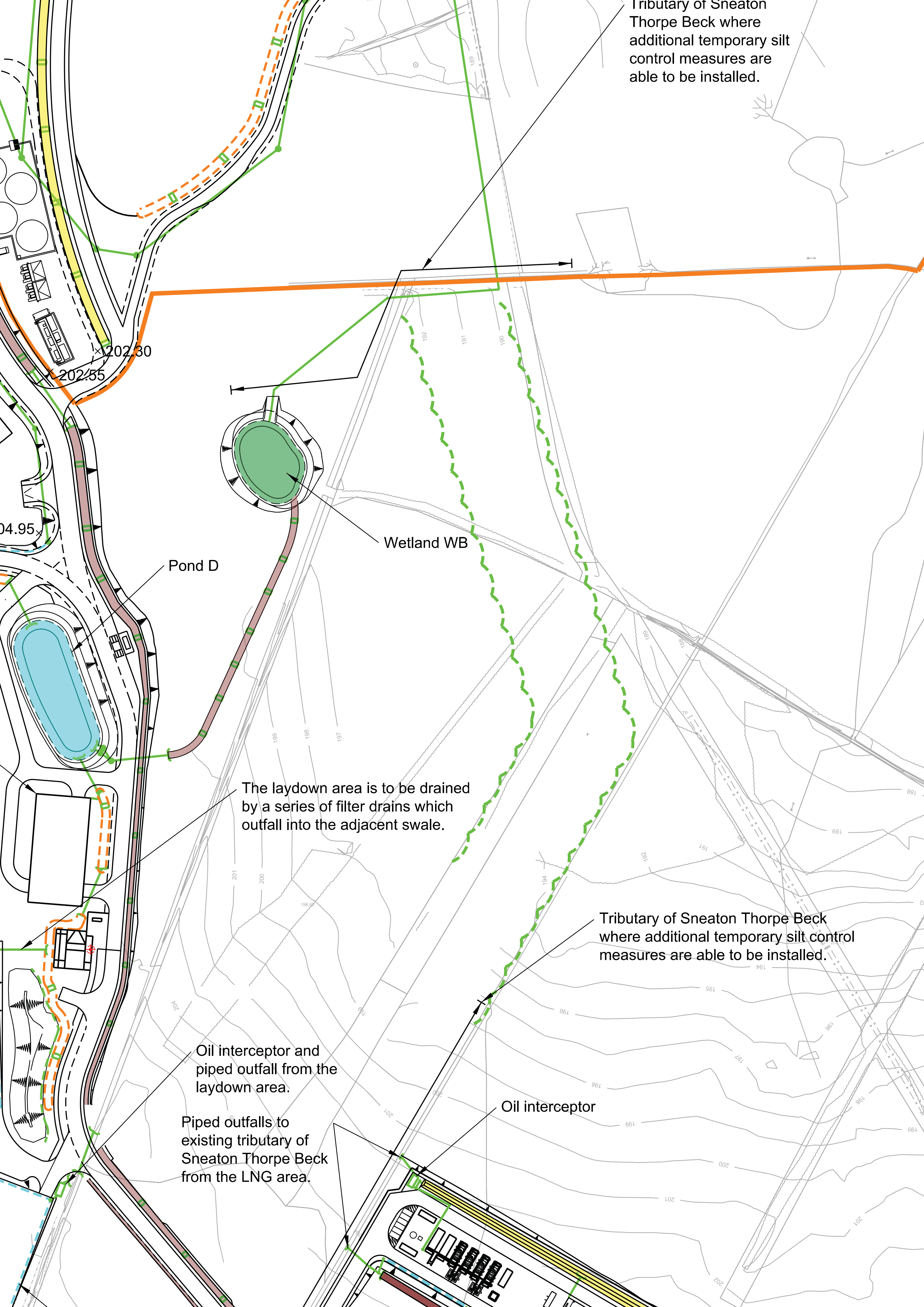
Phase 12 - Masterplan



02.95
200.9
200.11
extractive material
arisings in Bund F.
Ventilation unit.
Air compressor unit.
MTS shaft
welfare units.
Non domes
treatment p
202.57
HV
Working
Platform
204.90
Temporary
warehouses and
workshop.
202.30
202.55
No
tre
Concrete
batching
plant
204.95
206.00
Segregated
materials bunker.

Appendix B

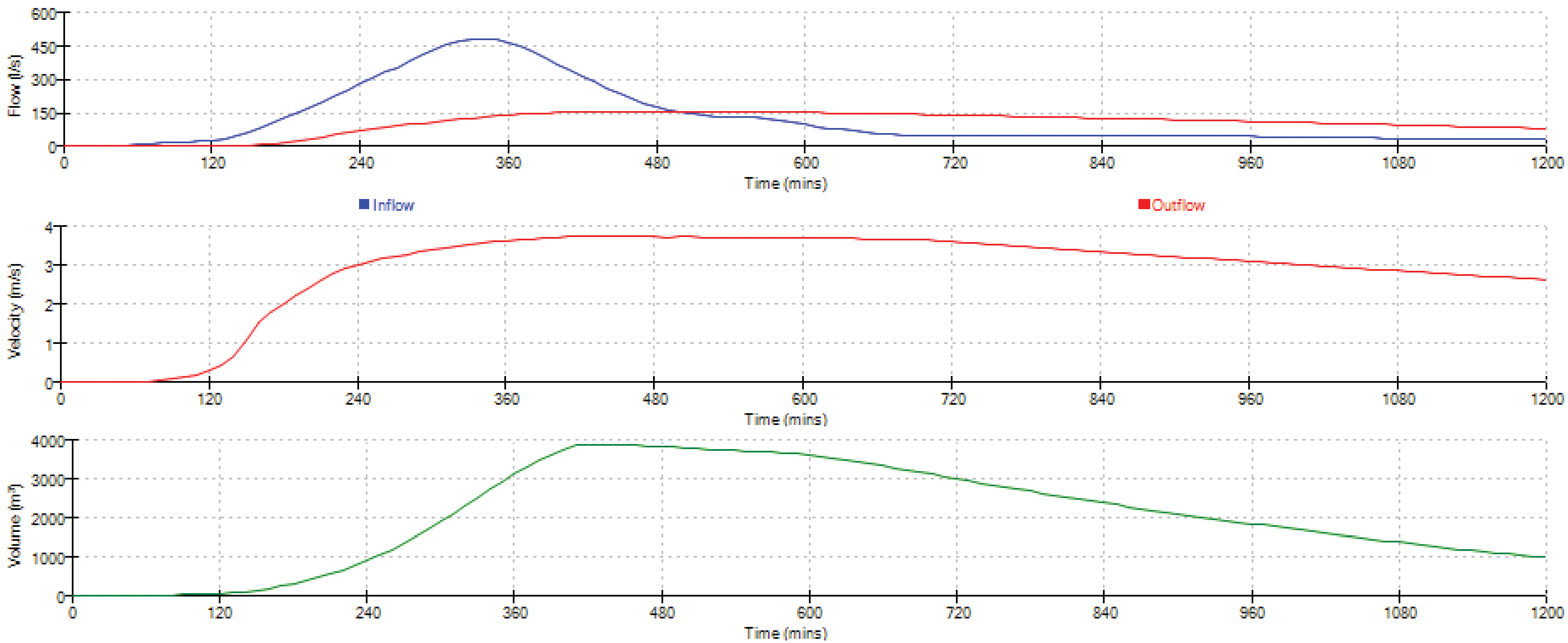
Phase 12 – Drainage Layout


Tributary of Sneaton
Thorpe Beck where
additional temporary silt
control measures are
able to be installed.
×202.30
×202.55
04.95×
Wetland WB
Pond D
The laydown area is to be drained
by a series of filter drains which
outfall into the adjacent swale.
Tributary of Sneaton Thorpe Beck
where additional temporary silt control
measures are able to be installed.
Oil interceptor and
piped outfall from the
laydown area.
Oil interceptor
Piped outfalls to
existing tributary of
Sneaton Thorpe Beck
from the LNG area.

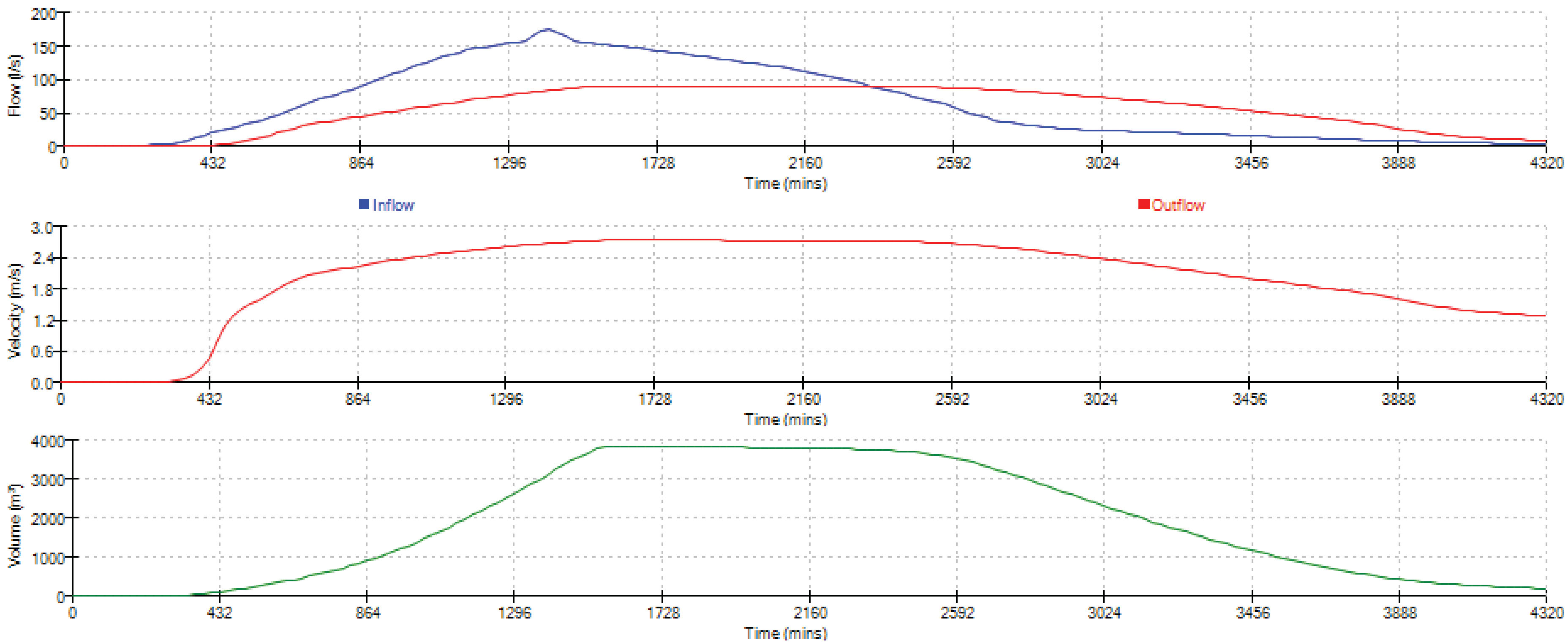
Appendix C

Micro Drainage Model Outputs

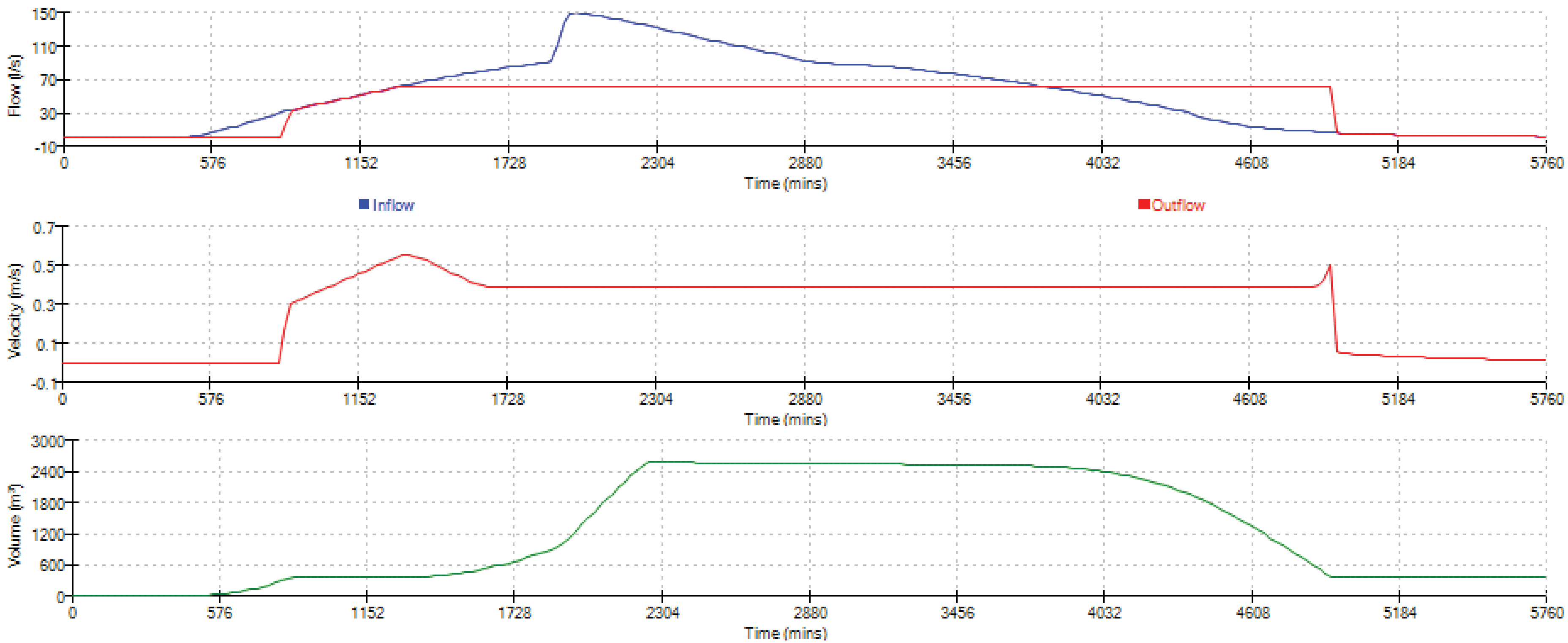
Graphs for Pipe PH3-N-1.036 US/MH PH3-N-1013 (Combined Networks)
600 minute 20 year Winter I+0%
Status: FLOOD RISK



Graphs for Pipe PH3-N-1.037 US/MH PH3-N-1014 (Combined Networks)
2160 minute 20 year Winter I+0%
Status: FLOOD RISK

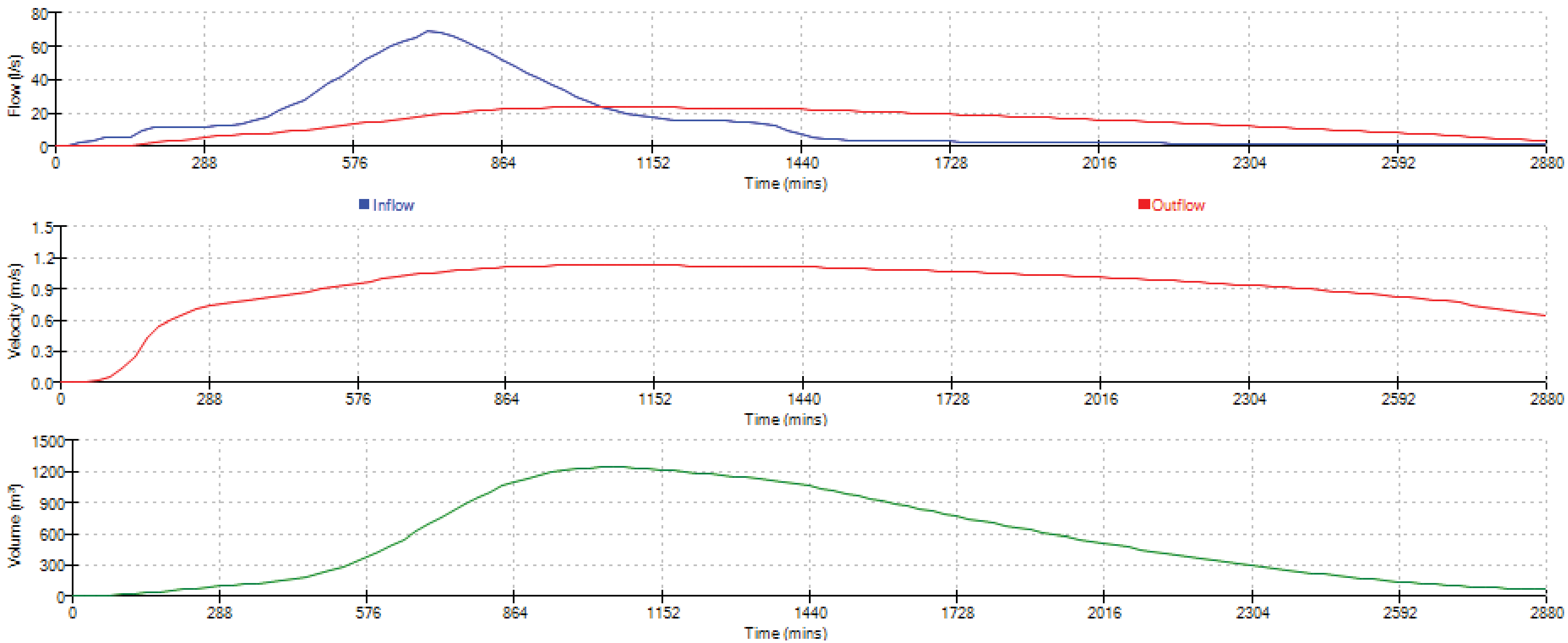


Graphs for Pipe PH3-N-1.038 US/MH PH3-N-1015 (Combined Networks)
2880 minute 20 year Winter I+0%
Status: FLOOD RISK



Ove Arup & Partners International Ltd		Page 1
The Arup Campus Blyth Gate Solihull B90 8AE		
Date 23/03/2020 16:37 File WS-Phase 12 2020-03-23.MDX	Designed by Daniel.Beech Checked by	
XP Solutions	Network 2019.1	

Graphs for Pipe PH3-N-18.006 US/MH PH3-N-37 (Combined Networks)
1440 minute 20 year Winter I+0%
Status: FLOOD RISK*



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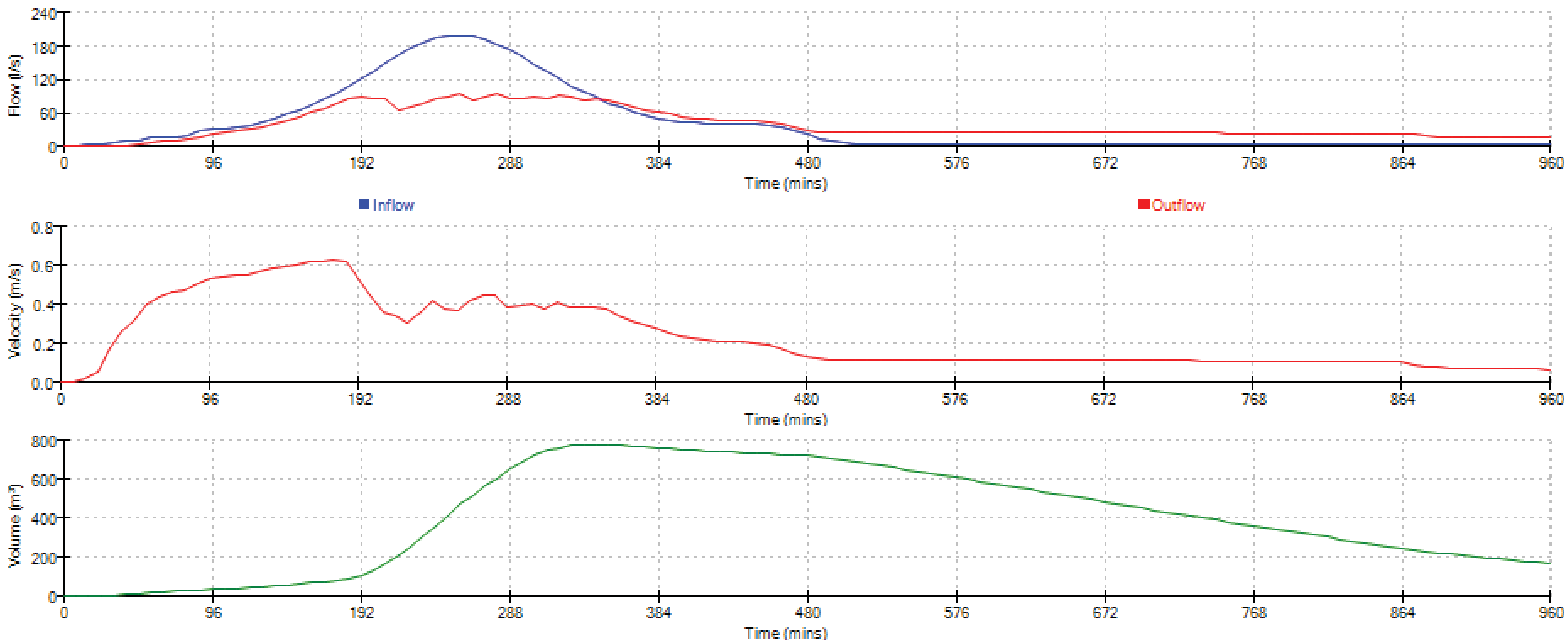
The Arup Campus Blyth Gate Solihull B90 8AE		
Date 23/03/2020 16:37 File WS-Phase 12 2020-03-23.MDX	Designed by Daniel.Beech Checked by	
XP Solutions	Network 2019.1	

Graphs for Pipe PH3-N-24.029 US/MH PH3-N-610 (Combined Networks)

480 minute 20 year Winter I+0%

Status: FLOOD RISK

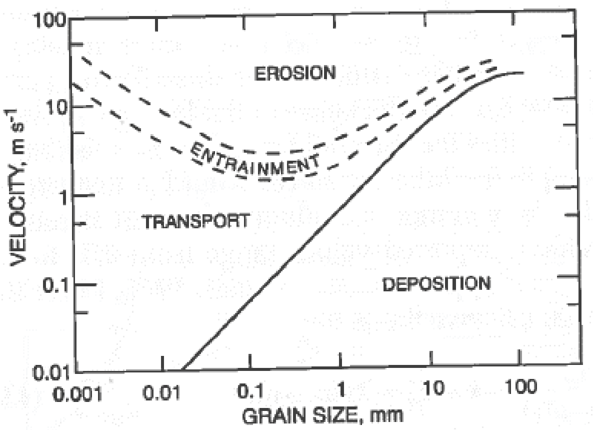


Appendix D

Outfall Velocity Calculations

Determination of a maximum velocity to discharge surface water into Sneaton Thorpe Beck tributaries.

The textbook "Fluvial Forms and Processes, A New Perspective" contains a graph that gives some basic limiting velocities for sediment erosion and entrainment based on various grain sizes.



The graph shows that no grain sizes are entrained into the flow until velocities are greater than 1m/s.

Using Ordnance Survey maps, topographic surveys and contours produced from lidar, Sneaton Thorpe Beck tributaries have an average gradient of approximately 1 in 20.

The tributaries of Sneaton Thorpe Beck are small. The photograph below shows the typical size of the tributaries downstream from the site. The width of the tributaries have been estimated at approximately 1m wide.

Flow monitoring has been undertaken at a number of locations on Sneaton Thorpe Beck. The monitoring data gives typical depths of flow at three monitoring points on the beck over a 4 month period. During rainfall events the depths at these monitoring points increases to about 200mm. The depths of the water in the beck will be dependent on the geometry at any specific location, but the data offers a guide to allow us to undertake some calculations. If we consider that the depth data only covers a 4 month period, we would expect increased depths during higher return period rainfall events.

Using the above information a manning's calculation was undertaken to give an indication of typical velocities in the existing beck during rainfall events:

Manning's "n" has been estimated using (Chow, 1959):
3a. Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged. Bottom: gravels cobbles and few boulders: normal n = 0.040

Slope: 1 in 20
Width of base = 1m
Depth of flow = varies

Manning's Equation

$$V = \frac{R^{2/3} S^{1/2}}{n}$$

V is average velocity (m/s)
R = hydraulic radius (m)
S = energy slope (m/m)
n = Manning's roughness coefficient

Depth of flow (mm)	Velocity (m/s)
100	1.07
200	1.53
300	1.83
400	2.05

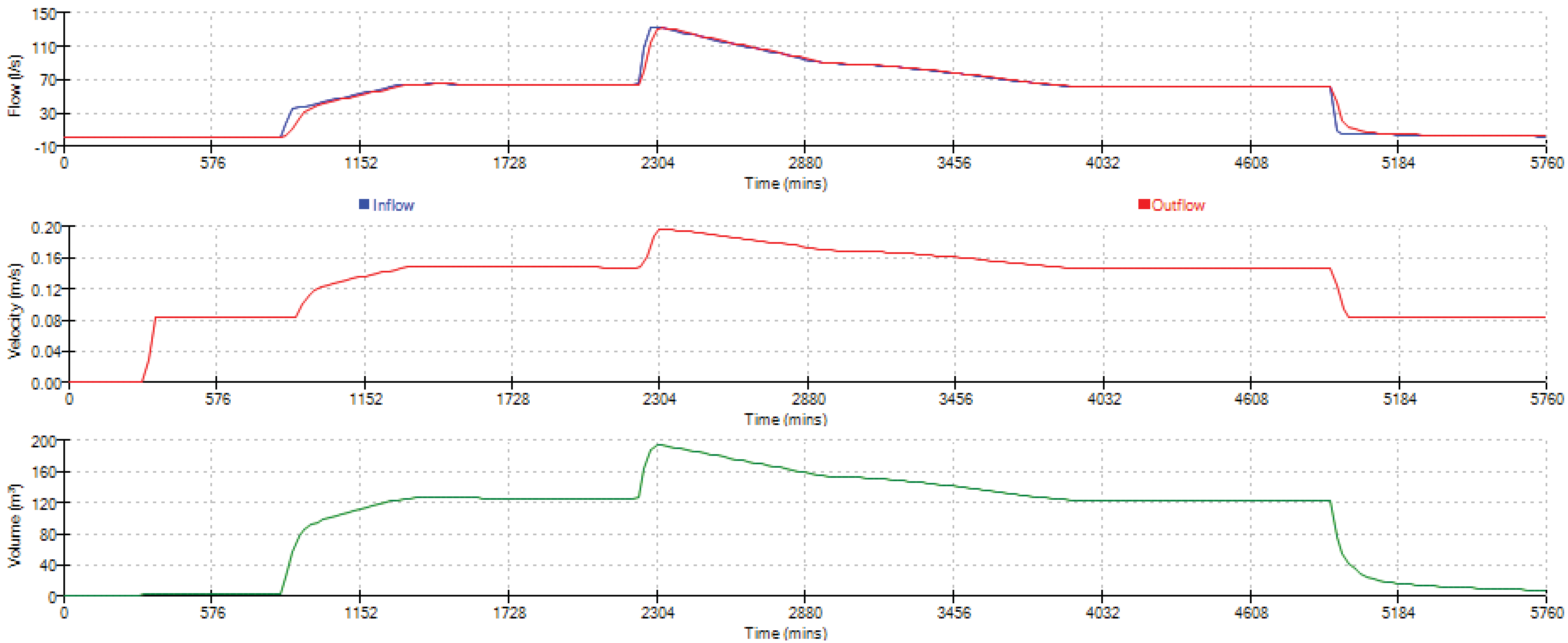
This table gives indicative average velocities in the tributary of Sneaton Thorpe Beck downstream of the outfall during rainfall events.

The results suggest velocities ranging from about 1 m/s to 2m/s would be expected during rainfall events. Velocities nearer the upper end of this range would be expected for large storm events such as a 1 in 20year return period event.

In an email from the Environment Agency on the 18th February 2016 contained guidance notes with typical outfall structures that contained limits to the exit velocities. These were 1.2m/s for a typical outfall without a stilling basin and 1.8m/s for outfalls with a stilling basin.

Using the information above, a conservative maximum discharge velocity to set for the outfalls from the site is 1.2m/s for return periods up to the 1 in 20 year return period event.

Graphs for Pipe PH3-N-1.039 US/MH PH3-N-1016 (Combined Networks)
2880 minute 20 year Winter I+0%
Status: FLOOD RISK*



NYMNPA
14/04/2020

SIRIUS MINERALS PLC

Project Title / Facility Name:

North Yorkshire Polyhalite Project

Document Title:

HYDROGEOLOGICAL RISK ASSESSMENT (NYMNPA 45 & 46 - PHASE 12) (HRA)

Document Review Status

- [x] 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
- [ ] 5. On Hold – Pending Project Restart & Ramp Up

By: Robert Staniland
On: 09 Apr 2020 16:36

Rev.	Revision Date (dd mmm yyyy)	Reason For Issue		Prepared by	Verified by	Approved by
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Document ID:

40-FWS-WS-70-WM-RA-0014

FWS Geotechnical & Environmental Consultants

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 and 47
REPORT	HYDROGEOLOGICAL RISK ASSESSMENT (NYMNPA 45, 46 and 47 – PHASE 12)
SITE	PHASE 12 WORKS AT WOODSMITH MINE, NORTH YORKSHIRE
DOCUMENT NUMBER	40-FWS-WS-70-WM-RA-0014

1433DevOR455Rev 3/April 2020

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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 and 47 – Phase 12)			
REPORT REFERENCE	1433DevOR455			
DOCUMENT NUMBER	40-FWS-WS-70-WM-RA-0014			
REVISION	**DATE**	**AUTHOR**	**CHECKED**	**APPROVED**
REV03	09/04/2020	RIL	ML	ML

CONTENTS

APPENDICES

HYDROGEOLOGICAL RISK ASSESSMENT (NYMNPA 45, 46 and 47 – PHASE 12)

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 12 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, 9, 10 and 11 Works (Refs. 2 to 12), the Hydrogeological Risk Assessment for the granted Environmental Permit for run-off and basal drainage from landscape mitigation screening (Permit number EPR/MB3399VR) (Ref. 13) and an assessment of the long term cumulative hydrogeological impacts, in support of the s73 application (Ref. 14).

1.2 Compliance with Conditions

Table 1 summarises where information is presented in this report to demonstrate compliance with the hydrogeologically related Planning Conditions 45, 46 and 47 to Planning Permission Ref No. NYM/2014/0676/MEIA (as varied by NYM/2017/0505/MEIA).

<u>Table 1 – Summary of Planning Conditions 45 and 46 and where Relevant Details are Provided in this Report</u>

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:- 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.	Comment on the requirement for implementation of the recharge trench and groundwater drainage beneath Bund F is presented in Section 7.1.

PLANNING CONDITIONS RELATING TO THE HYDROGEOLOGICAL RISK ASSESSMENT	
NYMNP Condition 46	**Compliance with Condition 46**
Prior to the commencement of each Phase of Construction 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) and Woodsmith Mine Phase 2 to 4 – Groundwater, Surface Water and Ecological Monitoring Completion Report (Annual monitoring report for 2017; 40-SMP-WS-7322-WM-RP-00001), Woodsmith Mine Annual Groundwater, Surface Water and Ecological Monitoring Report - 2018 (40-SMP-WS-7322-WM-RP-00010) and Woodsmith Mine Annual Groundwater, Surface Water and Ecological Monitoring Report - 2019 (40-SMP-WS-7322-WM-RP-00014, in preparation). 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 7.2 and Phase 11 GW&SWMS (Ref. 15).
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 7.3 and Phase 11 Remedial Action Plan (Ref. 25).

PLANNING CONDITIONS RELATING TO THE REMEDIAL ACTION PLAN	
NYMNP 46	**Compliance with Condition 46**
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.	
PLANNING CONDITIONS RELATING TO THE GROUNDWATER MANAGEMENT SCHEME	
NYMPA Condition 47	**Compliance with Condition 47**
Following the approval of the Revised Hydro-Geological Risk Assessment but prior to the commencement of development, a Groundwater Management Scheme (covering construction, operation and post-operation phases), shall be submitted to and approved in writing by the Local Planning Authority in consultation with the Environment Agency.	Section 7.4 and Phase 11 Groundwater Management Scheme (Ref. 26).
The Scheme shall include technical drawings detailing the conceptualised hydrogeology with the final detailed designs of the proposed mitigation measures outlined in the Environmental Statement and in accordance with the details in the York Potash Project: Habitats Regulations Assessment prepared by Amec Foster Wheeler dated June 2015 with document reference 35190CGos064R, and the final design details of the lining systems for the proposed shaft.	Final designs, technical details, a conceptualised hydrogeological cross section, plans of the mitigation measures, and details of the compliance monitoring and reporting to validate their implementation for the Phase 12 works are provided in Sections 3,4 6 and 7 and Phase 11 Groundwater Management Scheme (Ref. 26).
Development shall thereafter proceed only in strict accordance with the approved Scheme and a timetable to be included within it.	The timetable for implementing the Phase 12 Works Groundwater Management Scheme is presented in Section 3.4.

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 3, 7, 8, 9, 11 and 12 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. 14).

2 DATA SOURCES

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

<u>Hydrogeological Data</u>

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

- Groundwater Activity Permit Hydrogeological Risk Assessment for the Landscape Bund's 1433DevOR413 January 2019.
- 40-SMP-WS-7322-WM-RP-00001 – Woodsmith Mine Phase 2 to 4 – Groundwater, Surface Water and Ecological Monitoring Completion Report (Annual monitoring report for 2017),
- 40-SMP-WS-7322-WM-RP-00010 – Woodsmith Mine Annual Groundwater, Surface Water and Ecological Monitoring Report - 2018.
- 40-SMP-WS-7322-WM-RP-00014 – Woodsmith Mine Annual Groundwater, Surface Water and Ecological Monitoring Report – 2019 in preparation.
- 40-ARI-WS-7100-WM-RP-02001 – Hydrogeological impact assessment of groundwater abstraction from the Lias Group strata at Woodsmith Mine.
- 40-ARI-WS-7100-WM-RP-02002-3-PLA – Background Information for Abstraction of Groundwater from the Lias Group.
- 40-ARI-WS-7600-EN-PE-01001 - Groundwater Activity Working Plan.

Development Details of Phase 12 Works

- Sirius Minerals Plc Construction Method Statement (NYMNPA 94 – Phase 12) (CMS) Document No. 40-SMP-WS-7100-PA-MS- 00011.
- Arup NYMNPA 60 Surface Water Drainage Scheme Phase 12 Works – 40-ARI-WS-7100-CI-RP-01008.
- Construction Environmental Management Plan – 40-RHD-WS-70-EN-PL-0045.
- 40-ARI-WS-7100-CI-18-01072 – Phase 12 Earthworks.
- 40-ARI-WS-7100-CI-22-01067 – Phase 12 Masterplan.
- 40-ARI-WS-7100-CI-22-01068 – Phase 12 Planning Phases Comparison General Arrangement.
- 40-ARI-WS-7100-CI-22-01069 – Phase 12 Drainage General Arrangement.
- 40-ARI-WS-7100-CI-22-01070 – Phase 12 Hard and Soft Landscape General Arrangement.
- 40-ARI-WS-7100-CI-22-01071 – Phase 12 Additional Laydown Area.
- 40-ARI-WS-7100-CI-22-01072 – Phase 12 Surface Water Drainage.
- 40-ARI-WS-7100-CI-22-01073 – Phase 12 Bund F Basal Drainage.
- 40-ARI-WS-71-CI-DR-3019 – Groundwater Activity Permit Boundary.
- 40-ARS-WS-1100-CI-43-20001 – Woodsmith Production Shaft Preliminary Long Section
- 40-ARS-WS-1200-CI-43-10001 – Woodsmith Service Shaft Preliminary Long Section

Environmental Permits

- Environmental Permit EPR/MB3399VR 10/05/2019 York Potash Ltd. Runoff and Basal Drainage of Bunds at Woodsmith Mine.
- Water Resources Abstraction License York Potash Ltd, Woodsmith Mine, Sneaton, North Yorkshire, which is currently being determined by the Environment Agency.

3 DETAILS OF THE PHASE 12 WORKS

3.1 General Description

The proposed Phase 12 Works that will be undertaken concurrently with the Phase 3, 7, 8, 9, and 11 Works, include:-

- Assembly and operation of Shaft Boring Roadheaders (SBRs) at both Service Shaft and Production Shaft.
- Installation of additional welfare cabins.
- Installation of segregated materials bunker.
- Creation of laydown area for segment and tubbing storage; and
- Installation of lightning protection and canopy to SSUs; and
- Installation of access control measures.

The ongoing construction works from previous phases that will be undertaken concurrently with Phase 12 include the following:-

- Phase 3 – Concrete batching,
- Phase 7 – Excavation of Production shaft to 83.66 m AOD, earthworks and drainage,
- Phase 8 – Construction of permanent shaft buildings,
- Phase 9 – Installation and operation of Non-Domestic Waste-Water Treatment Plant (NDWwTP).
- Phase 11 – Landscape mitigation screening, tree clearance within Haxby Plantation, drill and blast sinking of the MTS shaft and construction of the materials handling area.

The following sections present details of the design levels and construction methodology for the Phase 12 Works.

3.2 Construction Methodology

3.2.1 Surface Works on Shaft Platform Area

The following works that are to be placed on the site platform area will have no additional hydrogeological impacts above that addressed in previous construction phases for the shaft platform and no site specific hydrogeological risk assessment is required for these aspects of the works:-

- Assembly of Shaft Boring Roadheaders (SBRs) at both Service Shaft and Production Shaft, and
- Satellite offices at each shaft.

3.2.2 Management of Landscaped Mitigation Screening

Management of the landscaped mitigation screening will be undertaken in compliance with Environmental Permit EPR/MB3399VR 10/05/2019. As part of the Phase 12 Works, a topsoil and subsoil strip will be undertaken to a depth of 0.6 m within the footprint of Bund F to accommodate placement of extractive material from the Service, Production and MTS shafts, as shown on construction Arup Drawings 40-ARI-WS-7100-CI-18-01072 and 40-ARI-WS-7100-CI-22-01073.

Extractive material generated from the shaft's construction, from the base of the pre-sink at approximately 85 m AOD to the base of the Lias at approximately -285 m OD, will comprise materials excavated by the Shaft Boring Roadheaders (SBR) from the Whitby Mudstone Formation, Staithes Sandstone, Cleveland Ironstone Formation and Redcar Mudstone Formation, which are characterised (Ref. 13) as of low pollution potential. The shaft sinking process will generate two excavation arising streams: rock and water. Each shaft will produce approximately 15,500m^3 of rock material to be placed in Bund F.

The rock will be managed via the Surface Materials Bunker, where geotechnical assessment will be undertaken prior to placement of acceptable Class 4 Landscape Fill in Bund F. If the material is too wet for placement, it will be transported to the Materials Handling Area to be mixed with dry rock and worked to an acceptable quality and then placed in Bund F. Any unacceptable material designated for off-site disposal, as defined by the Groundwater Activity Permit Working Plan (Ref. 40-ARI-WS-7600-EN-PE-01001) or following a pollution incident (e.g. burst hydraulic hose), will be transported to the Segregated Materials Bunker, as illustrated in Arup Drawing 40-ARI-WS-7100-CI-22-01068, where it will be stored prior to disposal to a licenced facility.

The water arisings, monitored by a flow meter, will be pumped via a Screw Tank to the surface for processing in the NDWwTP prior to discharge to Sneaton Thorpe Beck or disposal offsite to a suitably permitted facility, in accordance with the existing Discharge Environmental Permit EPR/LB3797/VJ.

A basal drainage system will be constructed at formation level in Bund F, as detailed for Phase 11 (Section 3 of Ref. 12) and illustrated in Arup Drawing 40-ARI-WS-7100-CI-22-01073.

As approved under Environmental Permit EPR/MB3399VR (Ref. 19), drainage from Bund F will discharge to a sequence of attenuation ponds and then discharged at a single point (Discharge OF8) to Sneaton Thorpe Beck (Arup Drawings 40-ARI-WS-7100-CI-22-101072 and 40-ARI-WS-71-CI-DR-3019).

Placement of the rock materials within Bund F will be limited to a working area of 1 ha plus a 1ha area for capping at any one time. The fill will be compacted to reduce the air void content and achieve an average permeability of $1x10^{-7}$ m/s (Ref. 13).

3.2.3 Sinking the Service and Production Shafts by the SBR Methodology

3.2.3.1 Construction Sequencing

The following sequence of probe drilling, targeted grouting, where necessary, and excavation using a cutting drum, on an extendable, rotating pneumatic head, will be adopted to progress the shafts from approximately 85 m AOD to the base of the Lias at approximately -285 m OD. As for the Phase 11 construction of the MTS shaft (Ref. 12), although the predominant strata within this construction depth is low permeability mudstone, grouting may be necessary if water bearing horizons are encountered in the Staithes Sandstone Formation, Cleveland Ironstone Formation or fractured sections of the Redcar Mudstone Formation. The objective of such grouting will be to limit the maximum permeability of the excavation annulus to $1x10^{-7}$ m/s or similar (Ref. 23) and, as such, horizons of higher permeability will be treated to this level and the mudstone strata with a permeability below this value will remain ungrouted.

- Following completion of the Phase 10 shaft sinking, grouting and hydrostatic undrained lining of the Service shaft to 86.8 m AOD and of the Phase 7 lining of the Production Shaft by Diaphragm Walling to 83.66m AOD, the continuation of these shaft lining works in Phase 12 will commence with construction of the top of the drained liners, as illustrated in Drawing 1433DevOD424 Appendix 1 and Arup Drawings 40-ARS-WS-1100-CI-43-20001 and 40-ARS-WS-1200-CI-43-10001.
- Probe drilling will first be undertaken to confirm groundwater inflows within the staged drill and blast excavations below this level. Targeted grouting will only be undertaken, where determined necessary by the Contractor.

- The SBR will bore by up to 8.5 m diameter.
- Arisings will be excavated and hauled to the surface.
- The permanent concrete lining will then be constructed from the SBR.

3.2.3.2 Probe Drilling to Define Targeted Grouting Requirements

Only limited grouting will be required to control groundwater ingress through the sandstone units of the Cleveland Ironstone Formation and Staithes Sandstone, and localised fractured horizons in the Redcar Mudstone Formation. Probe drilling will be undertaken in 40 m sections in advance of the SBR excavation and grouting undertaken only where probe holes indicate a water inflow above approximately 1 Lugeon (equivalent to an approximate rock hydraulic continuity of 1×10^{-7} m/s) (Ref. 23).

3.2.3.3 Grouting Process

The grouting process to be adopted during SBR sinking of the Service and Production Shafts will be the same as described for the Phase 11 Works (Ref. 12).

As for the Phase 11 works (Ref. 12), water used in drilling will be cleaned to remove silt to enable re-use. Recirculated water that doesn't meet the requirements of the grouting contractor will be disposed of off-site or treated through the NDWwTP for discharge to Sneaton Thorpe Beck, under a discharge permit.

3.2.3.4 Operation of Shaft Boring Roadheaders

Shaft excavation will be progressed using a roadheader cutting boom, which cuts 0.2 m deep diametral cuts into the rock, to progress the shaft in 1m deep intervals. A permanent drained shaft lining is then lowered down into place from an upper SBR deck. This excavation process will generate two streams of arisings: rock chippings and a water slurry. The rock arisings transferred up to the surface within kibbles and then placed within the landscaped screening mounds, where geotechnically suitable. The slurry will be managed via a Screw Tank system and then by the NDWwTP for processing prior to discharge to Sneaton Thorpe Beck or offsite disposal.

3.2.4 Lining

Phase 12 lining of the 6.75m internal diameter Service and Production shafts will comprise a conventional drained reinforced concrete liner, as illustrated in Arup Drawings 40-ARS-WS-1100-CI-43-20001 and 40-ARS-WS-1200-CI-43-10001, and commence from the base of the undrained liners that were keyed to the Whitby Mudstone at an elevation of around 85 m AOD, during the Phase 4a and 7 works.

Drain holes through the liner walls will enable free drainage of groundwater from the annulus of the exposed rock face into the shaft during construction. As detailed in the Hydrogeological Impact Assessment (Ref. 23), water ingress through the Lias into the shaft during construction, is expected to occur from the more permeable horizons within the Cleveland Ironstone, the Staithes Sandstone and the Siliceous Shales Member of the Redcar Mudstone. Such water will be collected at the shaft excavation bench level during construction and pumped to surface.

3.2.5 Laydown Area for Segment and Tubbing Storage

A laydown area for the temporary storage of shaft tubbing segments and tunnel segments will be constructed in the southern area of the site, as shown in Arup's Drawings 40-ARI-WS-7100-CI-22-01068 and 40-ARI-WS-7100-CI-22-01071. This area will have an unbound aggregate surfacing and surface water infiltration will drain to a filter drain, swale and outfall to the north, as shown in Arup's Drawing 40-ARI-WS-7100-CI-22-01069.

Construction of the laydown area is at grade, of only limited plan area and has no significant impact on hydrogeological conditions onsite.

3.2.6 Segregated Materials Bunker

The segregated materials bunker will be constructed on the east side of Bund C, just north of the security gatehouse, as shown in Arup's Drawing 40-ARI-WS-7100-CI-22-01068. The bunker will be covered to prevent the generation of additional leachate from the extractive materials contained within it. External roof drainage will discharge to site wide surface water drainage ditch system. The bunker will have a concrete sealed base with an internal drainage system. This will drain to a sump to contain any runoff from extractive materials and will be pumped to the NDWwTP or disposed of offsite, as shown in Arup's Drawing 40-ARI-WS-7100-CI-22-01069.

Construction of the bunker is at grade, of only limited plan area and has no significant impact on hydrogeological conditions onsite.

3.3 Groundwater Management Measures

During shaft construction through the Lias, pumping will be undertaken from the base of the shaft excavation to manage groundwater infiltration through the drained liner and flowing behind the liner within the bedrock. Design calculations (Ref. 24) have determined that temporary groundwater management during shaft construction in the Lias will be required to accommodate the following potentially peak and steady state groundwater inflows from the three concurrent shaft excavations.

Table 2 - Summary of Estimated Abstraction Rates During Shaft Construction

Groundwater Abstraction Point	Peak Abstraction Rate (m^3/day)	Likely Abstraction Rate (m^3/day)
Service Shaft Excavation	600	100
Production Shaft Excavation	600	100
MTS Shaft Excavation	600	100
Total Groundwater Abstraction Quantities during Phase 12	-	300

The groundwater inflow will be pumped to the surface from a sump where collection and storage will be managed by either offsite disposal or through the NDWwTP system.

During the construction phase, it is intended that abstracted water will be used where possible in the construction process, therefore limiting the amount of water that will need to be discharged. Surplus water will be discharged to a tributary to Sneatonthorpe Beck at grid reference NZ 89935 05186 under discharge consent EPR/LB3797/VJ or will be transported off-site to a suitably permitted disposal point.

3.4 Construction Programme

The construction programme for the Phase 12 surface works is expected to commence in July 2020, with the launch of the SBR at the Service Shaft in quarter 4 2020 and then launching the SBR in the Production Shaft in quarter 2 2021. The shaft construction and associated earthworks are expected to take approximately 6 months to complete from launch of the SBR's.

4 MINESITE HYDROGEOLOGICAL CONDITIONS

The surface Phase 12 works are either contained within the existing Shafts and Reinjection Well platform areas or are limited to only shallow excavation within the topsoil, subsoil and shallow Glacial Till deposits. As such, they will not penetrate or interact with groundwaters within the near surface aquifers.

As detailed for the Phase 11 MTS shaft lining works (Ref. 12) and illustrated in Drawing No. 1433DevOD424 Appendix 1 and Arup Drawings 40-ARS-WS-1100-CI-43-20001 and 40-ARS-WS-1200-CI-43-10001, the Phase 12 Service and Production shaft works between 120 m below ground level (bgl) (85 m AOD) and 490 m bgl (-285 m OD) will all be undertaken below the Secondary A aquifers of the Ravenscar Group. These works will be confined within the low permeability mudstones of the Lias Group from the Non Productive aquiclude strata of the Whitby Mudstone Formation, through the Secondary A aquifers of the Cleveland Ironstone Formation and the Staithes Sandstone and terminate at the base of the Redcar Mudstone Secondary Undifferentiated. Detailed descriptions of the geology, geotechnical properties and conditions of these strata are presented in the Phase 11 Hydrogeological Risk Assessment (Ref. 12).

Within the Lias Group, only limited weakly alkaline, sulphatic groundwaters are anticipated associated with fractured strata and localised more permeable arenaceous horizons within: the Cleveland Ironstone Formation at an elevation of around 12 and -5 m OD, in the Staithes Sandstone at -8 m OD and within the Siliceous Shales Member of the Redcar Mudstone at around -127 and -141 m OD. From groundwater levels recorded close to the site, a conservative groundwater level in the Lias Group has been adopted at 113 m AOD (Ref. 24), as shown in Drawing 1433DevOD424 Appendix 1.

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 1433DevOD426 Appendix 1 and summarised in Table 3.

Table 3 - 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

Type	Receptor	Sensitivity
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. 20) 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 to be a soligenous habitat within the shallow valley feature. As a precautionary measure, until discussed further, this receptor will be classified as of High sensitivity.

6 QUALITATIVE HYDROGEOLOGICAL RISK ASSESSMENT

6.1 Conceptual Model

The principal hydrogeological units underlying the Shaft platform areas, comprise perched waters in the Glacial Till non-aquifer, beneath which are Secondary A aquifers of local importance (Long Nab, Moor Grit, Scarborough, Cloughton and Saltwick), as illustrated in Drawing Nos. 1433DevOD424 and 1433DevOD425 Appendix 1 and Arup Drawings 40-ARS-WS-1100-CI-43-20001 and 40-ARS-WS-1200-CI-43-10001. Groundwater in the Ravenscar Group is of freshwater quality with limited vertical continuity between the individual aquifer units. The groundwater levels recorded on the minesite in these strata are at around 200m AOD in the Moor Grit, 190m AOD in the Scarborough and Cloughton, and 145m AOD in the Saltwick. These upper freshwater aquifers are isolated from the weakly alkaline and sulphatic discontinuous perched waters in the Lias by the Whitby Mudstone aquiclude at the top of the Lias Group, as illustrated in Drawing No. 1433DevOD424.

The upper sections of the hydrostatic undrained Service and Production shafts, installed as part of the Phase 4a works, penetrated 12 m into the Whitby Mudstone (92.4 to 80.8 m AOD), as illustrated in Drawing No. 1433DevOD424 and Arup Drawings 40-ARS-WS-1100-CI-43-20001 and 40-ARS-WS-1200-CI-43-10001. As such, the SBR lining operations, to extend the shafts below 80.8 m AOD, will be 12 m below the overlying sensitive Secondary A aquifers and isolated from the fresh waters in the Ravenscar aquifers by the undrained hydrostatic liners that seal the shafts into the upper section of the Whitby Mudstone aquiclude. The Phase 12 SBR shaft construction, from 85 m AOD to the base of the shafts at -285 m OD in the Calcareous Shales, will be confined within the low permeable argillaceous units, within which only localised permeable horizons are anticipated associated with thin interbeds of silty sandstone and fractured horizons. On the assumption that the maximum regional phreatic surface in the Lias is at 113 m AOD, estimates of potential water inflows into the shaft excavations and during operation post construction through the drained liners to the Service, Production and MTS shafts have been simulated (Ref. 24) and are summarised in Table 2. During shaft construction and post lining, groundwater entering the drained shafts will either evaporate or flow to the base of the shaft to be sump pumped to surface.

Within the minesite area, there are no hydrogeologically-supported terrestrial ecosystems or groundwater abstractions, as shown in Drawing 1433DevOD426 Appendix 1. 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. These shallow aquifers are isolated from Phase 12 SBR shaft construction works by the upper undrained shaft liners and by the upper section of the Whitby Mudstone aquiclude Drawing 1433DevOD424 Appendix 1. No surface water features are in hydraulic continuity with the Lias Group, due to the hydraulic discontinuity created by the low permeable Whitby Mudstone aquiclude.

Offsite, is the Ugglebarnby Moor spring flush soligenous habitat in the shallow valley feature fed by surface runoff and infiltration held in the superficial deposits, with only a minor and intermittent contribution from 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 close to the minesite (Drawing 1433DevOD426 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 1433DevOD426.

6.2 Groundwater Effects

The physical and chemical groundwater effects that may arise as a result of the Phase 12 Works are summarised in Tables 4 and 5: -

Table 4 – Physical Effects

Effect	Discussion	Magnitude of Effect at Source
	SBR Shaft Construction	
During the SBR construction process for the shafts, groundwater ingress could occur through fractured and arenaceous rock. Such ingress could inundate the excavation and inhibit construction operations.	Down the vertical profile of the Service and Production shafts, the strata to be excavated is predominantly argillaceous with a permeability of less than $1x10^{-7}$ m/s. Only local argillaceous sandstone beds and horizons of more fractured strata are expected, where permeabilities may be greater the $1x10^{-7}$ m/s. 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 by sump pumping from the base of the cut 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 construction of the shafts below the seal created in the Whitby Mudstone, as the shafts are advanced through the Lias Group, groundwater seepage will enter the shafts through the open face of the shaft prior to lining. As the shaft liners through the Lias Group will be drained, to relieve build up in water pressure, groundwater seepage from the Lias Group into the shafts will continue both during construction and through the operational life of the mine.	The hydrostatic liner installed for the shafts through the Ravenscar Group and terminating at a seal in the top of the Whitby Mudstone will isolate the fresh groundwaters in the Secondary A aquifers from underdrainage within the Lias, during construction and operation of the drained shaft liner section. In the event of the seal failing, underdrainage could occur of the Ravenscar Formation via the drained shaft lining promoting a draw down and reduction in groundwater levels in the Ravenscar aquifers. Ground water modelling of such a concurrent seal failure event occurring in all 3 shafts has been undertaken (Ref. 24), which demonstrated that such underdrainage would have a negligible impact on groundwater levels in the Ravenscar Formation.	Negligible Magnitude of Effect at Source.
	Construction of Bund F using SBR shaft Arisings	
Construction of the localised area of landscape Bund F will cause local reduction of infiltration into the near surface aquifers.	Due to the small surface area of the section of Bund F to be constructed during the Phase 12 works, the proposed earthworks will have no significant physical impact on recharge into the Scarborough and Cloughton aquifers with no significant physical impact to the groundwater levels.	Very Low Magnitude of Effect at Source.
Construction of Bund F above a low permeable cohesive subgrade could cause perched waters to develop within the fill over the long term, which could impact on the slope stability of the mound.	To prevent the future build-up of a perched water table within the landscape fill a basal drainage layer has been incorporated into the design, which will drain into the mine site's main surface water drainage system.	Low Magnitude of Effect at Source.
Groundwater ingress into the base of Bund F could occur along the spring line at the base of the Scarborough aquifer, which could present a future slope stability risk to the bund construction.	A groundwater drainage blanket is to be constructed where spring line issues have been observed to control these groundwater issues and to discharge collected waters to the surface water drainage system.	Low Magnitude of Effect at Source

6.2.1 Chemical Effects

Table 5 – Chemical Effects

Effect	Discussion	Magnitude of Effect at Source
	SBR Shaft Excavation	
Groundwater pollution from grout losses during targeted grouting.	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.	Very Low Magnitude of Effect at Source
Groundwater pollution from grouting operations using cementitious grouts.	Grouting operations will involve non-hazardous, non-ecotoxic inert cement-based grout, bentonite, plasticizers and retarders only. Potential Contaminants of Concern (CoC) from these works include total dissolved solids, turbidity, alkaline pH and elevated conductivity. Implementation of environmental control measures during grouting operations through the CEMP (Ref. 18) will limit the possibility of water flush loss, grout loss or spillage occurring. Published data on the geochemical impacts of cementitious materials on groundwater composition indicates that, whilst short-term variations in pH, alkalinity, Ca and K concentrations can occur local to the cementitious injection zone, once the concrete cures it is inert to groundwater leaching, with only marginally elevated levels of K, Ca and alkalinity remaining adjacent to the hardened concrete. As these ions are quickly buffered along the groundwater flow path, cementitious grouts present no significant risk of pollution contamination to groundwater quality.	Very Low Magnitude of Effect at Source
Groundwater pollution from targeted grouting operations using polyurethane based grouts.	Grouting operations may utilise polyurethane grouts, together with potassium ferricyanide and sodium persulphate catalysts. Potential CoC from these works include total dissolved solids, turbidity, low concentrations of Ferrate (3-) hexacyano-tripotassium, sodium persulphate, sodium bicarbonate, dibutyl phthalate and potassium chloride, which can present a risk of harm to fish and invertebrates. Implementing environmental control measures during grouting operations through the CEMP (Ref. 18) will limit the possibility of water flush loss, grout loss or spillage occurring and provide procedures to ensure that they are contained and dealt with quickly. As such, the magnitude of effect at source will be very low.	Very Low Magnitude of Effect at Source

Effect	Discussion	Magnitude of Effect at Source
Temporary and localised groundwater pollution around the shaft excavation may arise from leakage / spillage of; hydraulic lubricants from the road header excavation arm and / or recirculation of recycled flush water during drilling for grouting.	Rapidly biodegradable synthetic hydraulic oils are to be utilised by the excavation plant. These synthetic organic alcohols present a low pollution hazard to groundwater. A structured maintenance and monitoring regime will be adopted through the CEMP (Ref. 18) 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. To maintain a high-water quality to the drill flush waters, these will be passed through a recycling unit to remove particulates prior to recirculation. In the event of a hydraulic leak occurring during SBR operation any contaminated extractive material will be transported to the Segregated Materials Bunker for offsite disposal. All construction waste waters taken from the shaft excavation will either be disposed of offsite or treated within the NDWwTP facility, prior to discharge to Sneaton Thorpe Beck under an Environmental Permit surface water discharge consent.	Low Magnitude of Effect at Source.
Construction of Bund F using SBR Arisings		
Arisings from the SBR operations may contain residual concentrations of hydraulic oils from the excavation plant. Such contamination in the rock arisings could leach from the fill placed in Bund F and impact on ground and surface water quality.	Rapidly biodegradable synthetic hydraulic oils are to be utilised by the roadheader. These synthetic organic alcohols present a low pollution hazard to ground and surface water. In the event of a hydraulic leak occurring during SBR operation any contaminated water will be transported for offsite disposal. Water from the SBR cutting process will be taken to the non-NDWwTP plant for treatment. Wet material placed on the Material Handling Area will free drain into the hold tank prior to discharge via a penstock valve to the surface water perimeter drain. A structured maintenance and monitoring regime will be adopted through the CEMP (Ref. 18) for the construction operations to ensure that only low concentrations are present in the rock fill arisings placed in Bund F. Leaching of these CoC from the rock fill is determined to present a low pollution hazard to groundwater and to surface water quality both during construction and in the longer term.	Low Magnitude of Effect at Source.

Effect	Discussion	Magnitude of Effect at Source
During construction, surface water runoff from exposed rock arisings in Bund F will discharge to the perimeter drain within the main surface water drainage system that outflows to Sneaton Thorpe Beck. This discharge could therefore impact on water quality in Sneaton Thorpe Beck.	Chemical characterisation of the extractive materials to be generated from the shaft excavations (Ref. 13) has determined that water in contact with these materials could leach low concentrations of sulphate, chloride, heavy metals and PAH. Engineering measures have been incorporated into the design of Bund F to restrict the open area for filling and restoration to a maximum of 2 ha. This will minimise the surface area exposed to infiltration and will limit the volume and flow rate of construction surface waters off the rock fill that enter the main surface water drainage system. These construction surface waters will discharge to a perimeter swale flowing to an attenuation pond, where it will mix with clean surface water run-off from the shaft platform and completed bund areas prior to discharge to Sneaton Thorpe Beck at the northern tributary (Discharge OF8 Drawing (Arup Drawing 40-ARI-WS-71-CI-DR-3019). Although construction surface water runoff in contact with the rock fill materials could therefore affect the chemical quality of surface water drainage, engineering measures have been adopted to minimise the effects of waters discharging into Sneaton Thorpe Beck.	High Magnitude of Effect at Source
Precipitation onto operational and unrestored areas in Bund F that permeates through the rock fill will be collected by the basal drainage system. This will discharge to the perimeter drain within the main surface water drainage system that outflows to Sneaton Thorpe Beck. The basal drainage discharge could therefore impact on water quality in Sneaton Thorpe Beck.	Chemical characterisation of the extractive materials to be generated from the shaft excavations (Ref. 13) has determined that water in contact with these materials could leach low concentrations of sulphate, chloride, heavy metals and PAH. To minimise the quantity and flow of water from the basal drainage system, engineering measures have been incorporated into the design of the bund to include compaction of the rock materials to limit permeation of water through the rock fill and thereby restrict the generation of leachates. In addition, to limit the surface area open to infiltration, the operational and unrestored area is to be restricted to a maximum open area of 2 ha at any one time. To minimise water ingress into the rock fill after restoration, the bund will have a cover layer including a land drainage system. To maximise the dilution and attenuation of waters discharging from the basal drainage system into the surface water drainage system, it will first discharge to the perimeter swale and then flow to an attenuation pond where it will mix with clean surface water run-off from the shaft platform and completed bund area prior to discharge to Sneaton Thorpe Beck. Although discharge for the basal drainage system could therefore affect the chemical quality of surface water drainage, engineering measures have been adopted to minimise the effects of waters discharging into Sneaton Thorpe Beck.	High Magnitude of Effect at Source

Effect	Discussion	Magnitude of Effect at Source
Permeation of precipitation through the rockfill in Bund F, during construction and post restoration conditions, will mobilise soluble contamination from the fill that could permeate through the base of the bund into the underlying Moor Grit and Scarborough aquifers.	Chemical characterisation of the extractive materials to be generated from the shaft excavations (Ref. 13) has determined that water in contact with these materials could leach low concentrations of sulphate, chloride, heavy metals and PAH. To minimise the quantity and flow of water through the rock fill during construction, the bund materials are to be compacted to reduce their porosity and permeability. In addition, to limit the surface area open to infiltration, the operational and unrestored area is to be limited to a maximum open area of 2 ha at any one time. To minimise water ingress into the rock fill after restoration, the bund will have a cover layer including a land drainage system. To minimise permeation of water through the base of the bund into the Glacial Till and below formation level, a basal drainage system will be constructed. This drainage will limit the head of water that can build up above the prepared formation. By implementing these control measures only negligible infiltration will occur through the base of the bund that could impact on groundwater quality in the underlying Moor Grit and Scarborough aquifers.	Moderate 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.

For the evaluation of groundwater level impacts of abstraction from the Lias strata, numerical analysis of the radius of influence was undertaken as part of the Abstraction Permit application process (Ref. 23). The results of that assessment are evaluated in Section 6.4.

For the assessment of pollution impacts of the CoC within the rock arisings to be placed in Bund F, a quantitative hydrogeological risk assessment was undertaken as part of the Landscaped Bund design submitted for the approved Environmental Permit EPR/MB3399VR and the results (Ref. 13) are discussed 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, as well as the surface waters and springs, the qualitative risk assessment demonstrates that the Phase 12 Works will have a Negligible Physical and Chemical Impact. As detailed in the Section 73 Hydrogeological Risk Assessment (Ref. 14), this development will have a negligible cumulative long-term hydrogeological impact on all hydrogeological receptors.

For Bund F, groundwater and surface water contaminant transport modelling has been undertaken to simulate the potential pollution impacts of percolating waters through the rock fill (Ref. 13). That modelling submitted for the approved Environmental Permit EPR/MB3399VR demonstrated that the water ingress and permeation through the rock fill presents a negligible pollution risk to groundwaters in the underlying Moor Grit and Scarborough aquifers and to surface water quality in Sneaton Thorpe Beck.

The results of the ground water level modelling, to simulate the radius of influence of abstraction from the shafts during construction and operational conditions (Ref. 23), confirmed a negligible impact on hydrogeological receptors on and adjacent to the mine site.

7 MITIGATION MEASURES, MONITORING, REMEDIAL ACTION PLAN AND GROUNDWATER MANAGEMENT PLAN

7.1 Mitigation Measures

As part of this assessment, consideration has been given as to whether the recharge trench to the west of Bund C requires to be initiated as part of these Phase 12 Works. Taking account of the previously submitted quantitative modelling outputs and field monitoring data (Ref. 14), this hydrogeological risk assessment has demonstrated that these measures are not warranted at this stage of the construction process.

7.2 Monitoring

For the Phase 12 Works, construction stage monitoring should be continued in compliance with the procedures documented for the Phase 11 Works (Ref. 5) with ground and surface water quality Control and Compliance Trigger Values revised as presented in Appendix 4 (Tables 12, 13 and 23), to reflect compliance values presented in Reference 25 and as amended in Reference 26.

With regards to monitoring and evaluating shaft construction dewatering impacts on shallow aquifers, as detailed in Section 2.3 of the Phase 11 Ground and Surface Water Monitoring

Scheme (Ref. 15), the existing groundwater monitoring installations within the Ravenscar Group aquifers will be monitored throughout the SBR shaft sinking operations in the Lias, supplemented with the additional groundwater level monitoring detailed in Table 6, as per the abstraction permit.

Table 6 – Additional Phase 12 Groundwater Level Monitoring in accordance with the Abstraction Permit

Borehole Reference	Stratum monitored
GW103	Moor Grit
GW105	Scarborough Formation
GW106	Cloughton Formation
GW108	Cloughton Formation
GW122A	Moor Grit
GW124	Moor Grit
GW138	Cloughton Formation

In addition to groundwater level monitoring, as detailed in Ref. 23 during Phase 12 construction, the Phase 11 monitoring regime will be supplemented with in-line flow monitoring of water pumping rates abstracted from the shafts. The results of that monitoring will be assessed to evaluate the measured groundwater ingress and abstraction rates in comparison with the simulated rates presented in Table 2 of this document.

The groundwater level monitoring data will be evaluated in accordance with the trigger values presented in Section 2.3.4 (Ref. 15) and will be considered together with the in-line flow monitoring rates to identify evidence of non-seasonal changes in groundwater levels that could be attributed to the shaft sinking activities. Data will be collected for a three-month period before being analysed and presented to the Environment Agency as part of the groundwater abstraction licence application.

7.3 Remedial Action Plan

The procedures for evaluating, managing and reporting breaches in "Trigger Values" will be as detailed in Section 3.2 of the approved Remedial Action Plan for the Phase 11 Works (Ref. 22).

7.4 Groundwater Management Plan

As the Phase 12 Works will have a negligible physical and chemical impact on hydrogeological receptors and also as this phase incorporates the same groundwater management measures for Shaft Construction (i.e. grouting, inflow pumping and drained shaft liners) and for Construction of Bund F (i.e. inclusion of basal drainage, restrictions to working areas, engineered fill placement and a designed restoration cover layer) as incorporated and approved for the Phase 11 works, no addition or amendment is required to the current Phase 11 Groundwater Management Plan (Ref. 21) in respect of these elements.

R IZATT-LOWRY
CONSULTANT

M LAKEY
DIRECTOR

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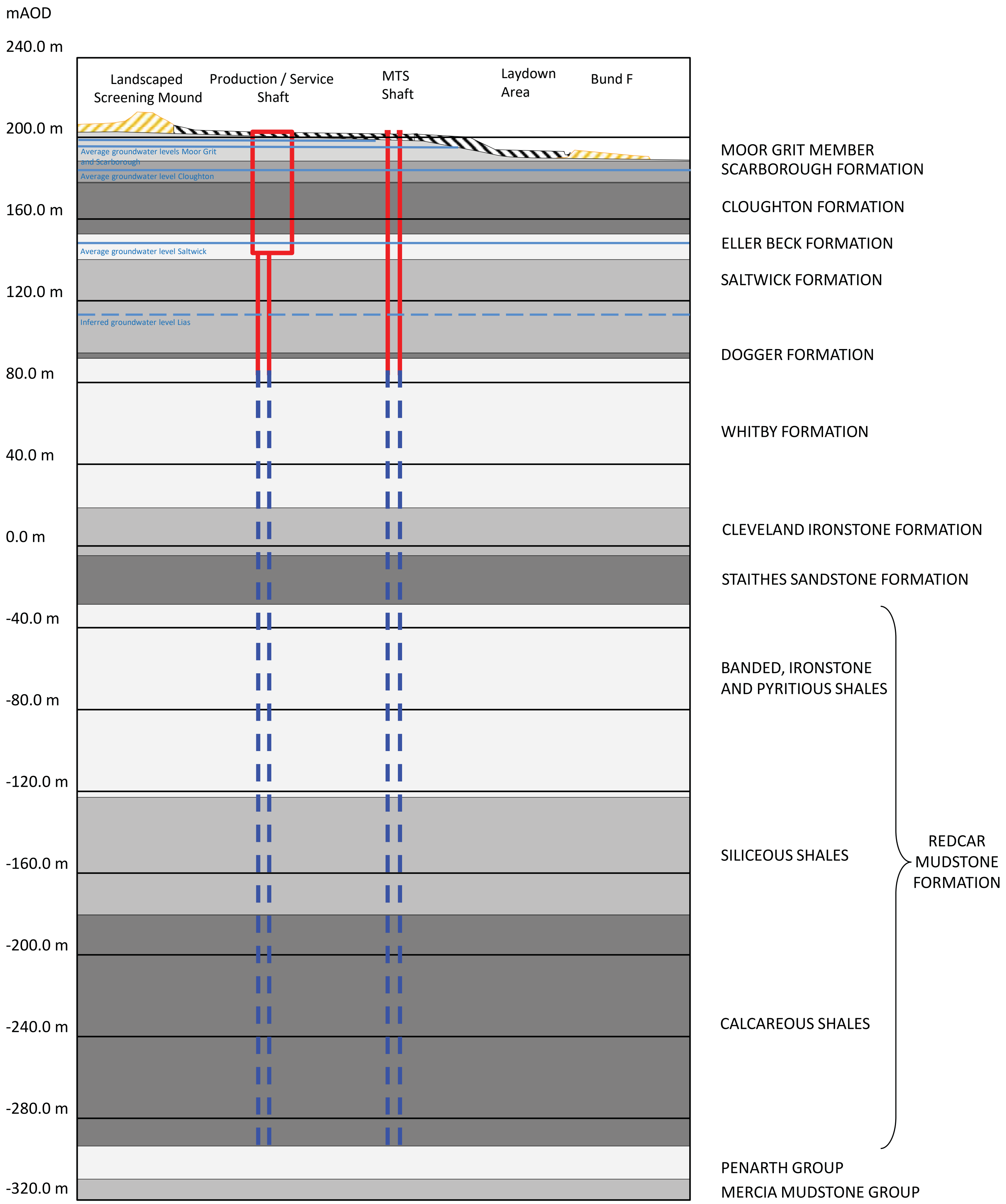
APPENDIX 1

DRAWINGS



NOTES / KEY

- HYDROSTATIC SHAFT LINER
- DRAINED SHAFT LINER
- LANDSCAPED SCREENING MOUND
- GRANULAR PLATFORM CONSTRUCTION AND LAYDOWN AREA

DRAWING TITLE

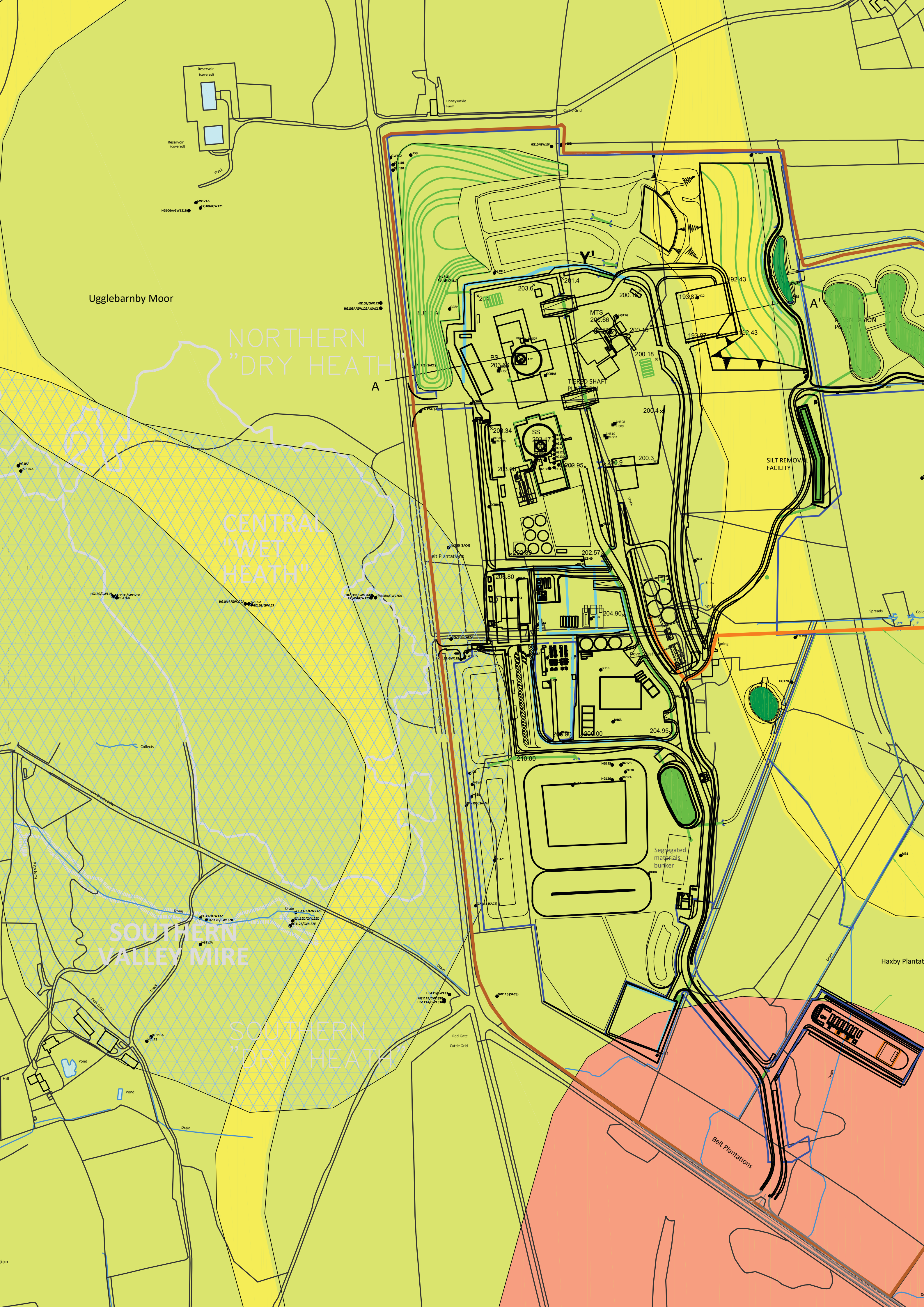
PHASE 12 - SCHEMATIC CROSS SECTION THROUGH BUND F, PRODUCTION SHAFT AND MTS SHAFT

PROJECT TITLE

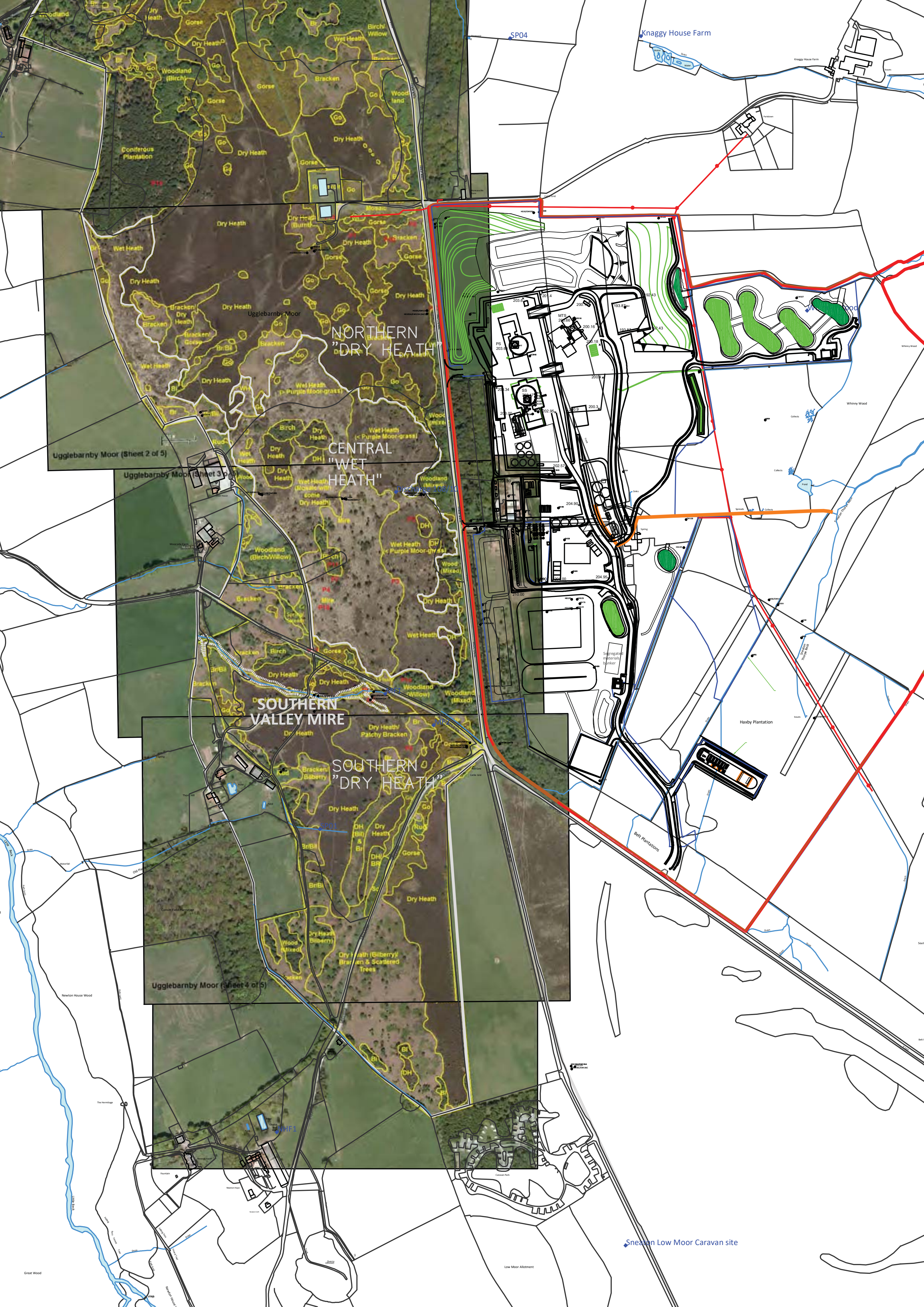
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT SIRIUS MINERALS PLC	
STATUS FINAL	PROJECT NUMBER 1433Dev
DRAWN BY CM	DATE April 2020
SCALE AS SHOWN	DRG. No. 1433DevOD424

FWS Geotechnical & Environmental Consultants
Unit 2 City West Business Park
St John's Road
Meadowfield Industrial Estate
Durham
DH7 8ER



Reservoir (covered)
Reservoir (covered)
Track
Honeysuckle Farm
Cattle Grid
Ugglebarnby Moor
NORTHERN "DRY HEATH"
CENTRAL "WET HEATH"
SOUTHERN VALLEY MIRE
SOUTHERN "DRY HEATH"
A
A'
Y'
201.4
203.6
192.43
193.87
MTS
200.66
200.18
PS
203.65
TIERED SHAFT PLATFORM
200.4
SS
200.3
202.57
204.90
204.95
210.00
SILT REMOVAL FACILITY
Segregated materials bunker
Belt Plantations
Haxby Plantat
Red Gate Cattle Grid
Pond
Drain
Collects
Spreads
Track



SP04
Knaggy House Farm
NORTHERN "DRY HEATH"
CENTRAL "WET HEATH"
SOUTHERN VALLEY MIRE
SOUTHERN "DRY HEATH"
Ugglebarnby Moor
Ugglebarnby Moor (Sheet 2 of 5)
Ugglebarnby Moor (Sheet 4 of 5)
Coniferous Plantation
Dry Heath
Wet Heath
Gorse
Bracken
Woodland (Birch)
Whinny Wood
Haxby Plantation
Belt Plantations
Segregated materials bunker
Sneaton Low Moor Caravan site

APPENDIX 2

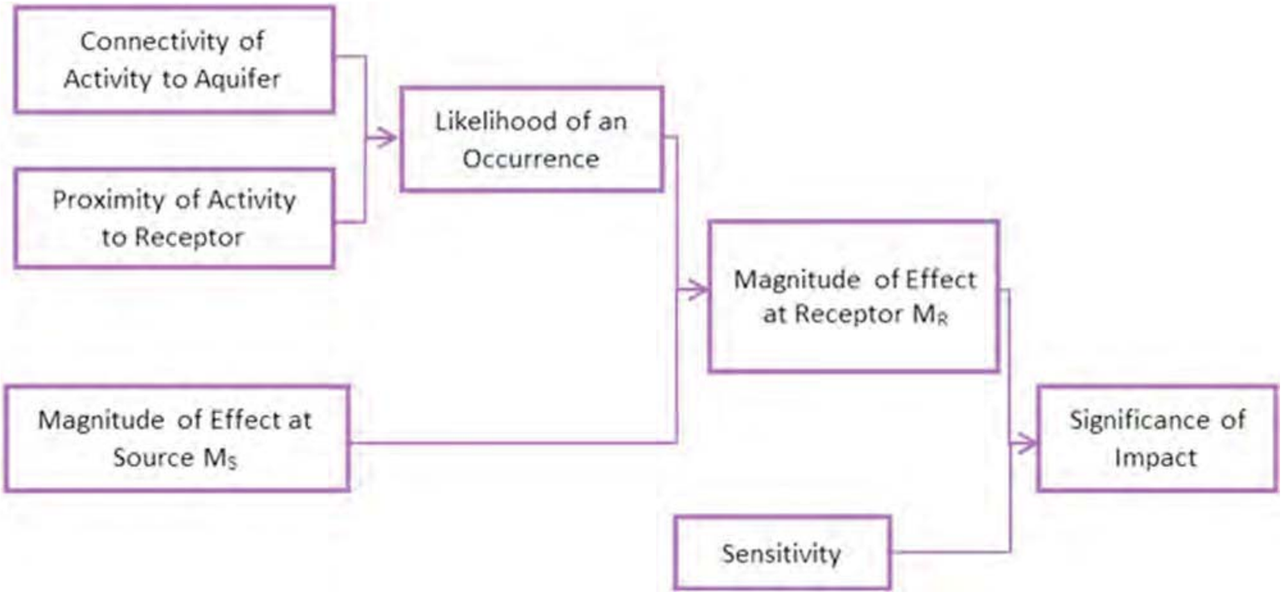
RISK ASSESSMENT METHODOLOGY

APPENDIX 2

1 RISK ASSESSMENT METHODOLOGY

The revised qualitative hydrogeological risk assessment presented in this report evaluates the "Significance of Impact" of the Phase 12 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 11 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

3.1 EVALUATION OF PROXIMITY OF RECEPTOR TO THE PHYSICAL AND CHEMICAL EFFECTS OF CONSTRUCTION WORKS ASSOCIATED WITH SPECIFIC PHASE 12 WORKS ACTIVITIES

3.2 QUALITATIVE HYDROGEOLOGICAL RISK ASSESSMENT – PHASE 12 WORKS

Northern Dry	**Dry Heath Ecology**	Distance (m)	165	185	
		Horizontal Proximity	High	High	
		Calculated Proximity	**Medium**	**Medium**	
Central Wet	**Wetland Ecology**	Distance (m)	190	160	
		Horizontal Proximity	High	High	
		Calculated Proximity	**Medium**	**Medium**	
Southern Dry	**Dry Heath Ecology**	Distance (m)	640	540	
		Horizontal Proximity	Low	Low	
		Calculated Proximity	**Very Low**	**Very Low**	
Southern Valley	**Wetland Ecology**	Distance (m)	580	515	
		Horizontal Proximity	Low	Low	
		Calculated Proximity	**Low**	**Low**	
Dry Heath Area	**Dry Heath Ecology**	Distance (m)	700	800	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
ck	**Surface Water**	Distance (m)	650	585	
		Horizontal Proximity	Low	Low	
		Calculated Proximity	**Low**	**Low**	
	Surface Water	Distance (m)	1255	1215	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
Caravan Park	**Drinking Water**	Distance (m)	1500	1405	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
	Drinking Water	Distance (m)	670	570	
		Horizontal Proximity	Low	Low	
		Calculated Proximity	**Low**	**Low**	
	Drinking Water	Distance (m)	1430	1350	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
	Drinking Water	Distance (m)	1480	1390	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
	Baseflow	Distance (m)	930	850	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
	Baseflow	Distance (m)	1020	1070	
		Horizontal Proximity	Very Low	Very Low	
		Calculated Proximity	**Very Low**	**Very Low**	
	Baseflow	Distance (m)	545	635	
		Horizontal Proximity	Low	Very Low	
		Calculated Proximity	**Low**	**Very Low**	
	Baseflow	Distance (m)	325	250	
		Horizontal Proximity	Medium	High	
		Calculated Proximity	**Medium**	**High**	
Spring	**Baseflow**	Distance (m)	595	670	
		Horizontal Proximity	Low	Low	
		Calculated Proximity	**Low**	**Low**	
y A Aquifer	**"Shallow aquifer/ Drinking water/ Baseflow"**	Distance (m)	0	0	
		Horizontal Proximity	Very High	Very High	
		Calculated Proximity	**Very High**	**Very High**	
condary A	**"Shallow aquifer/ Drinking water/ Baseflow"**	Distance (m)	0	0	
		Horizontal Proximity	Very High	Very High	
		Calculated Proximity	**Very High**	**Very High**	
ndary A Aquifer	**"Moderate depth aquifer/ Drinking water/ Baseflow"**	Distance (m)	0	0	
		Horizontal Proximity	Very High	Very High	
		Calculated Proximity	**Very High**	**Very High**	
lary A Aquifer	**Moderate depth aquifer**	Distance (m)	0	0	
		Horizontal Proximity	Very High	Very High	
		Calculated Proximity	**Very High**	**Very High**	
Fm Unproductive	**Deep depth aquiclude**	Distance (m)	0	0	
		Horizontal Proximity	Very High	Very High	
		Calculated Proximity	**Very High**	**Very High**	
e Fm Secondary	**Deep depth aquifer**	Distance (m)	0	0	

		Dry Heath Area	Heath Area	Dry Heath Area	Spring Flush Area	Area		Su
		Dry Heath Ecology	Wetland Ecology	Dry Heath Ecology	Wetland Ecology	Dry Heath Ecology	Surface Water	
process for the shafts, groundwater ingress could occur ceous rock. Such ingress could inundate the excavation rations.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	
	Receptor Proximity to Activity	Medium	Medium	Very Low	Low	Very Low	Low	
	Likelihood	Low	Low	Very Low	Low	Very Low	Low	
	Magnitude of Effect at Source	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**	
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	
hafts below the seal created in the Whitby Mudstone, as ugh the Lias Group, groundwater seepage will enter the e of the shaft prior to lining. As the shaft liners through ed, to relieve build up in water pressure, groundwater into the shafts will continue both during construction life of the mine.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	
	Receptor Proximity to Activity	High	Medium	Low	Very Low	Very Low	Low	
	Likelihood	Medium	Low	Low	Very Low	Very Low	Low	
	Magnitude of Effect at Source	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**	
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	
area of landscape Bund F will cause local reduction of face aquifers.	Connectivity between Activity and Receptor	Low	Low	Low	Low	Low	Low	
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low	
	Likelihood	Medium	Low	Low	Low	Low	Low	
	Magnitude of Effect at Source	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**	
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	
e a low permeable cohesive subgrade could cause within the fill over the long term, which could impact on und.	Connectivity between Activity and Receptor	Low	Low	Low	Low	Low	Low	
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low	
	Likelihood	Medium	Low	Low	Low	Low	Low	
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	
	Magnitude of Effect at Receptor	**Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	
e base of Bund F could occur along the spring line at the uifer, which could present a future slope stability risk to	Connectivity between Activity and Receptor	Low	Low	Low	Low	Low	Low	
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low	
	Likelihood	Medium	Low	Low	Low	Low	Low	
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	
	Magnitude of Effect at Receptor	**Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	

		Park Drinking Water	Drinking Water	Drinking Water	Drinking Water	Baseflow	Baseflow
process for the shafts, groundwater ingress could occur ceous rock. Such ingress could inundate the excavation rations.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
hafts below the seal created in the Whitby Mudstone, as ough the Lias Group, groundwater seepage will enter the e of the shaft prior to lining. As the shaft liners through ed, to relieve build up in water pressure, groundwater into the shafts will continue both during construction life of the mine.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
l area of landscape Bund F will cause local reduction of face aquifers.	Connectivity between Activity and Receptor	Medium	High	High	Medium	High	Medium
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Low	Medium	Medium	Low	Medium	Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
e a low permeable cohesive subgrade could cause within the fill over the long term, which could impact on und.	Connectivity between Activity and Receptor	Low	Low	Low	Low	High	Medium
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Low	Low	Low	Low	Medium	Low
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Low**	**Very Low**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
e base of Bund F could occur along the spring line at the uifer, which could present a future slope stability risk to	Connectivity between Activity and Receptor	Low	Low	Low	Low	High	Medium
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Low	Low	Low	Low	Medium	Low
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Low**	**Very Low**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**

		Aquifer	Aquifer	Aquifer	Aquifer	Strata	Aquifer	A
		Shallow aquifer/ Drinking water/ Baseflow	Shallow aquifer/ Drinking water/ Baseflow	Medium depth aquifer/ Drinking water/ Baseflow	Medium depth aquifer	Deep depth aquiclude	Deep depth aquifer/Unused	De aquif
process for the shafts, groundwater ingress could occur ceous rock. Such ingress could inundate the excavation rations.	Connectivity between Activity and Receptor	Very Low	Very Low	Medium	High	Very High	Very High	Ve
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Likelihood	Very Low	Very Low	Low	Medium	Very High	Very High	Ve
	Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
hafts below the seal created in the Whitby Mudstone, as ough the Lias Group, groundwater seepage will enter the e of the shaft prior to lining. As the shaft liners through ed, to relieve build up in water pressure, groundwater into the shafts will continue both during construction life of the mine.	Connectivity between Activity and Receptor	Very Low	Very Low	Medium	High	Very High	Very High	Ve
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Likelihood	Very Low	Very Low	Low	Medium	Very High	Very High	Ve
	Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
l area of landscape Bund F will cause local reduction of face aquifers.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Receptor Proximity to Activity	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Likelihood	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
re a low permeable cohesive subgrade could cause within the fill over the long term, which could impact on und.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Receptor Proximity to Activity	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Likelihood	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
e base of Bund F could occur along the spring line at the uifer, which could present a future slope stability risk to	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Receptor Proximity to Activity	Low	Low	Very Low	Very Low	Very Low	Very Low	Ve
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**

		Dry Heath Area	Heath Area	Dry Heath Area	Spring Flush Area	Area	
		Dry Heath Ecology	Wetland Ecology	Dry Heath Ecology	Wetland Ecology	Dry Heath Ecology	Surface Water
grout losses during targeted grouting.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
grouting operations using cementitious grouts.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
undwater pollution around the shaft excavation may of; hydraulic lubricants from the road header excavation recycled flush water during drilling for grouting.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Low
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
tions may contain residual concentrations of hydraulic nt. Such contamination in the rock arisings could leach F and impact on ground and surface water quality.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Low
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
water runoff from exposed rock arisings in Bund F will rain within the main surface water drainage system that Beck. This discharge could therefore impact on water eck.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Low
	Magnitude of Effect at Source	High	High	High	High	High	High
	Magnitude of Effect at Receptor	**Low**	**Low**	**Very Low**	**Very Low**	**Very Low**	**Low**
	Sensitivity (Value of Resource)	**Low**	**Low**	**Low**	**High**	**Low**	**Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
al and unrestored areas in Bund F that permeates collected by the basal drainage system. This will discharge n the main surface water drainage system that outflows e basal drainage discharge could therefore impact on	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Medium	Low	Very Low	Very Low	Very Low	Low
	Likelihood	Low	Low	Very Low	Very Low	Very Low	Low
	Magnitude of Effect at Source	High	High	High	High	High	High
	Magnitude of Effect at Receptor	**Low**	**Low**	**Very Low**	**Very Low**	**Very Low**	**Low**

		Park					
		Drinking Water	Drinking Water	Drinking Water	Drinking Water	Baseflow	Baseflow
grout losses during targeted grouting.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
grouting operations using cementitious grouts.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	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**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
undwater pollution around the shaft excavation may of; hydraulic lubricants from the road header excavation recycled flush water during drilling for grouting.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
tions may contain residual concentrations of hydraulic nt. Such contamination in the rock arisings could leach F and impact on ground and surface water quality.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
water runoff from exposed rock arisings in Bund F will rain within the main surface water drainage system that Beck. This discharge could therefore impact on water eck.	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	High	High	High	High	High	High
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**
	Sensitivity (Value of Resource)	**High**	**High**	**High**	**High**	**Very Low**	**Very Low**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
al and unrestored areas in Bund F that permeates collected by the basal drainage system. This will discharge n the main surface water drainage system that outflows e basal drainage discharge could therefore impact on	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
	Magnitude of Effect at Source	High	High	High	High	High	High
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**

		Aquifer	Aquifer	Aquifer	Aquifer	Strata	Aquifer	A
		Shallow aquifer/ Drinking water/ Baseflow	Shallow aquifer/ Drinking water/ Baseflow	Medium depth aquifer/ Drinking water/ Baseflow	Medium depth aquifer	Deep depth aquiclude	Deep depth aquifer/Unused	Dee aquif
	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Receptor Proximity to Activity	Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Likelihood	Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
grout losses during targeted grouting.	Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Receptor Proximity to Activity	Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Likelihood	Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
grouting operations using cementitious grouts.	Magnitude of Effect at Source	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Magnitude of Effect at Receptor	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very High	Very High	Ve
	Receptor Proximity to Activity	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
undwater pollution around the shaft excavation may	Likelihood	Low	Very Low	Very Low	Very Low	Medium	Medium	M
of; hydraulic lubricants from the road header excavation	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	
recycled flush water during drilling for grouting.	**Magnitude of Effect at Receptor**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Low**	**Low**	
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
	Receptor Proximity to Activity	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
tions may contain residual concentrations of hydraulic	Likelihood	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
nt. Such contamination in the rock arisings could leach	Magnitude of Effect at Source	Low	Low	Low	Low	Low	Low	
F and impact on ground and surface water quality.	**Magnitude of Effect at Receptor**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
water runoff from exposed rock arisings in Bund F will	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
rain within the main surface water drainage system that	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
Beck. This discharge could therefore impact on water	Magnitude of Effect at Source	High	High	High	High	High	High	
eck.	**Magnitude of Effect at Receptor**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**
	Sensitivity (Value of Resource)	**Medium**	**Medium**	**Medium**	**Medium**	**Very Low**	**Very Low**	**Ve**
	Significance of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Ne**
	Connectivity between Activity and Receptor	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
al and unrestored areas in Bund F that permeates	Receptor Proximity to Activity	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
collected by the basal drainage system. This will discharge	Likelihood	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Ve
n the main surface water drainage system that outflows	Magnitude of Effect at Source	High	High	High	High	High	High	
e basal drainage discharge could therefore impact on	**Magnitude of Effect at Receptor**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Ve**

APPENDIX 4

AMENDMENTS TO PHASE 11 GROUND AND SURFACE WATER TRIGGER VALUES

Table 12 – Control and Compliance Trigger Values for the Scarborough Formation

Contaminant of Concern (as specified by report 40-SMP-GE-7600-CI-RP-00001_1)	Units	Ground Water Quality Control Trigger Value	Ground Water Quality Compliance Trigger Value	Source of Assessment Value
pH	-	4.6 – 7.7	3 – 7.7	Max Baseline
Conductivity	mg/l	2,595	3,460	EQS
Ammoniacal Nitrogen as N	mg/l	1.47 mg/l	2.08 mg/l	Mean + 3 x Standard Deviation
Nitrate as N	mg/l	21.4 mg/l	37.5 mg/l	Mean + 3 x Standard Deviation
Total Petroleum Hydrocarbons	mg/l	0.46	0.94	Max Baseline Value
Visible Oil / Grease	Visual Assessment			N/A
Aluminium	mg/l	0.51	1.10	Max Baseline
Cobalt	mg/l	0.02	0.100	EQS
Manganese	mg/l	1.80	3.60	Max Baseline
Sodium, Dissolved	mg/l	212	290	Max Baseline
Potassium	mg/l	3.50	12.0	UK DWS
Nickel	mg/l	0.033	0.082	Max Baseline
Sulphate	mg/l	63.1	400	EQS
Chloride	mg/l	485	630	Max Baseline
Naphthalene	mg/l	<d.l	0.130	EQS
Fluoranthene	mg/l	<d.l	0.00051	Max Baseline
Benzo(b)fluoranthene	mg/l	<d.l	0.000017	EQS
Benzo(k)fluoranthene	mg/l	<d.l	0.000017	EQS
Benzo(a)pyrene	mg/l	<d.l	0.00027	EQS
Benzo(g,h,i)perylene	mg/l	<d.l	0.0000082	EQS

Table 13 – Control and Compliance Trigger Values for the Cloughton Formation

Contaminant of Concern (as specified by report 40-SMP-GE-7600-CI-RP-00001_1)	Units	Ground Water Quality Control Trigger Value	Ground Water Quality Compliance Trigger Value	Source of Assessment Value
pH	-	5.1 – 7.8	3.7 – 7.9	Max Baseline Range
Conductivity	mg/l	737	2,500	EQS
Ammoniacal Nitrogen as N	mg/l	1.14	1.63	To be determined by pre-commencement monitoring
Nitrate as N	mg/l	18.53	37.5	
Total Petroleum Hydrocarbons	mg/l	0.04	0.07	Max Baseline Value
Visible Oil / Grease	Visual Assessment			Environmental Permit
Aluminium	mg/l	0.80	1.50	Max Baseline
Cobalt	mg/l	0.017	0.100	EQS
Manganese	mg/l	1.62	3.30	Max Baseline
Sodium, Dissolved	mg/l	65.8	200	UK DWS
Potassium	mg/l	7.33	24	Max Baseline
Nickel	mg/l	0.032	0.067	Max Baseline
Sulphate	mg/l	50.4	400	EQS
Chloride	mg/l	171	340	Max Baseline
Naphthalene	mg/l	0.000084	0.13	EQS
Fluoranthene	mg/l	0.00068	0.0013	Max Baseline
Benzo(b)fluoranthene	mg/l	0.00012	0.0001	Max Baseline
Benzo(k)fluoranthene	mg/l	0.000058	0.00004	Max Baseline
Benzo(a)pyrene	mg/l	<d.l	0.00027	EQS
Benzo(g,h,i)perylene	mg/l	0.000041	0.00004	Max Baseline

Table 23 – Surface Water Quality Control and Compliance Trigger Values for Suite D

Contaminant of Concern	Detection Limit	Discharge Water Quality Control Trigger Value	Discharge Water Quality Compliance Trigger Value	Source of Compliance Trigger Value
pH		6.3 – 8.5	5.7– 8.9	Max Baseline Range
Conductivity	1 µS/cm	1,180 µS/cm	2,500 µS/cm	EQS
Turbidity	TBC	25 ftu	50 ftu	Max Baseline Value
Suspended Solids	5 mg/l	25 mg/l	50 mg/l	EQS
Aluminium	mg/l	0.35	0.58	Table 16 Groundwater Activity Permit GWSWMP (Ref. 25)
Cobalt	mg/l	0.0010	0.1	
Manganese	mg/l	0.25	0.29	
Nickel	mg/l	0.0017	0.034	
Potassium	mg/l	5.99	12	
Sodium, Dissolved	mg/l	192	280	
Chloride	mg/l	286	470	
Sulphate	mg/l	66	400	
Naphthalene	mg/l	d.l.(0.00005)	0.13	
Fluoranthene	mg/l	0.000057	0.00012	
Benzo(b)fluoranthene	mg/l	0.000065	0.00014	
Benzo(k)fluoranthene	mg/l	0.000011	0.00002	
Benzo(a)pyrene	mg/l	0.000021	0.00027	
Benzo(g,h,i)perylene	mg/l	0.00016	0.00036	
Note * d.l:- Detection Limit				